

Application Guide

PVED-CLS

Start-up guide



Revision history

Table of revisions

| Date | Changed | Rev |
|---------------|-------------------------------|------|
| November 2019 | Corrected wording for clarity | 0102 |
| October 2018 | First edition | 0101 |

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Introduction

PVED-CLS overview

This application guide will detail setting parameters for configuring the PVED-CLS as well as troubleshooting when the PVED-CLS goes into safe-state mode. There are other literature references in this document and it is recommended to have them read before configuration.

Literature references

- PVED-CLS user manual (included in firmware release package /technical manuals folder)
- Communication protocol (included in firmware release package /technical manuals folder)
- PLUS+1® Service Tool user guide (found in firmware release package /Service tool folder)
- PVED-CLS safety manual (must be requested from local eSteering Product Application Engineer or sales representative)

Additional resources

- PLUS+1® Service Tool

Introduction

Downloading the required software

1. Download the desired or latest firmware release package on the [PVED-CLS web page](#)
2. Optional: Request and download the [PLUS+1® Service Tool](#) under **Service Tool: Request** heading.

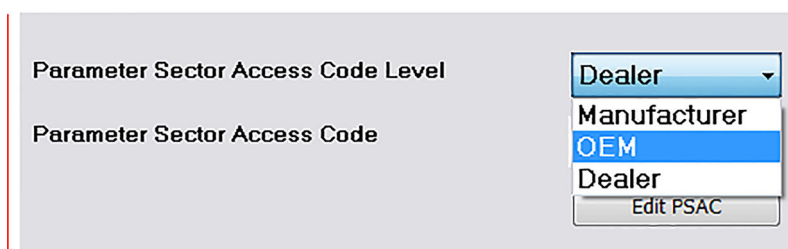
Introduction

PVED-CLS initial steps

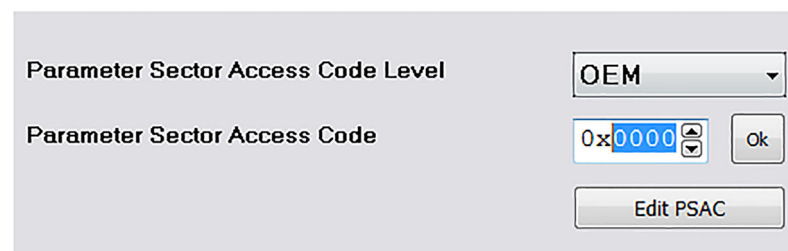
1. Open the Service Tool
2. Optional: If changing the firmware to a different revision, flash the Main and Safety Controller (**Release Package > Software**)
See Section 6.2 (pages 23-27) of the PLUS+1® Service Tool user guide. When changing to a newer firmware revision, please look at the Firmware Release Note found in the Firmware Release Package of the selected revision for additional steps.

[Reverting to an early revision of firmware may not be possible with the Service Tool depending on the specific revisions. Please contact the Danfoss technical representative if you have concerns about changing firmware.](#)

3. Install Diagnostic Data Files of selected Firmware Revision (**Release Package > Diagnostic data files**).
See Section 6.1 (pages 21-22) of the PLUS+1® Service Tool user guide found in the Firmware Release package under /Service tool folder.
4. Open .PID file in the Service Tool (**Release Package > Service Tool**)
5. Select **OEM** on the info page



6. Click **Edit PSAC** and enter correct hexadecimal number



7. Click **OK**

Parameter setting

PVED-CLS hydraulic configuration P3072-P3097

Navigate to the hydraulic configuration section via **System Navigator > Configuration > Hydraulic Config**

Example parameter settings

Hydraulic Config

| Upload parameters | New values |
|--|------------------------|
| Download parameters | <div>MAIN SAFETY</div> |
| P3072: Cut-off valve present | Present |
| P3073: Cut-off valve control mode | Closed loop |
| P3074: Cut-off valve CL pull current | 1100 |
| P3076: Cut-off valve CL hold current | 500 |
| P3078: Cut-off valve monitoring POST timeout | 900 |
| P3097: Cut-off valve PWM pre-load value | 100 |
| P3080: Invert flow direction | NO |
| P3081: Valve type | OSPE/EHI-E |
| P3082: Turns lock-to-lock EHPS | 450 |
| P3084: OSP displacement | 120 |
| P3086: Cylinder stroke volume | 500 |
| P3088: Valve capacity | 20 |
| P3089: LVDT offset compensation Enable/Disable | Enable |
| P3090: Absolute Spool neutral threshold range | 25 |

If the parameter change is not described below or conditions are not met, use the default values.

Parameter settings

| Parameter | Conditions for value changes |
|-----------|--|
| P3072 | Not present if there is no cut-off valve (usually with EHPS) |
| P3078 | Set to 0 if PVED-CLS is part of desk setup |
| P3097 | Set to 50 if using 12V coil on a 24V system |
| P3080 | Set to "YES" if using EHPS |
| P3081 | Set to match the valve type used |
| P3082 | If using EHPS, enter desired turns lock-to-lock x100 that matches the hydraulic system |
| P3084 | Set to match OSP displacement in cubic centimeters |
| P3086 | Set to match volume needed to turn lock-to-lock. If using unbalanced cylinder, set to average of left and right. |

The default parameters are based on 12V coil. Depending on the voltage, the following parameters may need to be changed:

| Parameter | 12V coil | 24V coil |
|-----------|----------|----------|
| P3074 | 1100mA | 550mA |
| P3076 | 500mA | 250mA |

The pre-load parameter P3097 is a PWM signal and it must be set to scale the input voltage down to the rated current of the spool:

Parameter setting

P3097 input voltage scaling

| Input voltage | 12V coil | 24V coil |
|---------------|----------|----------|
| 12V | 100% | N/A |
| 24V | 50% | 100% |
| 36V | 33% | 67% |

PVED-CLS parameter acceptance

Use the following steps to save and approve the parameters that have been set.

1. Press **Download** and wait for the script to complete.
2. Click **Close**.

It is mandatory to confirm that the parameters have been downloaded by the user.

3. Press **Approve Parameters**.

The text will change to **Approved** and the page can then be closed.

Leaving the page before parameters are accepted will cause an EEPROM fault and the PVED-CLS will go to safe-state mode.

Parameter setting

PVED-CLS peripherals configuration P3237-P3254

Navigate to the peripherals configuration section via **System Navigator > Configuration > Peripherals Config**

Example parameter settings

Peripherals Config

Upload parameters
Download parameters

New values

MAIN
SAFETY

GPS config

P3237: GPS present
Present

P3238: GPS2 present
Present

WAS config

P3245: Redundant WAS present
Present

P3244: WAS interface
Analogue

P3248: Generation of 5V sensor supply voltage (Deutsch connector pin 11)
Enable

P3249: AD low pass filter cut-off frequency
100

P3246: Voltage compensation for Primary analogue sensor
Enable

P3247: Voltage compensation for Redundant analogue sensor
Enable

Vehicle speed sensor lockout config

P3250: Max vehicle speed for engaging auto-guidance or AUX steering device
15

P3251: Max vehicle speed for steering program changes
15

P3252: Lower vehicle speed auto-guidance suspend threshold
50

P3253: Safe state vehicle speed threshold
25

Safe on-road monitoring

P3243: Max COV connection test current
100

P3241: Road switch present (connected to AD3)
Present

P3242: Road switch resistance check
Disable

AUX config

P3239: AUX present
Not Present

P3240: AUX type
mini steering wheel

P3254: EH-Steering disengage method
SASA

If the parameter change is not described below or conditions are not met, use the default values.

| Parameter | Conditions for value changes |
|-----------|--|
| P3237 | Set to match presence of GPS/auto-guidance controllers in system |
| P3238 | Set to match presence of GPS/auto-guidance controllers in system |

Parameter setting

| Parameter | Conditions for value changes |
|-----------|--|
| P3245 | Set to match presence of redundant WAS signal |
| P3244 | Set to match type of WAS signal: Analog, CAN, or None |
| P3246 | Enable only if using uncompensated Analog WAS |
| P3247 | Enable only if using uncompensated Analog WAS |
| P3250 | Vehicle speed must be below this threshold to allow auto-guidance or AUX device to be enabled (speed measured in km/h) |
| P3251 | Vehicle speed must be below this threshold to allow for switching steering wheel programs (speed measured in km/h) |
| P3252 | Vehicle speed must be above this threshold to use auto-guidance |
| P3253 | PVED-CLS will go into safe-state mode if vehicle speed is above this threshold |
| P3241 | Set to match presence of Safe On-Road Switch and electric architecture |
| P3239 | Set to match presence of AUX device |
| P3240 | Set to match type of AUX device |
| P3254 | Set to IMD if using EHi-H |

Approve the parameters by following the steps in [PVED-CLS parameter acceptance](#) on page 8.

Parameter setting

PVED-CLS vehicle geometry configuration P3421-P3428

Navigate to the vehicle geometry configuration section via **System Navigator > Configuration > Vehicle Geometry**

Example parameter settings

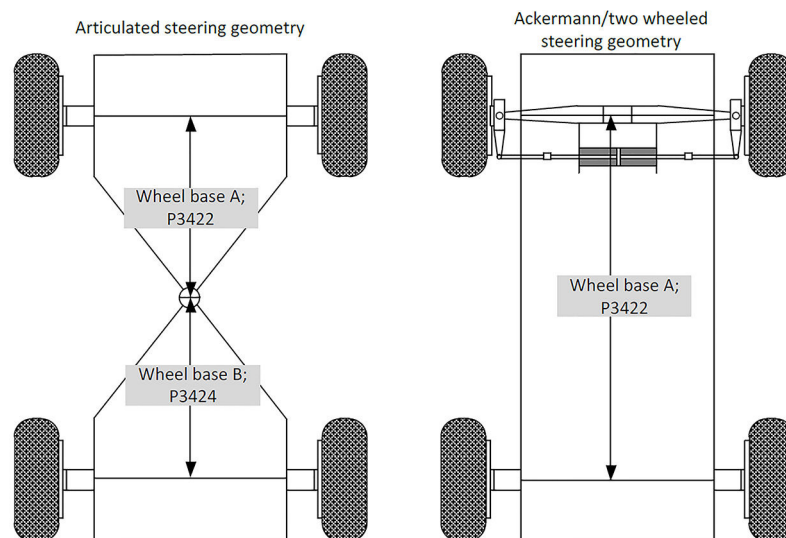
Vehicle Geometry

| | |
|-----------------------------------|------------------|
| Upload parameters | New values |
| Download parameters | MAIN SAFETY |
| P3421: Vehicle steering type | 2 Wheel Steering |
| P3422: Wheel base A | 4000 |
| P3424: Wheel base B | 4000 |
| P3426: Maximum steer angle, left | 35 |
| P3428: Maximum steer angle, right | 35 |

If the parameter change is not described below or conditions are not met, use the default values.

