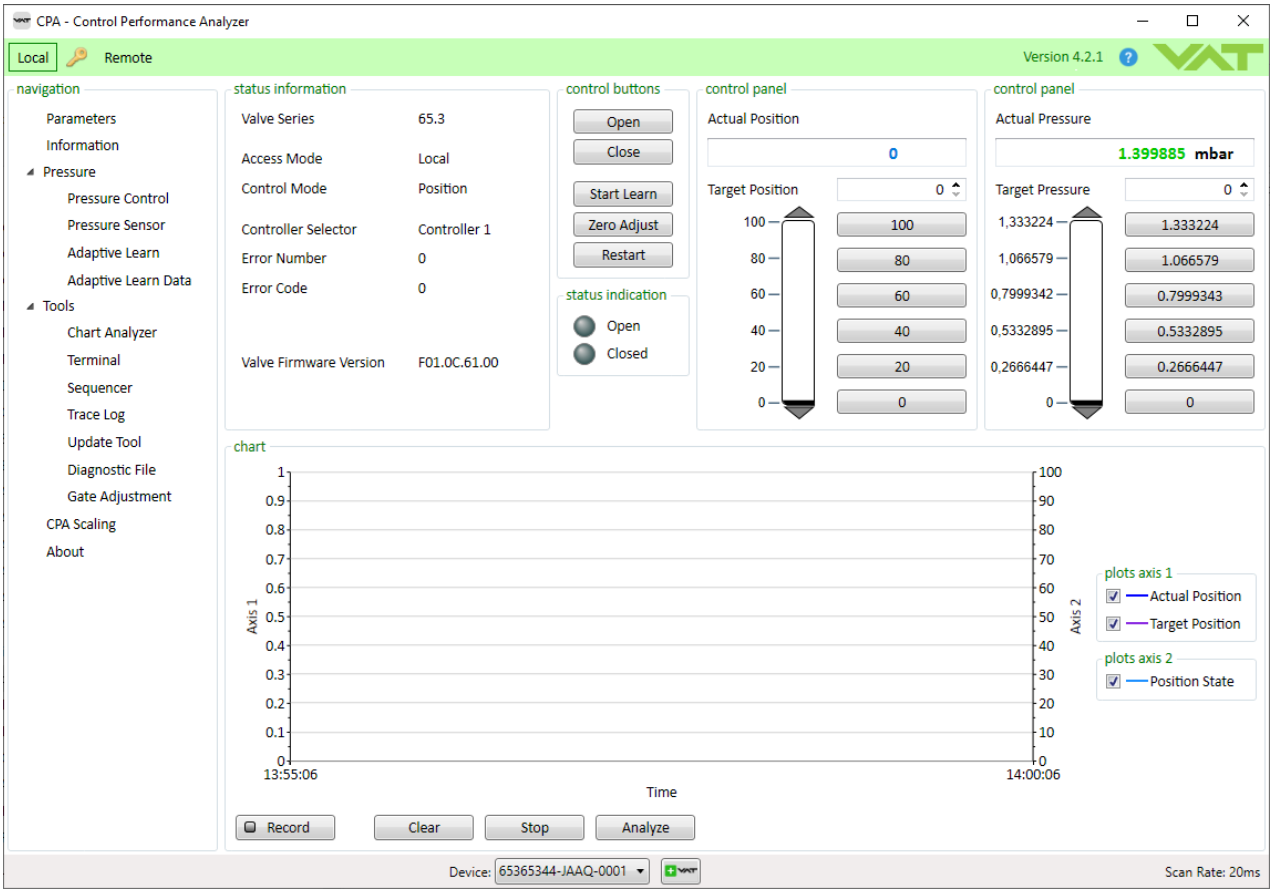
CPA IC2(USB) Manual



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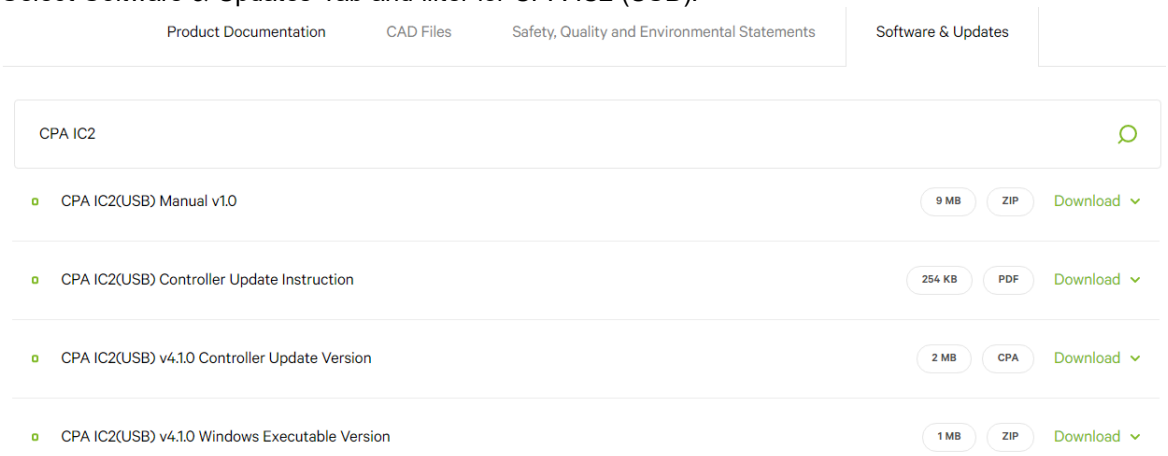
Part I

1 CPA

1.1 General Information

1.1.1 Update

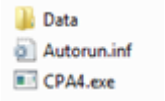
Link for download: Downloads
Select Software & Updates Tab and filter for CPA IC2 (USB).



Here are two types of CPA IC2 (USB) available.

Controller Update Version
Version is to update the CPA software on the valve directly.
See Update Procedure for more details. Load *.cpa version.

Windows Executable Version
Version is to use as a local version on the PC.
- Unzip the downloaded file is necessary.
- Connect the valve with your PC
- Start CPA from the unzipped folder (CPA4.exe)



No installation is necessary for both versions.

1.1.2 Version

In this chapter you will find the different CPA versions listed and the main changes and improvements of each version.

CPA Version 4.2.1

*Online Help (Download link: Downloads, Tab: Software&Updates)
*Improve CPA IC2 (USB) Manual rider (Contents shows only main chapters, Keyword search over whole help)
*About Window (Including Check for Update functionality for CPA IC2 (USB) Manual)
*Gate Adjustment Window (653, guided instruction to center the valve plate)

*Improve long term recording of Trace Log (Save Trace Log data automatically by disconnection)

*Bugfixes:
- Remote Desktop connection issue

CPA Version 4.2.0

*Multivalve (Update, Operating)
*Chart Analyzer improvements (Overlay, Records, Zoom and Cursor Function, with No Limit scan rate no successive equal values)
*Parameters Features (Highlight non-volatile parameters, Export Parameters to Excel includes also parameter description, Autosave option also for Parameters window)
*New Parameter values functions (shows single parameter description when the parameter is selected with the cursor, Copy Function of right parameter window)
*Update Tool (Support Sequencer Files)
*Simplified Adaptive Learn Window
*Improve long term recording of Chart Analyzer and Trace Log (Save Chart Analyzer data automatically by disconnection)
*Extend CPA IC2 (USB) Manual with the extended CPA functionalities as well as with a valve firmware chapter (also available in offline mode)

*Bugfixes:
-Forbid update in Remote Locked
-Now it is sufficient if a newer version than .NET Framework 3.5 is installed

CPA Version 4.1.0

*Pressure Control Window
*Pressure Sensor Window
*Adaptive Learn Window
*Chart Analyzer: separate description for plot axis
*Sequencer & Terminal: Add Commands and Value format option
*General: Permit open multiple Menus
*General: Parameter Window without Value-Refresh
*CPA 4 Manual with Help&Manual
*CPA loadable with .zip format

*Bugfixes:
-CPA crash because of out of memory error
-Chart Analyzer: Record Function activated -> Analyze shows not the whole chart
-Chart Analyzer: Deselect Auto scale Axis Settings -> Max value not correct
-Sequencer: No Limit Lines (old: 1000)
-Update Tool: Problem if attribute is read only
-Update Tool: Header needs also 1 Tab space beetween words if not an internal error occurs
-General: Problem with low screen size without high resolution

CPA Version 4.0.8

*New Update Tool
*Trace Log Tool
*Interface Firmware down-loadable
*Learn data Analyzer Tool
*Many minor improvements

*Bugfix:
-chart display issue

1.1.3 Requirements

- PC or Laptop with windows 7 (or higher)
- USB cable A/B male/male → ***Recommandation***: max. length 5 meters

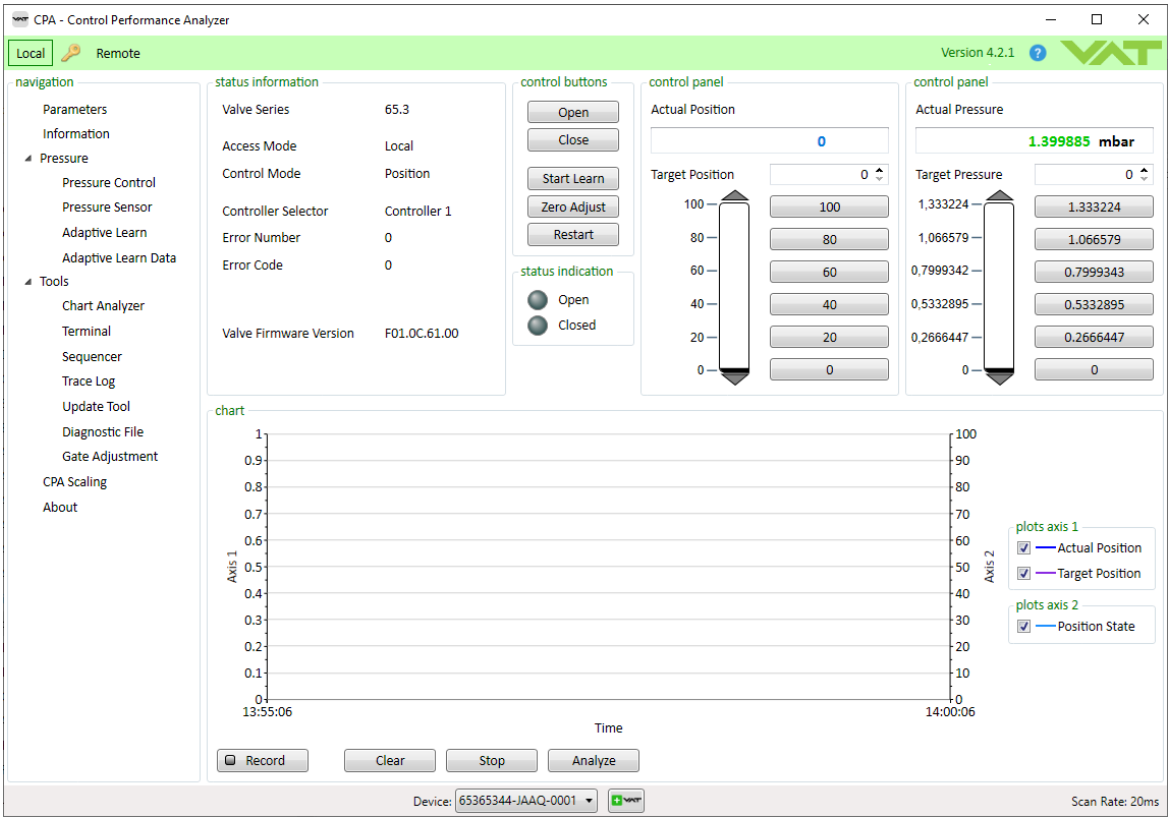
1.1.4 Multivalve

Since the CPA v4.2.0
CPA supports to connect more than one Valve to the PC.
This means the user can ether open for every connected Valve a separate CPA window or open once the CPA and than, switch between the connected Valves in one CPA window to do any local operations or Updates.

Recommandations:
-maximum of Valve 4

1. Switch between the Valves in one CPA window

- as you can see in the CPA version(picture bellow), is in the Status-bar the actual Serial Number of the connected Valve displayed.
- if there is more than one Valve connected to your PC, it will be able to Select the other Valve under the Status-bar (Drop-down)
- after that the CPA window will show you all the Parameters and information of the selected Valve.



2. Separate CPA window for each Valve

- If there are e.g. 3 Valves connected to your PC (via USB) then open 3 times CPA, so you will see in each CPA window the Parameters and information of one of these 3 Valves. If already a CPA instance is open than is possible to start a second one by pressing the plus button.
- In this case you will not have an Drop-down-Menu in the Status-bar to switch between the Valves.
  → In the Status bar will only be the Serial number of the actual Valve displayed.

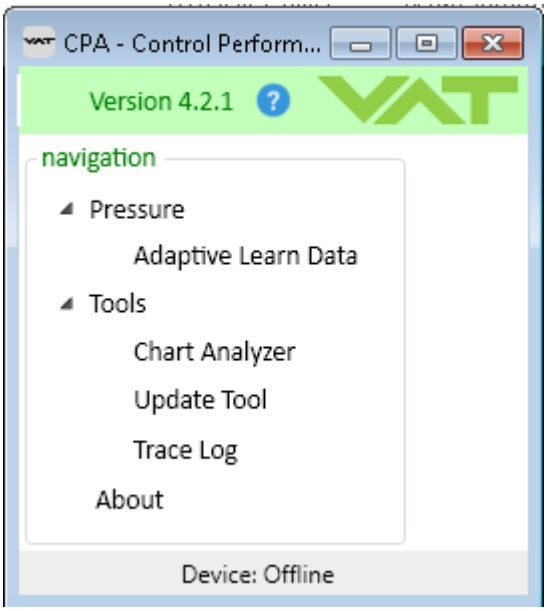
3. Updates via Multivalve

Attention: The Update with Multivalve is only supported for newer Firmware Versions (not older than 26.04.2020) and Valves with a official Serial Number!

→ See Chapter Update Procedure

1.1.5 Offline

This window can be opened by selecting Offline CPA if no USB communication is available.



Adaptive Learn Data
- Adaptive Learn Data
- Load from Valve and Save to Valve functionality are not available in Offline Mode.

Chart Analyzer
- Chart Analyzer
- Open recorded data file first.

Update Tool
- Update Procedure for general use.
- Trouble shooting for recovering an update issue.

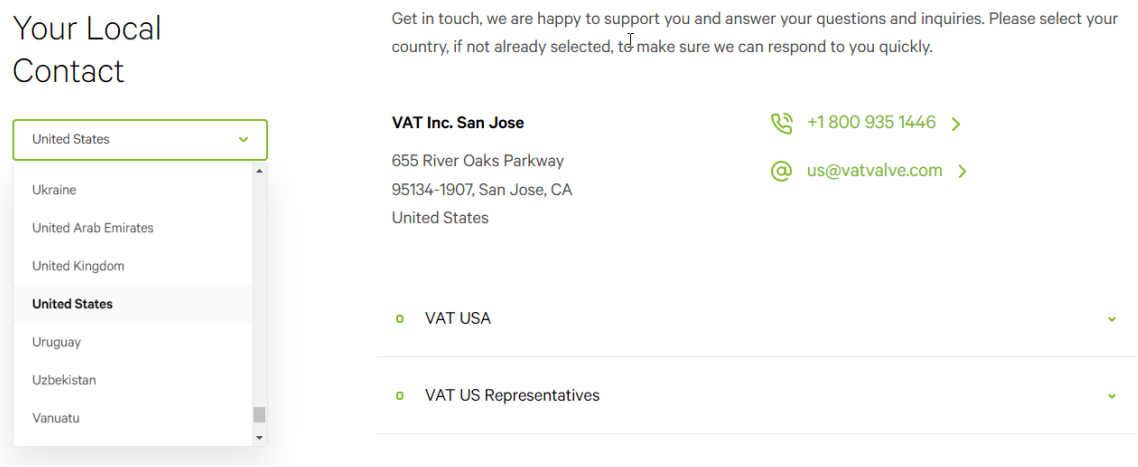
Trace Log
- Interface Trace
- Load Error Data
- System Trace

About
- About
- Update CPA IC2(USB) Manual

1.1.6 Trouble shooting

In case of a CPA failure following data are welcome:
- Failure description
- Print Screen of failure message
- Error text file (located under C:\Users\(Username)\AppData\Roaming\VAT\CPA; Necessary to enable hidden folder option)

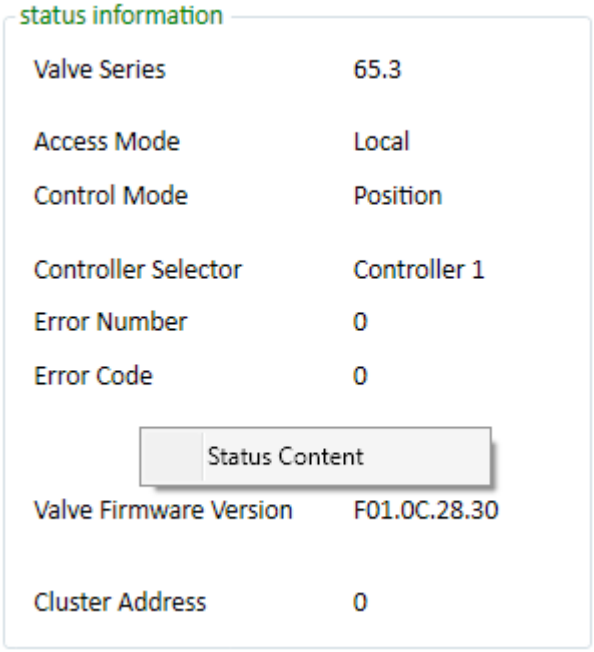
Please provide this information to your local contact Contact.



1.2 Main Window

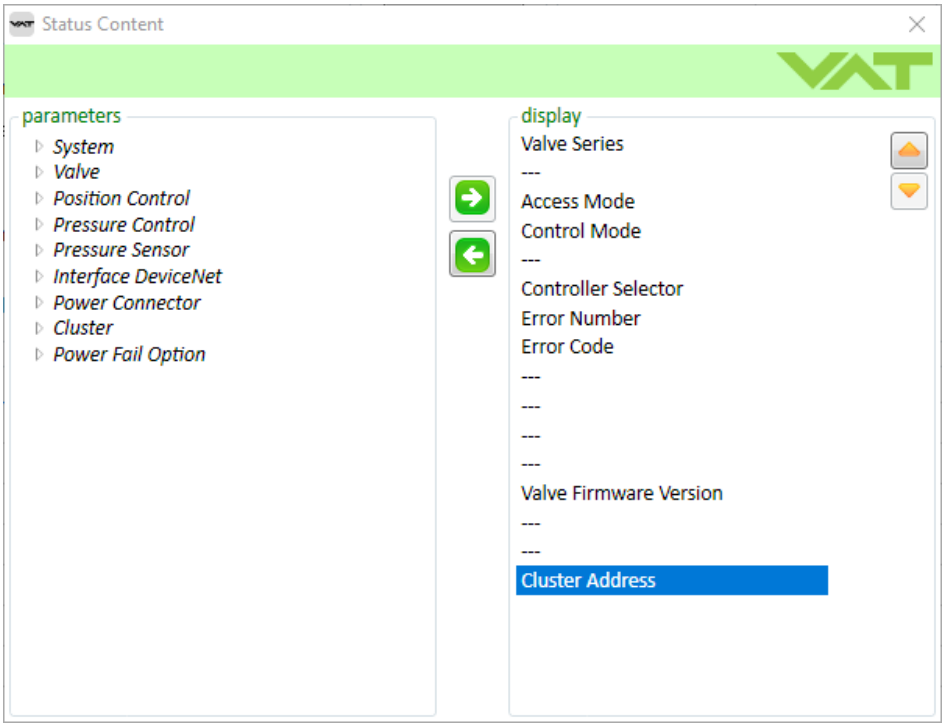
1.2.1 Status Information

This part of the main window shows current defined parameter values.



Right Click Menu

- Define status content

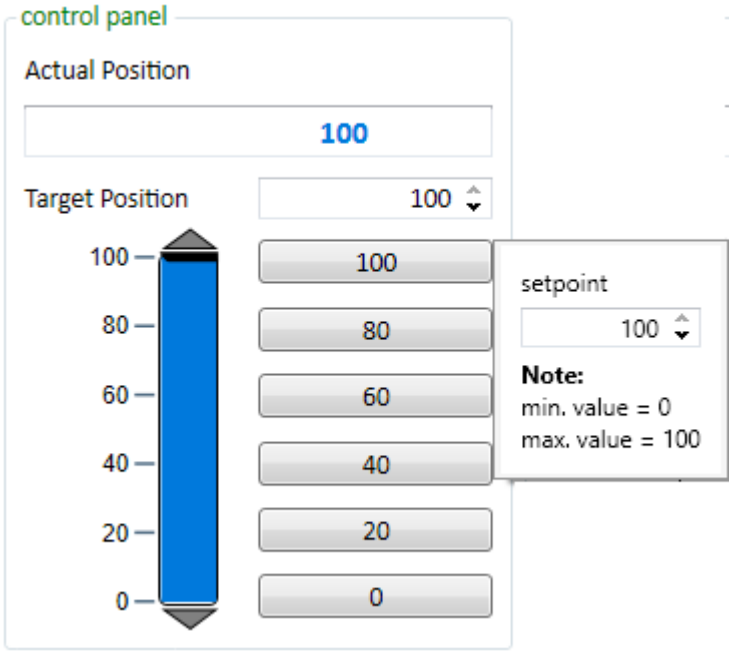


- Use right arrow to include selected parameter from the left parameters tree into the selected display area.
- Use left arrow to eliminate the selected parameter from the display area.
- Status content window allowed's to modify the parameter name.

1.2.2 Control Panel

Position

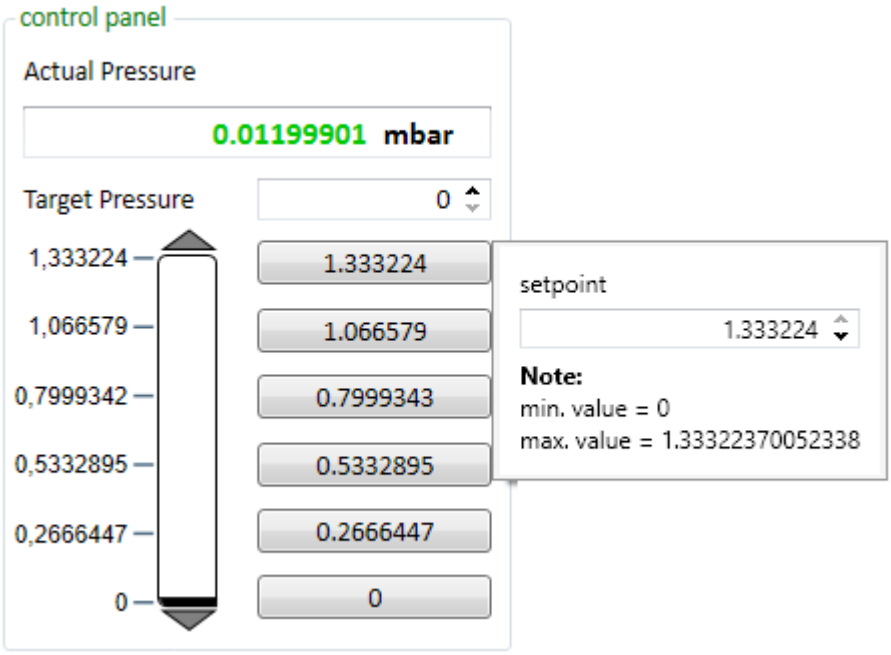
- Switch Control ***Mode*** to *Position* and define ***Target Position***.



- Right click on button value for value definition.

Pressure

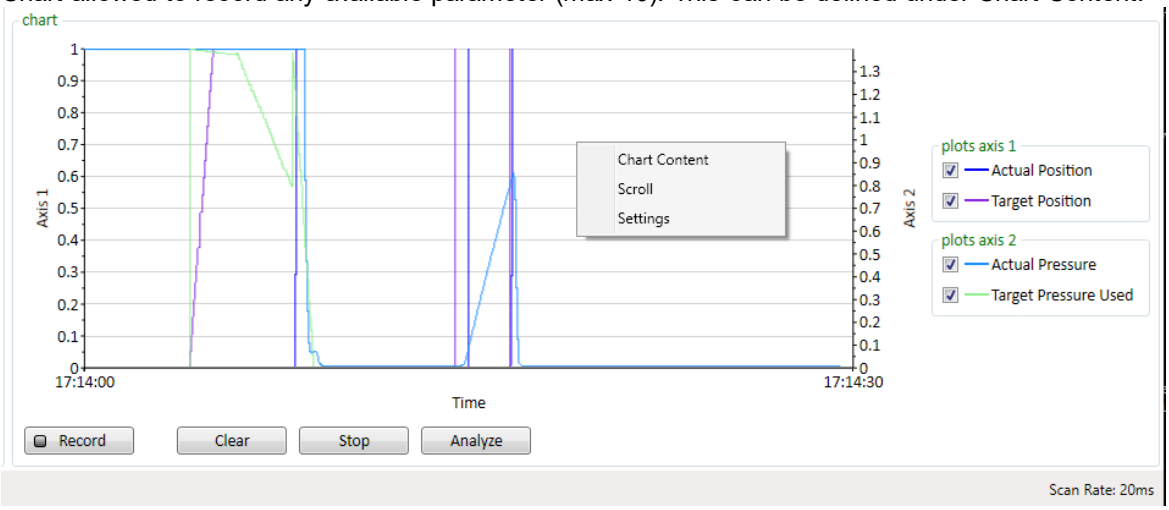
- Only visible if the valve supports pressure control.
- Switch Control ***Mode*** to *Pressure Control* and define ***Target Pressure***.



- Right click on button value for value definition.

1.2.3 Chart

Chart allowed to record any available parameter (max 10). This can be defined under Chart Content.



Right Click Menu

- Chart Content
- Scroll: Steady advance of the data display.
- Settings

Plots Axis 1, Plots Axis 2

- Option to hide parameter signal in the chart (if disabled this parameter is still recorded)

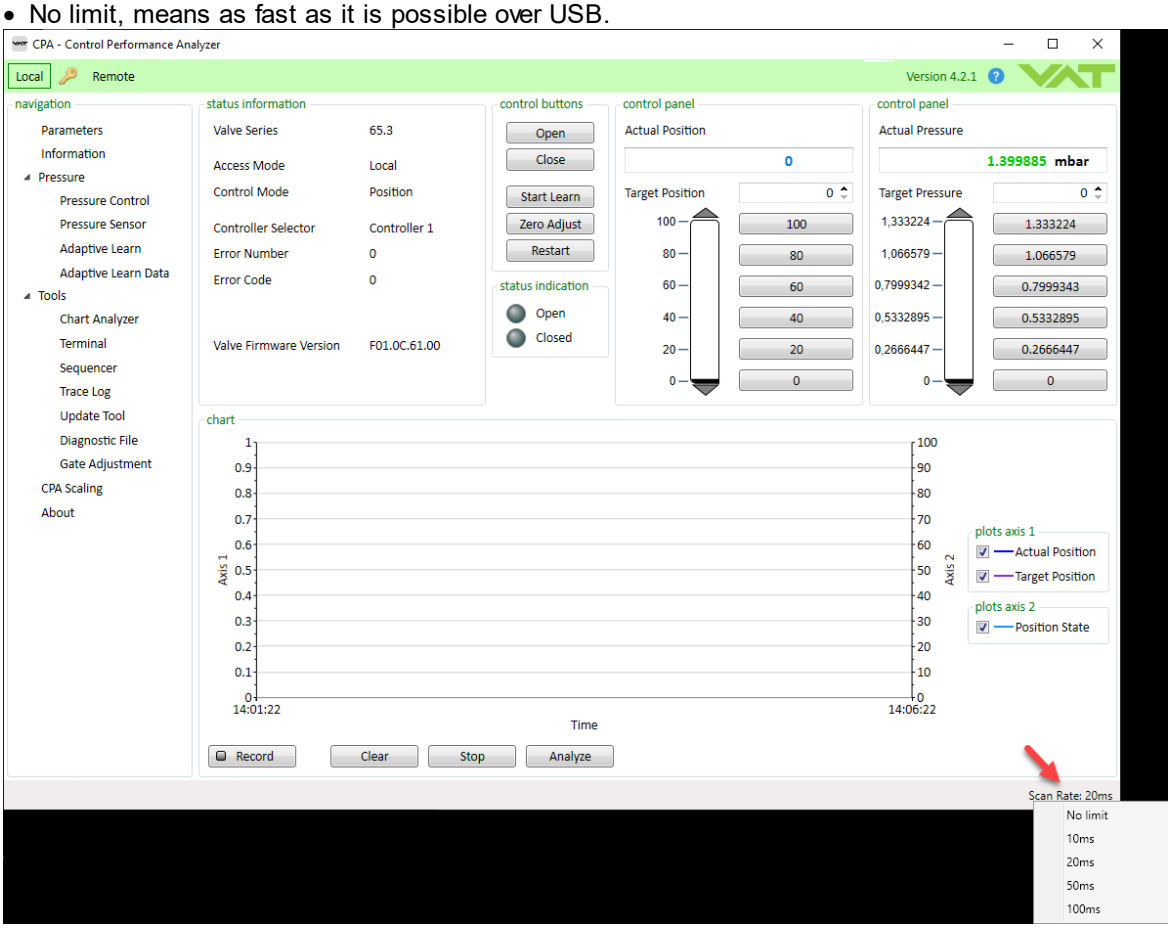
Record
- Start and stop of the recording.
- For more information see Record.

Clear
- Delete the actual chart data
- An active record is not interrupted by clear chart

Stop
- Stop the actual chart data
- Stop button change the function to "Start"
- An active record is not interrupted by clear chart

Analyze
- Opens the Chart Analyzer with the current chart data for deeper analyze.
- For more information see Chart Analyzer.

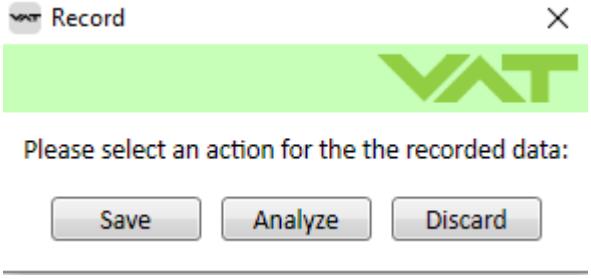
Scan Rate
- right click on "Scan Rate" at the right bottom corner and select the desired scan rate.
- No limit, means as fast as it is possible over USB.



1.2.3.1 Record

Recommandations:
- For long term recordings we recommend to use CPA version from 4.2.0, cause the Data saving process is improved.

Procedure
- By pressing Record button the recording is starting and in addition the green light is visible.
- It the Record button is selected again than following options are available:



Save
- Opens the save dialog for saving the recording data in a texfile.
- This text file can be used later in Chart Analyzer for deeper analysis.
- Default text file name includes ***Serial Number***, date, time and text "ChartData".

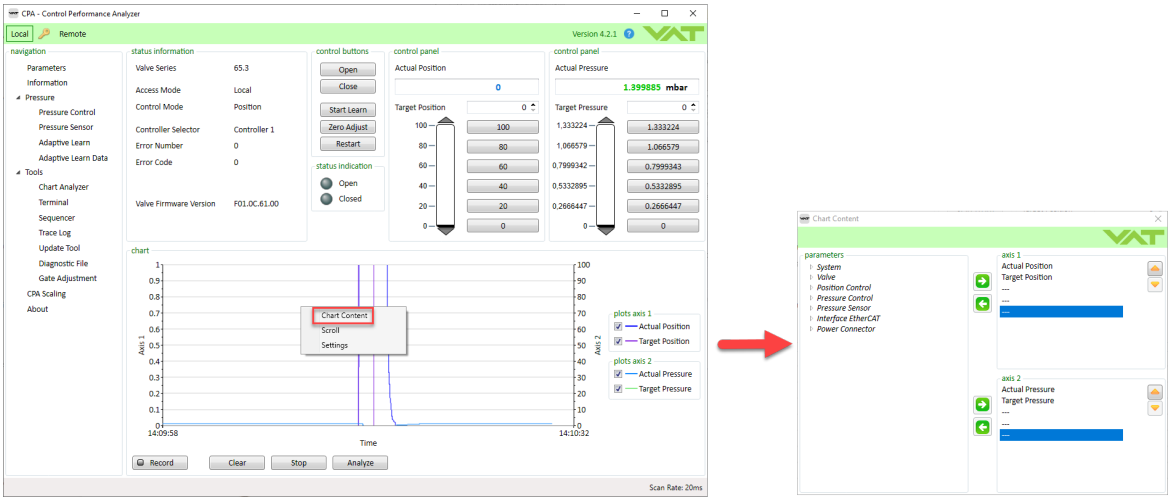
Analyze
- Show the recorded data in the Chart Analyzer window.
- Their is also the possibility to save the recorded data.

Discard
- The recorded data are discarded.

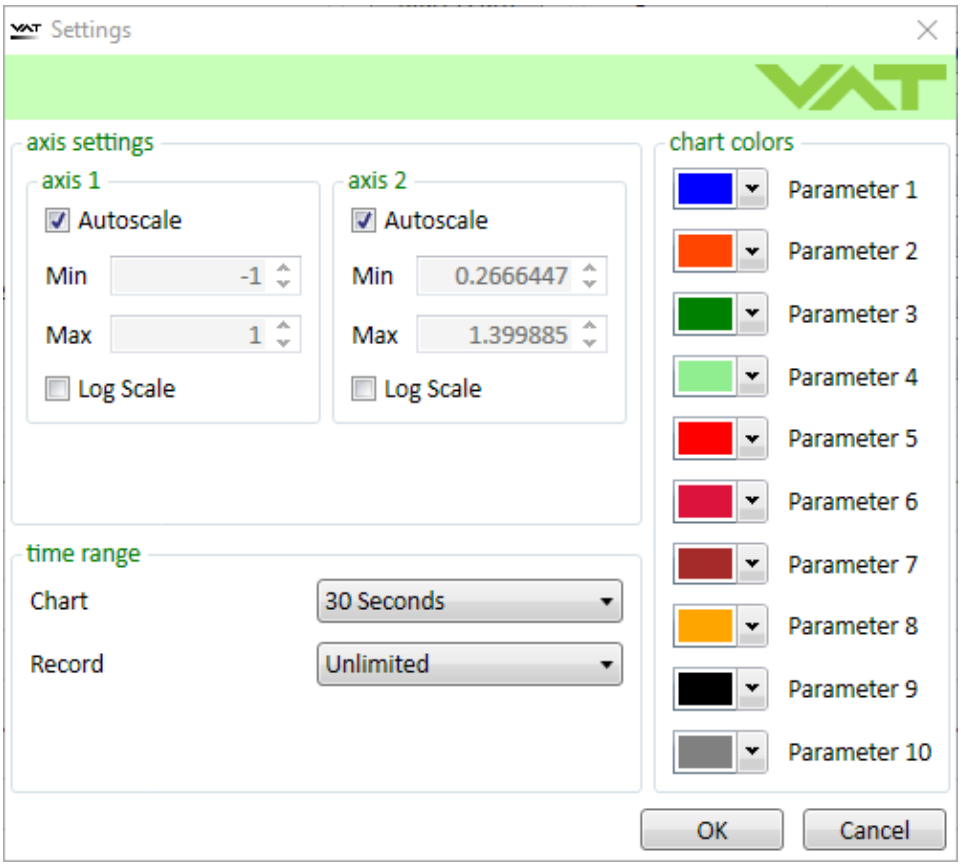
Note
- In case that chart record is running and a restart or power cycle of the controller happens, the user will be prompted to decide either to save the lastly recorded data or discard it.
- To change the Chart contents see Chart Content.
- Record start, stop commands are available in Sequencer (see Sequencer Commands)
- Duration of the recording can be defined under Settings.Time Range.Record.

1.2.3.2 Chart Content

Change the Parameters under Plots Axis 1, Plots Axis 2
- Right click on the Chart in the CPA window, and select the option "Chart Contents".
- A second window will pop-up and show the Parameter-Tree, here it is possible with the arrows in the middle area to add the desired Parameters to the Chart Content.



1.2.3.3 Settings



Axis Settings

Axes range: every axis range (Axis 1, Axis 2) can be defined individually

Autoscale → the Chart will automatically adapt the scaling depending on the recorded data.

Manual scaling → the User can set min and max values for individual axis

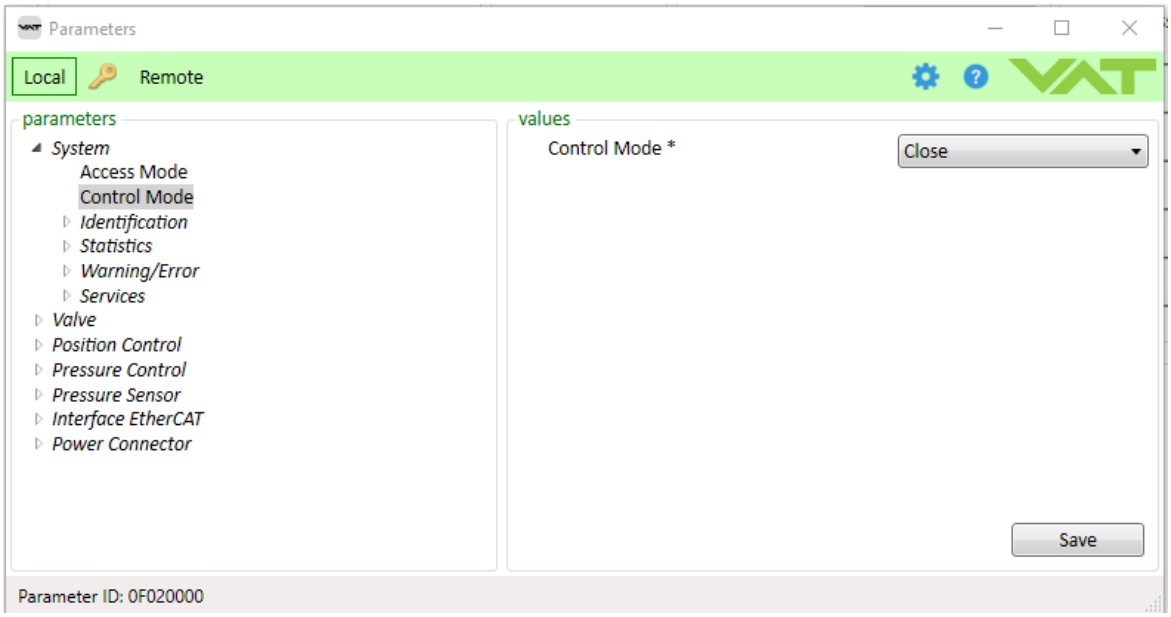
Log scale → the Chart will show the axis in logarithmic format

Time Range
Chart defines the maximum duration of the showed data in the main window chart.
Record defines the duration of the recording. 1 hours means that only the last hour of the measurement is saved.

Chart Colors
In the field chart colors, it is possible to change the chart color of individual parameters(Auto save).

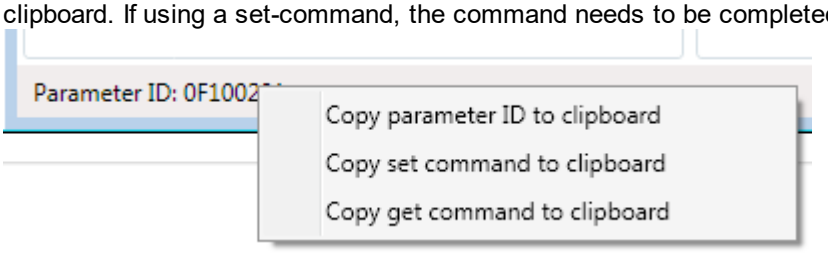
1.3 Parameters

This menu shows all customer settings.



* character after the parameter name means that this value has not yet been saved.

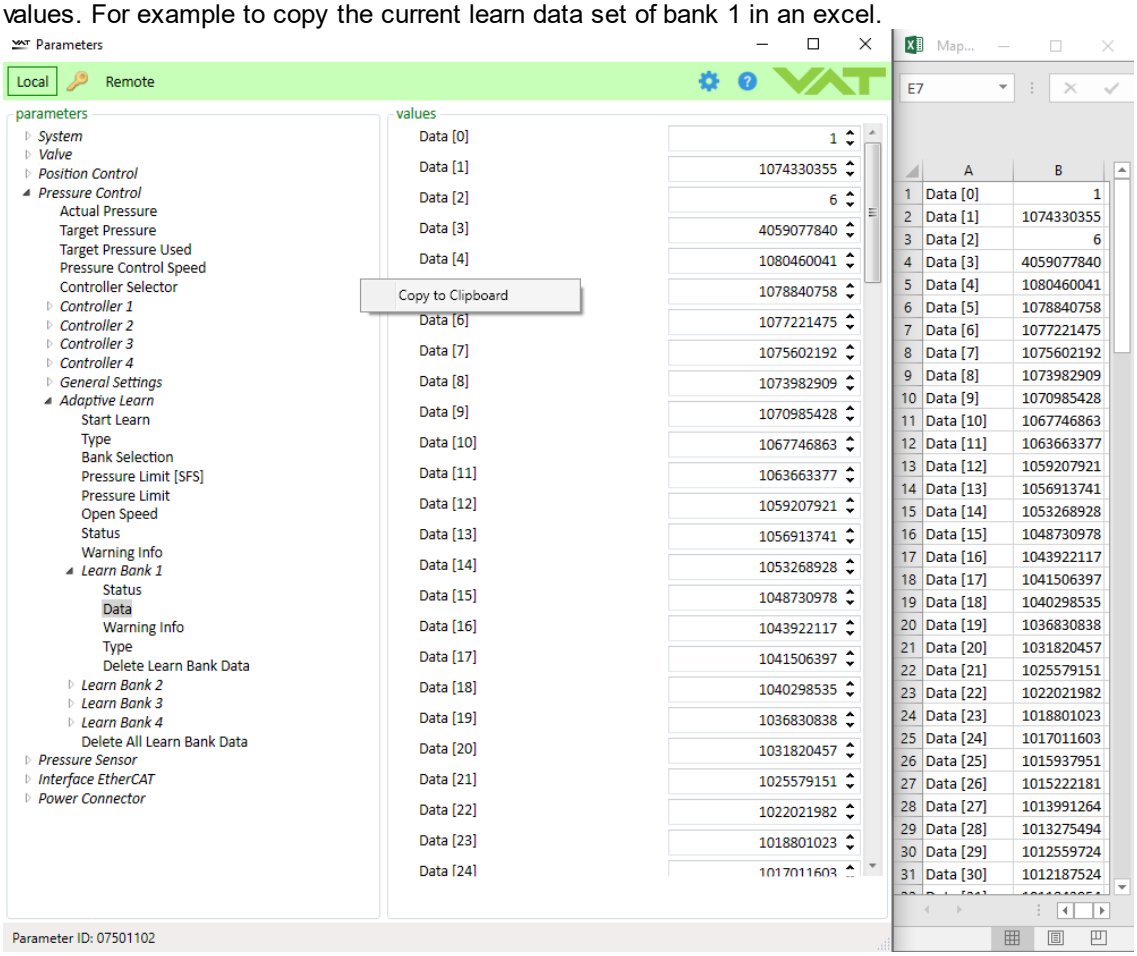
Parameter ID
The supported parameters is depending on the specific firmware version and the used hardware. This list of visible parameter can be exported by the CPA4 program directly. Please see chapter Export Parameters to Excel.
The parameter ID of a selected parameter is visible on the bottom of the parameter window.
By using right-click on the parameter ID, the corresponding command (Set or Get) is copied to the clipboard. If using a set-command, the command needs to be completed by the new value.



See Services for special parameter functionality.

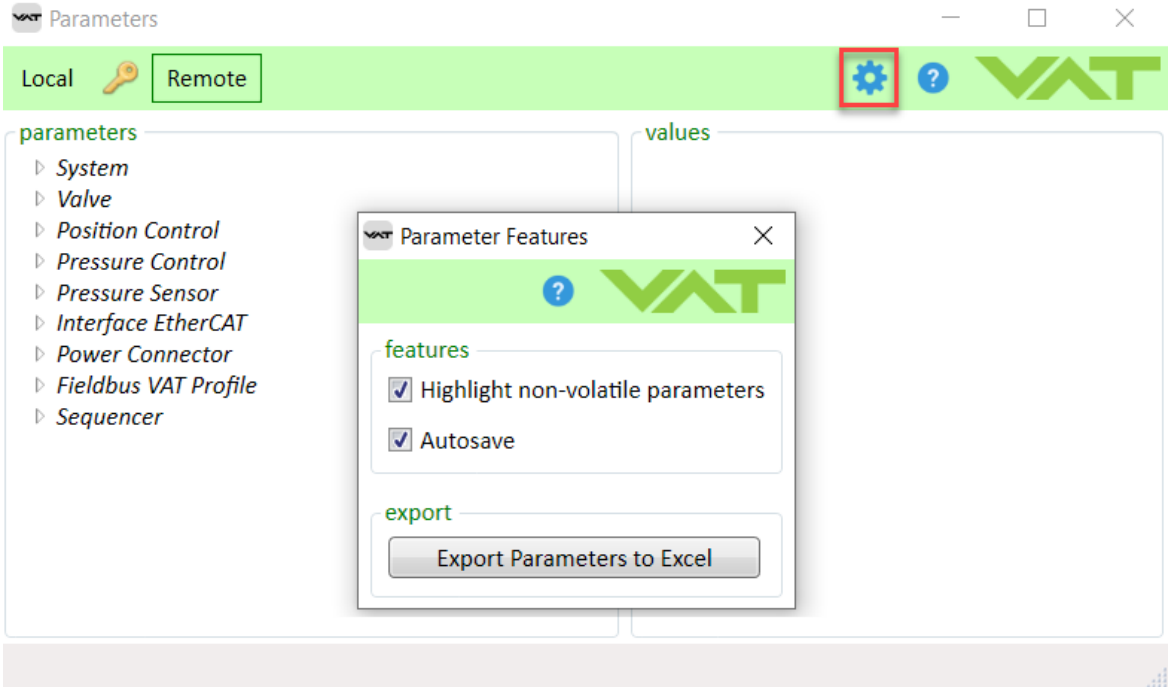
Copy to Clipboard with right click in values window

With this feature all parameters are copied to clipboard, which are visible on the right side under values. For example to copy the current learn data set of bank 1 in an excel.

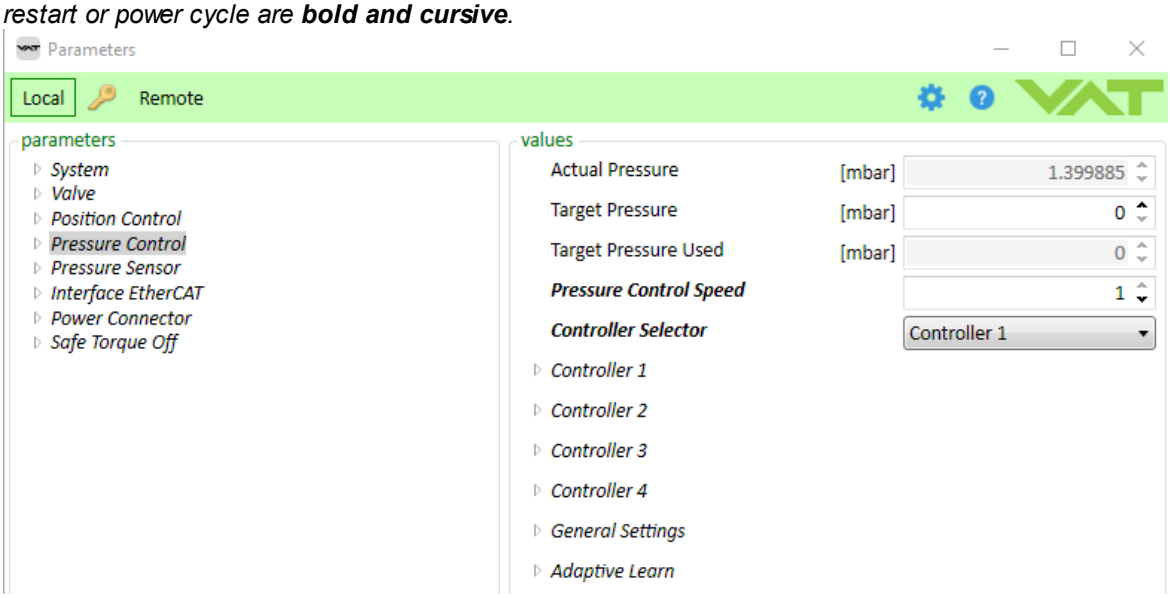


1.3.1 Features

Since the CPA v4.2.0
- Accessible over the "Gearwheel" symbol (red marked) in the picture bellow.
- Features setting are active after closing the window.



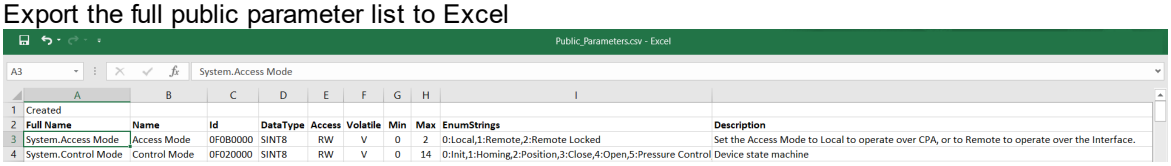
Highlight non-volatile parameters
Parameter *which are saved in non-volatile memory and therefore not loose their actual value after restart or power cycle are* ***bold and cursive***.



Autosave
Drop-down values are saved immediately when changed. Numerical values are saved either by

leaving the field or by pressing the Enter key or the Save button.
Without Autosave, all value changes in the Parameter window are saved with the Save button or by pressing Enter.
Note: Most CPA windows (e.g. Pressure Control or Pressure Sensor window) works in Autosave mode (no adjustable).

Export Parameters to Excel
Export the full public parameter list to Excel



	A	B	C	D	E	F	G	H	I	
1	Created									
2	**Full Name**	**Name**	**Id**	**DataType**	**Access**	**Volatile**	**Min**	**Max**	**EnumStrings**	**Description**
3	System.Access Mode	Access Mode	0F0B0000	SINT8	RW	V	0	2	0:Local,1:Remote,2:Remote Locked	Set the Access Mode to Local to operate over CPA, or to Remote to operate over the Interface.
4	System.Control Mode	Control Mode	0F020000	SINT8	RW	V	0	14	0:Init,1:Homing,2:Position,3:Close,4:Open,5:Pressure Control	Device state machine

1.4 Pressure

All this windows under Pressure are only visible if the controller hardware support pressure control with an pressure sensor input or EtherCAT interface.

1.4.1 Pressure Control

This window show all pressure controller specific settings. For more information about the functionality of the single parameter see Pressure Controller.

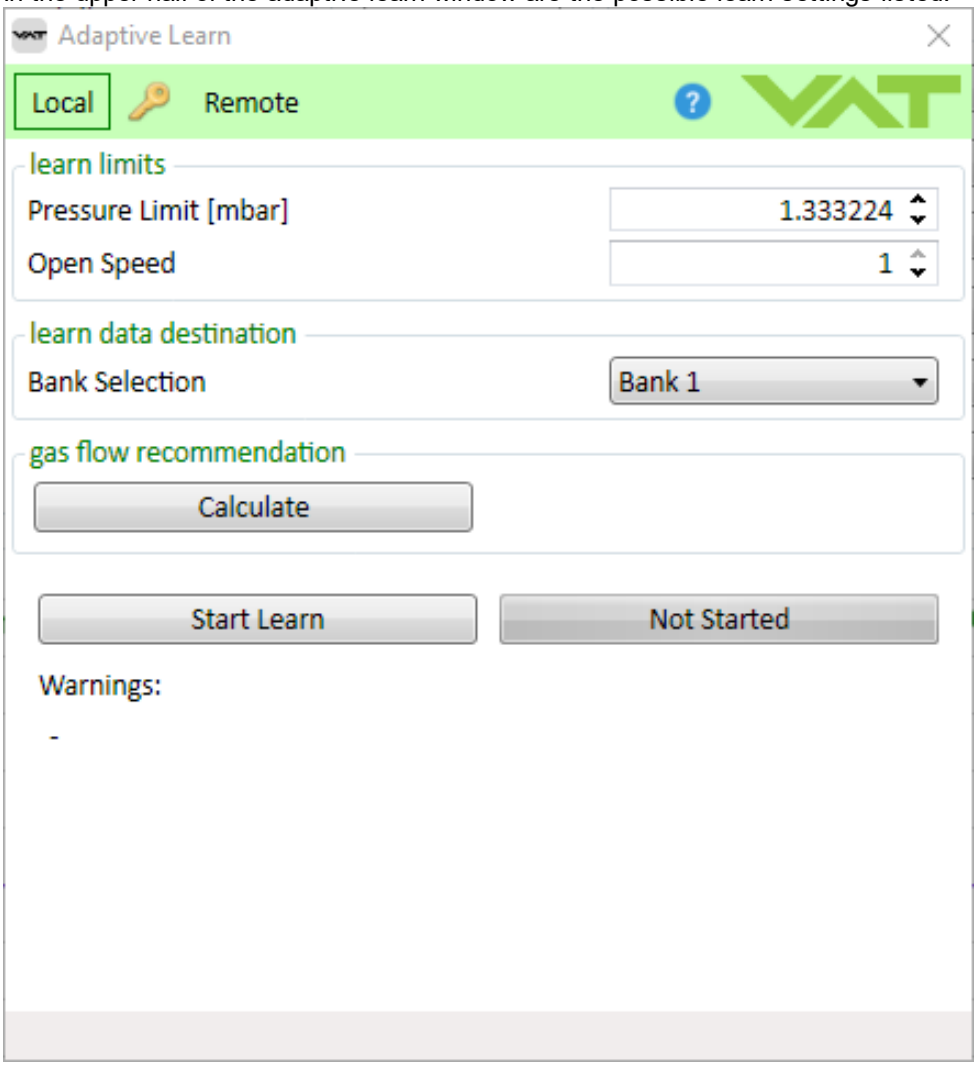
1.4.2 Pressure Sensor

This window shows all sensor relevant parameters for an easy set up. For more information of each setting see Configuration.

1.4.3 Adaptive Learn

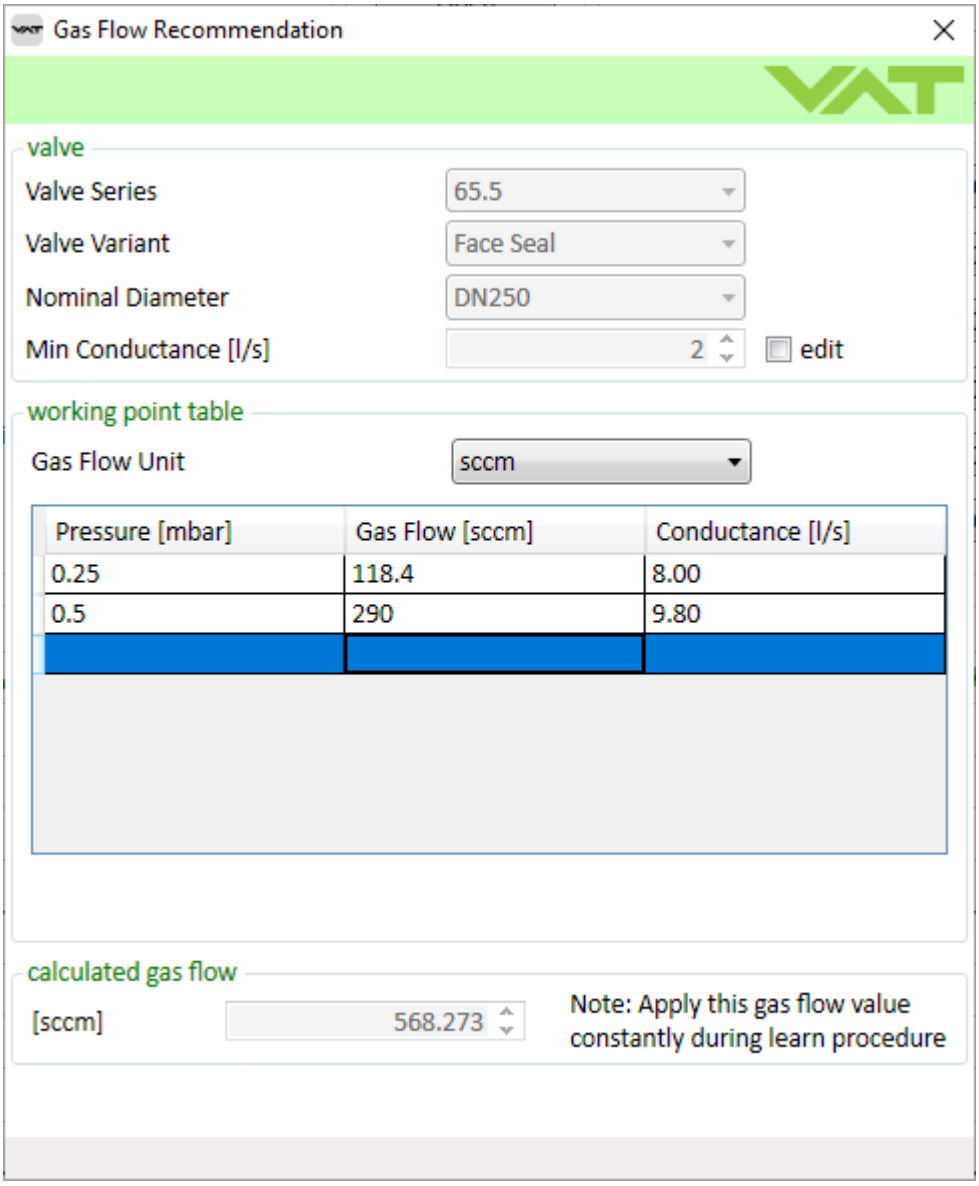
Learn is required for adaptive control algorithm. For further information see Learn.

In the upper half of the adaptive learn window are the possible learn settings listed.



Pressure Limit defines the maximum pressure which during the learn shall be executed. Standard value is sensor full scale. Reduce this value in case of the sensor full scale cannot or should not be reached.
Open Speed defines the speed for opening the valve during learn procedure between position 0% and 50%. Used to protect the pump from excessive gas flow. 1 means full speed.
Bank Selection defines where the learn data is saved after successfully execution. It exist four different learn bank which can be defined in each single pressure controller if the ***Control Algorithm*** is *adaptive*.

Gas flow recommendation
This tool helps to find a propper learn gas flow.
This window can be opened with Calculate button.



Working point table
By filling in the work point table the learning time can be reduced, only the valve positions that are needed for these work points will be learned.
For the calculation of the recommended gas flow the resulted lowest conductance value of the working point table will be considered. All conductance values which fall below the minimum valve conductance limit are ignored for this calculation (Warning).
Is the working point table empty than recommended gas flow is calculated using the ***Pressure Limit*** and the ***Min Conductance [l/s]*** (Value is saved in firmware and can be adjusted by using edit check box).
For more information regarding learn flow calculation see Gasflow calculation for Learn.
The Pressure unit of the working point table can be adjusted under Scaling.

Start Learn
Learn procedure starts by pressing Start Learn button. On the right side the progress bar shows the learn state. Is now the learn ongoing than the learn can be terminate with the Terminate Learn

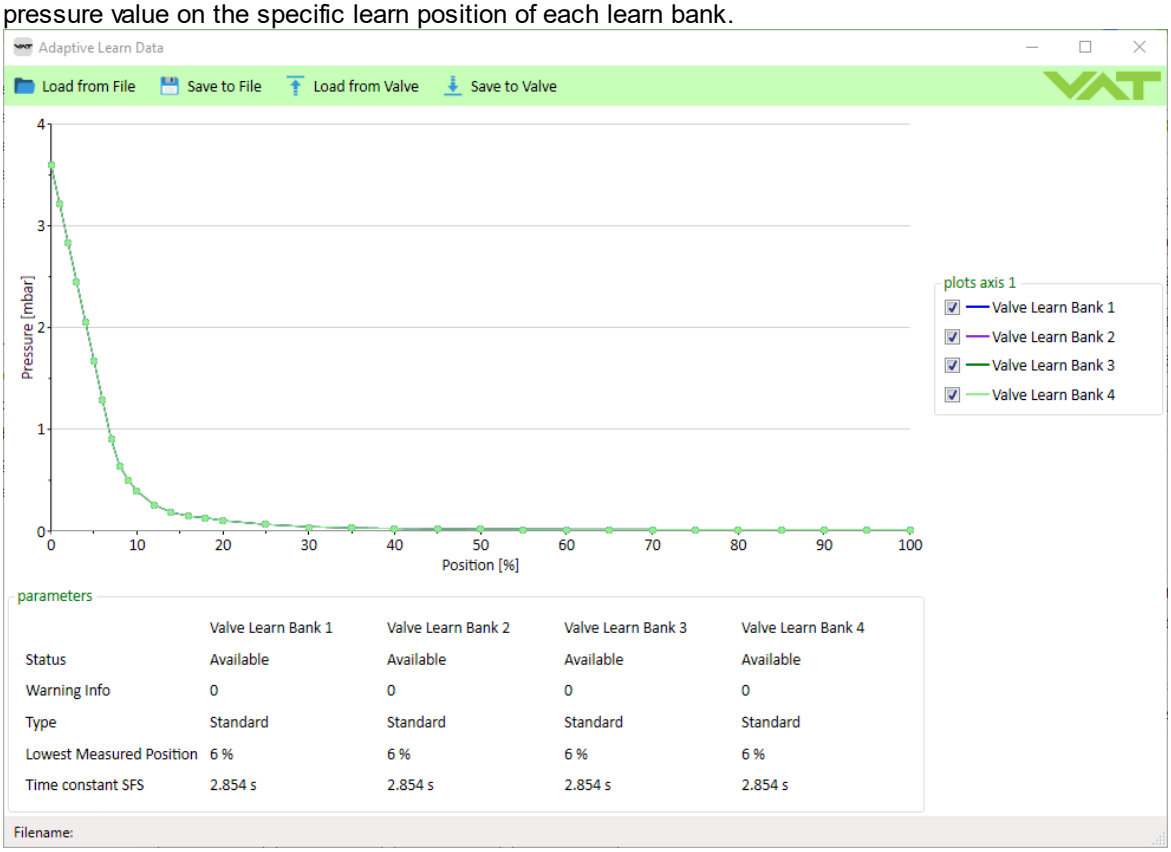
button. .

Warnings
Shows the occurred warnings during the learn procedure.
For possible learn warnings see Learn Warnings.

For more information about single learn steps see Execute a learn procedure.

1.4.4 Adaptive Learn Data

Adaptive Learn Data window supports different learn data functionality. It shows the saved actual pressure value on the specific learn position of each learn bank.



	Valve Learn Bank 1	Valve Learn Bank 2	Valve Learn Bank 3	Valve Learn Bank 4
Status	Available	Available	Available	Available
Warning Info	0	0	0	0
Type	Standard	Standard	Standard	Standard
Lowest Measured Position	6 %	6 %	6 %	6 %
Time constant SFS	2.854 s	2.854 s	2.854 s	2.854 s

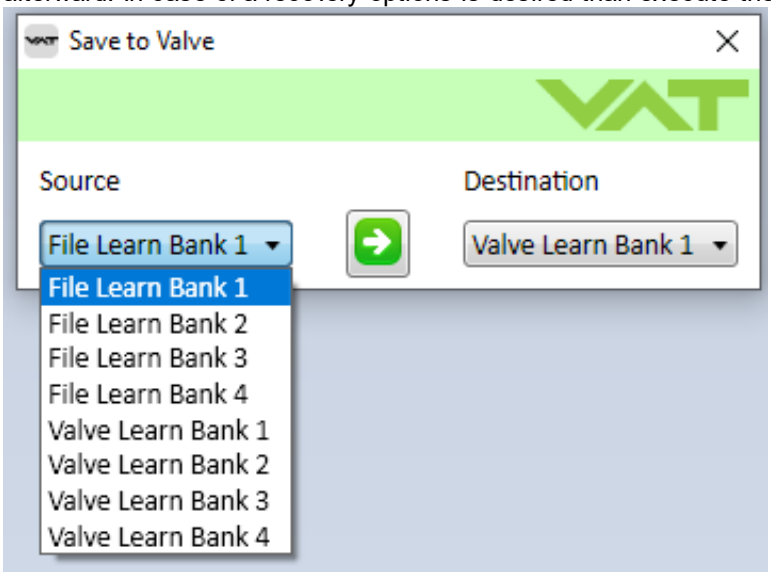
Per default the graph shows the current learn data information of the connected controller. Pressure unit of the y-axis can be adapted here Scaling.

Load from File
This function load the learn bank information and show it in the graph. It's possible to load the learn data directly from diagnose file as well as single learn bank information which previous saved by Save to File option.
If a file content is loaded than the Filename shows the file path.

Save to File
Learn Data information which is showed in the graph will be exported. This file can be loaded later again with the Load from File option in case of the file format is not changed.

Load from Valve
Chart data information will be updated with the connected controller learn data. This options is required if previously the Load from File option is executed and now the connected controller learn data should be displayed again.

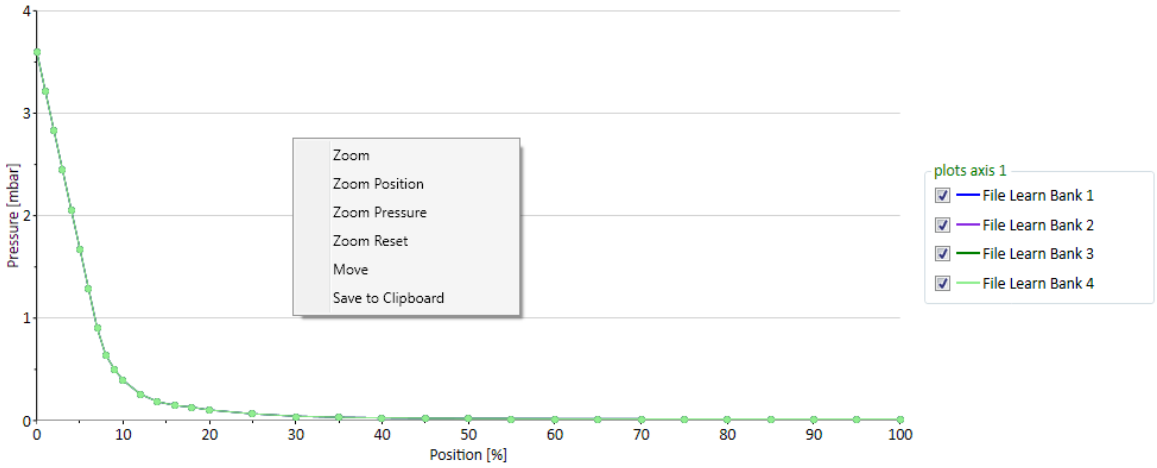
Save to Valve
Transfer single learn bank loaded from file or from connected controller to a defined learn bank on the controller. Be aware that the original learn data bank information on the connected controller are lost afterward. In case of a recovery options is desired than execute the Save to File option before.



Transferring Learn Data
- If no learn data information are available than either execute a learn procedure see Adaptive Learn or use Load from File option
- Execute Save to File option with the default csv file format.
- Connect different controller on which the learn data want to be transferred. Open Adaptive Learn Data window and execute Load from File option. Select the File which is created by Save to File option one step before.
- Execute Save to Valve option as last step

1.4.4.1 Chart Settings

Adaptive Learn Data graph options are selectable after right click into the graph area.

