

TECHNION



LtCrane

FORESTRY CRANE CONTROL SYSTEM

SERVICE MANUAL

Version 1.3

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TECHNION LTCRANE – INTRODUCTION

LtCrane is a crane control system for controlling forestry cranes. This user manual provides instructions on the safe and efficient use of the LtCrane and enables you to maximize productivity.

The safe and effective use of the system ensures the best possible performance and return of investment. For these reasons we highly recommend to read these instructions carefully before using the system.

This user manual has been drafted and arranged so that its systematic reading will provide a clear understanding of the structure, implementation and use of the LtCrane.

The first section of the manual deals with safety related issues of LtCrane.

The second section provides an overview of the system architecture and GUI (Graphical User Interface), followed by a detailed presentation of the functions controlled through the GUI.

All technical specifications, functions and instructions presented in this manual are based on the latest system information available at the time this manual version was drafted. As the system is constantly being developed, the manufacturer reserves the right to make changes to the product without prior notice.

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2. SYSTEM SAFETY

The use of the control system involves items that are vital to the safe operation of the machine.

Operators must comply with system safety instructions and warnings.

2.1 General warnings

Failure to observe these warnings will invalidate your guarantee.



WARNING



THE LTCRANE SYSTEM MAY ONLY BE USED AND ADJUSTED BY
TRAINED PERSONNEL!

THE EXAMPLE VALUES GIVEN FOR THE CONTROL PARAMETERS IN
THIS MANUAL ARE GUIDELINE VALUES, NOT OPTIMAL VALUES FOR
ALL MACHINES.



WARNING



ALWAYS SWITCH OFF THE CONTROL SYSTEM AND DEPRESSURIZE
THE EQUIPMENT BEFORE PERFORMING MAINTENANCE WORK!



WARNING



ALWAYS DISCONNECT ALL CONTROL SYSTEM CONNECTORS
FROM THE MODULES BEFORE PERFORMING WELDING WORK!



WARNING



ALWAYS USE A SPECIFIC CAN CABLE WITH TWISTED AND SHIELDED PAIR FOR THE CAN BUS!

3. SYSTEM ARCHITECTURE

The system is based on intelligent electronic control modules connected via CAN bus.

The main system components are the main controller TTC2038, service display Opus B2 or B3 and joysticks.

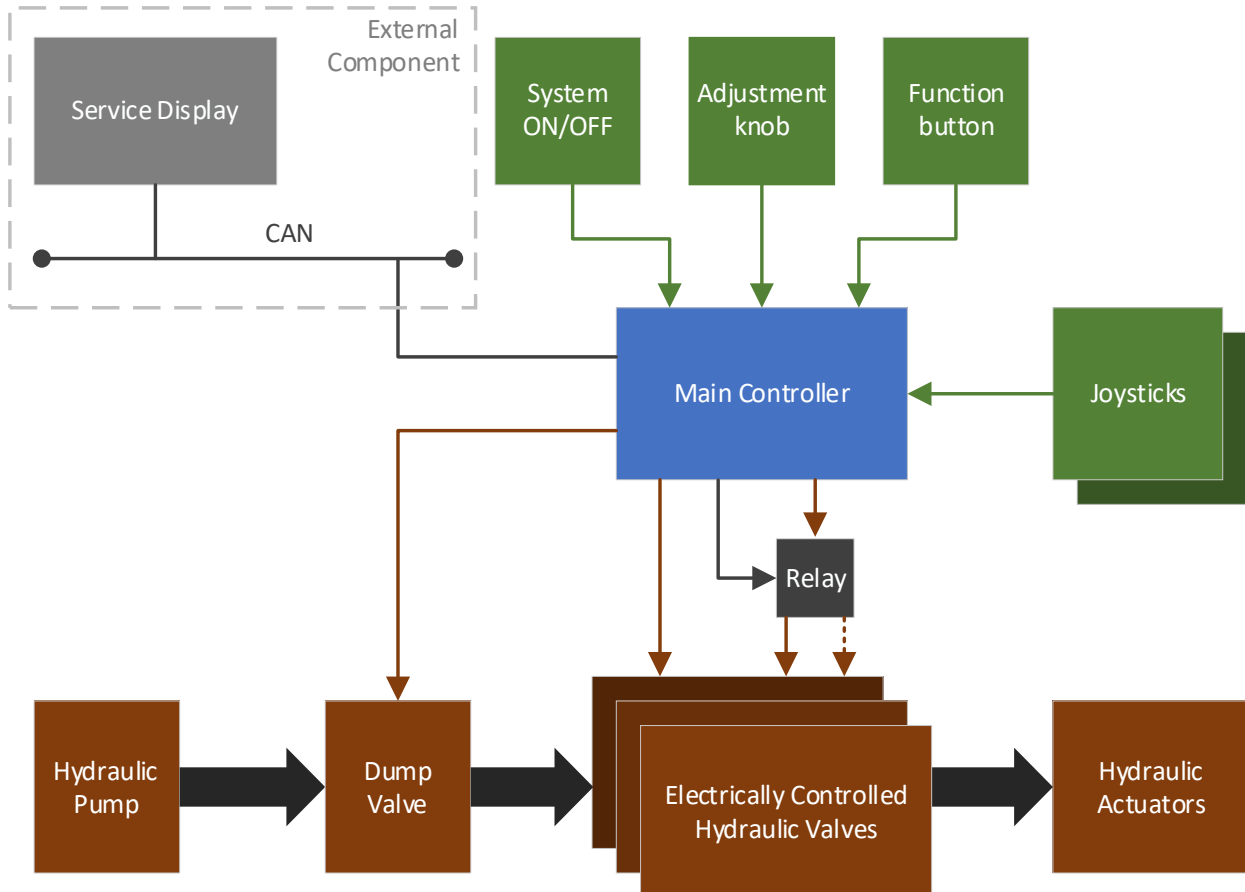


Image 1 LtCrane architecture.

4. USING LTCRANE

LtCrane can be controlled with the left-side joystick and right-side joystick. The stabilizers are activated when the left joystick button is pressed on, and all the movements are off.

NOTE! All movements are disabled until the on/off switch is released!

4.1 How to start and stop operation

To start the crane control, release the start/stop switch and set the stabilizers down using the left joystick button and control the stabilizer with left and right joystick Y-axels. Now the crane is ready to use with joysticks.

4.2 Control devices and functions

LtCrane has simple to use control devices and functions. As standard, joysticks' layout is as shown in the Table 1.

Table 1 Joystick layout

Axis	Function	Direction
Left – Y	Outreach	Forward/Backward
Left - X	Slewing	Clockwise/Counterclockwise
Left - Z	Telescope	Out/In
Right – Y	Lift	Up/Down
Right – X	Rotator	Clockwise/Counterclockwise
Right – Z	Grapple	Open/Close
Button + Left Y	Right stabilizer	Up/Down
Button + Right Y	Left stabilizer	Up/Down

With the potentiometer operator can adjust the system speed to meet the experience of the driver: Functions slow down CCW(counter-clockwise) and speed up CW (clockwise). STOP-button stops the system and all the functions stop moving, but it doesn't turn off the system. The control module is still powered.

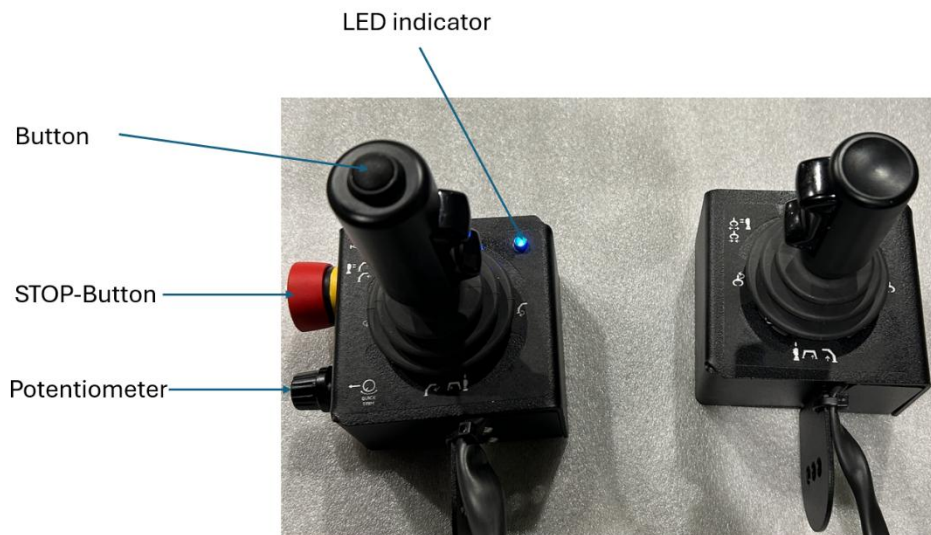


Image 2 Joysticks

4.3 Quick trim -functionality

The Technion Quick Trim -feature enables the operator to quickly adjust the speed of the crane according to instant needs. Technion Quick Trim is designed for daily work. Different situations require different crane speeds.

The feature increases or decreases the speed of all functions simultaneously. Technion Quick Trim can be adjusted by the potentiometer.

The speed of the crane is adjusted with two parameters: Maximum current and Technion Quick Trim.

When Technion Quick Trim is adjusted to 100%, the crane moves at maximum speed, which is dependent on set maximum current. Set the maximum current while Technion Quick Trim is set to 100%.

With lower Quick Trim values, the operator can adjust the balance between different movements. To adjust balance, the Quick Trim value can be decreased to e.g. 50%. The user will then be able to experience how the Technion Quick Trim parameters will affect the system.

Once the Technion Quick Trim parameters meet the requirements of the operator, the speed setting process of the maximum current is complete. Technion Quick Trim can now be adjusted according to the current working mode.

4.4 System indicator states (optional LED)

System green LED indicator is on when the LtCrane-module is powered.

If the fatal error is activated, the LED blinks to express the fault.

If the on/off switch is pressed, the crane movements are disabled, and the LED blinks in three second period.

Table 2 Error codes

Error type	Blink count
ADC input error (Read error from joystick or quick trim input)	1
ON/OFF-output error	3
PWM-output error	5
Joystick error	6
Flash memory error	7
Valve type error (Could not recognize valve type)	8
On/off switch is pressed	One time in 3 second period

5. WIRING DIAGRAM

The LTCrane wiring diagram can be found on Technion web site <https://technion.fi/complete-forestry-solutions/lcrane-en/> .

6. TROUBLESHOOTING

Most common troubleshooting cases are listed in Table 3. Contact your dealer for mor assistance.

Table 3 Troubleshooting

Problem	Symptoms	Solution
Crane is not moving	No power is supplied to the crane	Check the power connection and the fuse. Power connector requires power to two pins
Crane is not moving	Quick Trim-potentiometer is at zero	Adjust the potentiometer
Crane is not moving	Stop-button is pressed down	Release Stop-button
Single movement is not working	Connection to the valve is lost	Check the wiring to the valve connector
	Maximum control current level is too low	Adjust the maximum control current to correct level
	Joystick connection is not working	Check the connection between joysticks and wiring harness
	Joystick failure	Check fault log from service display
Movements are too slow	Maximum control current is too low	Adjust the maximum control current to a correct level.
	Potentiometer is adjusted wrong	Adjust the potentiometer
Movements are jerky	Minimum control current is too high	Decrease minimum control current
	Acceleration and deceleration ramps are too short	Increase ramp times

7. INSTALLATION INSTRUCTIONS

Installation of the LtCrane is a simple task and it can be split into two parts. The first part includes installation of the wiring harness to crane valve block. The wiring harness has 16 connectors for a total of 8 valve sections.