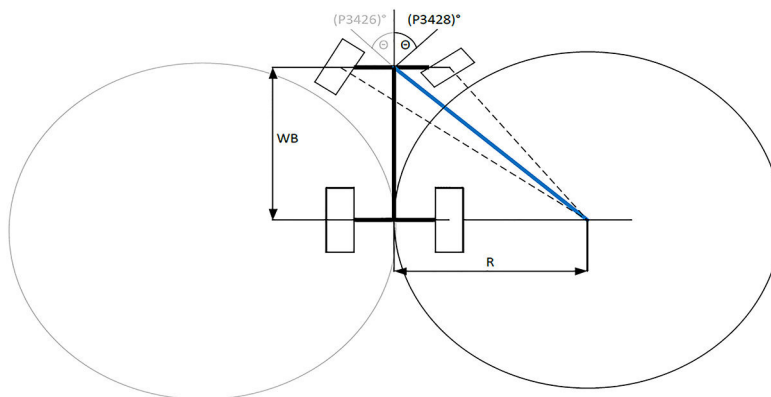
| Parameter | Conditions for value changes |
|-----------|--|
| P3421 | Set to match type of steering |
| P3422 | Change according to wheel base figure shown below (dimensions measured in mm) |
| P3424 | Change according to wheel base figure shown below (dimensions measured in mm) |
| P3426 | Change according to steer angle figure and formula shown below (measured in degrees) |
| P3428 | Change according to steer angle figure and formula shown below (measured in degrees) |

Wheel base



Parameter setting

Steer angle



Formula

$$\varnothing = \tan^{-1}(WB/R)$$

Approve the parameters by following the steps in [PVED-CLS parameter acceptance](#) on page 8.

Parameter setting

PVED-CLS SEHS protocol data P3292-P3331

Navigate to the SEHS protocol data section via **System Navigator > Configuration > SEHS Protocol Data**

Example parameter settings

SEHS Protocol Data

| | New values | |
|---|------------|--------|
| | MAIN | SAFETY |
| Upload parameters | | |
| Download parameters | | |
| P3310: PVED-CLS address claim - Function instance | 0 | |
| — CAN message monitoring — | | |
| P3287: SASA message monitoring - Max time difference between two messages | 8 | |
| P3288: Vehicle speed sensor message monitoring - Max time difference between two messages | 15 | |
| P3289: Auto-guidance message monitoring - Max time difference between two messages | 22 | |
| P3290: Wheel angle sensor message monitoring - Max time difference between two messages | 8 | |
| P3291: AUX message monitoring - Max time difference between two messages | 8 | |
| — Source Addresses — | | |
| P3297: PVED-CLS source address | 19 | 90 |
| P3292: GPS source address | 28 | 28 |
| P3293: GPS2 source address | 29 | 29 |
| P3294: Vehicle speed sensor source address | 251 | 251 |
| P3295: MMI source address | 252 | 252 |
| P3296: SASA sensor source address | 77 | 77 |
| P3298: Wheel angle sensor source address | 250 | 250 |
| P3299: AUX device (mini steering wheel) source address | 79 | 79 |
| P3300: AUX device (joystick) source address | 78 | 78 |
| — Transmission rates — | | |
| P3308: Transmission rate - Steering feedback message | 5 | 5 |
| P3309: Transmission rate - Guidance machine status message | 10 | 10 |
| P3301: Transmission rate - Operation Status Messages | 10 | 10 |
| P3302: Transmission rate - Status message 1 | 0 | 0 |
| P3303: Transmission rate - Status message 2 | 0 | 0 |
| P3304: Transmission rate - Status message 3 | 0 | 0 |
| P3305: Transmission rate - Status message 4 | 0 | 0 |
| P3306: Transmission rate - Status message 5 | 0 | 0 |
| P3307: Transmission rate - Status message 6 | 0 | 0 |
| P3327: Transmission rate - Status message 7 | 0 | 0 |
| P3331: Transmission rate - Status message 8 | 0 | 0 |

If the parameter change is not described below or conditions are not met, use the default values.

Parameter setting

| Parameter | Condition for value change |
|-------------|---|
| P3292-P3300 | Leave at default value unless source addresses conflict with other nodes on the CAN bus or another addressing scheme is desired |
| P3301 | Data is sent at the rate of "value" x 10ms |
| P3308-P3309 | Set to 0 if not using messages, otherwise data is sent at the rate of "value" x 10ms |
| P3302-P3307 | Set to over 0 if using messages to send data at the rate of "value" x 10ms, otherwise messages are disabled |
| P3327 | Set to over 0 if using messages to send data at the rate of "value" x 10ms, otherwise messages are disabled |
| P3331 | Set to over 0 if using messages to send data at the rate of "value" x 10ms, otherwise messages are disabled |

Parameter setting

PVED-CLS SEHS protocol data P3311-P3333

Example parameter settings

— PGN and PGN Offsets —

| | | |
|---|--|------------------------------------|
| P3311: PGN offset to operation status messages | <input type="text" value="32"/> | <input type="text" value="32"/> |
| P3312: PGN offset to status message 1 | <input type="text" value="33"/> | <input type="text" value="33"/> |
| P3313: PGN offset to status message 2 | <input type="text" value="34"/> | <input type="text" value="34"/> |
| P3314: PGN offset to status message 3 | <input type="text" value="35"/> | <input type="text" value="35"/> |
| P3315: PGN offset to status message 4 | <input type="text" value="36"/> | <input type="text" value="36"/> |
| P3316: PGN offset to status message 5 | <input type="text" value="37"/> | <input type="text" value="37"/> |
| P3317: PGN offset to status message 6 | <input type="text" value="38"/> | <input type="text" value="38"/> |
| P3328: PGN offset to status message 7 | <input type="text" value="39"/> | <input type="text" value="39"/> |
| P3332: PGN offset to status message 8 | <input type="text" value="40"/> | <input type="text" value="40"/> |
| P3329: PGN for AUX Elobau joystick | <input type="text" value="64982"/> | <input type="text" value="64982"/> |
| P3318: PGN offset to vehicle speed sensor message | <input type="text" value="64"/> | <input type="text" value="65"/> |
| P3319: PGN offset to steering wheel sensor messages | <input type="text" value="16"/> | <input type="text" value="17"/> |
| P3320: PGN offset to wheel angle sensor messages | <input type="text" value="18"/> | <input type="text" value="19"/> |
| P3321: PGN offset to AUX mini-steering wheel messages | <input type="text" value="20"/> | <input type="text" value="21"/> |
| P3322: PGN offset to AUX joystick messages | <input type="text" value="22"/> | <input type="text" value="23"/> |
| P3323: PGN offset to steering feedback message | <input type="text" value="24"/> | <input type="text" value="24"/> |
| P3324: PGN type for MMI message | <input type="text" value="Prop A"/> | |
| P3325: PGN offset to MMI message | | |
| P3326: GMS message layout as per ISO11783 | <input type="text" value="Layout according to ISO11783-7:2009"/> | |
| P3333: CAN message priority of operational status message | <input type="text" value="CAN message priority 6"/> | |

If the parameter change is not described below or conditions are not met, use the default values.

| Parameter | Condition for value change |
|-------------|--|
| P3311-P3317 | Leave at default unless PGN's conflict with others on the CAN bus or another addressing scheme is desired |
| P3328 | Leave at default unless PGN's conflict with others on the CAN bus or another addressing scheme is desired |
| P3332 | Leave at default unless PGN's conflict with others on the CAN bus or another addressing scheme is desired |
| P3329 | Leave at default unless PGN's conflict with others on the CAN bus or another addressing scheme is desired |
| P3318-P3323 | Leave at default unless PGN's conflict with others on the CAN bus or another addressing scheme is desired |
| P3324 | Leave at default unless "Proprietary B" message formatting of MMI is desired. If "Proprietary B" is chosen, PGN offsets can be edited via P3325. |

Approve the parameters by following the steps in [PVED-CLS parameter acceptance](#) on page 8.

Parameter setting

PVED-CLS Boot EE data

Navigate to the boot EE data section via **System Navigator > Configuration > Boot EE Data**

Boot Node ID's set the Source Addresses of the Main and Safety micro-controllers which are used for Bootloader mode. These addresses are seen in the ECU list in the PLUS+1® Service Tool. By default, these are different than the Main and Safety Source Addresses that are set in the SEHS Protocol Data page.

If the default addresses conflict with other addresses on the bus or a different messaging scheme is desired, modify parameters as described.

Boot EE Data

Upload parameters

Download parameters

P0003: BOOT Node ID

P0013: KWP DLC Validation

Note -> 0: Optimized DLC 255: Frame Padding

New values

MAIN

SAFETY

32

33

0

| Parameter | Condition for value change |
|---------------------------|--|
| P0003 (main controller) | Set to desired Bootloader Source Address for Main Controller |
| P0003 (safety controller) | Set to desired Bootloader Source Address for Safety Controller |

Accept Boot Node ID parameters

1. Download the changed parameters by pressing **Download parameters**
2. After changing the Boot Node ID's, cycle power on the PVED-CLS for new ID's to take affect
The new ID's will show up in the ECU list; however, the Service Tool pages are still linked to the old addresses and will produce an error.
3. Start to fix the address error by clicking the **Replace Missing ECU** icon shown below:



4. Follow the prompts and replace the default Main (32) and Safety (33) Source Addresses with the new addresses and press **OK** to complete.

Parameter setting

PVED-CLS WAS calibration

Navigate to the WAS calibration section via **System Navigator > Auto-Calibration > WAS Calibration**

WAS Calibration

The main WAS Calibration screen features two buttons on the left: 'Goto WAS Calibration Mode' and 'Reset Calibration'. On the right, there are three status sections: 'Operation status' with 'MAIN' and 'SAFETY' both set to 'On-road'; 'Service mode state' showing 'Information not available'; and 'WAS interface' set to 'CAN'.

