Perform-X
Radiographic System

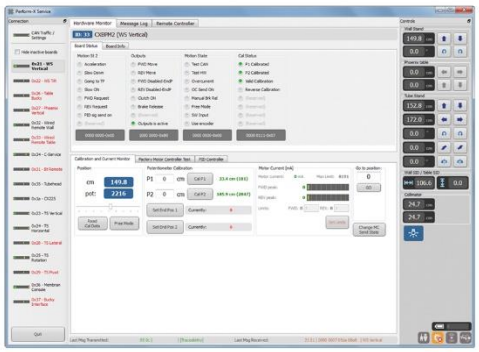
C-Service

Service Application Technical Manual

application version: 1.2.1

CE
1011





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1 INTRODUCTION

1.1 APPLICABILITY

The C-Service service application is a Windows application for configuring, calibrating and trouble-shooting the Perform-X Radiographic Systems. Specifically, it is used for the following motorized and/or CAN bus enabled configurations:

- Perform-X F100 floor mounted system
- Perform-X F200 floor mounted auto-tracking system
- Perform-X F300 floor mounted auto-stitching system
- Perform-X F400 floor mounted auto-positioning system
- Perform-X C100 ceiling mounted system
- Perform-X C200 ceiling mounted auto-tracking system
- Perform-X C300 ceiling mounted auto-stitching system
- Perform-X C400 ceiling mounted auto-positioning system

1.2 INSTALLATION

System requirements:

- Desktop or laptop PC;
- Windows 7 or 10 operating system (32/64 bit);
- USB port;
- Optionally drivers for the USB-to-serial port (in case Windows cannot find or install the drivers automatically).

It is also recommended to download the Control-X Medical remote support application in case remote assistance or trouble-shooting is required.

Download URLs:

- **C-Service**: https://cxmed.com/support.html (in section 'Downloads')
- The **USB-to-serial port drivers** should be automatically installed when connecting the USB cable to the DIAG BOX. USB-to-Serial converter drivers download location in case Windows cannot install them: https://www.ftdichip.com/Drivers/VCP.htm
  (please select driver according to OS and processor architecture).
- **CXRemoteSupport**: https://get.teamviewer.com/cxmed

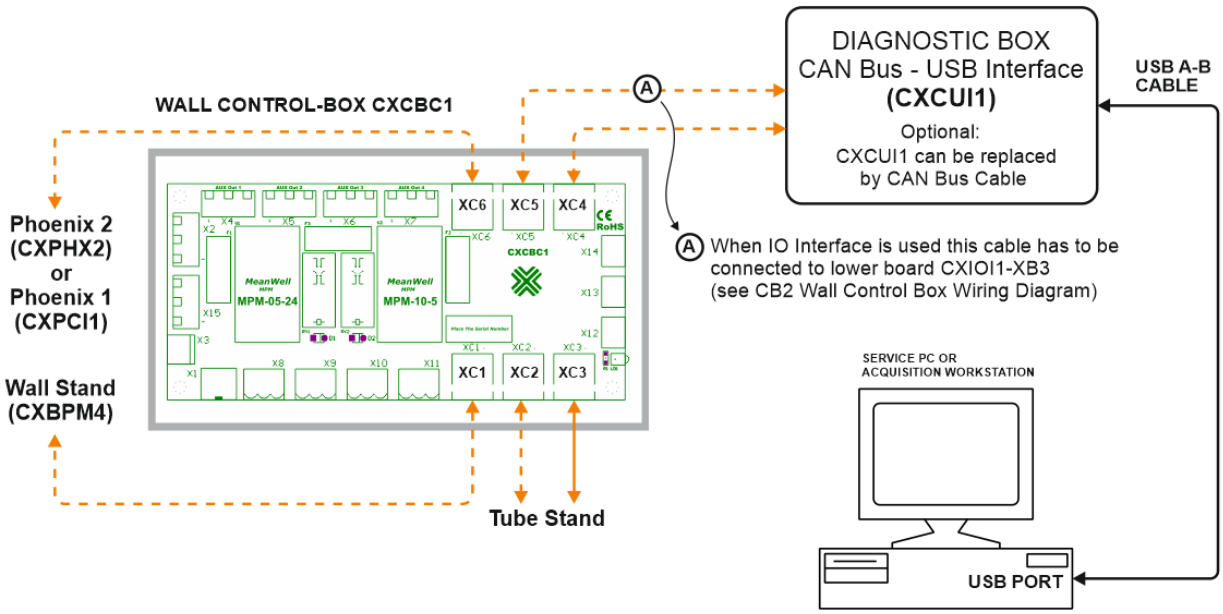
To install the C-Service app, simply **download and unzip** the archive to a folder of your choice. Make sure that the folder the files in the folder are writable and are NOT Read-only. To run the application, start the **C-ServiceApp.exe** file.

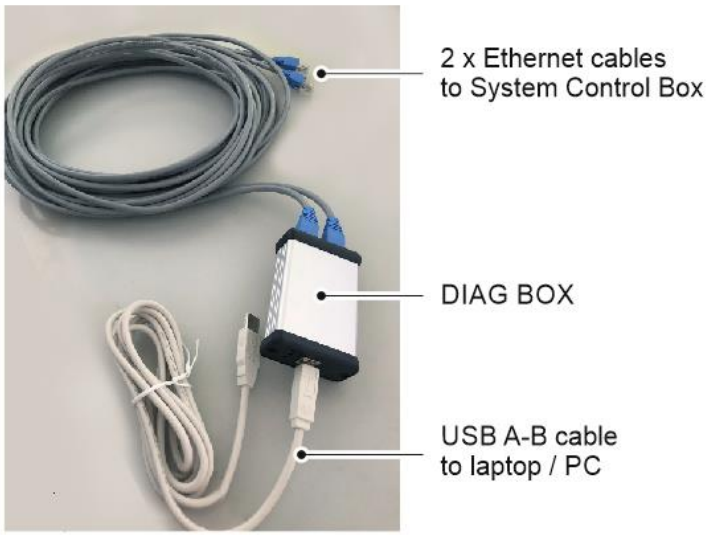
Once connected to the equipment, make sure the USB-to-serial port is assigned to **ports between COM 1 through COM 9.**

1.3 CONNECTING AND USING THE DIAGNOSTIC BOX

The C-Service application connects to the Perform-X CAN bus via an USB-to-serial interface located in the Diagnostic Box (CX DIAG BOX) supplied with the system.

When necessary (performing calibration / configuration or running diagnostics), connect the Diagnostic Box with the service PC using the supplied or any commercially available USB A-B cable:



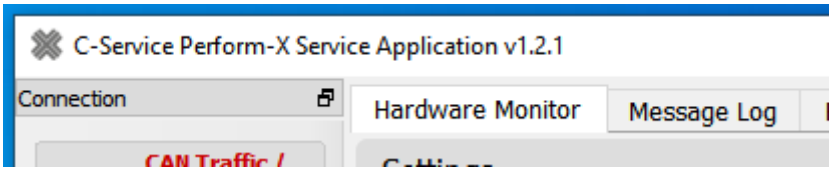


The Diagnostic Box and its connections

2 THE C-SERVICE WORKSPACE

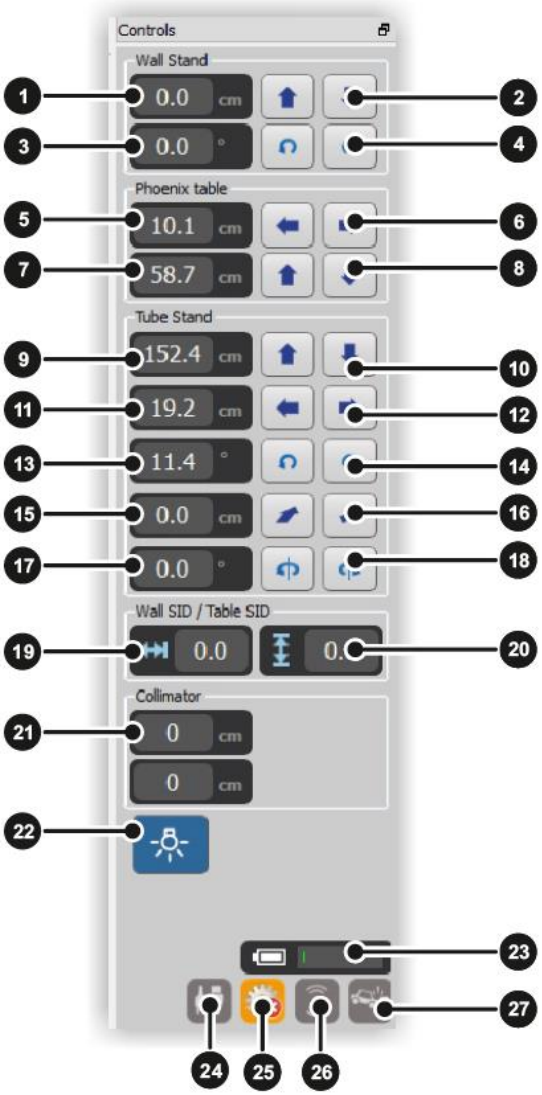
2.1 TITLE BAR

The title bar of the application displays the name and the **version** of the application:



2.2 CONTROLS MENU

By default, the Controls Menu is located on the right side of the application workspace. It has its own set of controls for each drive in the system. This makes it possible to control every component of the system from the application, including the collimator light field in case automatic collimator is installed making it easier to test the configuration.



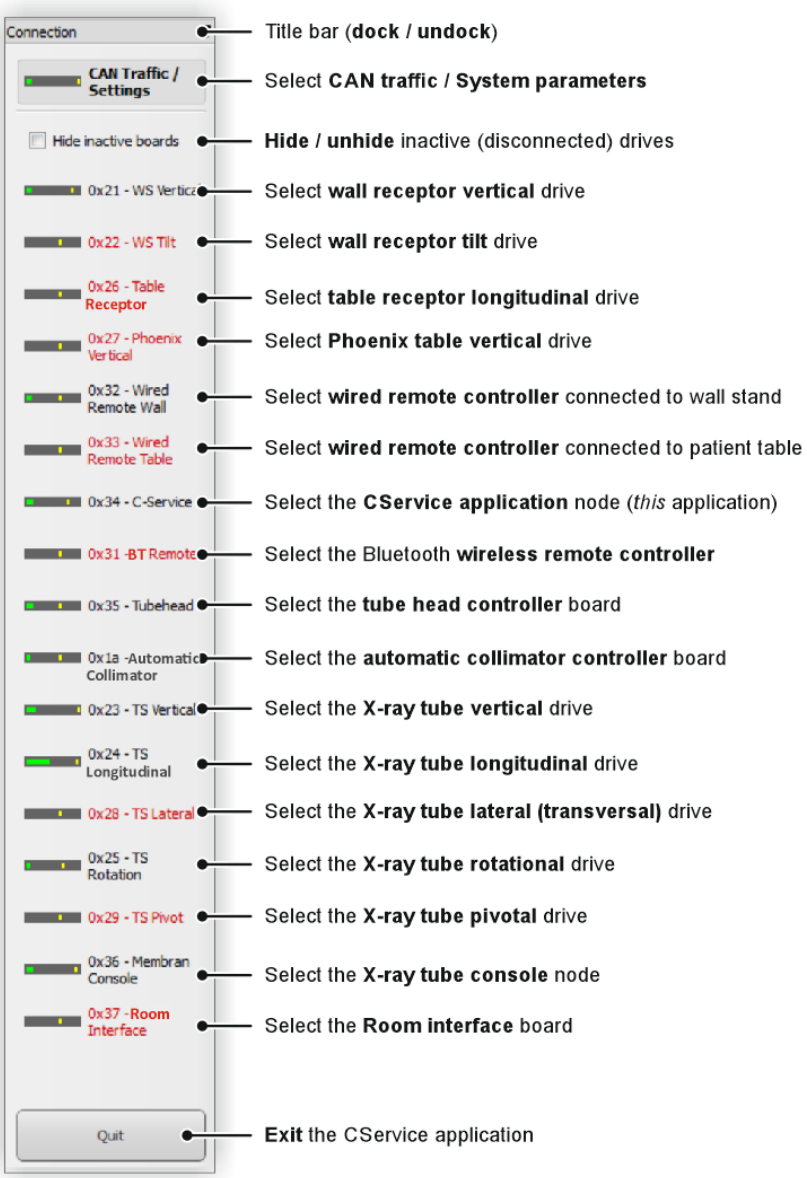
1. Wall receptor vertical position
2. Wall receptor move up/down control
3. Wall receptor tilt position
4. Wall receptor tilt CCW/CW control
5. Table receptor longitudinal position
6. Table receptor move left/right control
7. Phoenix tabletop vertical position
8. Phoenix tabletop vertical move up/down control
9. X-ray tube vertical position
10. X-ray tube vertical move up/down control
11. X-ray tube longitudinal position
12. X-ray tube longitudinal move left/right control
13. X-ray tube rotation
14. X-ray tube rotate CCW/CW control
15. X-ray tube lateral position
16. X-ray tube lateral move forward/backward control
17. X-ray tube pivot position
18. X-ray tube pivot CCW/CW control
19. Wall receptor SID
20. Table receptor SID
21. Collimator light field size
22. Collimator light field on/off control and indicator
23. BT remote control battery status
24. Connection status
25. Motorized movements status
26. Collision (proximity) error indicator
27. Crash error indicator