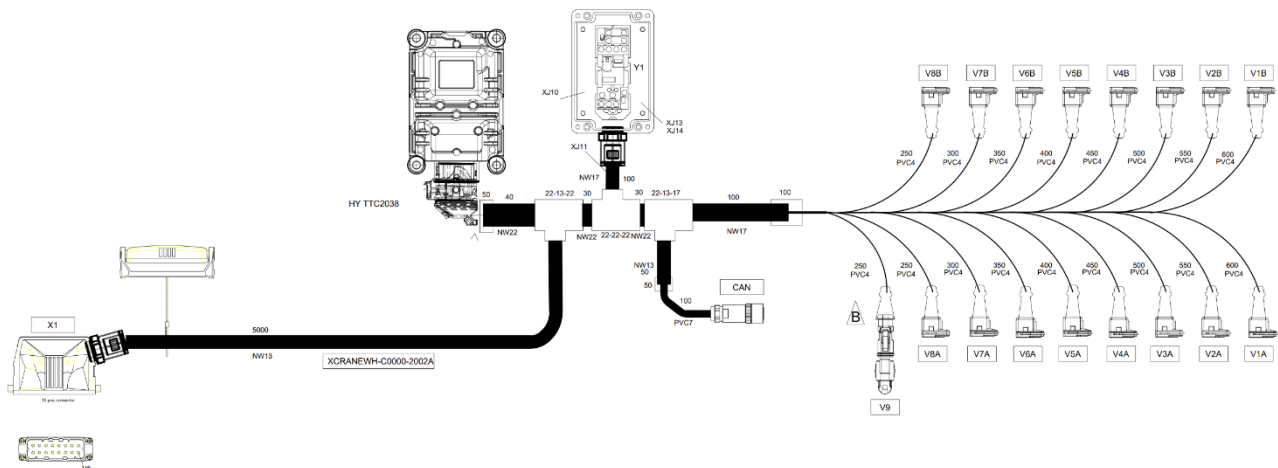


Image 3 LtCrane crane wiring harness

Install the control module and relay box in a well-protected place to protect them from moisture, dust and debris. Use screws to fix them on a flat surface and do not leave them hanging in the air. The best mounting orientation for the control module is connector vertical position connector facing down. The relay box is recommended to be installed cover facing up.

Fix the wiring harness to crane or to hydraulic hoses and make sure that there is no strain to the connectors.

After that, the valve connectors need to be installed. The order of the sections is fixed and can be found in the system's hydraulic diagram. Install the connectors according to Table 4. The wires are labeled V1A, V1B, V2A etc...

Table 4 Valve connections

Slewing CW	V1A
Slewing CCW	V1B
Lift Boom UP	V2A
Lift Boom DOWN	V2B
Outer boom forward	V3A
Outerboom toward	V3B
Rotator CW	V4A
Rotator CCW	V4B
Boom extension Out	V5A
Boom extension In	V5B
Grapple In	V6A
Grapple Out	V6B
Stabilizer Left Down	V7A
Stabilizer Left Up	V7B
Stabilizer Right Down	V8A
Stabilizer Right Up	V8B

There are connectors for joysticks and potentiometer in the cabin wiring harness as well as 3-pin plug for DIN9689-connector commonly used in e.g. tractors.

Install the joysticks to the armrest with suitable armrest kit (sold separately) or to the backwall of the tractor cabin with appropriate mechanical stand so that they are easy to use. The potentiometer is intended to be installed next to the left joystick with the stop button.

The connector connecting the cabin and trailer wiring harnesses should be installed outside, at the back of the cabin close to the rear window. In some tractor models there are special places to install such connectors, but if there is no such place, the installation should be done to a place that is rigid enough to keep the connector in place even if there is vibration or other strain for wiring harnesses

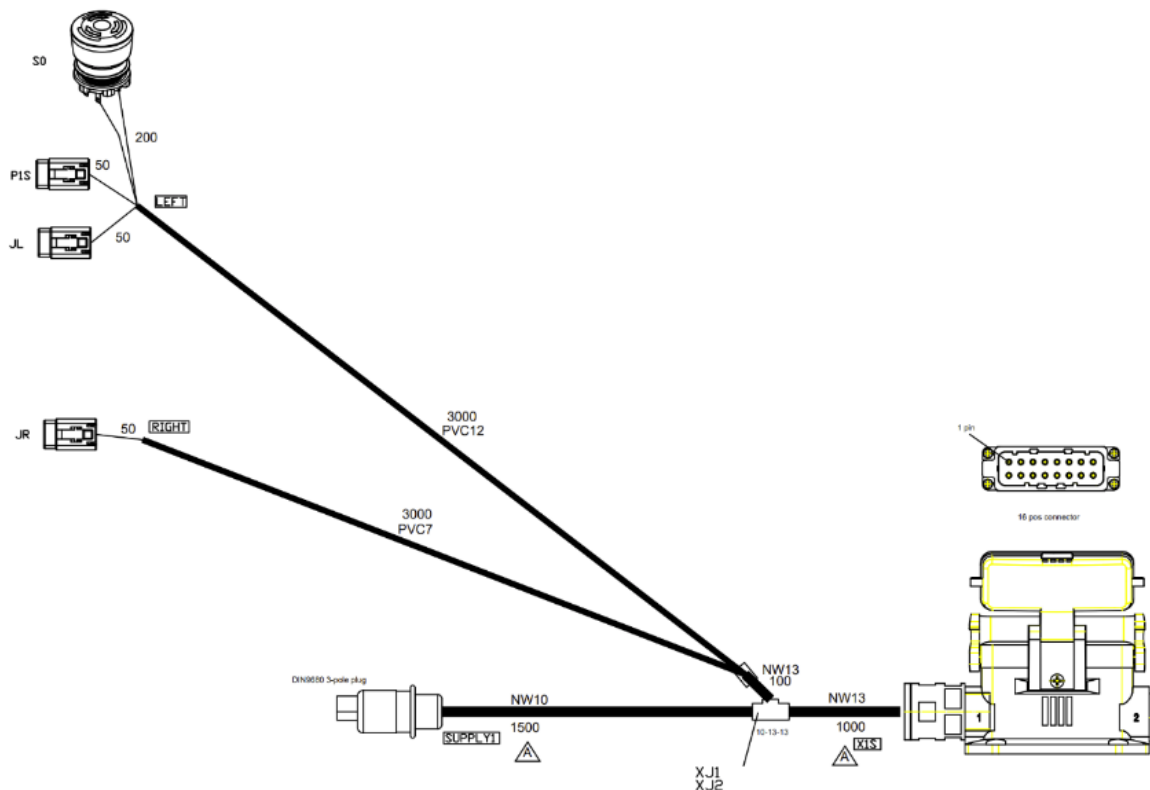


Image 4 LtCrane cabin wiring harness

8. COMMISSIONING

After the system is installed and connections are checked, commissioning of the system may start. Connect the service display to the system and do the following:

1. If crane configuration needs to be loaded, load it from the USB-stick to the system, see chapter 9.3
2. Calibrate joysticks, see chapter 9.5.2
3. Check that the functions' directions are correct and invert, if necessary, see chapter 9.6.2
4. Adjust the minimum currents, see chapter 9.4.2
5. Adjust the max currents, see chapter 9.4.1
6. Adjust the acceleration and deceleration ramps, see chapters 9.4.3 and 9.4.4
7. Adjust the quick trim -values if needed, see chapter 9.4.5
8. Test drive the crane and adjust the speed of the crane to the correct level with the potentiometer
9. Remove the service display from the system and restart the system
10. Test drive the crane and check that everything is working and moving in the right direction

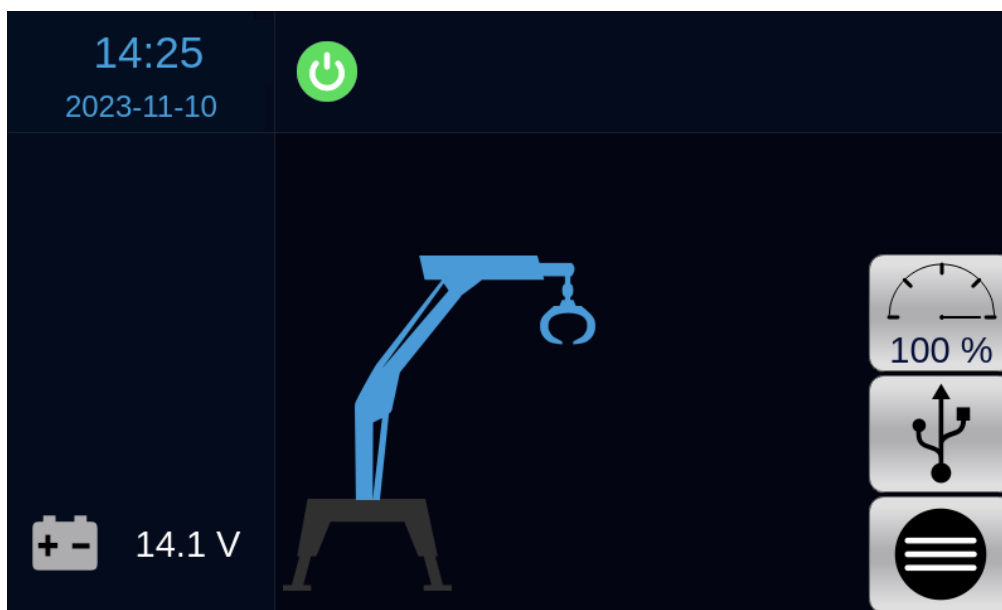
9. SERVICE DISPLAY

The service display is used for monitoring the crane control, troubleshooting, configuring and setting the crane parameters.

9.1 Menu structure

Settings – Crane	Settings – Joystick	Diagnostic	Settings – System
• Max current • Min current • Acceleration ramps • Deceleration ramps • Quick trim gain	• Dead band • Calibration	• Output • Joystick • Sensor • System • SW info • Fault log	• Display • Valve • Configure

9.2 Working view



In the work view user can see battery voltage, on/off-switch state, USB status, control mode and quick trim -percentage.

Green power button -icon indicates that on/off-switch is off, and crane is operable. Light blue indicates crane/stabilizer control.

Stabilizers can be controlled with joystick Y-axis when the left joystick button is pressed.

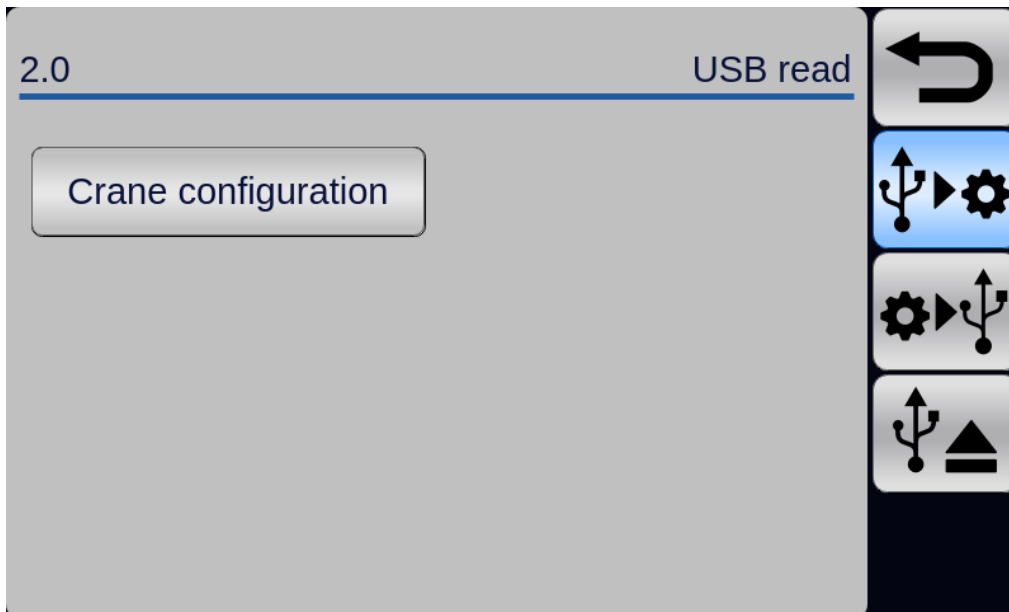
If the USB stick is installed, the USB icon is shown in black, and the USB functions can be accessed by pressing the USB-icon.