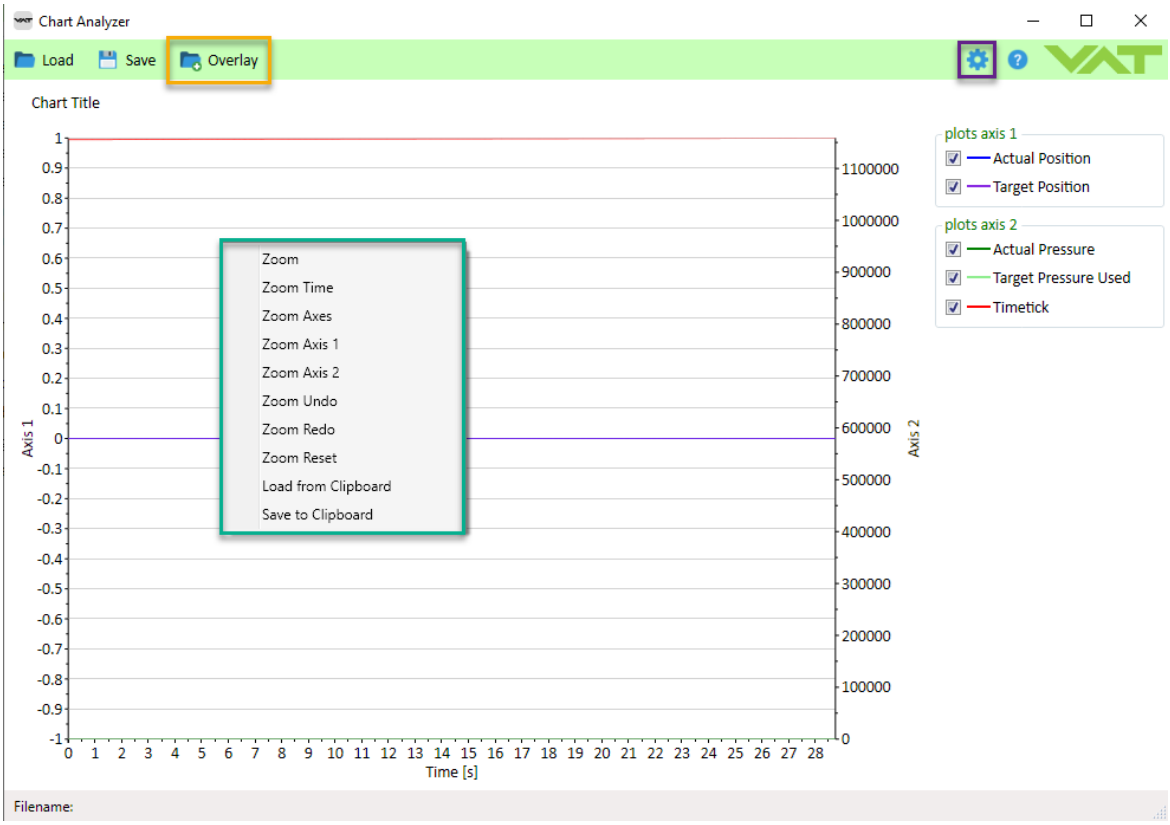


Function	Description
Zoom	Zoom in position and pressure axis
Zoom Position	Zoom in position axis
Zoom Pressure	Zoom in pressure axis
Zoom Reset	Reset the zoom in/out
Move	After zooming in desired area the move functionality is available Click and hold the mouse cursor to move the graph in position/pressure direction
Save to Clipboard	Allowed to copy learn position and pressure information in textfile or excel

1.5 Tools

1.5.1 Chart Analyzer

This window can be open in the navigation as well with Analyze button in the chart.



Load

- Previous saved chart data can be loaded again for deeper analysis.

Save

- Currently chart data is saved in a text file format.
- This file includes also the range information and the chart content.
- Note: Disabled signal are not stored in the text file.

Overlay

- Allows to compare two measurement in the same graphic.
- For further details see Overlay Function.

Right Click Menu

- Zoom
- Load from Clipboard: Update chart from clipboard.
- Save to Clipboard: Same functionality as Save button but the chart data are saved to the clipboard.

"Gearwheel"

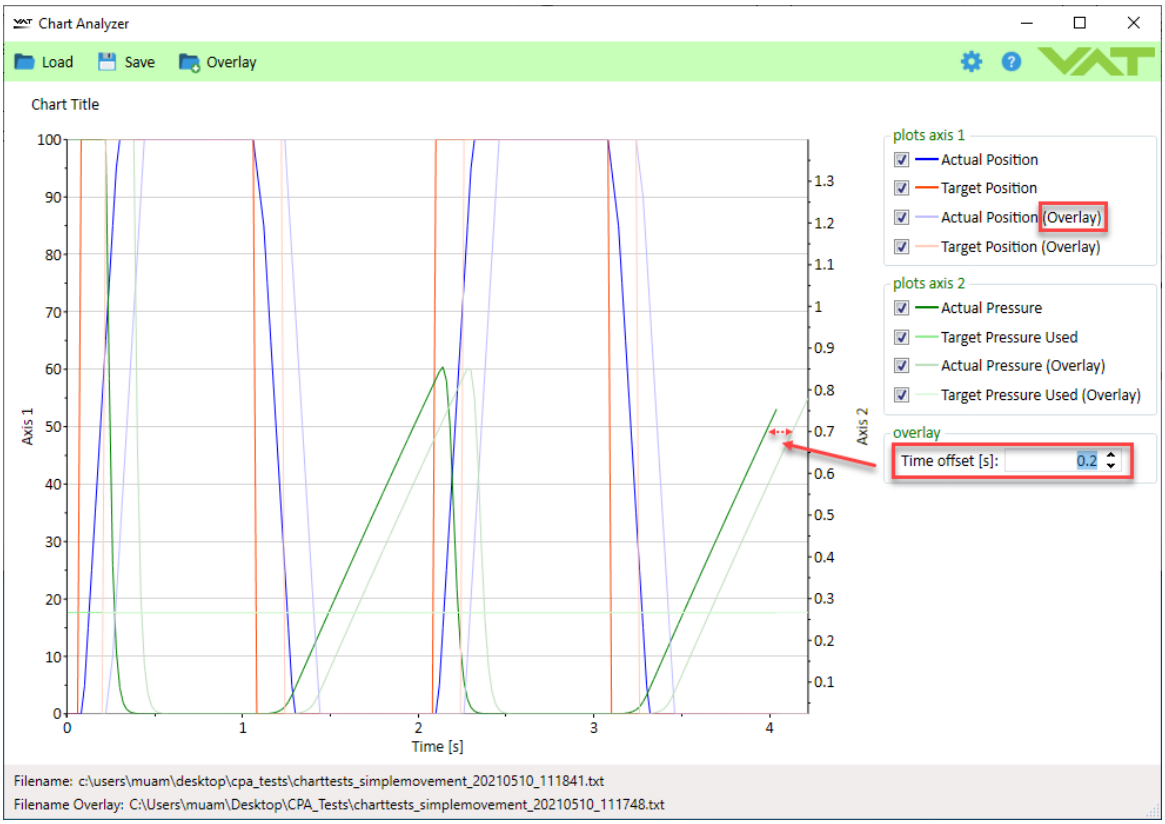
- Chart Settings

1.5.1.1 Overlay Function

Since the CPA 4.2.0 version it is possible to Load two recordings in one Chart.
So the User have the advantage to compare to graphs easier and faster with the Overlay Function.

Load a second recording

- Press the Button "Overlay" and add the desired recording File(*.txt)
- In the status bar it will show you the Filename and directory of the Data Files.
- The overlayed Parameters are marked with "(Overlay)".
- Possible to shift the overlayed graph (Time Axis) → "Time Offset". The Unit of the Time Offset is in seconds.
- With the Button "Save" - It is possible to save the overlayed data and the recorded data in one File.



1.5.1.2 Zoom Function

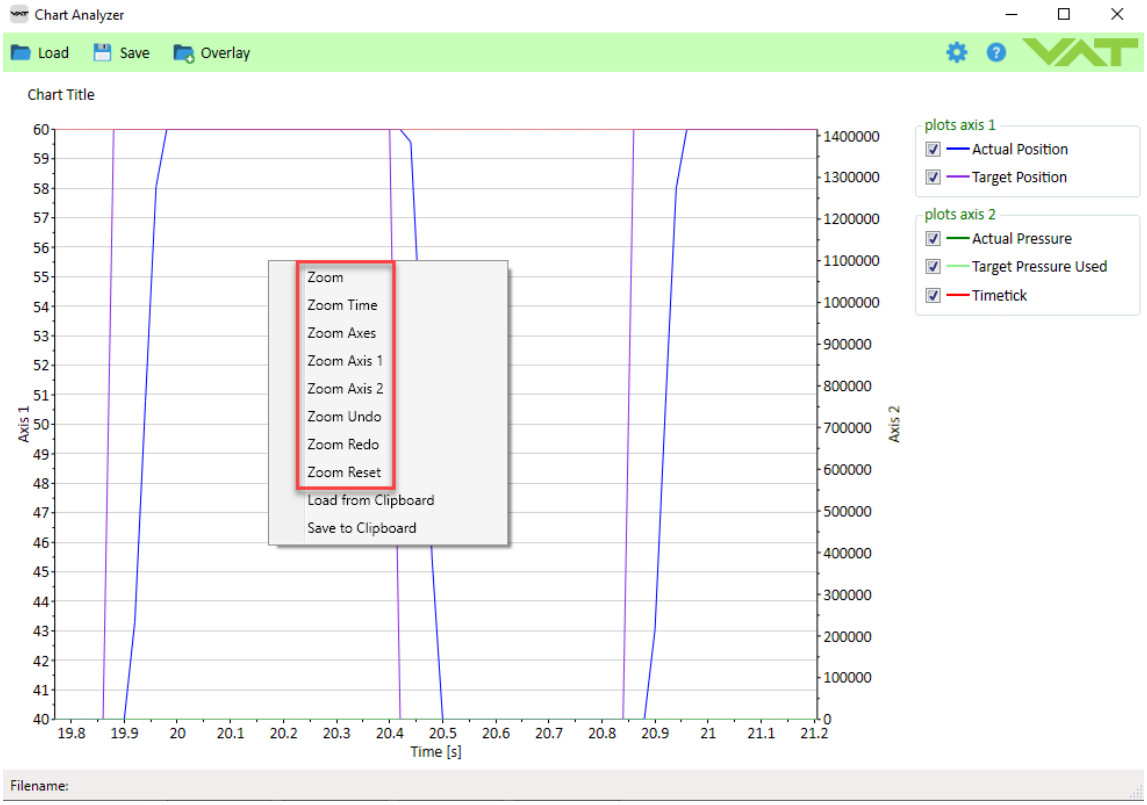
To analyze the recorded Graphs more in detail, there is the possibility to use the Zoom functionality in Chart Analyzer.

Zoom Function

- To use the "Zoom function" move with the Cursor into the graph and right click.
- After that a second option window will show up and then select one of the Zoom options.

Function	Description
Zoom	Zoom in vertical and horizontal axis
Zoom Time	Zoom in Time axis
Zoom Axes	Zoom in Axis 1 and 2

Function	Description
Zoom Axis 1	Zoom in only Axis 1
Zoom Axis 2	Zoom in only Axis 2
Zoom Undo	Go one zoom step backwards
Zoom Redo	Go one zoom step forward after Zoom Undo
Zoom Reset	Shows the original chart data



- After the desired Zoom function is selected, it is able to mark the area with the cursor, where to zoom in.

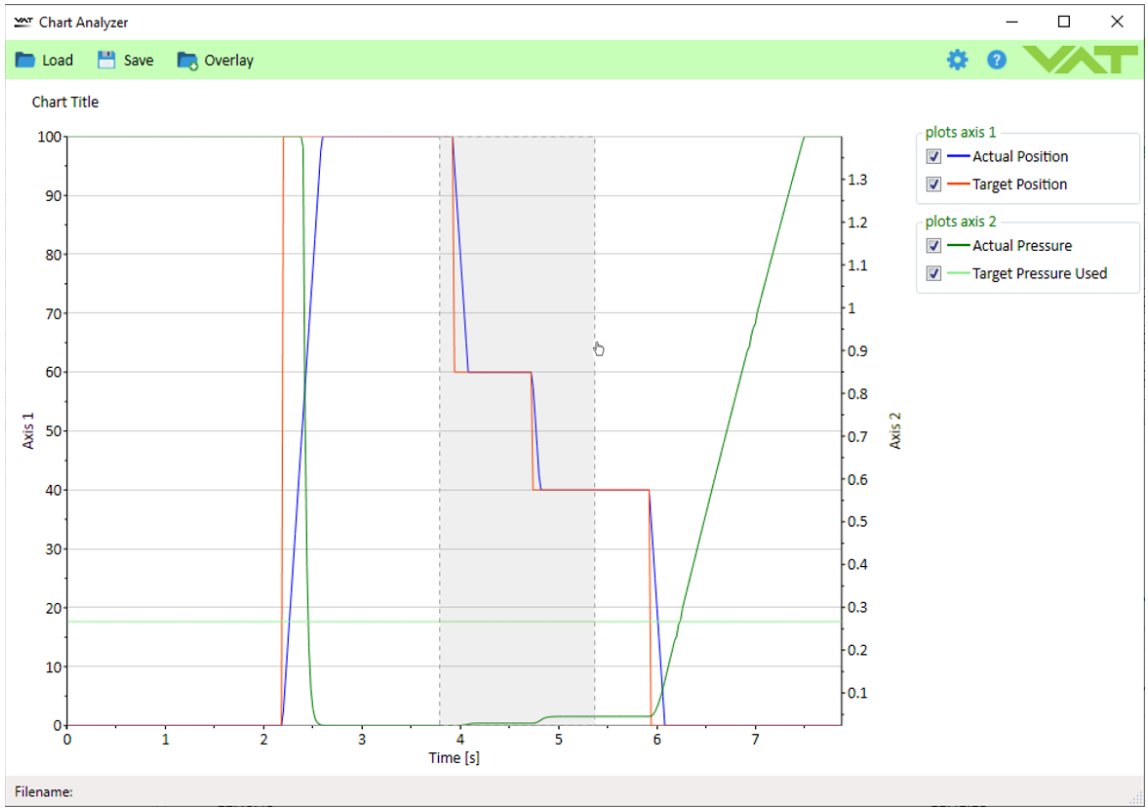
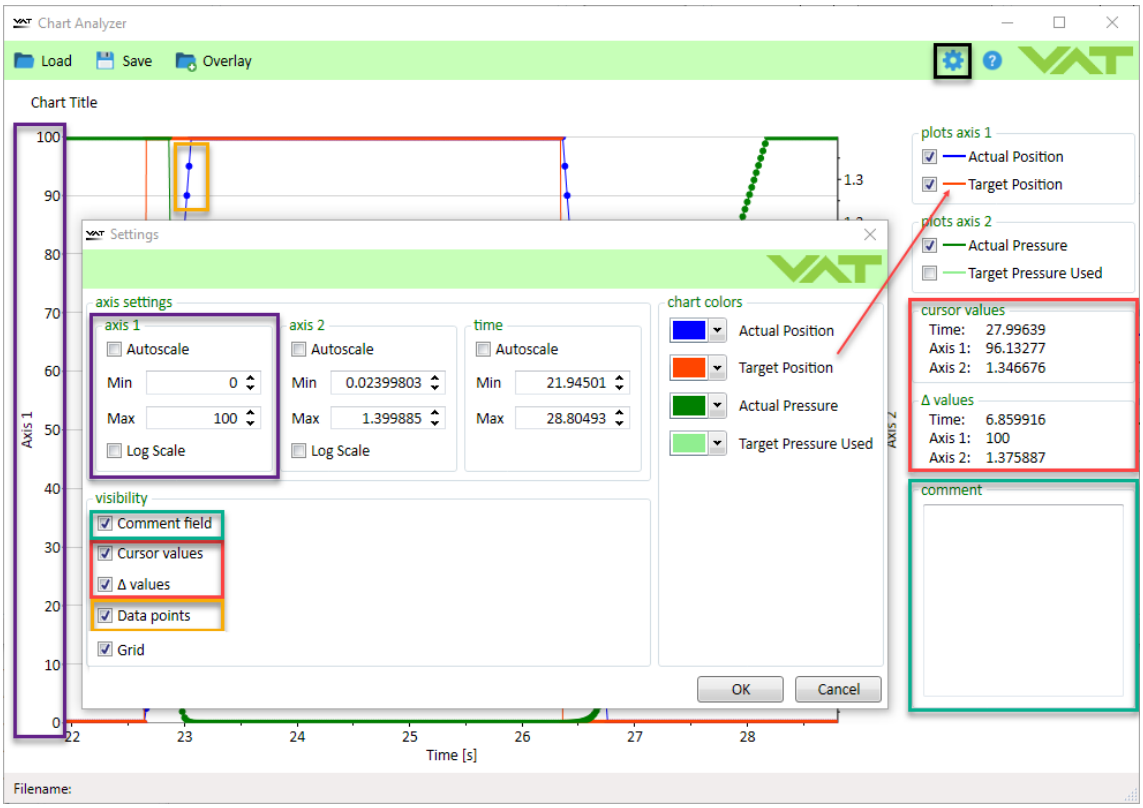


Chart Analyzer
Load
Save
Overlay
Chart Title
plots axis 1
Actual Position
Target Position
plots axis 2
Actual Pressure
Target Pressure Used
Axis 1
Axis 2
Time [s]
Filename:

1.5.1.3 Chart Settings

To adapt the recorded Graphs representation, there is the possibility to do some Settings in Chart Analyzer.



Axis settings

- Axes range: every axis range (Axis 1, Axis 2, Time) can be defined individually (marked purple)
  Autoscale → the Chart will automatically adapt the scalling depending on the recorded data.
  Manual scaling → the User can set min and max values for individual axis
  Log scale → the Chart will show the axis in logarithmic format

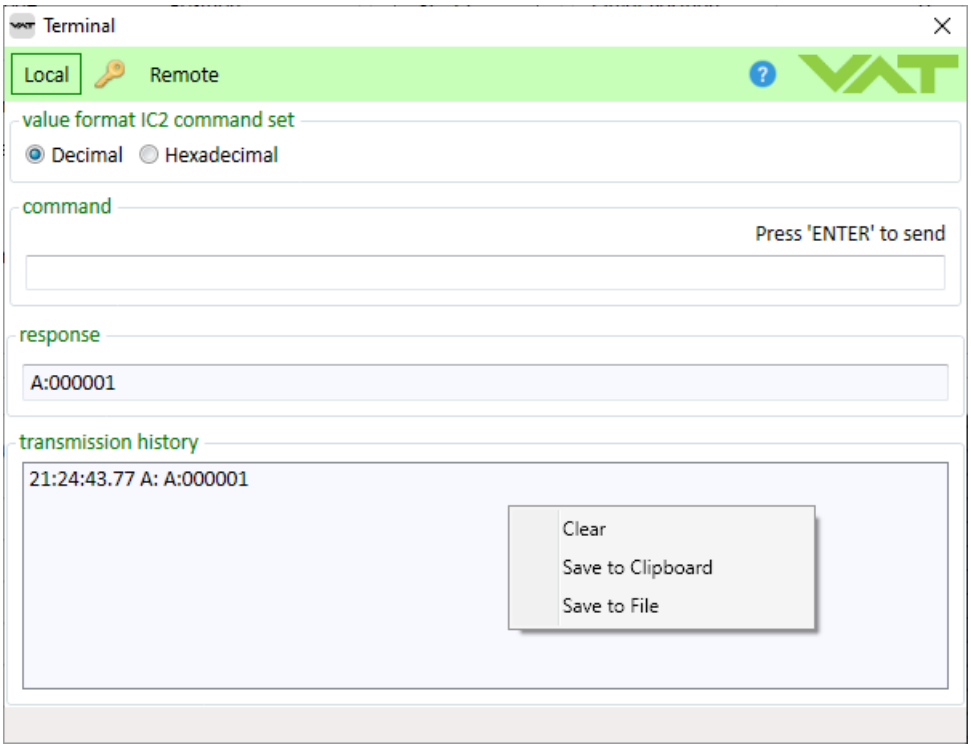
Visibility

- Cursor values: depending on the cursor position the actual axis values will be visible on the right site (marked red).
- Δ-values (Delta-Values): depending on the visible Axis Range the current axis differences will be visible on the right site (marked red).
- Data points: all real data values will marked with bullets in the chart analyzer window (marked orange)
- Comment Field: shows the commend field which allows to enter a short measurement description (marked green, will be saved in the text file)
- Grid: enable/disable the grid in the chart window
- Per default these settings (Comment field, Cursor values, Δ-values, Data points) are not selected.

Chart colors

- In the field chart colors, it is possible to change the chart color of individual parameters(Auto save).

1.5.2 Terminal



Value format IC2 command set
Command Set IC2

Right Click Menu
Clear: Clear terminal view.
Save to Clipboard: Allowed to copy terminal data information in text file or excel.
Save to File: Save terminal data in text file.

1.5.2.1 Chart Commands

Command	Description
chart clear	Deletes the current chart
chart start	Deletes the current chart and starts the plotting
chart stop	Freezing of the current chart
chart record start	Starts recording the chosen parameters (selectable via menu chart content)
chart record stop [*path*]	Stops recording and opens chart analyzer window Adding an optional filename saves

	Example: *chart record stop c:\temp\pressurelow.txt* Note: If spaces are requested in the name than use following notation: *chart record stop "c:\temp\name with spaces.txt*
chart record stop x.bmp chart record stop x.jpg chart record stop x.png	Stops recording and saves the chart in a file Example: *chart record stop x.jpg*
scanrate x	Setting the sampling rate in milliseconds Example: *scanrate 100* : 100ms sampling interval *scanrate 0* : as fast as possible (No Limit)

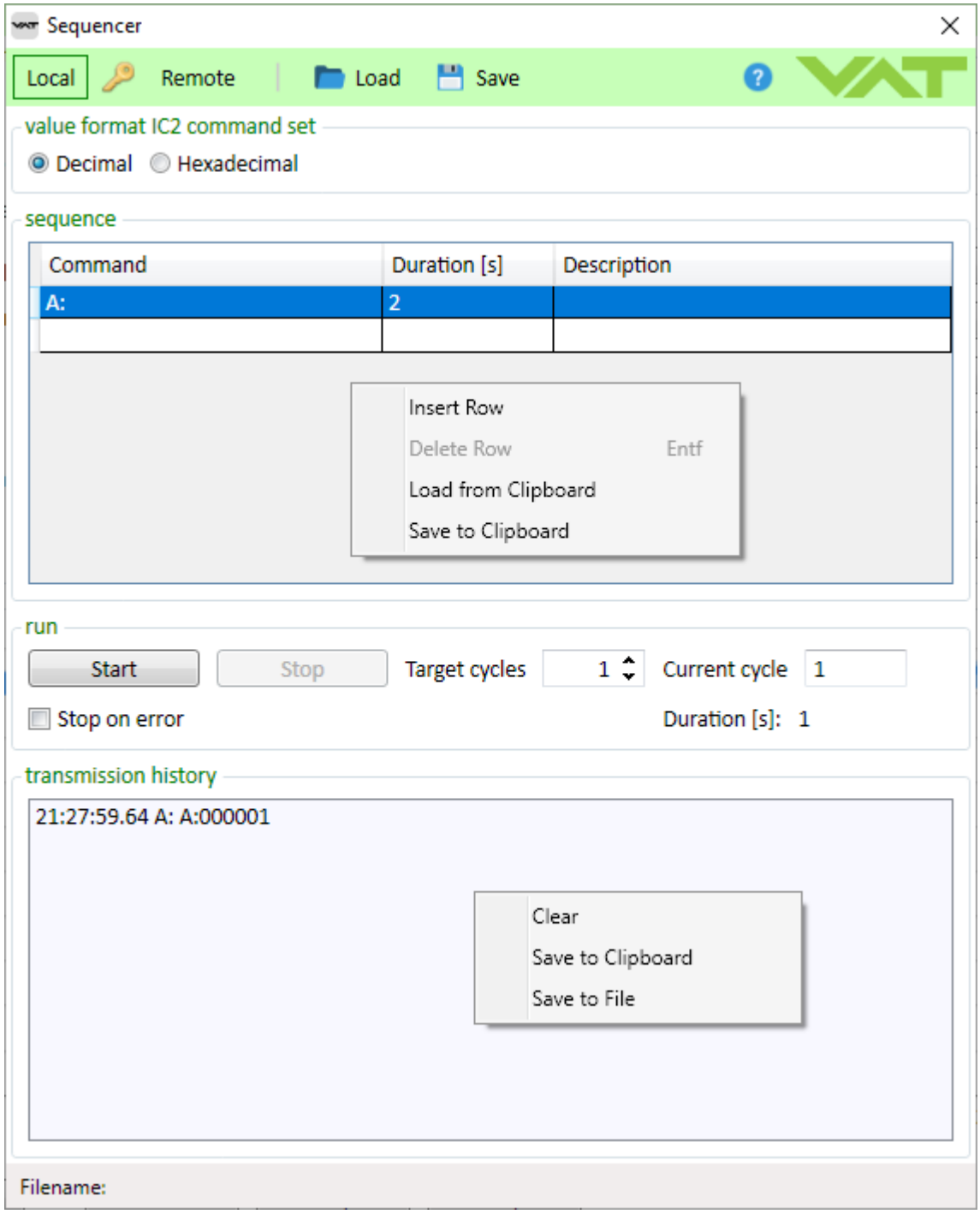
Note:

- Excecuting the commands clear, start or stop provides the same result as pressing the corresponding buttons below the chart

1.5.2.2 Command structure

Command structure is the same as over the RS232/485 Interface. (See in Command Set IC2)

1.5.3 Sequencer



Load

- Previous saved sequence can be loaded again.

Save

- Currently sequence is saved.

Value format IC2 command set

Command Set IC2

Right Click Menu sequence
Insert Row: New Row in sequence window for editing.
Delete Row: Eliminate Row in sequence window.
Load from Clipboard: Update sequence window from clipboard.
Save to Clipboard: Same functionality as Save button but the sequence data are saved to the clipboard.

Start
- Start sequence functionality

Stop
- Stop sequence functionality

Target cycles
- -1 runs sequence endless.

Current cycle
- Starts with value 1.

Stop on error
- Sequence stops in case a command result in an error.
- For more information regarding error see Command Set IC1 or Command Set IC2.

Duration [s]
- Shows how long the current command is already executed.

Right Click Menu transmission history
Clear: Clear terminal view.
Save to Clipboard: Allowed to copy terminal data information in text file or excel.
Save to File: Save terminal data in text file.

1.5.3.1 Commands

Command	Description
chart clear	Deletes the current chart
chart start	Deletes the current chart and starts the plotting
chart stop	Freezing of the current chart
chart record start	Starts recording the chosen parameters (selectable via menu chart content)
chart record stop	Stops recording and opens chart analyzer window
chart record stop x.bmp chart record stop x.jpg chart record stop x.png chart record stop x.txt	Stops recording and saves the data in a file (picture or data) Example: *chart record stop c:\temp\x.jpg (save chart picture)* *chart record stop c:\temp\x.txt (save data)* The resulting file will be named x_yyyymmdd_hhmmss.*

Command	Description
	Note: If spaces are requested in the name than use following notation: *chart record stop "c:\temp\name with spaces.txt"*
scanrate x	Setting the scan rate in the unit of milliseconds Example: *scanrate 100* : 100 ms update interval *scanrate 0* : as fast as possible (no limits)
transmission history clear	Deletes the transmission history window
transmission history save x.txt	Save transmission history window in a text file The resulting file will be named x_yyyymmdd_hhmmss.txt
value format hexadecimal	Set value format IC2 command set to hexadecimal
value format decimal	Set value format IC2 command set to decimal

Duration	Description
[dec value]	Wait time in seconds after sending the command.
Restart	Since the CPA v4.1.0 After a command which restarts the valve controller there can be use "Restart" instead of a fixed value for a delay time. With "Restart" the CPA will proceed with the sequence as soon as the controller is restarted. Example: p:010F5001000001 Restart

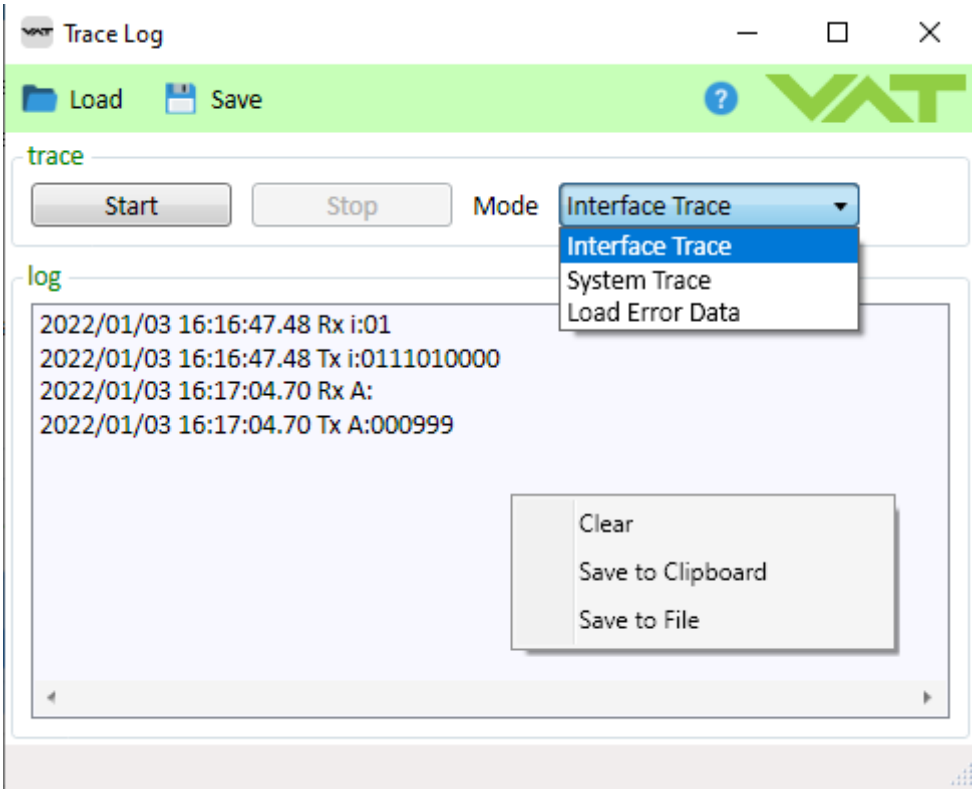
Note:

- Executing the commands clear, start or stop provides the same result as pressing the corresponding buttons below the chart

1.5.3.2 Command structure

Command structure is the same as over the RS232/485 Interface. (See in Command Set IC2)

1.5.4 Trace Log



Load
- Previous saved trace log data can be loaded again for deeper analysis.

Save
- Currently trace log data is saved in a text file format.

Start
- Start trace log functionality

Stop
- Stop trace log functionality

Mode
Interface Trace
Load Error Data
System Trace

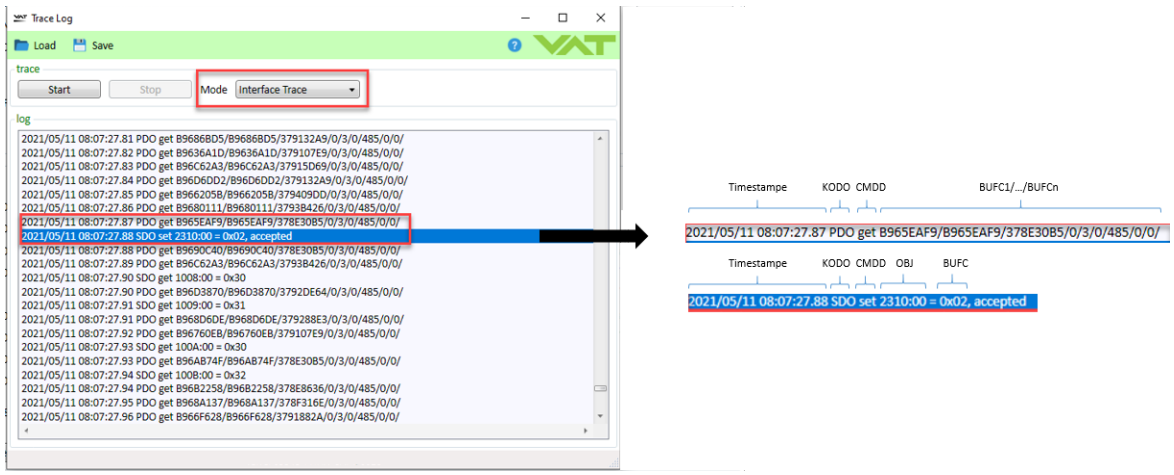
Right Click Menu
Clear: Clear trace log view.
Save to Clipboard: Allowed to copy trace log data information in text file or excel.
Save to File: Same functionality as Save button.

1.5.4.1 Interface Trace

Interface Trace functionality is available for EtherCAT, DeviceNet, RS232/485, CC-Link and Profibus Interface.
It is a useful tool in case of troubleshooting, e.g. if the valve does not execute the desired host commands, it can be checked what information our controller receives via interface channel.

For more information regarding Trace log structure see:
Fieldbus
RS232/485

Fieldbus



Cyclic Structure: (Time stamp) (KODO) (CMDD) (BUFC)
Acyclic Structure: (Time stamp) (KODO) (CMDD) (OBJ) (DATA)

KODO – Kind of Data Object:
PDO = Process Data Objects (cyclic communication)
SDO = Service Data Objects (acyclic communication)

CMDD – Command Direction:
get = Received Data over Interface
set = Transmitted Data over Interface

BUFC – Buffer Content:

Ethercat:	Order depends on the current PDO-Mapping
DeviceNet:	Order depends on the current used assembly
CC-Link:	Order depends on Profile 2
Pofibus:	Order depends on the current used Profile

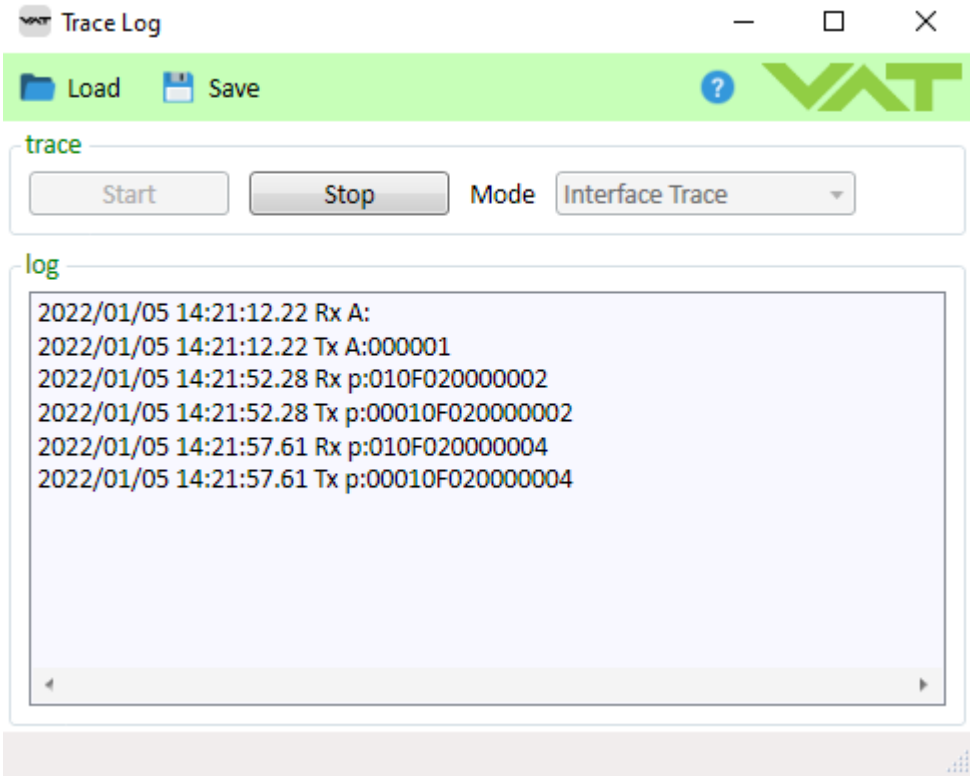
OBJ - Object:
The Parameter object where data is received or transmitted to it

DATA:
In case CMDD is get.

→ All data with data type float are send in IEEE-754 Standard

→ PDO cyclic data are traced in case of buffer content has changed.

RS232/485



Structure: (Time stamp) (KODO) (CMD)

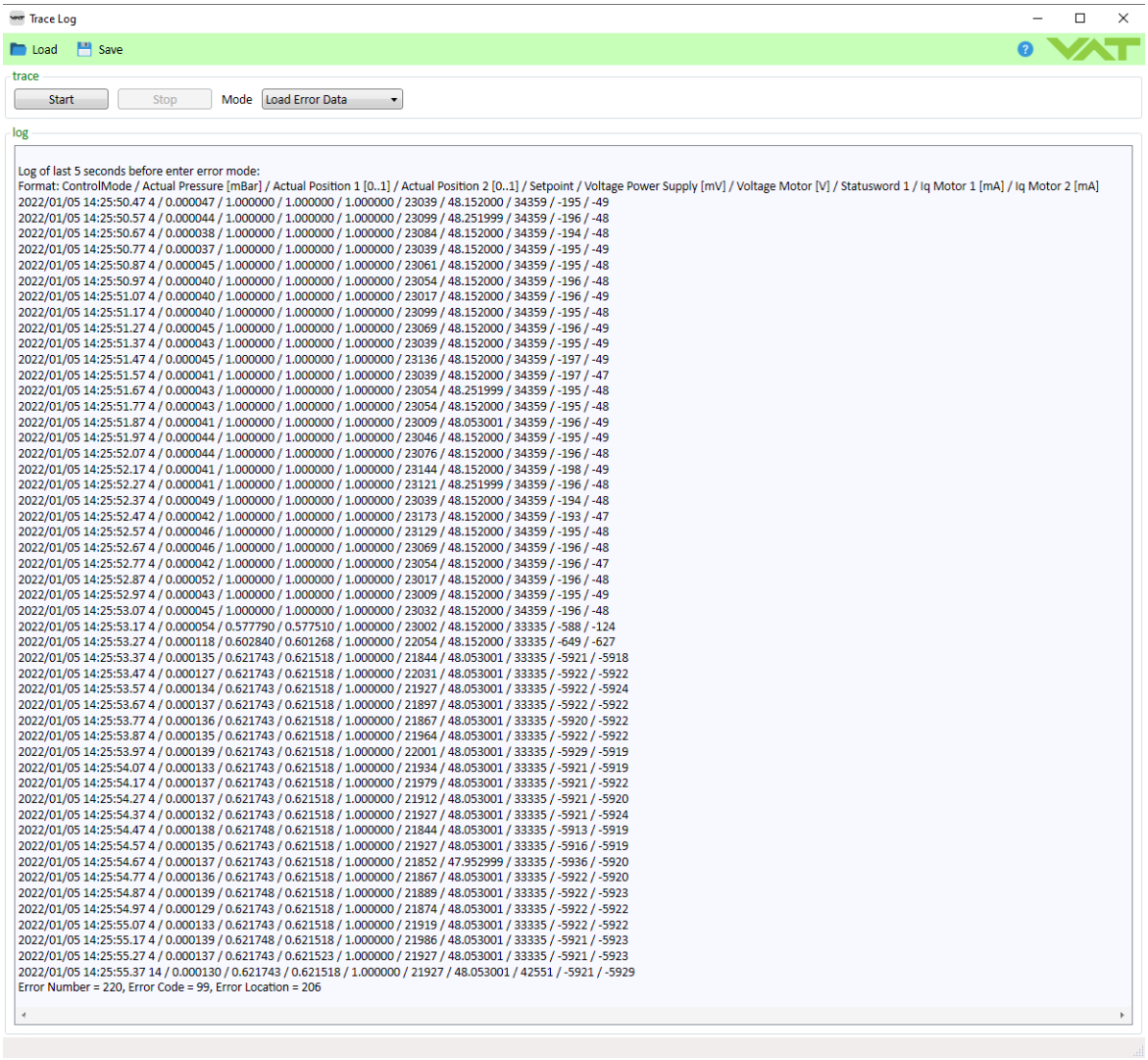
KODO – Kind of Data Object:
Rx = Received Data (send from host)
Tx = Transmitted Data (Answer of received command)

CMD - Command
For more information see Command Structure

1.5.4.2 Load Error Data

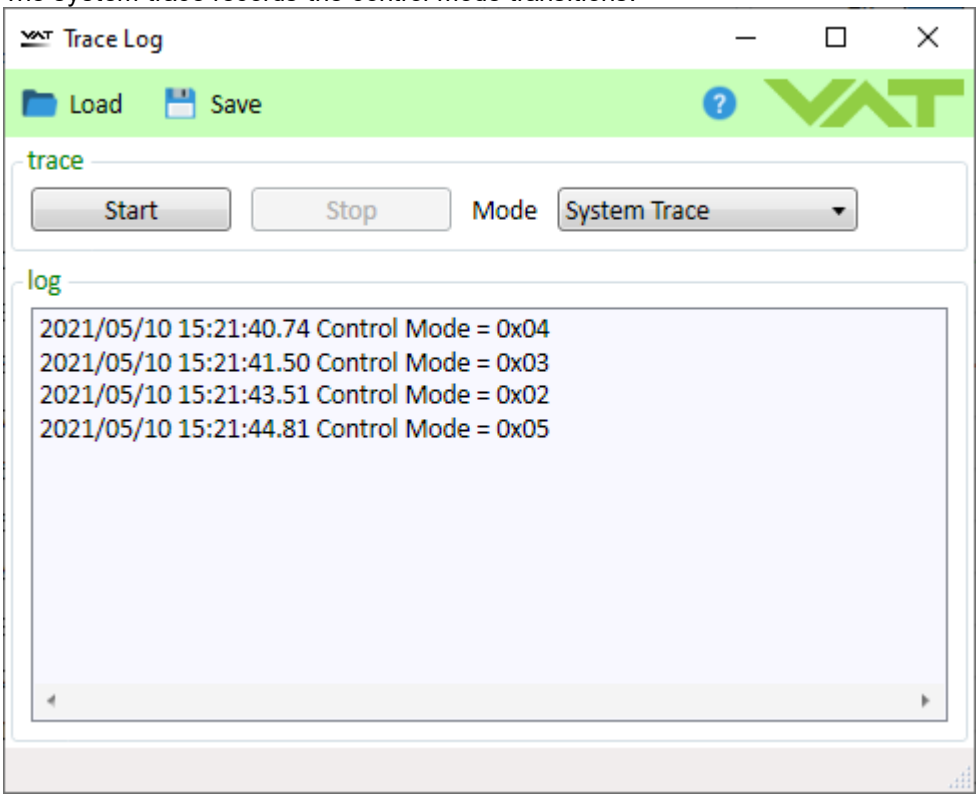
To read out the last 5 seconds before enter error mode.

Exceptions are:
- Firmware which are older than June 2017
- Firmware from July 2020 until November 2020 with EtherCAT interface


Trace Log
Load
Save
trace
Start
Stop
Mode
Load Error Data
log
Log of last 5 seconds before enter error mode:
Format: ControlMode / Actual Pressure [mBar] / Actual Position 1 [0..1] / Actual Position 2 [0..1] / Setpoint / Voltage Power Supply [mV] / Voltage Motor [V] / Statusword 1 / Iq Motor 1 [mA] / Iq Motor 2 [mA]
2022/01/05 14:25:50.47 4 / 0.000047 / 1.000000 / 1.000000 / 1.000000 / 23039 / 48.152000 / 34359 / -195 / -49
2022/01/05 14:25:50.57 4 / 0.000044 / 1.000000 / 1.000000 / 1.000000 / 23099 / 48.251999 / 34359 / -196 / -48
2022/01/05 14:25:50.67 4 / 0.000038 / 1.000000 / 1.000000 / 1.000000 / 23084 / 48.152000 / 34359 / -194 / -48
2022/01/05 14:25:50.77 4 / 0.000037 / 1.000000 / 1.000000 / 1.000000 / 23039 / 48.152000 / 34359 / -195 / -49
2022/01/05 14:25:50.87 4 / 0.000045 / 1.000000 / 1.000000 / 1.000000 / 23061 / 48.152000 / 34359 / -195 / -48
2022/01/05 14:25:50.97 4 / 0.000040 / 1.000000 / 1.000000 / 1.000000 / 23054 / 48.152000 / 34359 / -196 / -48
2022/01/05 14:25:51.07 4 / 0.000040 / 1.000000 / 1.000000 / 1.000000 / 23017 / 48.152000 / 34359 / -196 / -49
2022/01/05 14:25:51.17 4 / 0.000040 / 1.000000 / 1.000000 / 1.000000 / 23099 / 48.152000 / 34359 / -195 / -48
2022/01/05 14:25:51.27 4 / 0.000045 / 1.000000 / 1.000000 / 1.000000 / 23069 / 48.152000 / 34359 / -196 / -49
2022/01/05 14:25:51.37 4 / 0.000043 / 1.000000 / 1.000000 / 1.000000 / 23039 / 48.152000 / 34359 / -195 / -49
2022/01/05 14:25:51.47 4 / 0.000045 / 1.000000 / 1.000000 / 1.000000 / 23136 / 48.152000 / 34359 / -197 / -49
2022/01/05 14:25:51.57 4 / 0.000041 / 1.000000 / 1.000000 / 1.000000 / 23039 / 48.152000 / 34359 / -197 / -47
2022/01/05 14:25:51.67 4 / 0.000043 / 1.000000 / 1.000000 / 1.000000 / 23054 / 48.251999 / 34359 / -195 / -48
2022/01/05 14:25:51.77 4 / 0.000043 / 1.000000 / 1.000000 / 1.000000 / 23054 / 48.152000 / 34359 / -195 / -48
2022/01/05 14:25:51.87 4 / 0.000041 / 1.000000 / 1.000000 / 1.000000 / 23009 / 48.053001 / 34359 / -196 / -49
2022/01/05 14:25:51.97 4 / 0.000044 / 1.000000 / 1.000000 / 1.000000 / 23046 / 48.152000 / 34359 / -195 / -49
2022/01/05 14:25:52.07 4 / 0.000044 / 1.000000 / 1.000000 / 1.000000 / 23076 / 48.152000 / 34359 / -196 / -48
2022/01/05 14:25:52.17 4 / 0.000041 / 1.000000 / 1.000000 / 1.000000 / 23144 / 48.152000 / 34359 / -198 / -49
2022/01/05 14:25:52.27 4 / 0.000041 / 1.000000 / 1.000000 / 1.000000 / 23121 / 48.251999 / 34359 / -196 / -48
2022/01/05 14:25:52.37 4 / 0.000049 / 1.000000 / 1.000000 / 1.000000 / 23039 / 48.152000 / 34359 / -194 / -48
2022/01/05 14:25:52.47 4 / 0.000042 / 1.000000 / 1.000000 / 1.000000 / 23173 / 48.152000 / 34359 / -193 / -47
2022/01/05 14:25:52.57 4 / 0.000046 / 1.000000 / 1.000000 / 1.000000 / 23129 / 48.152000 / 34359 / -195 / -48
2022/01/05 14:25:52.67 4 / 0.000046 / 1.000000 / 1.000000 / 1.000000 / 23069 / 48.152000 / 34359 / -196 / -48
2022/01/05 14:25:52.77 4 / 0.000042 / 1.000000 / 1.000000 / 1.000000 / 23054 / 48.152000 / 34359 / -196 / -47
2022/01/05 14:25:52.87 4 / 0.000052 / 1.000000 / 1.000000 / 1.000000 / 23017 / 48.152000 / 34359 / -196 / -48
2022/01/05 14:25:52.97 4 / 0.000043 / 1.000000 / 1.000000 / 1.000000 / 23009 / 48.152000 / 34359 / -195 / -49
2022/01/05 14:25:53.07 4 / 0.000045 / 1.000000 / 1.000000 / 1.000000 / 23032 / 48.152000 / 34359 / -196 / -48
2022/01/05 14:25:53.17 4 / 0.000054 / 0.577790 / 0.577510 / 1.000000 / 23002 / 48.152000 / 33335 / -588 / -124
2022/01/05 14:25:53.27 4 / 0.000118 / 0.602840 / 0.601268 / 1.000000 / 22054 / 48.152000 / 33335 / -649 / -627
2022/01/05 14:25:53.37 4 / 0.000135 / 0.621743 / 0.621518 / 1.000000 / 21844 / 48.053001 / 33335 / -5921 / -5918
2022/01/05 14:25:53.47 4 / 0.000127 / 0.621743 / 0.621518 / 1.000000 / 22031 / 48.053001 / 33335 / -5922 / -5922
2022/01/05 14:25:53.57 4 / 0.000134 / 0.621743 / 0.621518 / 1.000000 / 21927 / 48.053001 / 33335 / -5922 / -5924
2022/01/05 14:25:53.67 4 / 0.000137 / 0.621743 / 0.621518 / 1.000000 / 21897 / 48.053001 / 33335 / -5922 / -5922
2022/01/05 14:25:53.77 4 / 0.000136 / 0.621743 / 0.621518 / 1.000000 / 21867 / 48.053001 / 33335 / -5920 / -5922
2022/01/05 14:25:53.87 4 / 0.000135 / 0.621743 / 0.621518 / 1.000000 / 21964 / 48.053001 / 33335 / -5922 / -5922
2022/01/05 14:25:53.97 4 / 0.000139 / 0.621743 / 0.621518 / 1.000000 / 22001 / 48.053001 / 33335 / -5929 / -5919
2022/01/05 14:25:54.07 4 / 0.000133 / 0.621743 / 0.621518 / 1.000000 / 21934 / 48.053001 / 33335 / -5921 / -5919
2022/01/05 14:25:54.17 4 / 0.000137 / 0.621743 / 0.621518 / 1.000000 / 21979 / 48.053001 / 33335 / -5921 / -5922
2022/01/05 14:25:54.27 4 / 0.000137 / 0.621743 / 0.621518 / 1.000000 / 21912 / 48.053001 / 33335 / -5921 / -5920
2022/01/05 14:25:54.37 4 / 0.000132 / 0.621743 / 0.621518 / 1.000000 / 21927 / 48.053001 / 33335 / -5921 / -5924
2022/01/05 14:25:54.47 4 / 0.000138 / 0.621748 / 0.621518 / 1.000000 / 21844 / 48.053001 / 33335 / -5913 / -5919
2022/01/05 14:25:54.57 4 / 0.000135 / 0.621743 / 0.621518 / 1.000000 / 21927 / 48.053001 / 33335 / -5916 / -5919
2022/01/05 14:25:54.67 4 / 0.000137 / 0.621743 / 0.621518 / 1.000000 / 21852 / 47.952999 / 33335 / -5936 / -5920
2022/01/05 14:25:54.77 4 / 0.000136 / 0.621743 / 0.621518 / 1.000000 / 21867 / 48.053001 / 33335 / -5922 / -5920
2022/01/05 14:25:54.87 4 / 0.000139 / 0.621748 / 0.621518 / 1.000000 / 21889 / 48.053001 / 33335 / -5922 / -5923
2022/01/05 14:25:54.97 4 / 0.000129 / 0.621743 / 0.621518 / 1.000000 / 21874 / 48.053001 / 33335 / -5922 / -5922
2022/01/05 14:25:55.07 4 / 0.000133 / 0.621743 / 0.621518 / 1.000000 / 21919 / 48.053001 / 33335 / -5922 / -5922
2022/01/05 14:25:55.17 4 / 0.000139 / 0.621748 / 0.621518 / 1.000000 / 21986 / 48.053001 / 33335 / -5921 / -5923
2022/01/05 14:25:55.27 4 / 0.000137 / 0.621743 / 0.621523 / 1.000000 / 21927 / 48.053001 / 33335 / -5921 / -5923
2022/01/05 14:25:55.37 14 / 0.000130 / 0.621743 / 0.621518 / 1.000000 / 21927 / 48.053001 / 42551 / -5921 / -5929
Error Number = 220, Error Code = 99, Error Location = 206

1.5.4.3 System Trace

The system trace records the control mode transitions.



1.5.5 Update Tool

1.5.5.1 Update Procedure

Update Tool is supported since the CPA v4.0.8
Multivalve Option is supported since CPA v4.2.0
In case of lower CPA version see CPA Update.

Note: During update process the valve does not operate, communication to the host get lost. Ensure no process is in work

1. Save the valve state (optional)
Generate Diagnostic File

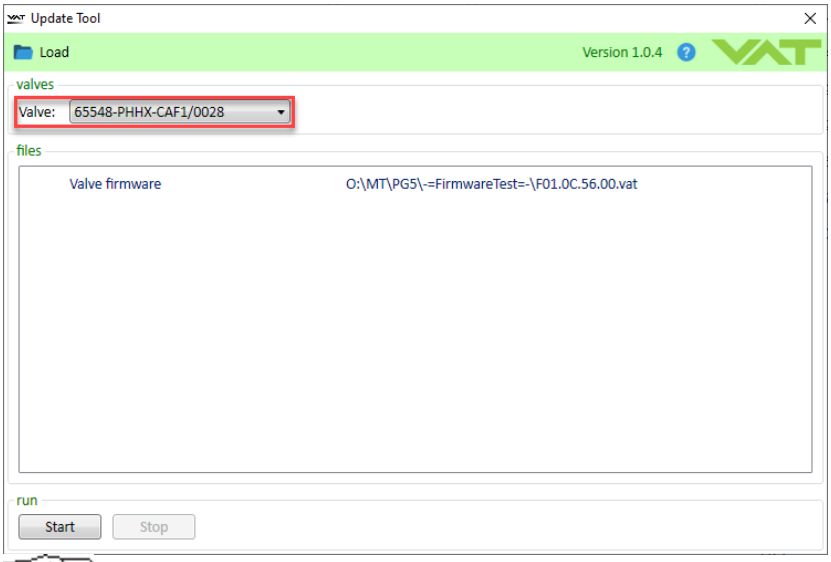
2. Open "Update Tool"
Activate the Local mode and open "Update Tool"

3. Load update file
Possible file type are

- *.vat (VAT Firmware)
- *.mc (Motion Controller Firmware)
- *.net (Interface Firmware)
- *.drive (Drive parameter file)
- *.config (Configuration parameter file)

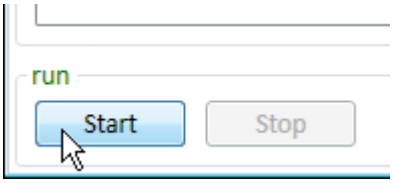
- *.seq (Sequence textile, since CPA v4.2.0)
- *.zip (Collection with multiple files)
- *.cpa (CPA software)

- Move the update file per drag and drop into the Update Tool
- Or Press 'Load' and choose the update file.

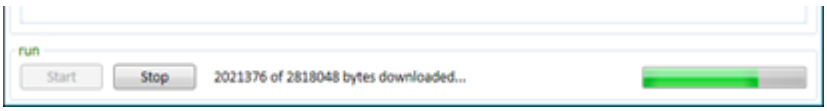


Valve selection in case of more than one valve is connected (Multivalve option required)

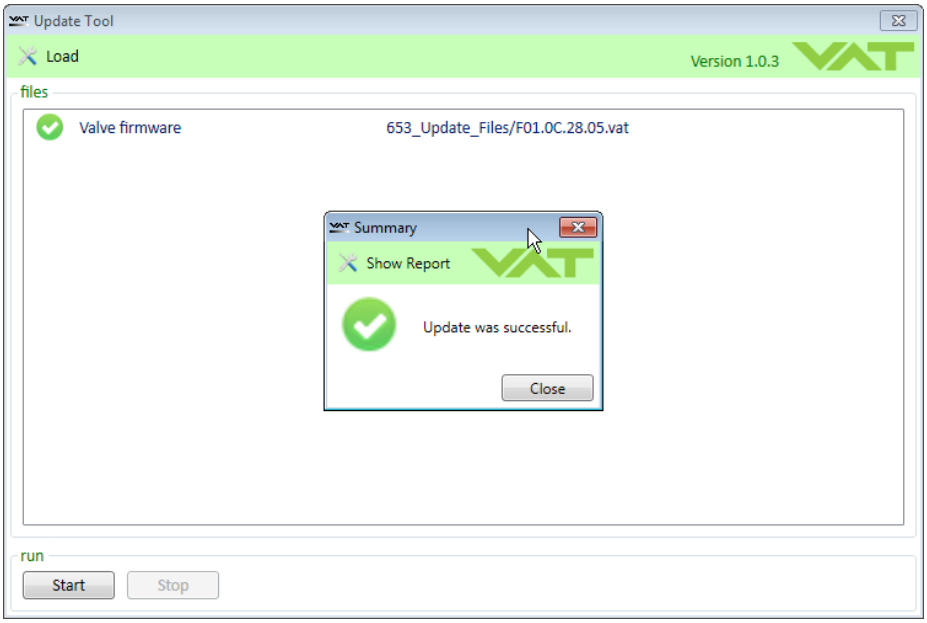
4. Press "Start" to initialize the download to the valve



Bytes downloaded and progress of download is shown
The download needs about 2 minutes



Information that update was successful



VAT-version is now updated on the valve.

5. Generate Report (Optional)
Open Report (Push Show Report Button) and Save File

```
Created: 15.05.2019 19:11:07

Device Information:
Valve Series = 65.3
Valve Variant = Standard
Nominal Diameter = DN320
Serial Number = n.a.
Valve Firmware Version = F01.0C.28.05
Configuration Parameters ID = n.a.
Controller Type = IC2H5
Interface Type = EtherCAT
Option Type = SPS + PFO + Cluster
Start Up Counter = 24

Updating 'Valve firmware' from '653_Update_Files/F01.0C.28.05.vat'
Update success

```

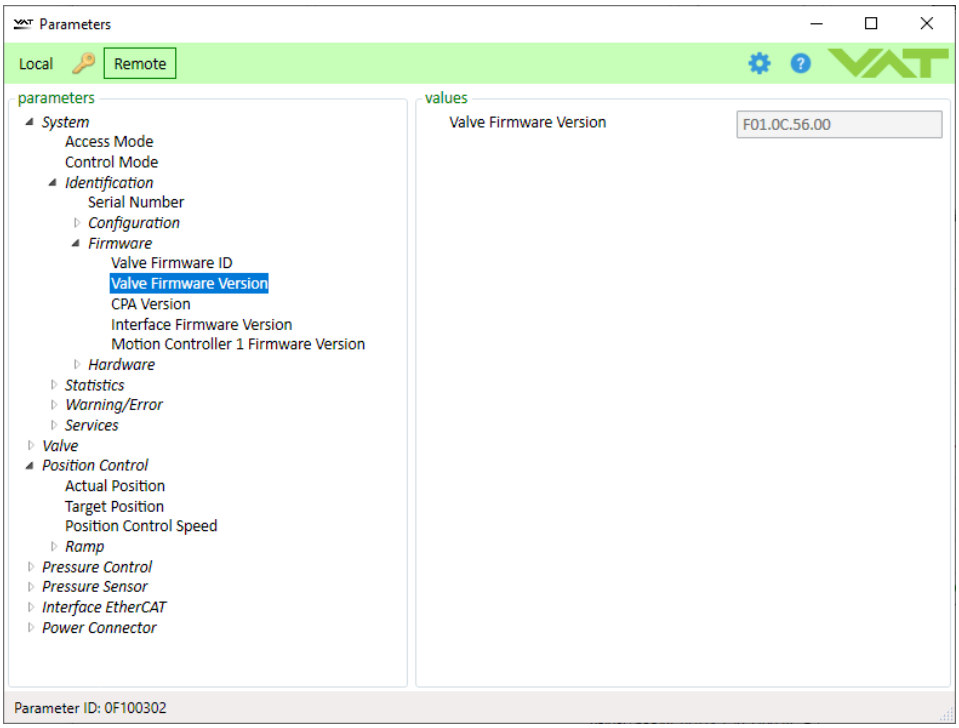
Close the Update Tool

6. Save the valve state (optional)
Generate Diagnostic File

1.5.5.2 Verify VAT firmware update

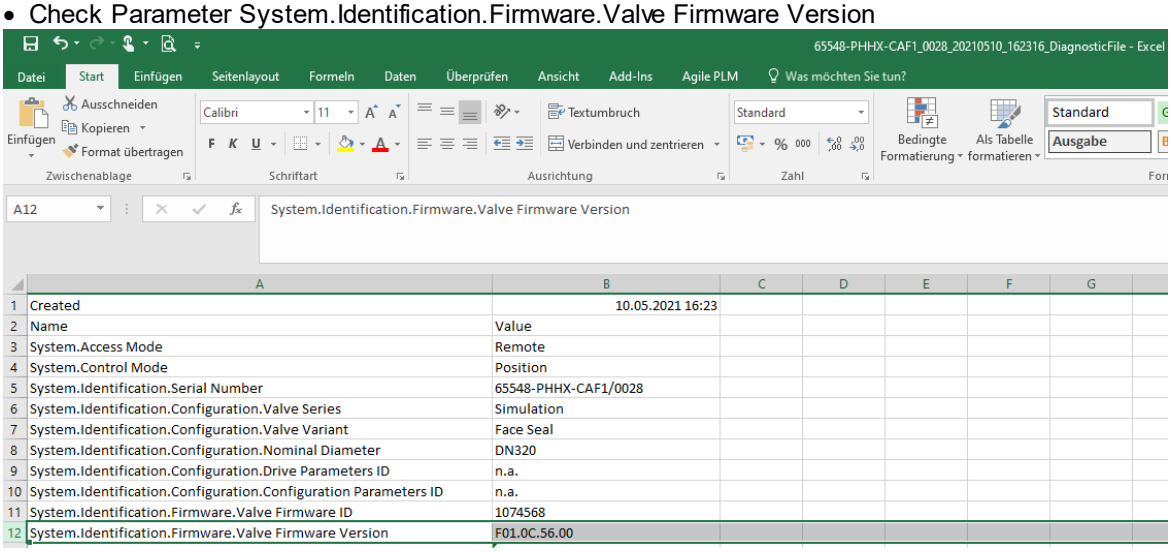
1. Parameters Menu

- Open "Parameters"
- Check Parameter System/Identification/Firmware/Valve Firmware Version



2. Diagnostic Files

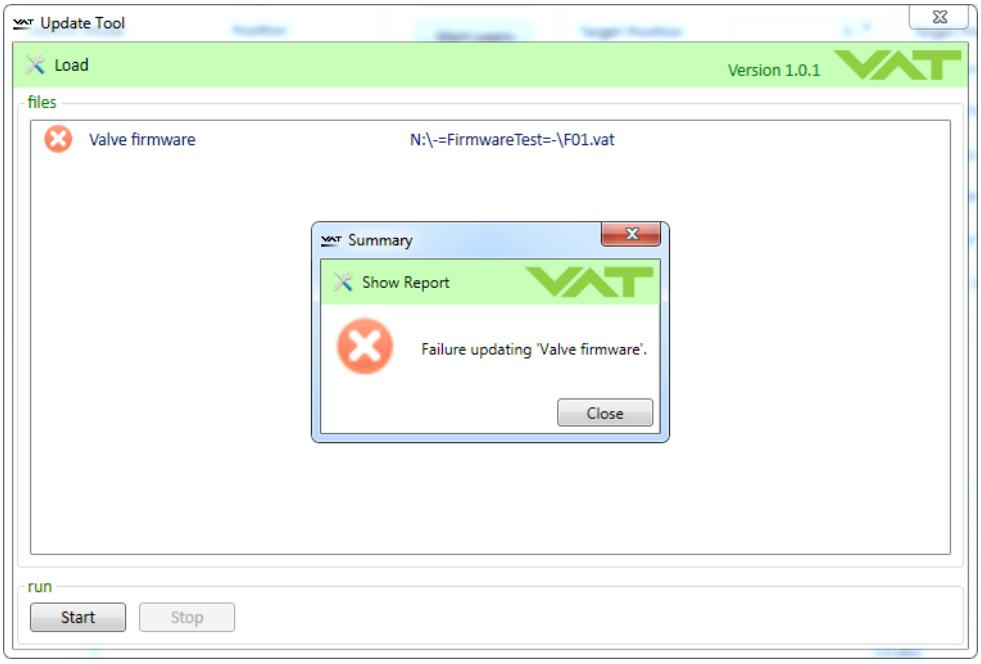
- Open Diagnostic File
- Check Parameter System.Identification.Firmware.Valve Firmware Version



	A	B	C	D	E	F	G
1	Created	10.05.2021 16:23					
2	Name	Value					
3	System.Access Mode	Remote					
4	System.Control Mode	Position					
5	System.Identification.Serial Number	65548-PHHX-CAF1/0028					
6	System.Identification.Configuration.Valve Series	Simulation					
7	System.Identification.Configuration.Valve Variant	Face Seal					
8	System.Identification.Configuration.Nominal Diameter	DN320					
9	System.Identification.Configuration.Drive Parameters ID	n.a.					
10	System.Identification.Configuration.Configuration Parameters ID	n.a.					
11	System.Identification.Firmware.Valve Firmware ID	1074568					
12	System.Identification.Firmware.Valve Firmware Version	F01.0C.56.00					

1.5.5.3 Trouble shooting

Situation



Download failure in Update Tool (since CPA v4.0.9) or Firmware Loader

Valve shows rotating 8 on display (valve is in bootloader mode) after start download a firmware over CPA.