The Control Menu

The Controls Menu is docked into the application window. To undock as a separate (floating) window, **double click** on the window title or **click on the icon in the upper right corner** of the window. To dock the Controls Menu again, **double click** on the title bar.

2.3 CONNECTION MENU

The Connection Menu is located on the left side of the application workspace by default. This menu displays all boards/drives of the system. The inactive boards (displayed in red) can be hidden using the **Hide inactive boards** checkbox. This menu also includes the CAN Traffic / Settings panel where important system parameters can be set. Next to each drive name a bar indicator shows the momentary traffic on the CAN bus network (when connected).



The Connection Menu

To undock the Connection Menu from as a separate (floating) window, **double click** on the window title or **click on the icon on the upper right corner** on the title bar. It can be moved anywhere on the screen and can also be docked into the Controls Menu. To dock it back to the original position, **double click** on the window title bar.

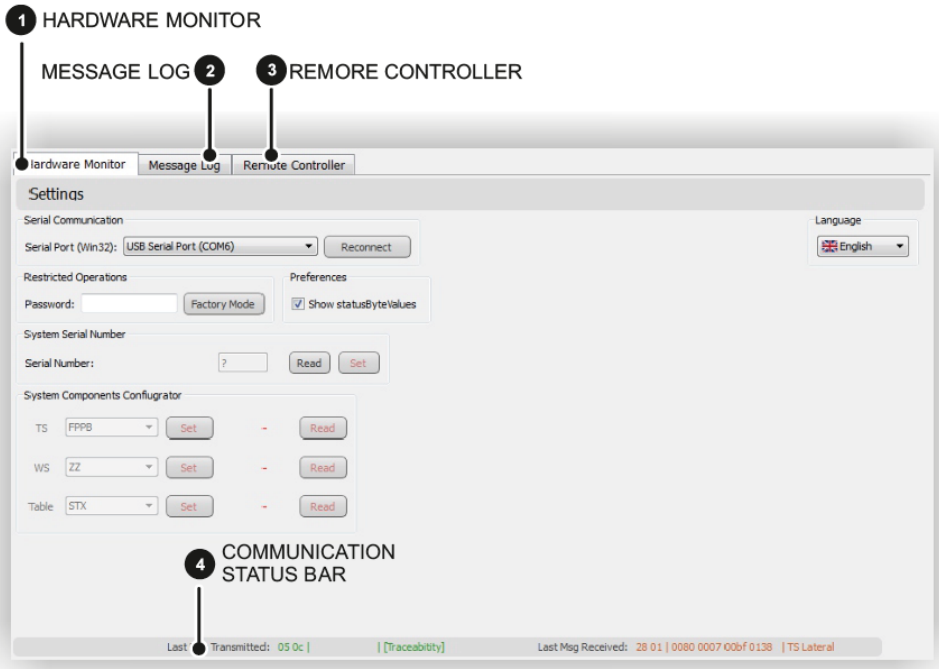
2.4 MAIN WINDOW

The Main Window of the application contains four different sections. The most frequently used part is the **Hardware Monitor tab** which displays the settings and all of the information about the currently selected controller board / node.

The **Message Log tab** contains the real time (optionally filtered) message flow on the CAN bus network.

The **Remote Controller tab** contains information to configure the optional Bluetooth remote controller.

At the bottom of the main window the **Communication Status Bar** shows the currently transmitted and received messages of the CAN bus network.



2.4.1 Hardware Monitor

The **Hardware Monitor tab** (1) displays the system settings (when clicking on CAN Traffic / Settings button in Connection menu) or the settings for the selected system board / node. This makes it possible for the service personnel to modify the configuration of each device/drive of the system and to carry out the necessary calibration procedures.

The Hardware Monitor screen is further divided into Board Status, Board Info and (depending on the selected node) other optional drive specific tabs on the lower part of the screen.

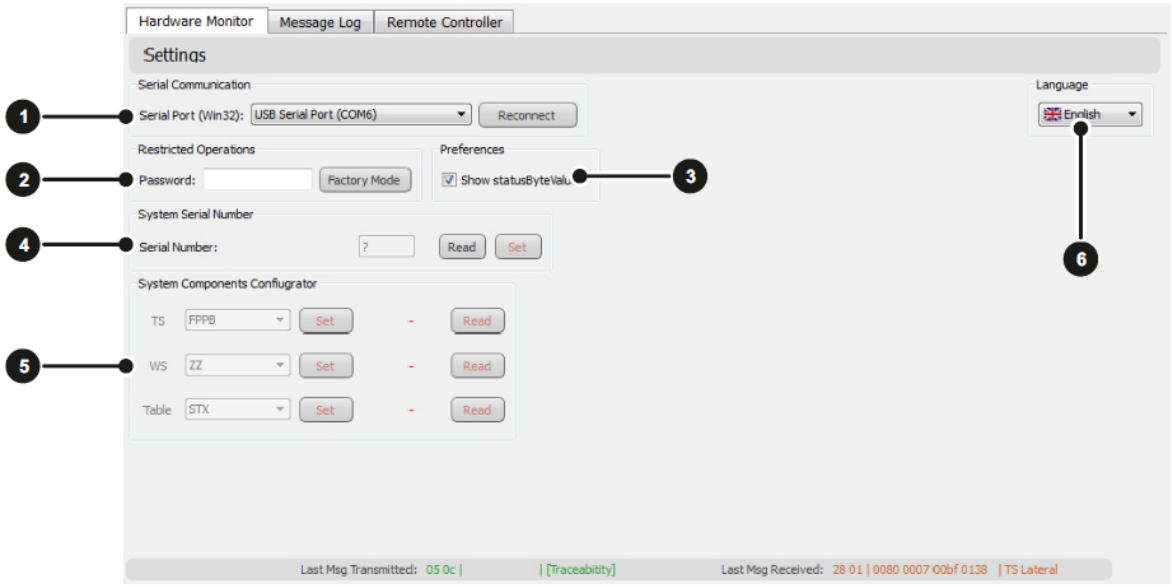
Below you can find the list of the board drives displayed in the Connection Menu together with the name of the board / node that it is connected to. The name of the board / node also appears at the top of the Hardware Monitor screen together with the CAN node ID of the drive.

CAN node ID		Name in Connection Menu	System board / node type	Physical location
Hex	Decimal			
0x21	33	WS Vertical	CXBPM4	WS99N E-box
0x22	34	WS Tilt	CXBPM4	WS99N E-box
0x26	38	Table Receptor	CXBPM4	Patient table
0x27	39	Phoenix Vertical	CXPHX2B	Phoenix table base
0x32	50	Wired Remote Wall	Handheld remote controller CXWRC	Handheld remote controller connected to WS99N W-box
0x33	51	Wired Remote Table	Handheld remote controller CXWRC	Handheld remote controller connected to Phoenix
0x34	52	C-Service	Service Application through the System Control Box	Customer supplied PC / laptop or installed on acquisition WS
0x31	49	BT Remote	Handheld BT Remote CXBRC1	Receiver interface on CXTSD4 in tube head assembly
0x35	53	Tube Head	CXTSD4	Tube head assembly
0x1a	26	Automatic Collimator	CXTSD4	Tube head assembly
0x23	35	TS Vertical	CXBPM4 or TSCTR7B	TS99N E-box
0x24	36	TS Longitudinal	CXBPM4 or TSCTR7B	TS99N E-box
0x28	40	TS Lateral	CXBPM4 or TSCTR7B	TS99N E-box
0x25	37	TS Rotation	CXBPM4 or TSCTR7B	TS99N E-box
0x29	41	TS Pivot	CXBPM4 or TSCTR7B	TS99N E-box
0x36	54	Console	TSCON3 membrane or LCD touchscreen	Tube head assembly
0x37	55	Room Interface	CXIOI	System control box mounted on wall

Please note that depending on system configuration, some of the nodes / drives may be inactive/disabled.

2.4.1.1 CAN Traffic / Settings screen

The CAN Traffic / Settings screen is displayed in the Main Window when the service application starts, but it is also available by clicking on CAN Traffic / Settings in Connection window. The Settings screen contains the following subsections:



1 **Communication / serial port**

To connect to the Perform-X CAN bus, the serial communication port must be selected. The list contains all of the available COM ports. To change another communication port, select an item from the list and press the **Reconnect** button. The application will attempt to communicate through the selected COM port. If connection is successful, the traffic indicators (green bars) of the available nodes become active.

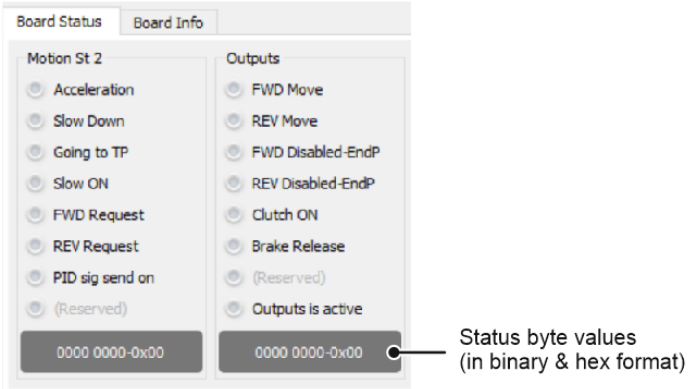
Typically (when multiple ports are available), the one with the name 'USB Serial Port' must be selected. The serial port selection is automatically saved and will be used the next time the application starts.

2 **Factory Mode**

This setting is reserved for factory use to adjust essential system settings.