To access settings, press menu-button.

NOTE!

Date and time are not visible in case of display variant Opus B2, since it does not have real time clock.

9.3 USB menu



The crane settings can be transferred from the USB stick to the module by pressing the “Crane configuration” -button when the “USB to system” -button is pressed.

NOTE!

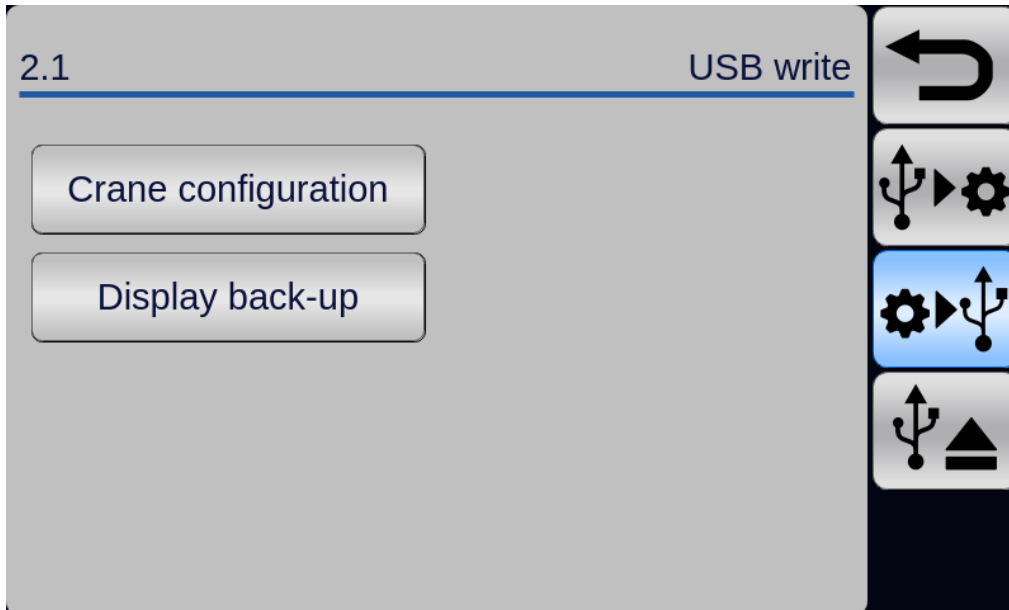
There should be only one crane setting file on the USB stick, otherwise the crane settings can't be transferred.

In such case the “Crane configuration” -button is grayed out and a circle with number indicating the number of configuration files in the USB-stick appears at the top right corner button.

NOTE!

Before transferring the configuration file from USB-stick to system, several checks are carried out to avoid undesired system behavior:

- If the file is not intact, downloading is cancelled
- If the file contains less parameters than the software, downloading is cancelled
- If the file was created with a later software version, downloading is cancelled
- If the file was created with an earlier software version, user may decide if to continue. The user needs to pay special attention on system behavior since it may not work as expected due e.g. missing parameters.



The crane settings can be transferred from crane module to the USB stick by pressing the "Crane configuration" -button when the "System to USB" -icon is selected.

The Display software back-up can be written on the USB stick by pressing "Display back-up" - button.

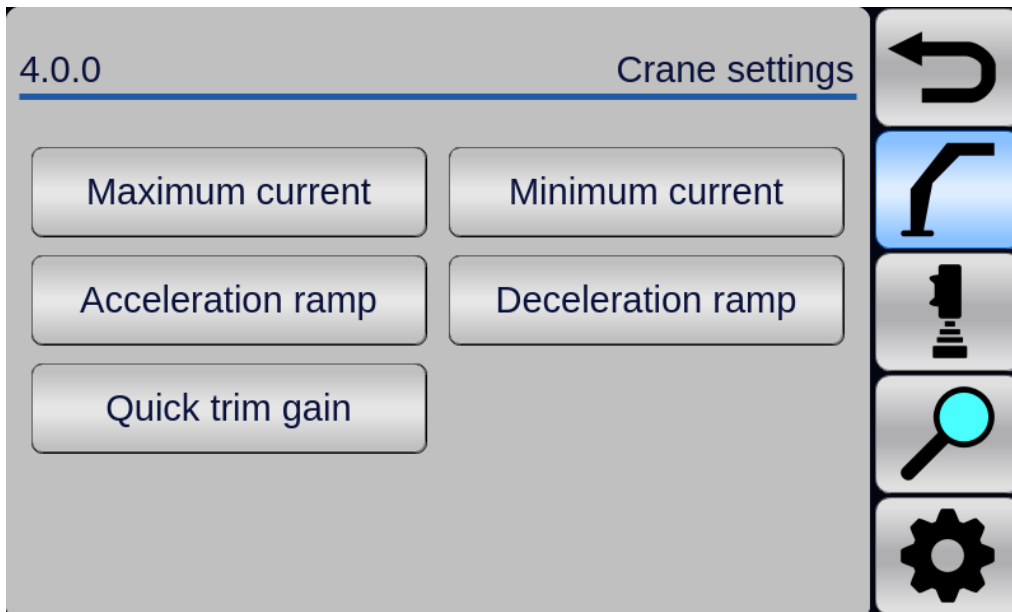
The icon in the right bottom corner is for ejecting the USB stick.



NOTE!

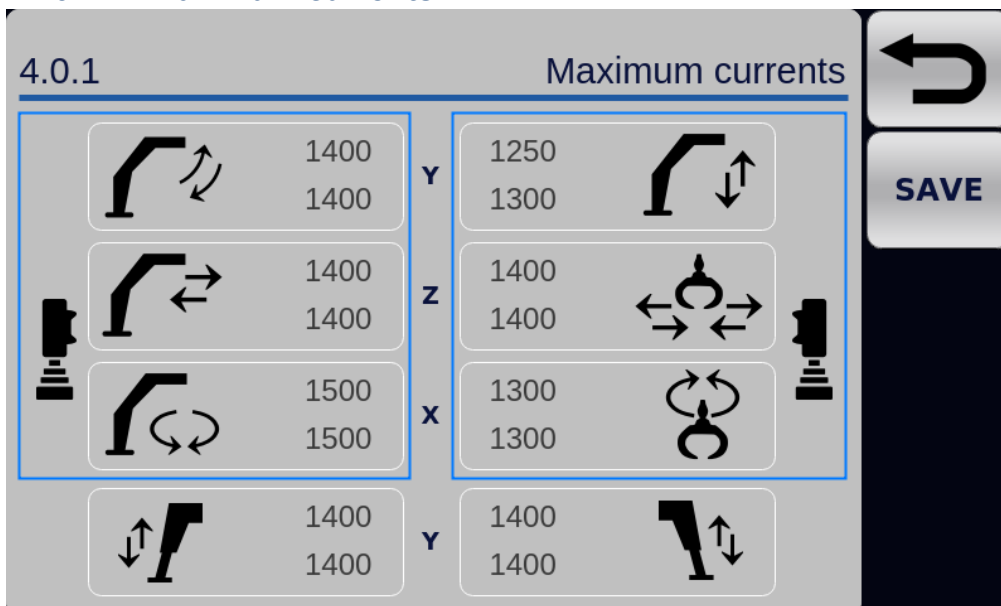
If the USB stick is installed with display back-up files, the display prompts for updating the display software.

9.4 Settings - Crane



In the Crane settings menu, all crane control parameters can be found under submenus.

9.4.1 Maximum currents



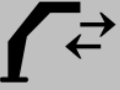
Maximum currents for all functions can be adjusted in "Maximum current" -page. The values are given in milliamperes and are applied after the save button is pressed.

NOTE!

See the specification of the valve in use for the maximum allowed current.

9.4.2 Minimum currents

4.0.2
Minimum currents

	630 640	Y	650 610	
	620 610	Z	620 600	
	630 630	X	630 630	
	630 630	Y	630 630	



SAVE

Minimum current control for the valves must be set according to following process:

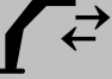
1. Increase the value until the crane function starts to move.
2. Press the save button to apply new value.
3. Decrease the value until the function stops.
4. Decrease 2 steps further (=20mA)
5. Perform this for each function and for each direction.
6. Press back icon and save the new settings.

NOTE!

The new setting are sent to the LtCrane module from display after the save button is pressed.

9.4.3 Acceleration ramps

4.0.3
Acceleration ramps
↶

	300 300	Y	500 500	
	300 300	Z	150 150	
	700 700	X	300 300	
	300 300	Y	300 300	

SAVE

The acceleration ramps in milliseconds define how quickly the function accelerates from minimum to maximum speed. The greater the ramp value, the longer time it will take reach the maximum speed. Set the acceleration ramps so that crane movements are smooth and response is fast enough.

9.4.4 Deceleration ramps

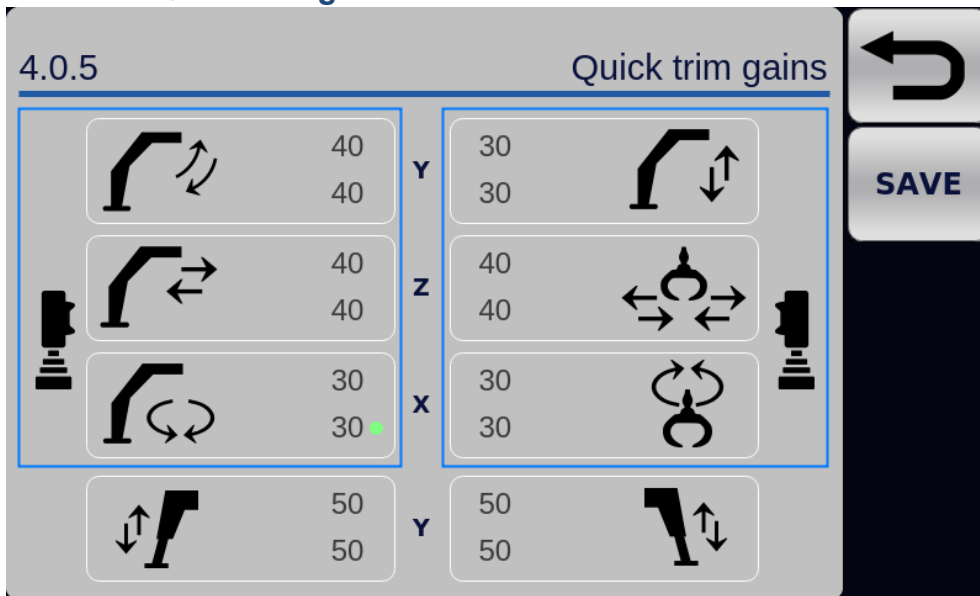
4.0.4
Deceleration ramps
↶

	300 300	Y	500 500	
	300 300	Z	150 150	
	800 800	X	300 300	
	300 300	Y	300 300	

SAVE

The deceleration ramps in milliseconds define how quickly the function decelerates from maximum to minimum speed. The greater the ramp value, the longer time it will take a function to stop. Set the deceleration ramps so that crane movements are smooth and response is fast enough, that is, a function does not keep going too long after releasing joystick, which could lead to an injury or damage.