Rotating 8 on display

Solution

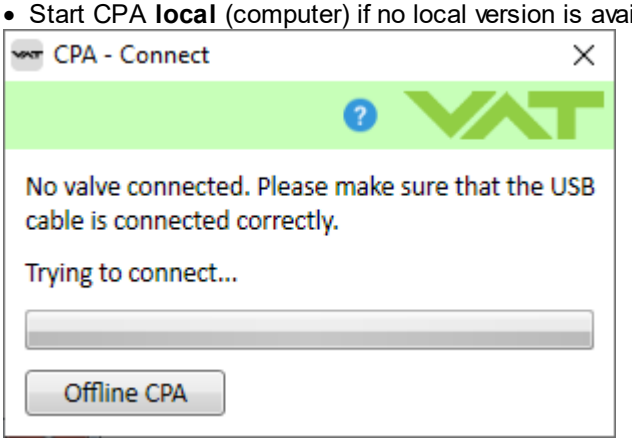
- Disconnect the USB cable
- Disconnect the power cable
- Reconnect the USB cable
- Reconnect the power cable

If the CPA now reconnects

- Open Update Tool (since CPA v4.0.9) or Firmware Loader
- Start firmware download again
- Problem should now be solved and otherwise start the download again

If the CPA does not reconnect

- Start CPA **local** (computer) if no local version is available than see Update



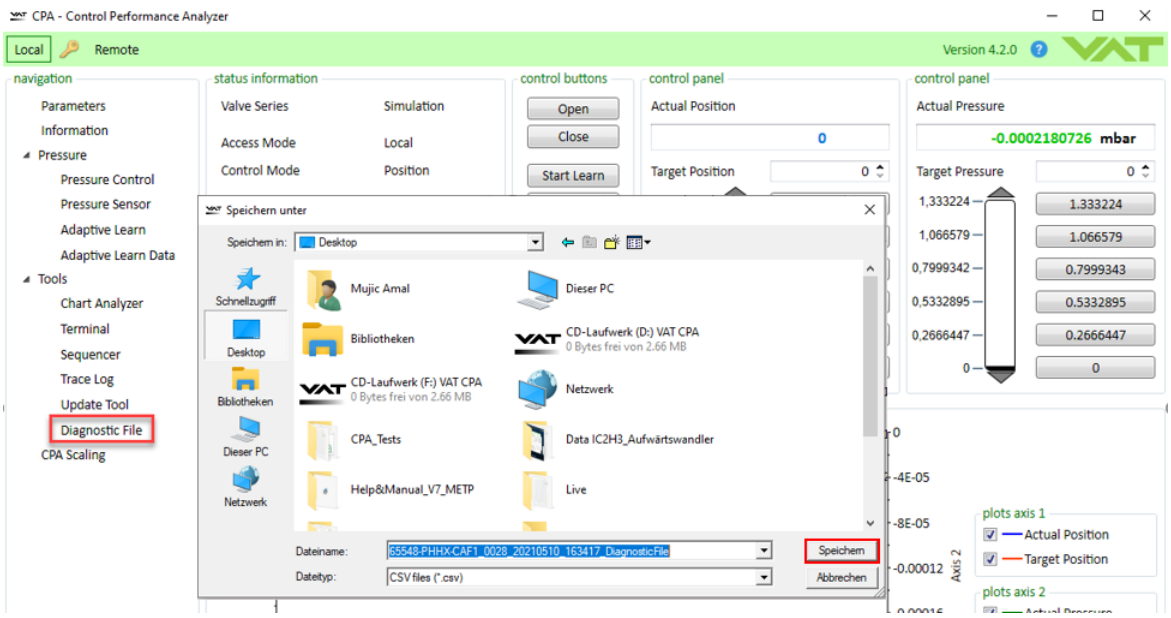
- Open Offline CPA
- Open Update Tool (since CPA v4.0.9) or Firmware Loader
- Select the valve firmware and start download
- If the update fails immediately could it be possible that it is a spare masterboard? In this case the update is locked and will not work.
- (Optional) Open CPA again
- (Optional) Open Update Tool
- (Optional) Select other firmware for download (example Motion Controller Firmware)
- Problem should now be solved and otherwise start the download again

1.5.6 Diagnostic File

Diagnostic File save the actual value of all parameters. This includes also additional information for troubleshooting purpose.

Following Steps are necessary to generate a diagnostic File:

- Open Diagnostic File functionality under Tools
- Define the location and press Save



Example of a Diagnostic File

980EC-24GQ-AAZ1_0147_20210104_100649_DiagnosticFile.csv - Excel

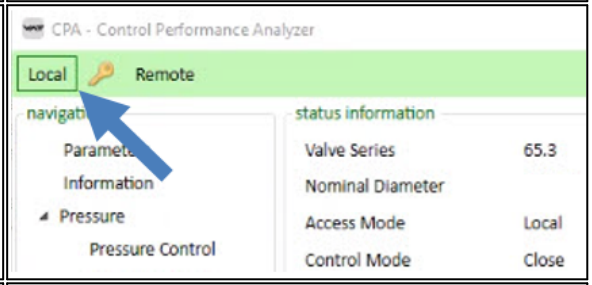
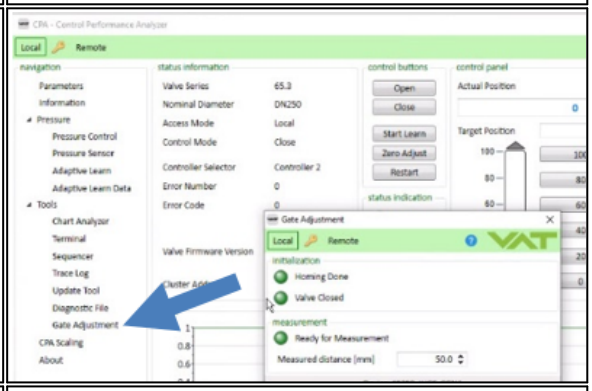
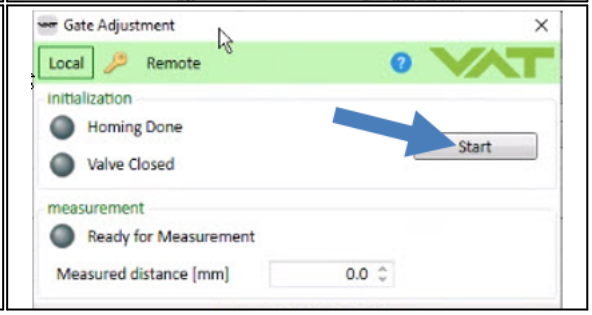
Datei Start Einfügen Seitenlayout Formeln Daten Überprüfen Ansicht Add-Ins Team Sie wüns Stucki An... Freigeben

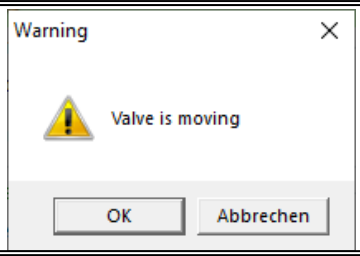
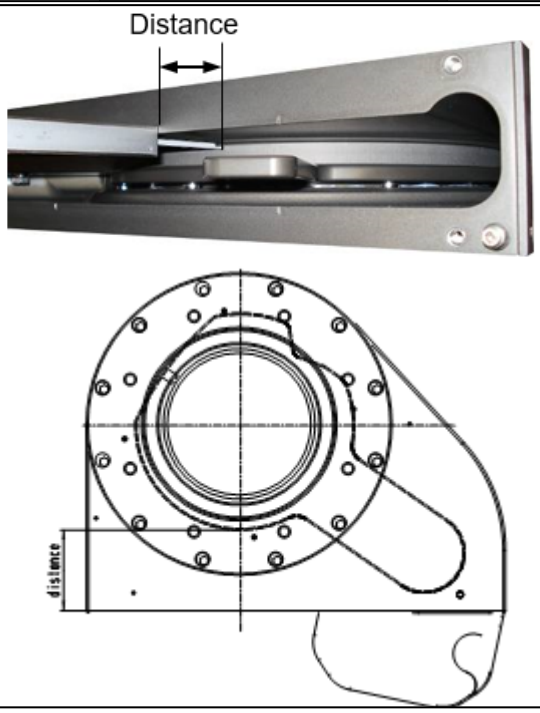
G15

	A	B
1	Created	04.01.2021 10:07
2	Name	Value
3	System.Access Mode	Local
4	System.Control Mode	Error
5	System.Identification.Serial Number	980EC-24GQ-AAZ1/0147
6	System.Identification.Configuration.Device Series	98.0
7	System.Identification.Configuration.Device Variant	Standard
8	System.Identification.Configuration.Nominal Diameter	None
9	System.Identification.Configuration.Drive Parameters ID	n.a.
10	System.Identification.Configuration.Configuration Parameters ID	n.a.
11	System.Identification.Firmware.Device Firmware ID	1059935
12	System.Identification.Firmware.Device Firmware Version	F04.0C.02.04
13	System.Identification.Firmware.CPA Version	4.1.0
14	System.Identification.Firmware.Interface Firmware Version	4.7.0.1
15	System.Identification.Firmware.Motion Controller 1 Firmware Version	FIR-v1726-B521662
16	System.Identification.Firmware.Motion Controller 2 Firmware Version	FIR-v1726-B521662
17	System.Identification.Firmware.Motion Controller 3 Firmware Version	FIR-v1726-B521662
18	System.Identification.Firmware.Motion Controller 4 Firmware Version	67
19	System.Identification.Hardware.Controller Type	IC2H4
20	System.Identification.Hardware.Interface Type	EtherCAT
21	System.Identification.Hardware.Option Type	Not Available
22	System.Statistics.Start Up Counter	1610
23	System.Statistics.Total Time Powered	5373056
24	System.Statistics.Time Since Power On	56
25	System.Warning/Error.Warning Bitmap	0
26	System.Warning/Error.Error Bitmap	16384
27	System.Warning/Error.Error Number	102

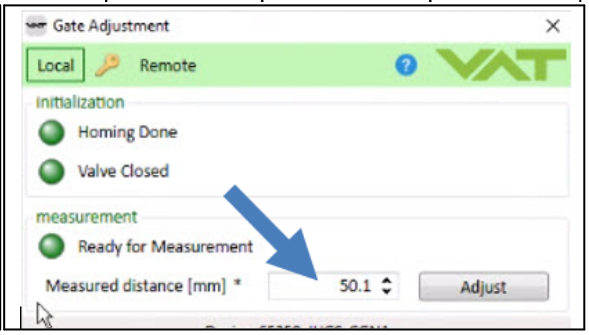
1.5.7 Gate Adjustment

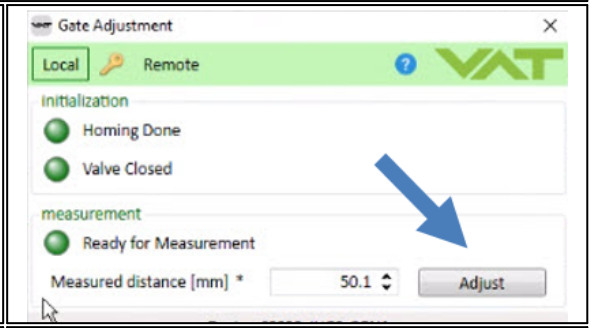
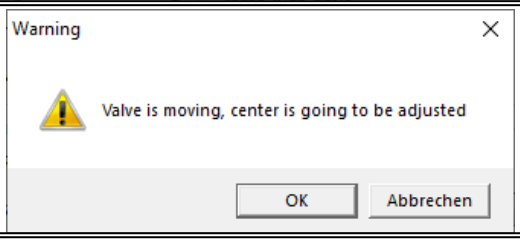
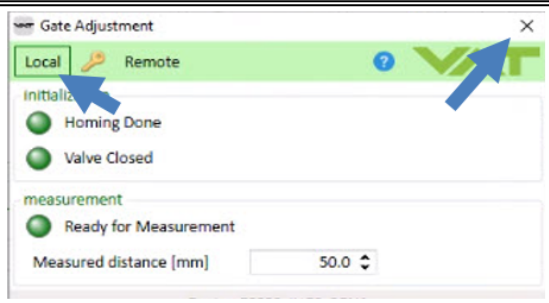
	**CAUTION** **Single person operation** Human body parts must be kept out of the valve opening and away from moving parts.

Description	
Preconditions of Gate Adjustment:	Bonnet must be disassembled.
1. Close valve and check if pendulum plate is in center of flange. Check can be done either visual or by measurement.	When the valve is mounted to a tool, the bonnet has to be removed and the center position can be measured by a depth gauge (see 6.) If the centering (expected distance) is not correct, proceed:
2. Run CPA.	Available on CPA Version 4.2.1.
3. Set access mode to **Local**.	
4. Open **Gate Adjustment** Valve will switch to Maintenance Speed.	
5. Start Initialization by pressing «**Start**». The valve will do a homing and close, if necessary.	

Description	
Vale is doing a movement after pressi Human body parts must be kept out c from moving parts.	
6. Measure value of distance [mm]. Measured distance between bonnet flange surface and pendulum plate. Maximum of adjustable value is **±1.5**mm.	

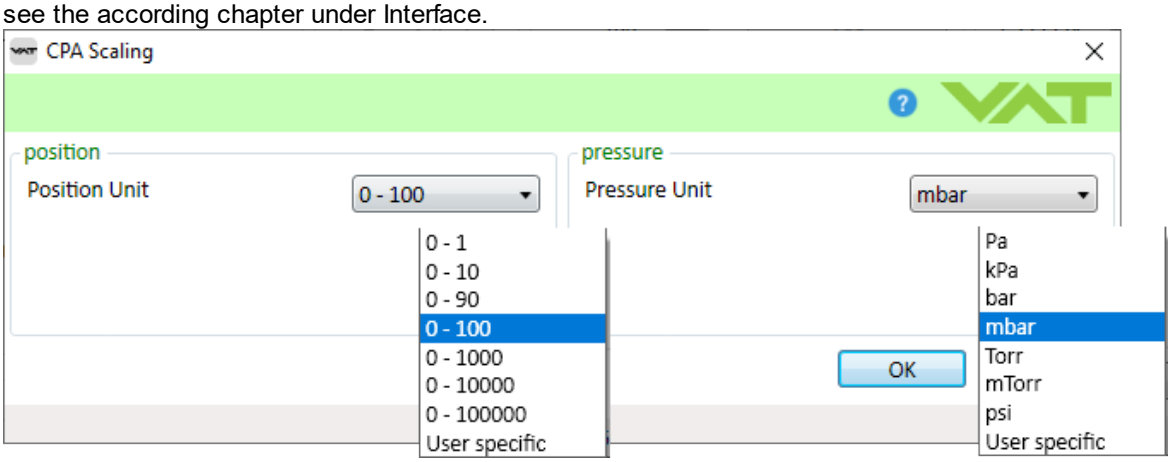
DN	63-100	160	200	250	320	350
Expected distance [mm]	**51.5** ± 0.5	**45.0** ± 0.5	**40.0** ± 0.5	**50.0** ± 0.5	**60.0** ± 0.5	**61.0** ± 0.5

7. Type in measured distance if value ≥ ±0.5mm of expected distance. If value is in expected distance range the gate is adjusted.	

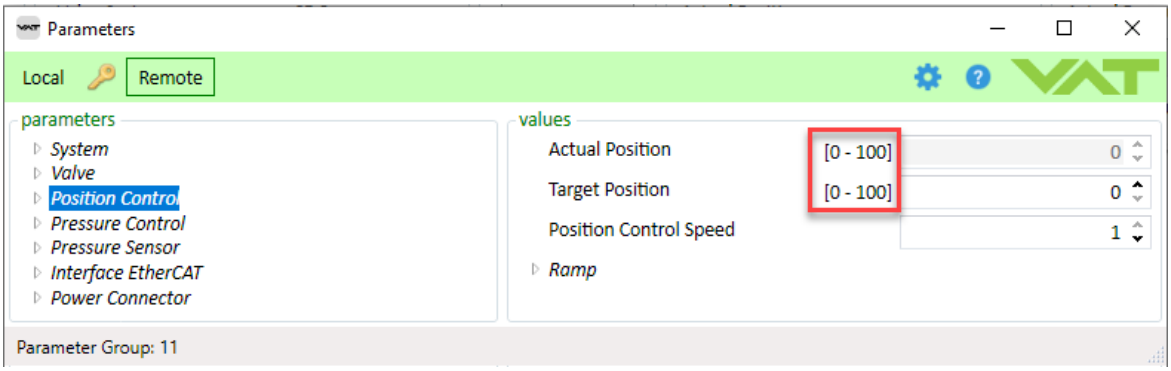
Description	
8. Press «**Adjust**», the valve will correct the center position of the gate.	
Vale is doing a movement after pressi Human body parts must be kept out c from moving parts.	
9. Re-measure the distance. Distance should be in distance range, otherwise retry the whole procedure.	
10. Close Gate Adjustment by closing the window. The maintenance speed will reset to normal speed. Make sure that the access mode is set to «**Local**», closing the Gate Adjustment tool will also ensure that the maintenance speed mode changes back to normal speed. If the access mode is set to «**Remote**», the valve will remain in maintenance speed mode after closing the Gate Adjustment tool. To switch to normal speed, restart the valve.	

1.6 CPA Scaling

With this window the Position and Pressure Unit can be defined for CPA. For the interface channel see the according chapter under Interface.



Since CPA v4.2.0 the Parameters Window shows the position and pressure unit left to the actual value.



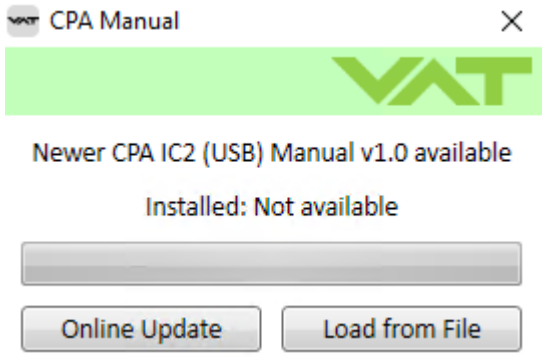
Default scaling for IC1 compatible purpose is:
Position Unit: 0-100000
Pressure Unit: User specific 0-1000000

1.7 About

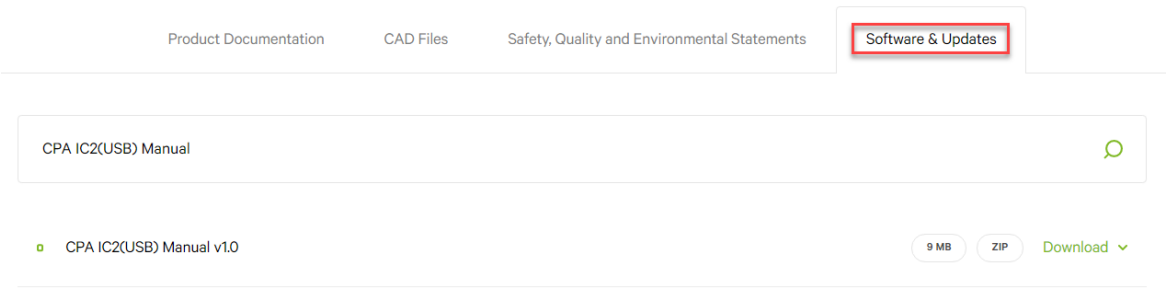
Since the CPA v4.2.1

CPA version
- Shows the current installed CPA version
- For update to latest version see Update (Controller Update Version)

CPA Manual version
- Shows the current CPA Manual version located on the PC.
- Check for Update opens the bellow window:



- Online Update will load the latest CPA Manual version from VAT Homepage automatically if an active internet connection is available.
- Load from File is necessary in case of no internet connection or a specific CPA Manual version is requested.
  - CPA Manual can be downloaded from VAT Homepage see Downloads. Select Software & Updates Tab and filter for CPA IC2(USB) Manual files.


Product Documentation
CAD Files
Safety, Quality and Environmental Statements
Software & Updates
CPA IC2(USB) Manual
CPA IC2(USB) Manual v1.0
9 MB
ZIP
Download

Part II

2 Valve Firmware

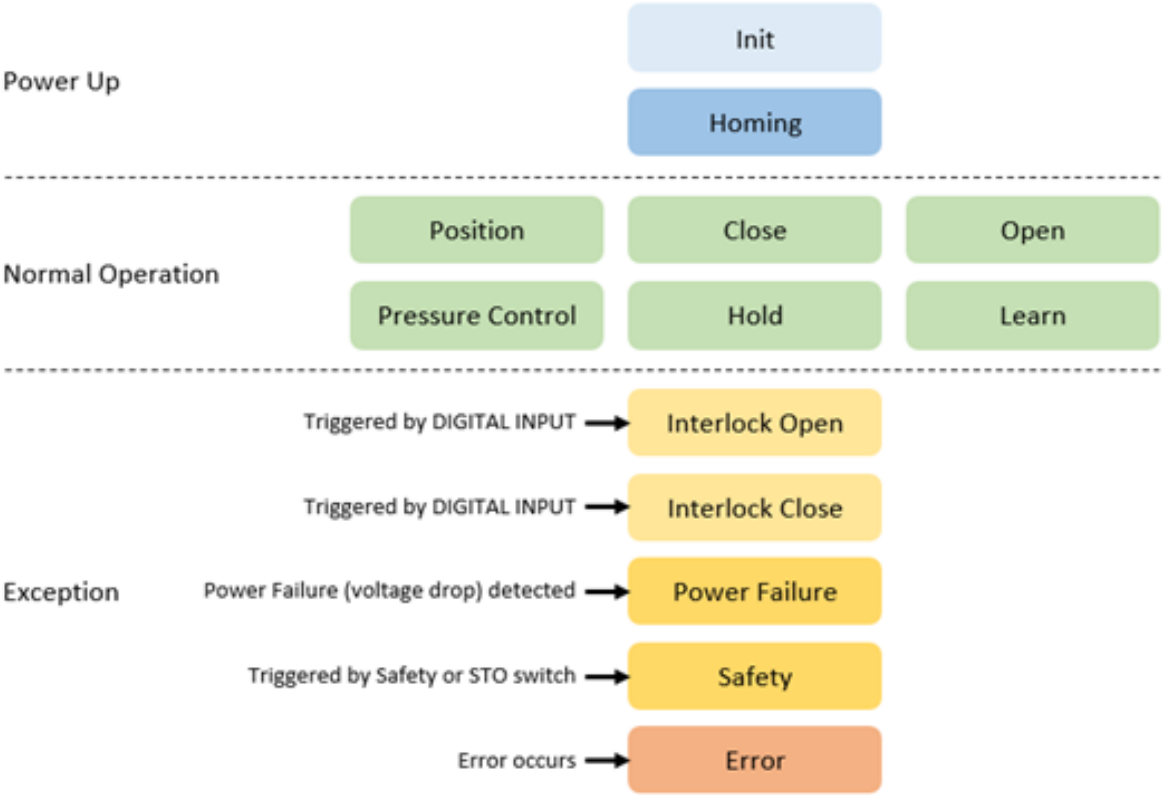
2.1 System

2.1.1 Services

Parameter name	Description
Restart Controller	Emulates a power cycle.
Error Recovery	Resets the *Error* state of the ***Control Mode*** to state *Init*. Alternative set the ***Control Mode*** to *Init* (Value 0) (Example EtherCAT cyclic communication) In some cases Error Recovery is not working (e.g. motor driver is in error state) and therefore a Restart Controller command is required. This function is available since mid-July 2020.
Store/Restore Settings.Restore Factory Parameters	Set Valve back to factory state.
Store/Restore Settings.Store User Parameters	Store all non volatile parameter settings in a backup memory inside the controller.
Store/Restore Settings.Restore User Parameters	Restore all non volatile parameter settings. It is important that a store user parameter function has been executed in the past.
Configuration Lock Mode	If configuration lock mode is enabled, all non volatile parameter are not settable anymore.

2.1.2 Control Mode

The ***Control Mode*** represents the state machine of the valve. Writing to ***Control Mode*** requests a change in the state while reading ***Control Mode*** returns the actual state of the state machine.

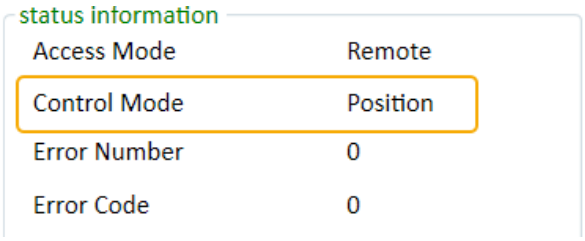


0	*Init*	State after power up. Remains if Homing is not started (see ***Homing.Start Condition***) or no Exception occurs
1	*Homing*	The valve performs the homing procedure to initialize the position. Start condition: depends on set ***Homing.Start Condition*** Behavior at end: depends on set ***Homing.End Control Mode*** Refer to chapter Homing
2	*Position*	The valve moves to the desired ***Target Position***.
3	*Close*	The valve closes.
4	*Open*	The valve opens.
5	*Pressure Control*	The valve controls to the desired ***Target Pressure***. Refer to chapter Pressure Control
6	*Hold*	The valve remains in the actual position. Usage during Pressure Control: • Reduce valve reaction during plasma ignition. • Stopping the valve movement to evaluate the stability of the sensor, flow meter, … Change from ***Control Mode*** 3 *Close* to 6 *Hold* is not possible
7	*Learn*	The valve performs the system learn. Necessary for Adaptive Pressure Control Refer to chaper Learn
8	*Interlock Open*	The valve opens and locks due to the actuation of a digital input. Release behaviour: ***Control Mode*** changes to 4 *Open* or to 1 *Init* if no Homing was performed yet. Refer to Power connector IO
9	*Interlock Close*	The valve closes and locks due to the actuation of a digital input. Release behaviour: ***Control Mode*** changes to 3 *Close* or to 1 *Init* if no Homing was performed yet. Refer to Power connector IO

12	*Power Failure*	Power loss occurred. The valve opens or closes (Only with optional Power Failure Option) Closing or opening behavior depends on set ***Power Failure.Functionality*** Refer to Pow er Failure Option
13	*Safety*	The motor of the valve is powerless due to a digital input. Release behavior: ***Control Mode*** changes to 1 *Init*
14	*Error*	The valve is in an error state, no movement possible. Recovery via ***Services.Restart Controller***. Set ***Services.Error Recovery*** *TRUE* for recovery w ithout restart (no communication lost). Refer to chapter Trouble Shooting

View:

CPA



First digit on display

Init	**I**
Homing	**H**
Close	**C**
Open	**O**
Pressure Control	**P**
Position	**A**
Interlock Open or Close	**I**
Hold	**H**
Learn	**L**
Safety Mode	**S**
Power Failure	**F**
Error	**E**

2.2 Valve

2.2.1 Homing

After a restart homing is necessary to determine the plate position

Parameter	Description	
Start Condition	Homing start option defines when the valve performs the homing procedure.	
	0 Standard	If valve is not in sealed state
	1 Open Command	On an open command
	2 Move Command	On any move command
	3 At Startup	All the time
	4 Homing Command	On homing command
	5 Move Command Without Close	On any move command except close command if the valve is closed
End Control	This control mode is set after a successful homing.	

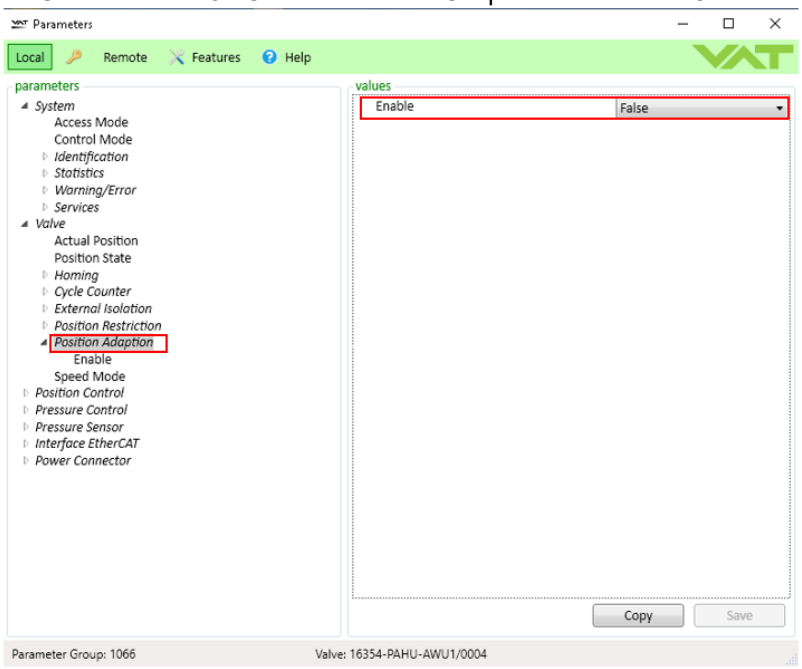
Mode	*2 Position* *3 Close* *4 Open* *5 Pressure Control*
End Position	In case the ***End Control Mode*** is set to *2 (Position)*, this parameter defines which position is set after successful homing.

2.2.2 Position Adaption

2.2.2.1 Offset

How to use the Position Offset at Single Valve

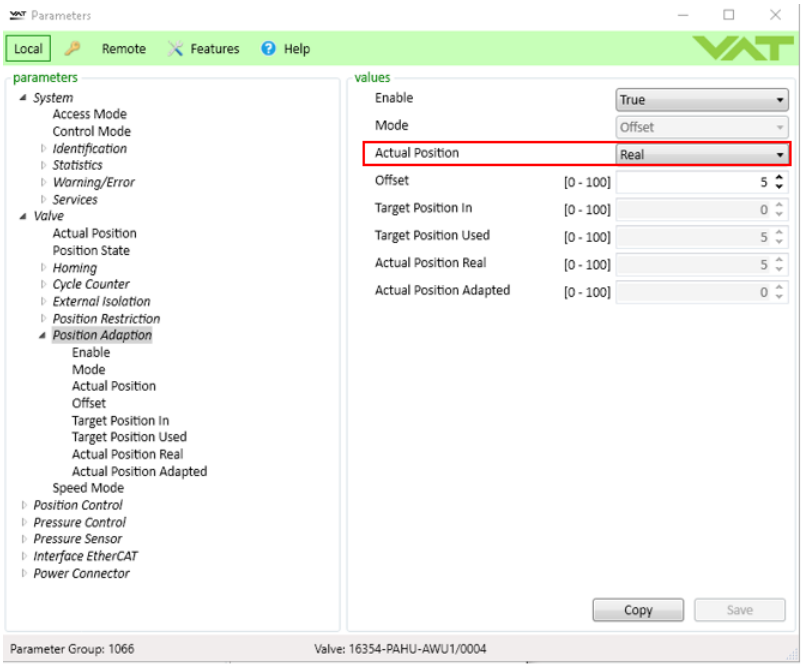
If the User wants to set a Position Offset, than the first step would be to “Enable” the “Position Adaption”, what is possible over the CPA4 under Parameters.Valve.PositionAdaption.Enable à “TRUE” or via RS232 Command – see Chapter Set Position Offset via RS232



Picture : Enable - Position Adaption

The Parameter “Actual Position”, what is shown in picture bellow, is a possibility for the user to show the Adapted Position or the Real Position of the Valve.

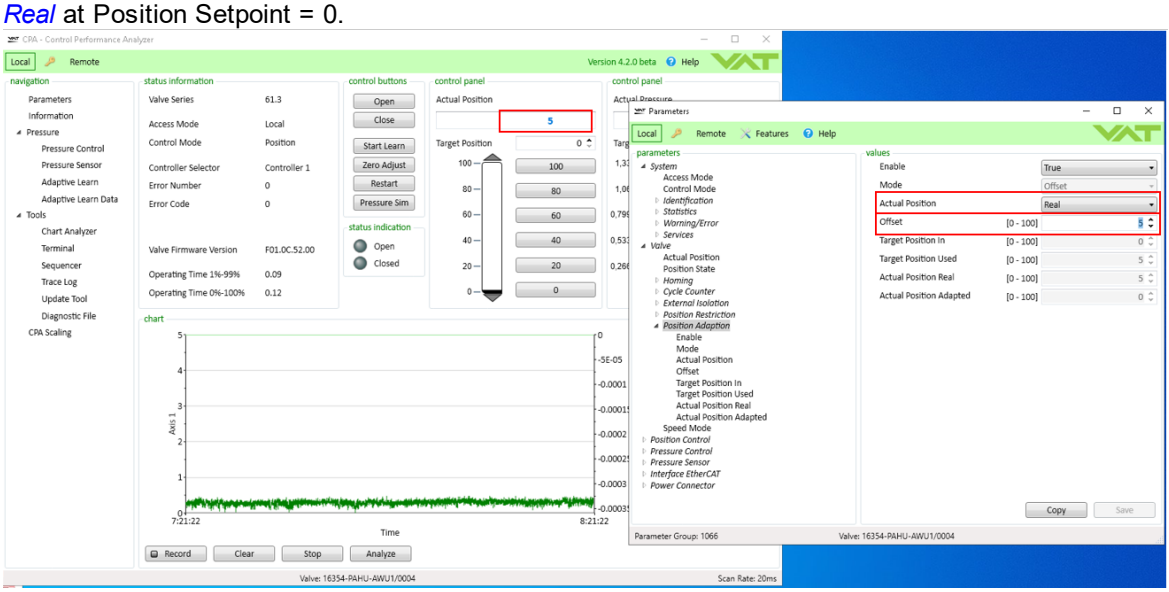
Actual Position:	Real	=	Position Setpoint + Offset
	Adapted	=	Position Setpoint



Picture : Actual Position - Option

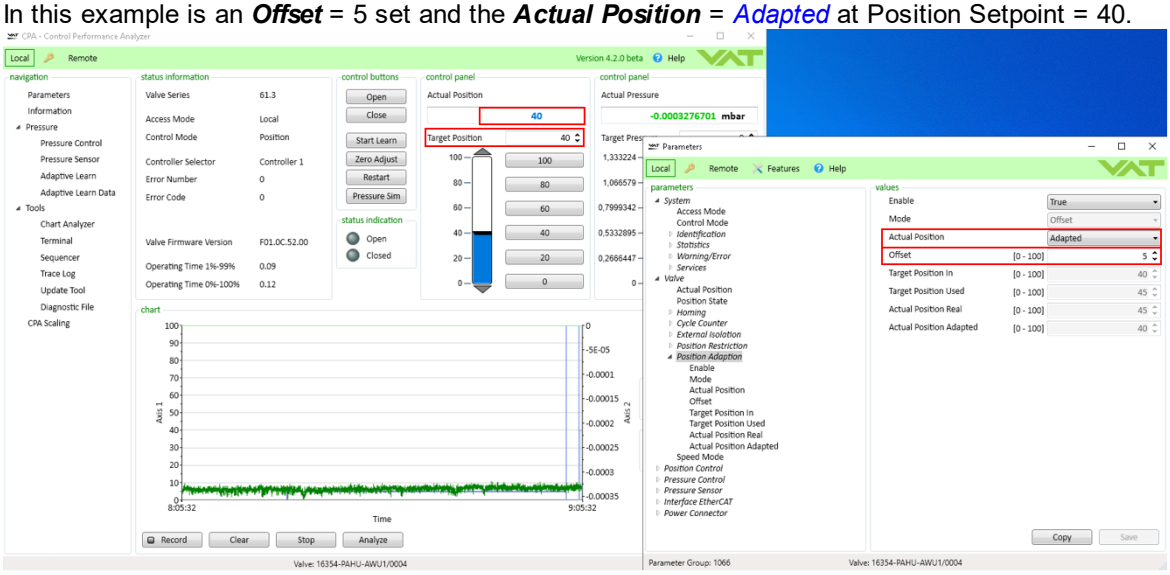
Now, if the Position Adaption is «Enabled» the user can set under the Parameter ***Parameter.Valve.PositionAdaption.Offset*** the desired Offset.

For example the User want to set an ***Offset*** = 5 and have selected the Option ***Actual Position*** = *Real* at Position Setpoint = 0.



Picture : Example with Actual Position Option - Real

In this example is an ***Offset*** = 5 set and the ***Actual Position*** = *Adapted* at Position Setpoint = 40.



Picture : Example with Actual Position Option = Adapted

The Position Offset is not active, if an Open or Close command is processed or the Valve is in Control Mode: Open or Close.

2.2.3 Oring Pull Out Prevention

The stiction effect occurs when the valve has been closed for a long period of time and when the valve has cooled down after heating up in the closed position.
The surface finish and the chemical properties of the process can intensify this effect.
It is possible that the O-ring of the sealing ring is pulled out of the groove, this leads to a loss of the sealing function.
The subsequent movement of the disc damages the O-ring. Immediate service is necessary.

2.2.3.1 Settings

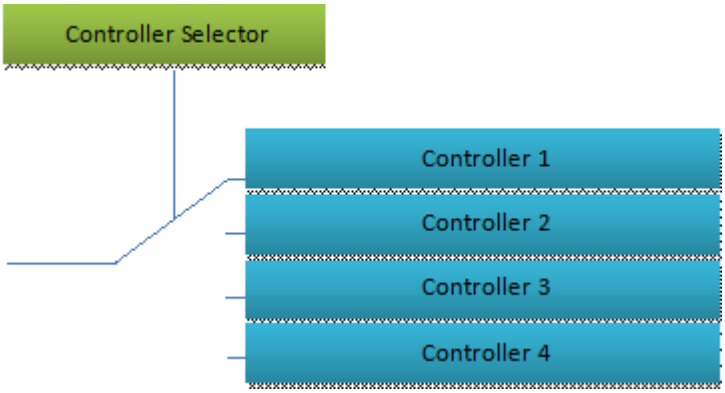
This function is available for valve series 620, 653, 655 and 670.

When opening, the sealing ring is lifted via compressed air. The plate remains in its position and waits for the set delay time.
This gives the O-ring time to release itself from the plate. The occurrence of the stiction effect can be reduced in this way.

Parameter	Description
Enable	Activate the function
Delay Homing	Delay time until start of *Homing* First opening after a power down
Delay Close	Delay time at all further openings after the *Homing*

2.3 Pressure Control

The valve has four identical pressure controller units. Controller Selector defines which unit is used for the pressure control.
Most applications do not need more than one controller unit. But if the result of the pressure control does not meet the expectations, the different controller units can be used for optimization: With the four controller units it's possible to use an own controller unit for a specific pressure working point. This controller unit can be parametrized optimally for this specific working point.



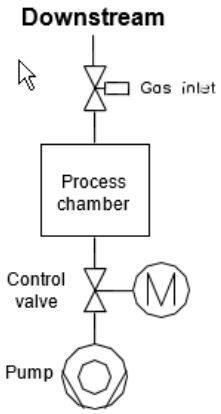
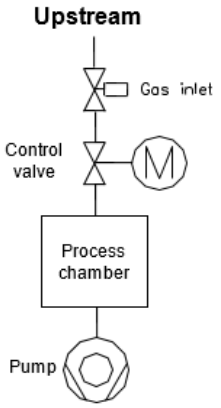
2.3.1 Control Algorithm

2.3.1.1 Overview

Control Algorithm	Description
Adaptive	This is the most dynamic control algorithm. Before using adaptive control algorithm, a special procedure called "learn" must be executed first (see chapter Execute a learn procedure). The valve will observe the behavior of the vacuum system by moving the valve to different positions. During the learn procedure the valve performs an internal parameter estimation correspondent to the vacuum system. Note: The adaptive pressure control work at its best if the conditions (mainly gas flow) are close the conditions at the learn procedure.
PI	This is a solid algorithm for pressure control. The performance will be behind the adaptive control algorithm. But if the condition varies a lot, it's possible that the adaptive control algorithm does not work properly so the PI algorithm provides the best result.
Soft Pump	Is a modified PI control algorithm to pump down from atmospheric pressure. This control algorithm has been optimized to prevent that the pressure in the chamber is falling too fast (reduce occurrence of undershoots).

2.3.1.2 Choose correct control algorithm

System Configuration	Constant gas flow available	Constant gas flow

	Tv*<= 500 sec	Tv* > 500 sec	
	**Adaptive**	**PI**	
	**PI**		
Soft Pump	**Soft Pump**		

* Use the formula below to define the applicable pressure control algorithm.

$$Tv = \frac{P_{SFS} \bullet CV}{q_L}$$

q_L gasflow for learn [mbarl/s]
p_{SFS} sensor full scale pressure [mbar]
Tv* Vacuum time constant [sec]
CV Chamber Volume [l]

2.3.2 Adaptive algorithm

This control algorithm may be used for downstream pressure control.
Before using adaptive control algorithm, a special procedure called “learn” must be executed first (see chapter Execute a learn procedure).

2.3.2.1 Control Parameter

Parameter	Description
Gain Factor	Main parameter to adapt the performance of the pressure control algorithm. A higher gain results in a faster response, higher over- / undershoots of pressure. A lower gain results in slower response, lower over- / undershoot of pressure.
Sensor Delay	For compensation of delays during the pressure detection. Pipes and orifices for sensor attachment can cause delays in response time and could impact badly the pressure control stability. By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.
Learn Data Selection	There are up to 4 different learn data sets available. Select which Learn Data set the adaptive controller shall use for pressure control.

2.3.2.2 Learn

Learn adapts the PID controller of the valve to the vacuum system and its operating conditions. Learn must be executed only once during system setup. The Learn routine determines the characteristic of the vacuum system. Based on this, the PID controller is able to run fast and accurate pressure control cycles.
This characteristic depends on various parameters such as chamber volume, conductance and flow regime. Therefore it must be performed with a specific gas flow according to instruction below.
The result of Learn is a pressure versus valve position data table. This table is used to adapt the PID parameters. The data table is stored in the device memory which is power fail save. The data table can be up-/downloaded via 'Control Performance Analyzer' software or remote interface. Due to encoding the data may not be interpreted directly.
By an *Open*, *Close*, *Position* or *Pressure Control* command the routine will be interrupted.

Parameter	Description
Bank Selection	Select one of four learn bank to place the result of the learn procedure. Note: Be sure pressure controller select this learn bank!
Pressure Limit [SFS]	Limit pressure to which pressure the learn shall be executed. The value is related to the sensor full scale of high sensor. 1.0 means the whole pressure range of the sensors
Open Speed	Define the speed for opening the valve during the learn procedure. May be necessary to prevent a pump from crashing. 1.0 means full speed
Status	State of the current learn *0: Not Started* *1: In Progress* *2: Completed Successfully* *3: Aborted* *4: Failed*

Warning Info	Warning of current learn procedure: *Bit 0: Learn is running* *Bit 1: Checksum error (learn data corrupt)* *Bit 2: Learn procedure terminated by user* *Bit 3: Pressure at position open > 50% of pressure limit* *Bit 4: Pressure at minimal conductance position < 10 % of pressure limit* *Bit 5: Pressure falls while move valve in direction of close* *Bit 6: Pressure at open position does not match pressure of previous open* *Bit 7: Learn procedure terminated by program* *Bit 8: Pressure <= 0 at open position (no gas flow set?)*

Execute a learn procedure

1. Set specific gas flow according to calculation (Gasflow calculation for Learn) or select Calculate button in CPA Adaptive Learn window:

   Learn does not need to be performed with the process gas. Instead N_2 or Ar may be used.

2. Set parameter ***Bank Selection***, if only one learn is used take Bank 1. Be sure that the pressure controller also selects this learn bank!
3. Reduce ***Open Speed*** if it is critical for the chamber if the pressure drops rapidly when the valve is opened.
4. Set a ***Pressure Limit [SFS]*** limit if sensor full scale cannot or should not be reached.
5. Set parameter ***Control Mode*** to *Learn* or press Start Learn button in CPA Adaptive Learn window.
6. Wait until the ***Control Mode*** leaves the *Learn* state which means the Learn procedure is finished or wait until progress bar is continue in CPA Adaptive Learn window.
7. Check if the learn was successful by checking if ***Status*** shows value 2 (=Completed Successfully). In best case ***Warning Info*** shows no warning.

➔Sensor signal must not shift during LEARN. Wait until sensor signal is stable before LEARN is performed. Learn may take several minutes.
➔Do not interrupt the routine as a single full run is required to ensure fast and accurate pressure control.
➔The PID controller covers 5% to 5000% of the gas flow which was used for learn.

Gasflow calculation for Learn

Do not apply a different gasflow for learn than determined below. Otherwise pressure control performance may be insufficient. Required pressure / flow regime must be known to calculate the most suitable learn gas flow for a specific application.

1. At first it is necessary to find out about the required control range respectively its conductance values. Each working point (pressure / flow) must be calculated with one following formulas. Choose the applicable formula depending on units you are familiar with.

$$C_{WP} = \frac{1000 \bullet q_{WP}}{p_{WP}}$$

C_{WP} required conductance of working point [l/s]
q_{WP} **gasflow** of working point [**Pa m3/s**]
p_{WP} **pressure** of working point [**Pa**]

$$C_{WP} = \frac{q_{WP}}{p_{WP}}$$

C_{WP} required conductance of working point [l/s]
q_{WP} **gasflow** of working point [**mbar l/s**]
p_{WP} **pressure** of working point [**mbar**]

$$C_{WP} = \frac{q_{WP}}{78.7 \bullet p_{WP}}$$

C_{WP} required conductance of working point [l/s]
q_{WP} **gasflow** of working point [**sccm**]
p_{WP} **pressure** of working point [**Torr**]

2. Out of these calculated conductance values choose the lowest.

$$C_R = \min(C_{WP1}, C_{WP2}, \ldots, C_{WPn})$$

C_R required lower conductance [l/s]
C_{WPx} required conductance of working points [l/s]

To make sure that the valve is capable to control the most extreme working point verify that CR ≥ Cmin of the valve (refer to «Technical data»).

3. Calculate gasflow for learn. Choose the applicable formula depending on units you are familiar with.

$$q_L = \frac{p_{SFS} \bullet C_{min}}{1100}$$

q_L gasflow for learn [**Pa m^3/s**]
p_{SFS} sensor full scale pressure [**Pa**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

$$q_L = \frac{p_{SFS} \bullet C_{min}}{1.1}$$

q_L gasflow for learn [**mbar l/s**]
p_{SFS} sensor full scale pressure [**mbar**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

$$q_L = 71 \bullet p_{SFS} \bullet C_{min}$$

q_L gasflow for learn [**sccm**]
p_{SFS} sensor full scale pressure [**Torr**]
C_{min} min. controllable conductance of valve [l/s], (refer to «Technical data»)

2.3.2.3 Tuning

Gain Factor adjustment

The Gain Factor effects: **Stability, Response time**

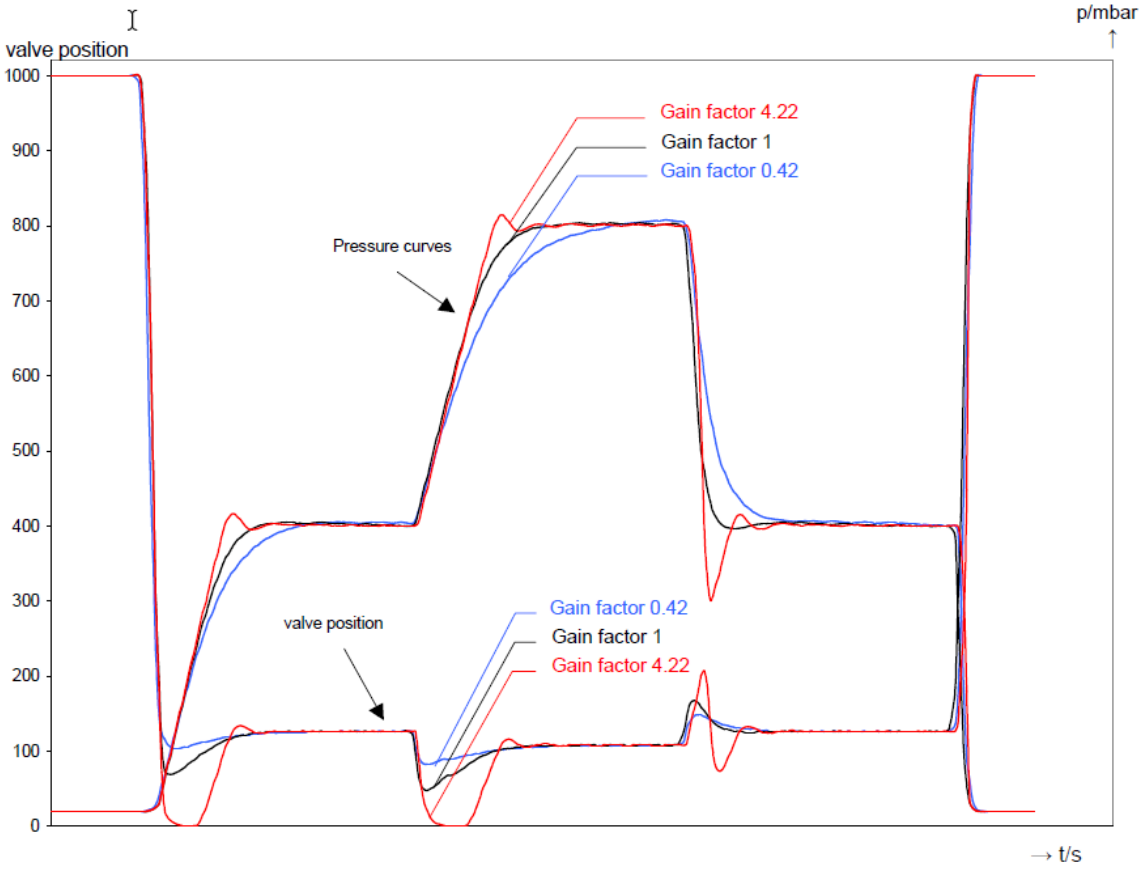
- Higher gain results in: faster response, higher over- undershoot of pressure
- Lower gain results in: slower response, lower over- undershoot of pressure

Adjustment procedure:

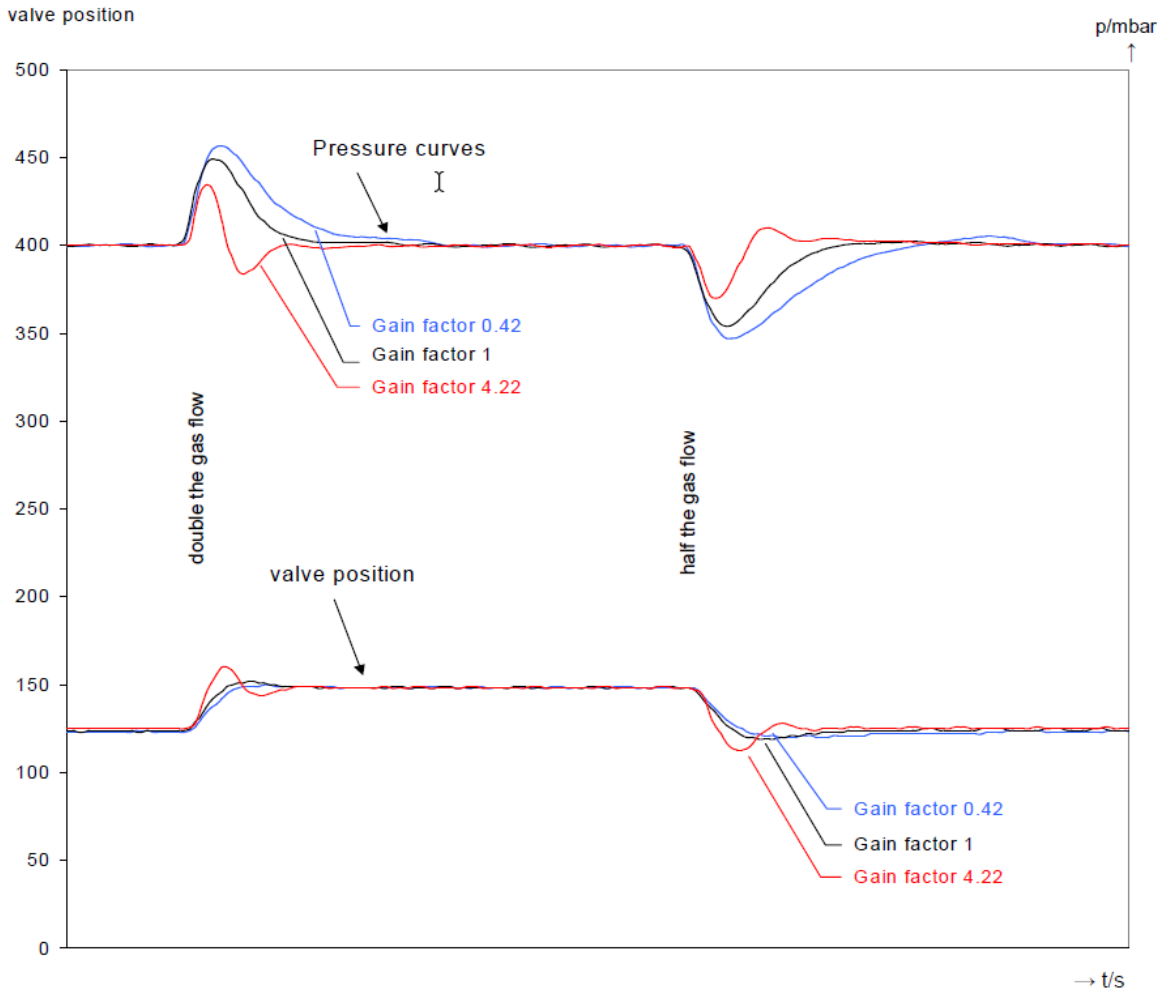
1. Start with Gain Factor 1.0
2. Open valve.
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with lower (higher) Gain Factors until optimal pressure response is achieved and stability is ok.

Normally adjustments down to Gain Factors of 0.42 should lead to good results. Otherwise you may need to improve sensor connection. Refer to «Requirements to sensor connection».

Below graph shows response when changing pressure setpoint command:



Below graph shows response when changing gas flow:



Sensor Delay adjustment

Sensor Delay adjustment effects: **Stability**

Adjustment range is from 0.0 to 1.0sec

Pipes and orifices for sensor attachment delay response time and so badly impact pressure control stability.
By adapting this parameter to the approximate delay time stability problems can be reduced. But control response time will be slowed down by this measure.

Whenever possible sensors should be attached to the chamber according to «Requirements to sensor connection». This is the most effective measure against stability issues. If your gauge attachment fulfills these criteria do not use this parameter.

Adjustment procedure:

1. Start with Gain Factor 1.0 and sensor delay 0s.
2. Open valve.

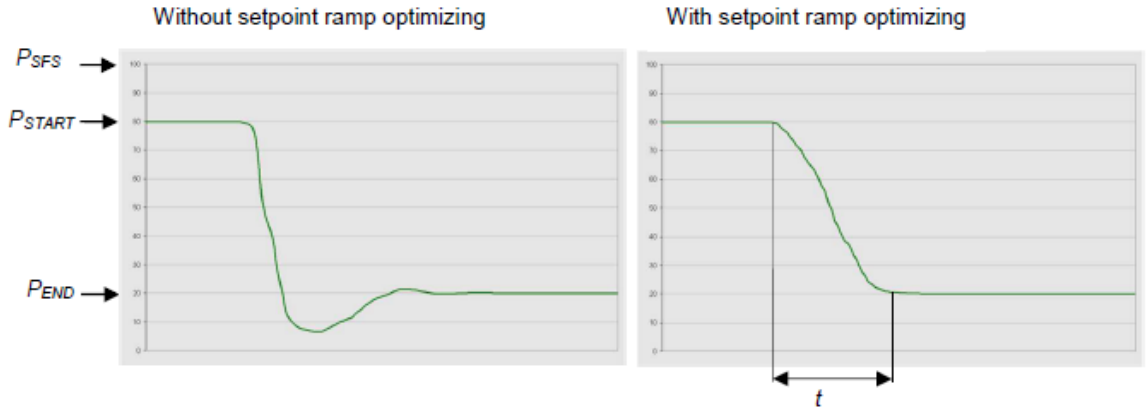
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with higher sensor delays until best possible stability is achieved.
5. Adjustment Gain Factor again. Refer to «Gain factor adjustment».

Setpoint Ramp adjustment

Setpoint Ramp effects: **Undershoot of pressure, Response time**

This parameter defines the time that is used to decrease / raise pressure between 2 setpoints. Especially in pressure decrease situations at low flows pressure response can be improved much by adapting setpoint ramp time.

Pressure chart



Choose the applicable formula depending on units you are familiar with.

t = Setpoint Ramp

Adjustment procedure:

1. Start with optimal Gain Factor and sensor delay time according to preceding tuning steps.
2. Control a typical pressure / flow situation.
3. Control a lower pressure.
4. Repeat from step 2 with longer setpoint ramps until best response is achieved.
5. Verify pressure control response for a setpoint raise situation.

In case a long ramp time is required to get optimal performance for pressure decrease situations it may be of advantage to apply different settings for decrease / raise control situations.

Pressure Control Speed adjustment

Valve speed effects: **Response time**

Adjustment range is from 0.001 to 1.0
Default value is 1.0

This parameter effects valve plate actuating speed.
Speed adjustment is effective for PRESSURE CONTROL and POSITION CONTROL.

Normally best pressure control response is achieved with maximum Pressure Control Speed. In particular applications it may be of advantage to have a slower valve response.
OPEN and CLOSE are always done with maximum speed.

Adjustment procedure:

1. Use optimal Gain Factor, sensor delay time and setpoint ramp according to preceding tuning steps.
2. Open valve.
3. Control a typical pressure / flow situation.
4. Repeat from step 2 with slower Pressure Control Speed until required response is achieved.

Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to **tuning-support@vat.ch**

2.3.3 PI algorithm

This control algorithm may be used for downstream or upstream pressure control depending on configuration.

2.3.3.1 Control Parameter

Parameter	Description
P-Gain	The ***P-Gain*** is the proportional factor of the fixed control algorithm. A higher ***P-Gain*** results in faster response, higher over- / undershoot of pressure.
I-Gain	The ***I-Gain*** is the integral factor. The ***I-Gain*** helps to reach the target pressure exactly.
Direction	The ***Control Direction*** defines the type of application, if the valve is mounted in downstream or upstream. Downstream means the valve is after the chamber and before the pump. Upstream, valve is mounted before chamber and pump.

2.3.3.2 Tuninig

The PI parameters of the pressure controller require correct adjustment. These parameters must be set once during system setup and are stored in the device memory which is power fail save. Based on the PI controller configuration, the valve is able to run fast and accurate pressure control cycles. The PI parameters can be evaluated using below instruction.

- In downstream control mode valve will move towards open when current pressure is higher than set point.
- In upstream control mode valve will move towards close when current pressure is higher than set point.

Introduction
PI controller mode is used if for any reason (e.g. too long system time constant) the adaptive control mode does not provide satisfying control performance.
In PI controller mode the parameters P-Gain and I-Gain have to be set according to the systems characteristics. The best set of parameters can be found by using the empiric method below.

Pressure and gas flow for optimization

A PI controller delivers the best results for a certain working point (pressure/gas flow). If there is only one working point, this pressure and gas flow has to be used for optimizing P and I-Gain. If there are several working points that have to be covered, the pressure for optimizing is the medium pressure between highest and lowest pressure to be controlled, the gas flow for optimizing is the highest flow out of all working points.

Two different pressure set points are necessary for optimization.
Set point 1 (SP1) is the pressure for optimizing as determined above.
Set point 2 (SP2) is about 10 - 20% lower than SP1.

Example: pressure range: 4 – 10 Torr
Flow range: 2 – 4 slm

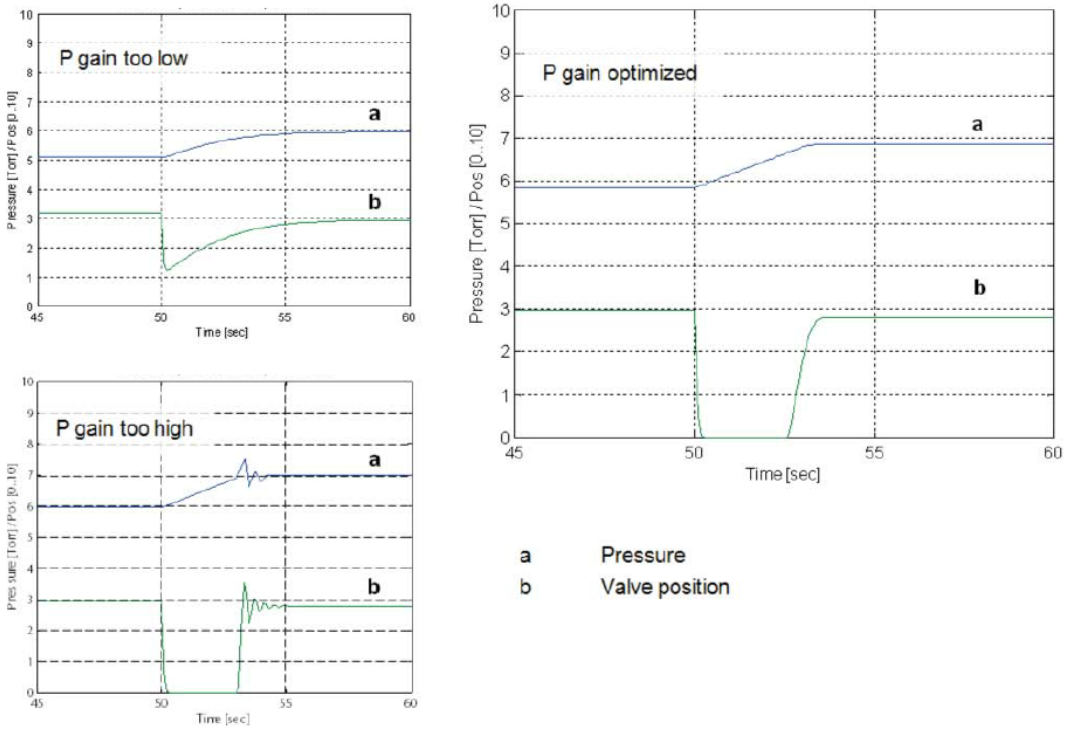
Pressure set points and gas flow for optimization:
SP1 = 7 Torr
SP2 = 6 Torr
Gas flow = 4 slm

Optimization P-Gain

While optimizing P-Gain, the gas flow determined above has to be constant all the time.

Start optimization with P-Gain set to 1.0 and I-Gain set to 0.0.
Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or even does not stabilize at all, the P-Gain is too high. If there is no over shoot and the pressure reaches SP1 asymptotically and very slow, P-Gain is too low.
The optimal P-Gain value is found if the transition from SP2 to SP1 results in a slight pressure over shoot. It does not matter if there is still a deviation between SP1 and actual pressure.

Example:

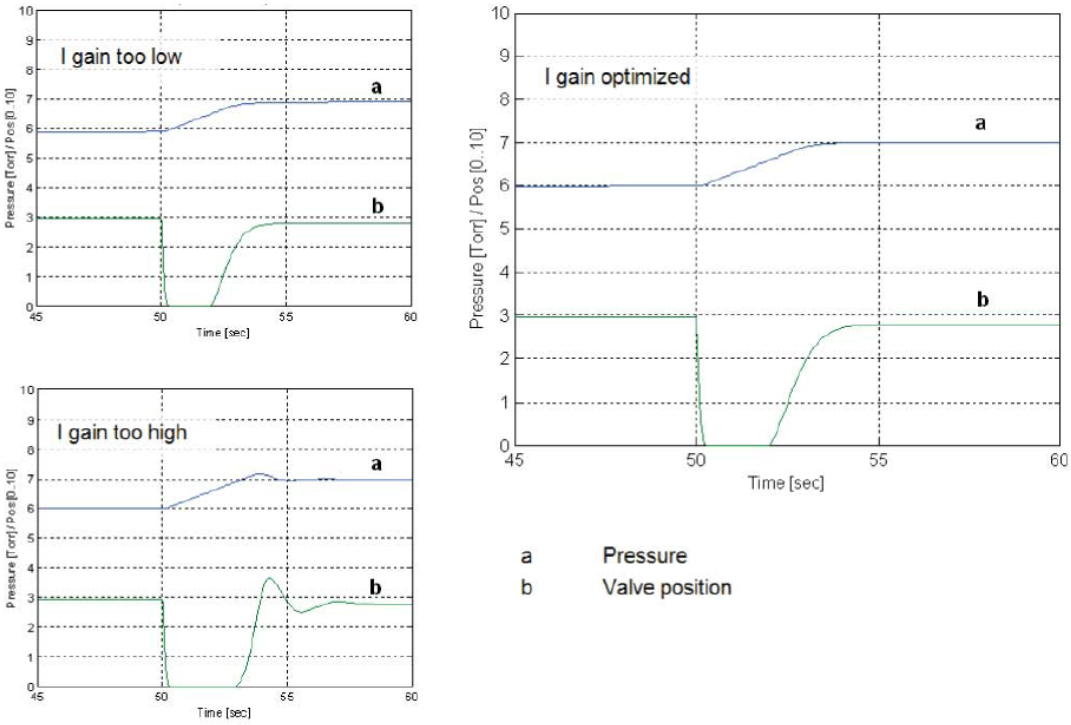


Optimization I-Gain

While optimizing I-Gain, the gas flow determined above has to be constant all the time.

Start with P-Gain set to half of the value found when optimizing P-Gain and set I-Gain to 1.0.
Keep the P-Gain constant.
Set chamber pressure to SP2, wait until the pressure is stable. Set pressure to SP1. If the transition from SP2 to SP1 results in a significant pressure over shoot or if the valve position does not stabilize, I-Gain is too high. If the transition results in a slow asymptotical pressure rise and there is still a constant deviation to SP2, the I-Gain is too low.
The optimal value for I-Gain is found if the transition from SP2 to SP1 result in just a slight pressure over shoot, a stable valve position and the actual pressure matches SP2 exactly.

Example:



Check control performance over the whole control range with parameters above.

Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to **tuning-support@vat.ch**

2.3.4 Softpump algorithm

This control algorithm may be used to control pressure ramps during pump down.

2.3.4.1 Control Parameter

Parameter	Description
P-Gain	The ***P-Gain*** is the proportional factor of the fixed control algorithm. A higher P-Gain results in faster response, higher over- / undershoot of pressure.
I-Gain	The **I-Gain** is the integral factor. The ***I-Gain*** helps to reach the

	target pressure exactly.
Ramp	See chapter Pressure Ramp

2.3.4.2 Tuning

Optimizing P-Gain

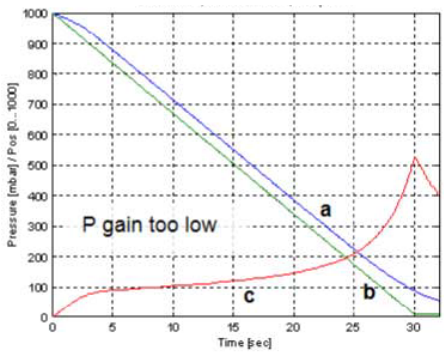
Start optimization with P-Gain set to 0.1 and I-Gain set to 0.0.
The pump down routine has to be controlled as follows:

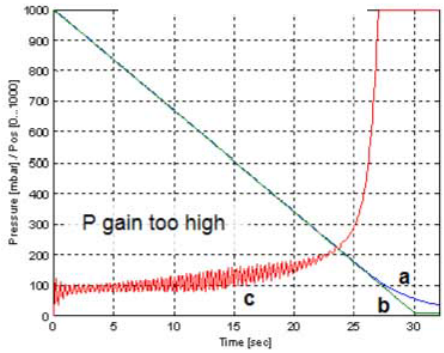
- Move control valve into close position
- Start pump down by opening the pump isolation valve or starting the pump
- Send the pressure set point to the valve controller.

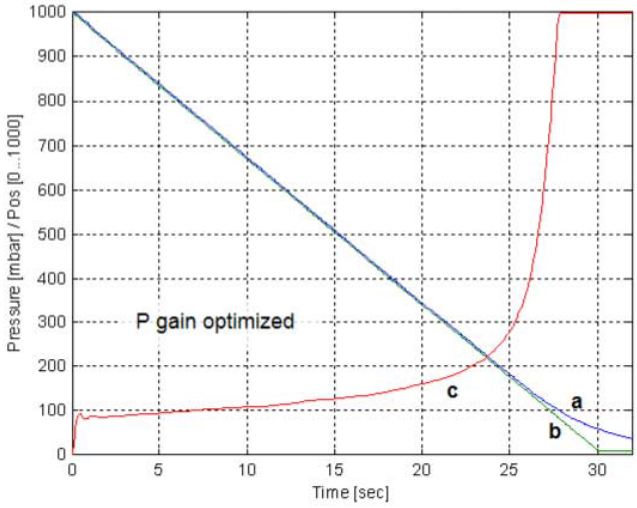
While pumping down chamber pressure and valve position should be data logged to compare the actual pump down curve with the ideal straight pump down line.
If the pressure follows the ideal pump down line with significant delay, the P-Gain is too low.
If the pressure oscillates around the ideal pump down line or if the valve position oscillates, P-Gain is too high.

P-Gain is optimized if the pressure follows the ideal pump down line closely and the valve position is not oscillating at all.