3 **Preferences**

The **status byte** values displayed on the Board Status tabs can be hidden. This is useful on smaller monitors where the settings would otherwise not fit on the screen. Hiding the status bytes is recommended for smaller vertical resolution display devices.



Status byte example

4 **Serial Number**
Reads the serial number of the system. **Reserved for future use / Factory Mode**

5 **System Components Configurator**
This section is for configuring the system components (stands and table).
Reserved for Factory Mode

6 **Language**
Available languages: English and Hungarian

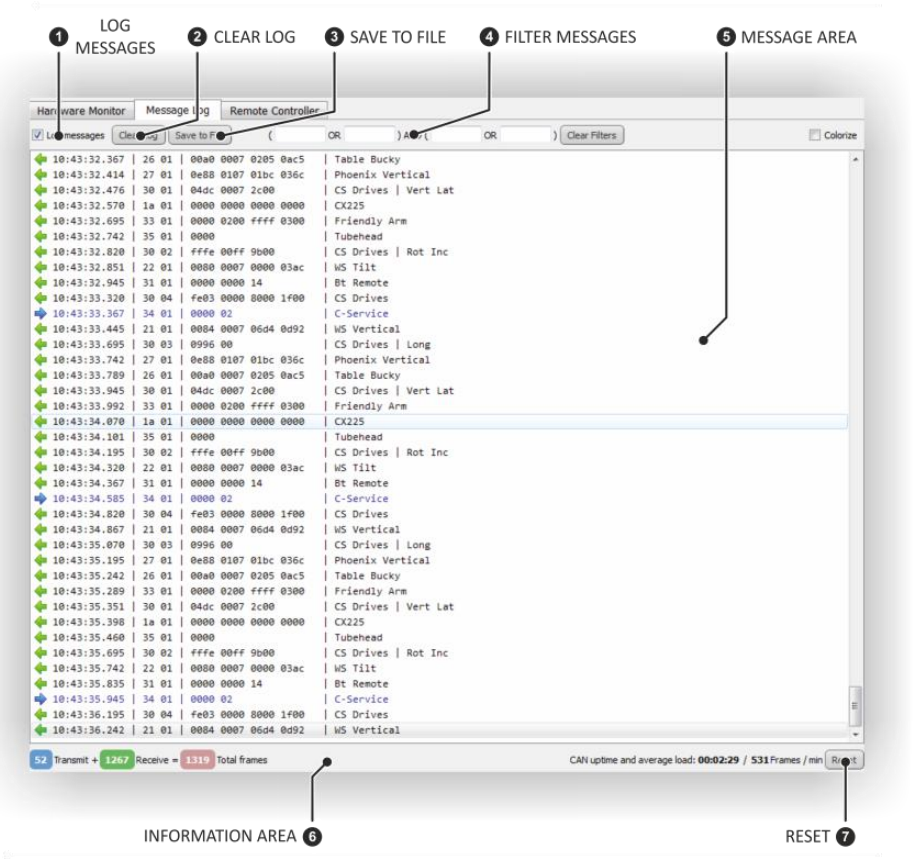
2.4.2 Message Log Tab

The message log provides deep diagnostics and is typically used by factory service specialists.

The **Message Log tab** shows the messages received and transmitted on the CAN bus. It can be used for testing the CAN communication and to monitor the controller node messages. The logging is continuous, but the message flow can be stopped (frozen). Green arrow represents incoming message, while a blue arrow in the front represents an outgoing message transmitted by the service application.

Message format: Time in ms | Msg Type Msg Command| Message body | Sender identification

Example: 12:21:03.887 | 34 01 | 0000 02 | C-Service



The Message Log tab

1 **Log messages**

By default, the message area updates the received messages continuously. If the log messages check box is unchecked, the message area will stop showing new messages. The number of entries is limited, only the last 500 messages are shown in the list.

2 **Clear log:**

Erase the contents of the message area.

3 **Save to File**

To save the contents of the message area into a log file, select the 'Save to File' button. The default filename is: "Perform-X_C-Service.yyyyMMdd-hhmmss.log".

4 **Filter messages**

The messages can be filtered by text fragments. Multiple fragments can be combined by logical OR and AND operators. The filter is activated if at least one of the filter fields is filled. After the filter is activated, the new non-matching messages are ignored. The button 'Clear Filter' clears all filter fields.

5 **Message area**

The message area shows the transmitted and received CAN bus messages.

6 **Information area**

The information area shows the number of transmitted, received and total messages. It also shows the average load (frames / min) of the CAN bus network.

7 **Reset**

Resets all message counters and statistics in the information area.

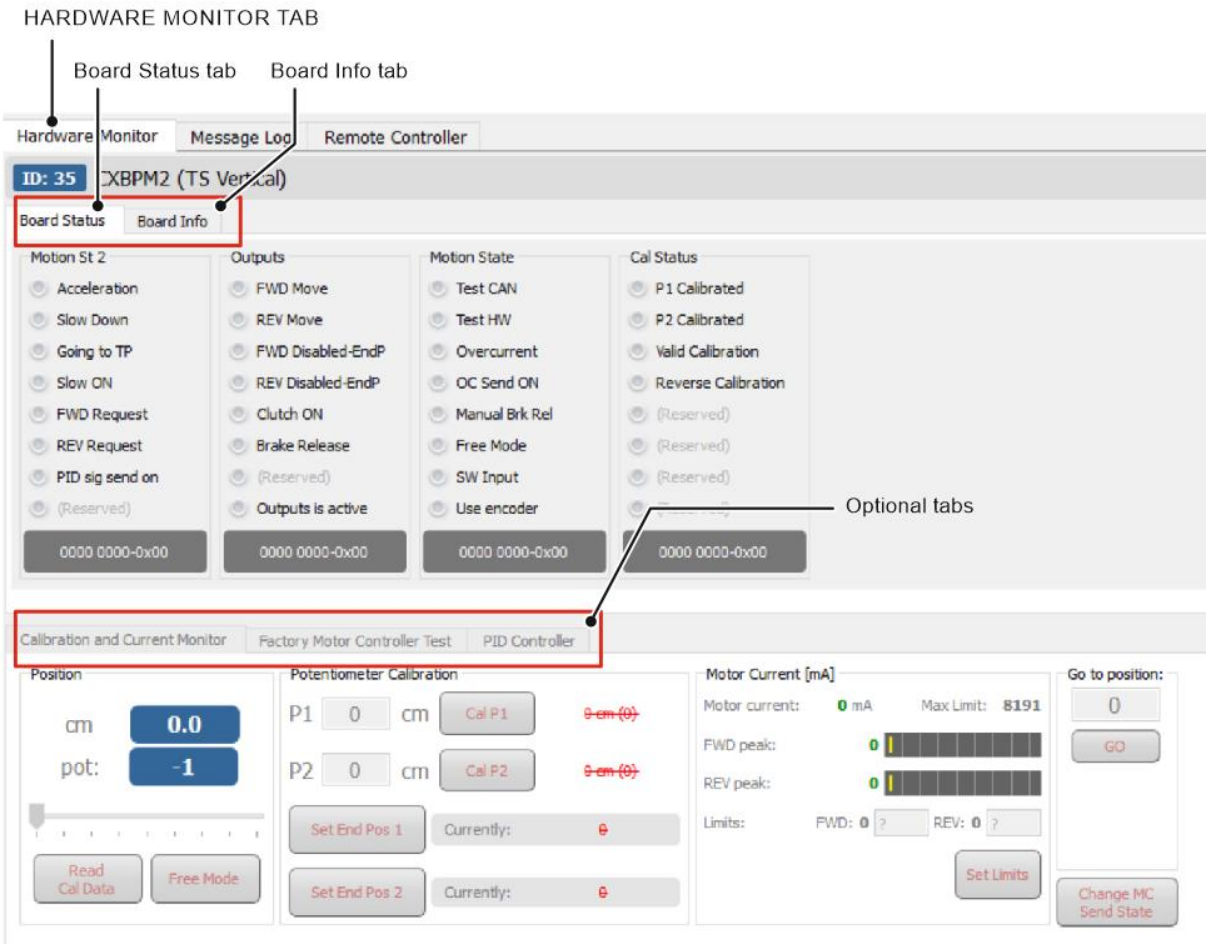
2.4.3 Remote Controller Tab

Please note that the Remote Controller Setup functionality is not available for service personnel and work only with Factory Mode permissions.

2.5 HARDWARE MONITOR CONTENT FOR BOARDS / NODES

2.5.1 Hardware Monitor Tab Layout

The Hardware Monitor contains two tabs in the top half and may or may not contain additional tabs on the bottom half of the pane depending on the node selection on the left.



Layout example of the Hardware Monitor tab
(motor controller node shown)

2.5.2 Board Status Tab

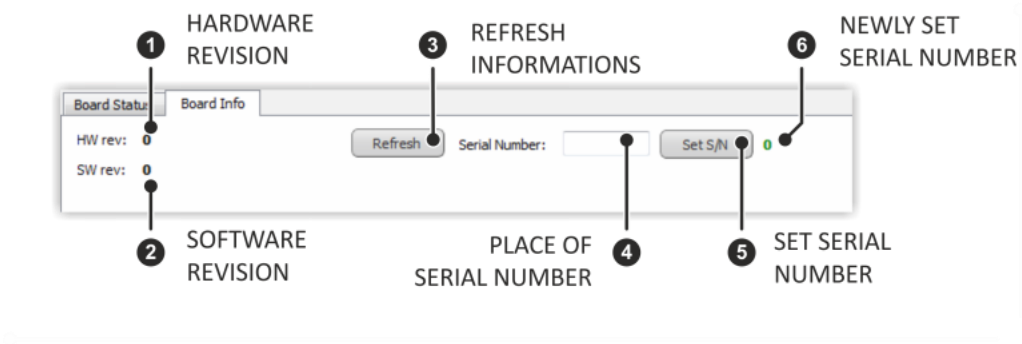
Each drive / node listed on the Connection Menu has a **Board Status tab** under the main Hardware Monitor tab.

The Board Status tab displays various status flags grouped into status bytes. These flags show configuration settings and display detailed and real time status of a number of inputs, outputs and node states. The flags provide for system-wide troubleshooting and system diagnostics. Green light indicates that the status bit (flag) and the associated functionality is active.

Depending on functionality, boards and nodes have different board status flags. However, some drives are controlled by the same type of circuit board, which means that these drives share the same flags in the Board Status tab.