9.4.5 Quick trim gain



With the Technion Quick Trim gain -settings you can adjust the effect of the Quick Trim - potentiometer for each function and direction. You may want that potentiometer affects only to some functions while others stay as they are. For that, set value for those functions < 100.

Use the save button to apply new values to LTCrane after adjusting the speed balance.

The use of Technion Quick Trim is explained with two simple examples.

The speed of a function can be determined as shown below:

QuickTrim gain = Quick Trim gain -value

QuickTrim = Potentiometer -value

MAXSpeed = Current joystick value

$$\left(100 - \frac{(100 - \text{QuickTrim gain}) * (100 - \text{QuickTrim})}{100}\right) * \frac{\text{MAXSpeed}}{100}$$

Example 1

QuickTrim gain = 0%

Max speed =100%

Quick trim = 50

$$\left(100 - \frac{(100 - 0) * (100 - 50)}{100}\right) * \frac{100}{100} = 50\%$$

The result is that the speed of a function is 50% of the max speed.

Example 2

QuickTrim gain =100%

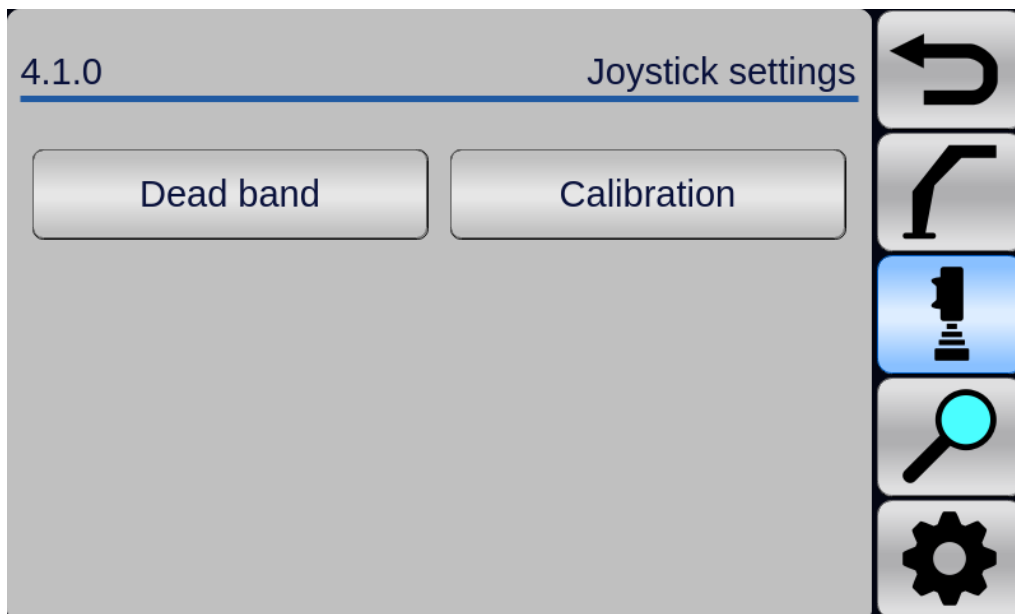
Max speed =100%

Quick Trim =50%

$$\left(100 - \left(\frac{(100 - 100) * (100 - 50)}{100}\right) * \frac{100}{100}\right) = 100\%$$

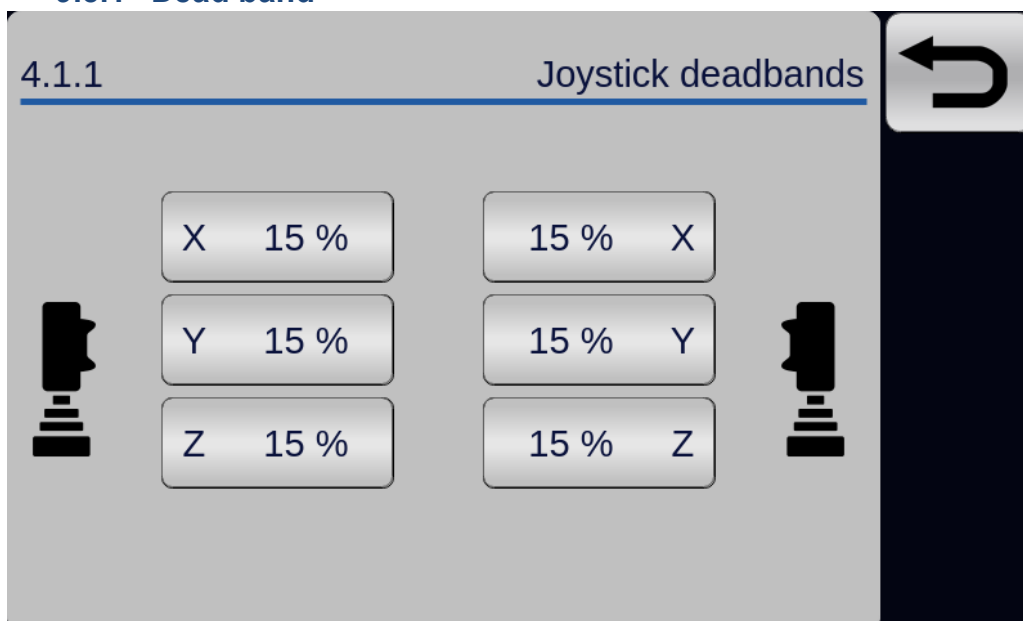
The result is that the Quick trim doesn't affect on the selected motion speed at all.

9.5 Settings - Joystick



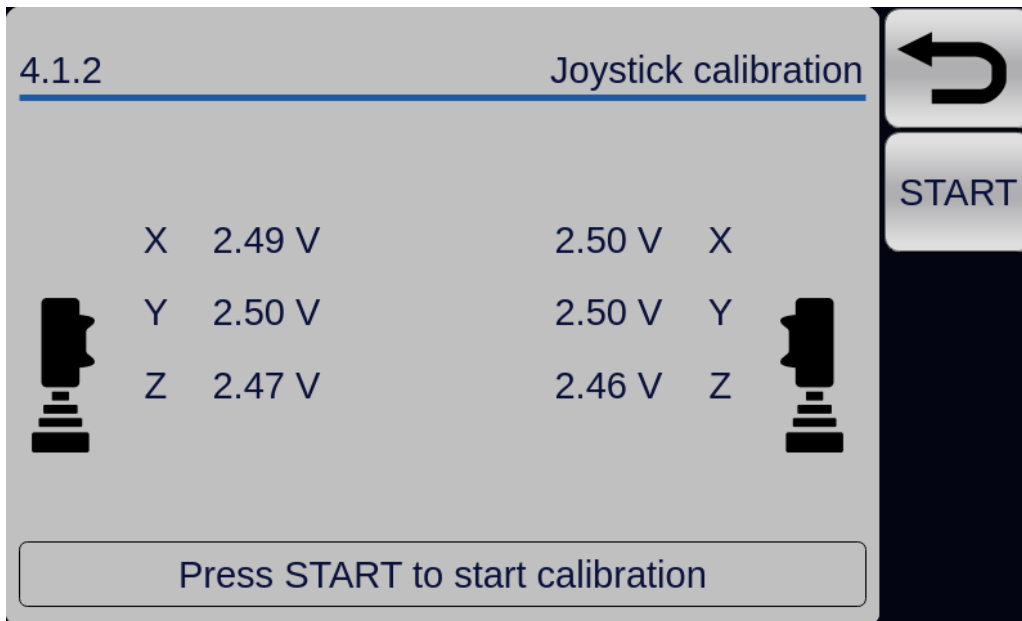
In the Joystick settings menu, the joystick dead band configuration and the joystick calibration can be found.

9.5.1 Dead band

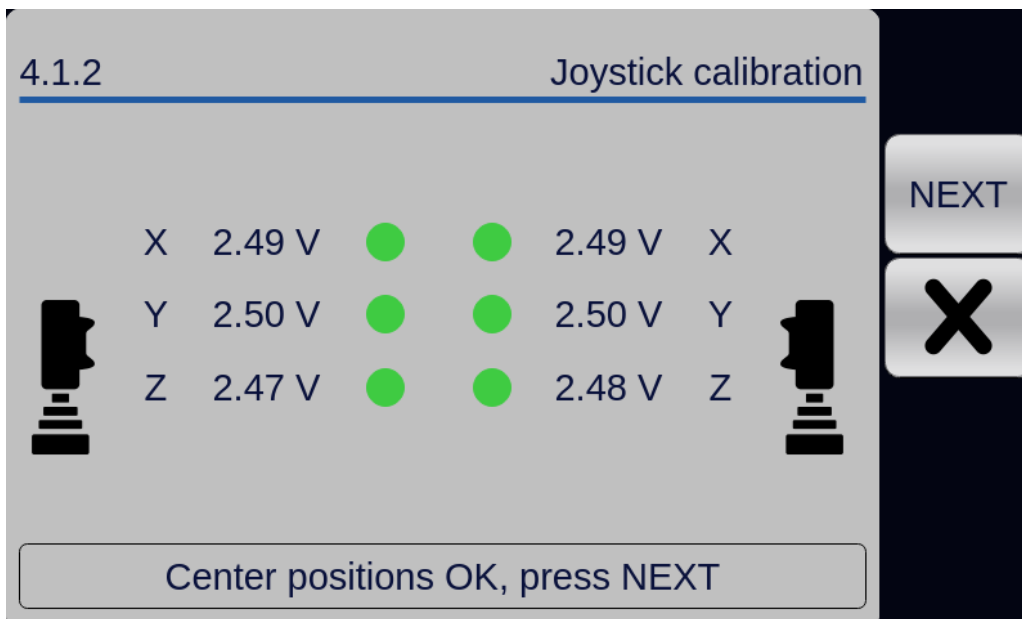


The Dead band settings define how much the joystick must move from the center position to activate a function. This is used to prevent unwanted movements, for example while driving the tractor.