Example:







a Pressure
b Ideal straight pump down line
c Valve position

Optimizing I-Gain

I-Gain is responsible to reach the setpoint. If reaching setpoint is not important (e.g. setpoint is 0) leave the I-Gain at 0. Otherwise start with P-Gain set to half of the value found when optimizing P-Gain and set I-Gain to 0.1. Keep the P-Gain constant. Start again the pump down. Check how the pressure reaches the setpoint:
If the setpoint is reached too slowly increase I-Gain
If there is an undershoot increase I-Gain

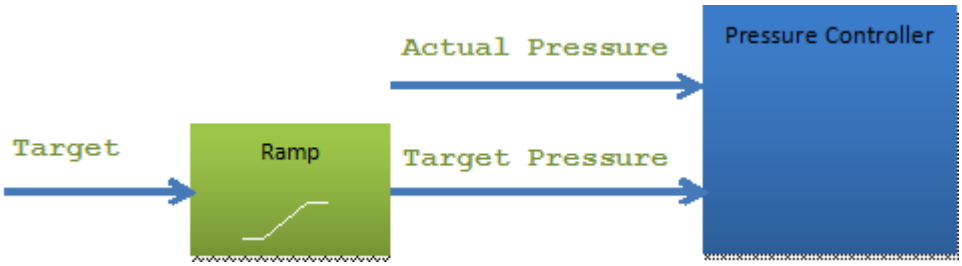
Required information for support:

- Go to 'Tools / Create Diagnostic File' in 'Control Performance Analyzer' and save file
- Pressure / flow / gas conditions to be controlled
- Chamber volume
- Pumping speed (l/s) and pump type (e.g. turbo pump)
- System description
- Problem description

Send diagnostic file with and all required information to **tuning-support@vat.ch**

2.3.5 Pressure Ramp

Basically, the pressure ramp is used to limit the rate of pressure change. It can also be used to minimize over- / undershoot of pressure.



2.3.5.1 Configuration

Parameter	Description
Enable	Activate / Deactivate pressure target ramp
Mode	*0:Use Ramp Time* *1:Use Ramp Slope* See description below
Time	Target reach time in seconds (Used if ***Mode*** = 0)
Slope	Limit the rate of pressure change in pressure per seconds (Used if ***Mode*** = 1)
Type	*0:Linear* *1:Logarithmic* *2:Exponential*
Start Value	*0:Previous Ramp Value*

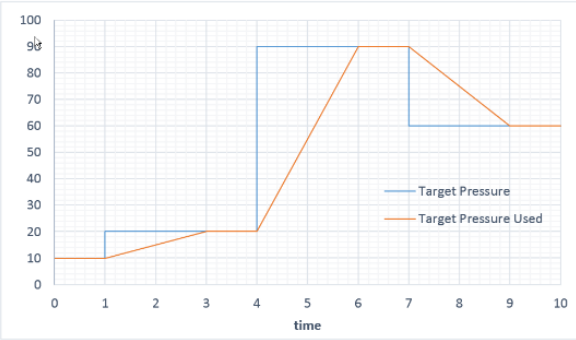
1:Actual Pressure Value

2.3.5.2 Mode

Time

Time is constant, slope varies

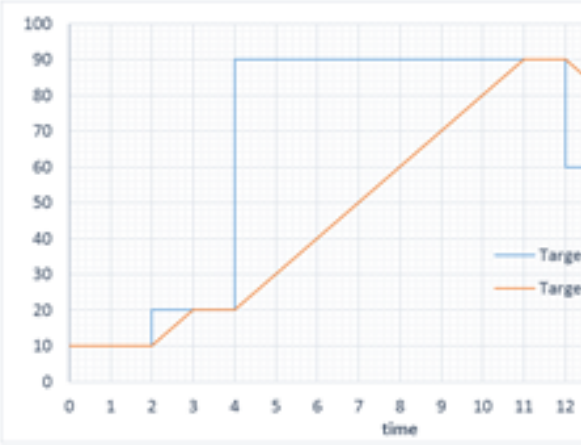
Example: 2sec



Slope

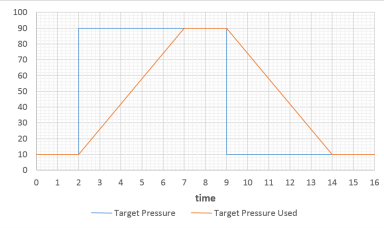
Slope is constant, time varies

Example: 10mTorr/second

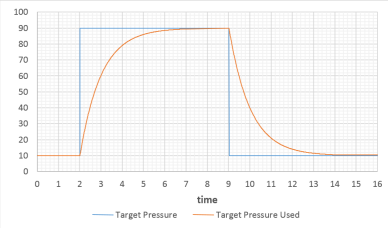


2.3.5.3 Type

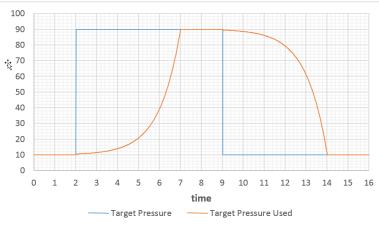
Linear



Logarithmic



Exponential



2.3.5.4 Applications Examples

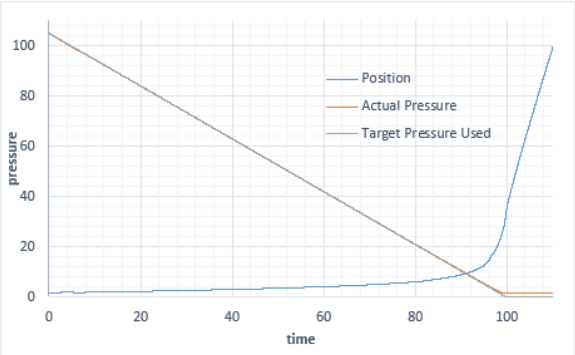
Softpump

Ramp Mode: Time

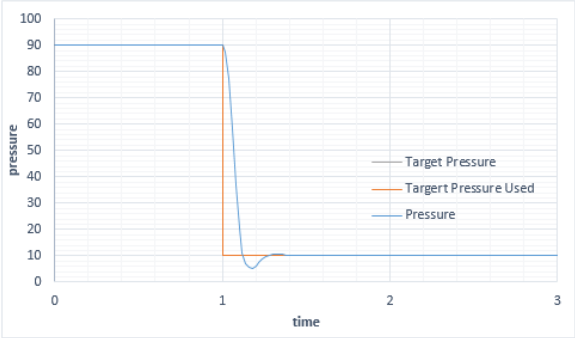
Ramp Time: 100 s

Ramp Type: Linear

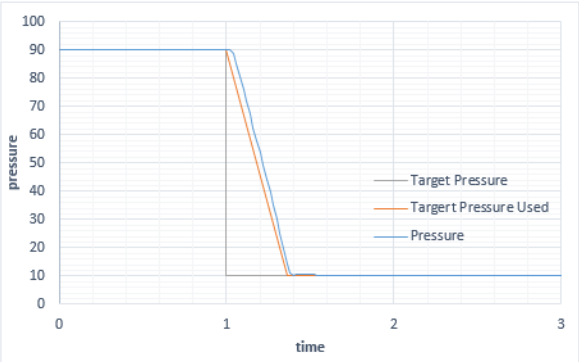
Nominal pressure: 0



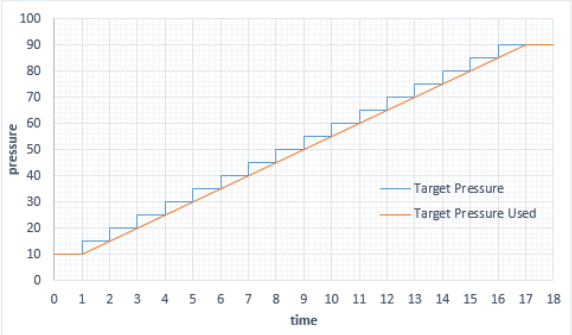
Without pressure ramp



With pressure ramp



Step information



Ramp Time: 1 s

Nominal pressure: 90

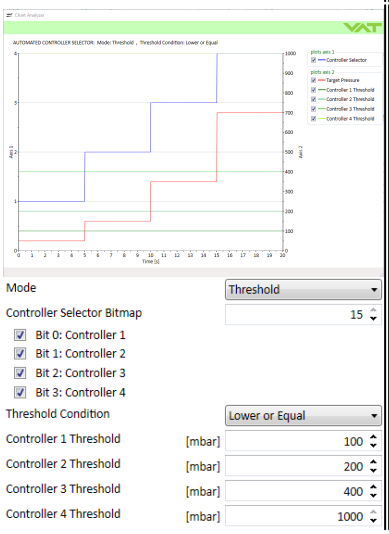
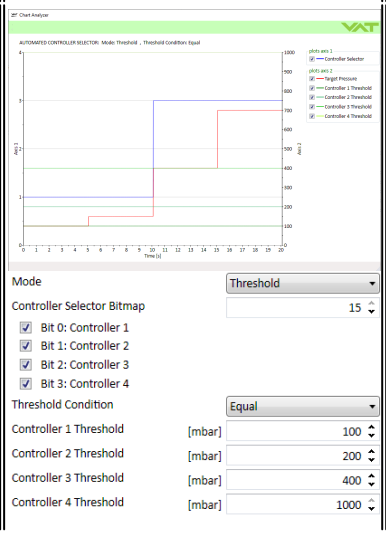
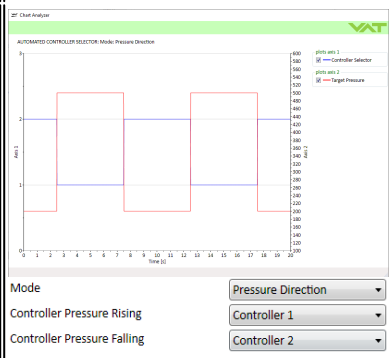
2.3.6 General Settings

2.3.6.1 Automated Controller

Define different Control Settings for different pressure ranges or for up - and down control

With the 4 Controllers it is possible to define different pressure control settings.
The Automated Controller Selector can select one of the 4 Controllers depending on (either or)

- Target Pressure (***Mode***: *Threshold*)
- Up- or Down Control (***Mode***: *Pressure Direction*)

Mode: *Threshold* ***Threshold Condition***: *Lower or Equal*	***Mode***: *Threshold* ***Threshold Condition:*** *Equal*	***Mode***: *Pressure Direction* ***Controller Pressure Rising***: *Controller 1* ***Controller Pressure Falling***: *Controller 2*
Controller Selector changes when the ***Target Pressure*** is below a specified ***Threshold*** value If ***Target Pressure*** is lower than several ***Thresholds*** values, the lowest one is taken. If ***Target Pressure*** is higher than the highest ***Threshold***, the highest one is taken.	***Controller Selector*** changes only when the ***Target Pressure*** is equal to a ***Threshold*** value	***Controller Selector*** changes depending on whether ***Target Pressure*** is rising or falling
		

Parameter:

Pressure Control.General Settings.Automated Controller Selector

Parameter	Description
Enable	Switches on/off the function
Mode	*Threshold* *Pressure Direction*
Controller Selector Bitmap	Used if ***Mode*** = *Threshold* Defines which controllers are automatically selected
Threshold Condition	Used if ***Mode*** = *Threshold* *Lower or Equal* *Equal* The Thresholds are related to ***Target Pressure***
Controller 1 Threshold ***Controller 2 Threshold*** ***Controller 3 Threshold*** ***Controller 4 Threshold***	Used if ***Mode*** = *Threshold* The Thresholds are related to ***Target Pressure***
Controller Pressure Rising	Used if ***Mode*** = *Pressure Direction* Select one Controller for up control and one for down control

Parameter	Description
Controller Pressure Falling	*Controller 1* *Controller 2* *Controller 3* *Controller 4*

2.3.6.2 Profile Ramp

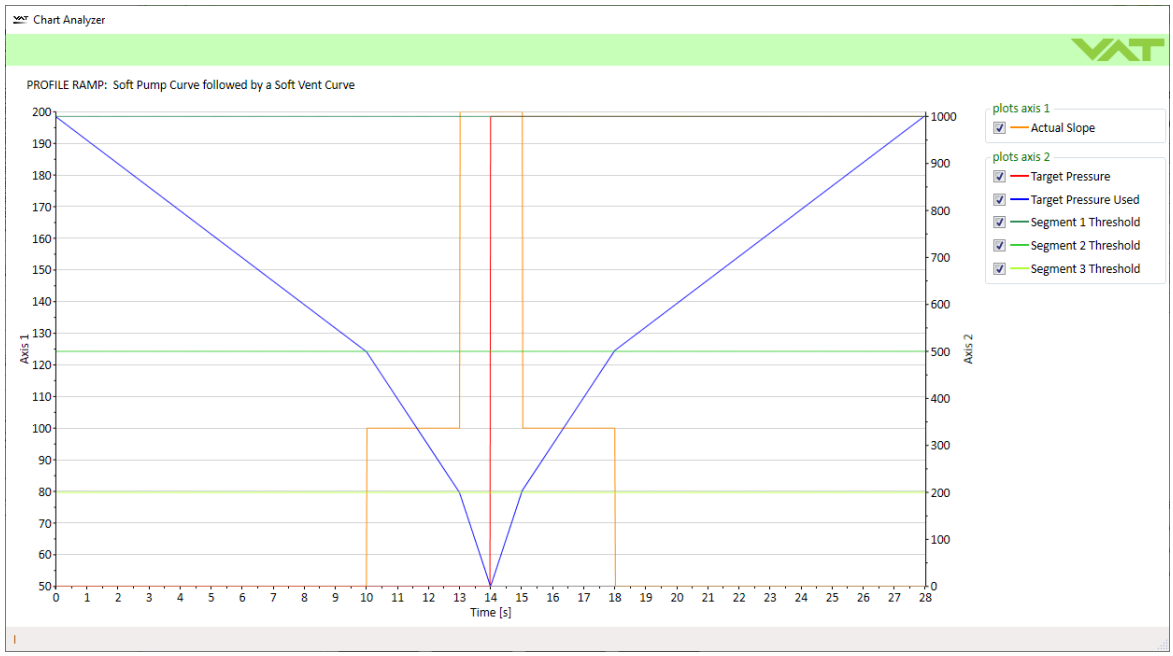
Profile Ramp is a Target Pressure ramp that depends on pressure ranges (segments).
It is mainly used to create soft pumping or soft venting profiles.

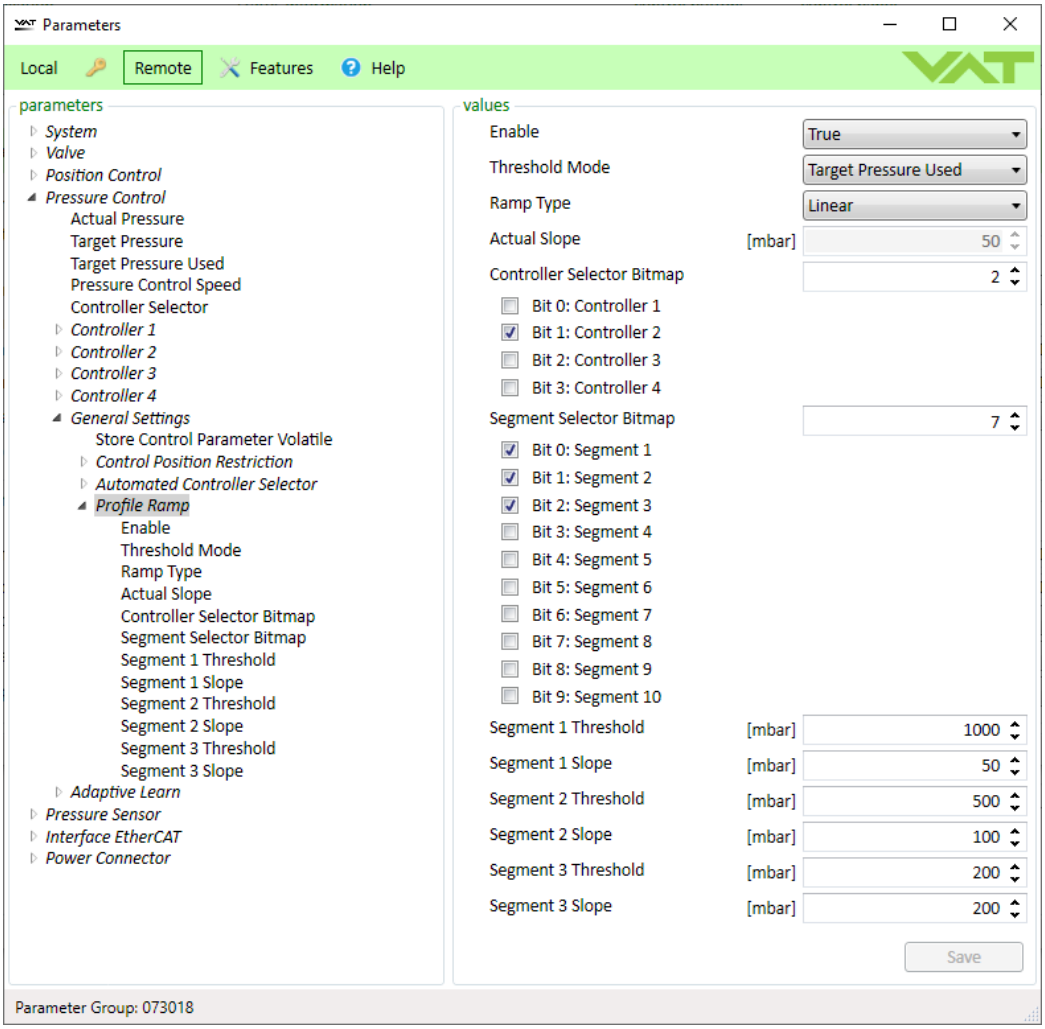
To design a profile, the segments (pressure ranges) must be defined
A segment is defined by the pressure Threshold and the Slope.
It is possible to define up to 10 segments.

Segment Nr	***Threshold*** mBar*	Resulting Segment mBar*	***Slope*** mBar*/sec
1	1000	500 to 1000	50
2	500	200 to 500	100
3	200	0 to 200	200

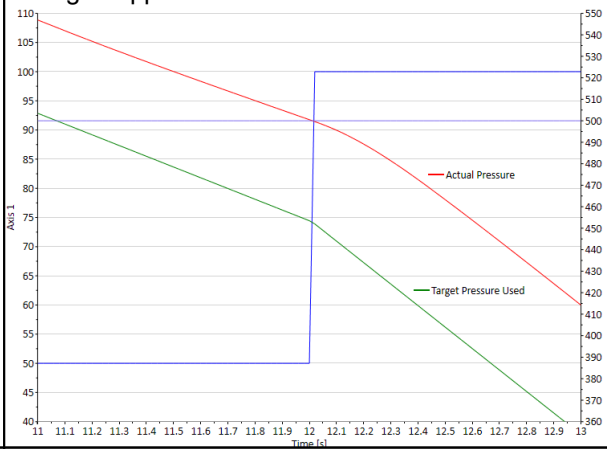
Example: Ramp Profile with 3 segments

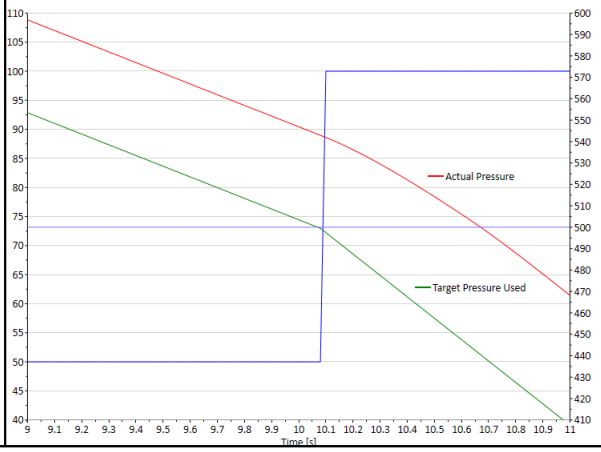
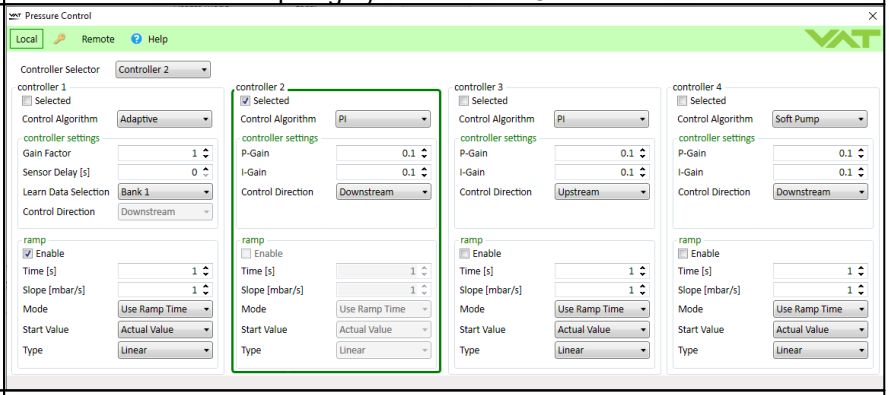
Result is a Target Pressure Ramp with different slopes.
See ***Target Pressure Used***, which is the output of the ramp generator.

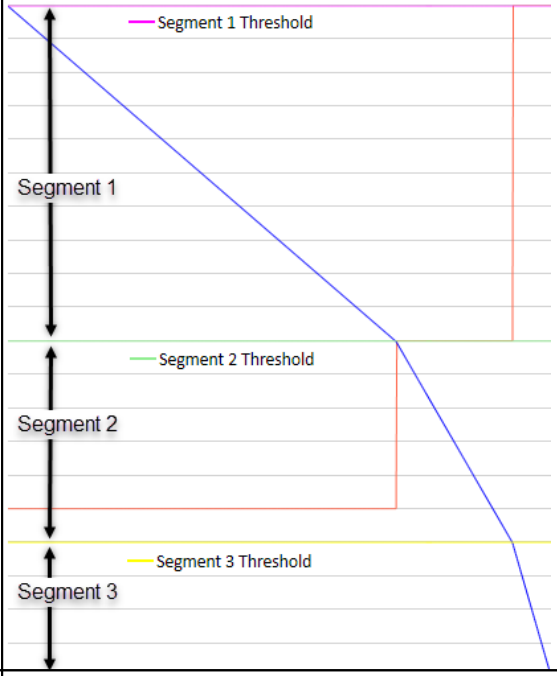




Parameters:

Parameter	Description	
Enable	Switches on/off the function	
Threshold Mode	Defines which pressure the threshold refers to	
	0 Actual Pressure	Change happens if ***Actual Pressure*** reaches the ***Threshold*** 
	1 Target	Change happens if ***Target Pressure Used*** reaches the

Parameter	Description
	Pressure Used ***Threshold*** 
Ramp Type	Defines the shape of the ramp in each segment *0 Linear* *1 Logarithmic* *2 Exponential*
Actual Slope	Used slope as the pressure difference per second (mBar*/sec)
Controller Selector Bitmap	Determines which Controller uses the profile ramp. When a Controller is selected, the ramp is no longer used in the controller itself. Therefore the ramp is grayed out in the CPA.
	
Segment Selector Bitmap	Defines which segment is used for the Profile Ramp.
Segment x Threshold	This is the upper limit of the segment. The lower limit is defined by the next lower ***Threshold***, or the lower limit is 0 if there is no lower ***Threshold*** If the ***Target Pressure*** is lower than several ***Thresholds***, the lowest one is taken. If the ***Target Pressure*** is higher than the highest ***Threshold***, the highest one is taken.

Parameter	Description
	
Segment x Slope	Defines the slope (mBar*/sec) in the segment

*** Unit adjustable**

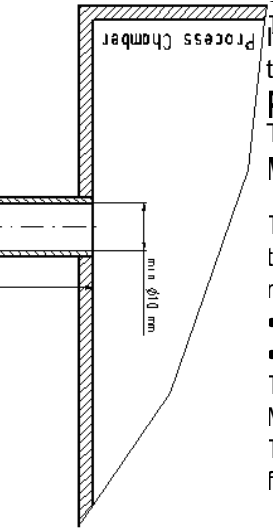
2.3.6.3 Store Control Parameter Volatile

If store control parameter volatile is set, no parameter setting will save in memory. This setting is only for pressure control parameters. That means, after loosing power (also a restart command), the last setting will be active.

This setting make sense if the pressure control settings is adapted continuously.

2.4.2 Configuration

It's important to do proper sensor configuration. The valve internally calculates in absolute values, so the valve needs to know what sensors are connected.



Pressure Sensor

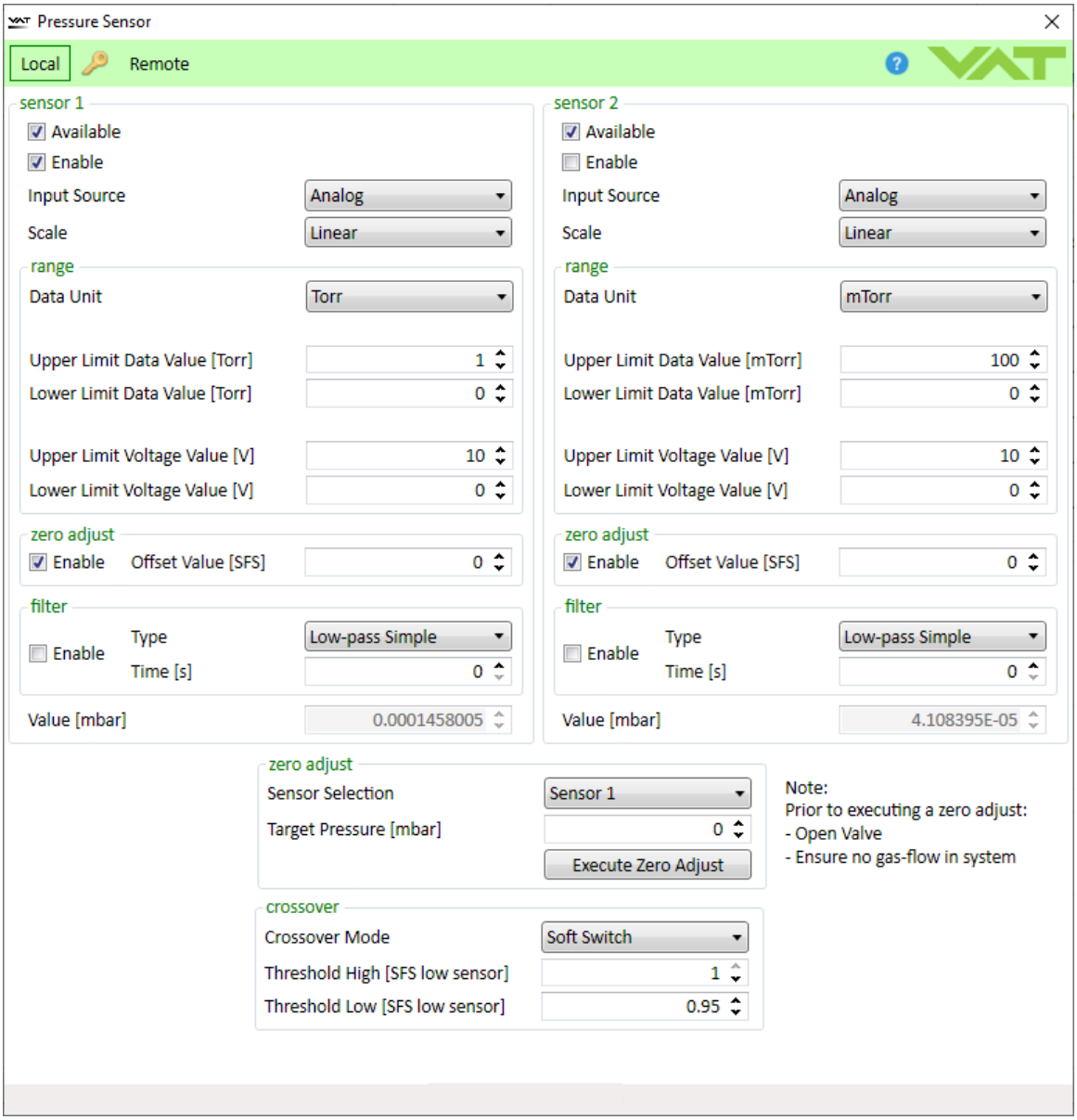
The CPA window shows a good overview of the sensor settings

Mechanical connection requirements

To achieve fast and accurate pressure control a fast sensor response is required. Sensor response time: < 50ms. The sensor is normally connected to the chamber by a pipe. To maintain that the response time is not degraded by this connection it needs to meet the following requirements:

- Inner diameter of connection pipe: > = 10 mm
- Length of connection pipe: < = 300 mm

These conductance guidelines must include all valves and limiting orifices that may also be present. Make also sure that there is no obstruction in front of sensor connection port inside the chamber. The sensor should also be mounted free of mechanical shock and vibration. Dynamic stray magnetic fields may introduce noise to sensor output and should be avoided or shielded.



Parameter	Description
Available	Set to *True* if a sensor is connected
Enable	Set to *True* if the sensor signal is used for pressure control
Input Source	*Analog* Sensor has an analog voltage interface and is direct connected to the valve. *Digital* Sensor and Valve have EtherCAT interface and is connected to the EtherCAT bus *Simulation* Testing the valve and pressure control without being connected to the system
Range.Scale	Select type of the sensor signal *Linear* *Logarithmic* Most gauges are linear type gauges.

Range.Data Unit	Set the pressure data unit of the gauge: *Pa, kPa, bar, mbar, Torr, mTorr, psia, psig*
Range.Upper Limit Data Value ***Range.Lower Limit Data Value***	Set the upper limit and lower limit of the gauge in the unit of ***Range.Data Unit*** Example for a 250mTorr linear sensor: Upper Limit = 250.0 Lower Limit = 0.0
Range.Upper Limit Voltage Value ***Range.Lower Limit Voltage Value***	These parameters are only used for gauges with analog voltage interface. The values corresponds to Range.Upper Limit Data Value and Range Lower Limit Data Value Example: Upper Limit: 10.0V à 250mTorr Range Upper Limit Data Value Lower Limit: 0.0V à 0.0mTorr Range Lower Limit Data Value
Filter.Enable	*True* enables the filter
Filter.Type	Available since April 2021. Low-pass Simple is backwards compatible.
Filter.Time	Set filter time in the range of 0.0 to 1.0 second. Note: Filter delays the sensor signals which is detrimental for pressure control

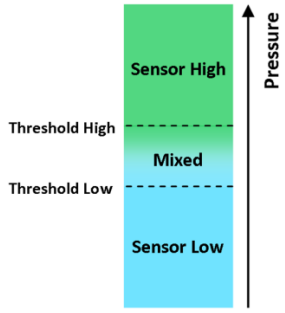
Location:
CPA Parameters
Pressure Sensor.Sensor 1
Pressure Sensor.Sensor 2
→ or use 'Pressure Sensor' window

2.4.3 Crossover (2 sensor operation)

When two sensors are used (enabled) for pressure control the crossover handles the two pressure signals to building one system pressure (Actual Pressure).

Parameter	Description
Crossover Mode	Crossover between 2 sensors (see below)
Threshold High [SFS low sensor] ***Threshold Low [SFS low sensor]***	Defines the crossover area (see below) The value is related to sensor full scale of low sensor (0.1 means 10% of sensor full scale of low sensor)
Delay	Switch over delay in Crossover Mode *Hard Switch*

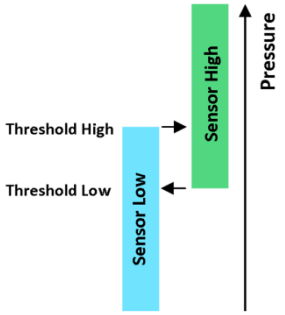
Crossover Mode Soft Switch	



Within the threshold levels, the resulting measurement value is a summation of the two sensors signals with a proportional ratio of the two measured values.

When to use
This is the standard mode. Values of both sensors need to fit together in the crossover area, otherwise crossover effect result (nonlinearity). Therefore, sensor ratio should not be too high (about <= 100).

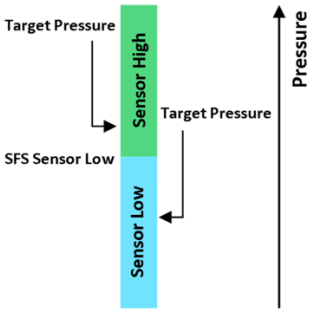
Crossover Mode Hard Switch



Switching between sensors according to the hysteresis threshold levels and an optional delay.

When to use
Preferred setting if the sensor signals do not fit together in the crossover area (for example if sensor ratio is high).

Crossover Mode Target Pressure



If target pressure is in the range of low sensor, low sensor is used; otherwise high range sensor.

When to use
As there is no switchover during pressure control while using this setting, undesired effects like nonlinearity or continuous switching between sensors don't occur.

Note
While in position control mode, 'Soft Switch' mode is used.
In case of soft pump controller only high sensor is used. (newer firmware version Dec. 2020)

Location:
CPA Parameters
Pressure Sensor.Crossover
→ or use 'Pressure Sensor' window

2.4.4 Zero Adjust

Zero Adjust allows for the compensation of the sensor offset voltage.

Note: A maximum offset voltage of +/- 1.4 V can be compensated.

Parameter	Description

Zero Adjust.Sensor Selection	Select the sensor for the zero adjust: • *Sensor 1 + 2* • *Sensor 1* • *Sensor 2*
Zero Adjust.Target Pressure	Normally this parameter is set to 0 in case the process chamber is fully evacuated (pressure <=1‰ of sensor full scale). If not you can align the sensor value to a known pressure (displayed on another readout in the system). In this case set ***Target Pressure*** to the known pressure. Note: ***Target Pressure*** is in the unit of pressure, see relevant interface: Example serial interface RS232/485 Scaling
Zero Adjust.Execute	*1: Start the zero adjust* *2: Clear offset value* After executing value return to 0
Sensor 1.Enable ***Sensor 2.Enable***	0: It's not possible to execute a zero adjust. A present offset value is ignored 1: It's possible to execute a zero adjust. A present offset value is respected.
Sensor 1.Offset Value [SFS] ***Sensor 2.Offset Value [SFS]***	Value which is deducted from the measured sensor value. The value is related to sensor full scale (0.1 means 10% of sensor full scale)

Location:
CPA Parameters
Pressure Sensor.Zero Adjust
Pressure Sensor.Sensor 1.Zero Adjust
Pressure Sensor.Sensor 2.Zero Adjust
Pressure Sensor.Sensor 1.Zero Adjust
Pressure Sensor.Sensor 2.Zero Adjust
→ or use 'Pressure Sensor' window

Performing a zero adjust:
1. Turn the gas flow off
2. Fully open the valve
3. Wait until the sensor signal is not shifting anymore. Refer to manual of sensor manufacturer for warm up time.
4. Wait until process chamber is evacuated.

Do not perform Zero Adjust, if the base pressure of your vacuum system is higher than 1‰ of sensor full scale. We recommend disabling Zero Adjust function or using of Zero Adjust.Target Pressure other than 0.0 in this case. Otherwise incorrect pressure reading is the result.

5. Perform zero with setting of Zero Adjust.Execute to 1
6. Check parameter Actual Pressure if the pressure is shifted as expected

2.5 Interface

In this chapter are all possible Interfaces described, which are supported by IC2 Controller.

Interface Types:
- Ethercat Interface
- DeviceNet Interface
- RS232/485 Interface

- Logic Interface
- CC-Link
- Profibus

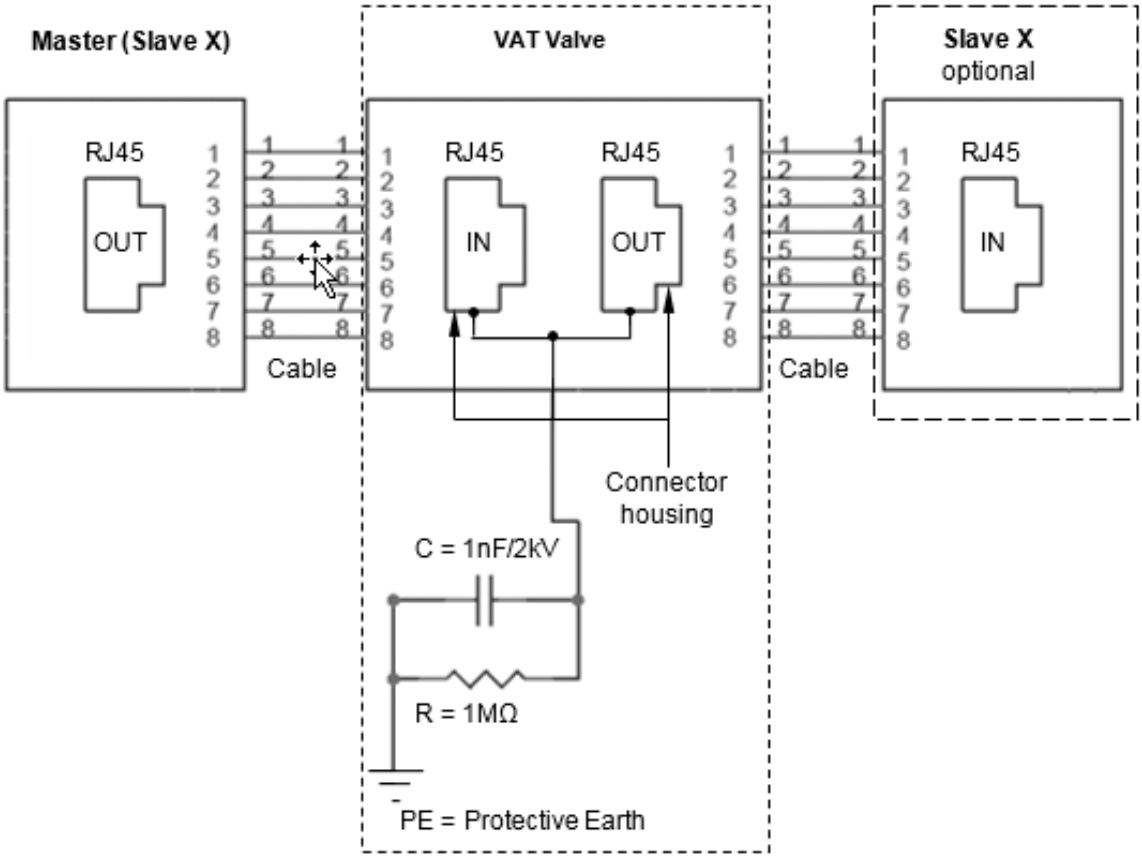
2.5.1 EtherCAT

Neither valve display information nor ***Control Mode*** values or any other fieldbus cyclic/acyclic data are related to any fieldbus states/notation

2.5.1.1 Connection

The EtherCAT interface is galvanic isolated from control unit.

Installation (example)



Network and cable

- Connector type: RJ45 standard connector
- Cable: CAT5, 6 or 7 STP (shielded twisted pair), not crossover

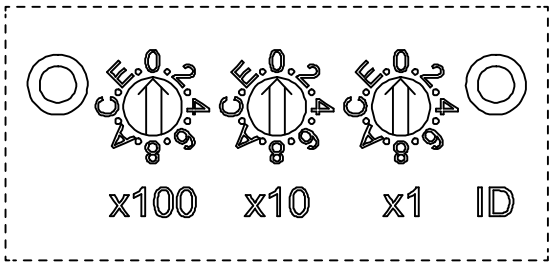
Cable length between Master and Slaves max. 100 m.

For all detail information about EtherCAT refer to EtherCAT homepage: http://www.ethercat.org

2.5.1.2 Device identification, Rotary switches

The Device Identification value (ID) is set by three hexadecimal rotary switches. That means the supported address range is 0-0xFFF in hexadecimal or 0-4095 in decimal.

The Device Identification value is read once after power on.

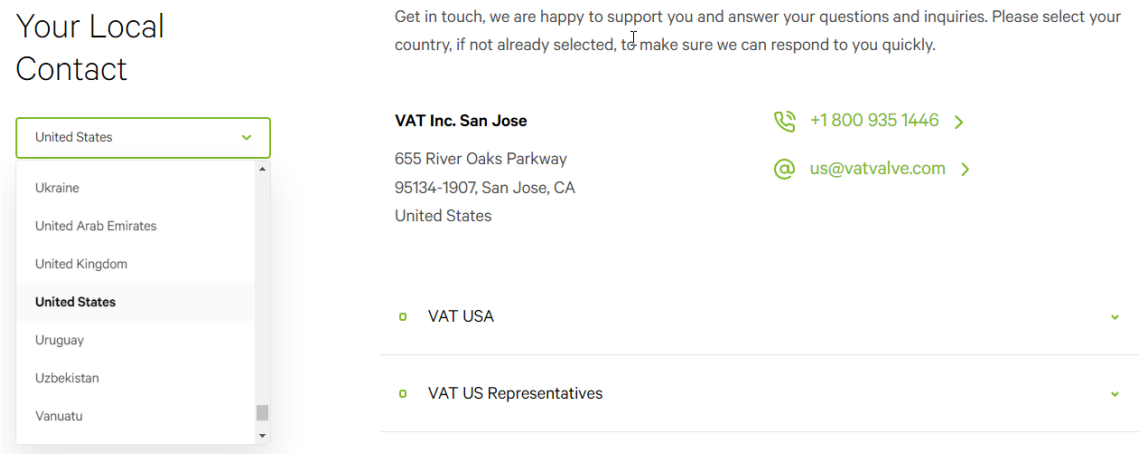


Example: 0

Note: In IC2 both kind of addresses Requested ID and Station Alias is defined by rotary switches.

2.5.1.3 ESI

It describes EtherCAT specific as well as application specific features of the slave.
For IC2 controller hardware the ESI file is depending on the installed firmware version. If the ESI file is missing please request this by your local contact Contact.



2.5.1.4 Connection Loss Reaction

Connection Loss reaction defines what the valve is doing in case the EtherCAT connection get lost.

Parameter	Description
Enable	*True* enables the connection loss reaction, in case of *False* there is no reaction on a connection loss (compatible IC1 Setting *keep Position*)
State	Current connection loss state
Functionality	Defines the functionality in case of connection loss. This can be *open* or *close*.

Parameter location:
CPA
Interface EtherCAT.Connection Loss Reaction

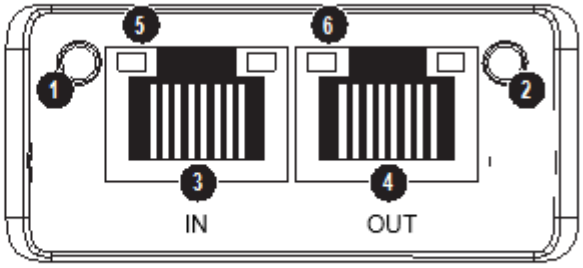
2.5.1.5 Communication failure

Failure detection with CPA	Action
Network failure: No EtherCAT communication is active	- Check EtherCAT cable. - Check the EtherCAT connection to master. - Check the process data output watchdog – SyncManager2 settings

If you need any further information, please contact one of our service centers.
You will find the addresses on our website: www.vatvalve.com.

2.5.1.6 LEDs

1. RUN LED[a)]
2. Error LED[a)]
3. EtherCAT (port 1) IN
4. EtherCAT (port 2) OUT
5. Link/Activity (port 1) IN
6. Link/Activity (port 2) OUT



a) The flash sequences for these LEDs are defined in DR303-3 (CiA)

Run LED (1)

This LED reflects the status of the CoE (CANopen over EtherCAT) communication.

LED State	Indication	Description
Off	INIT	Device in 'INIT'-state (or no power)
Green	OPERATIONAL	Device in 'OPERATIONAL'-state

Green, blinking	PRE-OPERATIONAL	Device in ‘PRE-OPERATIONAL’-state
Green, single flash	SAFE-OPERATIONAL	Device in ‘SAFE-OPERATIONAL’-state
Red a)	EXCEPTON state (Fatal Event)	-

a) If RUN and ERR turns red, this indicates a fatal event, forcing the bus interface to a physically passive state.

Error LED (2)

This LED indicates EtherCAT communication errors etc.

LED State	Indication	Description
Off	No error	No error (or no power)
Red, blinking	Invalid configuration	State change received from master is not possible due to invalid register or object settings.
Red, single flash	Unsolicited state change	Slave device application has changed the EtherCAT state autonomously; parameter ‘Change’ in the AL status register is set to 01h (change/error).
Red, double flash	Application watchdog timeout	Sync manager watchdog timeout
Red a)	Application controller is not responding any more	EXCEPTION state

a) If RUN and ERR turns red, this indicates a fatal event, forcing the bus interface to a physically passive state.

Link/Activity LED's (5/6)

These LED’s indicate the EtherCAT link status and activity.

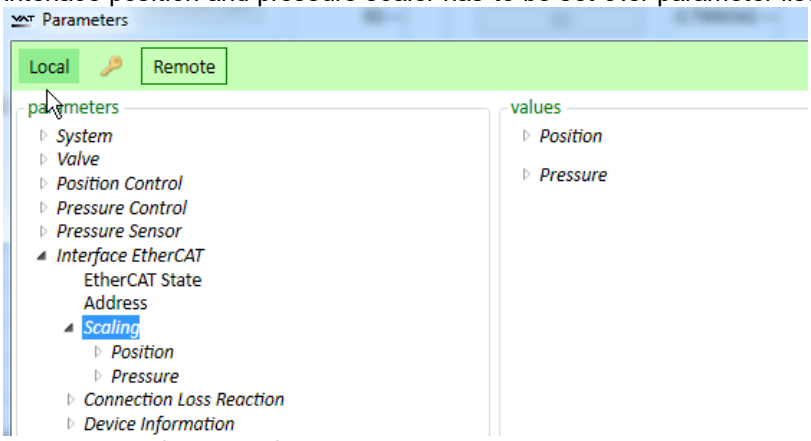
LED State	Indication	Description
Off	No link	Link not sensed (or no power)
Green	Link sensed, no activity	Link sensed, no traffic detected
Green flickering	Link sensed, no activity detected	Link sensed, traffic detected

2.5.1.7 Communication

Interface scaling

Interface Scaling - Ethercat

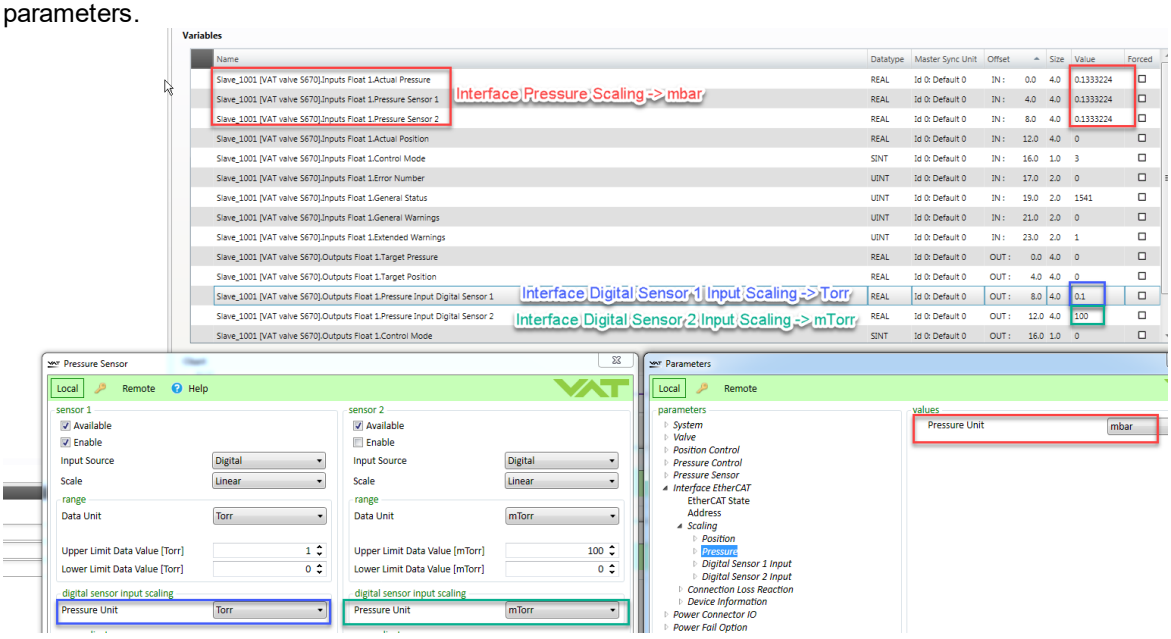
Interface position and pressure scaler has to be set over parameter list.



Example: Interface EtherCAT

Digital Sensor Scaling

If Sensor Source is digital, than the input unit can be defined separately from the other pressure parameters.



Cyclic Communication

Note: This chapter defines the standard PDO mappings which is used for the most pressure control application.

PDO Process data objects – cyclic communication

RxPDO Output mappings

The EtherCAT process data mapping is done automatically corresponding to the following list and respectively to the sync manager information.

Mapping object	*Mapping content*	
0x1600	SINT32	Target Pressur
	SINT32	Target Position
	SINT32	Pressure Input
	SINT32	Pressure Input
	SINT8	Control Mode
	UINT16	General Contro
	FLOAT	Pressure Ramp
0x1601 **(default)**	FLOAT	Target Pressur
	FLOAT	Target Position
	FLOAT	Pressure Input
	FLOAT	Pressure Input
	SINT8	Control Mode
	UINT16	General Contro
	FLOAT	Pressure Ramp
0x1602	SINT32	Target Pressur
	SINT32	Target Position
	SINT32	Pressure Input
	SINT32	Pressure Input
	SINT8	Control Mode
	UINT16	General Contro
0x1603	FLOAT	Target Pressur
	FLOAT	Target Position
	FLOAT	Pressure Input
	FLOAT	Pressure Input
	SINT8	Control Mode
	UINT16	General Contro
0x1604	SINT32	Target Position
	SINT8	Control Mode
	UINT16	General Contro
0x1605	FLOAT	Target Position
	SINT8	Control Mode
	UINT16	General Contro
0x16FF		Configurable m

Name	Byte	Range	Description
TARGET PRESSURE	4	Value in mBar Adjustable[1)]	Setpoint value fo **CONTROL MOD**
TARGET POSITION	4	0..100 Adjustable[1)]	Setpoint value fo **CONTROL MOD**
PRESSURE INPUT DIGITAL SENSOR 1	4	Value in mBar Adjustable[1)]	Pressure from di (Sensor with Eth
PRESSURE INPUT DIGITAL SENSOR 2	4	Value in mBar Adjustable[1)]	Pressure from di (Sensor with Eth
CONTROL MODE	1	2…7	**1** = Homing **2** = Position contr **3** = Close **4** = Open **5** = Pressure cor **6** = Hold **7** = Learn
GENERAL CONTROL SETPOINT	2	-	See bitmap table
PRESSURE RAMP TIME	1	0…10E6	Time in ms

1) To adjust range refer to chapter: «EtherCAT scaling»

GENERAL CONTROL SETPOINT bitmap table:

Bit		Description
0	**ZERO ADJUST**	Starts the zeroing of the sensors
1	**NOT USED** (reserved)	-
2	**PING PONG TX BIT**	Handshake mechanism Valve sends the inverted value of this bit in INPUT BUFFER → GENERAL STATUS → PING PONG RX BIT
3	**NOT USED** (reserved)	-
4	**ACCESS MODE LOCKED**	Defines which interface, remote (EtherCAT) or service (CPA), can control the valve.

Access Mode	Control Permission	Comment
Local	CPA	

		Remote / EtherCAT Master / CPA can switch to Local Locked / EtherCAT Master / CPA can't switch to Local If bit is set to **1** than the Access Mode = Locked It bit changes from **1** to **0** than the Access Mode changes to Remote Whether CPA has switched the Access Mode to Local can be seen in the Input Buffer: GENERAL STATUS → ACCESS MODE EXTENDED WARNING → REMOTE CONTROL NOT POSSIBLE Overview: **From** / **To** / **ACCESS MODE LOCKED bit** local or remote / locked / 0 → 1 locked / remote / 1 → 0 local / remote / 0 → 1 → 0
5-15	**NOT USED** (reserved)	-

TxPDO Input mappings

The EtherCAT process data mapping is done automatically corresponding to the following list and respectively to the sync manager information.

Mapping object	***Mapping content***		**Name**	**Byte**	**Range**	**Description**
0x1A00	SINT32	Actual Pressure	**ACTUAL PRESSURE**	4	Value in mBar adjustable[1)]	
	SINT32	Pressure Sensc				
	SINT32	Pressure Sensc	**PRESSURE SENSOR 1**	4	Value in mBar adjustable[1)]	
	SINT32	Actual Position				
	SINT8	Control Mode				
	UINT16	Error Number	**PRESSURE SENSOR 2**	4	Value in mBar adjustable[1)]	
	UINT16	General Status				
	UINT16	General Warnin				
	UINT32	Extended Warni	**ACTUAL POSITION**	4	0…100 adjustable[1)]	Note: 0 do not mean that the v sealing functionality is availab to the bit **SEALING STATE** in
0x1A01 ***(default)***	FLOAT	Actual Pressure				
	FLOAT	Pressure Sensc				
	FLOAT	Pressure Sensc				
	FLOAT	Actual Position				
	SINT8	Control Mode				
	UINT16	Error Number				
	UINT16	General Status				
	UINT16	General Warnin				
	UINT32	Extended Warni	**CONTROL MODE**	1	0…14	**0** = init **1** = homing **2** = position **3** = close **4** = open **5** = pressure **6** = hold **7** = learn **8** = interlock open **9** = interlock close **12** = power failure **13** = safety **14** = fatal error
0x1A02	SINT32	Actual Position				
	SINT8	Control Mode				
	UINT16	Error Number				
	UINT16	General Status				
	UINT16	General Warnin				
	UINT32	Extended Warni				
0x1A03	FLOAT	Actual Position	**ERROR NUMBER**	2	200…888	Refer to chapter «Errors»
	SINT8	Control Mode	**GENERAL STATUS**	2		See bitmap table below
	UINT16	Error Number	**GENERAL WARNING**	2		See bitmap table below
	UINT16	General Status	**EXTENDED WARNING**	2		See bitmap table below
	UINT16	General Warnin				
	UINT32	Extended Warni				

0x1AFF	Configurable ma

1) To adjust range refer to chapter: «Scaling of pressure and position values»

GENERAL STATUS bitmap table:

Bit		Description
0	**FIELDBUS DATA VALID**	**0** = Valve is not in the EtherCAT state OPERATIONAL or the process data output watchdog. (SyncManager2) is disabled **1** = Valve is in the EtherCAT state OPERATIONAL and the process data output watchdog (SyncManager2) is enabled
1	**ZERO ADJUST EXECUTED**	ZERO ADJUST successful executed, active for 2 seconds
2	**PING PONG RX-BIT**	Handshake mechanism Is the inverted PING PONG TX-BIT from OUTPUTBUFFER → GENERAL CONTROL SETPOINT
3	**PRESSURE SIMULATION**	**1** = Internal pressure simulation active
4	**TARGET PRESSURE REACHED**	**1** = The actual pressure is within 2% of the pressure setpoint
5-6	**NOT USED** (reserved)	-
7-8	**ACCESS MODE**	**bit 8 bit 7** 0 0 = LOCAL 0 1 = REMOTE 1 0 = LOCKED
9	**WARNINGS ACTIVE**	**1** = At least one WARNING of the warning bitmaps is active (GENERAL WARNING bitmap and EXTENDED WARNING bitmap)
10	**SEALING STATE**	**1** = valve is sealed, only valid if a sealing functionality is available
11	**INTERLOCK ACTIVE**	**1** = an interlock input is active
12-15	**NOT USED** (reserved)	-

GENERAL WARNING bitmap table:

Bit		Description
0	**NOT USED (reserved)**	-
1	**LEARN DATA SET**	Learn data not present. Learn required for adaptive pressure control. Just active if adaptive pressure control algorithm is choosen.
2	**NOT USED (reserved)**	-
3	**POWER FAILURE BATTERY**	Not ready, voltage too low. Just active if power failure is available.
4-5	**NOT USED (reserved)**	-
6	**FAN STALL ALARM**	Just available when fan provides a stall alarm

47-15	**NOT USED (reserved)**	-

EXTENDED WARNING bitmap table:

Bit		Description
0	**REMOTE CONTROL NOT POSSIBLE**	Remote control not possible, access mode local is active, change to access mode remote or access mode locked
1	**ACTUAL CONTROL MODE SETPOINT NOT ALLOWED**	Not possible to switch the actual control mode to CONTROL MODE SETPOINT • Control mode is interlock or fatal error • CONTROL MODE SETPOINT is **5** (pressure) or **7** (learn) and no sensor is selected (sensor mode configuration)
2	**ZERO DISABLED**	Using zero function not possible
3	**PFO DEACTIVATED**	Power Failure Option is deactivated
4	**NOT USED (reserved)**	-
5	**OUT OF RANGE: PRESSURE SETPOINT**	Value of PRESSURE SETPOINT is out of range
6	**OUT OF RANGE: POSITION SETPOINT**	Value of POSITION SETPOINT is out of range
7-9	**NOT USED (reserved)**	-
10	**OUT OF RANGE: CONTROL MODE SETPOINT**	Value of CONTROL MODE SETPOINT is out of range
11	**OUT OF RANGE: GENERAL CONTROL SETPOINT**	Value of GENERAL CONTROL SETPOINT is out of range
12-15	**NOT USED (reserved)**	-

Ping Pong

With the Ping pong mechanism the master can verify that the slave has read the PDO buffer content sent by the master.

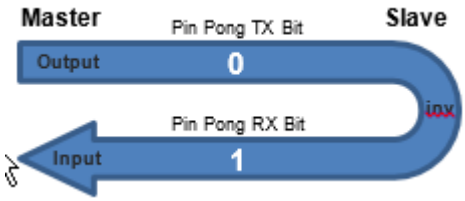
Principle:

Master sets the Ping pong bit in the object “General Control Setpoint”. When the slave receives the value of “General Control Setpoint”, the slave will invert this Ping pong bit and put it into ping pong of “General Status”

Example:

The master wants to have a confirmation that the slave has received a new value of “Target Position”:

1. Master sets “Target Position” to 123 and set Ping pong bit of “General Control Setpoint” to 0
2. Master waits till Ping pong bit of “General Status” has changed to 1 à This is the confirmation, that the PDO telegram with the new “Target Position” was received by the slave



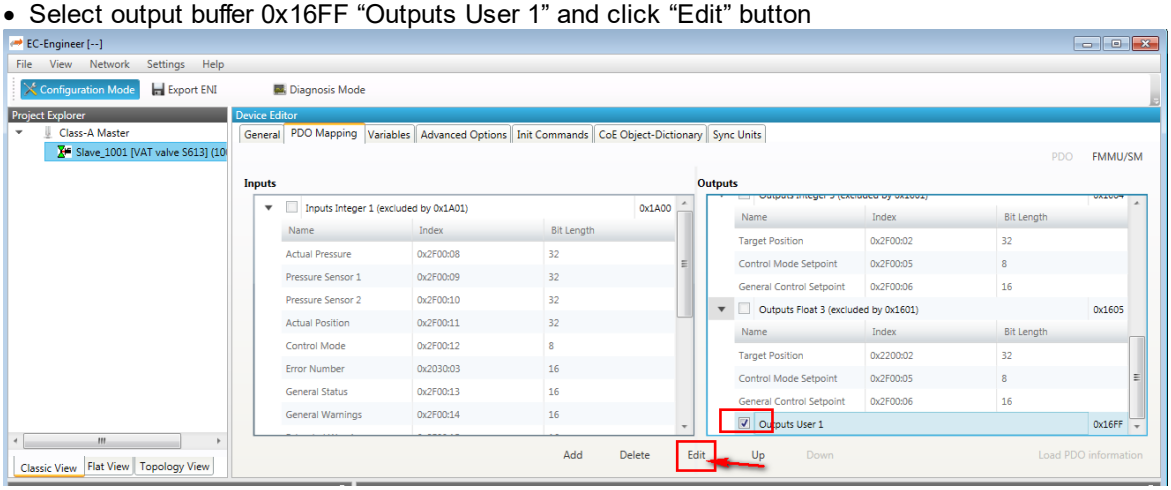
Configurable PDO mapping

User can add additional objects to PDO Output mapping 0x16FF and the Input PDO mapping 0x1AFF.

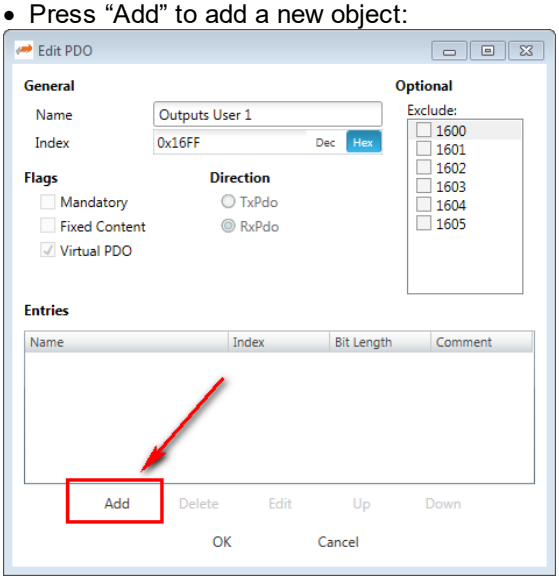
Example 0x16FF with EC-Engineer
To add the parameters Pressure Ramp Slope and Mode in addition to the standard buffer (0x1601) in the configurable PDO buffer (0x16FF) following steps are necessary:

Mapping object	Mapping content	
0x16FF	USINT8 FLOAT	Pressure Ramp Mode Pressure Ramp Slope

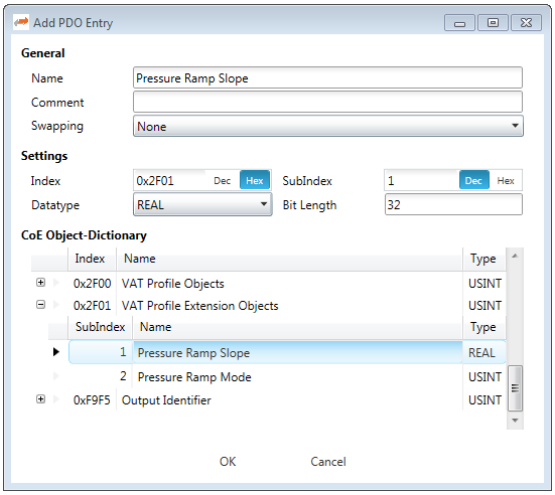
- In EC engineer the mapping the configuration is done in Configuration Mode
- Select output buffer 0x16FF “Outputs User 1” and click “Edit” button



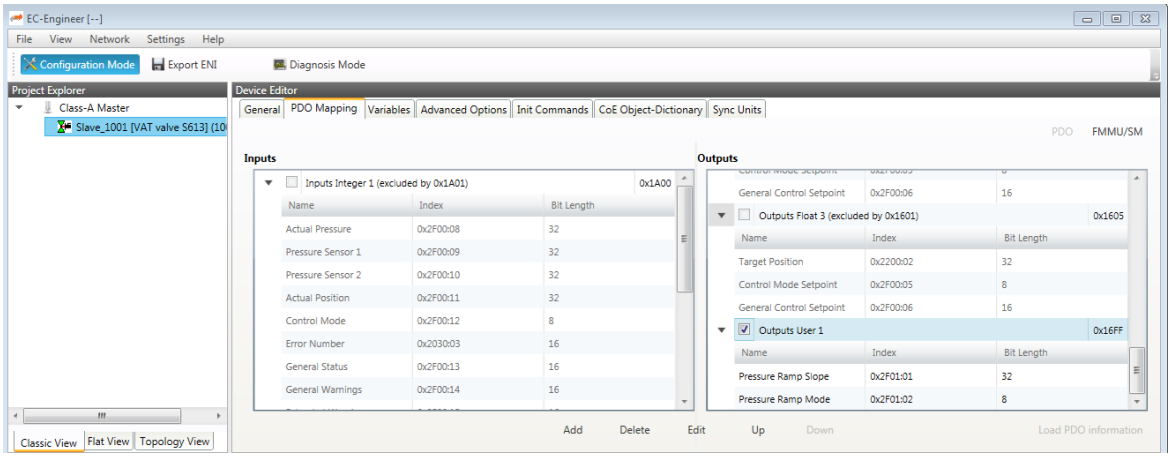
- Press “Add” to add a new object:



- Select object 0x2F01:01 “Pressure Ramp Slope” and press ok

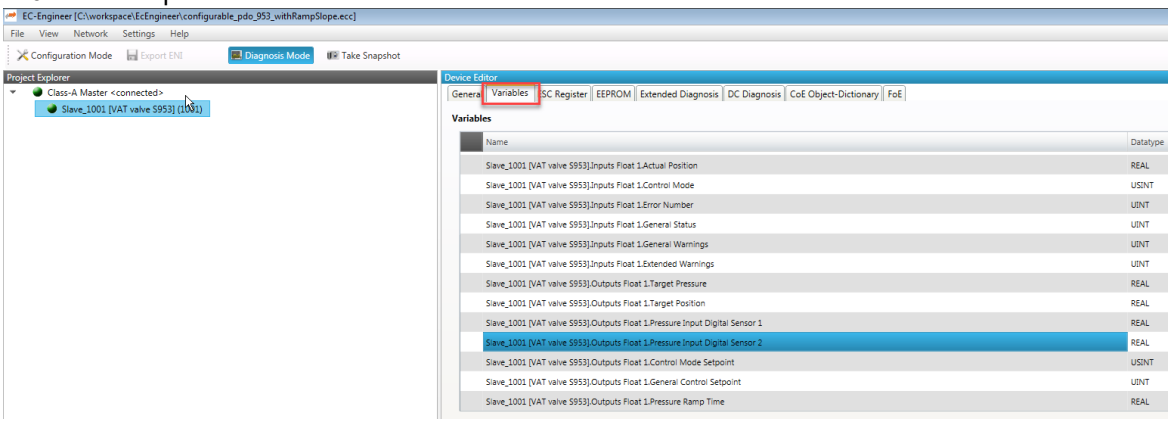


- Press again “Add” and select 0x2F01:02 “Pressure Ramp Mode”. Now the two additional objects should be added to 0x16FF:



Change in Diagnose Mode and change state to OP

- Now this parameters are visible under Variables



- Save master project to load this configuration on another device.

SDO Service data objects – acyclic communication

VAT uses for acyclic parameter data handling a standard EtherCAT mailbox transfer. The mailbox protocol is CoE (CANopen over EtherCAT), compliant to DS301 (CiA Draft Standard 301 v4.02).

Note: This list of the acyclic communication is depending on the installed firmware version. Please check this information in the product specific Manual.