1. Select **Go to WAS calibration mode**
2. Steer left, straight (neutral) and right (in any order) using the steering wheel and press the appropriate button when wheels are at the desired angle.
3. Press **Accept and save**

The capture screen is divided into three columns for 'Capture L', 'Capture N', and 'Capture R'. Each column has a steering wheel diagram and a 'Capture' button. Below each diagram are input fields for 'MAIN' and 'SAFETY' channels, including 'Primary WAS (CAN WAS)', 'Redundant WAS (CAN WAS)', and '5V Sensor supply'. At the bottom, there are three rows of hex input fields for parameters P3841, P3843, and P3845, each with a unit of [mV]. An 'Accept and Save' button is located at the bottom right.

Values will automatically change in either the Analog Sensor Calibration Data or CAN WAS Calibration Data page, based on which type of WAS was selected in the Peripherals configuration.

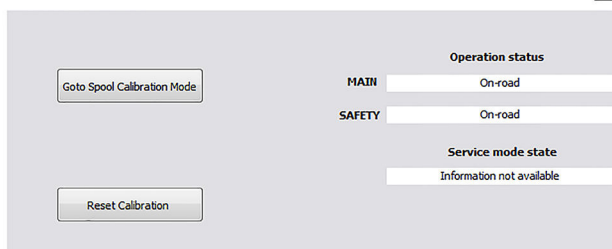
Parameter setting

PVED-CLS Spool calibration

Navigate to the Spool calibration section via **System Navigator > Auto-Calibration > Spool Calibration**

Calibrate closed loop spool dead-band with the following steps.

Spool Calibration

Operation status

MAIN On-road

SAFETY On-road

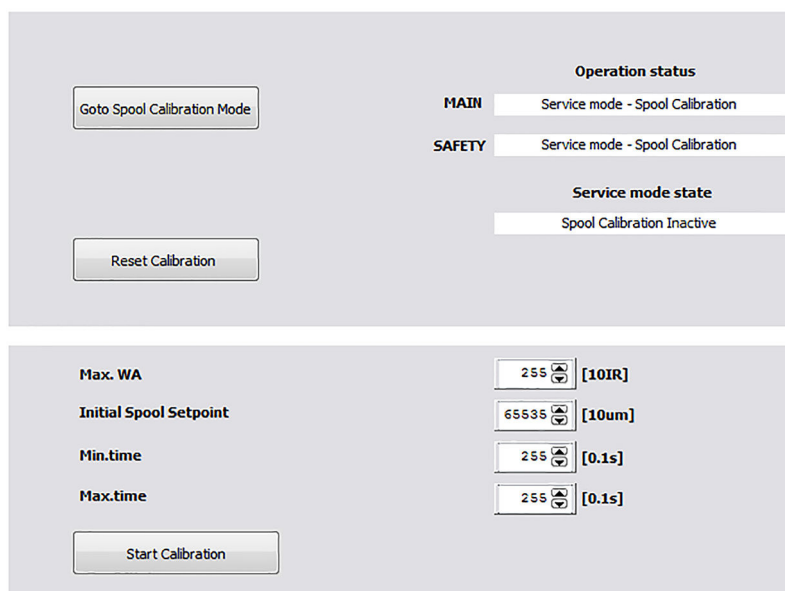
Service mode state

Information not available

Goto Spool Calibration Mode

Reset Calibration

1. Select **Go to calibration mode**
2. Turn the steering wheel so that **Service Mode State** changes to **Spool Calibration Getting Armed**.
3. Stop turning the steering wheel and secure the wheels in a central position so that it changes to **Spool Calibration Armed**.
4. Turn the wheels so that they are positioned straight ahead and within the range specified in parameter P3804. Then press **Start Calibration**.



Operation status

MAIN Service mode - Spool Calibration

SAFETY Service mode - Spool Calibration

Service mode state

Spool Calibration Inactive

Goto Spool Calibration Mode

Reset Calibration

Max. WA 255 [10IR]

Initial Spool Setpoint 65535 [10um]

Min.time 255 [0.1s]

Max.time 255 [0.1s]

Start Calibration

Wheels will turn back and forth (or machine will articulate).

Parameter setting

5. Watch the Left move and Right move progress info. When both have completed, press the **Accept and Save** button.

| | | |
|--|-------|--------|
| Max. WA | 255 | [10IR] |
| Initial Spool Setpoint | 65535 | [10um] |
| Min.time | 255 | [0.1s] |
| Max.time | 255 | [0.1s] |
| <input type="button" value="Start Calibration"/> | | |

| | | |
|--|------|--------|
| Result | | |
| Actual Spool setpoint | -125 | [10um] |
| Actual Spool Position | 0 | [10um] |
| Wheel Angle | -16 | [IR] |
| <input type="button" value="Accept and Save"/> | | |

| | | |
|-----------------------------------|---------------------------|--------|
| Status | | |
| Wheel movement status | | |
| Left move | In progress | |
| Right move | Information not available | |
| Calibration progress | 0 | [%] |
| Spool setpoint during last move | -125 | [10um] |
| Time needed to complete last move | No time recorded yet | [0.1s] |

Values will automatically change in Valve Calibration Data page. If values need to be changed manually, go to Valve Calibration Data page.

Parameter setting

PVED-CLS valve calibration data

Navigate to the valve calibration section via **System Navigator > Configuration > Valve Calibration Data**

Example parameter settings

Valve Calibration Data

Upload parameters
Download parameters

New values

MAIN
SAFETY

P3162: Max spool position, left

-420

P3164: Max spool position, right

420

P3166: Closed loop dead-band edge, left

-105

P3168: Closed loop dead-band edge, right

105

P3170: Open loop dead-band edge offset

25

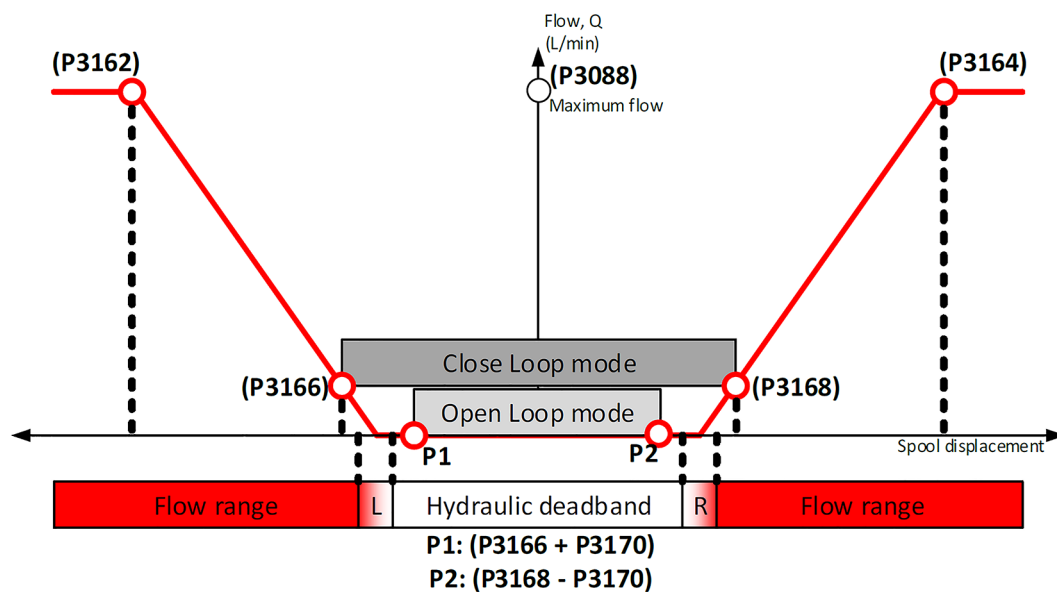
Sector CRC

Approve parameters

| Parameter | Condition for value change |
|-----------|--|
| P3162 | If using an EHPS, set the value to -700. Otherwise, use default value. |
| P3164 | If using an EHPS, set the value to 700. Otherwise, use default value. |
| P3166 | Adjust toward 0 for smaller minimum flow in Closed Loop modes (auto-guidance) and vice versa. See deadband figure below. |
| P3168 | Adjust toward 0 for smaller minimum flow in Closed Loop modes (auto-guidance) and vice versa. See deadband figure below. |
| P3170 | Can be decreased but do not increase. |

Parameter setting

Deadbands



PVED-CLS parameter acceptance

Use the following steps to save and approve the parameters that have been set.

1. Press **Download** and wait for the script to complete.
2. Click **Close**.

It is mandatory to confirm that the parameters have been downloaded by the user.

3. Press **Approve Parameters**.

The text will change to **Approved** and the page can then be closed.

Leaving the page before parameters are accepted will cause an EEPROM fault and the PVED-CLS will go to safe-state mode.

Parameter setting

PVED-CLS production/calibration flag

Navigate to the production/calibration flag section via **System Navigator > Configuration > Production/Calibration Flag**

If WAS Calibration and Spool Calibrations were used, flags will be set automatically. If flags are not set, PVED-CLS will boot into WAS Calibration mode until one of the WAS counters has been set above 0. Then the PVED-CLS will boot into Spool Calibration mode until the Spool calibration flag has been set above 0. If an analog joystick has been selected in Peripherals Config, the Joystick Calibration will need to be run to set the calibration for this, too.

Production/Calibration Flag

| Upload parameters | New values |
|--|------------|
| Download parameters | MAIN |
| P3771: Calibration counter - Spool calibration | 1 |
| P3773: Calibration counter - Analogue WAS | 0 |
| P3775: Calibration counter - CAN WAS | 1 |
| P3777: Calibration counter - Analogue joystick | 0 |

If the PVED-CLS is used in a desktop environment, then P3771, P3773, P3775 and P3777 must be set to 1 to avoid PVED-CLS from entering calibration mode. For more details, see the PVED-CLS User Manual.

If parameters are changed, be sure to select **Download parameters** to save parameter setting.

There is no **Approve parameters** option on this page.