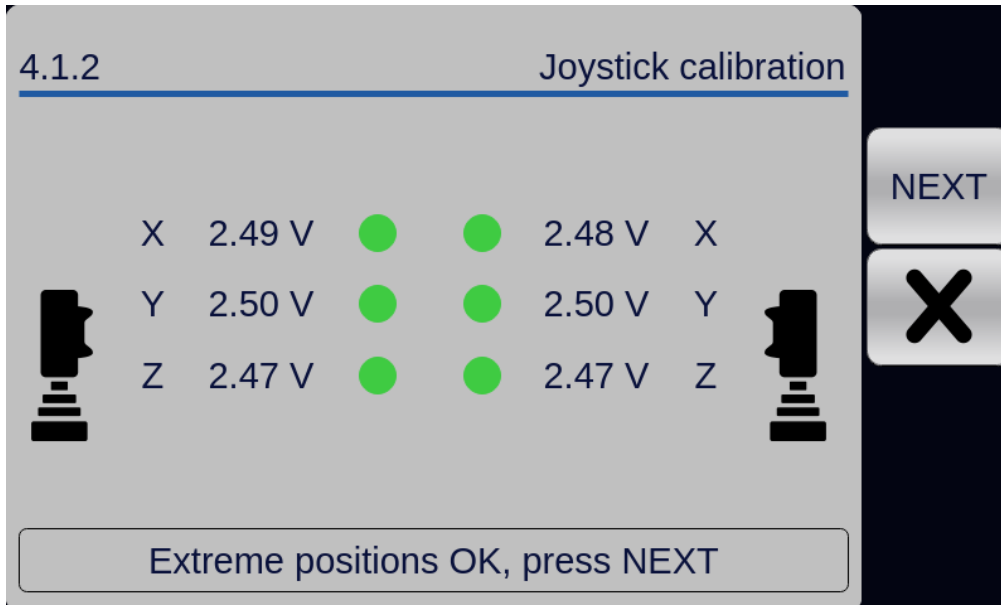
9.5.2 Calibration



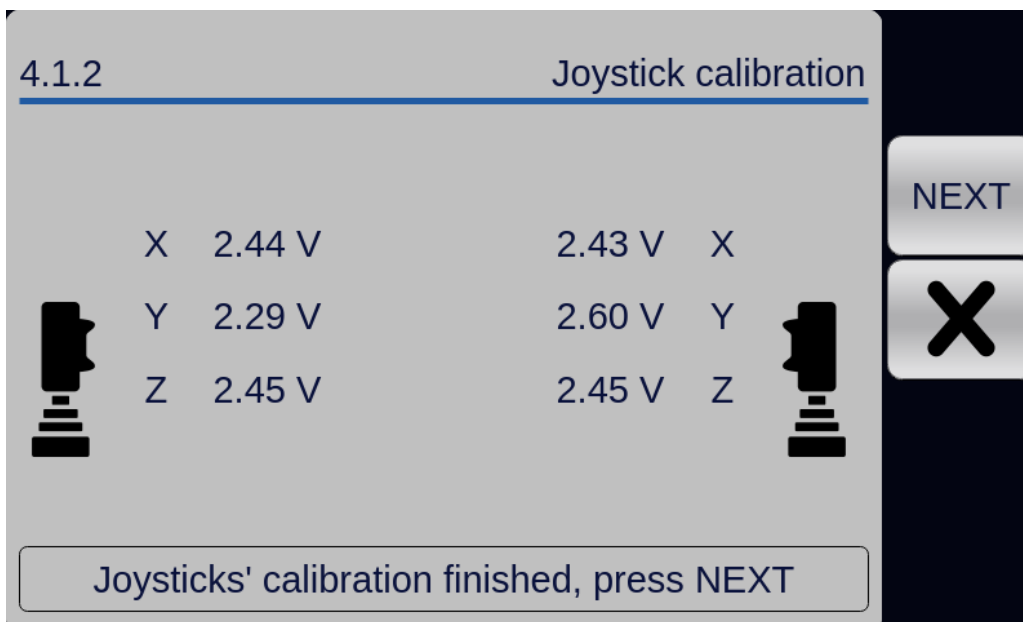
To start joystick calibration, press the START-button.



When the center positions are found, the green circles appear next to all axes. Press the NEXT-button to continue.

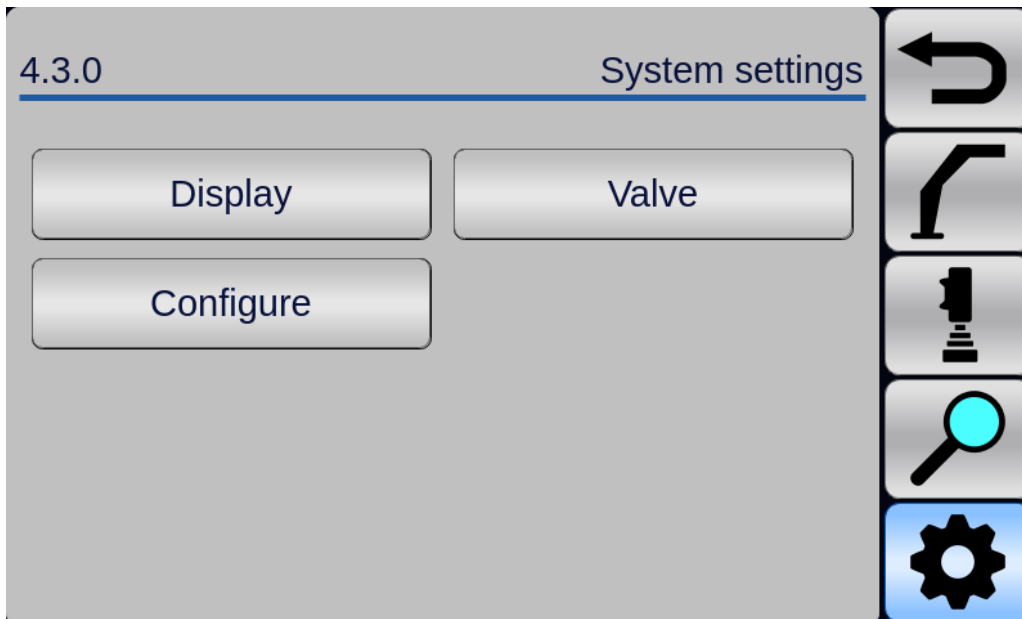


To set the joysticks' extreme positions, move the joystick to all directions and hold for about one second. When the positions have been detected, the green circles are shown next to all directions. Press the next icon to continue.



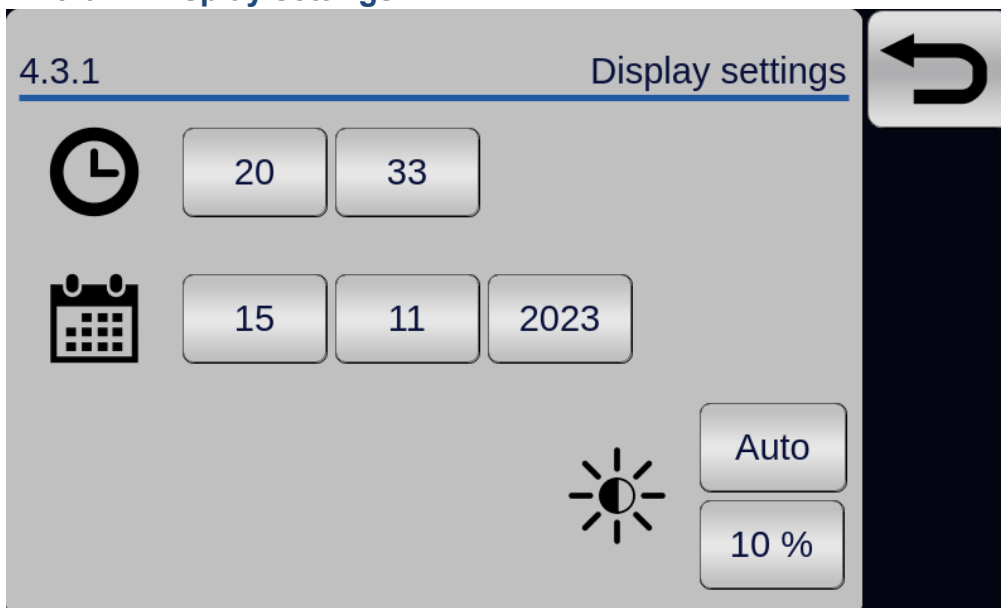
The calibration has been completed. Press "Next" to confirm your calibration data. Save your data by returning to the working view.

9.6 Settings - system



In the “System settings” -page, the submenus for configuring Display, valves and general system configurations can be accessed.

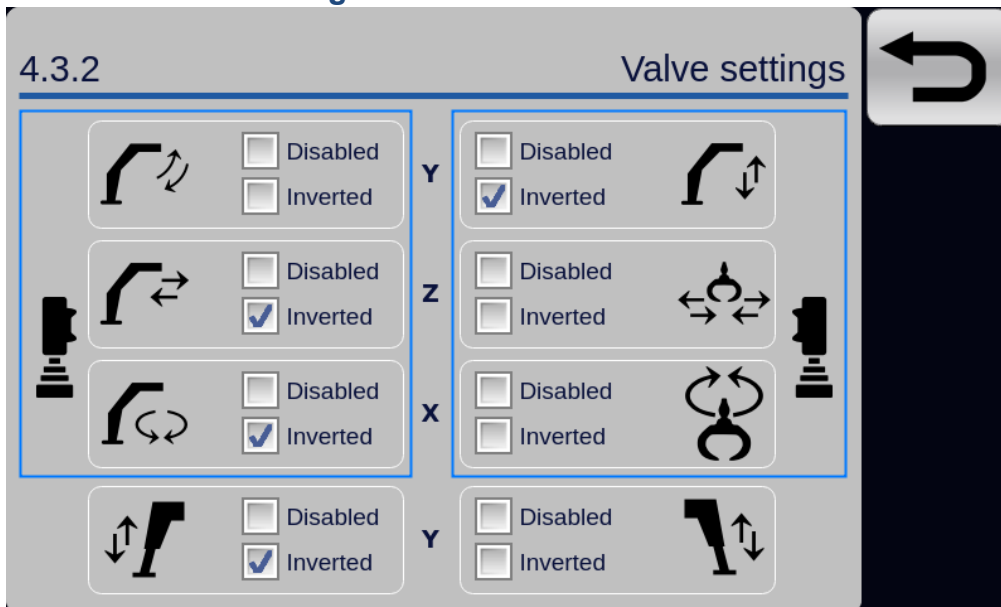
9.6.1 Display settings



The date, time, display brightness and brightness mode can be set in this screen.

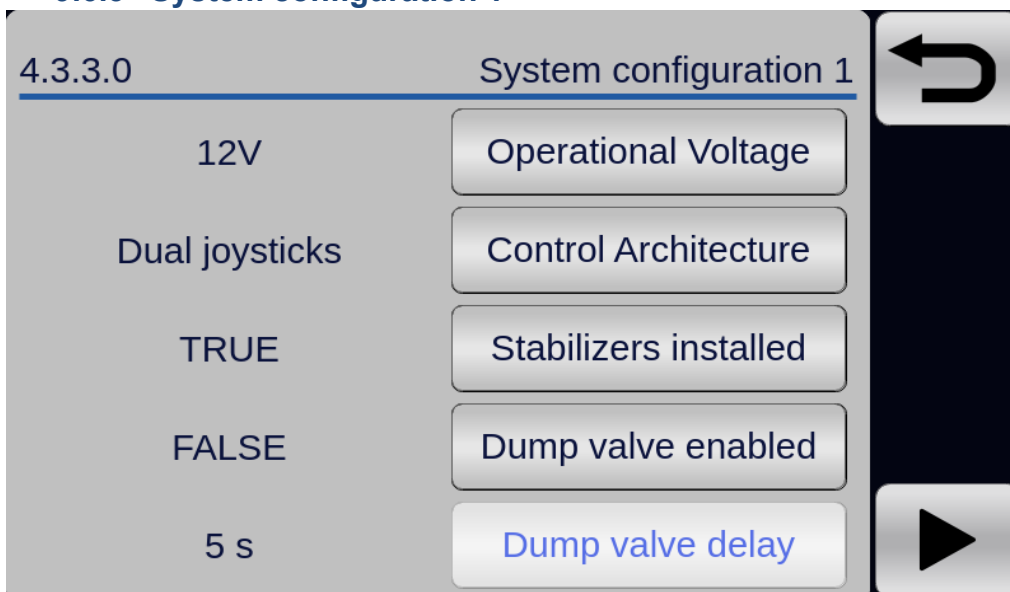
NOTE! Display variant Opus B2 does not have a clock nor light sensor and thus corresponding settings are not visible.

9.6.2 Valve settings



In “Valve settings” -page each valve can be disabled if it is not used or inverted if opposite direction is used.

9.6.3 System configuration 1



Choose the operation voltage of the system: 12 V or 24 V.

Select the control architecture: Dual joystick, left joystick or right joystick.

Select if stabilizers exist.

Enable the dump valve control if dump valve is used.

Select the delay for releasing the dump valve after the functions have stopped.

9.6.4 System configuration 2

4.3.3.1

System configuration 2



Hydac LX3 / LX6		Valve type	
TRUE		Quicktrim enabled	
Inverse		Quicktrim mode	
Current voltage	4.6 V	Set quicktrim max	
1.1 V	0.0 V	Set quicktrim min	

Select the valve type: Type is important to set correct parameters for PWM current control.