2.5.3 Board Info Tab

The board info displays details on the selected board / node. **Reserved for factory use.**



Board info tab

1 Hardware revision
2 Software revision
3 Refresh information: update HW rev and SW rev fields
4 Enter the serial number
5 Set serial number
6 Serial number (as read from the CAN bus)

3 CAN NODES

3.1 NODES WITH CXBPM4 / TSCTR7B BOARD

The CXBPM4 / TSCTR7B motor controller board is responsible for controlling the WS, TS and table receptor holder motorized or manual drives. The drives that are equipped with the motor controller:

WS Vertical	Wall receptor vertical movement
WS Tilt	Wall receptor detector tilt (-20 to +90 degrees)
Table Receptor	Table receptor longitudinal movement under the tabletop (left / right)
TS Vertical	X-ray tube vertical movement
TS Horizontal	X-ray tube longitudinal movement (left / right)
TS Lateral	X-ray tube lateral movement to or away from the operator (forward / backwards)
TS Rotation	X-ray tube rotation around the horizontal axis (e.g. rotated to the wall receptor)
TS Pivot	X-ray tube rotation around the vertical axis for lateral projections

3.1.1 Board Status

The CXBPM4 Board Status tab contains the following status bytes and flags:

Motion State 2 status byte		
Flag / bit	**Name**	**Description**
0x01	Acceleration	The drive is currently ACCELERATING
0x02	Slow Down	The drive is currently SLOWING DOWN
0x03	Going to TP	Moving to TARGET POSITION
0x04	Slow ON	SLOW speed enabled by operating software
0x10	FWD request	FORWARD movement (right / up / CW) is requested from a remote controller, console or the service app
0x20	REV request	REVERSE movement (left / down / CCW) is requested from a remote controller, console or the service app
0x40	PID sig send on	PID signal send to CAN bus is ON (factory use only)
0x80	Inverted Brake	The drive is equipped with a POSITIVE brake (released with power off and energized when voltage is applied)

Outputs status byte		
Flag / bit	**Name**	**Description**
0x01	FWD Move	The drive is currently MOVING FORWARD (right / up / CW)
0x02	REV Move	The drive is currently MOVING in REVERSE (left / down / CCW)
0x03	FWD Disabled – EndP	FORWARD END position is reached, forward movement is disabled

0x04	REV Disabled – EndP	REVERSE END position is reached, reserve movement is disabled
0x10	Clutch ON	The CLUTCH is currently ON (engaged)
0x20	Brake release	The BRAKE is currently RELEASED
0x40	Stepper Drive Selected	The drive is equipped with a STEPPER MOTOR.
0x80	Outputs active	The drive output is active / MOVING

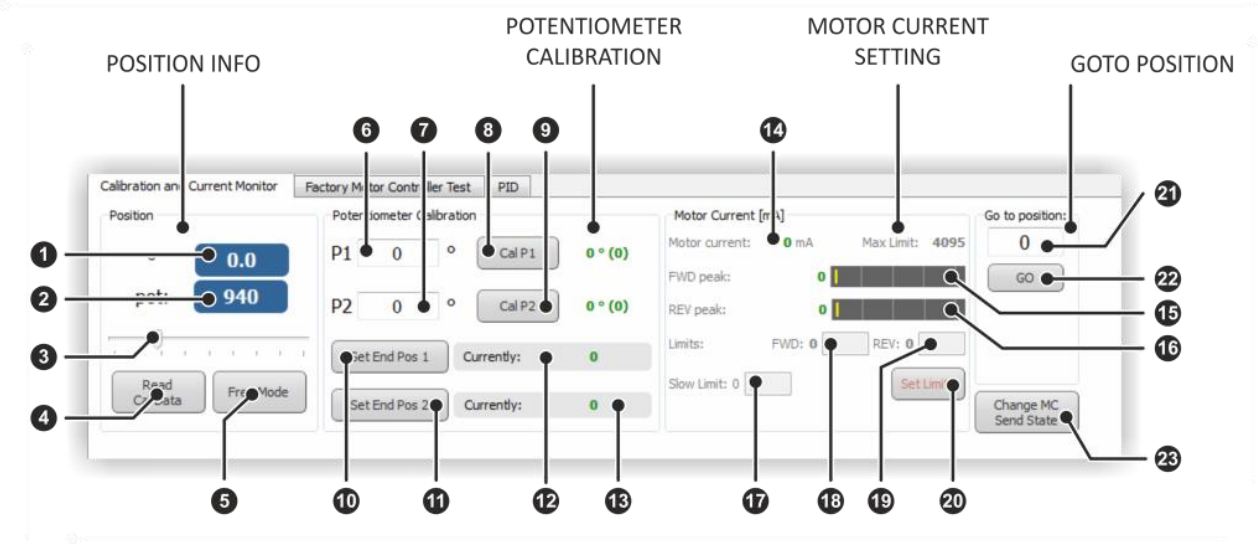
Motion State status byte		
Flag / bit	**Name**	**Description**
0x01	Test CAN	Reserved for factory use
0x02	Test HW	Reserved for factory use
0x03	Overcurrent	The drive is in OVERCURRENT state (current limit exceeded e.g. due to obstruction)
0x04	OC Send ON	OVERCURRENT status is sent to CAN bus
0x10	Manual Brk Rel	The brake is MANUALLY RELEASED (e.g. brake release button is pressed)
0x20	Free Mode	The drive can FREELY MOVE (motorized) regardless whether the drive is calibrated; it can also move past the end positions
0x40	Switch Input	Brake release input for wall stand OR for resetting encoders in tube stands
0x80	Use encoder	The drive is equipped with a precision ENCODER (as opposed to a potentiometer)

Cal Status status byte		
Flag / bit	**Name**	**Description**
0x01	P1 Calibrated	P1 position (typically the lower value) is CALIBRATED
0x02	P2 Calibrated	P2 position (typically the greater value) is CALIBRATED
0x03	Valid Calibration	The drive is calibrated, motorized movement is possible
0x04	Reverse Calibration	The P1 / P2 positions (lower / greater) are REVERSED
0x10	*(Reserved)*	*Reserved / not used*
0x20	*(Reserved)*	*Reserved / not used*
0x40	*(Reserved)*	*Reserved / not used*
0x80	*(Reserved)*	*Reserved / not used*

3.1.2 Calibration and Current Monitor Tab

This tab is separated into four different areas:

1. Position info
2. Potentiometer Calibration
3. Motor Current setting
4. Go to Position.



Calibration and Current Monitor tab for the motor controller

Position info:

1 Drive position (degree or cm)

2 Potentiometer / encoder value (between 0…4095 for potentiometers, approx. -10,000 … 10,000 for encoders)

3 Potentiometer slider
The slider represents the full range of the potentiometer and shows the current potentiometer value relative to the full range.

4 Read calibration data
Reads the calibration information from the drive and shows the values in the calibration fields.
Please note that all drive calibration data are stored locally on the motor drive board.

5 Free mode

CAUTION!

When FREE MODE is ON, the device is **able to move past the end positions** freely **without limitations** and **regardless of collision** status.

Potentiometer Calibration:

6-7 P1 and P2
Enter the new calibration value of P1 and P2 positions (may differ from end positions).

8-9 Execute P1/P2 calibration
Stores the value from fields 6/7 as calibration points of P1 and P2 positions.

10 Set end position for P1
Set the current position of the device as the lowest position.

11 Set end position for P2
Set the current position of the device as the highest position.

12-13 Current P1 and P2 end position values stored on board

*Motor Current settings (**factory calibrated** and available only with the **OC Send ON** flag active):*

14 **Motor current** value

15 **Forward current peak**: maximum value of the input current in forward direction.

16 **Reverse current peak**: maximum value of the input current in reverse direction.

17 *N/A in version 1.2*

18 Entry field for the **current limit in forward direction** (i.e. right / up / CW)

19 Entry field of the **current limit in reverse direction** (i.e. left / down / CCW)

20 **Set limits**: transmits and saves the current limits to the controller board.

23 **Change Motor Controller Send State** (toggle button)
The controller board sends or stops sending the motor current state of the selected drive periodically on the CAN bus.
Please note that the extra traffic of the real time motor current values slows down the CAN bus communication between the devices.

Go to position (for test purposes):

21 Enter the **new position** (in cm or degrees) where the device should move to

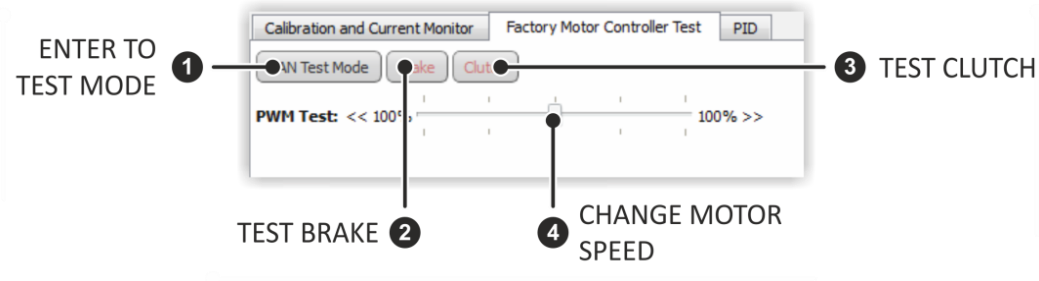
22 **GO**: the selected device (drive) will go to the position specified in field (21).

3.1.3 Factory Motor Controller Test Tab

Reserved for Factory Mode

This tab is used for testing the functionality of the motor driven by the selected motor controller board. The following functions can be tested:

- Brake;
- Clutch;
- Motor speed



Motor controller Factory Test functions

3.1.4 PID Controller

Reserved for Factory Mode

This tab is used in Factory Mode to adjust the parameters of the PID (proportional-integral-derivative) control loop of the drive in order to achieve optimal movement speed and positioning accuracy.

3.2 PHOENIX VERTICAL NODE (CXPHX2B BOARD)

This node / board is responsible for moving Phoenix table vertically. Several functions of the CXPHX2 elevating table controller board are similar to the CXBPM4 motor controller board. The differences are the following:

- several status flags are different;
- there are no current sense / current limitation features for the Phoenix vertical drive.

3.2.1 Board Status

The CXPHX2 Board Status tab contains the following status bytes and flags:

'Inputs' status byte:

Inputs status byte		
Flag / bit	**Name**	**Description**
0x01	Collision	COLLISION is detected while lowering the tabletop
0x02	Trns stop	The tabletop is in CENTER position TRANSVERSALLY
0x03	Down enable	DOWN movement is enabled (i.e. there is no collision and not past end position)
0x04	Up enable	UP movement is enabled (i.e. not past end position)
0x10	Brake release	Table RECEPTOR brake RELEASE is requested
0x20	Right ind sen	The inductive sensor on the right side is activated: the TABLETOP is pushed to the LEFT
0x40	Left ind sen	The inductive sensor on the left side is activated: the TABLETOP is pushed to the RIGHT
0x80	Auto test mode	Reserved for factory use

Outputs status byte		
Flag / bit	**Name**	**Description**
0x01	FWD Move	The drive is currently MOVING FORWARD (UP)
0x02	REV Move	The drive is currently MOVING in REVERSE (DOWN)
0x03	FWD Disabled – EndP	FORWARD END position is reached, UP movement is disabled
0x04	REV Disabled – EndP	REVERSE END position is reached, DOWN movement is disabled
0x10	Receptor LONG released	The RECEPTOR holder brake is RELEASED
0x20	Table long release	The longitudinal TABLETOP BRAKE is currently RELEASED
0x40	Table trns release	The transversal TABLETOP BRAKE is currently RELEASED
0x80	Outputs active	The drive output is active / MOVING

Motion State status byte		
Flag / bit	**Name**	**Description**
0x01	Speaker enabled	The SPEAKER for audible warnings is ENABLED
0x02	Test HW	Reserved for factory use
0x03	Going to TP	Moving to TARGET POSITION in progress
0x04	Free mode phx	The drive can FREELY MOVE (motorized) regardless whether the drive is calibrated; it **can also move past the end positions**
0x10	FWD request	FORWARD movement (UP) is requested by operator
0x20	REV request	REVERSE movement (DOWN) is requested by operator
0x40	Stop center pos en	Stopping at vertical CENTER / EXP position is enabled *(can be enabled / disabled by on-board DIP switch)*
0x80	Double kick en	The DOUBLE-KICK safety feature is enabled *(can be enabled / disabled by on-board DIP switch)*

Calibration and Pedals status byte		
Flag / bit	**Name**	**Description**
0x01	P1 Calibrated	P1 position (typically the lower value) is CALIBRATED
0x02	P2 Calibrated	P2 position (typically the greater value) is CALIBRATED
0x03	Valid Calibration	The drive is calibrated, motorized movement is possible
0x04	Reverse Calibration	The P1 / P2 positions (lower / greater) are REVERSED
0x10	Trans 1 pedal	The TRANS / LONG pedal on the left-hand side is pressed
0x20	Trans 2 pedal	The TRANS / LONG pedal on the right-hand side is pressed
0x40	Go up pedal	The UP pedal is pressed
0x80	Go down pedal	The DOWN pedal is pressed

3.2.2 Calibration and Current Monitor tab

The operation of the CXPHX2B board Calibration and Current Monitor tab is the same as that of the CXBPM4 / TSCTR7B boards, except:

- The **Motor Current functionality** (e.g. setting limits) is **not available**.