Parameter setting

PVED-CLS STW configuration

Navigate to the STW configuration section via **System Navigator > Configuration > STW Config**

Example parameter settings

STW Config

Upload parameters
Download parameters

New values

MAIN
SAFETY

Steering Wheel

P3521: Steering wheel no-activation threshold

5

P3570: Backlash region

5

P3583: STW in use - Velocity threshold

5

P3584: STW in use - Angle threshold

10

If the parameter change is not described below or conditions are not met, use the default values.

| Parameter | Condition for value change |
|-----------|---|
| P3570 | Change to 75 (7.5 degrees) to prevent amplifying re-centering of steering wheel. |
| P3583 | Can be increased if auto-guidance or AUX devices are being disengaged too easily by the steering wheel. |
| P3584 | Can be increased if auto-guidance or AUX devices are being disengaged too easily by the steering wheel. |

There are four subsets of steering wheel configuration: *Steering Wheel Programs*, *Soft-stop*, *Anti-jerk*, and *Anti-drift*. Be sure to Download and approve parameters when complete with Steering Wheel configuration.

PVED-CLS Steering wheel programs

There are 5 steering wheel programs with identical parameters. Use the details below as a reference for all 5 programs.

Example parameter settings (only Program 1 shown)

Steering Wheel - Program 1

P3522: No of turns @ Point A

800

P3524: No of turns @ Point B

800

P3526: No of turns @ Point C

800

P3528: Vehicle speed @ Point B

5

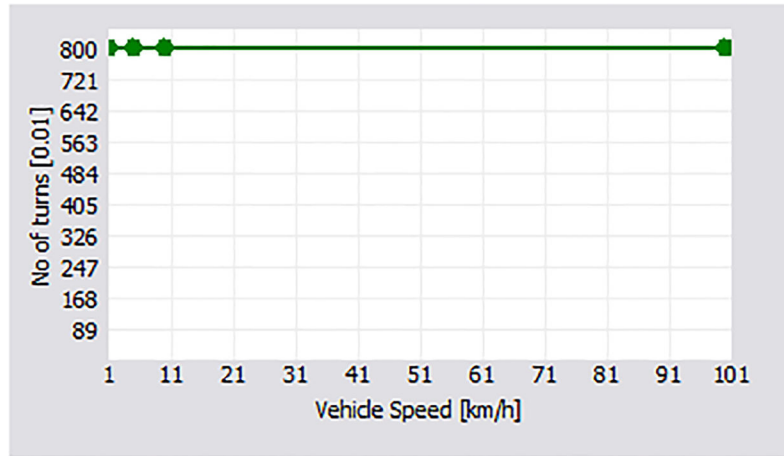
P3529: Vehicle speed @ Point C

10

| Parameter | Condition for value change |
|-----------|--|
| P3522 | Set to desired turns lock-to-lock [x0.01] at 0 km/h (see graph below) |
| P3524 | Set to desired turns lock-to-lock (y-axis) at desired vehicle speed in km/h (P3528) |
| P3526 | Set to desired turns lock-to-lock (y-axis) at desired vehicle speed in km/h (P3529) |
| P3528 | Set to desired vehicle speed in km/h (x-axis) at desired number turns lock-to-lock (P3524) |
| P3529 | Set to desired vehicle speed in km/h (x-axis) at desired number turns lock-to-lock (P3526) |

Parameter setting

Default steering wheel program



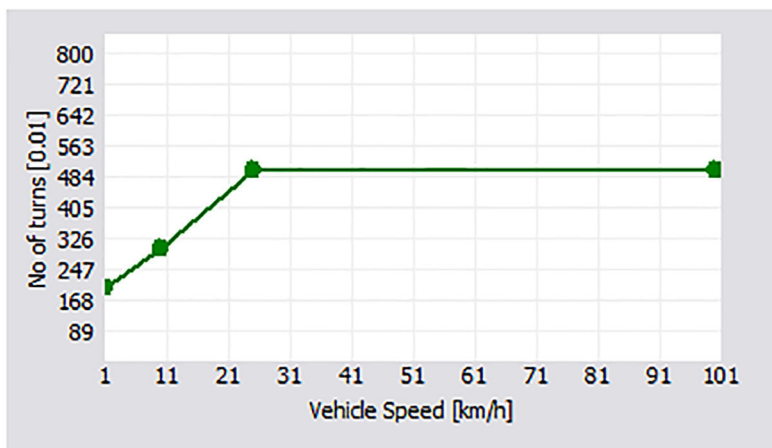
No amplification if orbital produces less than 8 turns lock-to-lock.

If all parameters for turns lock-to-lock are equal, the steering wheel program will have a fixed number of turns lock-to-lock. Steering wheel programs can be set so that the number of turns lock-to-lock changes depending on the vehicle speed.

Example of vehicle speed dependent steering wheel program

— Steering Wheel - Program 1 —

| | |
|--------------------------------|-----|
| P3522: No of turns @ Point A | 200 |
| P3524: No of turns @ Point B | 300 |
| P3526: No of turns @ Point C | 500 |
| P3528: Vehicle speed @ Point B | 10 |
| P3529: Vehicle speed @ Point C | 25 |



Parameter setting

PVED-CLS soft-stop

Soft-stop can decrease flow sent from the electro-hydraulic valve the to cylinders when wheels are close to end-stop to help prevent damage and jerk.

Example parameter settings

— Steering Wheel - Soft-stop —

P3562: STW soft-stop wheel angle region start

400

P3566: STW soft-stop wheel angle region end

0

P3564: STW soft-stop max flow @ cylinder end-stop

0

| Parameter | Conditions for value change |
|-----------|---|
| P3562 | Distance from end-stop flow starts to decrease [0.1%] |
| P3566 | Distance from end-stop flow stops decreasing [0.1%] |
| P3564 | Max allowed flow at cylinder end-stop [0.1%] |

Example of soft-stop flow limitation

— Steering Wheel - Soft-stop —

P3562: STW soft-stop wheel angle region start

200

P3566: STW soft-stop wheel angle region end

50

P3564: STW soft-stop max flow @ cylinder end-stop

100



Parameter setting

PVED-CLS anti-jerk

Anti-jerk can be used to decrease jerk in articulated vehicles. Changing parameters only effect jerk originating from the EH spool. Any jerk caused by the orbital will still exist, but amplified flow from variable rate steering programs will have less jerk.

Example parameter settings

— Steering Wheel - Anti-jerk —

| | |
|---|---------|
| P3571: STW anti-jerk function | None ▾ |
| P3572: STW relative set-point change, out from spool neutral position | 5 ▴ ▾ |
| P3573: STW relative set-point change, in towards spool neutral position | 5 ▴ ▾ |
| P3574: STW absolute set-point change, out from spool neutral position | 15 ▴ ▾ |
| P3576: STW absolute set-point change, in towards spool neutral position | 10 ▴ ▾ |
| P3578: STW anti-jerk cross-over start point | 10 ▴ ▾ |
| P3580: STW anti-jerk cross-over stop point | 10 ▴ ▾ |
| P3582: STW anti-jerk low pass filter cut-off frequency | 100 ▴ ▾ |

| Parameter | Conditions for value change |
|-------------|--|
| P3571 | Change to enable anti-jerk functionality |
| P3572-P3582 | See section 10.6 Anti-Jerk in User Manual for details on setting parameters. |

Tuning of anti-jerk will take trial and error. Set values low and increase them until articulated machine feels responsive but not jerky. The cross-over start and stop points (P3578 and P3580) can stay at defaults unless extra anti-jerk functionality is required.

PVED-CLS anti-drift

Anti-drift can be used to keep the steering wheel in the same position when driving straight ahead. This is adjusted by adding a percentage of full flow when the actual steering wheel angle doesn't match the ideal steering wheel angle.

— Steering Wheel - Anti-drift —

| | |
|--|--------|
| P3568: STW anti-drift - Max steering wheel drift correction | 20 ▴ ▾ |
| P3569: STW anti-drift - Max flow correction in percentage of full flow | 15 ▴ ▾ |

| Parameter | Conditions for value change |
|-----------|---|
| P3568 | Angle at which maximum correction flow is applied |
| P3569 | Maximum correction flow that can be applied |

Default values are recommended for these parameters. See Section 10.5 in the User Manual for more details.

Parameter setting

PVED-CLS AUX configuration

Navigate to the AUX configuration section via **System Navigator > Configuration > AUX Config**

The following parameters only apply if AUX is enabled.

AUX Config

| | |
|---------------------|-------------|
| Upload parameters | New values |
| Download parameters | MAIN SAFETY |

— AUX- Activation threshold —

P3646: AUX mini-steering in use - Velocity threshold

P3719: AUX mini-steering in use - Angle threshold

P3649: AUX - Mini-steering no-activation threshold

P3647: AUX joystick in use - Flow command threshold

P3648: AUX - Joystick no-activation threshold

| Parameter | Conditions for value change |
|--------------|--|
| P3646, P3719 | See PVED-CLS STW configuration on page 23 |
| P3647 | Set to minimum joystick command in 0.1% needed to switch into joystick steering. |

There are seven subsets of AUX configuration that apply only if an AUX device is selected in parameter P3240 in the Peripherals Config page: [AUX Mini-wheel programs](#), [Soft-stop](#), [Anti-jerk](#), [Anti-drift](#), [Flow limitation](#), [Closed loop joystick](#), and [Open loop joystick](#).

Approve the parameters by following the steps in [PVED-CLS parameter acceptance](#) on page 8.

PVED-CLS AUX mini-wheel programs

There are 5 AUX programs for mini steering wheels that each have a similar set of parameters. These are only used if a mini steering wheel is present.

— AUX- Program 1 —

P3650: AUX mini-steering 1 - No of turns @ Point J

P3652: AUX mini-steering 1 - No of turns @ Point K

P3654: AUX mini-steering 1 - No of turns @ Point L

P3656: AUX mini-steering 1 - Vehicle speed @ Point K

P3657: AUX mini-steering 1 - Vehicle speed @ Point L

| Parameter | Conditions for value change |
|-------------|--|
| P3650-P3657 | See PVED-CLS Steering wheel programs on page 23 for configuration details. |

Parameter setting

PVED-CLS AUX— soft-stop

AUX soft-stop can decrease flow to cylinders when wheels are close to end-stop to help prevent damage and jerk. This parameter is used for mini steering wheel and open loop joystick devices.

— AUX- Soft-stop —

| | |
|---|-----|
| P3708: AUX soft-stop max flow @ cylinder end-stop | 200 |
| P3710: AUX soft-stop wheel angle region start | 0 |
| P3712: AUX soft-stop wheel angle region stop | 0 |

| Parameter | Conditions for value change |
|-------------|--|
| P3708-P3712 | See PVED-CLS soft-stop on page 25 for configuration details. |

Wheels may not return from end-stops or will do so slowly if flow is set too low.
Do not decrease P3708 below 200.