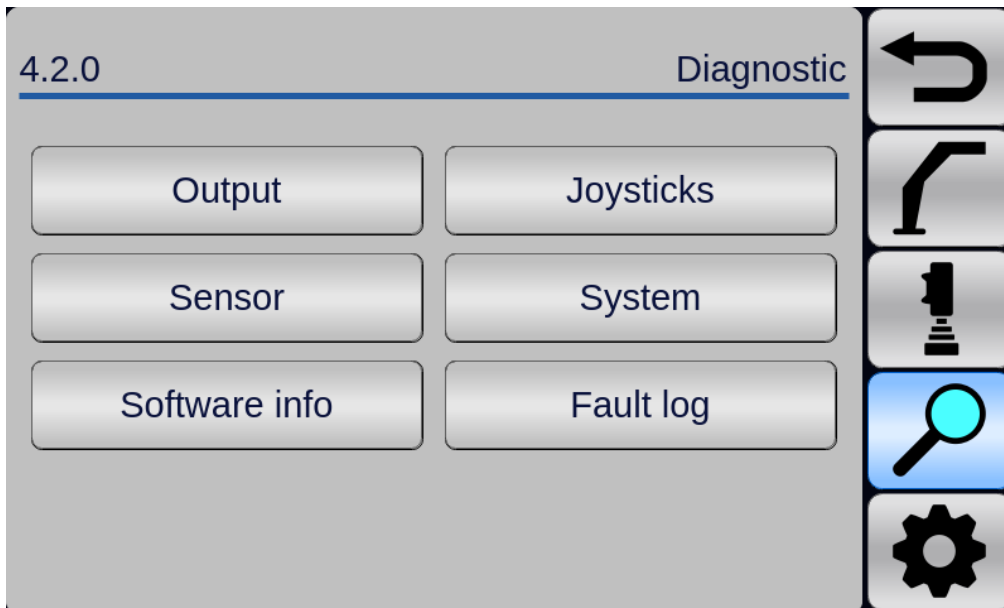
Select if the Quick Trim is used.

Select the Quick Trim -potentiometer control direction.

Set the Quick Trim maximum voltage.

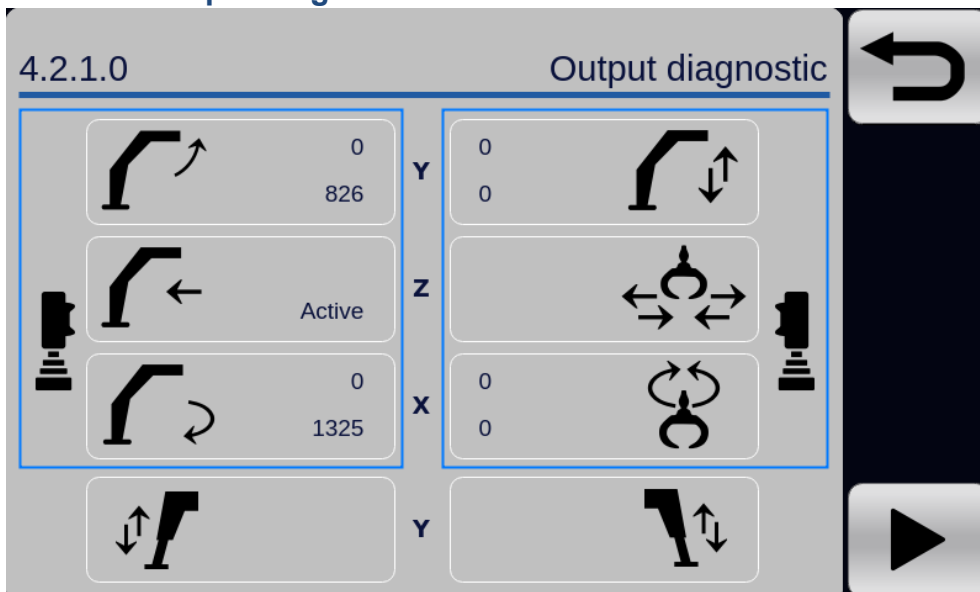
Set the Quick Trim minimum voltage.

9.7 Diagnostics



Diagnostic submenus can be accessed in “Diagnostic” -page.

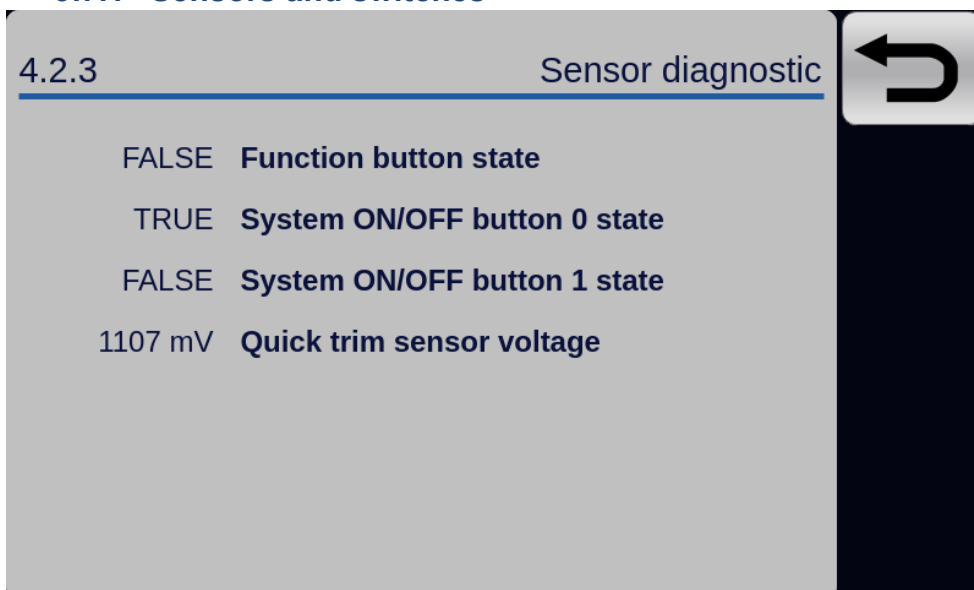
9.7.1 Output diagnostic



Outputs' currents in milli amperes can be monitored in this page.

For the rotator, telescope and stabilizer only activity is shown.

9.7.1 Sensors and switches

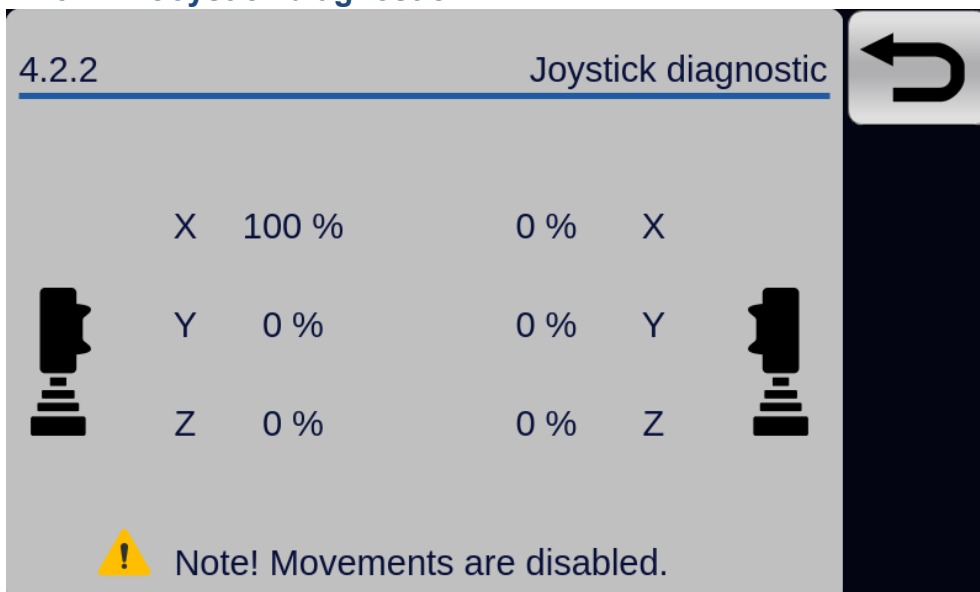


Joystick button state, On/off switch inputs state and the quick trim potentiometer voltage are shown in “Sensor Diagnostic” -page.

NOTE! The system on/off switch inputs 0 state needs to be TRUE and the input 1 needs to be FALSE to enable crane control.

The on/off switch state is also shown on the top of the working window: If the Power Button -icon is red, it means that the on/off switch is on, and the crane controls are disabled.

9.7.1 Joystick diagnostic



Joystick calibration can be tested on “Joystick diagnostic” -page. Each value should change -100%...100% when the joysticks are moved to extreme positions.

NOTE! The movements are disabled when “Joystick diagnostic” page is visible.

9.8 Fault log

4.2.6

System Time: 14:37:52

Fault log

	Timestamp	Error Code	# of Occurrence
⚠	14:25:52	0x8610	1
⚠	14:25:52	0x8611	1
⚠	Error Code Description Error code: 0x8610 Description: Joystick channel 0 low limit error.		

↶

Clear Log

If errors have occurred in the module, the fault code is added to the fault log.

The active fault code is shown in yellow color. When pressing the error code, more information is displayed about fault's reason.

Timestamp for the fault code is module on-time counter in seconds.

of occurrence is the counter for fault code, the counter increases only if the error is still present after the device reset.

NOTE! If the fault code is Fatal error, the crane control is not possible without resetting.

9.8.1 List of fault code types

Table 5 Fault codes

Fault code	Fault code type	Description	Fatal error
0x8160	ADC input	Protection active in left joystick x-axis	No
0x8161	ADC input	Protection active in left joystick y-axis	No
0x8162	ADC input	Protection active in left joystick z-axis	No
0x8163	ADC input	Protection active in right joystick x-axis	No
0x8164	ADC input	Protection active in right joystick y-axis	No
0x8165	ADC input	Protection active in right joystick z-axis	No
0x8166	ADC input	Protection active in left joystick button	No
0x8167	ADC input	Protection active in quick trim potentiometer	No
0x8170	ADC input	Protection reenable in left joystick x-axis	No
0x8171	ADC input	Protection reenable in left joystick y-axis	No
0x8172	ADC input	Protection reenable in left joystick z-axis	No
0x8173	ADC input	Protection reenable in right joystick x-axis	No
0x8174	ADC input	Protection reenable in right joystick y-axis	No
0x8175	ADC input	Protection reenable in right joystick z-axis	No
0x8176	ADC input	Protection reenable in left joystick button	No
0x8177	ADC input	Protection reenable in quick trim potentiometer	No
0x8180	ADC input	Protection permanent off in left joystick x-axis	Yes
0x8181	ADC input	Protection permanent off in left joystick y-axis	Yes
0x8182	ADC input	Protection permanent off in left joystick z-axis	Yes
0x8183	ADC input	Protection permanent off in right joystick x-axis	Yes
0x8184	ADC input	Protection permanent off in right joystick y-axis	Yes
0x8185	ADC input	Protection permanent off in right joystick z-axis	Yes
0x8186	ADC input	Protection permanent off in left joystick button	Yes
0x8187	ADC input	Protection permanent off in quick trim potentiometer	Yes
0x8190	ADC input	Voltage below minimum limit in left joystick x-axis	No
0x8191	ADC input	Voltage below minimum limit in left joystick y-axis	No