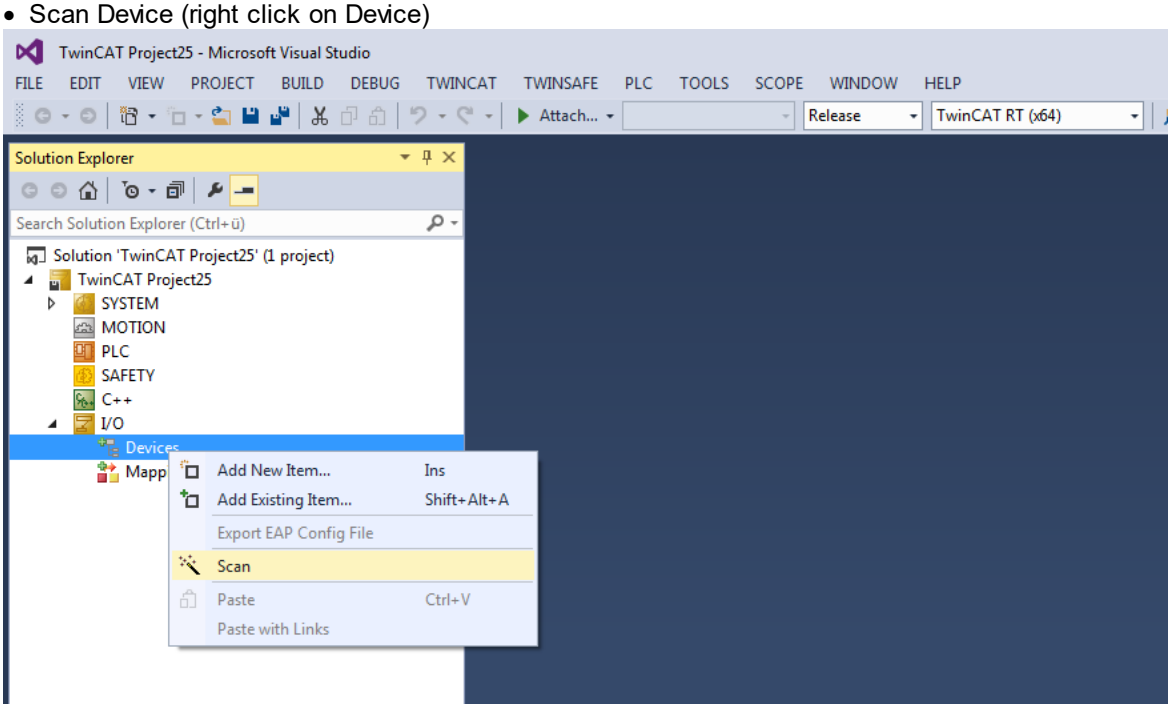
File over EtherCAT (FoE)

Via this profile, firmware and entire collections can be loaded via the EtherCAT interface. It is important that the name of the file must have a length of eight characters. The file ending is limited to three characters. Detailed information is given by the ETG.5003.2 profile.

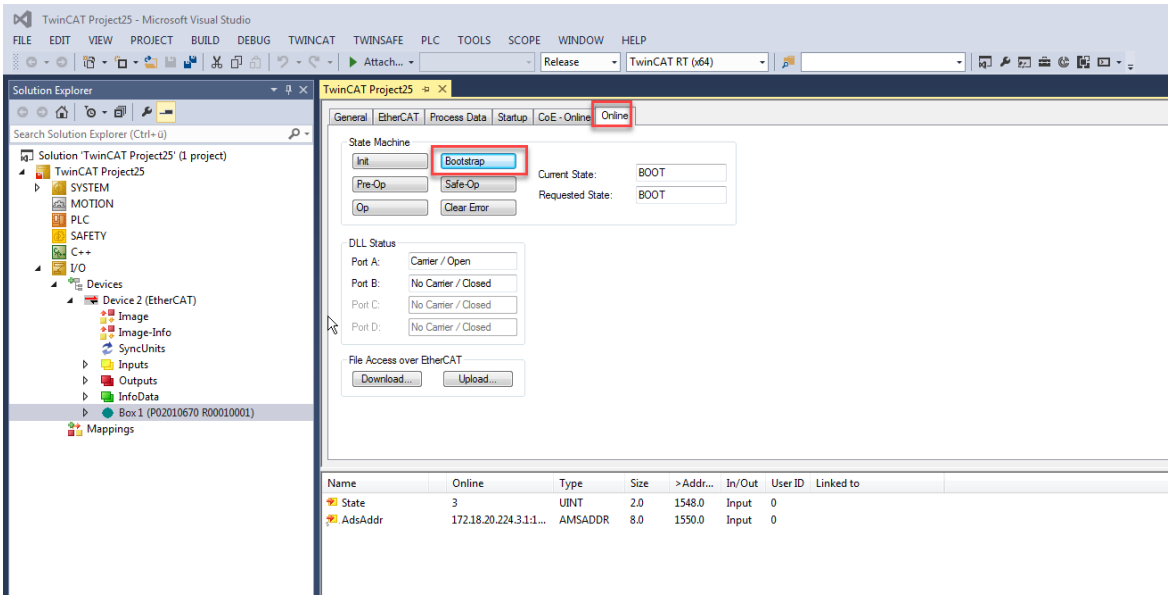
Example: vat specific firmware: F01.0C.28.08.vat becomes 010C2808.vat

Example TwinCAT
Step by step instructions to load a firmware via FoE.

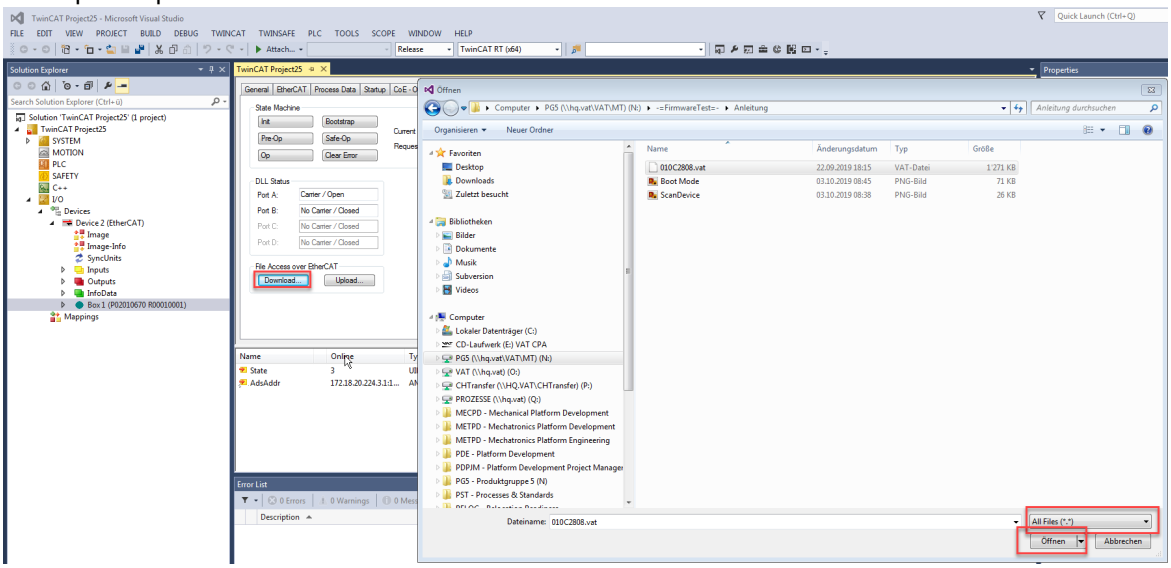
- Open TwinCAT Project
- Scan Device (right click on Device)



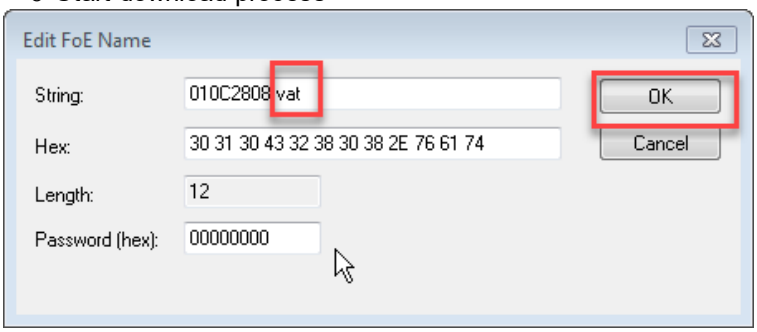
- Accept Hint Window
- Select Device (Normally the device is selected automatically)
- Scan for Boxes -> yes
- Activate Free Run -> yes
- Set Boot Mode
  - Double-click on device
  - Open Online Window
  - Select Bootstrap



- Download File (Attention File must have 8 characters)
  - Select Download
  - Change File type to All Files
  - Open requested firmware



- Add extension of the file
  - Start download process



- Wait until the green loading bar at the bottom right is finished.

- Set Init Mode
  - valve loads firmware -> running eights on display
  - wait until display shows general information -> firmware download process is finished
- Check Error List

2.5.2 RS232/485

RSRS232/485 is a simple, open, serial communication protocol that is easy to implement.
The Interface supports addition 2 digital inputs and 2 digital outputs with selectable functionality.
Additional there are an analog output 0 to 10V for pressure and position.
IC2 command set is always available. In parallel an older command set is possible to use in parallel.
If the ***Command Set*** does not cause a conflict, then commands from other command sets can be used even if it is not defined under ***Command Set***.

General settings on the Interface can be done with the VAT Program CPA4.

2.5.2.1 Settings

The Valve COM port settings must be identical with the settings from the Host control system.

	Parameter	Description
Settings	***Baud Rate***	Number of bit transfers per second Factory setting: *115200* After a Baud Rate change is a Valve reset necessary.
	Data Bit Length	Data bits in a transmission Factory setting: *8*
	Stop Bit	End of communication for a single packet Factory setting: *1*
	Command Set	Communication protocol Factory setting: *IC*
Operation Mode RS485	***Topology***	*Half* or *Full duplex* topology
	Network	*Multiple Device* or *Point to Point* network
	Address	Network address at multiple device communication

Operation Mode

Both operation modes RS232 and RS485 are with the same hardware possible.
- RS232 is a two wire point to point communication.
- RS485 is a four wire system (full duplex) or a two wire system (half duplex) and supports also multiple device communication.

	Enum	Description

Operation Mode	*RS232*	Communication over RS232 Use Pin RXD and TXD
	RS485	Communication over RS485 Use Pin A,B,X,Y
	Service Interface Over RS232	Communication with CPA over RS232 Use Pin RXD and TXD

2.5.2.2 Command Structure

In this chapter the command structure for the RS232/485 communication is described.
Here we have to distinguish between the different Command-Sets, mainly between IC2 and IC1 Command-Sets.

Syntax

- IC2 Command Set is always available independent from the setting ***Command Set***
- Commands and values are case sensitive.
- Acknowledgement within 10ms after reception of command (worst case).
- Wait for acknowledgement before sending a new command.
- Default command termination is CR and LF. This is adjustable.
  CR = Carriage Return (0D hexadecimal), LF = Linefeed (0A hexadecimal)
- Same Syntax for Commands over Terminal in the CPA as over RS232 interface.
- All characters are in ASCII code

	Command	Response
GET	p: service parameter index	p: error service parameter index value
SET	p: service parameter index value	p: error service parameter index value

service	service code in hexadecimal, 2 digits
parameter	parameter ID in hexadecimal, 8 digits
error	error code in hexadecimal, 2 digits
index	array index, if parameter is not an array use 00, 2 digits
value	set or response value, digits depends on value format

Service

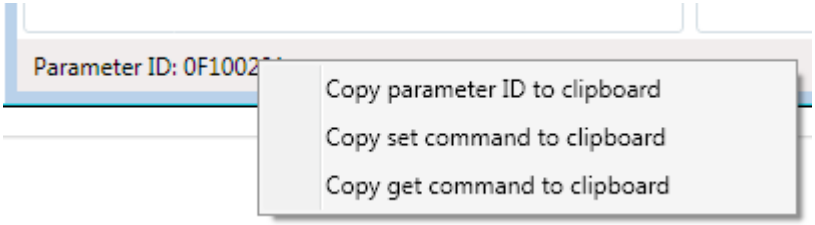
code	description
01	Set a parameter to a value
0B	Get a value of a parameter

Parameter

The supported parameters is depending on the specific firmware version and the used hardware. This list of visible parameter can be exported by the CPA4 program directly. Please see chapter Export Parameters to Excel.

The parameter ID of a selected parameter is visible on the bottom of the parameter window.

By using right-click on the parameter ID, the corresponding command (Set or Get) is copied to the clipboard. If using a set-command, the command needs to be completed by the new value.



Error

code	error text	description
00	no error	no error
0C	wrong command length	wrong command length
1C	value too low	value out of range: lower then min limit
1D	value too high	value out of range: higher then max limit
20	resulting zero adjust offset value out of range	resulting zero adjust offset value out of range
21	not valid because no sensor enabled	not valid because no sensor enabled
50	wrong access mode	wrong access mode
51	time out	
6D	EEProm not ready	
6E	wrong parameter ID	wrong parameter ID
6F	set to default value not possible	set to default value not allowed
70	parameter not settable	set value not allowed
71	parameter not readable	get value not allowed
72	set to initial value not possible	initial value not allowed
73	wrong parameter index	wrong parameter ID index (array)
74	initial value out of range	wrong initial value
76	wrong value	wrong value within range
77	wrong value, only reset possible	only value reset possible
78	not allowed in this state	not allowed in this state
79	Setting lock is active	configuration lock mode is active
7A	wrong service	service (action) not valid
7B	parameter not active	parameter is inactive
7C	parameter system error	parameter system error

code	error text	description
7D	communication error	communication error (e.g. buffer overrun)
7E	unknown service	
7F	unexpected character	
80	no access rights	wrong access mode
81	no adequately hardware	
82	wrong object state	example: wrong execution mode (DeviceNet)
84	no slave command	
85	command to unknown slave	
87	command to master only	
88	only G command allowed	
89	not supported	
8A	Not allowed: Internal sequencer is running	
8F	Not allowed: Entry already exists	
A0	function is disabled	
A1	already done	

Examples:

Open valve:

command		response	
p:010F020000004		p:00010F020000004	
		error	00 (successfully)
service	01 (set)	service	01 (set)
parameter	0F020000	parameter	0F020000
Index	00	index	00
Value	4	value	4

Close valve:

command		response	
p:010F020000003		p:00010F020000003	
		error	00 (successfully)
service	01 (set)	service	01 (set)
parameter	0F020000	parameter	0F020000
Index	00	index	00
Value	3	value	3

Position control:

command		response	
p:010F020000002		p:00010F020000002	
		error	00 (successfully)
service	01 (set)	service	01 (set)

parameter	0F020000	parameter	0F020000
Index	00	index	00
Value	2	value	2

Set Target Position:

command		response	
p:01110200000070.0		p:0001110200000070.0	
		error	00 (successfully)
service	01 (set)	service	01 (set)
parameter	11020000	parameter	11020000
Index	00	index	00
Value	70.0	value	70.0

Pressure control:

command		response	
p:010F020000005		p:00010F020000005	
		error	00 (successfully)
service	01 (set)	service	01 (set)
parameter	0F020000	parameter	0F020000
Index	00	index	00
Value	5	value	5

Note:

- Pressure and position range depend on scaling settings. See chapter CPA Scaling for USB Communication. Otherwhise the relevant interface: Example serial interface see RS232/485 Scaling

Compound Commands

This function allows to GET and/or SET several values with one command.
Note: This commands are available since firmware version July 2021.

Service

Code	Description
29	**GET** the values of all parameters in the compound array
28	**SET** the values of all parameters in the compound array
30	**SET** and **GET** combined. All parameters until the first empty entry (ID = 0) are set. All parameters after the first empty entry (ID = 0) are get.

Group	Parameter	ID [hex]	Data Type	Access	NV	Description
Parameter	***Compound 1***	A10A0100	UINT32[20]	RW	NV	Compound of Parameter IDs
	Compound 2	A10A0200	UINT32[20]	RW	NV	
	Compound 3	A10A0300	UINT32[20]	RW	NV	

	Compound 4	A10A0400	UINT32[20]	RW	NV	

Example:

Build Compound 1 (A10A0100) to get the values of several parameters:

Index	Parameter	ID [hex]	Commands to set the compound members
00	***Access Mode***	0F0B0000	p:01A10A0100000F0B0000
01	***Control Mode***	0F020000	p:01A10A0100010F020000
02	***Actual Position***	10010000	p:01A10A01000210010000
03	***Position State***	00100000	p:01A10A01000310100000
04	***Actual Pressure***	07010000	p:01A10A01000407010000
05	***Target Pressure***	07020000	p:01A10A01000507020000
06	***Target Pressure Used***	07030000	p:01A10A01000607030000
07	***Warning Bitmap***	0F300100	p:01A10A0100070F300100
08	***not used***	0	p:01A10A0100080
..	..	..	..

Note: All not used indexes must be set to 0

Execution:

	Send	Receive
Get	**p:29A10A010000**	**p:0029A10A0100000;2;45.0;0;1.45;30.0;30.0;0**

Build Compound 2 (A10A0200) to set the several parameters:

Index	Parameter	ID [hex]	Commands to set the compound members
00	***Access Mode***	0F0B0000	p:01A10A0200000F0B0000
01	***Control Mode***	0F020000	p:01A10A0200010F020000
02	***Target Position***	11020000	p:01A10A02000211020000
03	***Target Pressure***	07020000	p:01A10A02000307020000
08	***not used***	0	p:01A10A0200080
..	..	..	..

Note: All not used indexes must be set to 0

Execution:

	Send	Receive
Set	**p:28A10A0200000;2;45;30**	**p:0028A10A0200000;2;45;30**
Get	**p:29A10A020000**	**p:0029A10A0200000;2;45.0;30.0**

Compatible Command Sets

IC1

Note:
- All position and pressure values are integer values and they are scalable.
- Default range pressure 0 … 1000000, position 0 … 100000

System

Set	Resp	Get	Resp	Data Set, Get Resp	Description
c:01	c:01			aa	Access Mode: 0=Local, 1=Remote, 2=Locked
		i:80	i:80	abcdefgh	Hardware Configuration a Power Failure Option: 0=no, 1=yes b Sensor Power Supply: 0=no, 1=yes c Interface Type: 2=RS232, 3=RS323 with AO, 8=RS232/RS485, 9=RS232/485 with AO d Sensor Inputs: 0, 1 or 2 e Cluster Option: 0=no, 1=yes f External Isolation Valve: 0=no, 1=yes g Reserved h Small Size Controller: 0=no, 1=yes
		i:82	i:82	string	Firmware
		i:83	i:83	string	Serial Number
		i:30	i:30	abcdeeef	Device Status a Access Mode: 0=Local, 1=Remote, 2=Locked b Control Mode: 0=Init,1=Homing,2=Position,3=Close,4=Open,5=Pressure Control,6=Hold,7=Learn,8=Interlock Open,9=Interlock Close,12=Power Failure,13=Safety,14=Error c PFO Disabled: 0=no, 1=yes d Warning Present: (in i:51 or i:52) 0=no, 1=yes e Reserved f Sensor Simulation Active: 0=no, 1=yes
		i:76	i:76	aaaaaa bbbbbbbbcde	Compound a Pressure b Position c Access Mode: 0=Local, 1=Remote, 2=Locked d Control Mode: 0=Init,1=Homing,2=Position,3=Close,4=Open,5=Pressure Control,6=Hold,7=Learn,8=Interlock Open,9=Interlock Close,12=Power Failure,13=Safety,14=Error e Warning Present: (in i:51 or i:52) 0=no, 1=yes
s:04	s:04	i:04	i:04	abcdefgh	Valve Configuration a Homing End Position: 0=Close, 1=Open b Power Failure Position: 0=Close, 1=Open

Set	Resp	Get	Resp	Data Set, Get Resp	Description
					c External Isolation Valve Enable: 0=no, 1=yes d Control Stroke Limitation Enable: 0=no, 1=yes e Network Failure Position f Cluster Valve Offline g Homing Start: 0=Not Isolated or Move Command, 1=c:4303 Command, 2=Open Command, 3=Move Command, 4=At Power Up h Reserved
		i:50	i:50	aaa	Fatal Error Number: 20=Limit Stop Not Detected, 21=Blocked, 22=Blocked, 40=Motor Driver
c:53	c:53	i:51 i:53	i:51 i:53	abcdefgh	Warnings 1 a Service Request b Learn Data Warning c PFO not ready d Compressed Air Failure e Sensor Ratio f External Isolation Valve Warning g Cluster Slave Offline h Network Failure i:53 = nonvolatile, c :5300 = reset
c:54	c:54	i:52 i:54	i:52 i:54	abcdefgh	Warnings 2 a Rom Memory b Interface c Sensor ADC d Interface ADC e Reserved f Sensor value not valid g Cluster Slave Offline h Network Failure i:54 = nonvolatile, c :5400 = reset
c:20	c:20	i:70	i:70	aaaaaaaaaa	Counter Control Cycles c:2000 = reset
c:21	c:21	i:71	i:71	aaaaaaaaaa	Counter Isolation Cycles c:2100 = reset
c:22	c:22	i:72	i:72	aaaaaaaaaa	Counter Power Up c:2200 = reset
c:10	c:10			aa	Power Failure Option Off: 0=Off (volatile), 1=On
c:82	c:82			aa	Reset: 1=Reset

Position Control

Set	Resp	Get	Resp	Data Set, Get Resp	Description
		A:	A:	aaaaaa	Actual Position
C:	C:				Close
O:	O:				Open
R:	R:	i:38	i:38	aaaaaaaa	Position Control, a Target Position
H:	H:				Hold
N:	N:				Position Mode (Release Hold)
V:	V:	i:68	i:68	aaaaaa	Speed: 0 - 1000

Pressure Control

Set	Resp	Get	Resp	Data Set, Get Resp	Description
S:	S:	i:38	i:38	aaaaaaaa	Pressure Control, a Target Pressure
H:	H:				Hold
K:	K:				Pressure Control Mode (Release Hold)
s:02 s:02a	s:02	i:02 i:02a	i:02	abcdeeff	Pressure Control Setup a Controller: 0=Adaptive,1=PI Downstream,2=PI Upstream,3=Softpump b Gain Factor (Adaptive, not for this valve) 0=0.1,1=0.13,2=0.18,3=0.23,4=0.32,5=0.42,6=0.56,7=0.75,8=1.0,9=1.33,A=1.78,B=2.37, C=3.16,D=4.22,E=5.62,F=7.5,G=0.0001,H=0.0003,I=0.001,J=0.003,K=0.01,L=0.02,M=0.05 c Sensor Delay (Adaptive, not for this valve) 0=0,1=0.02,2=0.04,3=0.06,4=0.08,5=0.1,6=0.15,7=0.2, 8=0.25,9=0.3,A=0.35,B=0.4,C=0.5,D=0.6,E=0.8,F=1.0 sec d Ramp Time 0=0.0,1=0.5,2=1.0,3=1.5,4=2.0,5=2.5,6=3.0,7=3.5,8=4.0,9=4.5,A=5.0 sec e P-Gain (PI and Softpump) 0=0.001,1=0.0013,2=0.0018,3=0.0024,4=0.0032,5=0.0042,6=0.0056, 7=0.0075,8=0.01,9=0.013,10=0.018,11=0.024,12=0.032,13=0.042, 14=0.056,15=0.075,16=0.1,17=0.13,18=0.18,19=0.24,20=0.32,21=0.42, 22=0.56,23=0.75,24=1.0,25=1.3,26=1.8,27=2.4,28=3.2,29=4.2,30=5.6, 31=7.5,32=10,33=13,34=18,35=24,36=32,37=42,38=56,39=75,40=100 f I-Gain (PI and Softpump): Same values as P-Gain
s:02a01	s:02	i:02a01	i:02	value	Ramp Time: 0.0 – 1000000.0sec, **a** = Controller: A,B,C,D
s:02a02	s:02	i:02a02	i:02	value	Ramp Mode: 0=constant time, 1=constant slope, **a** = Controller: A,B,C,D
s:02a03	s:02	i:02a03	i:02	value	Control Direction: 0=downstream, 1=upstream, **a** = Controller: A,B,C,D
s:02a04	s:02	i:02a04	i:02	value	P-Gain: 0.001 – 100.0 (Control Algorithm = PI or Softpump) **a** = Controller: A,B,C,D
s:02a05	s:02	i:02a05	i:02	value	I-Gain: 0.001 – 100.0, **a** = Controller: A,B,C,D
s:02a06	s:02	i:02a06	i:02	value	Ramp Type: 0=linear, 1=logarithmic, 2=exponential, **a** = Controller: A,B,C,D
s:02a10	s:02	i:02a10	i:02	value	Control Algorithm: *0=Adaptive, 1=PI, 2=Softpump*, **a** = Controller: A,B,C,D
s:02Z00	s:02	i:02Z00	i:02	value	Control Unit Selector: 0 .. 3
s:02Z10	s:02	i:02Z10	i:02	value	Save Volatile: 0=non volatile, 1=volatile

Pressure Reading

Set	Resp	Get	Resp	Data Set, Get Resp	Description	
		P:	P:	aaaaaaaa	Actual Pressure	
s:01	s:01	i:01	i:01	abcccccc	Setup	
					a Sensor Mode	0=No Sensor 1=Sensor1 Only 3=Sensor2 Only 2=Sensor1 High, Sensor2 Low, Crossover Soft Switch 4=Sensor2 High, Sensor1 Low, Crossover Soft Switch 5=Sensor1 High, Sensor2 Low, Crossover High Disabled 6=Sensor2 High, Sensor1 Low, Crossover High Disabled 7=Sensor1 High, Sensor2 Low, Crossover Target Pressure 8=Sensor2 High, Sensor1 Low, Crossover Target Pressure 9=Sensor1 High, Sensor2 Low, Crossover Hard Switch 10=Sensor2 High, Sensor1 Low, Crossover Hard Switch
					b Zero Adjust Enable	0=disable, 1=enable
					c Sensor Factor	Ratio between the sensors * 100 Example: Sensor 1=1Torr, Sensor 2=100mTorr → c = 010000
Z:	Z:				Zero	
		i:60	i:60	aaaaaaaa	Offset Sensor 1	
		i:61	i:61	aaaaaaaa	Offset Sensor 2	
		i:62	i:62	aaaabbbb	Offsets: a Sensor 1, b Sensor 2, range -140 ... +150 of 1000	
		i:62	i:62	aaaaaaaa	Pressure Sensor 1	
		i:63	i:63	aaaaaaaa	Pressure Sensor 2	
c:6002	c:60			aaaaaaaa	Pressure Alignment, a = Alignment pressure	
c:6102	c:61			aaaaaaaa	Pressure Alignment, a = Alignment pressure	
c:90	c:90			aa	Pressure Simulation, 0=Off, 1=On	

Interface

Set	Resp	Get	Resp	Data Set, Get Resp	Description
s:20	s:20	i:20	i:20	abcdefgh	Setup1
					a Baud Rate: 0=600,1=1200,2=2400,3=4800,4=9600,5=19200,6=38400,7=57600,8=115200,9=230400
					b Parity Bit: 0=Even, 1=Odd, 2=Mark, 3=Space
					c Data Length: 0=7bit, 1=8bit
					d Stop Bit: 0=1bit, 1=2bit
					e Command Set: 0=IC, 1=PM
					f Digital Input 1: 0=Interlock Open, 1=Interlock Open Inverted, 2=Disabled
					g Digital Input 2: 0=Interlock Close, 1=Interlock Close Inverted, 2=Disabled
					h Second Answer (PM Command Set): 0=disabled, 1=enabled
s:21	s:21	i:21	i:21	abbbbbb	Setup2
					a Position Range: 0=1000, 1=10000, 2=100000
					b Pressure Range: 1000 .. 100000
s:22	s:22	i:22	i:22	abbbcdee	Setup3
					a Operation Mode: 0=RS232, 1=RS485, 2=RS485 Peer to Peer
					b Device Address: 0 ... 999
					c Duplex Mode: 0=Full, 1=Half
					d Termination: 0=LF (CR/LF), 1=CR
					e Reserved

Errors

Description	Error message
Protocol	
Parity error	E:000001
Input buffer overflow (to many characters)	E:000002
Framing error (data length, number of stop bits)	E:000003
Overrun (Service interface: Input buffer register overflow)	E:000004
Commands	
<CR> or <LF> missing	E:000010
: missing	E:000011
Invalid number of characters (between **:** and)	E:000012
Invalid value	E:000023
Value out of range	E:000030
Hardware	
Pressure mode, Zero or Learn without Sensor	E:000040
Command not applicable for hardware configuration	E:000041

Setup	
ZERO disabled	E:000060
Device Status	
Command not accepted due to local operation	E:000080
Command not accepted, Service Interface locked	E:000081
Command not accepted due to synchronization, CLOSED or OPEN by digital input, safety mode or fatal error	E:000082
Not accepted calibration and test mode	E:000089

RS485 Multiply device commands

To address multiply device, put [#][xxx] bevor the standard command. Instead xxx set the device address.

GET Command

Transmitted data
[#][xxx][p:][service][parameter][index]

Received data
[#][xxx][p:][error][service][parameter][index][value]

SET Command

Transmitted data
[#][xxx][p:][service][parameter][index][value]

Received data
[#][xxx][p:][error][service][parameter][index][value]

2.5.2.3 Scaling

Use the Parameter Scaling to set the communication range for position and pressure.

Parameter location:
CPA
Interface RS2332/RS485.Scaling

	Parameter	**Description**

Scaling	***Position***	Set one of the available position range: *0-1* *0-10* *0-90* *0-100* *0-1000* *0-10000* *0-100000* *User specific*
	Pressure	Set one of the pressure unit: *Pa* *kPa* *bar* *mbar* *Torr* *mTorr* *psi* *User specific*

2.5.2.4 Input/Output

The RS232/485 Interface allows the user to operation with digital and analog signals. Thera are following Inputs and Outputs available.

- 2 Digital Input
- 2 Digital Output
- 2 Analog Output

Digital Inputs

There are 2 Digital Inputs available.
The Digital Input functionality has the higher priority that the RS232/485 Communication

Parameter

	Parameter	Description
Digital Input 1..2	***Enable***	*True* means it is supported. *False* means it is not supported
	State	*True* means it is active. *False* means it is not active.
	Functionality	Each digital input can be assigned one of the functionality descript at the *table Functionality.*
	Inverted	Inverted the functionality of the signal.

Functionality

Functionality	Description
Interlock Open	Open the Valve
Interlock Close	Close the Valve

Digital Outputs

There are 2 Digital Outputs available.

Parameter

	Parameter	Description
Digital Output 1..2	***Enable***	*True* means it is supported. *False* means it is not supported
	State	True means it is active. False means it is not active.
	Functionality	Each digital input can be assigned one of the functionality descript at the *table Functionality.*
	Inverted	Inverted the functionality of the signal.

Functionality

Functionality	Description
Open	Indicate the Open status of the Valve.
Close	Indicate the Close status of the Valve.
Hold	Indicate the Hold status of the Valve.

Analog Outputs

Parameter

There are two outputs, one for **pressure** and one for **position**

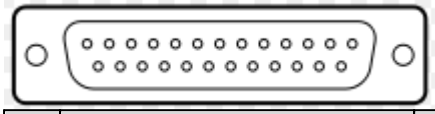
	Parameter	Description
Analog Output	***Value***	Indicate the applied voltage
	User Factor	1 default value for Input voltage 0 to 10V UserFactor = (MaxVolt – MinVolt) / 10 Example: Input voltage 2V to 8V (8-2)/10 = 0.6 User Factor

	User Offset	0 default value for Input voltage 0 to 10V UserOffset = MinVolt Example: Input voltage 2V to 8V 2.0 = User Offset

2.5.2.5 Wiring

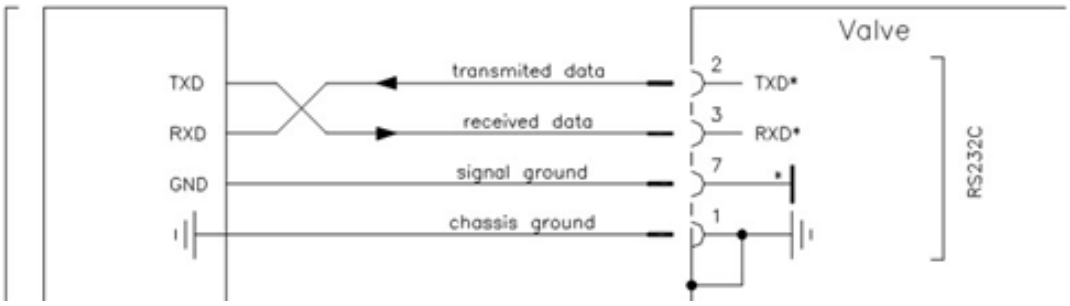
Connector assembling

The Connector on the Controller is a D-Sup 25 Pin female.



Pin	Signal	Description
1	Chassis GND	*Connected to case. Use this to connect cable shield.*
2	TXD	*Transmitted data to RS232*
3	RXD	*Received data from RS232*
7	GND Digital output	*GND (2) Digital output*
8	Open	*Digital output 1*
9	Close	*Digital output 2*
11	Y	*RS485 T+*
12	A	*RS485 R+*
13	B	*RS485 R-*
15	Close	*Digital Input 2*
17	Open	*Digital Input 1*
20	GND Analog output	*GND (1) Analog output*
21	Position	*Analog Output 1*
22	Pressure	*Analog Output 1*
23	GND Digital input	*GND (3)*
24	Z	*RS485 T-*
25	Common Digital input	*3.3V (3)*

RS232



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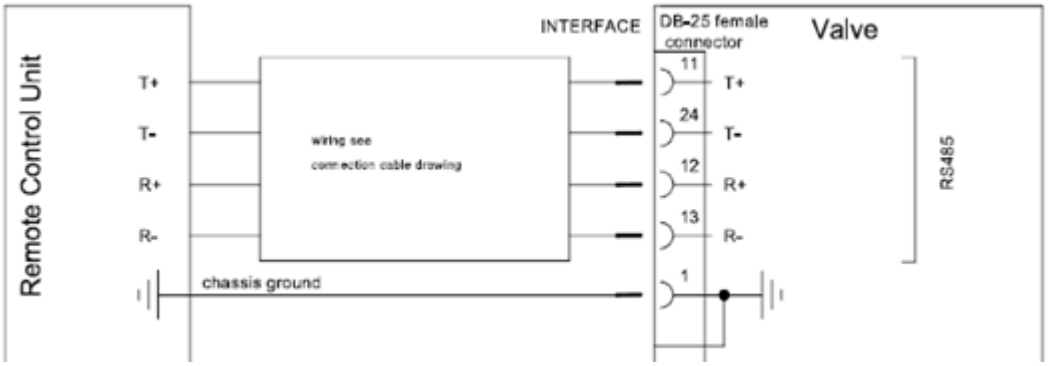
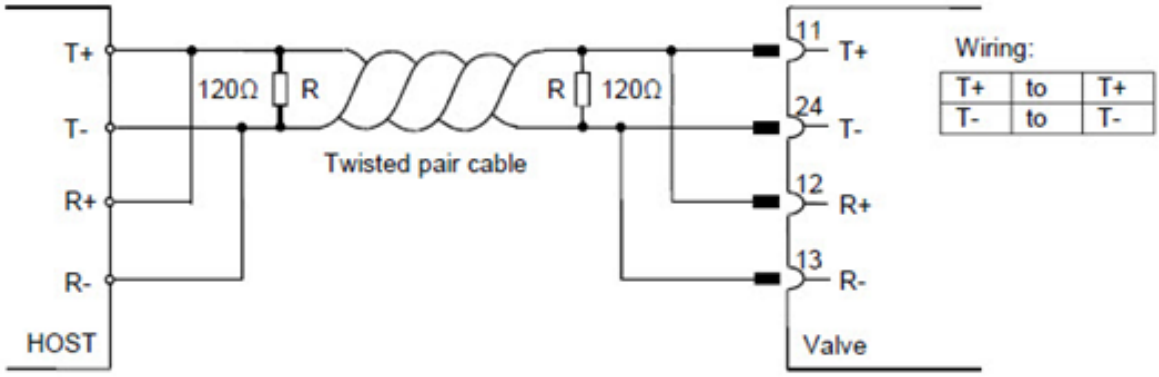
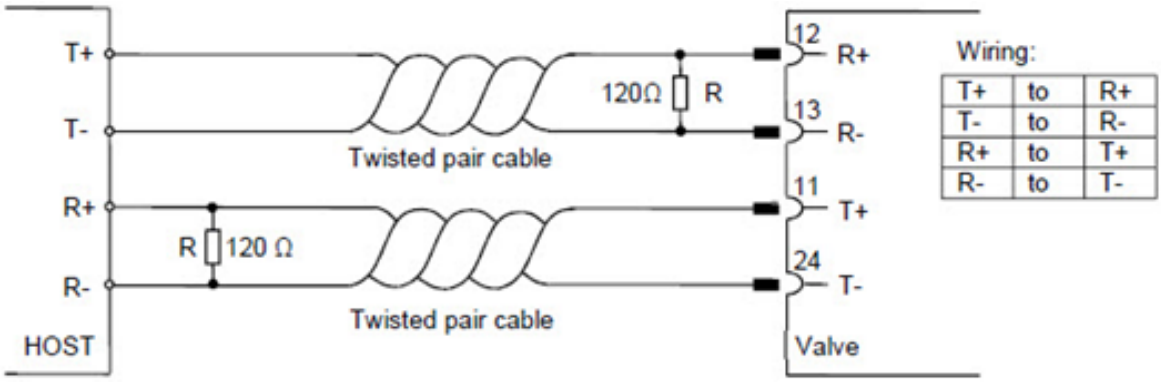
RS485



RS485 Half duplex

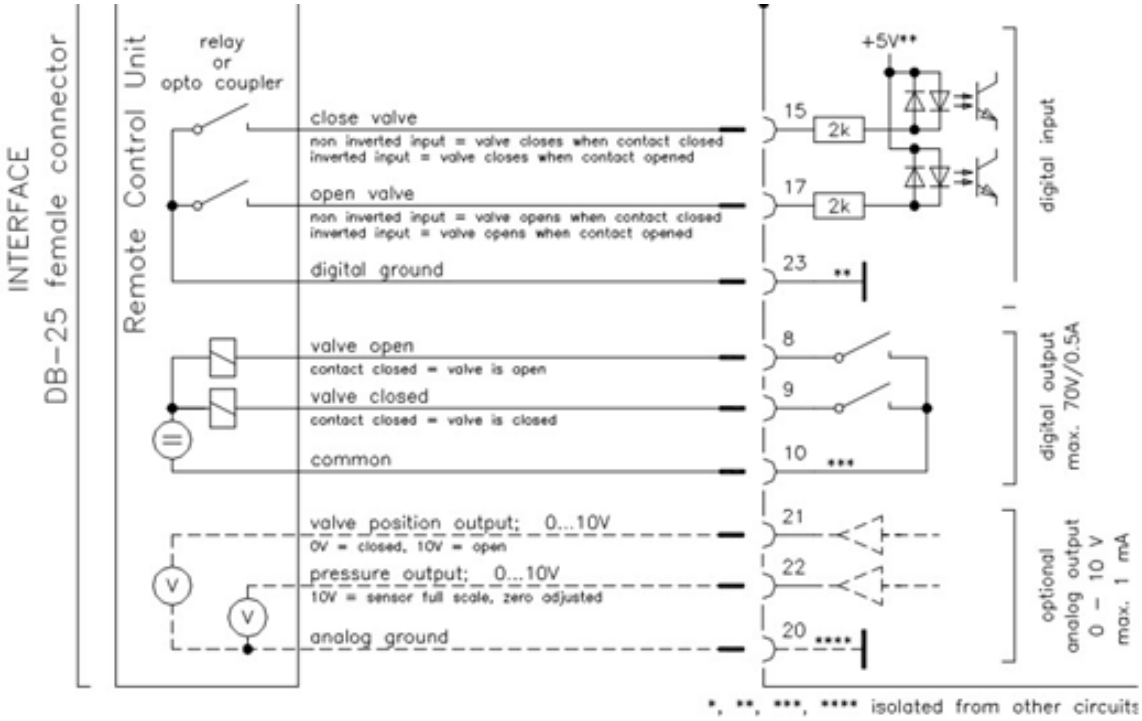


RS485 Full duplex

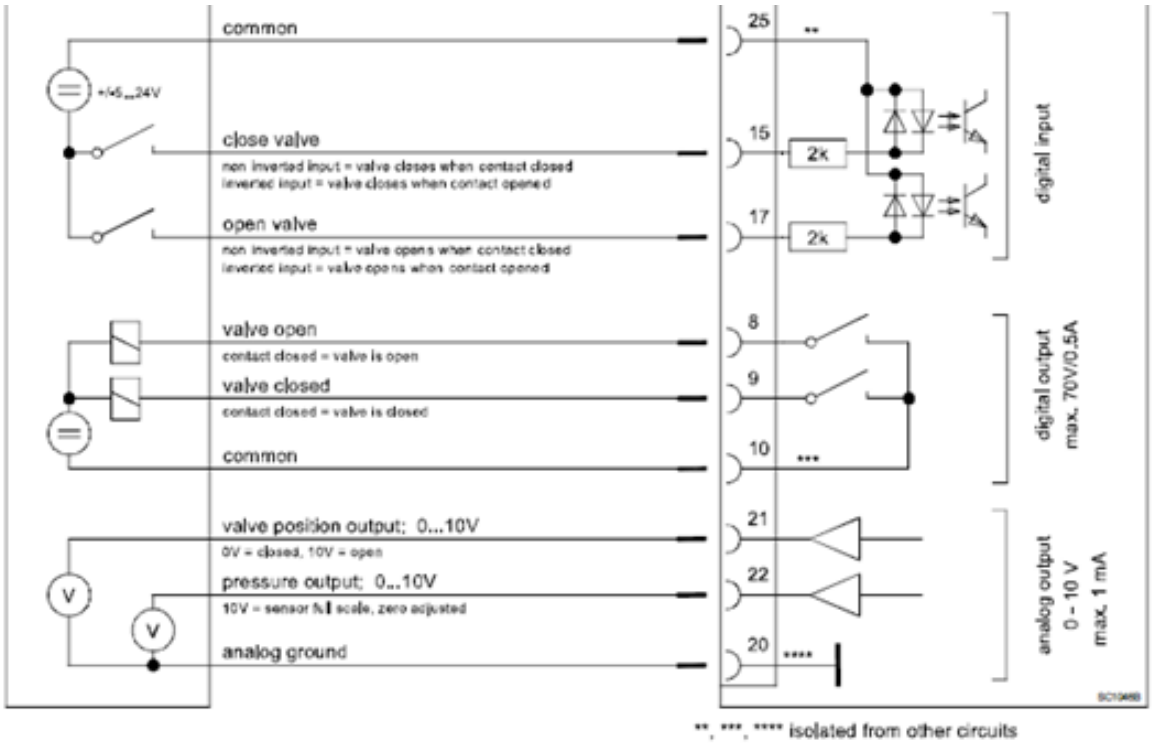


Input/Output

Configuration with switches



Configuration with Voltage



, *, **** isolated from other circuits

2.5.3 DeviceNet

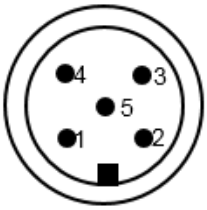
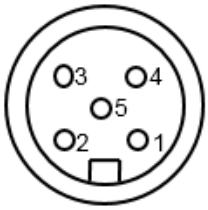
2.5.3.1 Connection

Connector type: Micro-style male (5 pin), connector is shown on panel refer to chapter «Installation into the system».

At valve controller	DeviceNet® cable		
PIN	**Name**	**Wire color**	**Description**
1	Drain	Bare	Shield
2	V+	Red	DeviceNet® power supply +
3	V-	Black	DeviceNet® power supply -
4	CAN_H	White	DeviceNet® signal
5	CAN_L	Blue	DeviceNet® signal

The DeviceNet® interface is galvanic isolated from control unit.

Micro Connector Pinout

Male (pins) at valve controller	Female (sockets) at DeviceNet® cable
	

2.5.3.2 LEDs

Mode

State of operation

LED Color	Description
GREEN	Operating in Normal Condition
FLASHING GREEN	The device needs commissioning due to configuration missing, incomplete or incorrect. The Device may be in the Standby state.
FLASHING RED	Recoverable Fault
RED	The device has an unrecoverable fault may need replacing. • Bus Off • Queue overload • Duplicate MAC ID
FLASHING GREEN & RED	The Device is in Self Test.

NET

State of the communication

LED Color	Description
FLASHING GREEN	Device is on–line but has no connections in the established state. The device has passed the Dup_MAC_ID test, is on–line, but has no established connections to other nodes.
FLASHING RED	One or more I/O Connections are in the Timed–Out state.

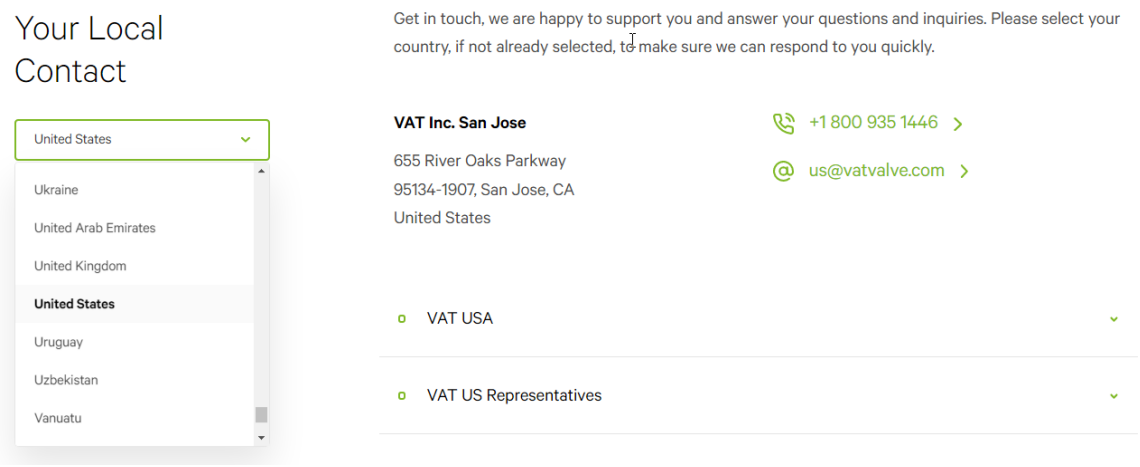
2.5.3.3 Communication

EDS

EDS file describe the communication parameters which are available from the specific device.

Choose the EDS file depending on valve series (example 613), data type (Int or Float) and profile (Process Control Device or Generic Device). If the EDS file is missing please request this by your

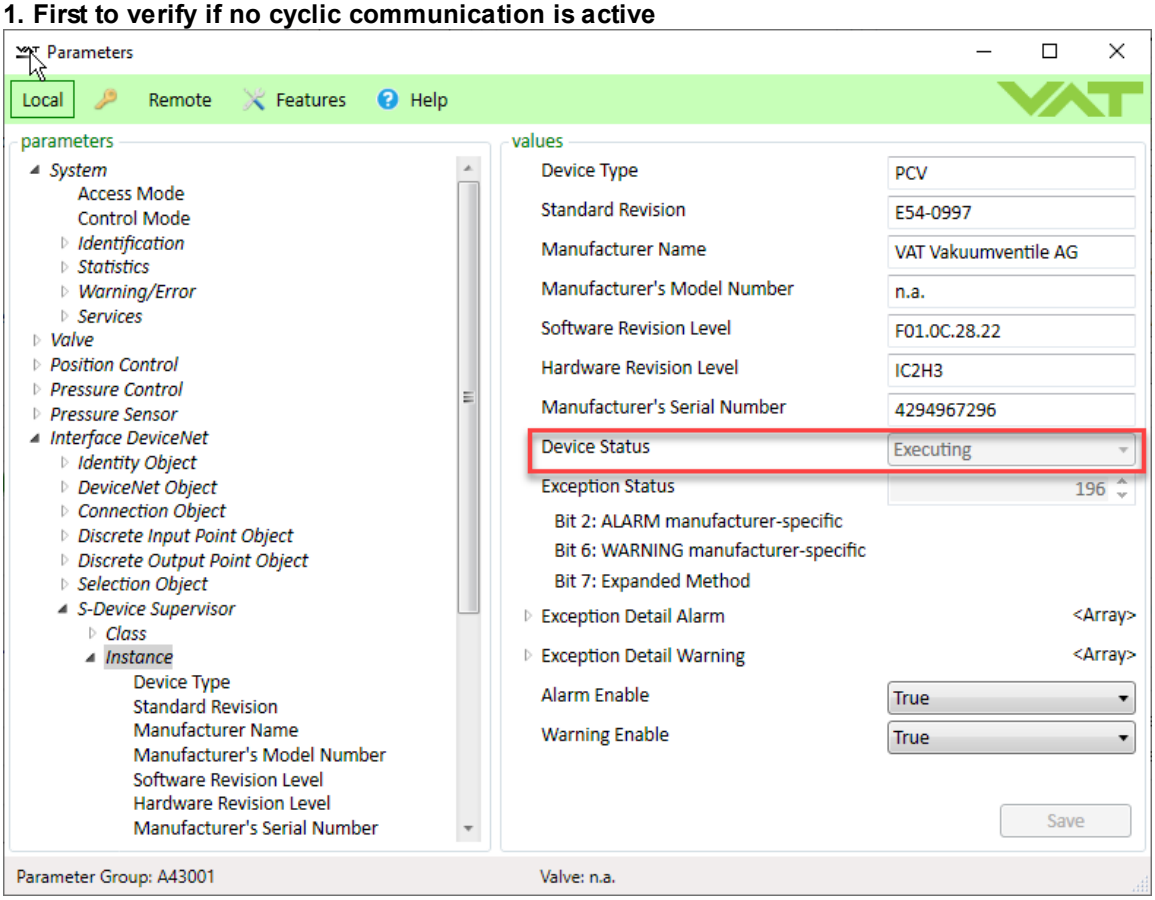
local contact Contact.



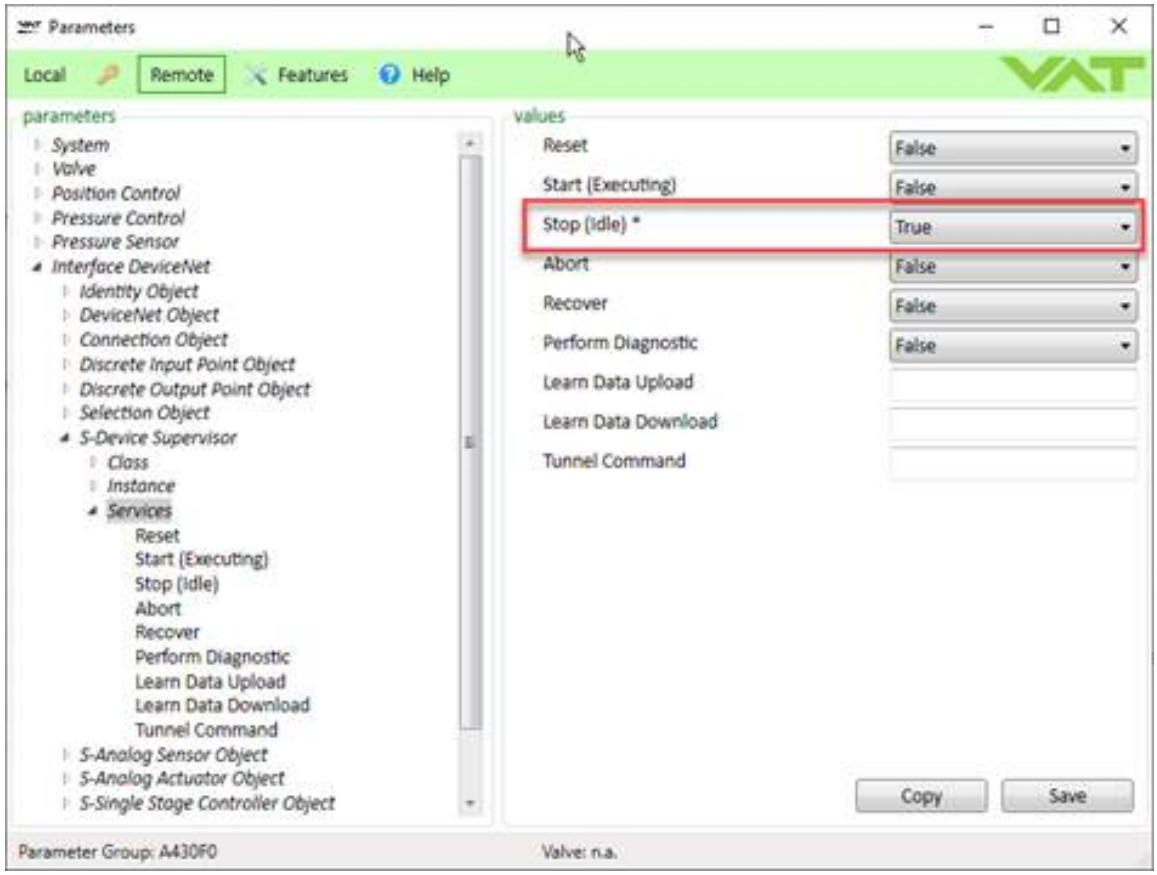
Initial Communication Settings

To establish communication via DeviceNet, the following settings should be defined.

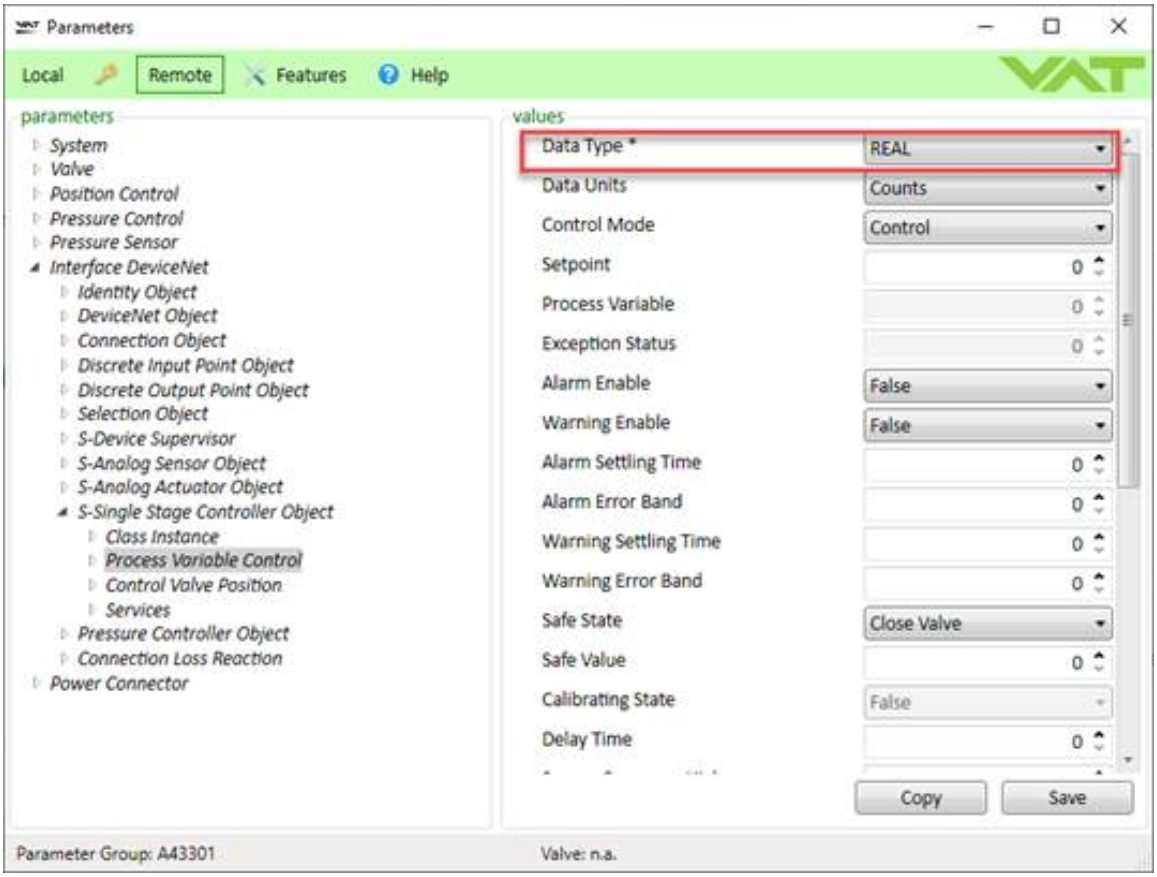
1. First to verify if no cyclic communication is active



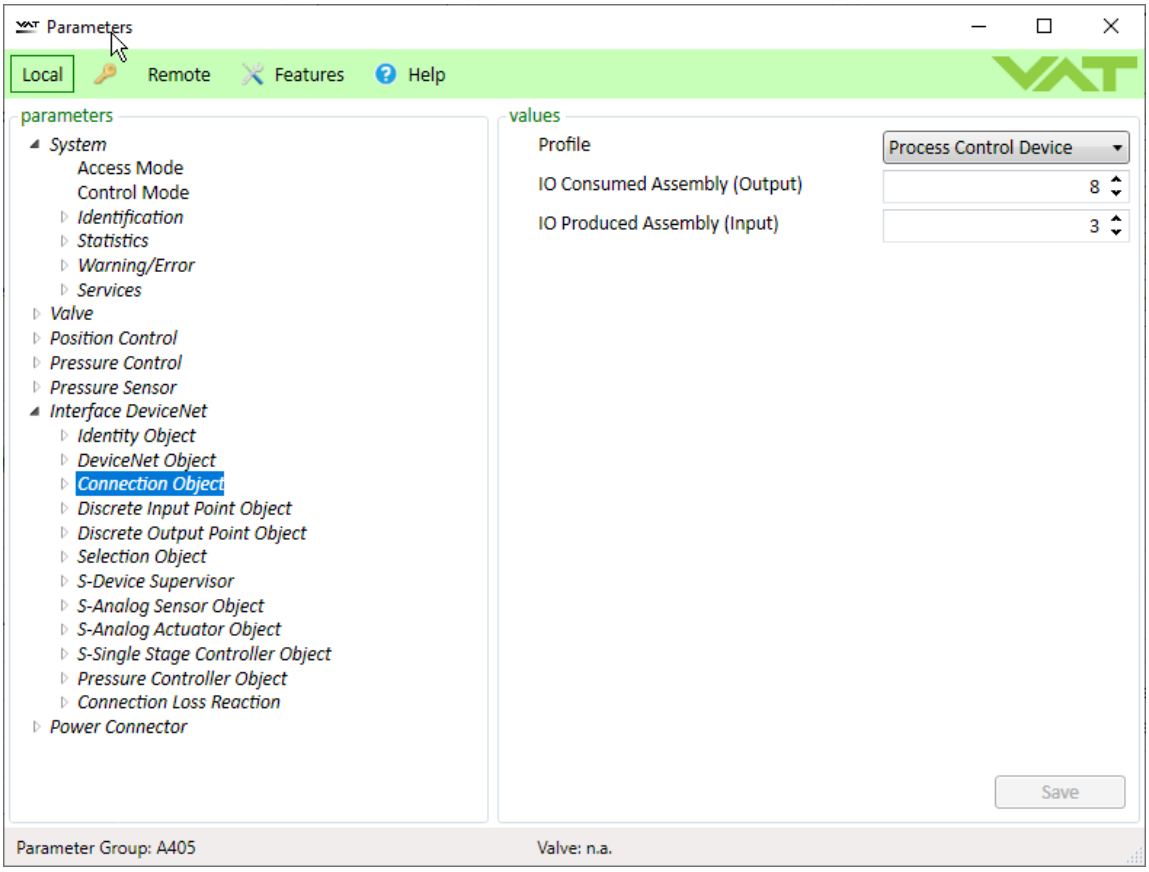
If Device Status shows Executing than execute stop service (see above)



2. Define Data Type for example under S-Single Stage Controller Object



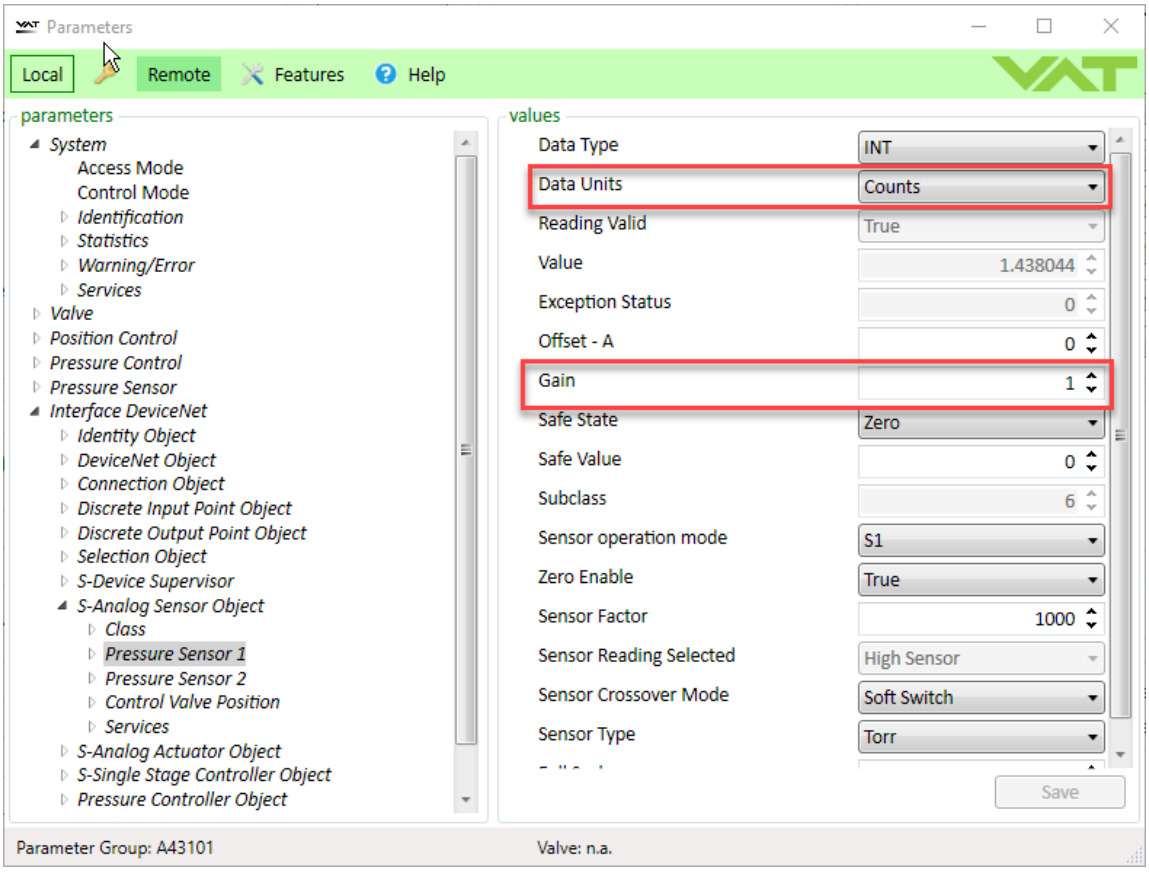
3. Define Profile and Assemblies



4. Define Data Units

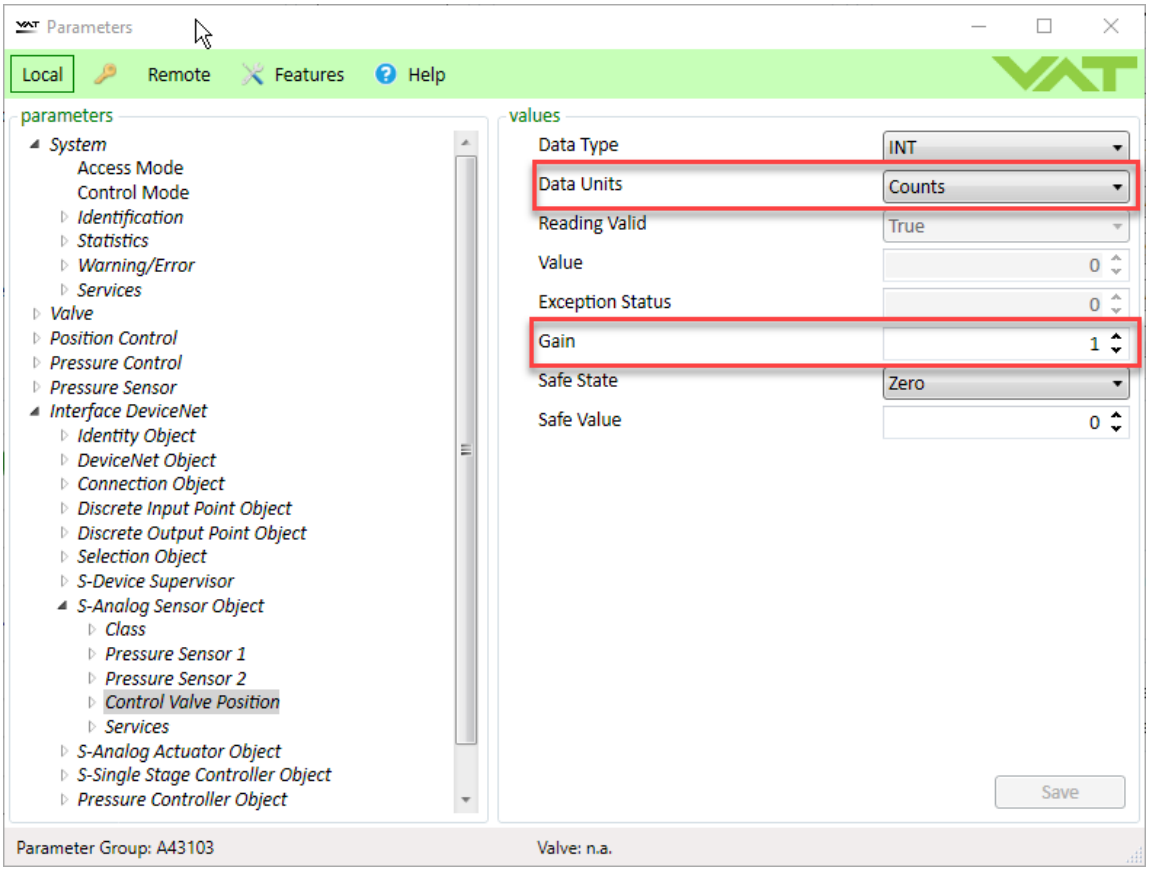
Note: General Device Profile allowed only Counts for Pressure and Position. Default Range is 0-10'000 (Gain value 1). With the gain value this can be limited in a range of 0-1 (Gain value 0.0001) until 0-32767 (Gain value 3.2767)

Pressure (Only necessary to set if Profile is Process Control Device):



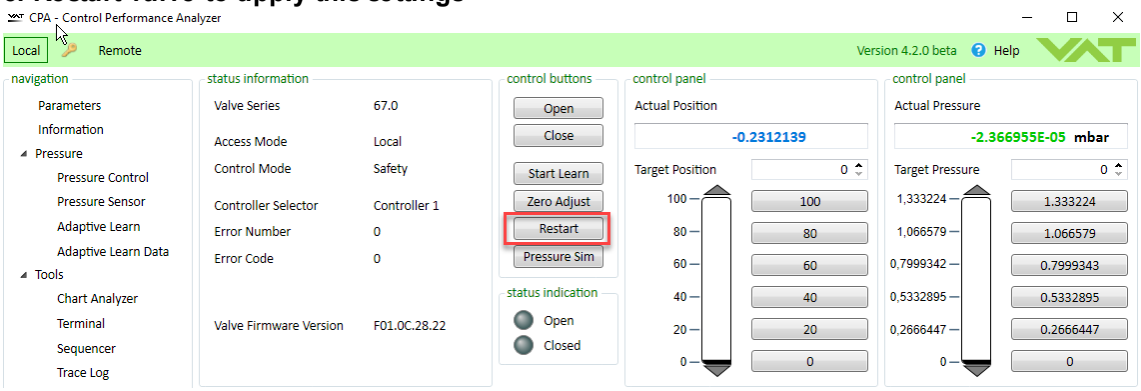
Set Gain value if a different range than 0-10'000 is requested (in case of Data Units is Counts).

Position (Only necessary to set if Profile is Process Control Device):



Set Gain value if a different range than 0-10'000 is requested (in case of Data Units is Counts).

5. Restart valve to apply this settings



The easiest way to execute a restart is by pressing restart button on the CPA 4 main window.