PVED-CLS AUX— anti-jerk

Anti-jerk can be used to decrease jerk in articulated vehicles. These parameters can be applied with a mini steering wheel or open-loop joystick.

— AUX- Anti-jerk —

| | |
|---|------|
| P3698: AUX anti-jerk function | None |
| P3699: AUX relative set-point change, in towards spool neutral position | 5 |
| P3700: AUX relative set-point change, out from spool neutral position | 5 |
| P3701: AUX absolute set-point change, in towards spool neutral position | 10 |
| P3703: AUX absolute set-point change, out from spool neutral position | 15 |
| P3714: AUX anti-jerk cross-over start point | 10 |
| P3716: AUX anti-jerk cross-over stop point | 10 |
| P3718: AUX anti-jerk low pass filter cut-off frequency | 100 |

| Parameter | Conditions for value change |
|-------------|--|
| P3698-P3718 | See Section 11.6 Open Loop Anti-Jerk in the User Manual for configuration details. |

PVED-CLS AUX— anti-drift

Anti-drift can be used to keep the mini steering wheel in the same position when driving straight ahead by adding a percentage of full flow when the actual mini steering wheel angle does not match the ideal angle.

— AUX- Anti-drift —

| | |
|---|----|
| P3706: AUX anti-drift - Max steering wheel drift correction | 20 |
| P3705: AUX anti-drift - Max flow correction in percentages of full flow | 15 |

| Parameter | Conditions for value change |
|--------------|--|
| P3706, P3705 | See Section 11.5 Open Loop Mini Wheel Anti-Drift in User Manual for details on setting parameters. |

Parameter setting

PVED-CLS AUX— flow limitation

AUX Flow Limitation is used with Open Loop Joysticks to restrict the maximum flow to steering cylinders as the vehicle speed increases. This function scales all joystick flow commands based on vehicle speed. Don't set flow limit below 200 (20%). See Section 11.9 Open Loop Joystick – Vehicle Speed Dependent Flow Scaling in the User Manual for more info.

—AUX- Flow limitation —

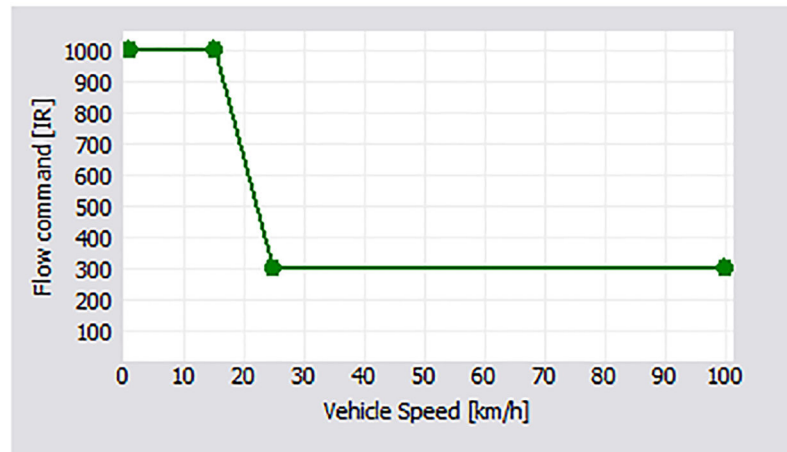
| | |
|---|------|
| P3690: AUX joystick - Flow limit for max joystick command @ Point M | 1000 |
| P3692: AUX joystick - Flow limit for max joystick command @ Point N | 50 |
| P3694: AUX joystick - Flow limit for max joystick command @ Point O | 25 |
| P3696: AUX joystick - Vehicle speed @ Point N | 15 |
| P3697: AUX joystick - Vehicle speed @ Point O | 25 |

| Parameter | Conditions for value change |
|-----------|---|
| P3690 | Set to desired flow limit [1000 = 100%] at 0 km/h (see graph below) |
| P3692 | Set to desired flow limit (y-axis) at desired vehicle speed in km/h (P3696) |
| P3694 | Set to desired flow limit (y-axis) at desired vehicle speed in km/h (P3697) |
| P3696 | Set to desired vehicle speed in km/h (x-axis) at desired flow limit (P3692) |
| P3697 | Set to desired vehicle speed in km/h (x-axis) at desired flow limit (P3694) |

Example of AUX flow limitation

—AUX- Flow limitation —

| | |
|---|------|
| P3690: AUX joystick - Flow limit for max joystick command @ Point M | 1000 |
| P3692: AUX joystick - Flow limit for max joystick command @ Point N | 1000 |
| P3694: AUX joystick - Flow limit for max joystick command @ Point O | 300 |
| P3696: AUX joystick - Vehicle speed @ Point N | 15 |
| P3697: AUX joystick - Vehicle speed @ Point O | 25 |



Parameter setting

PVED-CLS AUX— flow limitation tuning advice

1. Remove flow limitation (1000 for all 3 flow limits) and drive the machine first slowly and then at increasing speeds.
2. On each trial, steer full left or right with the joystick.

Vehicle tipping hazard!
Operate carefully to avoid tipping the vehicle.

If the machine does not feel controllable at a given vehicle speed, use the flow limitation to begin to decrease flow allowed at that speed.

3. Iterate until the operator can move the joystick as quickly as possible at any speed and avoid tipping. CAN logging can also be implemented to monitor vehicle speed and flow set-points from the Vehicle Speed message and Status Message 4 which are described in the PVED-CLS Communication Protocol document. Scatter plotting flow set-points vs. vehicle speed should yield a curve that can be reflected with the AUX Flow Limitation.

PVED-CLS AUX— closed loop joystick

AUX Wheel Angle Limit is used with Closed Loop Joysticks to limit the maximum wheel angle as the vehicle speed increases. This function scales all joystick wheel angle commands based on vehicle speed. See Section 11.10 Closed Loop Joystick – Vehicle Speed Dependent Wheel Angle Limitation in the User Manual for more info.

—AUX- Closed loop joystick —

| | |
|--|----|
| P3720: AUX joystick - Max wheel angle @ Point A | 15 |
| P3721: AUX joystick - Max wheel angle @ Point B | 10 |
| P3722: AUX joystick - Max wheel angle @ Point C | 5 |
| P3723: AUX joystick - Vehicle speed limiting wheel angle @ Point B | 15 |
| P3724: AUX joystick - Vehicle speed limiting wheel angle @ Point C | 25 |

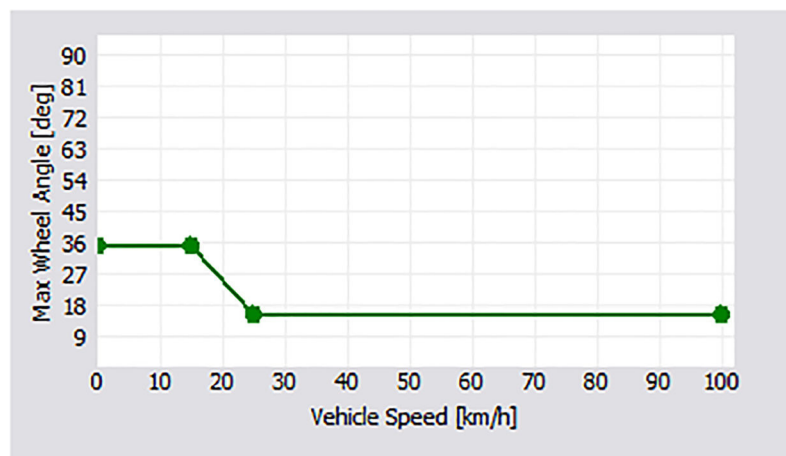
| Parameter | Conditions for value change |
|-----------|--|
| P3720 | Set to desired wheel angle limit [degree] at 0 km/h (see graph below) |
| P3721 | Set to desired wheel angle (y-axis) at desired vehicle speed in km/h (P3723) |
| P3722 | Set to desired wheel angle (y-axis) at desired vehicle speed in km/h (P3724) |
| P3723 | Set to desired vehicle speed in km/h (x-axis) at desired wheel angle (P3721) |
| P3724 | Set to desired vehicle speed in km/h (x-axis) at desired wheel angle (P3722) |

Example of AUX wheel angle limitation

—AUX- Closed loop joystick —

| | |
|--|----|
| P3720: AUX joystick - Max wheel angle @ Point A | 35 |
| P3721: AUX joystick - Max wheel angle @ Point B | 35 |
| P3722: AUX joystick - Max wheel angle @ Point C | 15 |
| P3723: AUX joystick - Vehicle speed limiting wheel angle @ Point B | 15 |
| P3724: AUX joystick - Vehicle speed limiting wheel angle @ Point C | 25 |

Parameter setting



Closed loop joystick tuning advice

1. Remove wheel angle limitation (raise all 3 wheel angle limits to maximum angle of vehicle), then steer full left or right with the joystick and keep the wheel angle in place.
2. Slowly increase the speed of the machine while driving in a circle until the machine starts to feel tipsy or unsafe.

Vehicle tipping hazard!

Operate carefully to avoid tipping the vehicle.

3. Use the wheel angle limitation to decrease the allowed wheel angle at that speed.
4. Iterate until the operator can move the joystick full left or right at any speed and avoid tipping.
CAN logging can also be used to monitor vehicle speed and wheel angle set-points from the Vehicle speed message and Status Message 5, which are described in the PVED-CLS Communication Protocol document. Scatter plotting wheel angle set-points vs. vehicle speed should yield a curve that can be mimicked with the AUX Wheel Angle Limitation function.