3.2.3 Factory Motor Controller Test tab

The operation of the CXPHX2B board Factory Motor Controller Test tab is the same as that of the CXBPM4 / TSCTR7B boards.

3.2.4 PID Controller tab

PID functionality for the CXPHX2B board is not available.

3.3 KEYPAD / CONTROLLER NODES (REMOTE CONTROLLERS AND C-SERVICE)

The **keypad / controller nodes** provide user interface for initiating movements, controlling tracking functions and adjusting / activating the collimator light field. The following keypad / controller nodes may be available in the Perform-X system:

- **Wired remote controllers** connected to the wall stand or the patient table
- **Bluetooth wireless remote controller**
- **C-Service service application**
- **Tube mount membrane or LCD touchscreen console (detailed separately)**

The **wired / wireless remote controllers** hold button statuses that initiate movements, tracking functions and control the collimator light field. Multiple controllers can be used simultaneously. Conflicting commands (e.g. move LEFT and RIGHT at the same time) are ignored by the target drives / CAN nodes.

The **C-Service** node in the application represents the status of the service application itself. The C-Service application controls and monitors the equipment sharing the Perform-X CAN bus and acts as a controller keypad, like the **wired remote controllers**.

This node does not have additional tabs or controls on the lower half of the screen.

3.3.1 Board Status

Most status bytes / flags are identical for the keypad / controller nodes with the exception of two extra status bytes for the Bluetooth remote controller.

Motion Ctrl status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	VERT UP	The VERTICAL UP button is pressed
0x02	VERT DOWN	The VERTICAL DOWN button is pressed
0x03	LONG LEFT	The LONGITUDINAL LEFT button is pressed
0x04	LONG RIGHT	The LONGITUDINAL RIGHT button is pressed
0x10	ROT CW	The ROTATE CW button is pressed
0x20	ROT CCW	The ROTATE CCW button is pressed
0x40	PIV CW	The PIVOT CW button is pressed
0x80	PIV CCW	The PIVOT CCW button is pressed

Function Ctrl status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	STOP	The STOP button is pressed
0x02	LIGHT	The collimator LIGHT FIELD button is pressed
0x03	LATERAL FW	The LATERAL FORWARD (towards the operator) button is pressed
0x04	LATERAL BW	The LATERAL BACKWARDS (away from the operator) button is pressed
0x10	WS TRACKING	Vertical tube-wall receptor TRACKING is ON
0x20	PHX VERT TRACKING	Table receptor VERTICAL TRACKING (constant SID) is ON
0x40	PHX AUTO-CENTER ON	Table receptor AUTO-CENTER is ON
0x80	DEVICE SEL	The DEVICE SELECT button is pressed

Selected Device status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	WS	The movement buttons will initiate WALL STAND movements
0x02	CS	The movement buttons will initiate TUBE STAND movements
0x04	PHOENIX	The movement buttons will initiate ELEVATING TABLE / TABLE RECEPTOR movements
0x08	COLLIMATOR	The movement buttons will change the LIGHT FIELD size.
0x10 – 0x80	*(Reserved)*	*Reserved / not used*

RCV STATUS status byte *(**Bluetooth** remote controller **ONLY)***		
Flag / bit	**Name**	**Description**
0x01	Connected	BT controller is connected
0x02	Data Mode	Data mode is selected
0x04	Cmd Mode	Command mode is selected
0x08	Ics ON	Extended internal communications mode
0x10	BT Power On	Bluetooth receiver is powered up
0x20	Detection Mode	Bluetooth remote is ready for pairing
0x40	Battery Ex. Low	Battery low
0x80	USB Powered	BT remote controller is powered from external source

3.4 TUBE HEAD NODE (CXTSD4 BOARD)

This board controls the brakes for the tube stand. The brake release buttons are located on the tube holder handle.

This board also provides interface for light field operation for manual collimator.

3.4.1 Board Status

Three flags are displayed on the Board Status tab, one for each brake release button. The indicator LEDs are green in case the brakes release switches are activated.

Input switches status byte		
Flag / bit	**Name**	**Description**
0x01	Left Brake SW	The LEFT side brake release switch is pressed
0x02	Center Brake SW	The CENTER brake release switch is pressed
0x04	Right Brake SW	The RIGHT side brake release switch is pressed
0x08 – 0x80	*(Reserved)*	*Reserved / not used*

Outputs status byte		
Flag / bit	**Name**	**Description**
0x01	Man Coll Light ON	Manual Collimator Light Field is ON
0x20 – 0x80	*(Reserved)*	*Reserved / not used*

Brak Rel Config status byte		
Flag / bit	**Name**	**Description**
0x01	VER brk rel disabled	The VERTICAL brake release is disabled: the vertical brake stays locked when pressing the brake release
0x20	VER brk rel disabled	The HORIZONTAL brake release is disabled: the horizontal (longitudinal) brake stays locked when pressing the brake release
0x40	VER brk rel disabled	The LATERAL brake release is disabled: the lateral brake stays locked when pressing the brake release
0x08 – 0x80	*(Reserved)*	*Reserved / not used*

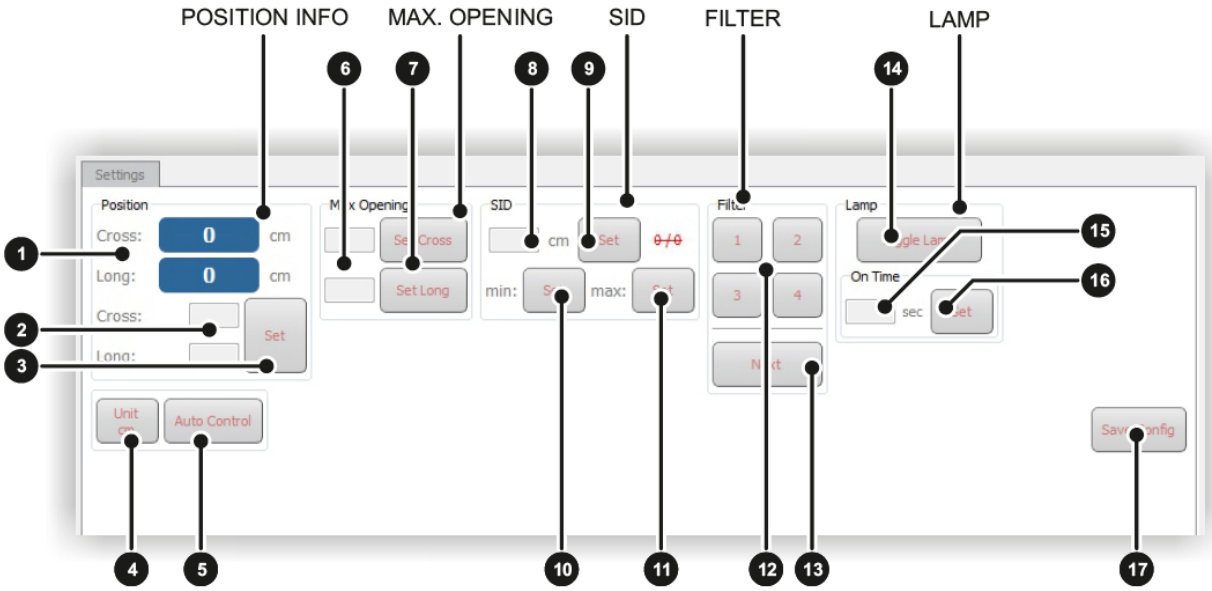
3.5 AUTOMATIC COLLIMATOR CONTROLLER NODE (CXR225 BOARD)

In case an automatic collimator is installed, the serial connection between the collimator and the system is established via the CXR225 board.

3.5.1 Board Status

Collimator status status byte		
Flag / bit	**Name**	**Description**
0x01	Selected filter 1	Filter #1 is selected (i.e. no additional filter added)
0x02	Selected filter 2	Filter #2 is selected
0x04	Selected filter 3	Filter #3 is selected
0x08	Selected filter 4	Filter #4 is selected
0x10	Cross Field Moving	Shutters are moving in CROSS (transverse) direction
0x20	Long Field Moving	Shutters are moving in LONGITUDINAL direction
0x40	At least one shutter closed	Collimator is CLOSED
0x80	Light on	Collimator LIGHT FIELD is ON (for automatic collimators)

In addition to the Board Status tab, a Settings tab is displayed for calibration purposes. This tab is divided into the following areas:



Collimator node Setting tab

Position (light field size) info:

1 Collimator LIGHT FIELD SIZE
2 Enter desired LIGHT FIELD SIZE
3 Set the LIGHT FIELD SIZE
4 UNIT of displayed size on the collimator (toggles cm / inches)
5 MODE selection: toggles AUTO / MANUAL

Maximum opening (light field size):

6 Enter light field LIMITS *(currently not available)*
7 Set the desired LIMITS *(currently not available)*

SID:

8 Enter desired SID
9 Set the desired SID
10 Enter minimum acceptable SID *(currently not available)*
11 Enter maximum acceptable SID *(currently not available)*

Filter:

12 Set one (1 through 4) of available filters
13 Select NEXT filter

Lamp (light field):

14 Toggle collimator light field ON / OFF
15 Enter collimator light field ON time
16 Set collimator light field ON time

3.6 TUBE MOUNT CONSOLE NODE (MEMBRANE KEYPAD OR LCD TOUCHSCREEN)

The Tube Mount Controller (a **membrane keypad** or an **LCD touch screen** depending on configuration) has the following functions:

- provides user interface for equipment movement, tracking and functions,
- behaves as a keypad / controller node much like the remote controller keypads,
- interfaces and calibrates the tube incline sensor (ONLY membrane keypad controller),
- provides system calibration (relative positioning calibration and orientation) facilities and
- stores a number of system settings.