Connection Loss Reaction

Connection Loss reaction defines what the valve is doing in case the DeviceNet connection get lost.

Parameter	Description
Enable	*True* enables the connection loss reaction, in case of *False* there is no reaction on a connection loss (compatible IC1 Setting *keep Position*)
State	Current connection loss state

Functionality	Defines the functionality in case of connection loss. This can be *open* or *close*.

2.5.3.4 Profile

In general two different profiles are supported.
Generic Device (GD) is the older and more common profile which is developed by VAT.
Process Control Device (PCD) is a profile which is defined by ODVA.

Comparison GD and PCD profile

Function	Generic Device	Process Control Device
S-Analog Sensor Instances	▪ Pressure ▪ Position	▪ Sensor 1 ▪ Sensor 2 ▪ Position
Data Units Pressure	▪ Counts ▪ Percent	▪ Counts ▪ Percent ▪ Psi ▪ Torr ▪ mTorr ▪ Bar ▪ mBar ▪ Pa ▪ atm
Data Units Position	▪ Counts	▪ Counts ▪ Percent ▪ Degrees
Set Point Type	Class 51, Instance 0, Attribute 8 **Data Length 1 Byte** Value: 0=pressure, 1=position	Class 46, Instance 1, Attribute 14 **Data Length 2 Byte** Value: 0=none,1=pressure, 2=position
Poll Output Assembly	Class 5, Instance 2, Attribute 100	Class 5, Instance 0, Attribute 100
Poll Input Assembly	Class 5, Instance 2, Attribute 101	Class 5, Instance 0, Attribute 101
Bit Strobe Produce Assembly	-	Class 5, Instance 0, Attribute 102
COS/Cyclic Produce Assembly	Class 5, Instance 4, Attribute 101	Class 5, Instance 0, Attribute 103
Sensor Setup	Sensor Mode, Sensor Factor	Sensor Full Scale, Sensor Unit (or Sensor Mode, Sensor Factor)
Learn	Service 100 in Class 51 Start with 0, Stop with 1	Service 99 in Class 51 Start with 1, Stop with 0
Additional Attributes and Functions		▪ Alarm / Warning Bands ▪ Sensor Crossover ▪ Process Variable Source ▪ Control Direction ▪ …

Firmware Download	No	Yes
Configuration and Read via Service Interface	No	▪ Sensor 1 Gain ▪ Sensor 2 Gain ▪ Position Gain ▪ Position Units ▪ Pressure Units ▪ Data Type ▪ Poll Input ▪ Poll Output ▪ Factory Reset ▪ Reset ▪ Exception Status ▪ Device Stats
Exception Detail	Device Exception Size: 5 Device Exception: Sensor Expt. Manufacturer Byte#5: FE Value	Device Exception Size: 4 Device Exception: not used Manufacturer Byte#5: FE Bits

Cyclic Communication (Assenblies)

PCD: Each Data Type has an assembly number
GD: Each assembly supports both data types

Arrangement	Type	GD			PCD			
			Integer	Float	Integer		Float	
		Nr	Length	Length	Nr	Length	Nr	Length
PRESSURE	Input	-	-	-	**1**	2	**17**	4
EXCEPTION STATUS PRESSURE	Input	-	-	-	**2**	3	**18**	5
EXCEPTION STATUS PRESSURE POSITION	Input	**3**	5	9	**3**	5	**19**	9
EXCEPTION STATUS PRESSURE SETPOINT	Input	**4**	5	9	**4**	5	**20**	9
EXCEPTION STATUS PRESSURE SETPOINT POSITION	Input	**5**	7	13	**5**	7	**21**	13
EXCEPTION STATUS PRESSURE SETPOINT CONTROL MODE POSITION	Input	-	-	-	**6**	8	**22**	14
SETPOINT SETPOINT TYPE	Output	**7**	3	5	**7**	4	**23**	6
CONTROL MODE SETPOINT SETPOINT TYPE	Output	**8**	4	6	**8**	5	**24**	7
EXCEPTION STATUS	Input	**-**	-	-	**10**	1	**-**	-
EXCEPTION STATUS PRESSURE POSITION CLOSE/OPEN CHECK	Input	-	-	-	**11**	6	**26**	10
CONTROL MODE SETPOINT KP (Gain Faktor) KI (Sensor Delay) KD (Ramp Time or Ramp Slope)	Output	-	-	-	-	-	**32**	17
EXCEPTION STATUS PRESSURE POSITION DEVICE STATUS 2 ACCESSMODE	Input	**100**	7	11	**100**	7	**105**	11
EXCEPTION STATUS PRESSURE POSITION CLOSE/OPEN CHECK DEVICE STATUS 2	Input	-	-	-	**101**	7	-	-
CONTROL MODE SETPOINT SETPOINT TYPE LEARN LEARN PRESSURE LIMIT ZERO	Output	**102**	8	12	**102**	9	**107**	13
CONTROL MODE SETPOINT SETPOINT TYPE CLUSTER ADDRESS CLUSTER ACTION	Output	-	-	-	**103**	7	**108**	9
EXCEPTION STATUS PRESSURE SENSOR 2 READING POSITION ACCESS MODE DEVICE STATUS 2 CLUSTER INFOMATION	Input	**104**	Min 9 Max 24	Min 15 Max 29	**104**	Min 9 Max 24	**109**	Min 15 Max 29
EXCEPTION STATUS PRESSURE POSITION SETPOINT DEVICE STATUS 2	Input	-	-	-	**106**	8	-	-
CONTROL MODE								

Acyclic Communication

Generic Device

Explicit messaging control commands

Command (DeviceNet® term if deviant)	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
EXECUTING	6	48	1	3		
	This command changes the valve to executing state. **Note:** EXECUTING must to be selected to enable for all executing commands such as control mode, close valve and open valve. **Note:** If valve is already in executing state and anew EXECUTING command is sent DeviceNet® will return an error message.					
IDLE	7	48	1	3		
	This command changes the valve to idle state.					
RESET	5	1	1	0		
	This command resets the DeviceNet® interface.					
FACTORY RESET	5	1	1	1		
	This command resets the DeviceNet® interface to factory default settings. **Note:** All previously done configurations will be overwritten.					
SETPOINT TYPE	Set	16	51	0	8	1	Y
	Get	14	51	0	8	1	
	Y: **0** pressure control **1** position control This command selects / returns current setpoint type. It toggles valve operation mode between position and pressure control. **Note:** To perform either position or pressure control also correct MODE must be selected.					
MODE (control mode)	Set	16	51	1 (pressure) 2 (position)	5	1	Y
	Get	14	51	1 (pressure) 2 (position)	5	1	

	Y: **0** control mode (pressure resp. position control) **1** close valve (valve will close) **2** open valve (valve will open) **3** hold (stops the valve at the current position) **4** safe state This command preselects / returns the mode for pressure resp. position control. By means of instance ID either pressure or position must be addressed. **Note:** To activate either pressure or position control you must select correct SETPOINT TYPE separately.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
	Description						
POSITION SETPOINT	Set	16	51	2	6	2 or 4	Y
	Get	14	51	2	6	2 or 4	
	Y: position setpoint according to selected DATA TYPE, **0** (closed) … **10'000** (open) This command transfers/reads the position setpoint to/from the valve.						
PRESSURE SETPOINT	Set	16	51	1	6	2 or 4	Y
	Get	14	51	1	6	2 or 4	
	Y: pressure setpoint according to selected DATA TYPE, nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled, refer also to command GAIN for details. This command transfers/reads the pressure setpoint to/from the valve.						
ASSEMBLY OBJECTS	Set	16	4	7 8 102	3	X	Y
	Get	14	4	3 4 5 13 14 100 101	3	X	

	X, Y: depending on respective assembly object, refer to «Assembly objects» for details. Instance ID = assembly object number. This command writes/reads the respective assembly object.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

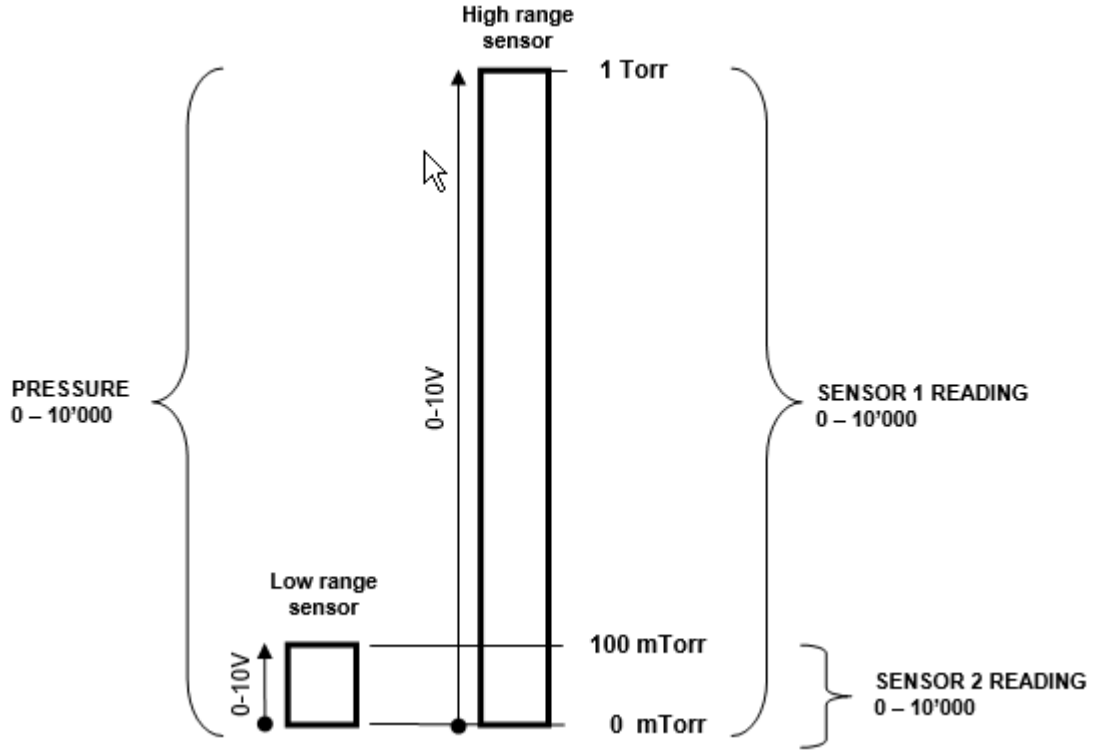
..1 Explicit messaging inquiry commands

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
	Description						
VALVE CLOSED CHECK (discrete input 1)	Get	14	8	1	3	1	
	This command returns: **0** valve is not closed **1** valve is closed						
VALVE OPEN CHECK (discrete input 2)	Get	14	8	2	3	1	
	This command returns: **0** valve is not open **1** valve is open						
POSITION	Get	14	49	3	6	2 or 4	
	This command returns the current valve position according to selected DATA TYPE. Position range is **0** (closed) … **10'000** (open).						
PRESSURE	Get	14	49	1	6	2 or 4	
	This command returns the actual pressure according to selected DATA TYPE. Nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
SENSOR 1 READING	Get	14	100	1	108	2 or 4	
	This function returns direct reading from sensor 1 according to selected DATA TYPE. Nominal range is **0** … **10'000** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
SENSOR 2 READING	Get	14	100	1	109	2 or 4	
	This function returns direct reading from sensor 2 according to selected DATA TYPE. Nominal range is **0** … **10'000** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						

SENSOR 1 OFFSET VALUE (Sensor 1 offset A)	Get	14	49	1	12	2 or 4	
			100	1	110		
	These commands return the offset voltage (adjusted by ZERO) of the sensor 1 according to selected DATA TYPE. Both commands are identical. Value range is **-1400** … **+1400** (-1.40V … +1.40V).						
SENSOR 2 OFFSET VALUE (Sensor 2 offset A)	Get	14	100	1	111	2 or 4	
	This command returns the offset voltage (adjusted by ZERO) of the sensor 2 according to selected DATA TYPE. Value range is **-1400** … **+1400** (-1.40V … +1.40V).						

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Example of PRESSURE and SENSOR READING allocation:



Above picture shows a 2 sensor system. In this configuration sensor 2 covers low range (100 mTorr) and sensor 1 covers high range (1 Torr).
Switchover between sensors is done automatically according to «Pressure control operation with 2 sensors».

Command (DeviceNet® term	**Service Code**	**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**

	Description						
LEARN STATUS (calibration state)	Get	14	51	1	106	2	

This command returns the status of the LEARN procedure. The status is binary coded.

Bit	Explanation:
(LSB) 0	**0** = LEARN not running **1** = LEARN running
1	**0** = LEARN data set present **1** = LEARN data set not present
2	**0** = ok **1** = LEARN terminated by user
3	**0** = ok **1** = pressure in position OPEN > 50% sensor full scale (of high range sensor in case of a 2 sensor system) or > LEARN PRESSURE LIMIT
4	**0** = ok **1** = pressure in position 0 < 10% sensor full scale (of low range sensor in case of a 2 sensor system)
5	**0** = ok **1** = pressure falling during LEARN
6	**0** = ok **1** = sensor not stable during LEARN
7	reserved
8	reserved
9	reserved
10	**0** = ok **1** = LEARN terminated by controller
11	**0** = ok **1** = pressure in position OPEN negativ
12	reserved
13	reserved
14	reserved
15	reserved
(MSB) 16	reserved

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‘h‘ (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
DEVICE STATUS 1	Get	14	48	1	11	1	Y
	Y: **1** self test **2** idle **3** self test exception **4** executing **5** abort This command returns the device status.						
DEVICE STATUS 2	Get	14	100	1	103	1	
	This command returns the device status. **0** = initialization, **1** = synchronization, **2** = POSITION CONTROL, **3** = CLOSED **4** = OPEN, **5** = PRESSURE CONTROL, **6** = HOLD , **7** = LEARN **12** = power failure, **13** = safety mode **14** = fatal error (read EXCEPTION DETAIL ALARM for details)						
EXCEPTION STATUS (status)	Get	14	48	1	12	1	
	This command returns the exception status. Bit Explanation: (LSB) 0 **0** (reserved) 1 **0** (reserved) 2 This bit is set to 1 in case of a manufacturer specific alarm. 3 **0** (reserved) 4 **0** (reserved) 5 **0** (reserved) 6 This bit is set to 1 in case of a manufacturer specific warning. (MSB) 7 **1** The exception status byte only indicates that alarms or warnings are present. In order to find out which alarm or warning is present, you must read EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING.						
EXCEPTION DETAIL ALARM	Get	14	48	1	13 14	15	

	With Attribute ID = 13 EXCEPTION DETAIL ALARM bytes will be returned. With Attribute ID = 14 EXCEPTION DETAIL WARNING bytes will be returned. For meaning see table on next page.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**	**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
	Description					

Table with EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING bits.

0 OK

1 Exception / Failure / Error (except for detail size bytes)

EXCEPTION DETAIL ALARM

EXCEPTION DETAIL WARNING

Data Component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCV Common Exception Detail Size	0	0	0	0	0	0	1	0
PCV Common Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Common Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Size	0	0	0	0	0	1	0	0
PCV Device Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #2	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #3	0	0	0	0	0	0	0	0
Manufacturer Exception Detail Size	0	0	0	0	0	1	1	0
Manufacturer Exception Detail Byte #1	Reserved	Reserved	Isolation valve position failure	Sensor ratio exceeded	PFO not ready	Compressed air failure	Learn data set invalid	Service request
Manufacturer Exception Detail Byte #2	Reserved	Reserved	Reserved	Reserved	Reserved	ADC not responding	Reserved	Reserved
Manufacturer Exception Detail Byte #3	Reserved	Reserved	Reserved	Wrong controller mode	Local mode	ZERO disabled	Optional hardware missing	No sensor
Manufacturer Exception Detail Byte #4	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	PFO off	Simulation active
Manufacturer Exception Detail Byte #5	Reserved	Reserved	Reserved	Reserved	E40 1)	E22 1)	E21 1)	E20 1)

	Manufacturer Exception Detail Byte #6	Reserved	Reserved	Reserved	Reserved	Setpoint invalid (safe state)	IO data missing (safe state)	Setpoint type invalid (safe state)	Control mode invalid (safe state)

1) Refer to «Trouble shooting» for details on these fatal errors.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length (number of bytes)**	**Service data field**
	Description						
THROTTLE CYCLE COUNTER	Get	14	100	1	101	4	
	This command returns the number of throttle cycles. Data type is unsigned long integer. A movement from max. throttle position to open back to max. throttle position counts as one cycle. Partial movements will be added up until equivalent movement is achieved.						
ISOLATION CYCLE COUNTER	Get	14	100	1	106	4	
	This command returns the number of isolation cycles. Data type is unsigned long integer. Each closing of the sealing ring counts as one cycle.						

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the lette,h' (e.g. 31h)

Explicit messaging setup commands

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
	Description						
DATA TYPE	Set	16	49	1	3	1	X
	Get	14	49	1	3	1	
	X: **195** integer **202** floating point This command defines the data type for PRESSURE, SENSOR READING, OFFSET and POSITION.						
GAIN	Set	16	49	1	14	4	X
	Get	14	49	1	14	4	

	X: gain, max. value is **3.2767**, data type is floating point This command selects the gain for PRESSURE and allows for scaling. Default value is **3.2767**. e.g.: Gain = 0.1 pressure value range results in 0-1'000 Gain = 1 pressure value range results in 0-10'000 Gain = 3.2767 pressure value range results in 0-32'767						
POLL OUTPUT	Set	16	5	2	100	1	X
	Get	14	5	2	100	1	
	X: output assembly object number (**7**, **8**, **102**) This command configures resp. reads the output assembly for poll connection.						
POLL INPUT	Set	16	5	2	101	1	X
	Get	14	5	2	101	1	
	X: input assembly object number (**3**, **4**, **5**, **13**, **14**, **100**, **101**) This command configures resp. reads the input assembly for polling.						
BIT STROBE INPUT	Not implemented						
CHANGE OF STATE / CYCLING INPUT	Set	16	5	4	101	1	X
	Get	14	5	4	101	1	
	X: input assembly object number (**3**, **4**, **5**, **13**, **14**, **100**, **101**) This command configures resp. reads the input assembly for change of state / cycling.						

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
ACCESS MODE	Set	16	100	1	107	1	X
	Get	14	100	1	107	1	
	X: **0** Local (operation via service port) **1** Remote (operation via DeviceNet®) **2** Locked (in remote mode) This command controls / returns the access mode of the valve.						
POWER UP CONFIGURATION	Set	16	100	1	112	1	X
	Get	14	100	1	112	1	

	X: **0** closed **1** open This command controls / returns the valve position after power up.						
POWER FAIL CONFIGURATION	Set	16	100	1	113	1	X
	Get	14	100	1	113	1	
	X: **0** closed **1** open This command controls / returns the target valve position in case of a power failure. Only for versions that have Power Fail Option equipped [612 . . - . . **C** . - . . . . or 612 . . - . . **H** . - . . . .].						

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
SENSOR MODE	Set	16	49	1	101	1	X
	Get	14	49	1	101	1	
	X: **0** no sensor **1** 1 sensor operation (sensor 1 input) **2** 2 sensor operation with automatic changeover (low range = sensor 2 input, high range = sensor 1 input) **3** 1 sensor operation (sensor 2 input) **4** 2 sensor operation with automatic changeover (low range = sensor 1 input, high range = sensor 2 input) This command controls / returns the sensor mode <u>for pressure control</u>. **Note:** Sensor modes 2, 3 and 4 are possible with 2 sensor hardware [612 . . - . . . **Q** - . . . .] only. **Note:** For applications where the high range sensor is used for for monitoring purpose only, select sensor operation modes 1 or 3 for pressure control with low range sensor and read high range sensor from SENSOR 1 READING resp. SENSOR 2 READING.						
SENSOR RATIO	Set	16	49	1	103	2 or 4	X
	Get	14	49	1	103	2 or 4	
	X: sensor ratio according to selected DATA TYPE, range is **100** … **10'000** This command defines the sensor ratio for 2 sensor operation. Sensor ratio = high range sensor full scale / low range sensor full scale * 100.						
ZERO CONTROL	Set	16	49	1	102	1	X

	Get	14	49	1	102	1	
	X: **0** Disable **1** Enable This command enables resp. disables the ZERO command. In case it is disabled ZERO does not work.						
ZERO	75		49	1			
	This command initiates ZERO. **Note:** Refer to «ZERO (setup step 4)» for correct zero procedure.						

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Command (DeviceNet® term if deviant)	**Service Code**		**Class ID**	**Instance ID**	**Attribute ID**	**Service data length** (number of bytes)	**Service data field**
LEARN PRESSURE LIMIT (calibration scale)	Set	16	51	1	100	2 or 4	Y
	Get	14	51	1	100		
	Y: learn pressure limit according to selected DATA TYPE, nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled, refer also to command GAIN for details. This command transfers/reads the pressure limit for LEARN. **Note:** Refer to «LEARN (setup step 5)» for correct learn pressure limit setting.						
LEARN (calibration service)	100		51	1	0		
	This command starts LEARN. With MODE commands open valve or close valve the routine may be interrupted. **Note:** Without LEARN the PID controller is not able to perform pressure control. Refer to «LEARN (setup step 5)» for correct learn gas flow and procedure.						
DOWNLOAD LEARN DATA	51		48	1		11	XY
	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) Y 8 data bytes ASCII coded (e.g. 30h 32h 33h 33h 33h 30h 33h 36h) Example of XY: 30h 30h 30h 30h 32h 33h 33h 33h 30h 33h 36h (11 bytes in total) This command loads the learn data sets from the host down to the valve. There are a total number of 104 data sets. Each data set needs to be downloaded separately.						
UPLOAD LEARN DATA	50		48	1		3	X

	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) This command loads the learn data sets from the valve up to the host. There are a total number of 104 data sets which need to be uploaded separately. Each answer consists of 11 bytes. Whereas the leading 3 bytes are the data set index followed by 8 data bytes. Data are ASCII coded.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Command (DeviceNet® term if deviant)	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
PID CONTROLLER GAIN FACTOR	Set	16	51	1	105	1	X
	Get	14	51	1	105	1	
	X: **0** = 0.10, **1** = 0.13, **2** = 0.18, **3** = 0.23, **4** = 0.32, **5** = 0.42, **6** = 0.56 **7** = 0.75, **8** = 1.00, **9** = 1.33, **10** = 1.78, **11** = 2.37, **12** = 3.16, **13** = 4.22 **14** = 5.62, **15** = 7.50, **16** = 0.0001, **17** = 0.0003, **18** = 0.001, **19** = 0.003, **20** = 0.01, **21** = 0.02, **22** = 0.05 This command selects/returns the gain factor for the PID controller. **Note:** Refer to «Gain factor adjustment» for details.						
PID CONTROLLER SENSOR DELAY	Set	16	51	1	107	1	X
	Get	14	51	1	107	1	
	X: **0** = 0, **1** = 0.02, **2** = 0.04, **3** = 0.06, **4** = 0.08, **5** = 0.10, **6** = 0.15 **7** = 0.20, **8** = 0.25, **9** = 0.30, **10** = 0.35, **11** = 0.4, **12** = 0.5, **13** = 0.6 **14** = 0.8, **15** = 1.0 This command selects/returns the sensor delay for the PID controller. **Note:** Refer to «Sensor delay adjustment» for details.						
PID CONTROLLER SETPOINT RAMP	Set	16	51	1	108	1	X
	Get	14	51	1	108	1	
	X: **0** = 0, **1** = 0.5, **2** = 1.0, **3** = 1.5, **4** = 2.0, **5** = 2.5, **6** = 3.0 **7** = 3.5, **8** = 4.0, **9** = 4.5, **10** = 5.0, **11** = 5.5, **12** = 6.0, **13** = 6.5 **14** = 7.0, **15** = 7.5, **16** = 8.0, **17** = 8.5, **18** = 9.0, **19** = 9.5, **20** = 10.0 This command selects/returns the setpoint ramp for the PID controller. **Note:** Refer to «Setpoint ramp adjustment» for details.						
VALVE SPEED	Set	16	51	2	101	2	X
	Get	14	51	2	101	2	

	X: valve speed, **1** … **1000** (1 = min. speed, 1000 = max. speed), This command selects/returns the actuating speed for the valve plate. Data type is unsigned integer. Speed selection is effective for pressure control and position control. Open valve and close valve are always done with max. speed. **Note:** Refer to «Valve speed adjustment» for details.

Note: Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter 'h' (e.g. 31h)

Process Control Device

Connection Object (Class ID 5)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
POLL OUTPUT	Set	16	5	0	100	1	X
	Get	14					
	X: output assembly object number (default 8) (refer to list of assembly objects) This command sets the output assembly resp. reads the currently active output assembly for poll connection. Host to valve **Note:** POLL OUTPUT must have always the same DATA TYPE as POLL INPUT.						
POLL INPUT	Set	16	5	0	101	1	X
	Get	14					
	X: input assembly object number (default 3) (refer to list of assembly objects) This command sets the input assembly resp. reads the currently active input assembly for poll connection for poll connection. Valve to Host **Note:** POLL INPUT must have always the same DATA TYPE as POLL OUTPUT.						
BIT STROBE INPUT	Set	16	5	0	102	1	X
	Get	14					
	X: input assembly object number (refer to list of assembly objects) This command configures resp. reads the input assembly for bit strobe connection.						
CHANGE OF STATE / CYCLING INPUT	Set	16	5	0	103	1	X
	Get	14					

	X: output assembly object number (refer to list of assembly objects) This command configures resp. reads the output assembly for change of state / cycling.

Discrete Input Object (Class ID 8)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
VALVE CLOSED CHECK	Get	14	8	1	3	1	X
	This command returns: **0** valve is not closed **1** valve is closed						
VALVE OPEN CHECK	Get	14	8	2	3	1	
	This command returns: **0** valve is not open **1** valve is open						

Selection Object (Class ID 46)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
SETPOINT TYPE	Set	16	46	1	14	2	X
	Get	14					
	X: **0** none **1** pressure control **2** position control This command selects / returns current setpoint type. It toggles valve operation mode between position and pressure control. **Note:** To perform either position or pressure control also correct CONTROL MODE must be selected.						

S-Device Supervisor Object (Class ID 48)

<table>
<tr><th rowspan="2">Command</th><th>Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length (number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="6">Description</th></tr>
<tr><td rowspan="2">EXECUTING</td><td>6</td><td>48</td><td>1</td><td>-</td><td>3</td><td>X</td></tr>
<tr><td colspan="6">This command changes the valve to executing state.
Note: EXECUTING must to be selected to enable for all executing commands such as control mode, close valve and open valve.
Note: If valve is already in executing state and anew EXECUTING command is sent DeviceNet® will return an error message.</td></tr>
<tr><td rowspan="2">IDLE</td><td>7</td><td>48</td><td>1</td><td>3</td><td>-</td><td>-</td></tr>
<tr><td colspan="6">This command changes the valve to idle state.</td></tr>
<tr><td rowspan="2">DEVICE STATUS</td><td>Get</td><td>14</td><td>48</td><td>1</td><td>11</td><td>1</td><td>X</td></tr>
<tr><td colspan="6">X: 1 self test
2 idle
3 self test exception
4 executing
5 abort
This command returns the device status.</td></tr>
<tr><td rowspan="3">EXCEPTION STATUS</td><td>Get</td><td>14</td><td>48</td><td>1</td><td>12</td><td>1</td><td></td></tr>
<tr><td colspan="6">The exception status byte only indicates that alarms or warnings are present. For details see
EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING.</td></tr>
<tr><td colspan="6"><table>
<tr><th>Bit 7</th><th>Bit 6</th><th>Bit 5</th><th>Bit 4</th><th>Bit 3</th><th>Bit 2</th><th>Bit 1</th><th>Bit 0</th></tr>
<tr><td>1</td><td>Manufacturer specific warning</td><td>reserved</td><td>reserved</td><td>reserved</td><td>Manufacturer specific alarm</td><td>reserved</td><td>reserved</td></tr>
</table></td></tr>
</table>

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
EXCEPTION DETAIL ALARM **EXCEPTION DETAIL WARNING**	Get 14	48	1	13 (alarm) 14 (warning)	15	

Table with EXCEPTION DETAIL ALARM resp. EXCEPTION DETAIL WARNING bits.

0 OK

1 Exception / Failure / Error (except for detail size bytes)

Data Component	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
PCV Common Exception Detail Size	0	0	0	0	0	0	1	0
PCV Common Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Common Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Size	0	0	0	0	0	1	0	0
PCV Device Exception Detail Byte #0	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #1	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #2	0	0	0	0	0	0	0	0
PCV Device Exception Detail Byte #3	0	0	0	0	0	0	0	0
Manufacturer Exception Detail Size	0	0	0	0	0	1	1	0
Manufacturer Exception Detail Byte #1	Reserved	Reserved	Isolation valve position failure	Sensor ratio exceeded	PFO not ready	Compressed air failure	Learn data set invalid	Service request
Manufacturer Exception Detail Byte #2	Reserved	Reserved	Reserved	Reserved	Reserved	ADC not responding	Reserved	Reserved
Manufacturer Exception Detail Byte #3	Reserved	Reserved	Reserved	Wrong Controller Mode	Wrong Access Mode	ZERO disabled	Optional hardware missing	No sensor
Manufacturer Exception Detail Byte #4	Reserved	Reserved	Reserved	Reserved	Reserved	Reserved	PFO off	Simulation active
Manufacturer Exception Detail Byte #5	Reserved	Reserved	Reserved	Reserved	E40	E22	E21	E20
Manufacturer Exception Detail Byte #6	Reserved	Reserved	Reserved	Valve power OFF or internal com. error	Setpoint invalid (safe state)	IO data missing (safe state)	Setpoint type invalid (safe state)	Control mode invalid (safe state)

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
UPLOAD LEARN DATA	50	48	1	-	11	XY
	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) This command loads the learn data sets from the valve up to the host. There are a total number of 104 data sets which need to be uploaded separately. Each answer consists of 11 bytes. Whereas the leading 3 bytes are the data set index followed by 8 data bytes. Data are ASCII coded.					
DOWNLOAD LEARN DATA	51	48	1	12	1	
	X: index (**000** .. **103**, whereas these indices must be ASCII coded, e.g. 000 = 30h 30h 30h, 001 = 30h 30h 31h, etc.) Y 8 data bytes ASCII coded (e.g. 30h 32h 33h 33h 33h 30h 33h 36h) Example of XY: 30h 30h 30h 30h 32h 33h 33h 33h 30h 33h 36h (11 bytes in total) This command loads the learn data sets from the host down to the valve. There are a total number of 104 data sets. Each data set needs to be downloaded separately.					
SYNCHRONIZATION	52	48	1	-	6	X
	X: C:8202 (string) synchronize valve This tunnel command starts the synchronization of the valve.					

S-Analog Sensor Object (Class ID 49)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
DATA TYPE	Set	16	49	1	3	1	X
	Get	14					

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
	X: **195** signed integer **202** floating point This command defines the data type for PRESSURE, PRESSURE SETPOINT, POSITION, POSITION SETPOINT, SENSOR 1 READING, SENOR 1 OFFSET VALUE, SENSOR 2 READING, SENSOR 2 OFFSET VALUE, SENSOR LEARN LIMIT Default value is 195.						
PRESSURE UNITS	Set	16	49	1	4	2	X
	Get	14					
	X: **4097** counts **4103** percent **4864** psi **4865** Torr **4866** mTorr **4871** bar **4872** mbar **4873** Pascal **4875** atm This command selects the unit for the pressure. Default value is 4097.						
POSITION UNITS	Set	16	49	3	4	2	X
	Get	14					
	X: **4097** counts **4103** percent **5891** degrees This command selects the unit for the positions. Default value is 4097						
SENSOR READING	Get	14	49	1 (Sensor 1) 2 (Sensor 2)	6	2 int 4 float	
	This function returns direct reading from sensor according to selected DATA TYPE. Nominal range is **0** … **10'000** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
POSITION READING	Get	14	49	3	6	2 int 4 float	

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
	This command returns the current valve position according to selected DATA TYPE. Position range is **0** (closed) … **10'000** (open).					

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
SENSOR OFFSET VALUE	Get	14	49	1 (Sensor 1) 2 (Sensor 2)	12	2 int 4 float	
	These commands return the offset voltage (adjusted by ZERO) of the sensor 1 according to selected DATA TYPE. Nominal range is **-1400** … **+1400** but it may be scaled. Refer also to command GAIN and picture on the following page for details.						
SENSOR GAIN	Set	16	49	1 (Sensor 1) 2 (Sensor 2) 3 (Position)	14	2 int 4 float specified by attribute 3	X
	Get	14					
	X: gain, max. value is **3.2767**, data type is floating point This command selects the gain for PRESSURE/POSITION and allows for scaling. The gain pressure can only be used if the PRESSURE/POSITION UNITS is "counts". Default value is 1 (E8 03h). e.g.:						
	Gain		Pressure/Position value		X(float)		X(int)
	0.1		1'000		3Dh CCh CCh CCh		E8 03
	1.0		10'000		3Fh 80h 00h 00h		10 27
	3.2767		32'767		40h 51h B5h 73h		FF 7F
SENSOR TYPE	Set	16	49	1 (Sensor 1) 2 (Sensor 2)	198	1	X
	Get	14					

	X: **0** Pa **1** bar **2** mbar **3** ubar **4** Torr **5** mTorr **6** atm **7** psi **8** psf This command sets the unit of sensors.

SENSOR FULL SCALE	Set	16	49	1 (Sensor 1) 2 (Sensor 2)	199	4	X
	Get	14					
	X: **0** sensor not in use **1…1000000** sensor full scale This command sets the full scale of sensors.						

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
ZERO CONTROL	Set	16	49	1	102	1	X
	Get	14					
	X: **0** Disable **1** Enable This command enables resp. disables the ZERO command. In case it is disabled ZERO does not work.						
ZERO	75		49	1	-	-	-
	This command initiates ZERO. **Note:** Refer to «ZERO (setup step 4)» for correct zero procedure.						

S-Singel Stage Controller Object (Class ID 51)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
CONTROL SETPOINT	Set	16	51	1 (pressure) 2 (position)	6	2 int 4 float	Y
	Get	14					
	Y: position setpoint according to selected DATA TYPE, **0** (closed) … **10'000** (open) or Y: pressure setpoint according to selected DATA TYPE, nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled, refer also to command GAIN for details. This command transfers/reads the position/pressure setpoint to/from the valve.						
SAFE STATE	Set	16	51	1 (pressure) 2 (position)	17	1 int	Y
	Get	14					
	Y: 0 close (default) 1 open 2 hold value (valve changes to Control Mode HOLD) 3 use SAFE VALUE (valve moves to a position, refer to SAFE VALUE) This command specifies the control behavior for states others than execute.						
SAFE VALUE	Set	16	51	1 (pressure) 2 (position)	18	2 int 4 float	Y
	Get	14					
	Y: position value according to selected DATA TYPE (refer to CONTROL SET POINT for data format) This command defines the position where the valve moves to when in safe state. Two different positions can be defined.						
PRESSURE	Get	14	51	1	7	2 int 4 float	
	This command returns the actual pressure according to selected DATA TYPE. Nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled. Refer also to command GAIN and picture on the following page for details.						

<table>
<tr><th rowspan="2">Command</th><th colspan="2">Service Code</th><th>Class ID</th><th>Instance ID</th><th>Attribute ID</th><th>Service data length
(number of bytes)</th><th>Service data field</th></tr>
<tr><th colspan="7">Description</th></tr>
<tr><td rowspan="3">VALVE SPEED</td><td>Set</td><td>16</td><td rowspan="2">51</td><td rowspan="2">2</td><td rowspan="2">101</td><td rowspan="2">2</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td></td></tr>
<tr><td colspan="7">X: valve speed, 1 … 1000 (1 = min. speed, 1000 = max. speed),
This command selects/returns the actuating speed for the valve plate. Data type is unsigned integer. Speed selection is effective for pressure control and position control. Open valve and close valve are always done with max. speed.
Note: Refer to «Valve speed adjustment» for details.</td></tr>
<tr><td rowspan="3">PID CONTROLLER GAIN FACTOR</td><td>Set</td><td>16</td><td rowspan="2">51</td><td rowspan="2">1</td><td rowspan="2">105</td><td rowspan="2">1</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td></td></tr>
<tr><td colspan="7">X: 0 = 0.10, 1 = 0.13, 2 = 0.18, 3 = 0.23, 4 = 0.32, 5 = 0.42, 6 = 0.56
7 = 0.75, 8 = 1.00, 9 = 1.33, 10 = 1.78, 11 = 2.37, 12 = 3.16, 13 = 4.22
14 = 5.62, 15 = 7.50, 16 = 0.0001, 17 = 0.0003, 18 = 0.001, 19 = 0.003,
20 = 0.01, 21 = 0.02, 22 = 0.05
This command selects/returns the gain factor for the PID controller.
Note: Refer to «Gain factor adjustment» for details.</td></tr>
<tr><td rowspan="3">PID CONTROLLER SENSOR DELAY</td><td>Set</td><td>16</td><td rowspan="2">51</td><td rowspan="2">1</td><td rowspan="2">107</td><td rowspan="2">1</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td></td></tr>
<tr><td colspan="7">X: 0 = 0, 1 = 0.02, 2 = 0.04, 3 = 0.06, 4 = 0.08, 5 = 0.10, 6 = 0.15
7 = 0.20, 8 = 0.25, 9 = 0.30, 10 = 0.35, 11 = 0.4, 12 = 0.5, 13 = 0.6
14 = 0.8, 15 = 1.0
This command selects/returns the sensor delay for the PID controller.
Note: Refer to «Sensor delay adjustment» for details.</td></tr>
<tr><td rowspan="3">PID CONTROLLER SETPOINT RAMP</td><td>Set</td><td>16</td><td rowspan="2">51</td><td rowspan="2">1</td><td rowspan="2">108</td><td rowspan="2">1</td><td>X</td></tr>
<tr><td>Get</td><td>14</td><td></td></tr>
<tr><td colspan="7">X: 0 = 0, 1 = 0.5, 2 = 1.0, 3 = 1.5, 4 = 2.0, 5 = 2.5, 6 = 3.0
7 = 3.5, 8 = 4.0, 9 = 4.5, 10 = 5.0, 11 = 5.5, 12 = 6.0, 13 = 6.5
14 = 7.0, 15 = 7.5, 16 = 8.0, 17 = 8.5, 18 = 9.0, 19 = 9.5, 20 = 10.0
This command selects/returns the setpoint ramp for the PID controller.
Note: Refer to «Setpoint ramp adjustment» for details.</td></tr>
<tr><td>LEARN</td><td colspan="2">99</td><td>51</td><td>1</td><td>0…Cancel Learn
1…Start Learn</td><td>-</td><td>-</td></tr>
</table>

Command	Service Code	Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description					
	This command starts LEARN. With CONTROL MODE commands open valve or close valve the routine may be interrupted. **Note:** Without LEARN the PID controller is not able to perform pressure control. Refer to «LEARN (setup step 5)» for correct learn gas flow and procedure.					

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
LEARN PRESSURE LIMIT	Set	16	51	1	100	2 int 4 float	Y
	Get	14					
	Y: learn pressure limit according to selected DATA TYPE, nominal pressure range is **0** … **10'000** (sensor full scale) but it may be scaled, refer also to command GAIN for details. This command transfers/reads the pressure limit for LEARN. **Note:** Refer to «LEARN (setup step 5)» for correct learn pressure limit setting.						
LEARN STATUS	Get	14	51	1	106	2	

This command returns the status of the LEARN procedure. The status is binary coded.

	Bit	Explanation:
(LSB)	0	**0** = LEARN not running **1** = LEARN running
	1	**0** = LEARN data set present **1** = LEARN data set not present
	2	**0** = ok **1** = LEARN terminated by user
	3	**0** = ok **1** = pressure in position OPEN > 50% sensor full scale (of high range sensor in case of a 2 sensor system) or > LEARN PRESSURE LIMIT
	4	**0** = ok **1** = pressure in position 0 < 10% sensor full scale (of low range sensor in case of a 2 sensor system)
	5	**0** = ok **1** = pressure falling during LEARN
	6	**0** = ok **1** = sensor not stable during LEARN
	7	reserved
	8	reserved
	9	reserved
	10	**0** = ok **1** = LEARN terminated by controller
	11	**0** = ok **1** = pressure in position OPEN negativ
	12	reserved
	13	reserved
	14	reserved
	15	reserved
(MSB)	16	reserved

Pressure Controller Object (Class ID 100)

Command	Service Code		Class ID	Instance ID	Attribute ID	Service data length (number of bytes)	Service data field
	Description						
CONTROLLER MODE	Get	14	100	1	103	1	
	This command returns the device status. **1** = synchronization, **2** = POSITION CONTROL, **3** = CLOSED **4** = OPEN, **5** = PRESSURE CONTROL, **6** = HOLD , **7** = LEARN **12** = power failure, **13** = safety mode **14** = fatal error (read EXCEPTION DETAIL ALARM for details) **255** = Valve power OFF or internal communications error						
THROTTLE CYCLE COUNTER	Get	14	100	1	101	4	
	This command returns the number of throttle cycles. Data type is unsigned long integer. A movement from max. throttle position to open back to max. throttle position counts as one cycle. Partial movements will be added up until equivalent movement is achieved.						
ISOLATION CYCLE COUNTER	Get	14	100	1	106	4	
	This command returns the number of isolation cycles. Data type is unsigned long integer. Each closing of the sealing ring counts as one cycle.						
ACCESS MODE	Set	16	100	1	107	1	X
	Get	14					
	X: **0** Local (operation via service port) **1** Remote (operation via DeviceNet®) **2** Locked (in remote mode) This command controls / returns the access mode of the valve.						
POWER UP CONFIGURATION	Set	16	100	1	112	1	X
	Get	14					
	X: **0** closed **1** open This command controls / returns the valve position after power up.						
POWER FAIL CONFIGURATION	Set	16	100	1	113	1	X
	Get	14					

	X: **0** closed **1** open This command controls / returns the target valve position in case of a power failure. Only for versions that have Power Fail Option equipped [612 . . - . . **C** . - . . . . or 612 . . - . . **H** . - . . . . or 612 . . - . . **U** . - . . . . or 612 . . - . . **W** . - . . . .].

Unless otherwise specified all values in the table above are in decimal notification. Hexadecimal values are indicated by the letter ‚h' (e.g. 31h)

Process Control Valve

This additional acyclic objects are available for GD and PCD profile since firmware end of January 2021

131 VAT Pressure Controller

Supported Instances: 1 (1)

RW Read Write, **RO** Read Only, **NV** Non Volatile

Attr	Name	Data Type	Acc	NV	Unit	Min	Max	Def	Description
3	***Pressure Controller Selector***	USINT	RW	NV**		1	4	1	Active Controller in ***Control Mode*** = Pressure **1**:Controller 1 **2**:Controller 2 **3**:Controller 3 **4**:Controller 4
4	***Pressure Control Speed***	REAL	RW	NV**		0.001	1.0	1.0	Speed valid in ***Control Mode*** = Pressure, 1.0 equals to full speed
5	***Target Pressure Used***	REAL	RO	V	mbar*	0.0	SFS		This value is set as pressure controller input. It differs to the ***Target Pressure*** if a pressure ramp is used.
16	***Store Control Parameter Volatile***	BOOL	RW	NV		0	1	0	**0**:Store in NV Memory **1**:Do Not Store in NV Memory
17	***Pressure Control Position Restriction Enable***	BOOL	RW	NV		0	1	0	Limit the valve movement in ***Control Mode*** Pressure
18	***Minimum Control Position***	REAL	RW	NV	pos*	0.0*	100.0*	0.0*	
19	***Maximum Control Position***	REAL	RW	NV	pos*	0.0*	100.0*	100.0*	

132 VAT Pressure Control Units

Supported Instances: 4 (1..4)

Attr	Name	Data Type	Acc	NV	Unit	Min	Max	Def	Description
1	***Control Algorithm***	USINT	RW	NV**		0	2	**xx**	**0**:Adaptive **1**:PI **2**:Soft Pump **xx** Controller 1 = 0, Controller 2 and 3 = 2, Controller 4 = 3
2	***Control Direction***	USINT	RW	NV**		0	1	**xx**	Used for ***Control Algorithm*** PI and Soft Pump **0**:Downstream **1**:Upstream **xx** Controller 1,2 and 4 = 0, Controller 3 = 1
16	***Learn Data Selection***	USINT	RW	NV**		0	3	0	Used for ***Control Algorithm*** Adaptive **0**:Bank 1 **1**:Bank 2 **2**:Bank 3 **3**:Bank 4
17	***Gain Factor***	REAL	RW	NV**		0.0001	100.0	1.0	Used for ***Control Algorithm*** Adaptive
18	***Sensor Delay***	REAL	RW	NV**	sec	0.0	1.0	0.0	Used for ***Control Algorithm*** Adaptive
32	***P-Gain***	REAL	RW	NV**		0.001	100.0	0.1	Used for ***Control Algorithm*** PI and Soft Pump
33	***I-Gain***	REAL	RW	NV**		0.	100.0	0.1	Used for ***Control Algorithm*** PI and Soft Pump
48	***Ramp Enable***	BOOL	RW	NV**		0	1	1	Activate/Deactivate pressure target ramp. The effective target pressure can be read in **Target Pressure Used**
49	***Ramp Time***	REAL	RW	NV**	sec	0.0	1000000.0	1.0	Target reach time
50	***Ramp Slope***	REAL	RW	NV**	mbar*/sec	0.0	SFS	1.333224	Limit the rate of pressure change
51	***Ramp Mode***	USINT	RW	NV**		0	1	0	**0**:Use ***Ramp Time*** **1**:Use ***Ramp Slope***
52	***Ramp Start Value***	USINT	RW	NV**		0	1	1	**0**:Previous Ramp Value **1**:Actual Pressure Value
53	***Ramp Type***	USINT	RW	NV**		0	2	0	**0**:Linear **1**:Logarithmic **2**:Exponential

* Scaling: Class 49 S-Analog Sensor Object, Attribute 4 Data Unit, Pressure: Instance 1, Position: Instance 3

** In case of ***Store Control Parameter Volatile*** is 1 (true) the value will not be stored in nonvolatile memory.

*** Valve series specific

Tunnel Command

This functionality is used to send an serial command over DeviceNet interface. This enables some turnaround solution if a specific acyclic object is not available over DeviceNet interface.

Service (hex): 34
Class (hex): 30
Instance: 01
Service data: ASCII command in HEX format

Here an example how to send an IC2 command with the tunnel command:

Send

Set																		
	dec:	52	48	1	112	58	48	49	49	48	54	48	48	49	48	48	48	48	48
	hex:	34	30	01	70	3A	30	31	31	30	36	30	30	31	30	30	30	30	30
	ascii:				p	:	0	1	1	0	6	0	0	1	0	0	0	0	0

Receive

dec:	52	48	1	112	58	48	48	48	49	49	48	54	48	48	49	48	48	48	48	48
hex:	34	30	01	70	3A	30	30	30	31	31	30	36	30	30	31	30	30	30	30	30
ascii:				p	:	0	0	0	1	1	0	6	0	0	1	0	0	0	0	0

This command disable the ***Follow Valve*** option for an external isolation valve.

Possible Failure Response:

Note: In case of failure the response is **E:**xxxxxx

x	Failure Number	Description
	11	':' in the command missing
	12	Invalid numbers of characters
	20, 21	Unknown command
	22, 23	Invalid value
	30	Value out or range
	80	Command not accepted due to local operation
	81	Command not accepted due to Synchronization, CLOSED or OPEN by digital input, Safety mode or Fatal error

Example Failure response:

dec:	52	48	1	69	58	52	50	48	49	48	49
hex:	34	30	01	45	3A	30	30	30	30	33	30
				E	:	0	0	0	0	3	0

2.5.4 Logic

The Logic Interface allows the user to operation with digital and analog signals. Thera are following Inputs and Outputs available.

- 8 Digital Input
- 4 Digital Output
- 1 Analog Input
- 2 Analog Output

2.5.4.1 Digital Inputs

There are 8 Digital Inputs with different functionality available.
At Access mode Local only the Remote Locked functionality supported.

Parameter

	Parameter	Description
Digital Input 1..8	***Enable***	*True* means it is supported. *False* means it is not supported
	State	*True* means it is active. *False* means it is not active.
	Functionality	Each digital input can be assigned one of the functionality descript at the *table Functionality*.
	Inverted	Inverted the functionality of the signal.

Table Parameter Digital Input

Functionality

Functionality	Description	Priority Control Mode
Open	Open the Valve.	4
Close	Close the Valve.	2
Pressure Control	Activates the Control Mode Pressure. The non- activated Control Mode is Position.	5
Pressure Low Range	Set the low range of sensor full scale The Low Range is defined on Parameter: Settings, ***Pressure Range [SFS]***	
Zero	Compensates the Pressure Offset Voltage. Set the Pressure Value to Zero.	
Learn	Activates the Control Mode Learn. At case the Learn procedure should not run over the complete scale. A Learn Limit can be set with Parameter: Settings, ***Learn Limit*** = True. Now the Learn Limit can be set over the Analog Input.	1 Negative edge interrupt the procedure 3 Positive edge start the procedure
Remote Locked	Activates the Access Mode Remote Locked. At Access Mode Remote Locked is operation via service port in Local mode not possible.	Supported at Access Mode Local
Hold	Stops the Valve at the current position, Learn procedure will be not interrupted.	5
Controller Selector	Set the ***Controller Selector*** to *Controller 1* or	

	Controller 2	

Table Functionality Digital Input

Priority:
Highest priority is 1. Functions with lower priorities will not be effective as long as higher priority functions are active.
These digital inputs have higher priority than all RS232 commands.
RS232 commands will not be accepted while digital inputs are active.

2.5.4.2 Digital Outputs

There are 4 Digital Outputs available.

Parameter

	Parameter	Description
Digital Output 1..3	***Enable***	*True* means it is supported. *False* means it is not supported
	State	*True* means it is active. *False* means it is not active.
	Functionality	Each digital input can be assigned one of the functionality descript at the *table Functionality.*
	Inverted	Inverted the functionality of the signal.

Table Parameter Digital Outputs

Functionality

Functionality	Description
Open	Indicate the Open status of the Valve.
Close	Indicate the Close status of the Valve.
Busy	In case of selected(=*True*) ***IC Compatible Mode***, the Busy Output functionality will have the same behavior as in the past the Alarm Output (IC1 naming). ⇒ The ***IC Compatible Mode*** is settable under *Settings*. ***IC Compatible Mode*** *False*: Busy is when: ***Control Mode*** is: *Init, Homing, Learn, Power failure* or in *Error.* *At* ***Control Mode*** *Pressure*: Actual Pressure is +/- 2% out of range. *Position*: Actual Position is +/- 0.1% out of range. → same ranges for Position and Pressure, if *Hold* will be active

	IC Compatible Mode *True*: Busy is when: ***Control Mode*** is: *Homing, Learn, Power Failure* or in *Error.* At ***Control Mode***: *Pressure*: Actual Pressure is +/- 2% out of range. *Position, Open & Interlock Open*: Actual Position is +/- 0.1% out of range → same ranges for Position and Pressure, if *Hold* will be active *Init, Close & Interlock Close:* Valve is still not isolated/sealed.
Ready	If ***IC Compatible Mode*** is selected (=*True*), the Ready Output will have a slightly different functionality. ⇛ The ***IC Compatible Mode*** is settable under *Settings*. → Ready means. Ready for remote operation. ***IC Compatible Mode*** *False*: Valve is not in ***Access Mode*** *Local* and not in one of following ***Control Mode***: *Init, Homing, Interlock Open, Interlock Close, Power failure, Safety, Error* or *Not define.* ***IC Compatible Mode*** *True*: Valve is not in ***Access Mode*** *Local* and not in one of following ***Control Mode***: *Interlock Open, Interlock Close, Power failure, Safety, Error* or *Not define.* *Init & Homing:* when valve is or was not isolated/sealed

Table Functionality Digital Outputs

-> If ***IC Compatible Mode*** is not visible, installed firmware does not provide this setting. Please check with VAT for firmware update.

2.5.4.3 Analog Input

There are 1 Analog Inputs from 0 to 10 V available.

Parameter

	Parameter	Description
Analog Input	***Enable***	*True* means it is supported. *False* means it is not supported
	Value	Indicate the applied voltage
	User Factor	1 default value for Input voltage 0 to 10V UserFactor = (MaxVolt – MinVolt) / 10 Example: Input voltage 2V to 8V (8-2)/10 = 0.6 User Factor
	User Offset	0 default value for Input voltage 0 to 10V

		UserOffset = MinVolt Example: Input voltage 2V to 8V 2.0 = User Offset
	Functionality	The Functionality is depend on the Current Control Mode Control Mode Learn: ***Pressure Limit [SFS]*** Control Mode Pressure: ***Target Pressure*** Control Mode Position: ***Target Position*** For settings ***Pressure Limit [SFS]*** must be Settings, ***Learn Limit*** = *True*

Table Parameter Analog Input

2.5.4.4 Analog Output

There are 2 Analog Outputs from 0 to 10V available

Parameter

	Parameter	Description
Analog Output	***Enable***	*True* means it is supported. *False* means it is not supported
	Value	Indicate the applied voltage
	User Factor	1 default value for Input voltage 0 to 10V UserFactor = (MaxVolt – MinVolt) / 10 Example: Input voltage 2V to 8V (8-2)/10 = 0.6 User Factor.
	User Offset	0 default value for Input voltage 0 to 10V UserOffset = MinVolt Example: Input voltage 2V to 8V 2.0 = User Offset
	Functionality	Each analog output can be assigned one of the functionality descript at the *table Functionality.*

Table Parameter Analog Output

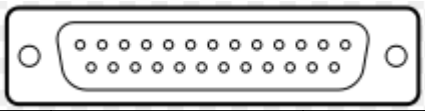
Functionality

Functionality	Description
Position	Indicate the Valve position
Pressure	Indicate the Valve pressure

Table Functionality Analog Output

2.5.4.5 Connector assembling

The Connector on the Controller is a D-Sup 25 Pin female.

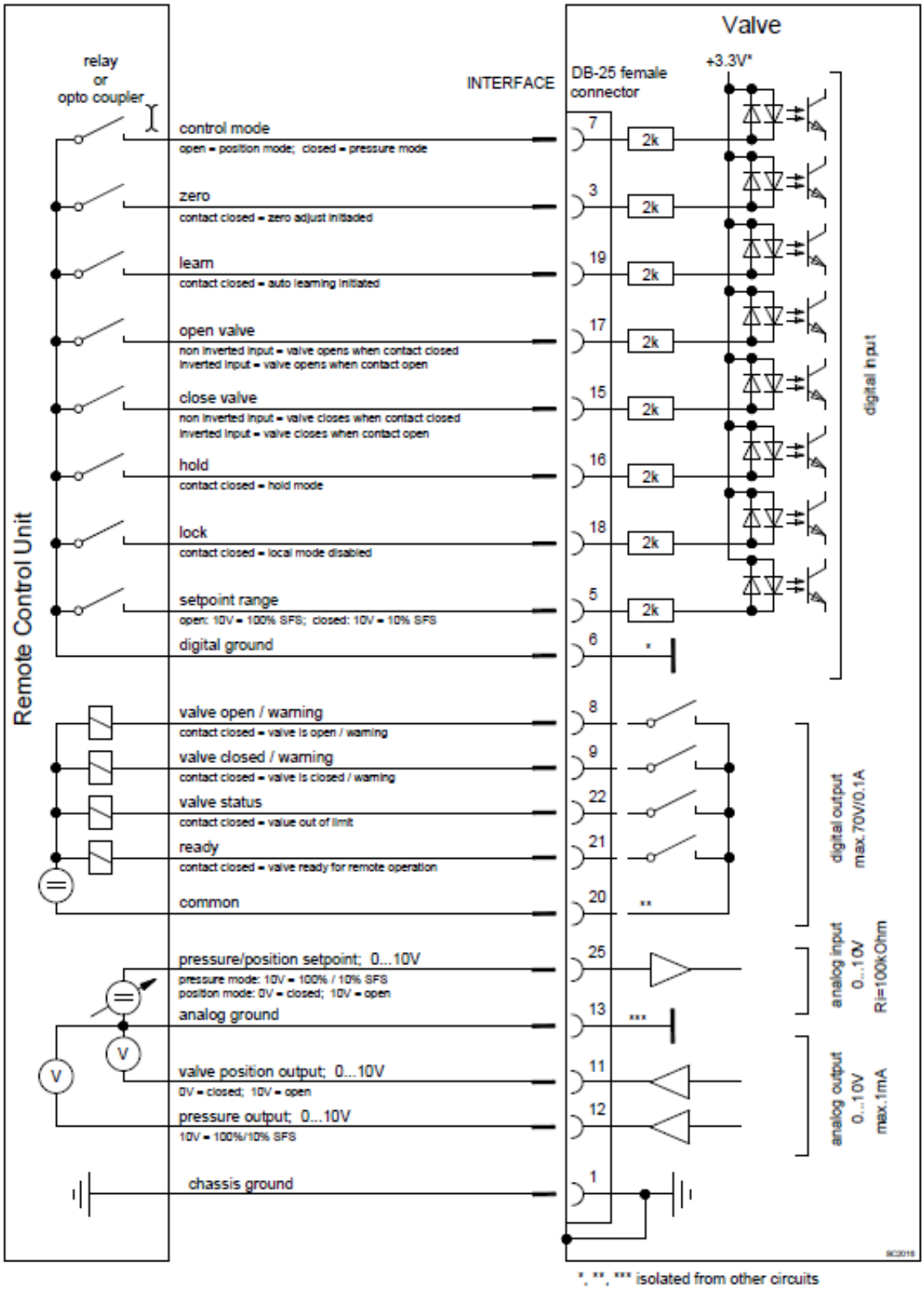


Pin	Function	Description
1	Chassis GND	*Connected to case. Use this to connect cable shield.*
2	Reserve 3	*Digital Input 11*
3	Zero	*Digital Input 3*
5	Pressure Low Range	*Digital Input 2*
6	GND	*Input (GND)*
7	Pressure Control	*Digital Input 1*
8	Open	*Digital Output 1*
9	Close	*Digital Output 2*
10	Reserve 2	*Digital Input 10*
11	Position	*Analog Output 1*
12	Pressure	*Analog Output 2*
13	GND	*Analog*
14	Reserve 4	*Digital Input 12*
15	Close	*Digital Input 4*
16	Hold	*Digital Input 8*
17	Open	*Digital Input 5*
18	Remote Locked	*Digital Input 7*
19	Learn	*Digital Input 6*
20	Output Common	*Output Common*
21	Ready	*Digital Output 3*
22	Busy	*Digital Output 4*
23	Reserve 1	*Digital Input 9*
25	Position/Pressure	*Analog Input 1*

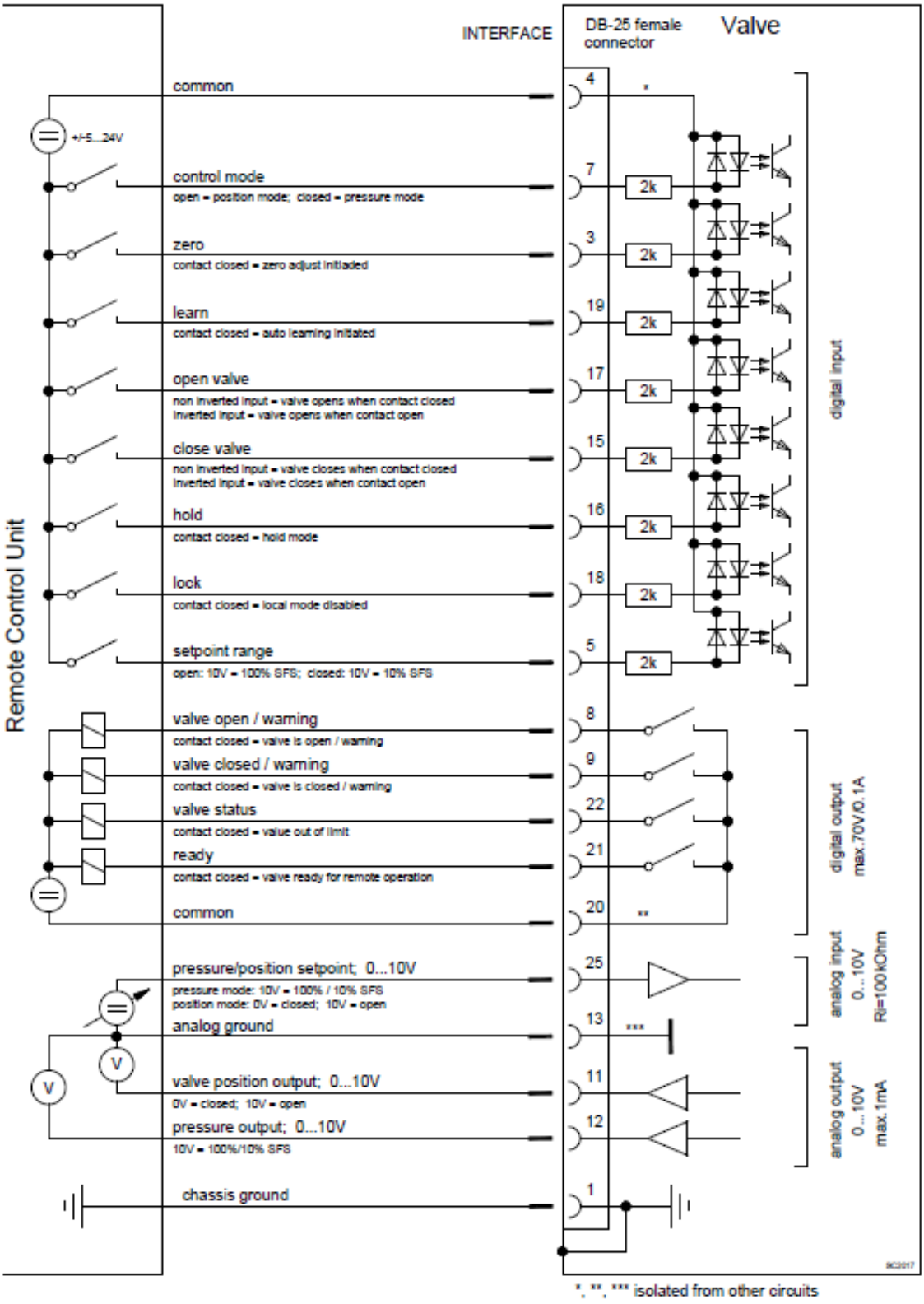
Table Connector

2.5.4.6 Wiring

Configuration with switches



Configuration with Voltage



2.5.5 CC-Link

2.5.5.1 LEDs

CC-Link Slave LEDs

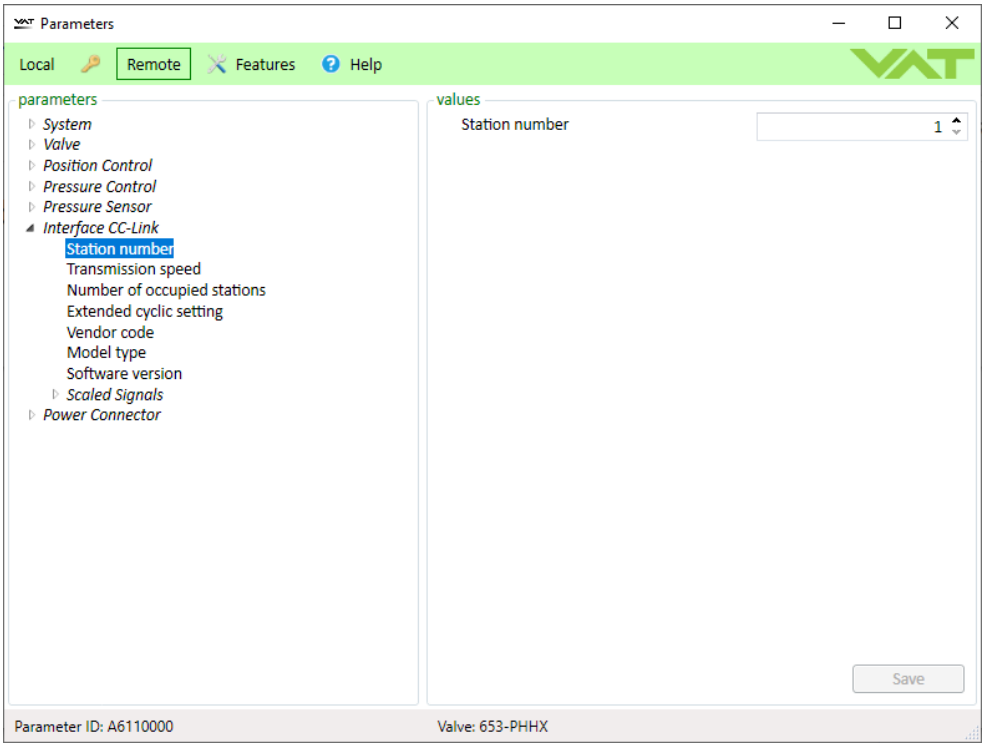
The communication status LEDs are used to represent the CC-Link Slave status. There are two LEDs: L RUN and L ERR.

LED	Color	State	Meaning
L RUN	LED green		
	Green	On	After establishing the connection with the CC-Link network, the device is receiving the cyclic data
	Off	Off	1. Connection with network not yet established 2. No carrier can be recognized 3. Timeout occurred 4. Hardware reset happened
L ERR	LED red		
	red	blinking	Switch position has been changed while pulling the reset (It blinks for 0.4 seconds)
	red	On	1. CRC error 2. Address parameter error (Address 0, or greater than 64 is set, including number of occupied stations) 3. Error in settings of baud rate switches while pulling the reset (5 or greater)
	Off	Off	1. Normal communication 2. Hardware is resetting

2.5.5.2 Configuration

Station Number

The parameter "Station number" is used to distinguish between stations on the CC-Link network. Unique station numbers in consecutive order without duplication must be used, when assigning stations to the CC-Link network. The allowed range is from 1 to 64. "Station number" can be set via CPA as it is shown on the snapshot:

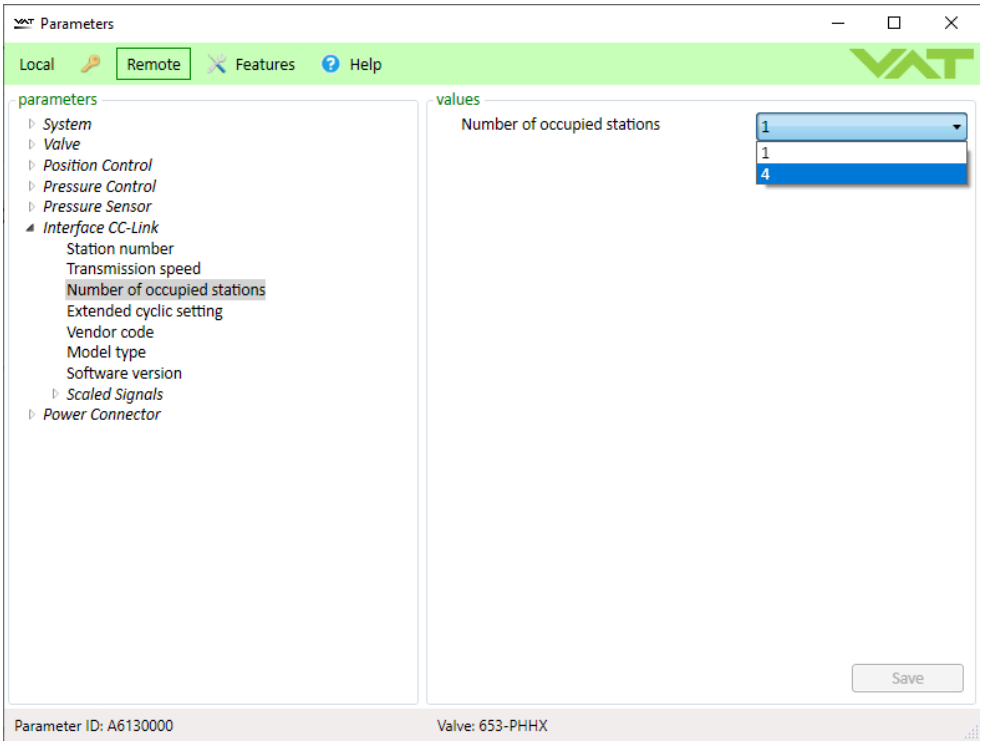


Number of occupied stations

This parameters represents the number of stations (occupying one stations worth of memory area) used by a single slave station in a network. It is one of the two parameters that define operational settings. In case of VAT controllers, it is always paired with parameter "extended cyclic setting" in the following way.