PVED-CLS AUX— closed loop gain

AUX Closed Loop Gain sets the gain used by the Closed Loop Joystick algorithm to a static value or to vary based on vehicle speed. See section 11.11 Closed Loop Joystick – Vehicle Speed Dependent Closed Loop Control in the User Manual for more information.

| | |
|---|----|
| P3725: AUX joystick - CL gain @ Point A | 50 |
| P3726: AUX joystick - CL gain @ Point B | 50 |
| P3727: AUX joystick - CL gain @ Point C | 50 |
| P3728: AUX joystick - Vehicle speed @ Point B | 15 |
| P3729: AUX joystick - Vehicle speed @ Point C | 25 |

| Parameter | Conditions for value change |
|-----------|---|
| P3725 | Set to desired closed loop gain [%] at 0 km/h |
| P3726 | Set to desired closed loop gain (y-axis) at desired vehicle speed in km/h (P3728) |
| P3727 | Set to desired closed loop gain (y-axis) at desired vehicle speed in km/h (P3729) |
| P3728 | Set to desired vehicle speed in km/h (x-axis) at desired closed loop gain (P3726) |
| P3729 | Set to desired vehicle speed in km/h (x-axis) at desired closed loop gain (P3727) |

Tuning advice: keep gains constant and as high as possible without causing overshoot or instability.

Parameter setting

| | |
|--|-----|
| P3730: AUX joystick - Max CL steady state error threshold | 100 |
| P3731: AUX joystick - Min time for CL steady state error threshold | 50 |
| P3732: AUX joystick - Max closed loop error for engaging closed loop joystick steering | 100 |

| Parameter | Conditions for value change |
|-----------|---|
| P3730 | Max closed loop error [IR, 100=10%] allowed when switching device from AUX to Auto-guidance. |
| P3731 | Minimum time [x10ms] where steady state threshold can't be exceeded to switch device from AUX to Auto-guidance. |
| P3732 | Max closed loop error [IR, 100=10%] before closed loop joystick steering is enabled. |

PVED-CLS AUX— open loop joystick transfer function

Open Loop Joystick transfer function scales the position of the open loop joystick to a requested flow.

—AUX- Open loop joystick —

| | |
|--|------|
| P3734: AUX joystick - Maximum deflection region offset | 0 |
| P3736: AUX joystick - Dead-band region | 0 |
| P3738: AUX joystick - Interpolation point X for open loop joystick transfer function | 1000 |
| P3740: AUX joystick - Interpolation point Y for open loop joystick transfer function | 1000 |

| Parameter | Conditions for value change |
|-------------|--|
| P3734-P3740 | See Section 11.8 in the User Manual for more information |

Parameter setting

PVED-CLS GPS configuration

Navigate to the GPS configuration section via **System Navigator > Configuration > GPS Config**

These parameters only apply if GPS is enabled. GPS Flow Limitation is used with auto-guidance to restrict the maximum flow to steering cylinders as the vehicle speed increases. See Section 12.5 Vehicle Speed Dependent Flow Command Limitation in the User Manual for more info.

GPS Config

Upload parameters

Download parameters

New values

MAIN SAFETY

— Flow limitation —

| | |
|--|------|
| P3451: GPS - Max flow @ Point D | 1000 |
| P3453: GPS - Vehicle speed limiting flow @ Point E | 15 |
| P3455: GPS - Max flow @ Point E | 50 |
| P3457: GPS - Vehicle speed limiting flow @ Point F | 25 |
| P3459: GPS - Max flow @ Point F | 25 |

| Parameter | Conditions for value change |
|-----------|---|
| P3451 | Set to desired flow limit [IR, 1000=100%] at 0 km/h (see graph below) |
| P3453 | Set to desired vehicle speed in km/h (x-axis) at desired flow limit (P3455) |
| P3455 | Set to desired flow limit (y-axis) at desired vehicle speed in km/h (P3453) |
| P3457 | Set to desired vehicle speed in km/h (x-axis) at desired flow limit (P3459) |
| P3459 | Set to desired flow limit (y-axis) at desired vehicle speed in km/h (P3457) |

There are three subsets of GPS tuning that will need configuring if GPS is enabled.

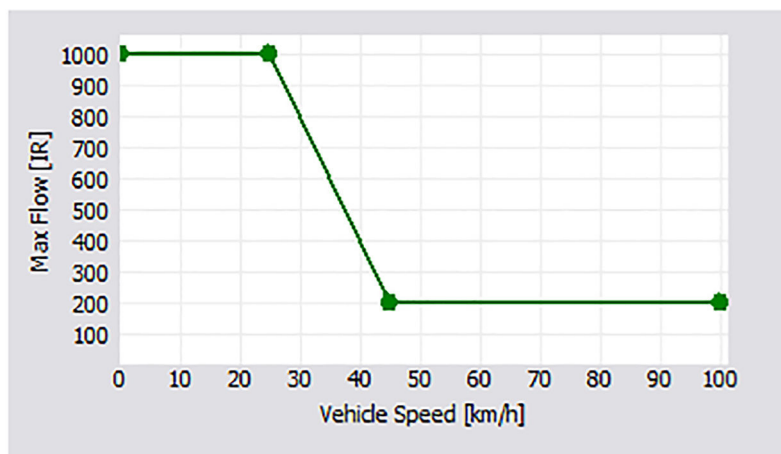
Approve the parameters by following the steps in [PVED-CLS parameter acceptance](#) on page 8.

PVED-CLS example of GPS flow limitation

— Flow limitation —

| | |
|--|------|
| P3451: GPS - Max flow @ Point D | 1000 |
| P3453: GPS - Vehicle speed limiting flow @ Point E | 25 |
| P3455: GPS - Max flow @ Point E | 1000 |
| P3457: GPS - Vehicle speed limiting flow @ Point F | 45 |
| P3459: GPS - Max flow @ Point F | 200 |

Parameter setting



PVED-CLS GPS flow limitation— tuning advice

1. Remove flow limitation (1000 for all 3 flow limits) and drive the machine first slowly and then at increasing speeds.
2. On each trial, command full left or right.

Vehicle tipping hazard!
Operate carefully to avoid tipping the vehicle.

If the machine does not feel stable steering that quickly at that speed, use the flow limitation to begin to decrease flow allowed at that speed.

3. Iterate until the auto-guidance can command full left or right at any speed and avoid tipping.
CAN logging can also be implemented to track vehicle speed and flow set-points from the Vehicle Speed message and Status Message 4, which are described in the PVED-CLS Communication Protocol document. Scatter plotting flow set-points vs. vehicle speed should yield a curve that shows the demands from the auto-guidance controller and that can be mimicked with the GPS Flow Limitation function.

PVED-CLS GPS— wheel angle limitation

GPS Wheel Angle Limitation decreases the allowed maximum wheel angle as the vehicle speed increases. See Section 12.3 Vehicle Speed Dependent Wheel Angle Limitation in the User Manual for more info.

— Wheel angle limitation —

| | |
|---|----|
| P3461: GPS - Max wheel angle @ Point G | 35 |
| P3463: GPS - Vehicle speed limiting wheel angle @ Point H | 15 |
| P3465: GPS - Max wheel angle @ Point H | 15 |
| P3467: GPS - Vehicle speed limiting wheel angle @ Point I | 25 |
| P3469: GPS - Max wheel angle @ Point I | 10 |

| Parameter | Conditions for value change |
|-----------|--|
| P3461 | Set to desired angle limit [deg] at 0 km/h (see graph below). Should be the same as max wheel angles in Vehicle Geometry . |
| P3463 | Set to desired vehicle speed in km/h (x-axis) at desired wheel angle limit (P3465) |
| P3465 | Set to desired wheel angle limit (y-axis) at desired vehicle speed in km/h (P3464) |
| P3467 | Set to desired vehicle speed in km/h (x-axis) at desired wheel angle limit (P3469) |
| P3469 | Set to desired wheel angle limit (y-axis) at desired vehicle speed in km/h (P3467) |

Parameter setting

Example of GPS wheel angle limitation

— Wheel angle limitation —

P3461: GPS - Max wheel angle @ Point G

45

P3463: GPS - Vehicle speed limiting wheel angle @ Point H

15

P3465: GPS - Max wheel angle @ Point H

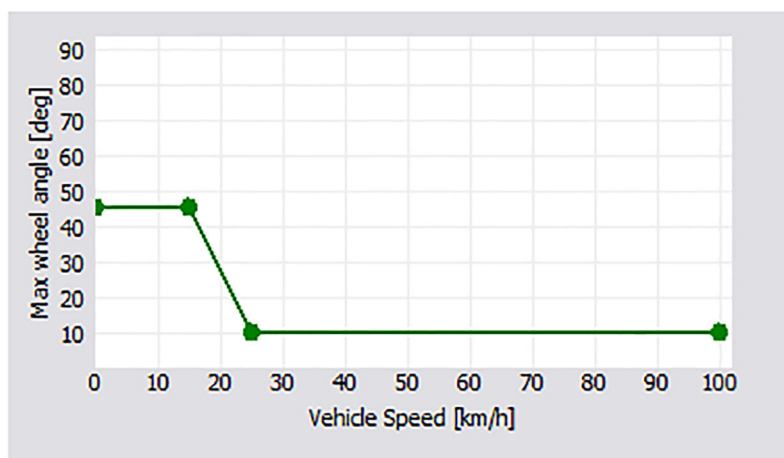
45

P3467: GPS - Vehicle speed limiting wheel angle @ Point I

25

P3469: GPS - Max wheel angle @ Point I

10



PVED-CLS GPS— wheel angle limitation tuning advice

1. Remove wheel angle limitation (raise all 3 wheel angle limits to maximum angle of vehicle), then steer full left or right with the steering wheel or auto-guidance controller and keep the wheel angle there.
2. Slowly increase the speed of the machine while driving in a circle until the machine starts to feel tipsy or unsafe.

Vehicle tipping hazard!

Operate carefully to avoid tipping the vehicle.

3. Use the wheel angle limitation to decrease the allowed wheel angle at that speed.
4. Iterate at faster speeds until an appropriate wheel angle limit is created for all vehicle speeds.

CAN logging can also be implemented to track vehicle speed and wheel angle set-points from the Status Messages while auto-guidance is engaged. Scatter plotting wheel angle set-points vs. vehicle speed should yield a curve that shows the demands from the auto-guidance controller and that can be mimicked with the GPS Wheel Angle Limitation function.

Parameter setting

PVED-CLS GPS—vehicle speed dependent closed loop control

GPS Vehicle Speed Dependent Closed Loop Control sets the closed loop gain for the auto-guidance commands. There are 2 different sets of gain values, 1 for each possible auto-guidance device. It is best to keep the gain values static rather than vary them with speed.