3.6.1 Board Status

Brake Rel Coll Ctrl Buttons status byte		
Flag / bit	**Name**	**Description**
0x01	Vert Release Button	VERTICAL brake release button is pressed
0x02	Rot Release Button	TUBE ROTATION brake release button is pressed
0x04	Piv Release Button	TUBE / COLUMN PIVOT brake release button is pressed
0x08	All Brake Release Button	ALL LINEAR brakes release button is pressed
0x10	Long Release Button	LONGITUDINAL brake release button is pressed
0x20	Lat Release Button	LATERAL brake release button is pressed
0x40	Col Auto Mode Button	Collimator Auto Mode button is pressed
0x80	Col Manual Mode Button	Collimator Manual Mode button is pressed

Tracking Control Buttons status byte		
Flag / bit	**Name**	**Description**
0x01	WS Tracking Button	WS VERTICAL tracking button is pressed
0x02	Phx Tracking Button	TABLE VERTICAL tracking button is pressed
0x04	Receptor Auto-Centering Btn	Receptor auto-centering button is pressed
0x08	Stitching Button	Stitching button is pressed
0x10	Go to Position P1	P1 position button is pressed
0x20	Go to Position P2	P2 position button is pressed
0x40	Go to Position P3	P3 position button is pressed
0x80	Interlock Clear	

'Console Status' status byte:

Console Status status byte		
Flag / bit	**Name**	**Description**
0x01	WS is active	WALL receptor selected for tracking and SID display
0x02	TS is active	TABLE receptor selected for tracking and SID display
0x04	ACC Rot Calibrated	Tube rotation accelerometer is calibrated (optional)
0x08	Acc Sign Send ON	Tube rotation accelerometer values are being sent to CAN bus (optional)
0x10	WS is On Left Side	Wall stand installed LEFT of patient table (otherwise installed on right side)
0x20	WS SID 150 Calibrated	Wall stand and X-ray tube relative position (horizontal SID) is calibrated
0x40	Receptor Long Calibrated	X-ray tube and TABLE receptor longitudinal relative position (when centered) is calibrated
0x80	Inch Display Selected	SID is displayed in INCHES (on the console only)

Tracking Functions status byte		
Flag / bit	**Name**	**Description**
0x01	WS Tracking ON	X-ray tube / WALL receptor VERTICAL tracking is ON
0x02	Phx Tracking ON	X-ray tube / TABLE receptor VERTICAL tracking (constant vert SID) is ON
0x04	Receptor Auto Center ON	X-ray tube / TABLE receptor LONGITUDINAL tracking is ON
0x08	Stitching in PREP	System is being prepared for stitching mode (but position is not yet locked)
0x10	Stitching in Pos	Stitching pos
0x20	Stitching Pos 1	Equipment is in frame 1 (top frame)
0x40	Stitching Pos 2	Equipment is in frame 2 (center frame)
0x80	Stitching Pos 3	Equipment is in frame 3 (bottom frame)

Phx Ts Enable Signal status byte		
Flag / bit	**Name**	**Description**
0x01	Phx Up Enabled	Current equipment position allows motorized TABLETOP UP movement
0x02	Phx Down Enabled	Current equipment position allows motorized TABLETOP DOWN movement
0x04	Ts Left Enabled	Current equipment position allows motorized X-RY TUBE LEFT movement

0x08	Ts Right Enabled	Current equipment position allows motorized X-RY TUBE RIGHT movement
0x10	Ts Vert Up Enabled	Current equipment position allows motorized X-RY TUBE UP movement
0x20	Ts Vert Down Enabled	Current equipment position allows motorized X-RY TUBE DOWN movement
0x40	Ts Lat FW Enabled	Current equipment position allows motorized X-RY TUBE LAERAL FORWARD movement
0x80	Ts Lat RV Enabled	Current equipment position allows motorized X-RY TUBE LAERAL BACKWARDS movement

*'Motion Ctrl' status byte (**common** for all keypad / controller nodes):*

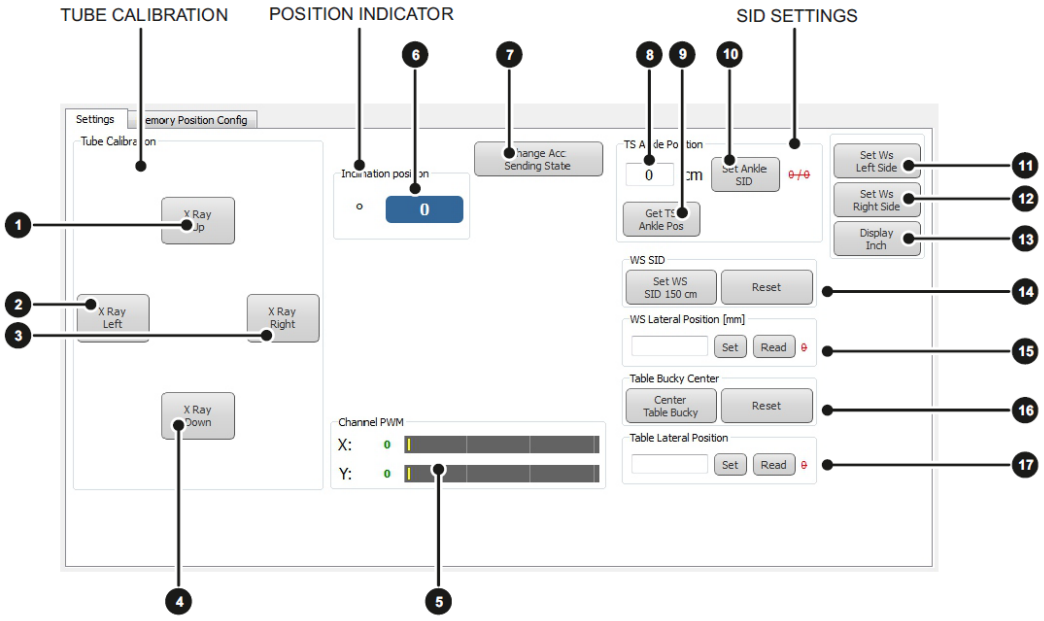
Motion Ctrl status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	VERT UP	The VERTICAL UP button is pressed
0x02	VERT DOWN	The VERTICAL DOWN button is pressed
0x03	LONG LEFT	The LONGITUDINAL LEFT button is pressed
0x04	LONG RIGHT	The LONGITUDINAL RIGHT button is pressed
0x10	ROT CW	The ROTATE CW button is pressed
0x20	ROT CCW	The ROTATE CW button is pressed
0x40	PIV CW	The PIVOT CW button is pressed
0x80	PIV CCW	The PIVOT CCW button is pressed

Function Ctrl status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	STOP	The STOP button is pressed
0x02	LIGHT	The collimator LIGHT FIELD button is pressed
0x03	LATERAL FW	The LATERAL FORWARD (towards the operator) button is pressed
0x04	LATERAL BW	The LATERAL BACKWARDS (away from the operator) button is pressed
0x10	WS TRACKING	Vertical tube-wall receptor TRACKING is ON
0x20	RECEPTOR AUTO CTR	Table receptor AUTO-CENTER is ON
0x40	STITCHING	STITCHING is ON
0x80	DEVICE SEL	The DEVICE SELECT button is pressed

Selected Device status byte *(**common** for all keypad / controller nodes)*		
Flag / bit	**Name**	**Description**
0x01	WS	The movement buttons will initiate WALL STAND movements
0x02	CS	The movement buttons will initiate TUBE STAND movements
0x04	PHOENIX	The movement buttons will initiate ELEVATING TABLE / TABLE RECEPTOR movements
0x08	COLLIMATOR	The movement buttons will change the LIGHT FIELD size.
0x10 – 0x80	*(Reserved)*	*Reserved / not used*

Positioning status byte		
Flag / bit	**Name**	**Description**
0x01	LAT Central to WS	The tube is LATERALLY centered to the WALL receptor *(only for CEILING mount systems)*
0x02	LAT Central to Table	The tube is LATERALLY centered to the TABLE receptor *(only for CEILING mount systems)*
0x03	TS WS Centered	The tube is VERTICALLY centered to the WALL receptor
0x04	TS Table Receptor Centered	The tube is LONGITUDINALLY centered to the TABLE receptor
0x10	TS PHX SID in Tracking	Table SID matches target SID when in TUBE to TABLE receptor vertical tracking mode (no tube or table movement is necessary)
0x20	Demo Mode	For demonstration mode only
0x40	*Status Button*	*Reserved for future use*
0x80	WS Movements Enabled	Equipment position allows all wall receptor movements

3.6.2 Settings Tab



1 Press to **calibrate tube rotation** in the X-ray tube UP position (beam directed to ceiling)

2 Press to **calibrate tube rotation** in the X-ray tube LEFT position (beam directed to left)

3 Press to **calibrate tube rotation** in the X-ray tube RIGHT position (beam directed to right)

4 Press to **calibrate tube rotation** in the X-ray tube DOWN position (beam directed to floor)

5 Accelerometer X and Y axes value (for information / diagnostics only)

6 Current rotation value in degrees

7 Toggle sending the accelerometer values to the CAN bus (increases CAN traffic when turned on)

SID Settings & Calibration:

8 Enter **maximum SID for ankle** / low extremities examinations
In order **to avoid collision** between tube and table during low extremities examinations at the wall stand with the tube near the floor, the maximum ankle SID must to be configured.

9 **Read** the maximum SID where table position allows ankle / low extremities tube position

10 **Set** the maximum ankle SID

11 Set WS **orientation**: wall stand is **left** of the patient table

12 Set WS **orientation**: wall stand is **right** of the patient table

13 Set the **unit of SID** on the membrane (cm or inch)

14 Press to **save 150 cm SID** / **reset** current value stored in console

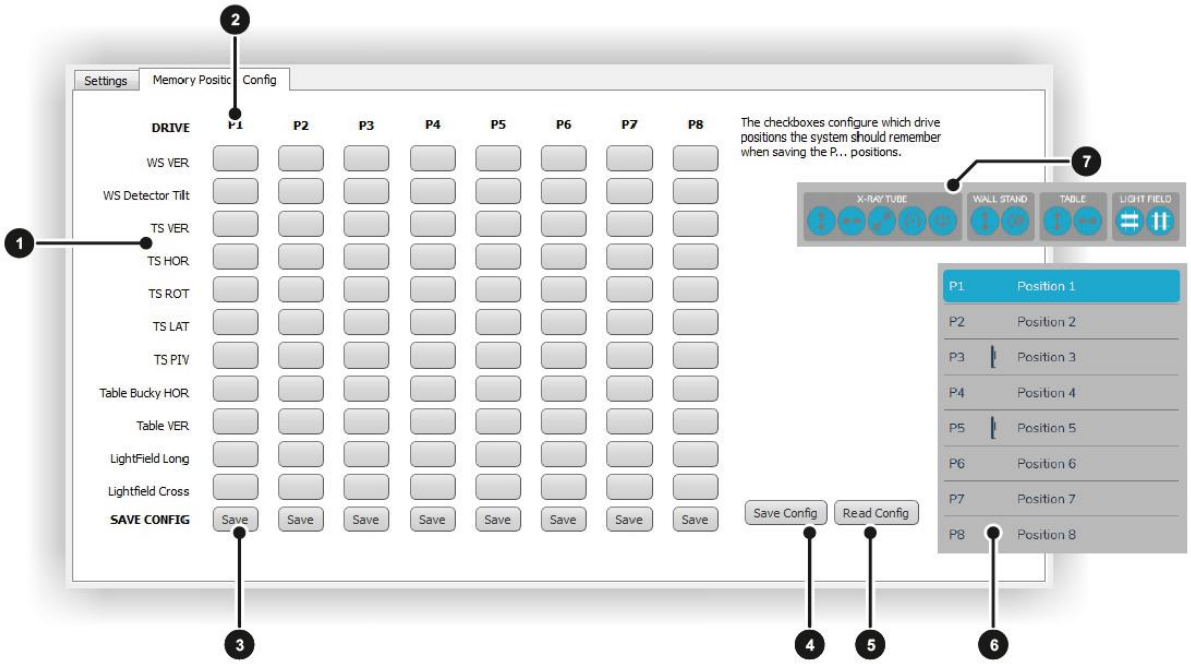
15 Enter or read X-ray **tube lateral position when laterally centered with WALL receptor** *(ceiling mount systems ONLY)*

16 Set or reset **table receptor center** position

Set when the VERTICAL X-ray beam is longitudinally centered with TABLE RECEPTOR to allow receptor auto-centering.