Number of occupied stations: **1** & Extended cyclic setting: **Octuple**
Number of occupied stations: **4** & Extended cyclic setting: **Double**

The VAT slave supports only these two combinations of the CC-Link parameter settings.
It can be configured via CPA as it is shown on the snapshot:

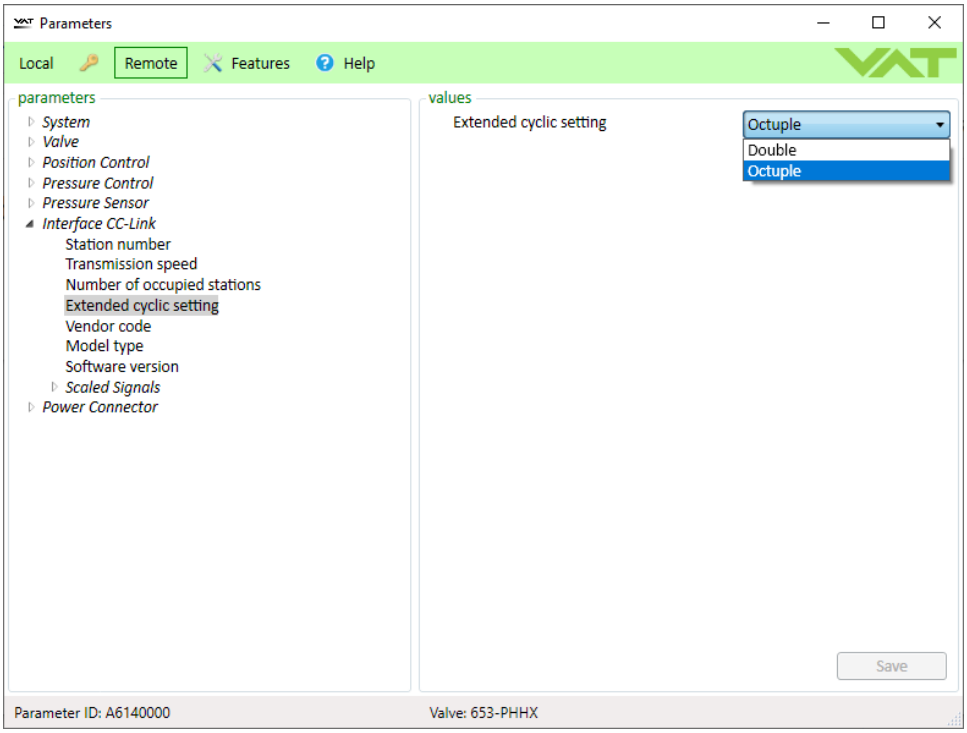


Extended cyclic setting

This is the extended cyclic transmission. The extended cyclic points can be set as 2 times, 4 times or 8 times of the normal cyclic transmission points. In case of VAT controllers, it is always paired with "Number of occupied station" in the following way.

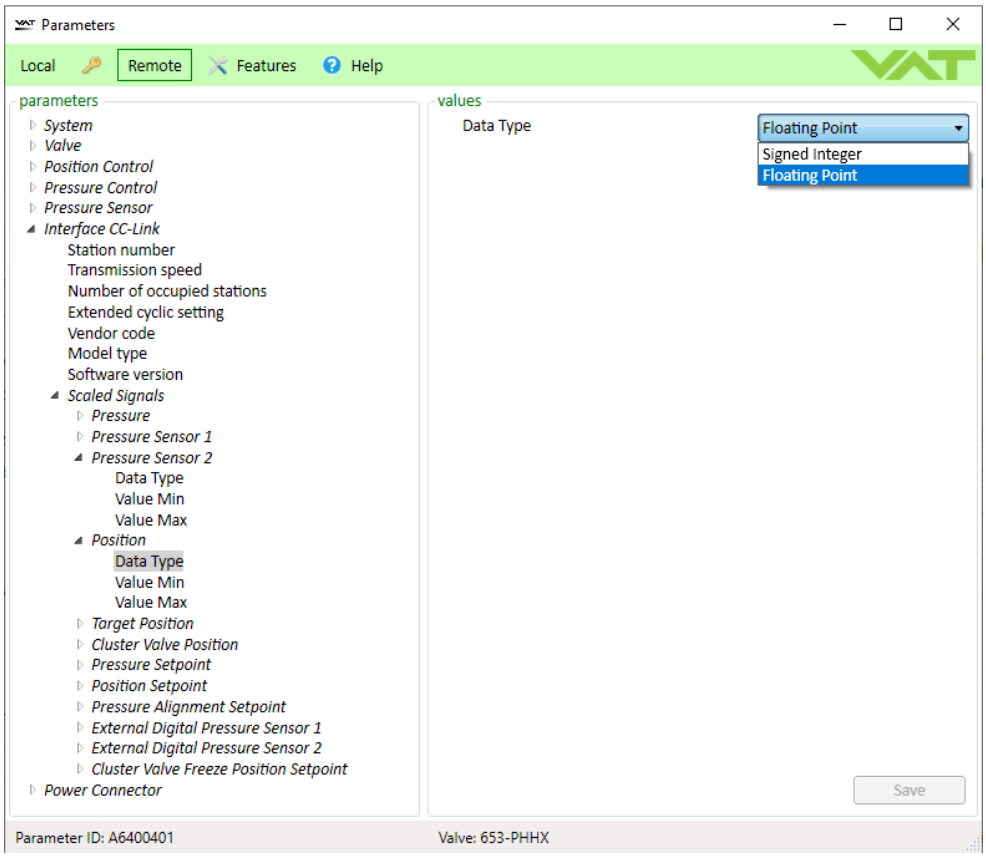
Number of occupied stations: **1** & Extended cyclic setting: **Octuple**
Number of occupied stations: **4** & Extended cyclic setting: **Double**

The VAT slave supports only these two combinations of the CC-Link parameter settings.
It can be configured via CPA as it is shown on the snapshot:



Data Type of Pressure and Position values

The data type of different pressure and position values can be optionally changed between 32-bit signed integer and 32-bit floating point (IEEE-754 standard).
They are all set to the floating point type by default. The data type can be set via CPA for each of the 12 parameters separately:



Range of Pressure and Position values

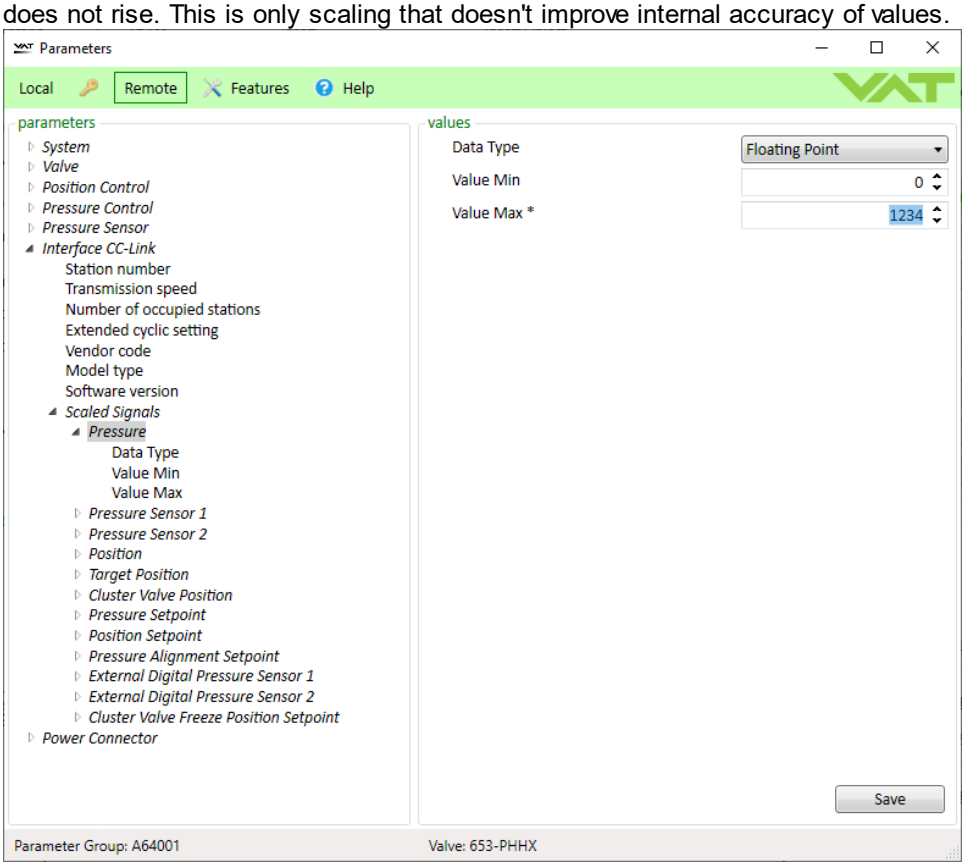
The range of all listed pressure and position values can be adjusted. That means, for example, that the valve position values for “CLOSE” and “OPEN” can be set to other ones then the default values 0 and 100’000.

		Default range limits	
#	Parameter name	Min	Max
Inputs			
1	Pressure	0	1’000´000
2	Pressure Sensor 1	0	1’000’000
3	Pressure Sensor 2	0	1’000’000
4	Position	0	100’000
5	Target Position	0	100’000
6	Cluster Valve Position	0	100’000
Outputs			
7	Pressure Setpoint	0	1’000’000
8	Position Setpoint	0	100’000
9	Pressure Alignment Setpoint	0	1’000’000

10	External Digital Pressure Sensor 1	0	1’000’000
11	External Digital Pressure Sensor 2	0	1’000’000
12	Cluster Valve Freeze Position Setpoint	0	100’000

The range of pressure and position values can be configured via CPA for each of the 12 parameters separately:

The range of pressure and position values is independent of the data type (signed integer and floating point). The internal accuracy of valve is for all positions is the precision of IEEE-754 Floating point number. If the range of pressure and position values is rising, the accuracy of pressure and position does not rise. This is only scaling that doesn't improve internal accuracy of values.



2.5.5.3 Connection Setup

Handshake Procedure

Before the communication between the CC-Link master and the CC-Link slave (IC2 controller) is possible, the handshake process needs to take place. Without it no data from the master will be transmitted to station. The procedure has 3 steps:

1. If the network parameter are correct, the slave station will set the bit "**Initial data processing request flag**".
2. Upon receiving thi bit, the master answers to the request with the bit "**Initial data processing complete flag**".
3. Finally, the station (slave) sets the bit "**Remote READY**". That means the slave is in the normal

operation mode.

Location of the handshake bits

Slave (Controller) à Master	
Device	Signal name
…	
RX(m+n)8	Initial data processing request flag
RX(m+n)9	Initial data setting complete flag
RX(m+n)A	Error status flag
RX(m+n)B	Remote READY
…	

Master à Slave (Controller)	
Device	Signal name
…	
RY(m+n)8	Initial data processing complete flag
RY(m+n)9	Initial data setting request flag
RY(m+n)A	Error reset request flag
…	

The two tables are showing the part of the memory, mapped in bits, where the handshake flags are located.
m - Address assigned to the master module by the station number setting. This defines the memory area dedicated for this slave. It begins at address m of the master.
n - It depends on the number of occupied stations and the extended cyclic setting, as shown in the table:

	Case 1	Case 2
Number of occupied stations	1	4
Extended cyclic setting	Octuple	Double
n	0x7	0xD

2.5.5.4 Cyclic Communication - Process Data

The buffer naming (output and input) is always from the customer's point of view, which is from the master (PLC).
The data are transmitted using Intel format, where the lower byte is being sent first.
Since the communication goes over words (16bit), each one byte signal is stored in a lower byte of the word, and the upper one is a padding one, not used. The lower byte is also called LSB (Least

Significant Byte)

Output Buffer

Output Buffer					
Byte	Word	Parameter	Content	Bytes	Words
0	0	1	Pressure Setpoint	4	2
1					
2	1				
3					
4	2	2	Position Setpoint	4	2
5					
6	3				
7					
8	4	3	Pressure Alignment	4	2
9					
10	5				
11					
12	6	4	External Digital Pressure Sensor 1	4	2
13					
14	7				
15					
16	8	5	External Digital Pressure Sensor 2	4	2
17					
18	9				
19					
20	10	6	Control Mode Setpoint	1	1
21			Padding	1	
22	11	7	General Control Setpoint	2	1
23					
24	12	8	PKW	2	1
25					
26	13	9	PKW	2	1
27					

28 29	14	10	PKW	2	1
30 31	15	11	PKW	2	1
32 33 34 35	16 17	12	Cluster Freeze Position	4	2
36	18	13	Cluster Address	1	1
37			Padding	1	
38 39	19	14	Cluster Valve Control Setpoint	2	1
40	20	15	Cluster Monitoring Address	1	1
41			Padding	1	

Bitmap parameter definitions:

Object	Bit	Parameter
General control setpoint	0	Zero
General control setpoint	1	Not Used
General control setpoint	2	Ping Pong TX
General control setpoint	3	Not Used
General control setpoint	4	Access Mode
General control setpoint	5	Plasma Mode On
General control setpoint	6	Plasma Mode Off
General control setpoint	5…15	Not Used

Input Buffer

Input Buffer					
Byte	Word	Parameter	Content	Bytes	Words
0 1	0	1	Pressure	4	2
2 3	1				
4 5	2	2	Pressure Sensor 1	4	2
6 7	3				

8	4	3	Pressure Sensor 2	4	2
9					
10	5				
11					
12	6	4	Position	4	2
13					
14	7				
15					
16	8	5	Target Position	4	2
17					
18	9				
19					
20	10	6	Control Mode	1	1
21			Padding Byte	1	
22	11	7	Fatal Error	2	1
23					
24	12	8	PKW	2	1
25					
26	13	9	PKW	2	1
27					
28	14	10	PKW	2	1
29					
30	15	11	PKW	2	1
31					
32	16	12	General Status	2	1
33					
34	17	13	General Warnings	2	1
35					
36	18	14	Extended Warnings	2	1
37					
38	19	15	Cluster Monitoring Address	1	1
39			Padding Byte	1	
40	16	16	Cluster Valve Position	4	2
41					

42	17				
43					
44	18	17	Cluster Valve Control Mode	1	1
45			Padding Byte	1	
46	19	14	Cluster Valve Status	2	1
47					
48	20	15	Cluster Valve Warnings	2	1

Bitmap parameter definitions:

General status	0	Fieldbus Data Valid
General status	1	Zero Executed
General status	2	Ping Pong RX
General status	3	Pressure Simulation
General Status	4	Pressure Setpoint Reached
General Status	5,6	Not Used
General Status	7	Access Mode
General Status	8	Access Mode
General Status	9	Warnings Active
General Status	10	Sealed
General Status	11...15	Not Used

General Warnings	0	Service Request
General Warnings	1	Learn Data Set
General Warnings	2	Compressed Air Failure
General Warnings	3	Power Failure Battery
General Warnings	4	Sensor Overlapping
General Warnings	5	Iso Valve Failure
General Warnings	6	Offline
General Warnings	7…9	Not Used
General Warnings	10	Sensor Measurement Unit Faulty, Plasma On
General Warnings	11…15	Not Used

Extended Warnings	0	Remote Control Not Possible
Extended Warnings	1	Actual Control Mode Setpoint Not Allowed
Extended Warnings	2	Zero Disabled
Extended Warnings	3	PFO Deactivated
Extended Warnings	4	Not Used
Extended Warnings	5	Out Of Range Pressure Setpoint
Extended Warnings	6	Out Of Range Position Setpoint
Extended	7	Not Used

Warnings		
Extended Warnings	8	Out Of Range Sensor 1
Extended Warnings	9	Out Of Range Sensor 2
Extended Warnings	10	Out Of Range Control Mode Setpoint
Extended Warnings	11	Out Of Range Control Setpoint
Extended Warnings	12	Process Data Settings not valid
Extended Warnings	13…15	Not Used

Cluster Valve Control Setpoint	0	Freeze
Cluster Valve Control Setpoint	1	Freeze Mode: 0 Position, 1 Close
Cluster Valve Control Setpoint	2	Data Valid
Cluster Valve Control Setpoint	3… 15	Reserved

Cluster Valve Status	0…1	Access Mode
Cluster Valve Status	2	Freeze Mode
Cluster Valve Status	3	Offline Status
Cluster Valve Status	4…7	Reserved
Cluster Valve Status	8	Service Request
Cluster Valve Status	9	Compressed Air Failure
Cluster Valve Status	10	PFO Voltage Low
Cluster Valve Status	11	Iso Valve Failure
Cluster Valve Status	10…15	Reserved

Cluster Valve Warning	0	Out of Range Freeze Position Setpoint
Cluster Valve Warning	1	Out of Range Freeze Address Setpoint
Cluster Valve Warning	2	Out Of Range Control Setpoint
Cluster Valve Warning	3	Out of Range Monitoring Address Setpoint
Cluster Valve Warning	4… 15	Reserved

2.5.6 Profibus

General information about PROFIBUS is available on the homepage http://www.profibus.com

Naming:
The naming given in this chapter corresponds to the view from the customer (master's) side. In practice it is from a PLC perspective.

Data format:
All signals are transmitted and received in Motorola format (high byte first). Float32 signals are used according the standard data format IEEE754

2.5.6.1 Connection

Connector

The Profibus interface is DB9F (DB-9 pin female). It is galvanic isolated from the rest of the controller. The PIN allocation is given in the table.

Table - Connector PIN Allocation

PIN	Signal	Description
1	-	Not Used
2	-	Not Used
3	B Line	Positive RxD/TxD, RS485 level
4	RTS	Request to send
5	GND Bus	Bus Ground (isolated)
6	+5V Bus Output	+5V termination power (isolated)
7	-	Not Used
8	A Line	Negative RxD/TxD, RS485 level
9	-	Not Used
Housing	Cable Shield	Internally connected to the protective earth via cable shield filters according to the Profibus standard.

Caution!
Any current drawn from the pin 6 will affect the total power consumption. The Profibus connector must not be used for other application that may damage the Profibus interface.

Cable

Table shows the recommended specification for cables.

Table - Profibus Cable Specification

Measure	Range

Impedance	135 … 165 Ω
Capacitance	< 30 pF / m
Resistance	< 110 Ω / km
Wire Diameter	> 0,64 mm
Conductor cross section	> 0,34 mm²

Dependency between the maximum cable length an the baud-rate is given in the following table.

Table - Baud Rate & Max Cable Length

Baud rate [kbit/s]	Max. cable length [m]
9.6	1200
19.2	
31.25	
45.45	
93.75	
187.5	1000
500	400
1500	200
3000	100
6000	
12000	

Line Termination

At the connectors of the first and the last station, the Profibus line must be terminated by a resistor network. Sometimes this network is already integrated on the Profibus connector as an On/Off Switch. The switch position must be ON at the first and last station and OFF at “X..Station”. The shield of the cable must be connected to protection earth. The following picture describes this.

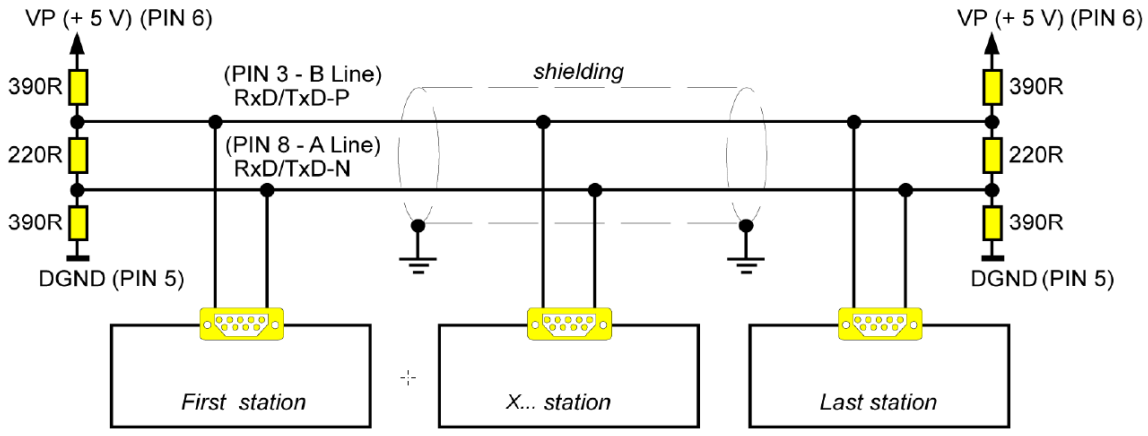


Figure - Line Termination

2.5.6.2 LEDs

Geben Sie hier den Text ein.

LED Communication (COM)

LED COM description

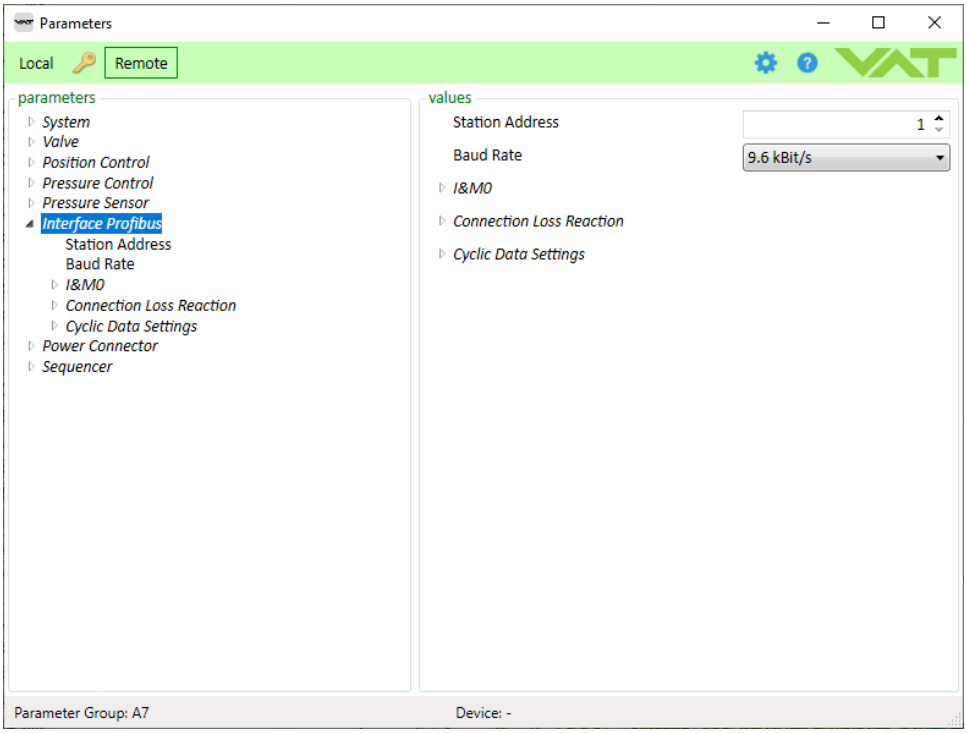
Light Color	State	Meaning
Green	On	Online, running, data exchange, cyclic communication
	Blinking cyclic at 2Hz	Master in the state “Clear”
Red	Blinking acyclic at 1Hz	Device (controller) is not configured
	Blinking cyclic at 2Hz	Not running, no communication, connection error
	On	Wrong Profibus DP-Configuration
Green and Red	Off	Device if Off. No power.

LED Diagnostic (DIA)

LED DIA is always on. No diagnosis information. This is an application-specific function.

2.5.6.3 Communication

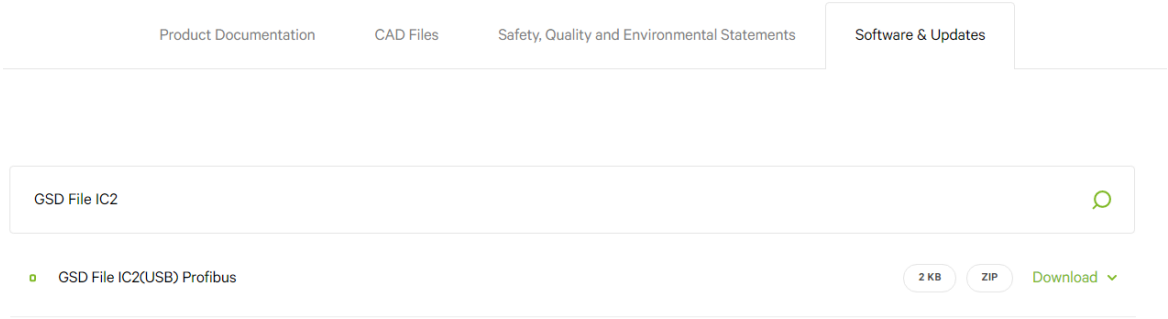
To configure the Profibus interface or to edit pre-configured settings, the easiest way is through the CPA tool.
The following picture shows the overview of all available parameters.
They are described in the sub-topics.



GSD

GSD file describe the communication parameters which are available from the specific device.

Link for download: Downloads
Select Software & Updates Tab and filter for GSD File IC2.



Station address

Profibus Station Address has range from 0 to 126 but zero is reserved for diagnosis devices.
Therefore the selected address needs to be in range 1..126.
Addresses are checked for duplicates. Master should have the lowest address 1, and slaves should follow starting with 2. This is only a recommendation: 1 is still allowed for a slave.

Baud Rate

The GSD sets the Profibus to the auto detection of the baud rate. The controller can be set to any among the offered baud rates:

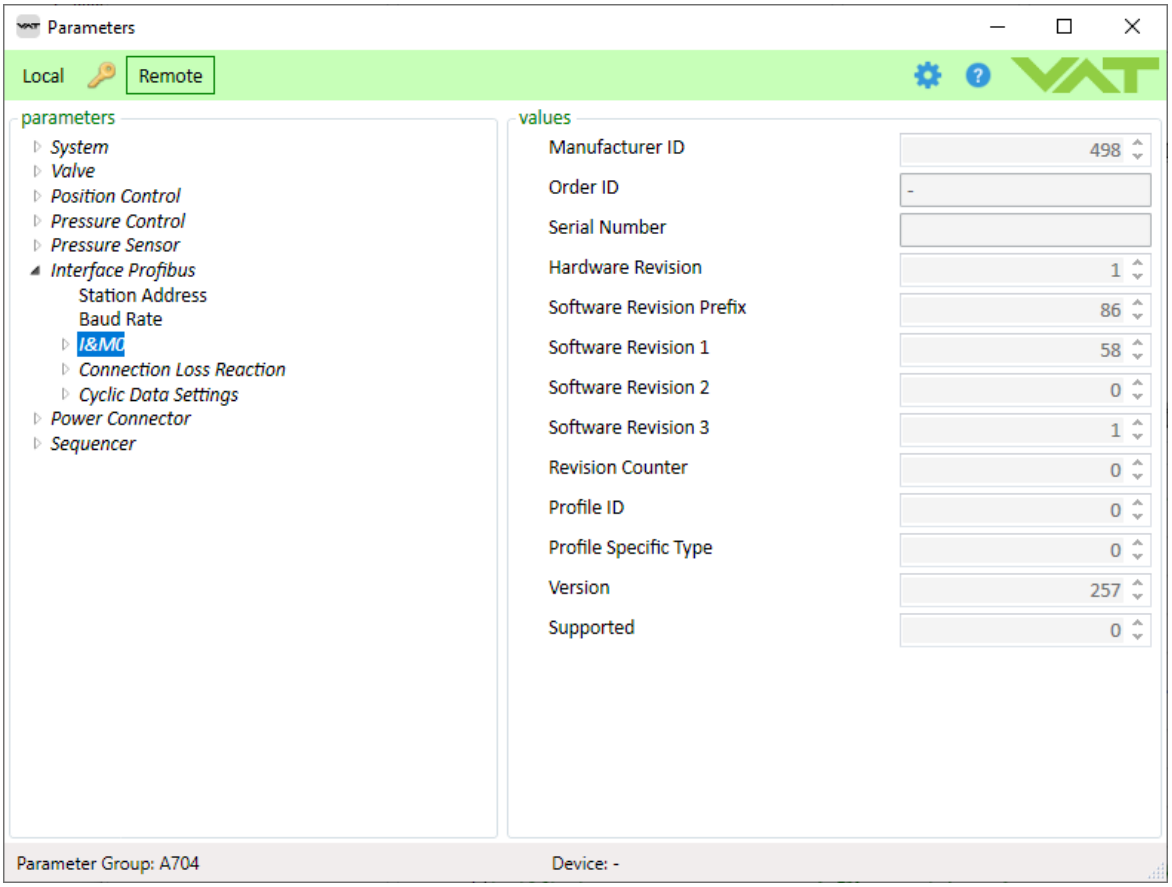
Table - List of supported baud rates

Baud Rates	
9.6	kBit/s
19.2	
31.25	
45.45	
93.75	
187.5	
500	
1.5	Mbit/s
3	
6	
12	

I&M0 record

This is a collection of manufactured data. Its fields are listed in the table.

I&M0 is a read-only data record provided by the device manufacturer. I&M0 data is permanently stored inside the device by the device vendor, this data is related to the device application layer.



Record fields description

Table - Description of the I&M0 record fields

Field	Description
Manufacturer ID	Manufacturer ID of VAT Vakuumventile AG listed at www.profibus.com/IM/Man_ID_Table.xml
Order ID	Order ID of the device. This is the Order ID, or model number or SKU number of the device. It is assigned by the vendor and should be equal to customer readable markings on the device.
Serial Number	Controller Serial Number
Hardware Revision	Hardware revision of the device
Software Revision Prefix	Same value as in GSD file Part FAB.CD.EF.GH
Software Revision 1	Part YY of the controller Firmware Version F01.XX.YY.ZZ
Software Revision 2	Part ZZ of the controller Firmware Version F01.XX.YY.ZZ
Software Revision 3	Mapped part XX of the controller Firmware Version F01.XX.YY.ZZ in following way: XX == 0B à 'Software Revision 1' = 0 XX == 0C à 'Software Revision 2' = 1 XX == 0T à 'Software Revision 3' = 2

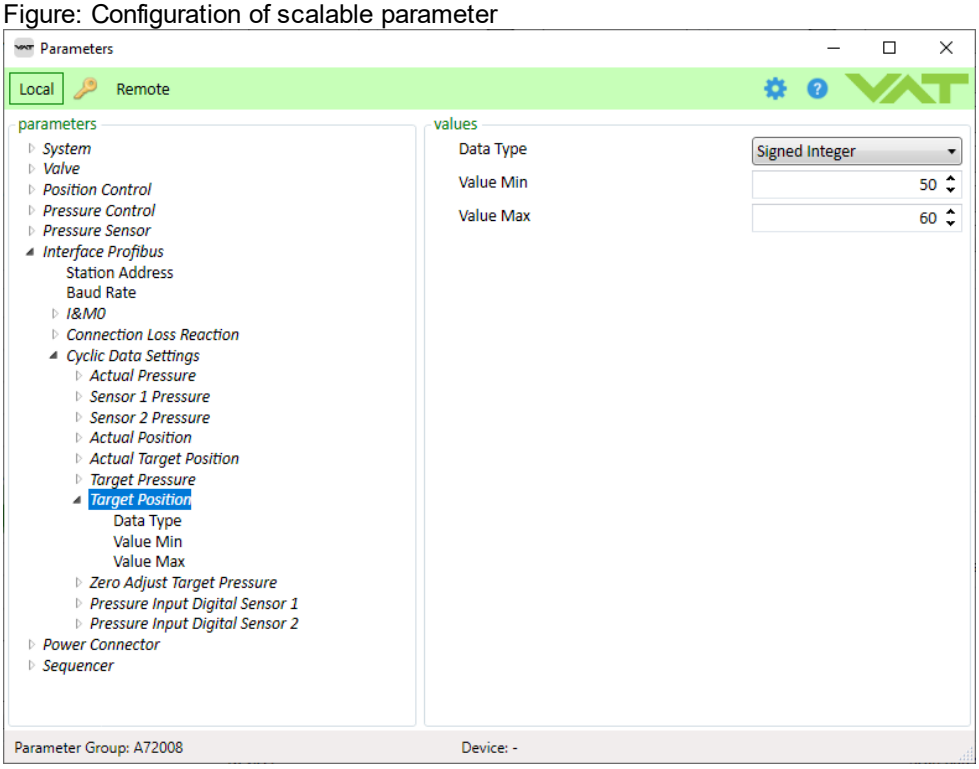
	XX == 0P à 'Software Revision 4' = 3 XX == something else à 'Software Revision 4' = 9
Revision Counter	Initial value 0. Increments on every set of I&M data.
Profile ID	For details refer to\nwww.profibus.com/IM/Profile_ID_Table.xml
Profile Specific Type	For details refer to\nwww.profibus.com/IM/ Profile_specific_type_table_6282.xml
Version	I&M version the Hilscher Stack
Supported	Bitmask that defines which I&M fields are supported by the device For details refer to Hilscher API manual PROFIBUS DP Slave Protocol API 19 EN.pdf chapter PROFIBUS_FSPMS_CMD_SET_IM0_REQ

Cyclic Data Settings

Depending on profile (standard or some other) here is possible to configure the profile relevant scalable cyclic parameters. For each of these parameters are settable the data type and its range. This makes the slave flexible to accept variety of incoming data and to apply them on its internal ranges. For example, as shown on Figure bellow, if Target Position is set to has "signed type" with range from 50 to 60, it means all incoming values over the fieldbus between 50 and 60 will be automatically scaled in order to control the local target position that internally might have range, for example, 0 to 1000.

The external value 50 corresponds to internal 0, 60 to 1000, 54 to 400 etc.

Figure: Configuration of scalable parameter



The ranges can encompass the negative number as well, in case of both, float and signed integer data type.

The float type is 32 bit, IEEE-754 standard. The signed integer is 32 bit long.

Scalable cyclic data parameters are in Table. These parameters are integral part of the complete cyclic data buffers described in next section "Cyclic Buffers"

Table - Scalable Cyclic Parameters

#	Parameter	Input/Output	Default Value Range	
			Min	Max
1	***Actual Pressure***	Input	0	1'000'000
2	***Sensor 1 Pressure***	Input	0	1'000'000
3	***Sensor 2 Pressure***	Input	0	1'000'000
4	***Actual Position***	Input	0	100'000
5	***Actual Target Position***	Input	0	100'000
6	***Slave Actual Position***	Input	0	100'000
7	***Target Pressure***	Output	0	1'000'000
8	***Target Position***	Output	0	100'000
9	***Zero Adjust Target Position***	Output	0	1'000'000
10	***Pressure Input Digital Sensor 1***	Output	0	1'000'000
11	***Pressure Input Digital Sensor 2***	Output	0	1'000'000
12	***Slave Freeze Target Position***	Output	0	100'000

Connection Loss Reaction

If the connection to the Profibus gets lost, the valve will go to desired state (open or close).

Enable = Activating of the feature
State = True **if** the the connection loss has been detected
Functionality = Position/Mode where the valve ends up upon the connection loss

Parameter location:
CPA
Interface Profibus.Connection Loss Reaction

2.5.6.4 Cyclic Buffers

The highlighted **slave** parameters in both buffers are used in case of cluster configuration. Otherwise they can be ignored.

Input Buffer

Table - Cyclic Data: Input buffer

Bytes		Slot	Name	Size [Bytes]	Data Type	Description	Default Range for scalable parameters

0 - 3		16	***Actual Pressure***	4	SINT32 or FLOAT		0 - 1’000’000
4 - 7		17	***Pressure Sensor 1***	4	SINT32 or FLOAT	In case of default valid range: Physical full scale value of the sensor (10 Volt) equals to 1’000’000.	0 - 1’000’000
8 - 11		18	***Pressure Sensor 2***	4	SINT32 or FLOAT	Optional signal, only in case of two sensors. In case of default valid range: Physical full scale value of the sensor (10 Volt) corresponds to 1’000’000.	0 - 1’000’000
12 - 15		19	***Actual Position***	4	SINT32 or FLOAT	Maximal value in the range = Valve is open Minimal value in the range = Valve is closed* *Valid for valves without isolation function	0 - 100’000
16 - 19		20	***Actual Target Position***	4	SINT32 or FLOAT		0 - 100’000
20		21	***Control Mode***	1	UINT	0 = Init 1 = Homing 2 = Position 3 = Close 4 = Open 5 = Pressure Control 6 = Hold 7 = Learn 8 = Interlock Open, 9 = Interlock Close 10 = Maintenance 12 = Power Failure 13 = Safety 14 = Error	Not scalable
21 - 22		22	***Error Number***	2	UINT16	20 = no stop detected during homing 21 = valve blocked during homing 22 = valve blocked 40 = motor driver fault	Not scalable
23 - 24		23	PKW_PKE In	2	UINT16	Not Used	Not scalable
25 - 26		24	PKW_IND In	2	UINT16	Not Used	Not scalable
27 - 28		25	PKW_PWE1 In	2	UINT16	Not Used	Not scalable
29 - 30		26	PKW_PWE2 In	2	UINT16	Not Used	Not scalable
31 - 32		27	***General Status***	2	UINT16	Bitmap that holds device status bits. For details, see the sub-chapter General Status - Bitmap Description.	Not scalable
33 - 34		28	***General Warnings***	2	UINT16	For details, see the sub-chapter General Warnings - Bitmap Description.	Not scalable
35 - 36		29	***Extended Warnings***	2	UINT16	For details, see the sub-chapter Extended Warnings - Bitmap description	Not scalable

37		30	***Slave Address***	1	UINT8	Address of the slave that reports back following parameters: - Slave Actual Position - Slave Control Mode - Slave Status - Slave Warnings	Not scalable
38 - 41		31	***Slave Actual Position***	4	SINT32 or FLOAT	Actual position of the slave selected by the output buffer parameter "**Slave** Monitoring Address"	0 - 100'000
42		32	***Slave Control Mode***	1	UINT8	Control mode of the slave selected by the output buffer parameter "**Slave** Monitoring Address"	Not scalable
43 - 44		33	***Slave Status***	2	UINT16	Slave status bit-field of the slave selected by the output buffer parameter "**Slave** Monitoring Address". For details, see the sub-chapter Slave Status - Bitmap description	Not scalable
45 - 46		34	***Slave Warnings***	2	UINT16	Slave warnings bit-field of the slave selected by the output buffer parameter "**Slave** Monitoring Address" Details are given in the sub-chapter Slave Warnings - Bitmap description	Not scalable

General Status - Bitmap description

General Status				
Bit	**Name**	**Description**		
0	Fieldbus Data Valid	Communication over the bus is running errorless		
1	Zero Executed	ZERO successful executed, active for 2 seconds		
2	Ping Pong RX	Inverted bit "Ping Pong TX" from General Control bitmap. Details given in section Communication between Master (PLC) and Slave (VAT-Valve)		
3	Pressure Simulation	Internal pressure simulation is active. Real sensor inputs are being ignored		
4	Target Pressure Reached	Actual pressure is within 2% of the target pressure		
5	Iso Valve Open	External valve isolation is in state Open		
6	Iso Valve Close	External valve isolation is in state Close		
7 – 8	Access Mode		Bit 7	Bit 8
		Local	0	0
		Remote	1	0
		Locked	0	1
9	Warnings Active	At least one bit of General Warnings or Extended Warnings is active.		
10	Plasma Mode Status	Plasma mode is active. Pressure control is slowed down		
11	Interlock Active	Interlock input is active		

12 - 15	Not Used	Reserved

General Warnings - Bitmap description

General Warnings		
Bit	**Name**	**Description**
0	Service Request	Service Request Active. Valve movement tight.
1	Learn Data Set	No valid learn parameter data present. Learn is required for adaptive pressure control. It can be active only when adaptive pressure control algorithm is chosen.
2	Compressed Air Pressure	Compressed air pressure has not a valid operational level
3	Power Failure Battery	Battery is not ready. Voltage is too low
4	Sensor Overlapping	Sensor deviation between sensor 1 and sensor 2 is >= ±10%
5	Isolation Valve Failure	Invalid state of isolation valve signals: open or close
6	Not Used	Reserved
7-9	Not Used	Reserved
10	Sensor Measurement Unit Faulty	Analog-Digital Convertor of Sensor 1 or 2 on the master board is faulty.
11 - 15	Not Used	Reserved

Extended Warnings - Bitmap description

Extended Warnings		
Bit	**Name**	**Description**
0	Remote Control Not Possible	Remote control not possible, access mode local is active, change to access mode remote or access mode locked
1	Actual Control Mode Target Not Allowed	Not possible to switch the current control mode to given "Control Mode Target" because of reasons: • Actual Control mode is interlock or fatal error • Control Mode Target is 5 (pressure), 6 (hold) or 7 (learn) and no sensor is selected (sensor mode configuration)
2	Zero Disabled	Using zero function not possible
3	PFO Deactivated	Power Failure Option is deactivated
4	Not Used	Reserved
5	Out Of Range: Target Pressure	Target Pressure value is out of its defined range
6	Out Of Range: Target Position	Target Position value is out of its defined range
7	Not Used	Reserved
8	Out Of Range Sensor 1	Pressure Sensor 1 value is out of the defined range
9	Out Of Range Sensor 2	Pressure Sensor 2 value is out of the defined range
10	Out Of Range Control Mode	Control Mode Target value is out of its defined range

	Target	
11	Out Of Range: General Control	General Control value is out of its defined range
12	Not Used	Reserved
13 - 15	Not Used	Reserved

Slave Status - Bitmap description

Slave Status		
Bit	**Name**	**Description**
0 - 1	Access Mode	0 = Local 1 = Remote 2 = Remote Locked 3 = Local and Remote
2	Freeze Mode	0 = Not Frozen, 1 = Frozen
3	Offline Status	0 = Online, 1 = Offline
4 - 7	Not Used	Reserved
8	Service Request	0 = Inactive, 1 = Active
9	Compressed Air Failure	0 = No Failure, 1 = Failure
10	PFO Voltage Low	0 = Voltage High Enough, 1 = Voltage Low
11	Iso Valve Failure	0 = No Failure, 1 = Failure
10 - 15	Not Used	Reserved

Slave Warnings - Bitmap description

Slave Warnings		
Bit	**Name**	**Description**
0	Slave Freeze Target Position	Out of range: Slave Freeze Target Position
1	Slave Control Address	Out of range: Slave Control Address
2	Slave Control	Out of range: Slave Control
3	Slave Monitoring Address	Out of range: Slave Monitoring Address
4 - 15	Not Used	Reserved

Output Buffer

Bytes	Slot	Name	Size [Bytes]	Data Type	Description	Default Range
0 - 3	1	***Target Pressure***	4	SINT32 or	Used as the target value In case the valve is in pressure mode (5),	0 - 1’000’

				FLOAT		000
4 - 7	2	***Target Position***	4	SINT32 or FLOAT	Used as the target value in case the valve is in position mode (2)	0 - 100’000
8 - 11	3	***Zero Adjust Target Pressure***	4	SINT32 or FLOAT	Typically 0, when the chamber is completely pumped down. Valid internal range is from -0.14 to 0.14	0 - 1’000’000
12 - 15	4	***Pressure Input Digital Sensor 1***	4	SINT32 or FLOAT	Input from the digital sensor 1	0 - 1’000’000
16 - 19	5	***Pressure Input Digital Sensor 2***	4	SINT32 or FLOAT	Input from the digital sensor 2	0 - 1’000’000
20	6	***Control Mode Target***	1	UINT8	2 = Position 3 = Close: 4 = Open 5 = Pressure 6 = Hold: Valve kept in current position (Valid for Position and Pressure mode) 7 = Learn: Valve starts the internal learn procedure	Not scalable
21 - 22	7	***General Control***	2	UINT16	Bit-field of control bits. See the sub-chapter General Control - Bitmap description	Not scalable
23 - 24	8	PKW_PKE Out	2	UINT16	Not Used	
25 - 26	9	PKW_IND Out	2	UINT16	Not Used	
27 - 28	10	PKW_PWE1 Out	2	UINT16	Not Used	
29 - 30	11	PKW_PWE2 Out	2	UINT16	Not Used	
31 - 34	12	***Slave Freeze Target Position***	4	SINT32 or FLOAT	Used as the target position whenever "**Slave** Control" brings freeze mode 0 (position) to the controller. Scalable parameter.	0 - 100’000
33 - 34	13	***Slave Control Address***	1	UINT8	The address of controlled slave. Used for addressing for parameters "**Slave** Freeze Target Position" and "**Slave** Control"	Not scalable
35 - 36	14	***Slave Control***	2	UINT16	Bit 0 - Freeze: 1 = True, 0 = False Bit 1 - Freeze Mode: 0 = Position, 1 = Close Bit 2 - Data Valid: 0 = False, 1 = True	Not scalable

37	15	***Slave Monitoring Address***	1	UINT8	Address of the slave that should report back following parameters within the input buffer: - **Slave** Actual Position - **Slave** Control Mode - Slave Status - **Slave** Warnings	Not scalable

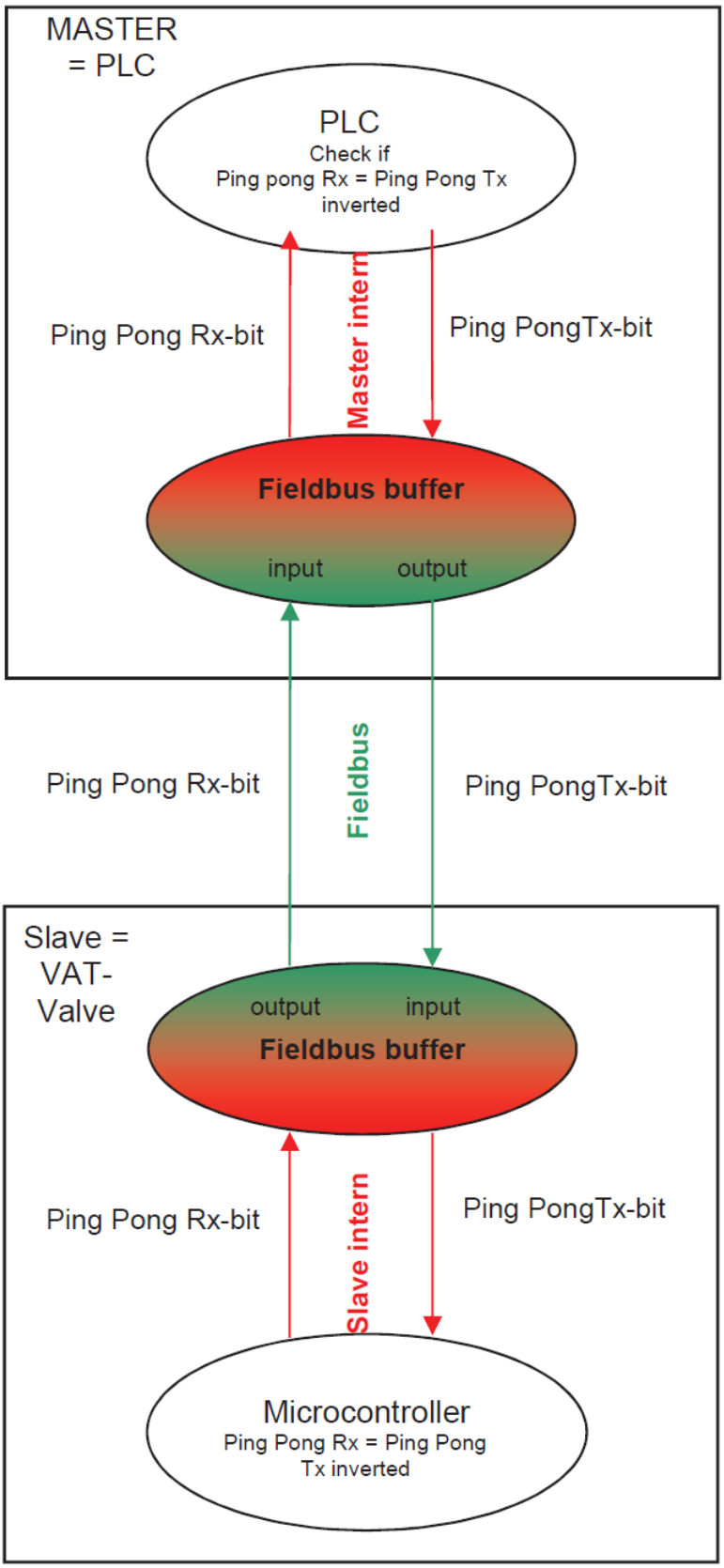
General Control - Bitmap description

General Control				
Bit	**Name**	**Description**		
0	Zero	0 = No Operation 1 = ZERO adjust, the actual pressure signal is set to internal pressure 0. The valid range for adjustment is limited to range from -1.4V to+1.4V. Otherwise the sensor must be adjusted!		
1	Not used	Reserved		
2	PING PONG TX BIT	This bit, transmitted from the master (PLC), is used to check the loop "Master - VAT station". See Section Communication between Master (PLC) and Slave (VAT-Valve)		
3	Not used	Reserved		
4	Access Mode Locked	**Start Mode**	**Access Mode Locked**	**End Mode**
		local or remote	0 → 1	locked
		locked	1 → 0	remote
		Example: From local to remote: 0→ 1, 1 → 0		
5	Plasma Mode On	0 = No Action 1 = Turn Plasma Mode ON if previously this bit was 0		
6	Plasma Mode Off	0 = No Action 1 = Turn Plasma Mode OFF if previously this bit was 0 Bits 5 and 6 are in collision. Therefore the bit 6 has higher priority than the bit 5.		
5 – 15	Not used	Reserved		

Communication between Master (PLC) and Slave (VAT-Valve)

Ping Pong Rx' and 'Pink Pong Tx' bits are listed in Table 8 and Table 12. The diagram below on Figure bellow shows visually the exchanging between the master (PLC) and the slave (VAT Controller)

Figure - Communication Master-Slave: Ping Pong Rx and Tx bits


MASTER
= PLC
PLC
Check if
Ping pong Rx = Ping Pong Tx
inverted
Ping Pong Rx-bit
Master intern
Ping PongTx-bit
Fieldbus buffer
input
output
Ping Pong Rx-bit
Fieldbus
Ping PongTx-bit
Slave =
VAT-
Valve
output
input
Fieldbus buffer
Ping Pong Rx-bit
Slave intern
Ping PongTx-bit
Microcontroller
Ping Pong Rx = Ping Pong
Tx inverted

2.6 Power connector IO

Do not connect other pins than indicated in the schematics!
Use only screws with 4-40UNC thread for fastening the DA-15 connector!

2.6.1 Digital Inputs

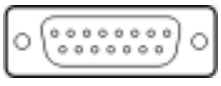
	Parameter	Description
Digital Input 1.2	***Enable***	*True* means it is supported. *False* means it is not supported
	State	*True* means it is active. *False* means it is not active.
	Functionality	*Interlock Open* Open the Valve. *Interlock Close* Close the Valve. *Hold* Hold the actual position. High priority functionality
	Inverted	Inverted the functionality of the signal.

2.6.2 Digital Outputs

	Parameter	Description
Digital Output 1..2	***Enable***	*True* means it is supported. *False* means it is not supported
	State	*True* means it is active. *False* means it is not active.
	Functionality	*Open* Indicate the Open status of the Valve. *Close* Indicate the Close status of the Valve. *Hold* Indicate the Hold status of the Valve.
	Inverted	Inverted the functionality of the signal.

2.6.3 Connector assembling

The Connector on the Controller is a D-Sup 15 Pin male.

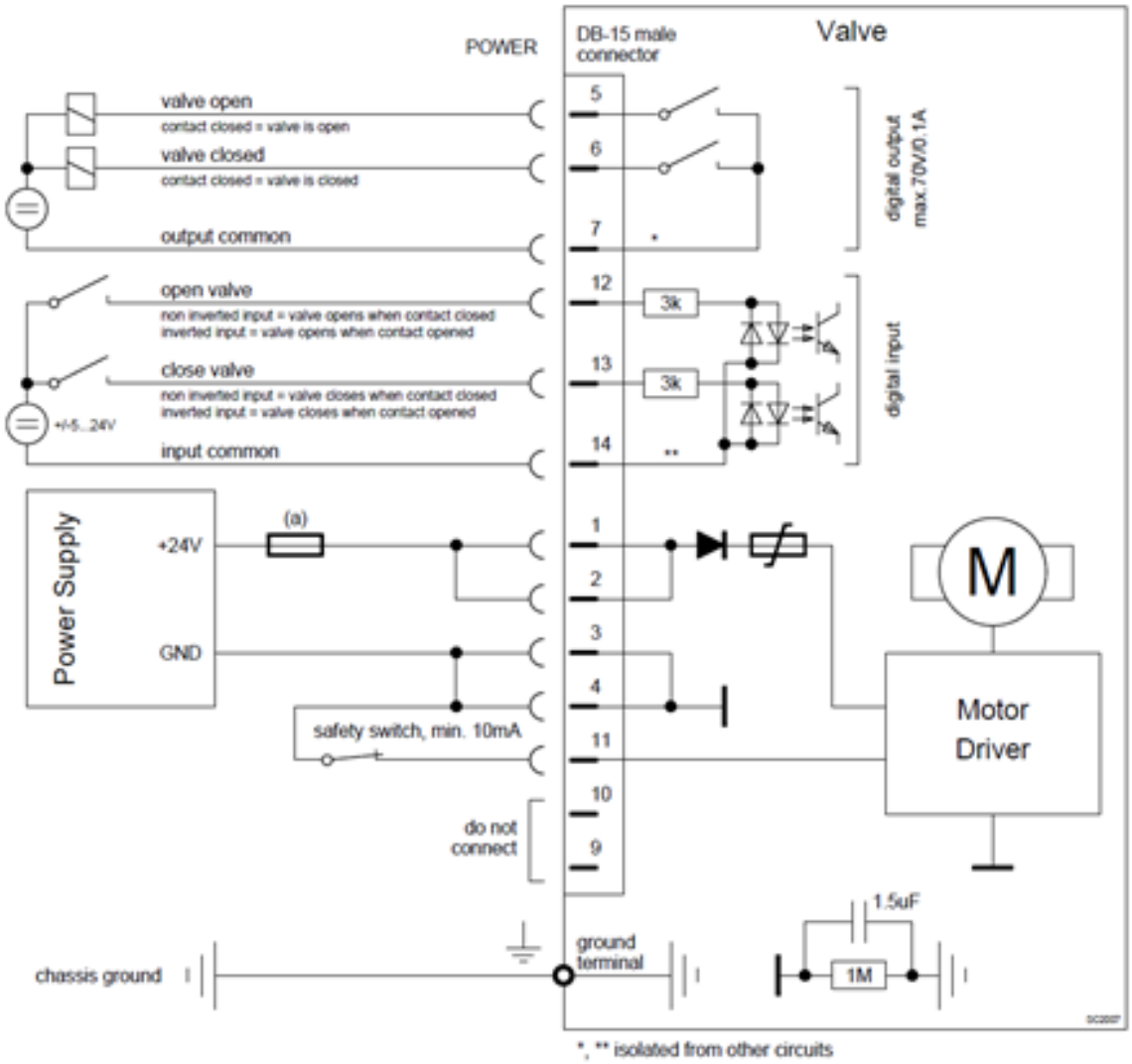


Pin	Signal	Description
1	+24VDC	*Power supply fuse recommendation 5 AF*
2	+24VDC	*Power supply*

3	GND	*Ground*
4	GND	*Ground*
5	Open	*Digital output 1*
6	Close	*Digital output 2*
7		*Common output*
9	Sensor power +15V	*Input Sensor power +15V*
10	Sensor power -15V	*Input Sensor power -15V*
11	Safety	*Input Enable. Safety function. Input must be bridged to GND. Otherwise motor drive is not energized.*
12	Open	*Digital input 1*
13	Close	*Digital input 2*
14		*Common input*

2.6.4 Wiring

Note: Only voltage control is possible for digital input. Specification: +-5..24V / 4..8mA



a) slow-blow fuse

2.7 Options

In this chapter are all possible Options for the IC2 Controller described in general.

Options:
- Cluster
- PFO (Power Failure Option)
- SPS (Sensor Power Supply)

2.7.1 Power Down, Power Failure Option

2.7.1.1 Behaviour in case of power failure

Valve position before power failure:	Reaction of valve:	
	Without Power Failure Option (PFO) ... . . - . . **G** . - .... / ... . . - . . **A** . -	With Power Failure Option (PFO) ... . . - . . **H** . - .... / ... . . - . . **C** . - ....
Closed (isolated)	Valve remains closed.	Valve will close or open depending on Power Failure Option configuration. Default is close. Display indicates **F**.
Valve open or in any intermediate position	The plate remains at the current position.	

All parameters are stored in a power fail save memory.

2.7.1.2 Power Failure Option

Power Failure option is circuit board that can store as much energy to close or open the valve in the event of a power failure.

Technical data

Charging Time	2 minutes max.
Durability	Up to 10 years @ 25°C ambient

These settings define what the valve is doing in case the power fails.

Valve must be equipped with the 'Power Failure Option'
[... . . - . . **C** . - . . . . or ... . . - . . **H** . - . . . .]
For PFO retrofit and other options refer to chapter: «Spare parts».

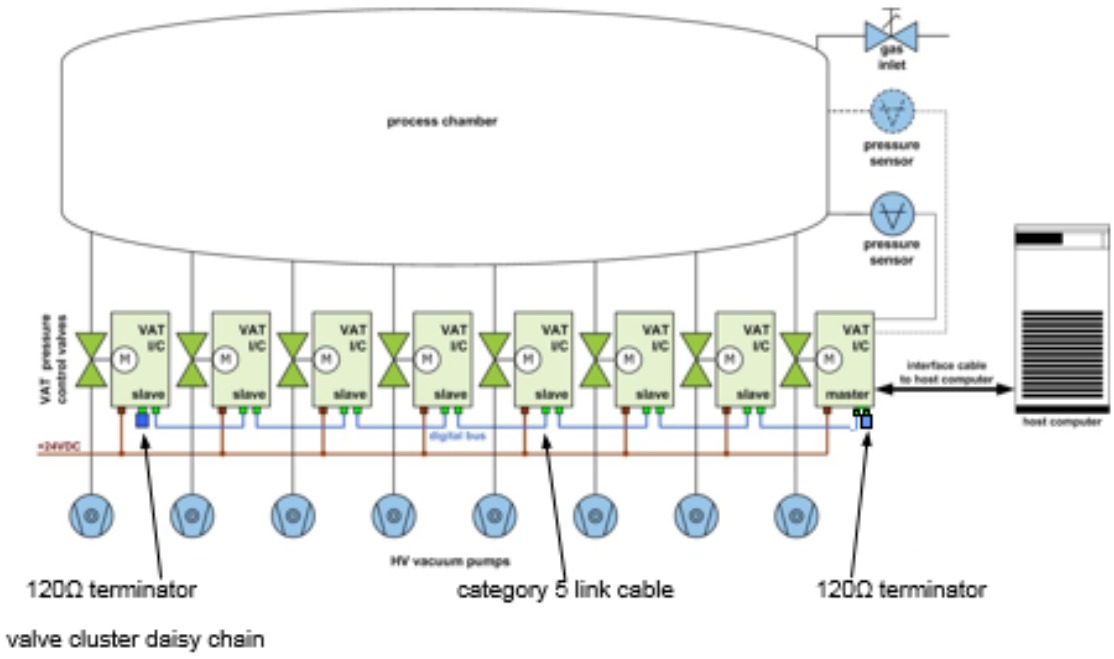
Parameter	Description
Enable	'True' enables the power fail reaction. 'False' there is no reaction on a power fail
State	**0** Battery is Charging **1** Ready to Use **2** Active **3** Failure
Functionality	**0** Open **1** Close
Delay	In seconds After this delay the power failure reaction starts after the power failed. Helps to bridge a short power interruption.
Battery Voltage	Shows state of charge
Power Fail Cycles	Counts Power Failure

Location:
CPA Parameters
Power Fail Option

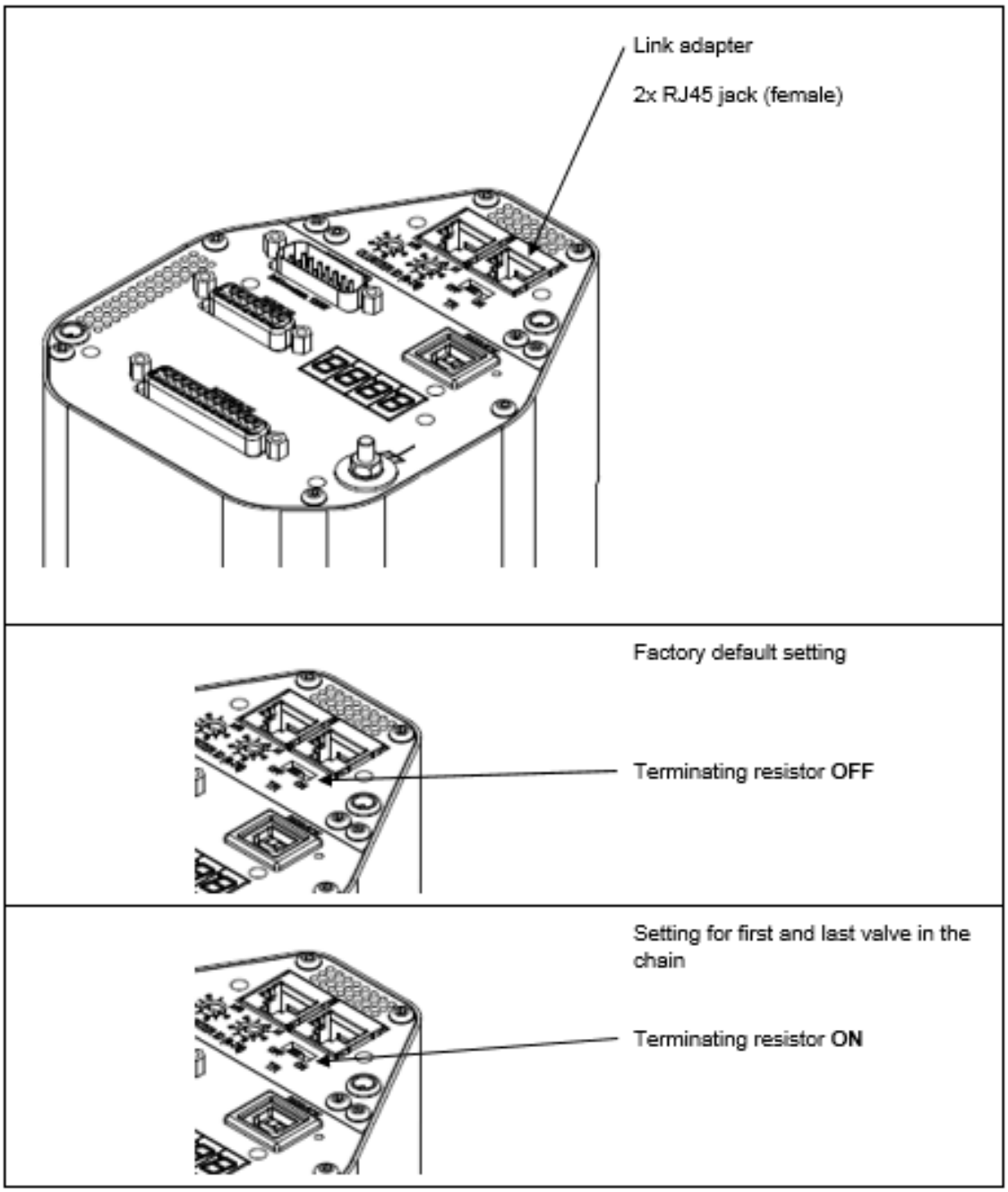
2.7.2 Cluster

2.7.2.1 Connection

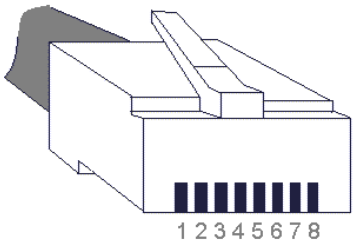
The valve cluster uses a two wire bus for the inter communication between the Master and the Slave valves. The valves are connected in a daisy chain and the **bus must be terminated on both sides** by a 'Terminating Resistor' switch (**TR**). Refer to chapter: «Valve cluster address configuration».



Link Adapter



Link cable



RJ45 pinning: active pins 4 and 5

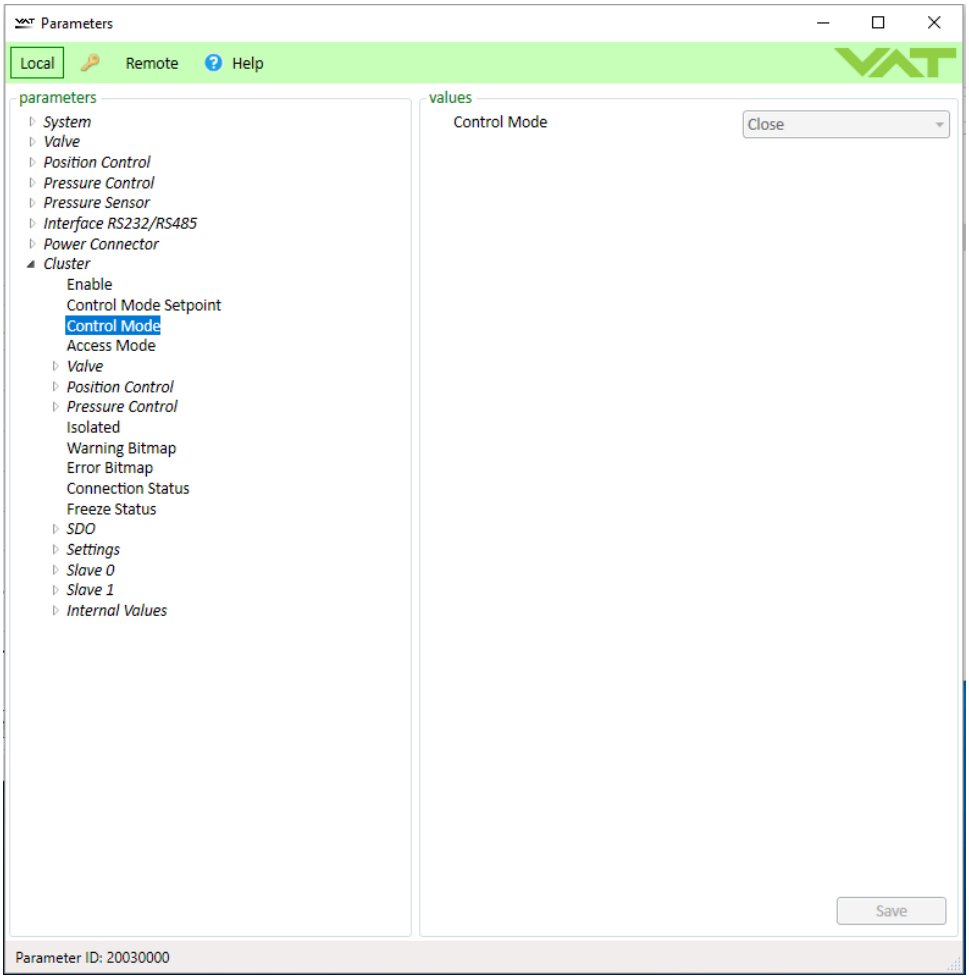
Pin	Description
1	not used
2	not used
3	not used
4	Data
5	Data
6	not used
7	not used
8	not used

VAT recommends a cable with the following specification:

- Standard patch cable
- Category 5 or higher
- Double ended with shielded RJ45 connector
- Straight through connection 1:1

2.7.2.2 CPA Parameters

In this Chapter the Program behavior and the most relevant Cluster functionalities and parameters of the CPA 4 will be described. The following picture shows an overview about the Cluster system Parameters.