— Gain —

| | |
|--------------------------------------|----|
| P3473: GPS - CL gain @ Point P | 50 |
| P3474: GPS - CL gain @ Point Q | 50 |
| P3475: GPS - CL gain @ Point R | 50 |
| P3476: GPS - CL gain @ Point S | 50 |
| P3477: GPS - CL gain @ Point T | 50 |
| P3478: GPS - CL gain @ Point U | 50 |
| P3479: GPS - Vehicle speed @ Point Q | 30 |
| P3480: GPS - Vehicle speed @ Point R | 31 |
| P3481: GPS - Vehicle speed @ Point S | 32 |
| P3482: GPS - Vehicle speed @ Point T | 33 |
| P3483: GPS - Vehicle speed @ Point U | 34 |

| Parameter | Condition for value change |
|-------------|--|
| P3473-P3478 | Set all Closed Loop gains to same desired value [%] unless speed dependent gain is desired. If that is the case then set desired gains for each point which corresponds with a vehicle speed below. |
| P3479-P3483 | If keeping all Closed Loop gains the same, these values can remain at defaults, otherwise match the desired vehicle speed [km/h] at each point corresponding to CL gains above. <u>The vehicle speeds cannot be the same value or an EEPROM error will be triggered. Set the speeds so that they increase with increasing parameter number.</u> |

P3484: It is highly recommended that Flow Command filter is left at the default setting.

P3496: GPS- Algorithm Type can be changed if desired. Please see Sections 12.2, 12.6 and 12.7 in the PVED-CLS User Manual for an overview of the benefits of both and how to set other parameters accordingly.

PVED-CLS GPS— CL control tuning advice

1. Tuning Advice: Start with default gain.
2. Using CAN logging, look at the curvature command and estimated curvature found respectively in the Guidance System Command and Guidance Machine Status messages described in the Communication Protocol.

If estimated curvature is taking too long to approach the commanded curvature, increase the gain.

If estimated curvature is overshooting the commanded curvature, decrease the gain.

The spool auto-calibration may also influence the auto-guidance performance.

Parameter setting

Auto calibration configuration

Navigate to the Auto calibration configuration section via **System Navigator > Configuration > Auto Calibration Config**

PVED-CLS auto calibration— sensor

Sensor Calibration parameters can define a window of allowed neutral positions to be captured during Analog sensor and/or CAN WAS calibration, as well as a required voltage offset between captured neutral and left/right values.

These do not need to be changed for CLS to function.

Auto Calibration Config

| | Upload parameters | Download parameters | New values |
|--|-------------------|---------------------|-------------|
| | | | MAIN SAFETY |
| — Sensor Calibration — | | | |
| P3791: Max allowable analogue sensor signal to be captured in neutral | | | 4500 |
| P3793: Min voltage needed in between the captured analogue sensor values | | | 0 |
| P3795: Min allowable analogue sensor signal to be captured in neutral | | | 500 |
| P3841: Max allowable CAN WAS signal to be captured in neutral | | | 4500 |
| P3843: Min voltage needed in between the captured CAN WAS values | | | 0 |
| P3845: Min allowable CAN WAS signal to be captured in neutral | | | 500 |

PVED-CLS auto calibration— cylinder stroke and max steer angles

Automatically adjusted cylinder stroke and max steer angle values are used for vehicles where changing tires may affect the maximum steering angles (decreasing because larger wheels or duals may impact the vehicle if the same end-stops are used).

This is a set of parameters to map the voltage of the WAS to left/right cylinder stroke volume and max steer angle. These should be set by the OEM using the actual steering geometry to determine values. For more information on setting these parameters see Section 9.1.1 Automatic Adjustment of Maximum Steer Angles and Cylinder Stroke Volume in the User Manual.

Parameter setting

— Automatically adjusted cylinder stroke and max steer angle-values —

| | |
|--|------|
| P3815: Mapped cyl. str. vol. (steering left) at 33% VB | 333 |
| P3817: Mapped cyl. str. vol. (steering left) at 67% VB | 667 |
| P3819: Mapped cyl. str. vol. (steering left) at 100% VB | 1000 |
| P3821: Mapped VB for cyl. str. vol. (steering left) | 2000 |
| P3823: Mapped cyl. str. vol. (steering right) at 33% VB | 333 |
| P3825: Mapped cyl. str. vol. (steering right) at 67% VB | 667 |
| P3827: Mapped cyl. str. vol. (steering right) at 100% VB | 1000 |
| P3829: Mapped VB for cyl. str. vol. (steering right) | 2000 |
| P3831: Mapped max WA (steering left) at 33% VB | 30 |
| P3832: Mapped max WA (steering left) at 67% VB | 60 |
| P3833: Mapped max WA (steering left) at 100% VB | 89 |
| P3834: Mapped VB for max WA (steering left) | 2000 |
| P3836: Mapped max WA (steering right) at 33% VB | 30 |
| P3837: Mapped max WA (steering right) at 67% VB | 60 |
| P3838: Mapped max WA (steering right) at 100% VB | 89 |
| P3839: Mapped VB for max WA (steering right) | 2000 |

PVED-CLS auto calibration— spool dead-band

If the parameter change is not described below, use the default values.

Spool Dead-band Calibration values set the behavior of the Auto Spool Calibration routine which finds the Closed Loop dead-band edges for the spool calibration.

See Section 9.4.1.1 in the User Manual for more detailed descriptions of the parameters.

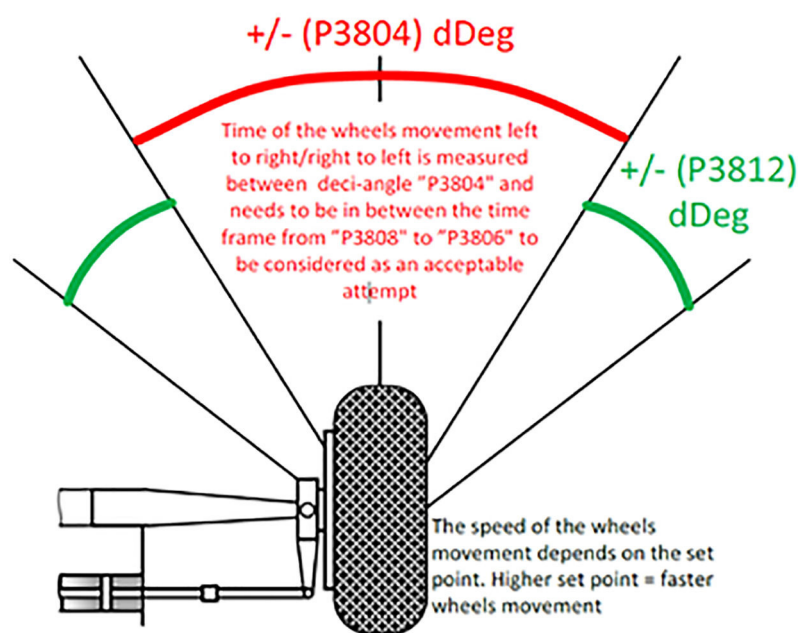
Example parameter settings

— Spool dead-band calibration —

| | |
|--|-----|
| P3797: Spool calibration - Max closed loop dead-band edge | 300 |
| P3799: Spool calibration - Min closed loop dead-band edge | 0 |
| P3801: Spool calibration - Activation timeout | 20 |
| P3802: Spool calibration - Initial spool position | 125 |
| P3804: Spool calibration - +/- turn range sweep | 25 |
| P3806: Spool calibration - Max time for acceptable CL dead-band edge | 110 |
| P3808: Spool calibration - Min time for acceptable CL dead-band edge | 60 |
| P3810: Spool calibration - Vector sample size | 7 |
| P3811: Spool calibration - Min valid samples | 5 |
| P3812: Spool calibration - +/- turn range sweep add-on | 25 |
| P3814: Spool calibration - Spool set-point increase/decrease step | 10 |

Parameter setting

| Parameter | Conditions for value change |
|-----------|--|
| P3797 | Set max value of captured Closed Loop Dead-Band edges [x10 μ m] |
| P3799 | Set min value of captured Closed Loop Dead-Band edges [x10 μ m] |
| P3801 | Time [sec] after turning the steering wheel before calibration can no longer be activated |
| P3802 | Initial spool set-point [x10 μ m] for calibration routine |
| P3804 | Angle [0.1 deg] on both sides of neutral that wheels move through while being timed (see figure below) |
| P3806 | Upper time limit [0.1 sec] for wheels to move through angle specified in P3804 |
| P3808 | Upper time limit [0.1 sec] for wheels to move through angle specified in P3804 |
| P3810 | Number of attempted spool set-points attempts kept in memory |
| P3811 | Minimum number of spool set-point attempts that must match in memory to complete calibration |



PVED-CLS auto calibration— spool dead-band tuning advice

1. During machine startup, use default Auto Spool Calibration parameters as described in the calibration section.
2. Manually adjust closed loop dead-band edges while tuning GPS steering.
3. Change Auto Spool Calibration parameters to achieve similar closed loop dead-band edges under end-of-line conditions.
4. Iterate on parameters until the Auto Spool Calibration can consistently achieve good GPS steering performance from end-of-line calibration.

The main parameters of interest are P3806 and P3808 which define the time limits for the wheels to turn through the turn range sweep set in P3804 (5 degrees by default). By increasing or decreasing the times, the closed loop dead-band edges will be smaller or larger (absolute value) respectively. By decreasing the gap between the values, the captured dead-band edges will be more consistent from machine to machine.

PVED-CLS advanced parameter setting

Read section 8 (pages 38-55) of the PLUS+1® Service Tool User Guide found in firmware release package under Service Tool to learn how to use the following pages:

- Parameter File Interface_OEM
- Parameter File Interface_VPS
- Clone PVED-CLS

These files are used to export and import parameter configurations.

Troubleshooting

Resolving safe-state mode by soft reset

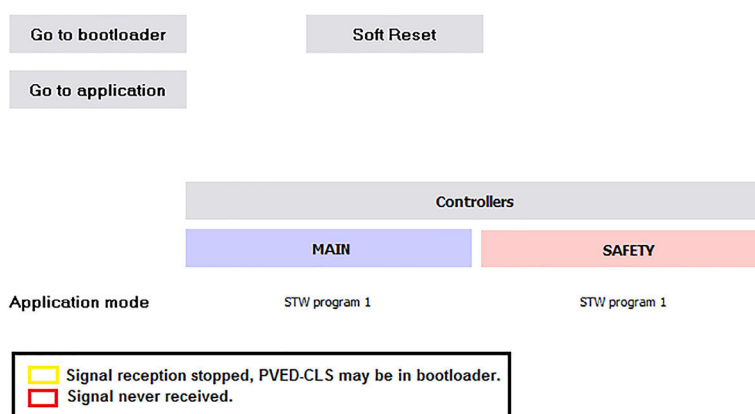
If the PVED-CLS is in safe-state mode, it is possible that a soft reset will resolve the underlying issue.