17 Enter or read X-ray **tube lateral position when laterally centered with TABLE receptor** *(ceiling mount systems ONLY)*

3.6.3 Memory Position Config Tab



Tube Controller Memory Position Config tab

When equipped with an LCD display tube controller, the Perform-X system can memorize up to eight preset equipment positions. These positions can be accessed and saved on the LCD display's Preset Positions screen. The Memory Position Config tab in the C-Service application can be used to select which drive positions are saved for each of these preset equipment positions.

For example: for an upright projection on the wall receptor (e.g. a chest AP procedure) the table vertical position does not have to be memorized – otherwise the table would unnecessarily move during repositioning.

The columns correspond to P1-P8 preset equipment positions, and rows correspond to the blue drive icons displayed on the LCD display's Preset Positions screen.

1 **Available drives**: depending on system configuration, some drives could be unavailable
2 **Preset Positions**
3 **Save** setting
4 **Save all** positions + configuration
5 **Read** existing configuration
6 Displayed **preset positions** on the tube head LCD display
7 Displayed **drive icons** on the tube head LCD display

4 PERFORM-X CALIBRATION

The calibration must be carried out after the mechanical installation and alignment is completed. The purpose of the calibration procedure is to:

- set the **end positions** of the movements,
- **calibrate the position sensors**,
- set the **relative positions** of the equipment (tube stand, wall stand and patient table).

The Perform-X system is shipped with calibrated drives: the end positions and potentiometers / encoders of some drives are factory adjusted (therefore on-site calibration is not necessary)**. Depending on the system configuration, the following calibration steps must ALWAYS be carried out during the installation:**

- X-ray tube **longitudinal end positions** (only for stands with motorized longitudinal drive)
- Verify X-ray **tube rotation**
- X-ray **tube and wall receptor vertical position**
- Verify / set system orientation
- Rotation / pivot position and movement
- Set 150 cm horizontal SID (TS / WS relative position calibration)
- X-ray beam – receptor centering both laterally and longitudinally

4.1 X-RAY TUBE LONGITUDINAL CALIBRATION

4.1.1 Floor Mounted Systems

CAUTION!

During installation, the potentiometer position is adjusted to an arbitrary position. **This calibration step requires a properly installed horizontal SID potentiometer.** See section *Horizontal SID Potentiometer Adjustment* of the Perform-X System Installation Manual.

1. Select TS Horizontal drive in the Connection Menu
2. Move the tube column manually to the **leftmost** position and press button '**Set End Pos 1**'
3. Move the tube column manually to the **rightmost** position and Press button '**Set End Pos 2**'

Absolute position calibration is not necessary as it is factory calibrated.

4.1.2 Ceiling Mounted Systems

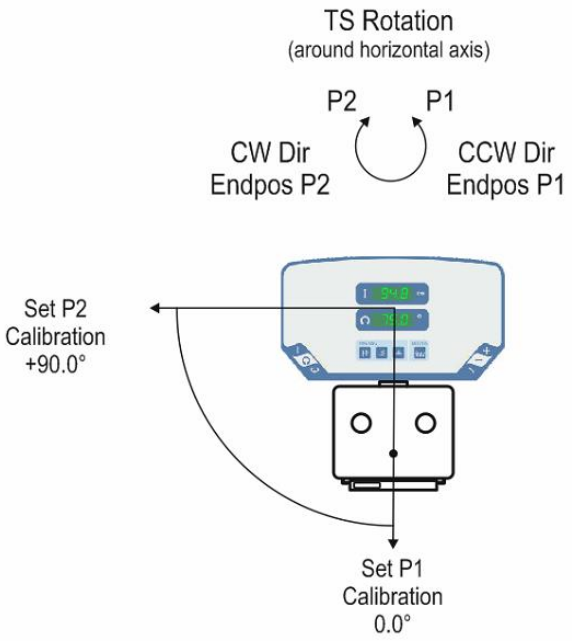
1. Select TS Horizontal drive in the Connection Menu
2. Move the telescope manually to the **leftmost** SAFE position and press button '**Set End Pos 1**'
3. Move the telescope manually to the **rightmost** SAFE position and press button '**Set End Pos 2**'

Absolute position calibration is not necessary as it is factory calibrated.

4.2 VERIFY AND CALIBRATE X-RAY TUBE ROTATION

Check X-ray beam wandering in both horizontal (90°) and vertical (0°) beam directions in the entire SID range. Use the projected collimator laser guide if available. If the beam wandering is larger than 1 cm, perform the mechanical alignment procedure as described in the *Perform-X System Installation Manual*.

Once the mechanical centering / adjustment is acceptable, the tube rotation drive positioning accuracy must be verified and calibrated if necessary.



Calibration procedure for **LEFT wall stand orientation**:

1. Select TS Rotation Drive in Connection Menu.
2. Using the remote controller, turn the X-Ray tube towards the Wall receptor so that the X-ray beam travels horizontally.
3. Enter **90** into **P2** field and press **Cal P2**.
4. Using the remote controller, turn the X-Ray tube towards the Table receptor so that the X-ray beam travels vertically.
5. Enter **0** into **P1** field and press **Cal P1**.
6. Setting the X-ray tube to 0° and 90° (e.g. using the GO TO position function in the service application), check the beam wandering in both directions in the entire SID range. If necessary, repeat the calibration procedure until the beam wandering is acceptable.

Calibration procedure for **RIGHT wall stand orientation**:

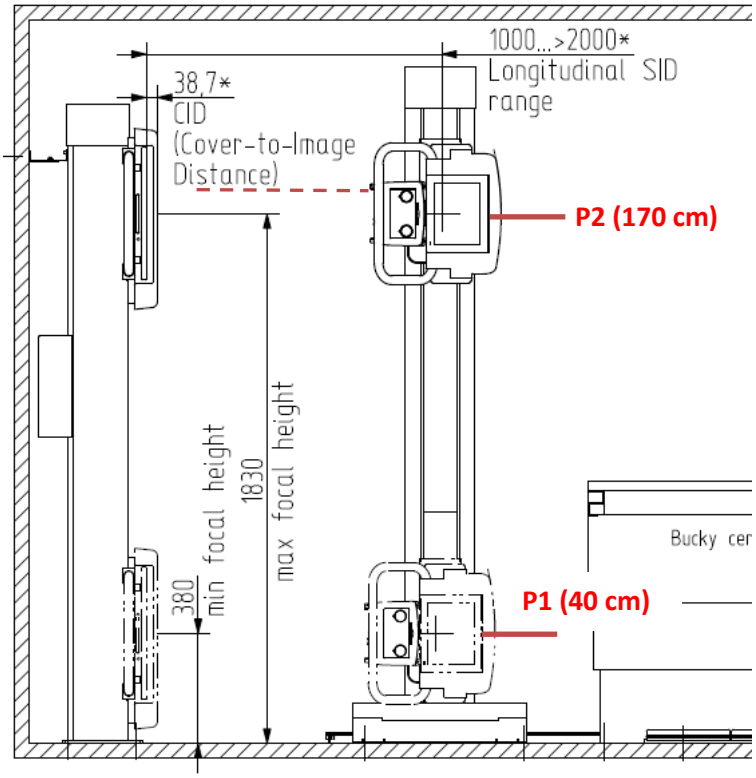
IMPORTANT! During the calibration, the rotation values are negative for RIGHT beam direction. The console (user mode) rotation display shows positive values when turned towards the wall receptor.

1. Select TS Rotation Drive in Connection Menu.
2. Using the remote controller, turn the X-Ray tube towards the Wall receptor so that the X-ray beam travels horizontally.

3. Enter **-90** into **P1** field and press **Cal P1**.
4. Using the remote controller, turn the X-Ray tube towards the Table receptor so that the X-ray beam travels vertically.
5. Enter **0** into **P2** field and press **Cal P2**.
6. Setting the X-ray tube to 0° and –90° (e.g. using the GO TO position function in the service application), check the beam wandering in both directions in the entire SID range. If necessary, repeat the calibration procedure until the beam wandering is acceptable.

4.3 CALIBRATE X-RAY TUBE VERTICAL POSITION

The X-ray tube absolute vertical position (especially in ceiling mounted systems) is affected by the mechanical installation and room properties (e.g. room height).



1. Select **TS Rotation** Drive in Connection Menu.
2. Using the GO TO Position function, set the X-ray tube rotation to 90° (LEFT orientation systems) or to –90° (RIGHT orientation systems) so that the beam is directed towards the wall receptor.
3. Make sure that vertical wall receptor to X-ray tube **tracking is OFF**.
4. Select **TS Vertical** Drive in Connection Menu.
5. Move the X-ray tube vertically to 170 cm focus-to-floor height.
6. Enter **170** into field **P2** and press **Cal P2**.
7. Select **WS Vertical** Drive in Connection Menu.
8. Move the wall receptor vertically so that the receptor is centered with the X-ray beam. Use the collimator laser guide if available.
9. Enter **170** into field **P2** and press **Cal P2**.
10. Select **TS Vertical** Drive in Connection Menu.

11. Move the X-ray tube vertically to 40 cm focus-to-floor height.
12. Enter **40** into field **P1** and press **Cal P1**.
13. Select **WS Vertical** Drive in Connection Menu.
14. Move the wall receptor vertically so that the receptor is centered with the X-ray beam. Use the collimator laser guide if available.
15. Enter **40** into field **P1** and press **Cal P1**.

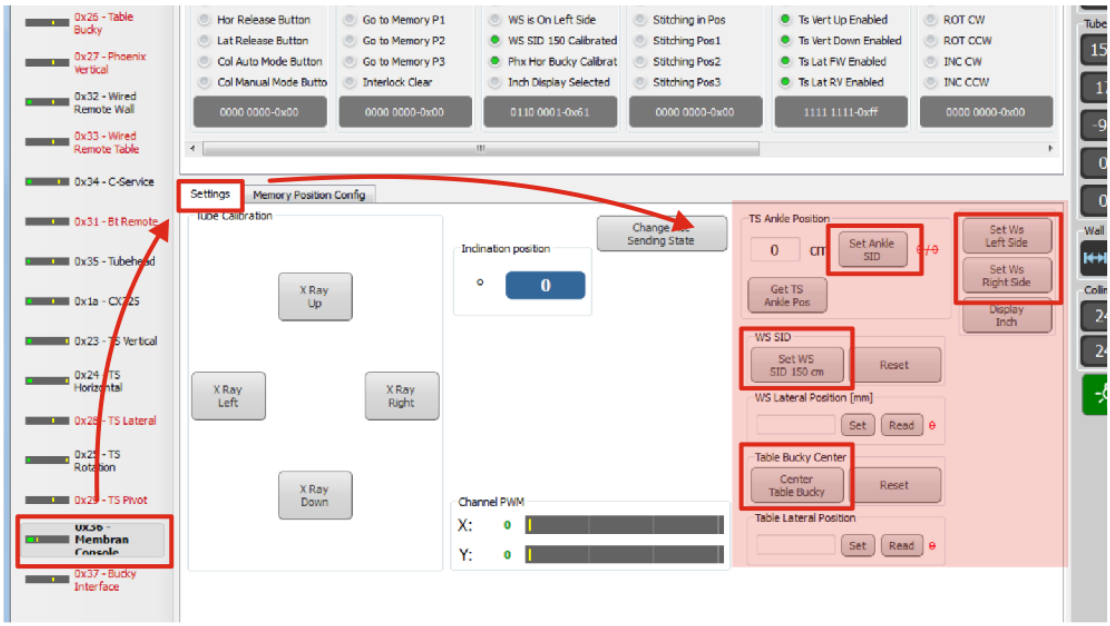
4.4 RELATIVE EQUIPMENT POSITION CALIBRATION

Each Perform-X installation must be calibrated based on exact equipment relative positions and room properties.