0x8192	ADC input	Voltage below minimum limit in left joystick z-axis	No
0x8193	ADC input	Voltage below minimum limit in right joystick x-axis	No
0x8194	ADC input	Voltage below minimum limit in right joystick y-axis	No
0x8195	ADC input	Voltage below minimum limit in right joystick z-axis	No
0x8196	ADC input	Voltage below minimum limit in left joystick button	No
0x8197	ADC input	Voltage below minimum limit in quick trim potentiometer	No
0x81A0	ADC input	Voltage over maximum limit in left joystick x-axis	No
0x81A1	ADC input	Voltage over maximum limit in left joystick y-axis	No
0x81A2	ADC input	Voltage over maximum limit in left joystick z-axis	No
0x81A3	ADC input	Voltage over maximum limit in right joystick x-axis	No
0x81A4	ADC input	Voltage over maximum limit in right joystick y-axis	No
0x81A5	ADC input	Voltage over maximum limit in right joystick z-axis	No
0x81A6	ADC input	Voltage over maximum limit in left joystick button	No
0x81A7	ADC input	Voltage over maximum limit in quick trim potentiometer	No
0x8310	Digital output	Short to GND on startup in valve V5A/V7A	No
0x8311	Digital output	Short to GND on startup in valve V5B/V7B	No
0x8312	Digital output	Short to GND on startup in valve V6A/V8A	No
0x8313	Digital output	Short to GND on startup in valve V6B/V8B	No
0x8314	Digital output	Short to GND on startup in relay control	No
0x8315	Digital output	Short to GND on startup in valve V9	No
0x8320	Digital output	Open load on startup in valve V5A/V7A	No
0x8321	Digital output	Open load on startup in valve V5B/V7B	No
0x8322	Digital output	Open load on startup in valve V6A/V8A	No
0x8323	Digital output	Open load on startup in valve V6B/V8B	No
0x8324	Digital output	Open load on startup in relay control	No

0x8325	Digital output	Open load on startup in valve V9	No
0x8330	Digital output	Short to battery on startup in valve V5A/V7A	No
0x8331	Digital output	Short to battery on startup in valve V5B/V7B	No
0x8332	Digital output	Short to battery on startup in valve V6A/V8A	No
0x8333	Digital output	Short to battery on startup in valve V6B/V8B	No
0x8334	Digital output	Short to battery on startup in relay control	No
0x8335	Digital output	Short to battery on startup in valve V9	No
0x8340	Digital output	Short to other on startup in valve V5A/V7A	No
0x8341	Digital output	Short to other on startup in valve V5B/V7B	No
0x8342	Digital output	Short to other on startup in valve V6A/V8A	No
0x8343	Digital output	Short to other on startup in valve V6B/V8B	No
0x8344	Digital output	Short to other on startup in relay control	No
0x8345	Digital output	Short to other on startup in valve V9	No
0x8360	Digital output	Protection active in valve V5A/V7A	No
0x8361	Digital output	Protection active in valve V5B/V7B	No
0x8362	Digital output	Protection active in valve V6A/V8A	No
0x8363	Digital output	Protection active in valve V6B/V8B	No
0x8364	Digital output	Protection active in relay control	No
0x8365	Digital output	Protection active in valve V9	No
0x8370	Digital output	Protection reenable in valve V5A/V7A	No
0x8371	Digital output	Protection reenable in valve V5B/V7B	No
0x8372	Digital output	Protection reenable in valve V6A/V8A	No
0x8373	Digital output	Protection reenable in valve V6B/V8B	No
0x8374	Digital output	Protection reenable in relay control	No
0x8375	Digital output	Protection reenable in valve V9	No
0x8380	Digital output	Protection permanent off in valve V5A/V7A	Yes
0x8381	Digital output	Protection permanent off in valve V5B/V7B	Yes
0x8382	Digital output	Protection permanent off in valve V6A/V8A	Yes
0x8383	Digital output	Protection permanent off in valve V6B/V8B	Yes
0x8384	Digital output	Protection permanent off in relay control	Yes

0x8385	Digital output	Protection permanent off in valve V9	Yes
0x8390	Digital output	Short to GND in valve V5A/V7A	No
0x8391	Digital output	Short to GND in valve V5B/V7B	No
0x8392	Digital output	Short to GND in valve V6A/V8A	No
0x8393	Digital output	Short to GND in valve V6B/V8B	No
0x8394	Digital output	Short to GND in relay control	No
0x8395	Digital output	Short to GND in valve V9	No
0x83A0	Digital output	Open load in valve V5A/V7A	No
0x83A1	Digital output	Open load in valve V5B/V7B	No
0x83A2	Digital output	Open load in valve V6A/V8A	No
0x83A3	Digital output	Open load in valve V6B/V8B	No
0x83A4	Digital output	Open load in relay control	No
0x83A5	Digital output	Open load in valve V9	No
0x83B0	Digital output	Short to battery in valve V5A/V7A	No
0x83B1	Digital output	Short to battery in valve V5B/V7B	No
0x83B2	Digital output	Short to battery in valve V6A/V8A	No
0x83B3	Digital output	Short to battery in valve V6B/V8B	No
0x83B4	Digital output	Short to battery in relay control	No
0x83B5	Digital output	Short to battery in valve V9	No
0x83C0	Digital output	Power off in valve V5A/V7A	Yes
0x83C1	Digital output	Power off in valve V5B/V7B	Yes
0x83C2	Digital output	Power off in valve V6A/V8A	Yes
0x83C3	Digital output	Power off in valve V6B/V8B	Yes
0x83C4	Digital output	Power off in relay control	Yes
0x83C5	Digital output	Power off in valve V9	Yes
0x83D0	Digital output	Write error	No
0x83D1	Digital output	Busy error	No
0x83FF	Digital output	General error	No
0x8500	PWM output	Startup error in valve V1A	No
0x8501	PWM output	Startup error in valve V1B	No

0x8502	PWM output	Startup error in valve V2A	No
0x8503	PWM output	Startup error in valve V2B	No
0x8504	PWM output	Startup error in valve V3A	No
0x8505	PWM output	Startup error in valve V3B	No
0x8506	PWM output	Startup error in valve V4A	No
0x8507	PWM output	Startup error in valve V4B	No
0x8510	PWM output	Startup short to GND in valve V1A	No
0x8511	PWM output	Startup short to GND in valve V1B	No
0x8512	PWM output	Startup short to GND in valve V2A	No
0x8513	PWM output	Startup short to GND in valve V2B	No
0x8514	PWM output	Startup short to GND in valve V3A	No
0x8515	PWM output	Startup short to GND in valve V3B	No
0x8516	PWM output	Startup short to GND in valve V4A	No
0x8517	PWM output	Startup short to GND in valve V4B	No
0x8520	PWM output	Startup open load in valve V1A	No
0x8521	PWM output	Startup open load in valve V1B	No
0x8522	PWM output	Startup open load in valve V2A	No
0x8523	PWM output	Startup open load in valve V2B	No
0x8524	PWM output	Startup open load in valve V3A	No
0x8525	PWM output	Startup open load in valve V3B	No
0x8526	PWM output	Startup open load in valve V4A	No
0x8527	PWM output	Startup open load in valve V4B	No
0x8530	PWM output	Startup short to battery in valve V1A	No
0x8531	PWM output	Startup short to battery in valve V1B	No
0x8532	PWM output	Startup short to battery in valve V2A	No
0x8533	PWM output	Startup short to battery in valve V2B	No
0x8534	PWM output	Startup short to battery in valve V3A	No
0x8535	PWM output	Startup short to battery in valve V3B	No
0x8536	PWM output	Startup short to battery in valve V4A	No
0x8537	PWM output	Startup short to battery in valve V4B	No

0x8538	PWM output	Startup short to battery in valve V5A	No
0x8539	PWM output	Startup short to battery in valve V5B	No
0x853A	PWM output	Startup short to battery in valve V6A	No
0x853B	PWM output	Startup short to battery in valve V6B	No
0x853C	PWM output	Startup short to battery in valve V7A	No
0x853D	PWM output	Startup short to battery in valve V7B	No
0x853E	PWM output	Startup short to battery in valve V8A	No
0x853F	PWM output	Startup short to battery in valve V8B	No
0x8540	PWM output	Startup short to other in valve V1A	No
0x8541	PWM output	Startup short to other in valve V1B	No
0x8542	PWM output	Startup short to other in valve V2A	No
0x8543	PWM output	Startup short to other in valve V2B	No
0x8544	PWM output	Startup short to other in valve V3A	No
0x8545	PWM output	Startup short to other in valve V3B	No
0x8546	PWM output	Startup short to other in valve V4A	No
0x8547	PWM output	Startup short to other in valve V4B	No
0x8548	PWM output	Startup short to other in valve V5A	No
0x8549	PWM output	Startup short to other in valve V5B	No
0x854A	PWM output	Startup short to other in valve V6A	No
0x854B	PWM output	Startup short to other in valve V6B	No
0x854C	PWM output	Startup short to other in valve V7A	No
0x854D	PWM output	Startup short to other in valve V7B	No
0x854E	PWM output	Startup short to other in valve V8A	No
0x854F	PWM output	Startup short to other in valve V8B	No
0x8560	PWM output	Protection active in valve V1A	No
0x8561	PWM output	Protection active in valve V1B	No
0x8562	PWM output	Protection active in valve V2A	No
0x8563	PWM output	Protection active in valve V2B	No
0x8564	PWM output	Protection active in valve V3A	No
0x8565	PWM output	Protection active in valve V3B	No

0x8566	PWM output	Protection active in valve V4A	No
0x8567	PWM output	Protection active in valve V4B	No
0x8568	PWM output	Protection active in valve V5A	No
0x8569	PWM output	Protection active in valve V5B	No
0x856A	PWM output	Protection active in valve V6A	No
0x856B	PWM output	Protection active in valve V6B	No
0x856C	PWM output	Protection active in valve V7A	No
0x856D	PWM output	Protection active in valve V7B	No
0x856E	PWM output	Protection active in valve V8A	No
0x856F	PWM output	Protection active in valve V8B	No
0x8570	PWM output	Protection reenable in valve V1A	No
0x8571	PWM output	Protection reenable in valve V1B	No
0x8572	PWM output	Protection reenable in valve V2A	No
0x8573	PWM output	Protection reenable in valve V2B	No
0x8574	PWM output	Protection reenable in valve V3A	No
0x8575	PWM output	Protection reenable in valve V3B	No
0x8576	PWM output	Protection reenable in valve V4A	No
0x8577	PWM output	Protection reenable in valve V4B	No
0x8578	PWM output	Protection reenable in valve V5A	No
0x8579	PWM output	Protection reenable in valve V5B	No
0x857A	PWM output	Protection reenable in valve V6A	No
0x857B	PWM output	Protection reenable in valve V6B	No
0x857C	PWM output	Protection reenable in valve V7A	No
0x857D	PWM output	Protection reenable in valve V7B	No
0x857E	PWM output	Protection reenable in valve V8A	No
0x857F	PWM output	Protection reenable in valve V8B	No
0x8580	PWM output	Protection permanent off in valve V1A	No
0x8581	PWM output	Protection permanent off in valve V1B	No
0x8582	PWM output	Protection permanent off in valve V2A	No
0x8583	PWM output	Protection permanent off in valve V2B	No