1. Open the **Mode switch** page.

The Mode Switch page is used to change between Bootloader and Application modes. When a **Config** page is entered while in Normal View in the Service Tool, the PVED-CLS enters Bootloader mode. To return to Application mode go to the **Mode switch** page and press the "Go to application" button.

If the PVED-CLS is already in application mode (there is no red or yellow box around the Main and Safety states) the "Go to application" button does not need to be pressed.

Mode switch



2. Press the "Soft Reset" button to reboot the PVED-CLS.

This may clear the Safe State if it was caused by exceeding a speed threshold or a temporarily missing message.

If the PVED-CLS remains in safe-state mode, proceed to the [Resolving safe-state mode with SPN and FMI codes](#) on page 42 section for further troubleshooting.

Troubleshooting

Resolving safe-state mode with SPN and FMI codes

In order to resolve safe-state mode with this method, SPN and FMI codes must be obtained and referred to in the User Manual. There are two ways to obtain SPN and FMI codes: through the error history pages or the error occurrence counter page.

SEHS error history

1. Go to **System Navigator > Diagnostics > SEHS Error History_Main (or _Safety)**.

SEHS Error History(Main)

| | | | | |
|------------------|---------------------|---|--|--|
| Error Record 1 | WAS CAN sensor | <div> Error Code: 255 Setpoint: 0 [10 um] Demand Value: 0 [10 um] Current Spool Position: 0 [10 um] Battery Voltage: 0.0 [V] File No: 0 Line No: 0 PCB Temperature: 0 [deg C] Error Occurrence: 0 Operating Time: 0.0 [sec] Device state: Unknown state SPN: 0 Reserved FMI: 32 Empty Clear Error History </div> | Spool Setpoint [0.1 mm] 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 0 | Spool Position [0.1 mm] 1 0 2 0 3 0 4 0 5 0 6 0 7 0 8 0 9 0 |
| Error Record 2 | WAS CAN sensor | | | |
| ➔ Error Record 3 | Demanded safe state | | | |
| Error Record 4 | Reserved | | | |
| Error Record 5 | Reserved | | | |
| Error Record 6 | Reserved | | | |
| Error Record 7 | Reserved | | | |
| Error Record 8 | Reserved | | | |
| Error Record 9 | Reserved | | | |
| Error Record 10 | Reserved | | | |
| Error Record 11 | Reserved | | | |
| Error Record 12 | Reserved | | | |
| Error Record 13 | Reserved | | | |
| Error Record 14 | Reserved | | | |
| Error Record 15 | Reserved | | | |
| Error Record 16 | Reserved | | | |

The blue arrow shows the most recent error in the list.

After 16 errors are recorded, new errors are written over previous errors starting at Error Record 1.

2. Click the corresponding "Error Record" button to see more details on the error. This will display the Suspect Parameter Number (SPN) and the Failure Mode Identifier (FMI) of the error.
3. Search the SPN in the User Manual and then look for the correct FMI to learn more about the error and find possible root causes.

Troubleshooting

PVED-CLS clear error history

Once all errors have been dealt with or it is desired to clear the history buffer.

Press the **Clear Error History** Button to clear all recorded errors in the controller's memory and press **OK** on the prompt. Each controller (Main and Safety) has its own error buffer.

Device state

STW program 1

SPN

520208

Demanded safe state

FMI

31

Condition exists

Clear Error History

Warning

Clearing the error history will erase all records of fault codes which are used for troubleshooting and for warranty purposes.

Ensure that all errors have been taken care of properly before clearing the error history.

SEHS error occurrence

The SEHS error occurrence page is the second method used to troubleshoot safe-mode in PVED-CLS.

Go to the SEHS error occurrence page via **System Navigator > Diagnostics > SEHS Error Occurrence Counter** to see the total number of each error that has occurred in both controllers.

This page can display more than the 16 errors in the error history of each controller to be displayed.

When the error history is cleared on the Main or Safety Error History pages, it clears the information in the SEHS Error Occurrence Counter as well.

SEHS Error Occurrence Counter

| Description | | | | MAIN | | SAFETY | |
|-------------|-------------------------|--|--------|------|-----|--------------------------|---|
| | SPN | FMI | | SPN | FMI | Error Occurrence Counter | |
| 0 | Software Initialization | Unknown root-cause | 299005 | 11 | 0 | 0 | |
| 1 | Division by zero | Unknown root-cause | 299004 | 11 | 0 | 0 | |
| 2 | Variable truncation | Unknown root-cause | 299002 | 11 | 0 | 0 | |
| 3 | Interpolation | Unknown root-cause | 298968 | 11 | 0 | 0 | |
| 4 | Vbat | Voltage above normal or short-circuit to high source | 627 | 3 | 0 | 0 | |
| 5 | Vbat | Voltage below normal or short-circuit to low source | 627 | 4 | 0 | 0 | |
| 6 | +5V | Data erratic, intermittent or incorrect | 520582 | 2 | 0 | 0 | |
| 7 | LVDT calculation | Data erratic, intermittent or incorrect | 520583 | 2 | 0 | 0 | |
| 8 | Vref generation | Data erratic, intermittent or incorrect | 520585 | 2 | 0 | 0 | |
| 9 | GND level | Voltage above normal or short-circuit to high source | 520586 | 3 | 0 | 0 | |
| 0 | LVDT demod A | Data erratic, intermittent or incorrect | 520588 | 2 | 0 | 0 | |
| 1 | LVDT demod B | Data erratic, intermittent or incorrect | 520589 | 2 | 0 | 0 | |
| 2 | Soft error | Condition exists | 520229 | 31 | 0 | 0 | |
| 3 | LVDT sinus signal | Abnormal frequency or pulse width or period | 520212 | 8 | 0 | 0 | |
| 4 | Safe ON-Road Monitoring | Stuck Closed | 520206 | 30 | 0 | 3 | ✖ |
| 5 | Safe ON-Road Monitoring | Data erratic, intermittent or incorrect | 520206 | 2 | 0 | 0 | |
| 6 | Safe ON-Road Monitoring | Message missing | 520206 | 22 | 0 | 0 | |
| 7 | EEPROM STW config | Data erratic, intermittent or incorrect | 520243 | 2 | 0 | 2 | ✖ |
| 8 | EEPROM STW config | Special instructions | 520243 | 14 | 0 | 0 | |
| 9 | EEPROM AUX config | Data erratic, intermittent or incorrect | 520244 | 2 | 0 | 0 | |
| 10 | Cut-off solenoid | Received network data in error | 520210 | 19 | 0 | 0 | |
| 11 | Coil supply switch | Received network data in error | 520210 | 19 | 0 | 0 | |

Troubleshooting

Status messages

Go to the status messages page via **System Navigator > Diagnostics > Status Messages** to view the contents of status messages.

Status Messages

Signal reception stopped, PVED-CLS r
 Signal never received.

| Controllers | | | | | | |
|------------------------------|---|---------------------------------|---------|---------------------------------|--------|--------|
| MAIN | | | SAFETY | | | |
| — Operation Status Message — | | | | | | |
| 10 ms | Current Operation state | STW program 1 | | STW program 1 | | 10 ms |
| 100 ms | Lock-out status for steering device changes | Steering device changes allowed | | Steering device changes allowed | | 100 ms |
| | Lock-out status for STW/AUX program | Program changes allowed | | Program changes allowed | | |
| | Lock-out status for EH-steering functionality | Information not available | | Information not available | | |
| | AUX Steering device lockout status | Information not available | | Information not available | | |
| | GPS receiver selection and lockout status | No GPS receiver selected | | No GPS receiver selected | | |
| | Service mode state | Information not available | | Information not available | | |
| — Status Message 1 — | | | | | | |
| Off | Requested spool position | 0 | [10 um] | 0 | Off | |
| | Actual spool position | 1 | [10 um] | 1 | | |
| 10 ms | Data from the external analog input 1 | 0 | [mV] | 0 | 10 ms | |
| 100 ms | Data from the external analog input 2 | 0 | [mV] | 0 | 100 ms | |

If a yellow or red box appears around any messages of interest, they are not currently being received or transmitted. Follow these sub-steps to resolve the issue:

Troubleshooting

- Press the "10ms" or "100ms" buttons to request the messages be sent at the respective frequency.
- Press the "Off" button to request that the message stop sending.

Direct output control

Direct Output Control can be used to set the directional spool to a given set-point. This will send flow to the steering cylinders. Direct Output Control is therefore useful for verifying the hydraulic circuit is working, that the electronics can send flow, and for doing a rough spool calibration.

Go to the direct output control page via **System Navigator > Diagnostics > Direct Output Control**

Direct Output Control

Caution! Only for skilled personnel. The Controls on this service page can lead to sudden steering movements.

Signal rec
Signal new

Goto Direct Output Control Mode

Application mode

Wheel Angle Sensor position

Spool Position set point

| Controllers | |
|--|---------------|
| MAIN | SAFETY |
| STW program 1 | STW program 1 |
| 2000 | [IR] 2000 |
| <div style="display: flex; align-items: center; justify-content: center;"> <div style="border: 1px solid black; padding: 2px 10px;">0</div> <div style="margin: 0 5px;">↑ ↓</div> <div style="border: 1px solid black; padding: 2px 10px;">[10um]</div> </div> | |

Request Spool Position

Request Neutral Spool Position

Request Cut-off valve On

Request Cut-off valve Off

- Press the "Go to Direct Output Control Mode" button.
- Press the "Request Cut-off Valve On" button to enable the directional spool to move and flow to be sent to the steering cylinder.
- Enter a number into the Spool Position set point field. Negative numbers move the spool left and should steer the wheels left. Positive numbers move the spool right and should steer the wheels right
- Press the "Request Spool Position" button to make spool move to set point.
- Press the "Request Neutral Spool Position" button to make the spool move back to neutral.
- Press the "Request Cut-off Valve Off" button when finished with Direct Output Control Mode.

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