ATTENTION!

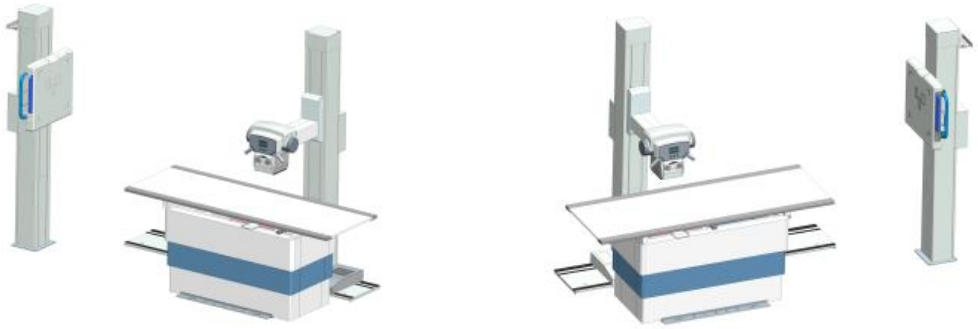
The relative positioning requires **properly aligned stands and patient table**. I.e. the X-ray beam must be aligned with both receptors in the entire movement range. See *Perform-X System Installation Manual* for instructions and details.

The relative positions of each component are set using the service application selecting the **Console** page. The position controls are located on the 'Settings' tab.



4.4.1 Checking / Setting System Orientation

The Perform-X system can be shipped / installed in left or right orientation. The orientation affects the horizontal SID measurement, the low extremities SID functionality and the automatic positioning (if applicable).



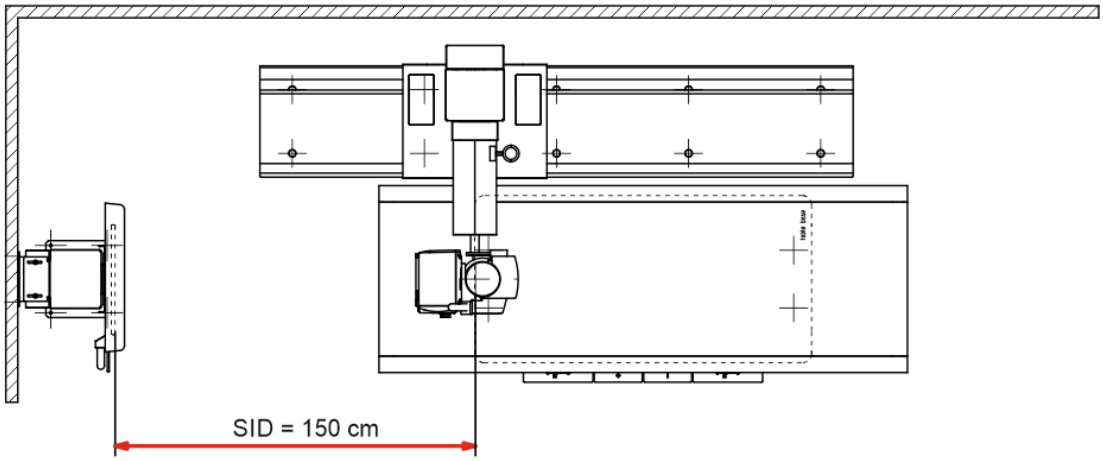
LEFT orientation example *RIGHT orientation example*

Using the '**Set Ws Left Side**' and the '**Set Ws Right Side**' buttons will set the physical orientation.

4.4.2 Setting the 150 cm Horizontal SID

To calibrate the horizontal SID display, simply set 150 cm horizontal SID on the equipment and press the '**Set WS SID 150 cm**' button in the service application.

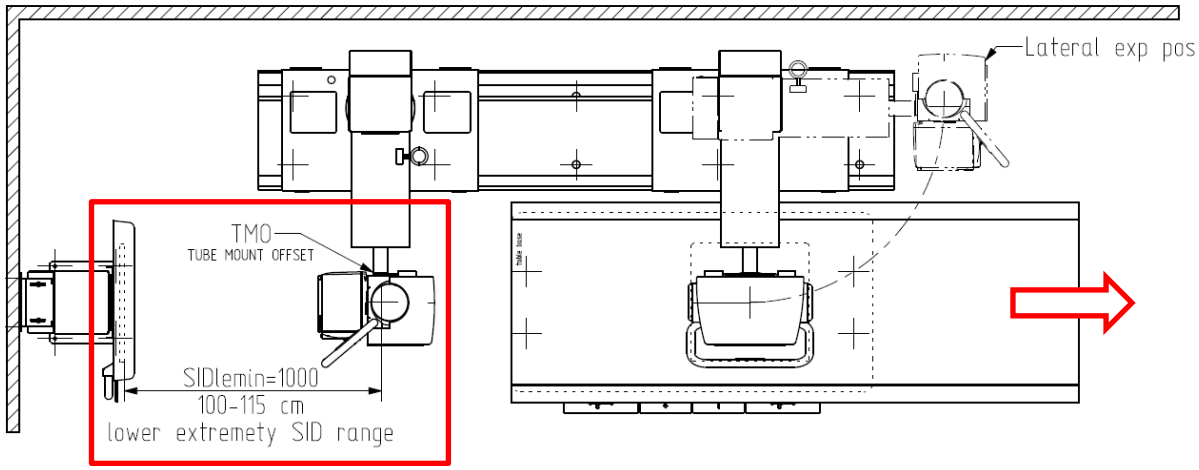
Make sure that the SID is measured between the X-ray tube **focal point and the image plane**.



Setting the 150 cm horizontal SID for calibration

4.4.3 Setting the Minimum SID for Low Extremity Procedures

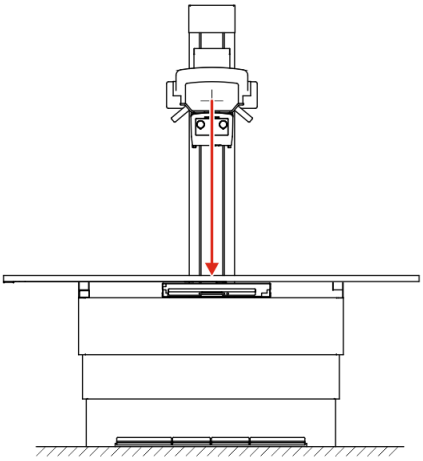
In order **to avoid collision** between the X-ray tube and the patient table during low extremity examinations at the wall stand (with the tube near the floor), the maximum ankle SID must to be configured.



Example room layout allowing low extremity procedures with the tabletop pushed aside

1. Select Console node from the Connection Menu
2. Slide the tabletop away from the wall receptor to allow the X-ray tube to travel near the floor
3. Move the X-ray tube into low extremity exposure position making sure that there is safe clearance between the X-ray tube assembly and the patient table (at least 5 cm)
4. Read the SID value shown in the Control Menu area of the service application. Enter this value into field '**TS Ankle Position'** and press '**Set Ankle SID**'.

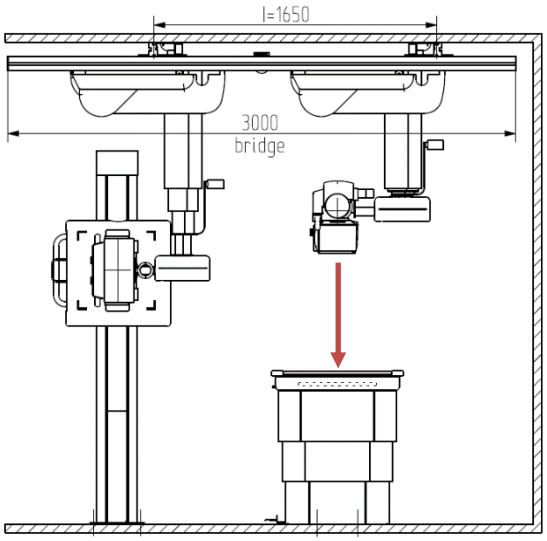
4.4.4 Centering the Table Receptor Longitudinally



For systems with automatic table receptor centering, the relative longitudinal position of the X-ray tube and the table receptor must be calibrated.

1. Position the X-ray tube over the table receptor center with vertical X-ray beam. Make sure that the receptor is in the exact center of the travel. Press the '**Center Table Receptor** button to calibrate and save the position.

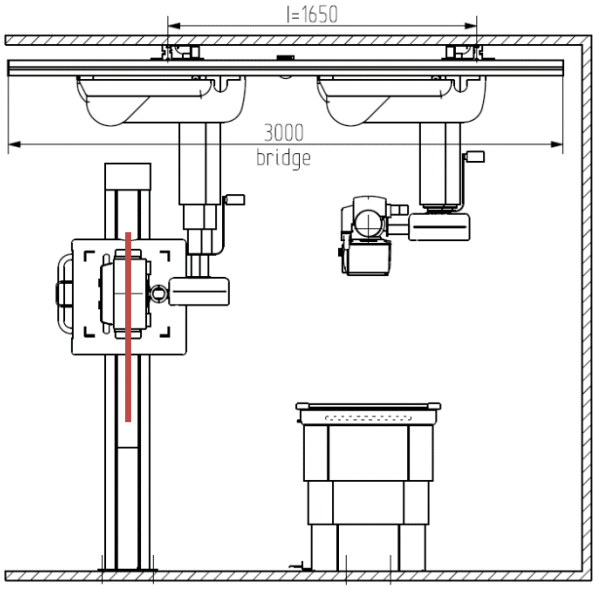
4.4.5 Centering the Tube to the Table Receptor Laterally (Only for Ceiling Mount Systems)



For CEILING mount systems, the relative lateral position of the X-ray tube and the table receptor must be calibrated.

1. Click on Membrane Console drive and find **Table Lateral Position** area inside Settings tab
2. Make sure that the tube rotation and tube pivot are 0°
3. Position the X-ray tube so that the tube is LATERALLY centered with the TABLE receptor
4. Read the X-ray tube lateral position value from the Controls Menu on the right. Enter this value (in cm with mm precision, e.g. 150.3) into the **Table Lateral Position** field and press **Set**

4.4.6 Centering the Tube to the Wall Receptor Laterally (Only for Ceiling Mount Systems)



For CEILING mount systems, the relative lateral position of the X-ray tube and the wall receptor must be calibrated.

1. Click on Membrane Console drive and find **WS Lateral Position** area inside Settings tab
2. Make sure that the tube rotation is 90° and tube pivot is 0°
3. Position the X-ray tube so that the tube is LATERALLY centered with the WALL receptor
4. Read the X-ray tube lateral position value from the Controls Menu on the right. Enter this value ((in cm with mm precision, e.g. 25.5) into the **WS Lateral Position** field and press **Set**