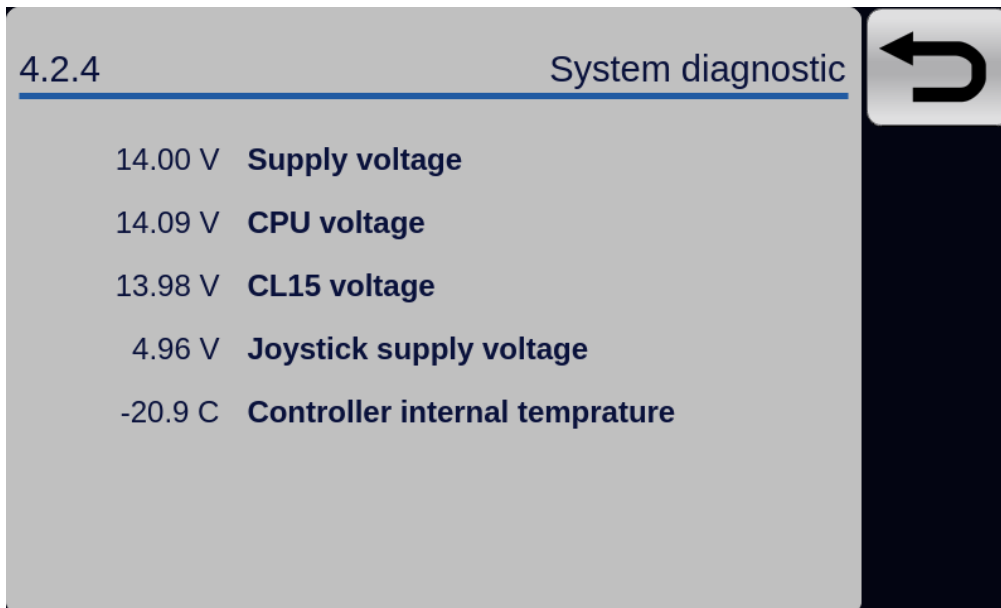
0x8584	PWM output	Protection permanent off in valve V3A	No
0x8585	PWM output	Protection permanent off in valve V3B	No
0x8586	PWM output	Protection permanent off in valve V4A	No
0x8587	PWM output	Protection permanent off in valve V4B	No
0x8588	PWM output	Protection permanent off in valve V5A	No
0x8589	PWM output	Protection permanent off in valve V5B	No
0x858A	PWM output	Protection permanent off in valve V6A	No
0x858B	PWM output	Protection permanent off in valve V6B	No
0x858C	PWM output	Protection permanent off in valve V7A	No
0x858D	PWM output	Protection permanent off in valve V7B	No
0x858E	PWM output	Protection permanent off in valve V8A	No
0x858F	PWM output	Protection permanent off in valve V8B	No
0x8590	PWM output	Short to GND in valve V1A	No
0x8591	PWM output	Short to GND in valve V1B	No
0x8592	PWM output	Short to GND in valve V2A	No
0x8593	PWM output	Short to GND in valve V2B	No
0x8594	PWM output	Short to GND in valve V3A	No
0x8595	PWM output	Short to GND in valve V3B	No
0x8596	PWM output	Short to GND in valve V4A	No
0x8597	PWM output	Short to GND in valve V4B	No
0x8598	PWM output	Short to GND in valve V5A	No
0x8599	PWM output	Short to GND in valve V5B	No
0x859A	PWM output	Short to GND in valve V6A	No
0x859B	PWM output	Short to GND in valve V6B	No
0x859C	PWM output	Short to GND in valve V7A	No
0x859D	PWM output	Short to GND in valve V7B	No
0x859E	PWM output	Short to GND in valve V8A	No
0x859F	PWM output	Short to GND in valve V8B	No
0x85A0	PWM output	Open load in valve V1A	No
0x85A1	PWM output	Open load in valve V1B	No

0x85A2	PWM output	Open load in valve V2A	No
0x85A3	PWM output	Open load in valve V2B	No
0x85A4	PWM output	Open load in valve V3A	No
0x85A5	PWM output	Open load in valve V3B	No
0x85A6	PWM output	Open load in valve V4A	No
0x85A7	PWM output	Open load in valve V4B	No
0x85A8	PWM output	Open load in valve V5A	No
0x85A9	PWM output	Open load in valve V5B	No
0x85AA	PWM output	Open load in valve V6A	No
0x85AB	PWM output	Open load in valve V6B	No
0x85AC	PWM output	Open load in valve V7A	No
0x85AD	PWM output	Open load in valve V7B	No
0x85AE	PWM output	Open load in valve V8A	No
0x85AF	PWM output	Open load in valve V8B	No
0x85B0	PWM output	Short to battery in valve V1A	No
0x85B1	PWM output	Short to battery in valve V1B	No
0x85B2	PWM output	Short to battery in valve V2A	No
0x85B3	PWM output	Short to battery in valve V2B	No
0x85B4	PWM output	Short to battery in valve V3A	No
0x85B5	PWM output	Short to battery in valve V3B	No
0x85B6	PWM output	Short to battery in valve V4A	No
0x85B7	PWM output	Short to battery in valve V4B	No
0x85B8	PWM output	Short to battery in valve V5A	No
0x85B9	PWM output	Short to battery in valve V5B	No
0x85BA	PWM output	Short to battery in valve V6A	No
0x85BB	PWM output	Short to battery in valve V6B	No
0x85BC	PWM output	Short to battery in valve V7A	No
0x85BD	PWM output	Short to battery in valve V7B	No
0x85BE	PWM output	Short to battery in valve V8A	No
0x85BF	PWM output	Short to battery in valve V8B	No

0x85C0	PWM output	Power off in valve V1A	Yes
0x85C1	PWM output	Power off in valve V1B	Yes
0x85C2	PWM output	Power off in valve V2A	Yes
0x85C3	PWM output	Power off in valve V2B	Yes
0x85C4	PWM output	Power off in valve V3A	Yes
0x85C5	PWM output	Power off in valve V3B	Yes
0x85C6	PWM output	Power off in valve V4A	Yes
0x85C7	PWM output	Power off in valve V4B	Yes
0x85C8	PWM output	Power off in valve V5A	Yes
0x85C9	PWM output	Power off in valve V5B	Yes
0x85CA	PWM output	Power off in valve V6A	Yes
0x85CB	PWM output	Power off in valve V6B	Yes
0x85CC	PWM output	Power off in valve V7A	Yes
0x85CD	PWM output	Power off in valve V7B	Yes
0x85CE	PWM output	Power off in valve V8A	Yes
0x85CF	PWM output	Power off in valve V8B	Yes
0x85D0	PWM output	PWM write error	No
0x85D1	PWM output	PWM busy error	No
0x85FF	PWM output	PWM general error	No
0x8610	Joystick	Low limit error on left joystick x-axis	No
0x8611	Joystick	Low limit error on left joystick y-axis	No
0x8612	Joystick	Low limit error on left joystick z-axis	No
0x8613	Joystick	Low limit error on right joystick x-axis	No
0x8614	Joystick	Low limit error on right joystick y-axis	No
0x8615	Joystick	Low limit error on right joystick z-axis	No
0x8620	Joystick	High limit error on left joystick x-axis	No
0x8621	Joystick	High limit error on left joystick y-axis	No
0x8622	Joystick	High limit error on left joystick z-axis	No
0x8623	Joystick	High limit error on right joystick x-axis	No
0x8624	Joystick	High limit error on right joystick y-axis	No

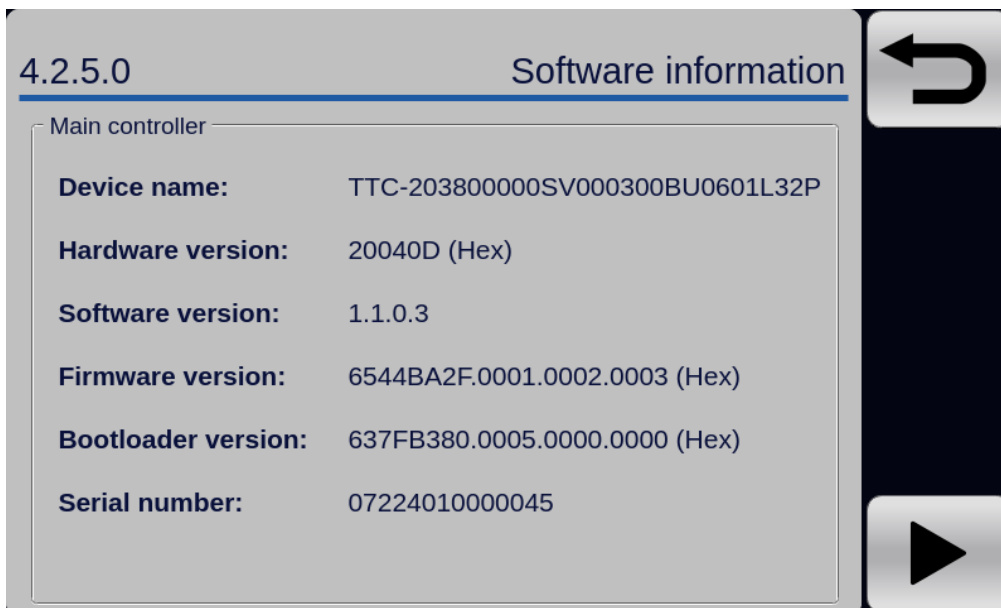
0x8625	Joystick	High limit error on right joystick z-axis	No
0x86FF	Joystick	General error	No
0x8701	Memory	Default settings on	Yes
0x8702	Memory	Flash read error	Yes
0x8704	Memory	Flash version error	Yes
0x8708	Memory	Flash corrupted	Yes
0x8710	Memory	Flash write error	Yes
0x8720	Memory	Flash initialization error	Yes
0x8705	Memory	Default settings on	Yes
0x8800	Valve type	Unsupported valve type	Yes

9.9 System diagnostic

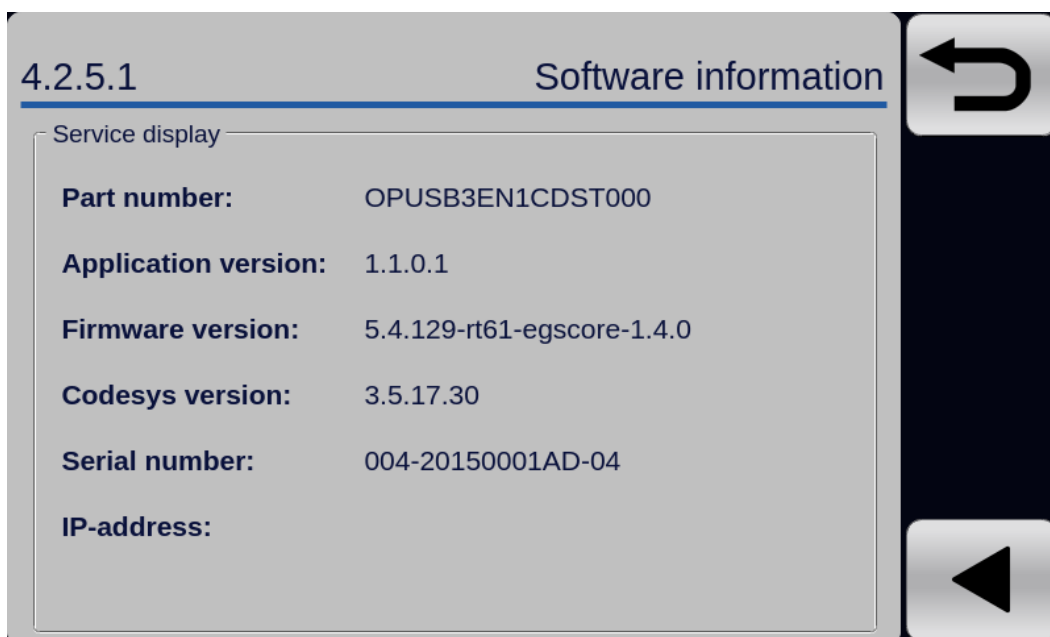


System voltages and controller internal temperature are shown in the “System diagnostic” -page.

9.10 Software information



Crane controller software versions are shown in the first “Software information” -page.



Display software versions are shown in the second “Software information” -page.