Access Mode

In this case the parameter “Access Mode” stays for the whole Cluster system, means if one Slave is in Local-Mode it will be visible at the Parameter “Access Mode”. In normal operation all cluster participants are in REMOTE mode. In this Mode the periodically and aperiodically commands (named “SDO” – are commands that can be send to an individual slave in the cluster) from the Master to the slave valves will be received and processed. If a Slave is in Local-Mode the periodically commands will be ignored, but the aperiodically commands will be processed, if the actual state of the valve controller will let them to process.

Control Mode Setpoint/ Control Mode

Within the Parameter “Control Mode Setpoint” it is possible to set different Control Modes to the whole Cluster system. There are not all Control Modes setable. The parameter “Control Mode” shows only the actual state.

Freeze Mode

With the Freeze Mode functionality it is possible to decouple an individual Slave from the cluster system. This means that the Slave, which is actual in the Freeze state, is not anymore following the cluster system and can be operate individually. From the Master it is possible to see, which slave is in Freeze Mode at the parameter “Freeze Status”.

Connection Status

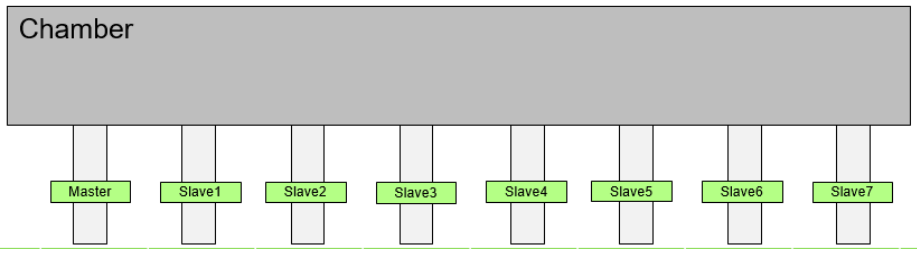
If a cluster participant does not respond within a defined timeout, the Offline status for this Slave will be set in the Master. This can have several reasons (e.g. Controller Power-OFF, cluster network error, other

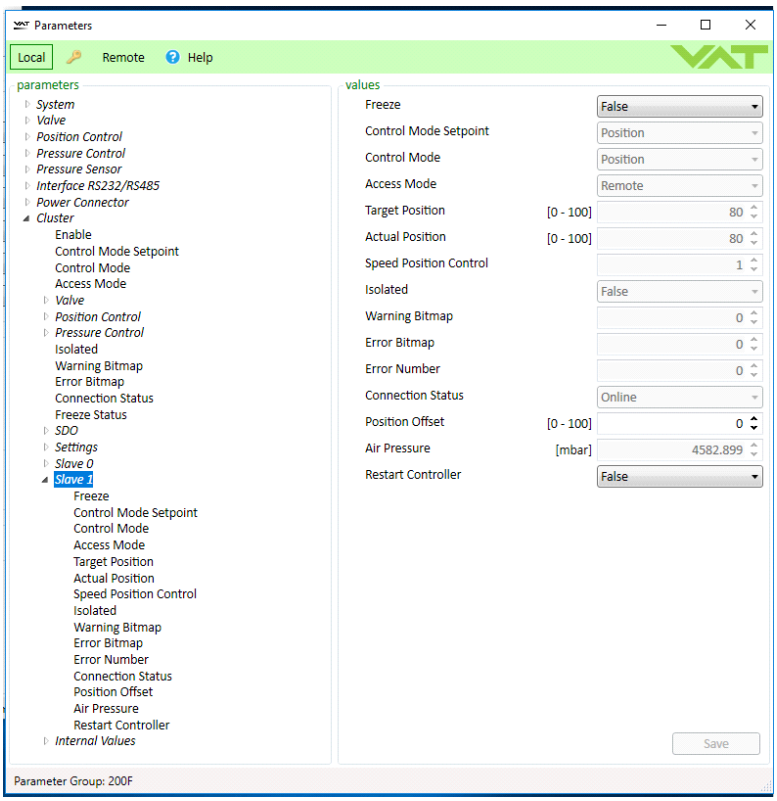
defects). If the cluster participants are not able to communicate on the cluster network (timeout), then they will move to a defined position (connection-loss reaction) and remain there until communication is available again.

Position Offset

Through the Position Offset it is possible to adapt the Actual Position of a valve. The Position Offset can be set in a range of -/+ 30 % of the actual position scaling. It is also possible to select at the position offset whether the adapted position or the real position of the valve should be output. The Adapted Position is equal to the position setpoint and the real position is the sum of the position setpoint and the position offset. The Position Offset is available at a single valve or in the Cluster system. If the Position offset is used in a cluster system the Parameter - Actual Position "Adapted/Real" will be broadcasted from the master to each slave. Only the Position Offset is setable at each participating valve individually.

The following Schematic will show a cluster system with the same position offset, that is +20 % of the actual position scaling. Actual Position of the master valve (no position offset) is set to 10% of the actual position scaling. In this case the Real position will be shown – means at each valve where a position offset is set – the expected position should be the sum of the Actual Position and the position offset.



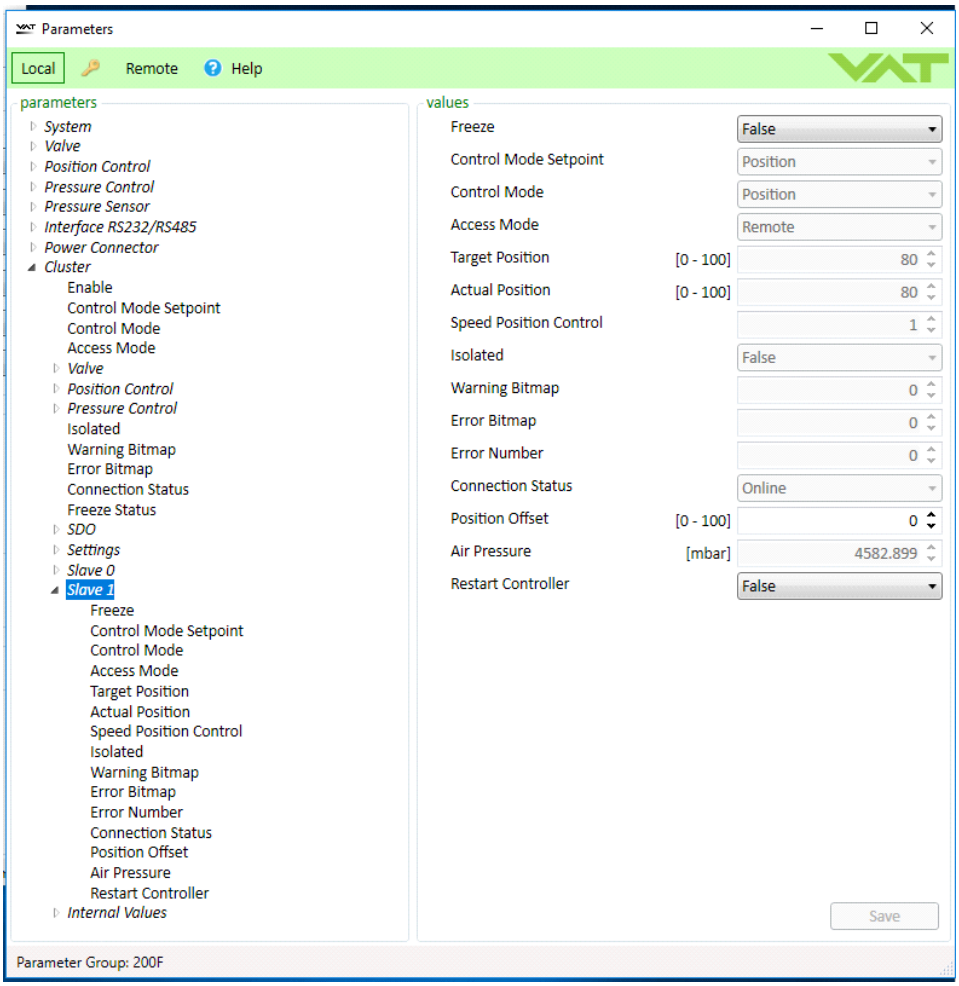


G-Command:

The G-commands are used to communicate with the individual cluster members individually. At the IC2 the G commands are still supported and finally transferred as aperiodical data (named "SDO") to the respective slave. The corresponding conversion takes place in the master Controller.

Display on the valve controller:
Is a Valve configured as a Slave, it will show the Slave Address (SLxx) on the display. Here is the Master represented as Slave 0 (SL 0). Leading zeros in the slave address are not displayed. The display changes periodically with the contents of the standard display (control mode + position).
If the Cluster option is active the parameter groups: Valve, Position Control, Pressure Control, Warning and Error Bitmap will be shown under the Cluster parameter group. The Functionality of these Parameters are the same, it is just that the Settings at the Master valve will be broadcasted to each salve to have the same behavior.

Settings:
Under the parameter group Settings it is possible to do general settings to configure the cluster system as it is needed. For example the ***Number of Valves*** that are participating in the cluster system.
Slave x(x= stands for the cluster address):
The Parameter group e.g. Slave 0 represents all the settings that are processed to the Master valve. The same overview is given for every participating valve in the cluster system. That gives the possibility to steer all the settings from the master valve. The following picture should give an overview what parameters are covered by the parameter group Slave x.



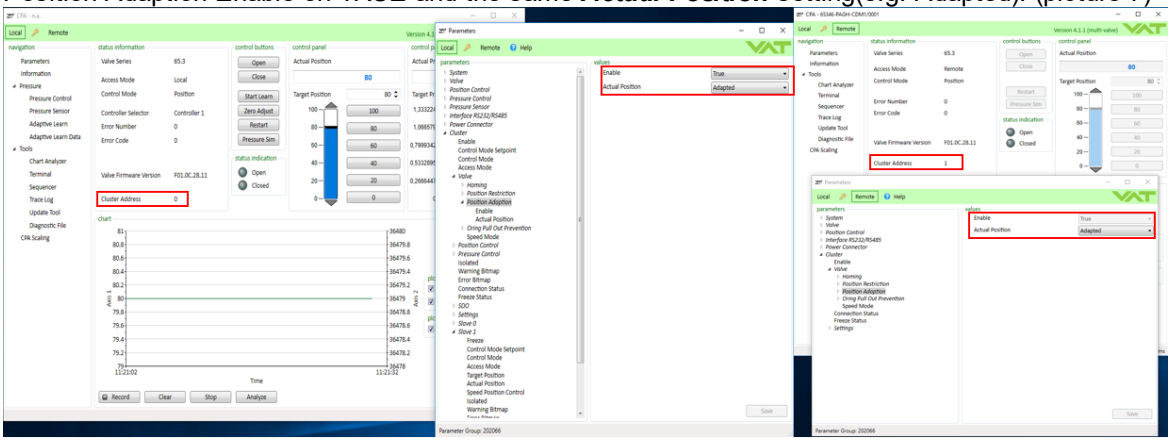
2.7.2.3 Position Offset

Attention: Position Offset for Master Valve is no more available from Firmware Version F01.0C.28.27! (same as IC1)

If the User wants to set a ***Position Offset***, than the first step would be to ***Enable*** the Position Adaption,
what is possible over the Master through the CPA4 under
Parameters.Cluster.Valve.PositionAdaption.Enable à TRUE
The Parameter ***Actual Position***, what is shown in picture 7, is a possibility for the user to show the Adapted Position or the Real Position of the individual Slave.

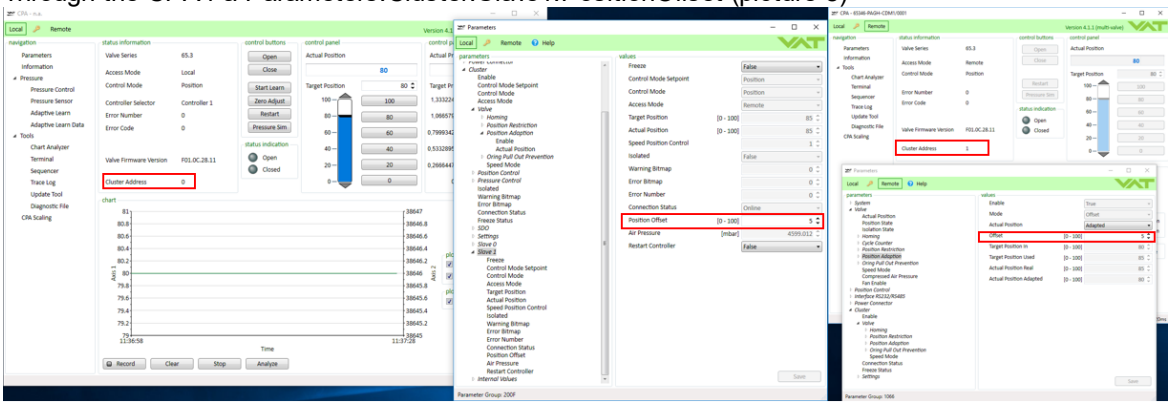
Actual Position:	Real	=	Position Setpoint + Offset
	Adapted	=	Position Setpoint

This settings will be shared with all the other participants (=Slaves), that means every Slave will have Position Adaption Enable on TRUE and the same ***Actual Position*** setting(e.g. Adapted). (picture 7)



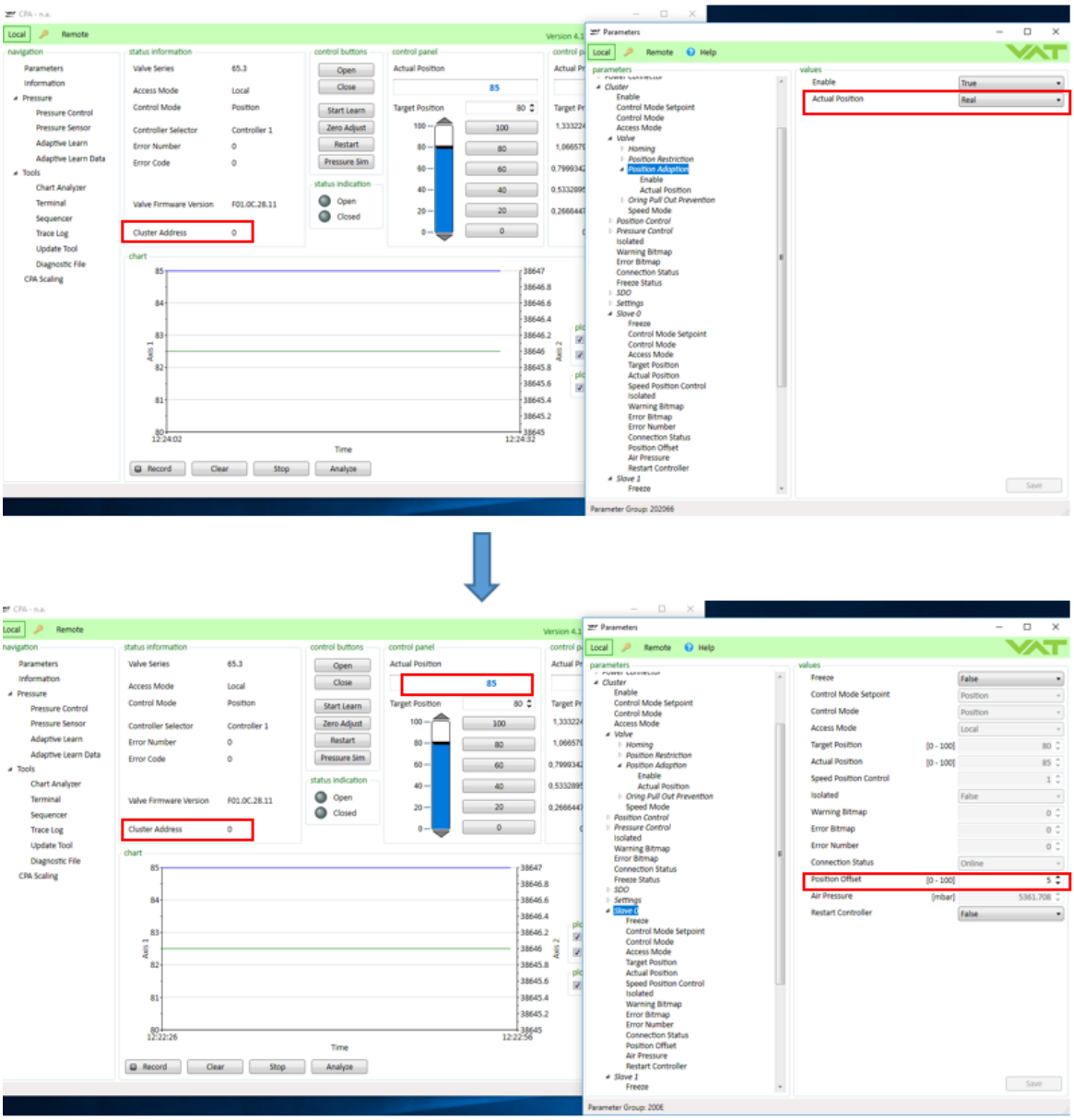
Picture : Position Adaption Enable - TRUE

Now the user can set an individual Position Offset to every Slave in the Cluster System over the Master Valve (Cluster Address 0). For example to set a Position Offset to Slave1 (Cluster address 1) Through the CPA4 à Parameters.Cluster.Slave1.PositionOffset (picture 8)

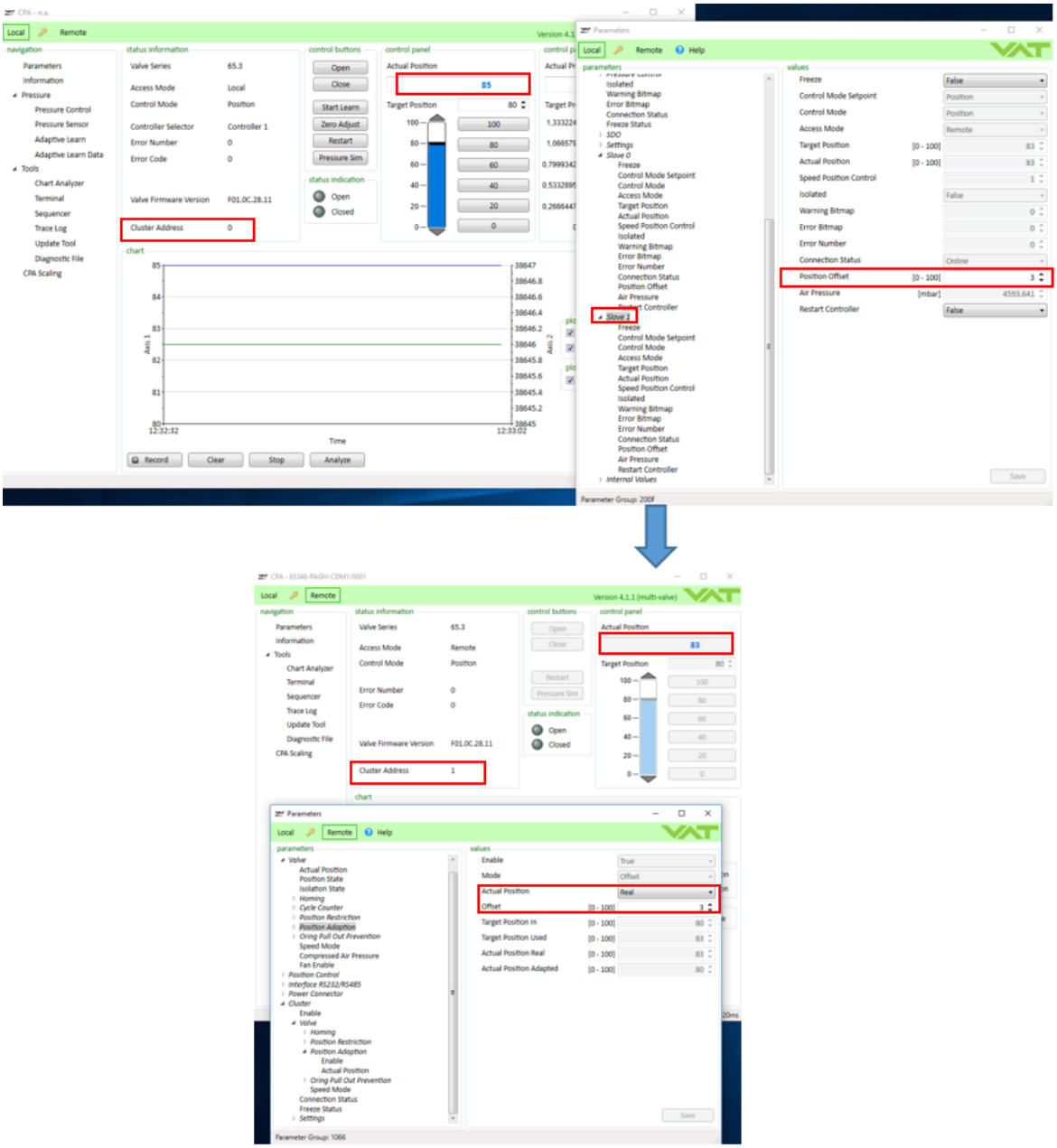


Picture : Set Position Offset over Master in CPA4

The following pictures should give an overview how it looks like if the Parameter ***Actual Position*** is set to Real and what impact it have to the Actual Position.



Picture :Position Offset with Actual Position - Real Setting



Picture : Position Offset with Actual Position - Real setting
PositionOffset = 3 (at Slave1 means Cluster Address 1) and Position Offset = 5 (at Slave0 means Master → Cluster Address 0)

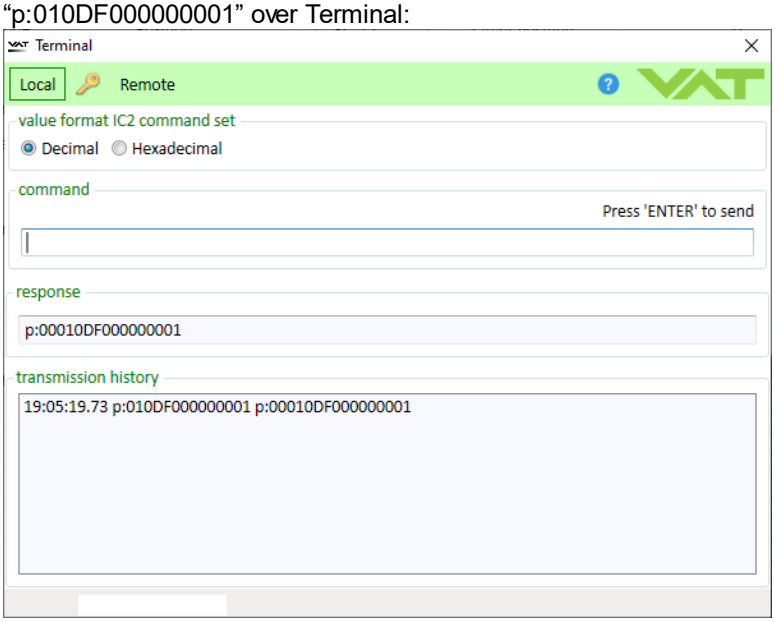
2.8 Sequencer

2.8.1 Intro

Sequencer is an internal feature of the IC2 firmware that provides possibility to program and run several consecutive commands on the controller, without using any external interface and device. It supports up to 20 different commands that also could be periodic. Its main purpose is to have long time tests possible and to investigate performance and behavior of device in a timely controlled way.

Activation in the CPA

In the CPA, by default, the sequencer is hidden. It can be made visible by sending the command “p:010DF000000001” over Terminal:



2.8.2 Main Parameter

Run - The main control that activates and deactivates the sequence running.
State – The main state (read-only) that tells in which stage is the sequence running now: IDLE, RUNNING, STOPPING, STOPPED, FINISHED, TIMEOUT or ERROR.
Starting Command – This parameter defines at which command in the sequence the execution starts at beginning.
Current command – Currently executing command or the last executed command in case a delay is going on.
Pre-Cycle Commands – String that lists all commands executed before the loop (cycle) if any.
Cycle commands – String that lists commands executed in a loop, if any.
Target Cycles - Number of cycles that the sequence need to pass before it reaches the state FINISHED.
Target Time – Number of seconds that the sequence need to run before it goes to state FINISHED
Cycle Counter – Number of executed cycles. Depending on “Saving Mode” parameter, it might be stored in memory.
Cycle time – Number of seconds that tells how long is current cycle running.
Running Time – Total sequence execution time. Depending on “Saving Mode” parameter, it might be stored in memory.
Controlword Bitmap – This bit-field controls more parameters at once It supports controlling the valve over EtherCAT. Bit 0 with it rising edge (from 0 to 1) makes the parameter “Run” to be TRUE.

Bit 1 makes the same parameter “Run” to be FALSE, regardless of its rising edge. In addition, it has higher priority than the bit 0, which means, as long as the bit 1 is high, the sequencer will never run. Bit 2 makes “Cycle Counter” zero whenever its transition from 0 to 1 happens (rising edge).

Section “Settings”

Run From State Stopped – This is relevant only in case the sequence is in state stopped. The parameter defines how the sequence will starts again. Possibilities are to continue with the next command or to start the whole sequence from the beginning again with or without the pre-cycle. If not, the first command will be the beginning of the loop (cycle).

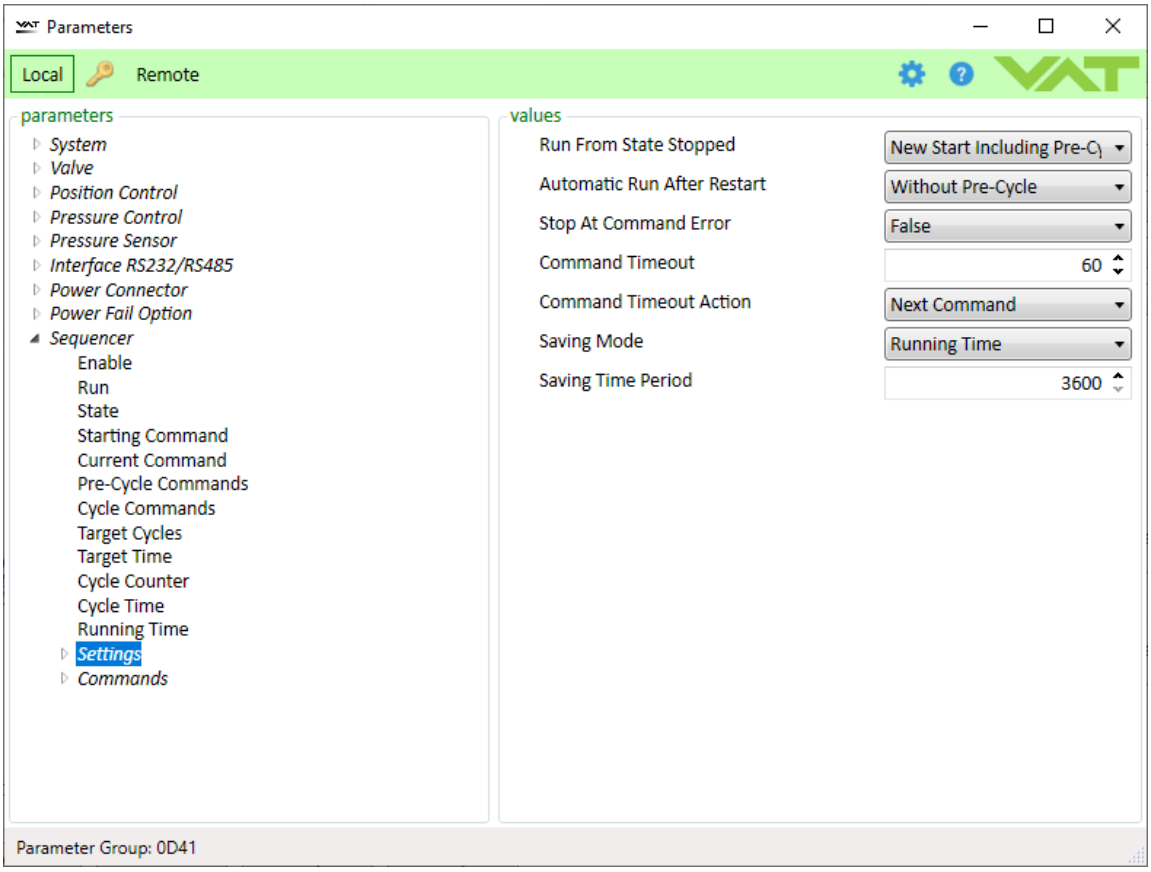
Automatic Run After Restart – In case an external restart (power cycle) or an internal one (restart command) happens; here we define if we want automatically to continue the sequence run, once the controller has power supply again. Optionally, the pre-cycles can be included.

Stop At Command Error – Each command internally receives a feedback that may be an error report. If this happens, for whatever reason, here we define whether the sequencer stops (and goes to state ERROR) or not.
Command Timeout – In case that some command execution takes too long, here we define how long the sequencer will wait. Once this timeout is been reached, the sequencer will act according the following parameter “Command Timeout Action”: stop or proceed to the next command.

Command Timeout Action – Here is defined what happens in case the timeout has been reached. Option “Stop” will bring the sequencer in state “Timeout”. Option “Next Command” executes the next command (if any) after the timeout.

Saving Mode – In case the sequencer is running for a long time we might need to store the counter (cycles or time) in the non-volatile memory. «Saving Mode» defines whether the controller periodically stores elapsed time or number of already finished cycles in memory. In this way, the sequencer will continue counting after any kind of interruption. There are three options for saving: time, cycles, or nothing

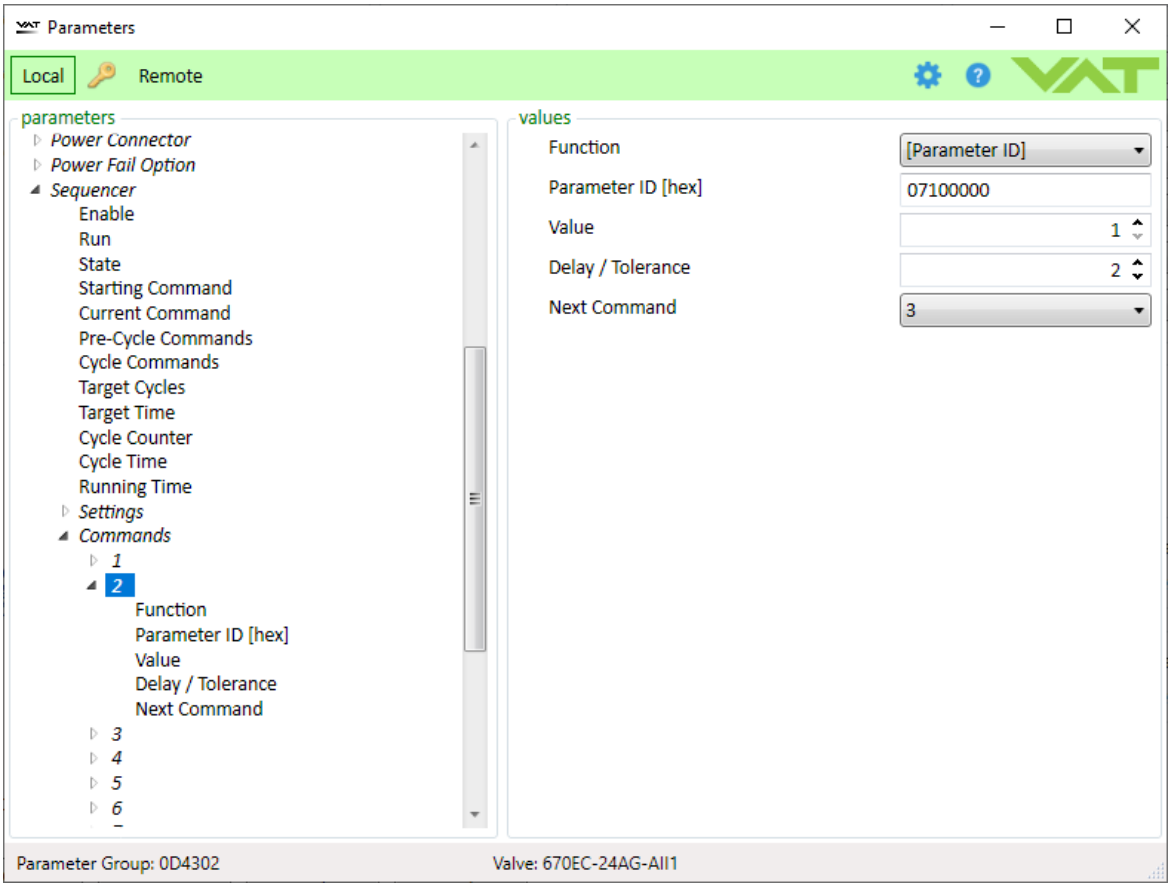
Saving Cycle period and Saving Time Period – Depending on the previous parameter, here we define the saving period (how often the parameters will be saved). For example, if it is selected “Saving Cycle period” to be 100, and a system restart happens at the cycle number 294, the “Cycle counter” will have stored value 200, because it is the biggest number that is multiplication of 100 and less than 294. The current cycle number is sometimes additionally stored in memory after stopping and starting, regardless of the defined periods.



Section “Commands”

Function – For each command in the sequence this parameter defines the function. There are eight options: Parameter ID, Open, Close, Position, Pressure, Learn, Homing and Time Delay. Depending on selected function, the rest of parameters might be irrelevant. For example, Open and Close functions don’t depend on the parameter Value.

Parameter ID and Parameter ID [hex] explicitly define which parameter is being controlled in case the function “[Parameter ID]” has been selected.



Value – The value feeds different functions with position, pressure, etc.

Delay/Tolerance – This parameter has several purposes, depending on its value.
If it is positive, it defines a delay that the sequencer will wait until it starts execution of the next command in a sequence.
If it is equal to -1, it means that next command, if any, will be executed only when the current command reaches its goal: "Open" and "Position" reach the final positions, Homing is done, Target Pressure is achieved etc.
If it is negative, bug greater than -1, it will define the percentage tolerance of the given target Position or Pressure. For example -0.1 represents 10%, -0.25 represents 25% of the full scale etc. If a command's function is position with the target of 73 (out of 100), and the tolerance is -0.2 (20%), the goal will be achieved as soon as position reaches the range between 73 – 0.2 x 100 and 73 + 0.2 x 100, which is [53, 93]. Therefore, the next command will execute earlier comparing to the case with tolerance 0. This range has no effect on functions other than pressure and position.

Next command – It defines the following command. It can even be the same command, or some that is already been executed. Changing of these connections between commands directly updates the order of the commands execution.

Example

In the following example is described how the sequencer via CPA can be set to periodically run following 6 commands:

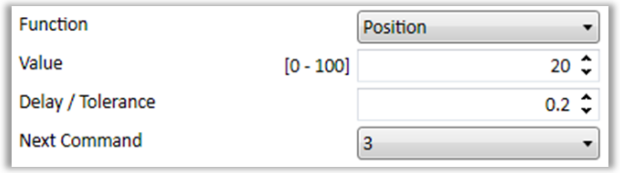
Command	1	2	3	4	5	6
Function	open	position	position	open	pressure	Open

Value	/	20%	70%	/	3 Torr	/
Delay	2s	0.2s	0.2s	2s	5s	2s

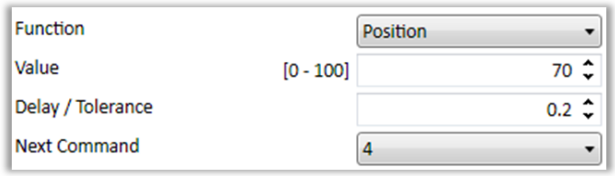
Commands need to be defined with all their fields, as shown in following snapshots:

Commands 1, 4 and 6:

Command 2



Command 3



Command 5

2.8.3 Interface EtherCAT

To use this sequencer functionality over EtherCAT a special firmware is required as well a specific ESI File to have all sequencer objects available in offline mode.

Sequencer Configurable PDO mapping
User can add additional objects to PDO Output mapping 0x16FF and the Input PDO mapping 0x1AFF.

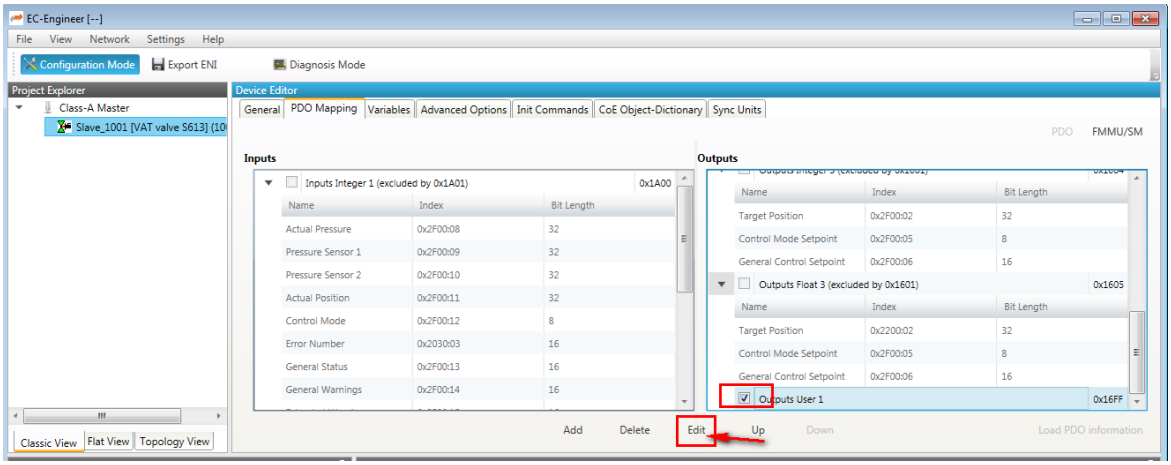
How to create Input & Output mapping with EC-Engineer
To add the PDO parameters for the Sequencer in addition to the standard buffer (0x1601) in the configurable PDO buffer (0x16FF) following steps are necessary:

Mapping object	*Mapping content*		*Index*	*Sub-Index*	*Note*
0x16FF	SINT	***Starting Command***	0x2D00	3	
	UDINT	***Target Cycles***	0x2D00	5	See Note below*
	REAL	***Target Time***	0x2D00	6	See Note below*
	UINT	***Controlword Bitmap***	0x2D00	10	Bit0:Run, Bit1:Stop, Bit2:Reset Cycle Counter

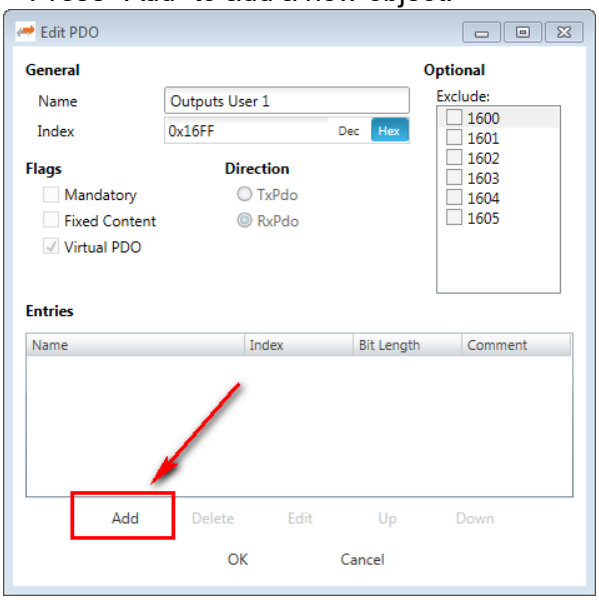
0x1AFF	UDINT	***Cycle Counter***	0x2D00	7	
	SINT	***Current Command***	0x2D00	4	
	REAL	***Cycle Time***	0x2D00	8	Optional
	REAL	***Running Time***	0x2D00	9	Optional
	SINT	***State***	0x2D00	2	

*The Objects ***Target Cycles*** and ***Target Time*** are there to limit the Sequence. If both Objects are set to ZeSro this means that the Sequence will run until the user will set the Parameter/Object 'Run' to 'False'. If both Objects are set e.g. ***Target Cycles***=3, ***Target Time***=10 then the sequence will run until the lower limit of these two Objects are reached.

- In EC engineer the mapping the configuration is done in Configuration Mode
- Select output buffer 0x16FF "Outputs User 1" and click "Edit" button



- Press "Add" to add a new object:

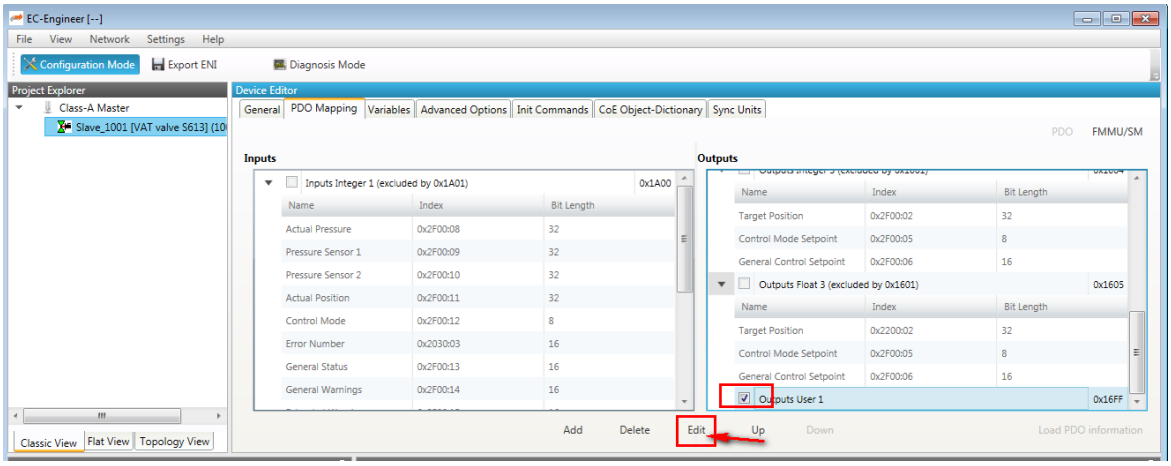


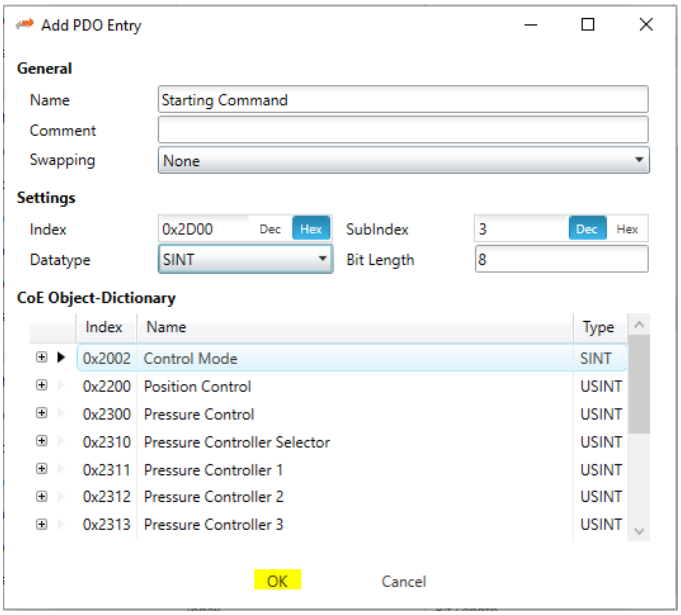
- Now the User should enter the settings – e.g.:

Name: 'Starting Command'

Index: '0x2D00'
Sub-Index: '3'
Datatype: SINT à If a Datatype is selected, the Bit Length will be adapted automatically by the program EC-Engineer.

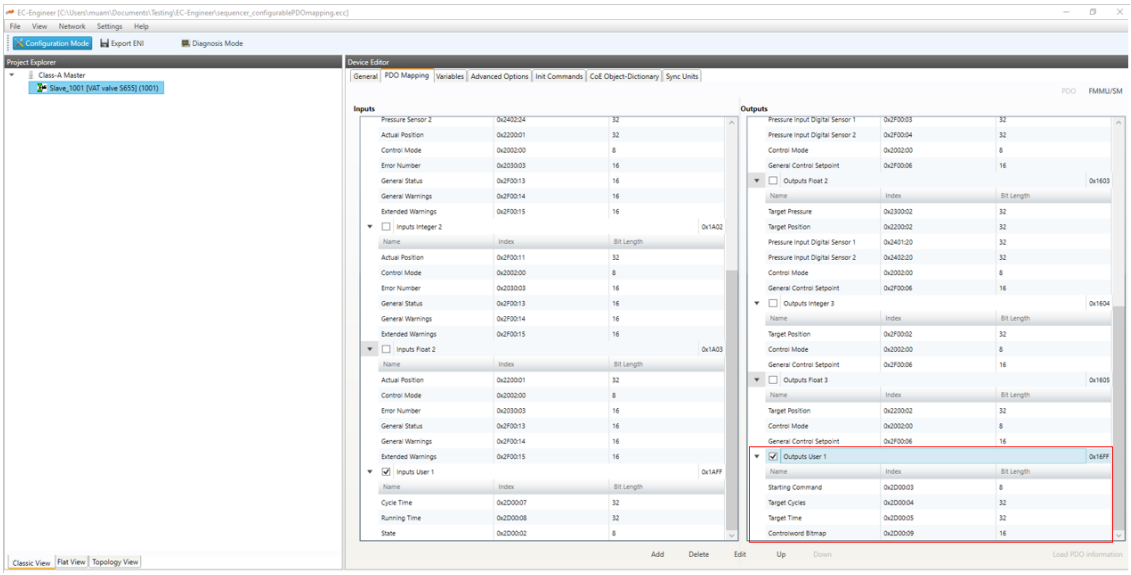
After all settings are Edit – the user can press OK.





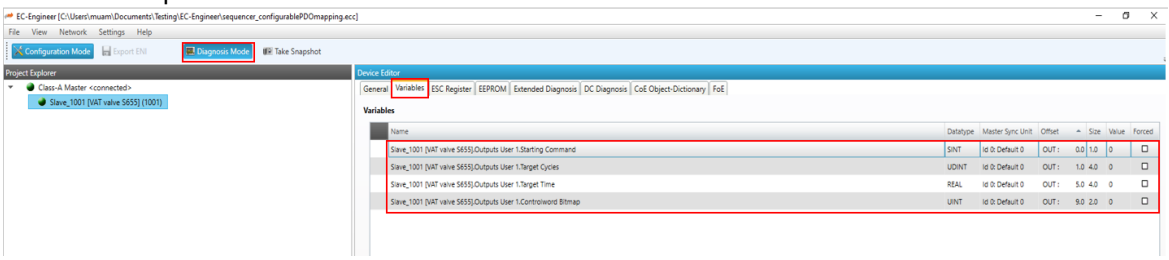
After pressing OK, the user should see the new Added Object. (Red Arrow)

- Press again "Add" and edit the other 3 PDO output objects (Target Cycles, Target Time, Controlword Bitmap) to the PDO output buffer 0x16FF.

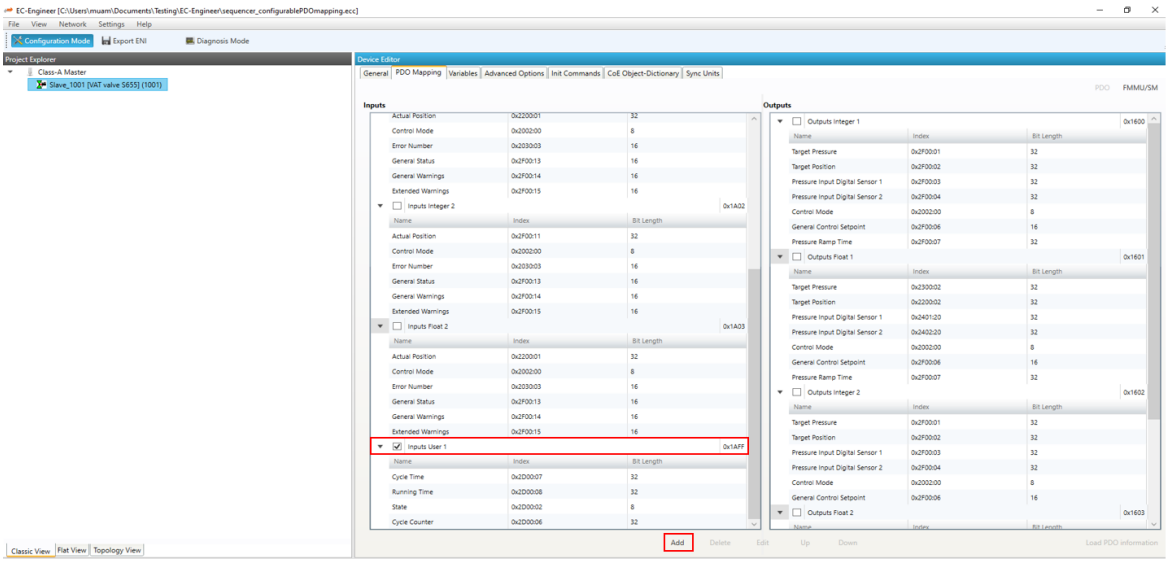


Change in Diagnose Mode and change state to OP

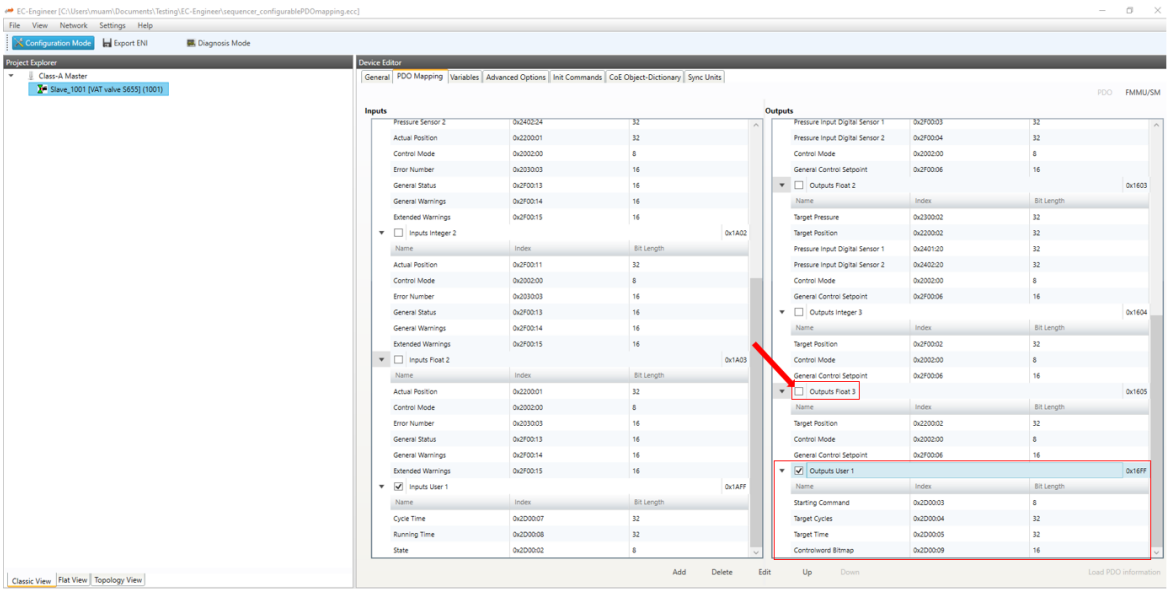
- Now this parameters are visible under Variables



- The PDO Input buffer(0x1AFF) can be Added in the same way.



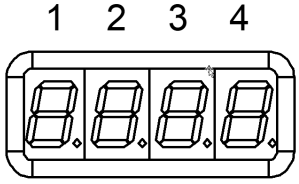
- It is possible to select also Standard PDOmappings to ‘Variables’ and use them. In the picture bellow e.g. Target Position, Control Mode and General Control Setpoint.



- At the End - Save master project to load this configuration on another device.

2.9 Display information

There is a 4 digit display located on the controller. It displays configuration, status and position information.
For details refer to following tables.



2.9.1 Power up

Description	Digit 1	Digit 2	Digit 3	Digit 4
? 1st Power On: All dots are illuminated	**#**	**#**	**#**	**#**
? 2nd Valve series e.g. **67.0**		**6**	**7**	**0**
? 3rd Firmware: generation.type e.g. **01.0C**	**0**	**1**	**0**	**C**
? 4th Firmware: version.firmware e.g. **07.00**	**0**	**7**	**0**	**0**
? 5th Controller configuration: e.g. **11.00**	**Controller** **1**=H1 **2**=H2 **3**=H3 **4**=H4 **5**=H5 **6**=H6 **7**=H7	**Interface** **1**=RS232/RS485 **2**=EtherCAT **3**=DeviceNet **5**=Logic	**Options** **00**=none **01**=SPS **02**=PFO **03**=Cluster **04**=SPS & PFO **05**=SPS & Cluster **06**=PFO & Cluster **07**=SPS & PFO & Cluster	
'Ho' homing is running	**H**	**o**		

2.9.2 Operation

Description / Mode	Digit 1	Digit 2	Digit 3	Digit 4
Init (start up)	**I**	**n.**		
Init (start up, leak tight)	**I**	**n.**		**C**
Close	**C.**	**C, 0…100** valve position		
Open	**O.**			
Pressure control	**P.**			
Position control	**A.**	C = closed, leak tight 0 = minimal conductance		

Interlock Valve closed or open by digital input	**I.**		
Hold (position frozen)	**H.**		
Learn	**L.**		
Safety Refer to «Safety mode» for details.	**S.**		
Power failure	**F.**		

2.9.3 Error

Description	Digit 1	Digit 2	Digit 3	Digit 4
Error number (xyz)	**E.**	**x**	**y**	**z**
alternately (if error code exist)				
Error code		**u**	**v**	**w**

 For Error number / code. Refer to «Trouble shooting» for details

2.10 Trouble shooting

2.10.1 General

Failure	Check	Action
Display does not light up	- 24 V power supply	- Connect valve to power supply according to 'Power, ground and sensor connection' and make sure that power supply is working.
Remote operation does not work	- Local operation via service port active	- Switch to remote or locked operation Refer to 'Remote and local operation'
	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' >> 'Digital Input'
POSITION CONTROL does not work	- Safety mode active Check for S on display	- Check 'Drive Power Enable Switch' Refer to 'Power, ground and sensor connection'
	- Interlock mode active Check for I on display	- Check Digital Input Refer to 'Power connector IO' >> 'Digital Input'
	- POSITION CONTROL selected, check for A on display?	- Select POSITION CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
Pressure reading is wrong	- Sensor connection	- Refer to 'Power, ground and sensor connection'

Failure	Check	Action
	- ZERO done?	- Perform ZERO when base pressure is reached. Refer to 'Pressure Sensor' >> 'Zero Adjust'
	- Does sensor power supply provide enough power for sensor(s)?	- Verify sensor supply voltage.
ZERO does not work	- ZERO disabled?	- Enable ZERO. Refer to 'Pressure Sensor' >> 'Zero Adjust'
	- Sensor voltage shifting?	- Wait until sensor does not shift any more before Performing ZERO.
Pressure is not '0' after ZERO	- System pumped to base pressure?	- OPEN VALVE and bring chamber to base pressure before performing ZERO.
	- Sensor offset voltage exceeds ±1.4V	- Adjust the offset direct at the sensor - Check function of the sensor.
PRESSURE CONTROL does not work	- PRESSURE CONTROL selected, check for P on display?	- Select PRESSURE CONTROL mode. Refer to 'Control Mode' in 'EtherCAT' interface
	- LEARN done?	- Perform LEARN. Refer to 'Pressure control' >> 'Adaptive algorithm' >> 'Learn'
	- Sensor signal ok?	- Refer to 'Pressure Sensor'
	- Pressure control setup done	- Refer to 'Pressure control'
PRESSURE CONTROL not optimal	- LEARN successfully done?	- Perform LEARN. Check 'Status' and 'Warning Info' in 'Pressure control' >> 'Adaptive algorithm' >> 'Learn'
	- ZERO performed before LEARN?	- Perform ZERO then repeat LEARN. Refer to 'Pressure Sensor' >> 'Zero Adjust'
	- Was gas flow stable during LEARN?	- Repeat LEARN with stable gas flow. Refer to 'Pressure control' >> 'Adaptive algorithm' >> 'Learn'
	- Tuning done?	- Tune valve for application. Refer to the tuning sections in 'Pressure Control'
	- Is sensor range suited for application?	- Use a sensor with suitable range (controlled pressure should be >3% and < 98% of sensor full scale).
	- Noise on sensor signal?	- Make sure a shielded sensor cable is used.

2.10.2 Errors

2.10.2.1 Error numbers

Error numbers are three-digit decimal numbers (**xyz**) whereas:

x = component	**y** = mode	**z** = error type
1 = All Motor Units **2** = Motor Unit 1 **3** = Motor Unit 2 **4** = Motor Unit 3 **8** = Other	**0** = Homing **2** = Operation Mode **8** = Other	**0** = Position Error 1) **1** = Not running: No communication with component **x** **2** = Error State: component **x** is running but in Status Error **8** = Other

1) Only in combination with component 1, 2, 3

2.10.2.2 Error code

Procedure in case of an error

- For deeper analysis of the error case are following data necessary:
  Diagnostic file (before Restart command) -> see Diagnostic File.
  Load Error Data -> see Load Error Data.
- Check the corresponding error code and execute the necessary steps
- To leave the *Error* ***Control Mode***, the ***Error Recovery*** function can be used or ***Restart Controller*** see Services.

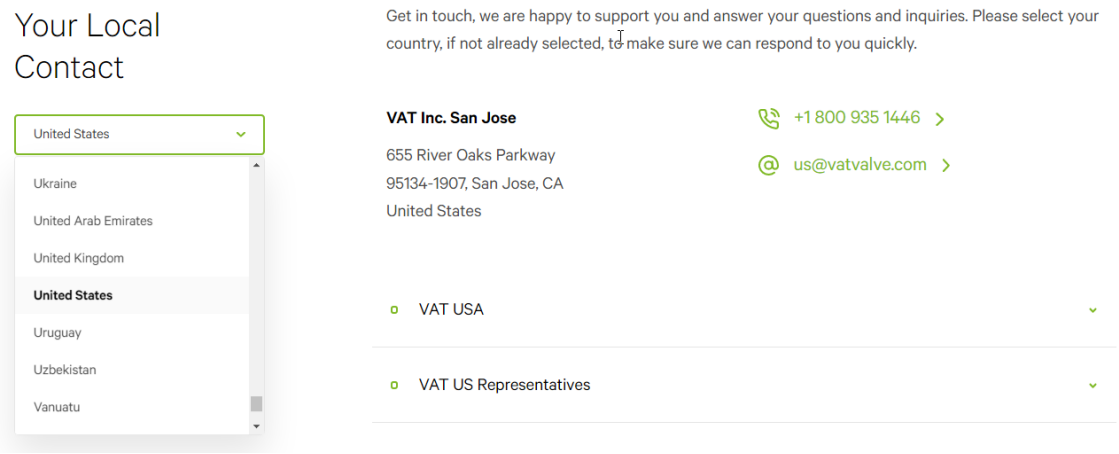
Code *u v w*	**Description**	**Solution**
1	No valve connected	Connect valve controller to the valve
2	Non volatile memory failure	Replace valve controller
3	Analog digital converter of sensor input failure	Replace valve controller
4	Initialization of motion controller failed	• Wrong motion controller firmware version → Update motion controller firmware
5	Encoder index pulse not found	• Encoder failure • O-Ring sticking • 1)
6	Initialization of interface module failed	• Fieldbus: Valve firmware does not support interface type → Update valve firmware • Wrong interface firmware version → Update interface firmware
7	Initialization of external drive eeprom failed	• Check cables
1 0	Closing position can't be reached	• 1)
1 1	Homing position can't be reached	• 1)

Code *u v w*	Description	Solution
		• Plate not mounted
1 2	Motion controller: Internal voltage error	• Check power supply
1 3	Motion controller: Internal error temperature	• Check for a heat accumulation
1 4	Motion controller: Unexpected behavior	Contact vat support • Axis inverted • Encoder not connected • Break not released
1 5	Motion controller: Target position can't be reached	• 1) • Current settings
1 6	Motion controller: Position minimal conductance cannot be reached	• 1) • Check Plate and Seal ring • Check Parameter "Isolation Position Enter [r]"
1 7	Motion controller: Position to push back the Differential Plate cannot be reached	• 1) • Check Different Plate • Check Parameter "Differential Plate Push Back Position [r]"
1 8	Motion controller: Minimal isolation position cannot be reached	• 1) • Check Plate and Seal ring • Check Parameter "Isolation Position [r]"
2 0	Break slippery detected	Replace actuator
3 0	SFV: Motion controller failure in master-slave communication	Contact vat support
4 0	Compressed air error	Check compressed air
4 2	Power supply, low voltage detected	Check if power supply is ok and is able to deliver needed power
9 6	SFV: Position deviation axis1 to axis2 at homing procedure	• O-Ring sticking • 1)
9 7	SFV: Position deviation axis1 to axis2 at operating	1)
9 8	Position error during closing procedure	1)
9 9	Position error at operating	1)
2 0 0	Valve configuration error, not possible to operate the valve with these configuration	Contact VAT support
7 0 1	Wrong ident code axis 1	Check wiring
7 0 2	Wrong ident code axis 2	
7 0 3	Wrong ident code axis 2 AND axis 1	
7 0 4	Wrong ident code axis 3	
7 0 5	Wrong ident code axis 3 AND axis 1	
7 0 6	Wrong ident code axis 3 AND axis 2	
7 0 7	Wrong ident code axis 3 AND axis 2 AND axis 1	
7 7 7	Do not operating mode active	

1) Mechanical movement problem:
- Check for differential pressure
- Remove foreign object in movement area

- Eliminate tight movement
- Repair mechanical failure

If you need any further information, Please provide this information to your local contact Contact.



2.11 Appendix

2.11.1 Conversion Tables

2.11.1.1 Pressure

	Pa ($N\,m^{-2}$)	bar	mbar	µbar ($dyn\,cm^{-2}$)	Torr (mm Hg)	micron (µ, mTorr)	atm	psi ($lbf\,inch^{-2}$)	psf ($lbf\,ft^{-2}$)
Pa ($N\,m^{-2}$)	1	$1\cdot10^{-5}$	$1\cdot10^{-2}$	10	$7.5\cdot10^{-3}$	7.5	$9.87\cdot10^{-6}$	$1.45\cdot10^{-4}$	$2.09\cdot10^{-2}$
bar	$1\cdot10^{5}$	1	1000	$1\cdot10^{6}$	750	$7.5\cdot10^{5}$	0.987	14.5	$2.09\cdot10^{3}$
mbar	100	$1\cdot10^{-3}$	1	1000	0.75	750	$9.87\cdot10^{-4}$	$1.45\cdot10^{-2}$	2.09
µbar ($dyn\,cm^{-2}$)	0.1	$1\cdot10^{-6}$	$1\cdot10^{-3}$	1	$7.5\cdot10^{-4}$	0.75	$9.87\cdot10^{-7}$	$1.45\cdot10^{-5}$	$2.09\cdot10^{-3}$
Torr (mm Hg)	133	$1.33\cdot10^{-3}$	1.33	1330	1	1000	$1.32\cdot10^{-3}$	$1.93\cdot10^{-2}$	2.78
micron (µ,mTorr)	0.133	$1.33\cdot10^{-6}$	$1.33\cdot10^{-3}$	1.33	$1\cdot10^{-3}$	1	$1.32\cdot10^{-6}$	$1.93\cdot10^{-5}$	$2.78\cdot10^{-3}$
atm	$1.01\cdot10^{5}$	1.013	1013	$1.01\cdot10^{6}$	760	$7.6\cdot10^{5}$	1	14.7	$2.12\cdot10^{3}$
psi ($lbf\,inch^{-2}$)	$6.89\cdot10^{3}$	$6.89\cdot10^{-2}$	68.9	$6.89\cdot10^{4}$	51.71	$5.17\cdot10^{4}$	$6.8\cdot10^{-2}$	1	144
psf ($lbf\,ft^{-2}$)	47.8	$4.78\cdot10^{-4}$	0.478	478	0.359	359	$4.72\cdot10^{-4}$	$6.94\cdot10^{-3}$	1

2.11.1.2 Gas flow and leak rate

	Pa m^3 s	mbar ls	Torr ls	atm cm^3 s	lusec	sccm	slm	Mol s^{-1}
Pa m^3 s^{-1}	1	10	7.5	9.87	$7.5 \cdot 10^3$	592	0.592	$4.41 \cdot 10^{-4}$
mbar ls^{-1}	0.1	1	0.75	0.987	750	59.2	$5.92 \cdot 10^{-2}$	$4.41 \cdot 10^{-5}$
Torr ls^{-1}	0.133	1.33	1	1.32	1000	78.9	$7.89 \cdot 10^{-2}$	$5.85 \cdot 10^{-5}$
atm cm^3 s^{-1}	0.101	1.01	0.76	1	760	60	$6 \cdot 10^{-2}$	$4.45 \cdot 10^{-5}$
lusec	$1.33 \cdot 10^{-4}$	$1.33 \cdot 10^{-3}$	10^{-3}	$1.32 \cdot 10^{-3}$	1	$7.89 \cdot 10^{-2}$	$7.89 \cdot 10^{-5}$	$5.86 \cdot 10^{-8}$
sccm	$1.69 \cdot 10^{-3}$	$1.69 \cdot 10^{-2}$	$1.27 \cdot 10^{-2}$	$1.67 \cdot 10^{-2}$	12.7	1	10^{-3}	$7.45 \cdot 10^{-7}$
slm	1.69	16.9	12.7	16.7	$1.27 \cdot 10^4$	1000	1	$7.45 \cdot 10^{-4}$
Mol s^{-1}	$2.27 \cdot 10^3$	$2.27 \cdot 10^4$	$1.7 \cdot 10^4$	$2.24 \cdot 10^4$	$1.7 \cdot 10^7$	$1.34 \cdot 10^6$	$1.34 \cdot 10^3$	1

2.11.1.3 Temperature

	K	°C	°F
K	1	K -273.15	9/5 x K -459.67
°C	°C +273.15	1	9/5 x °C +32
°F	5/9 x (°F +459.67)	5/9 x (°F -32)	1

2.11.1.4 Torque

	Nm	ft lbs	kp m	kgf cm
Nm	1	0.738	0.102	10.2
ft lbs	1.36	1	0.138	13.8
kp m	9.81	7.23	1	100
kgf cm	0.098	0.072	0.01	1