

Technical Manual

ZEPRO Z 1500/2000

ZEPRO ZDK 250

ZEPRO

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ZEPRO

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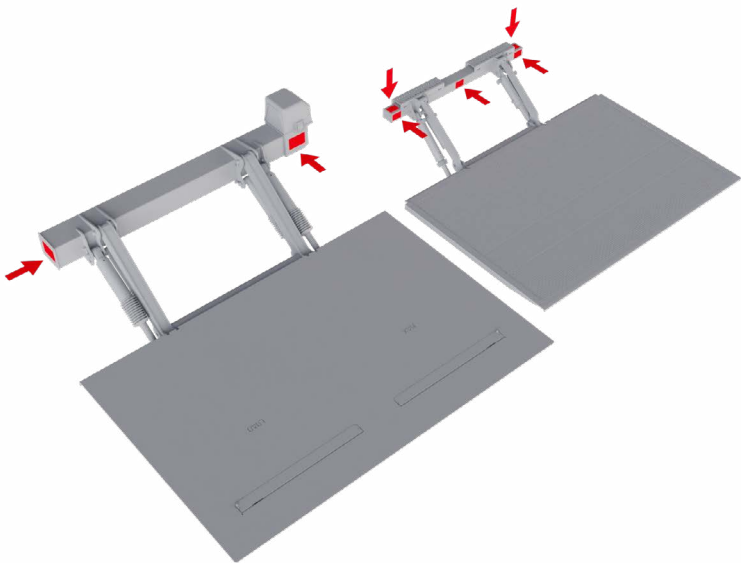
1 Product overview

1.1 Product variants and identification

1.1.1 The type sign

The Zepro Z 1500/2000 product family consists of the Z 1500 and Z 2000 tail lifts and their variants such as the Zepro ZDK 250. These products are available in a number of different variants with varying levels of functionality. The control systems, cylinder configurations, available control units and sensors can vary between the variants. It is therefore crucial to first identify the variant at hand to be able to find the correct technical information for it.

The first step in the process of identifying the variant is locating the type sign and reading the information in the tail lift type-field. The location of the typesign varies between different tail lift models but it is always riveted onto the support beam of the lift with the most common location being shown on the figure below. There should also be a sticker showing the same information in the users manual and on the door sill on the drivers side of the vehicle



For the Zepro Z 1500/2000, the following nomenclature is used. The first one or two letters is the model designation where Z is the standard model and the ZL is the model with the wide lift arm. The following four digit number denotes the lifting capacity of the tail lift, in kilograms, and the three digit number that follows is the approximate maximum lifting height of the lift in centimeters. The lifting height is followed by the cylinder configuration and lastly the system voltage.

| | Model | Capacity | | Lifting height | Cylinder configuration | System voltage |
|-------|-------|----------|---|----------------|------------------------|----------------|
| | Z | 1500 | | 135 | MA | 12V |
| ZEPRO | / | / | — | 155 | / | / |
| | ZL | 2000 | | / | DA | 24V |
| | | | | 175 | | |

For the Zepro ZDK 250, the same nomenclature is used with the only difference being the capacity which is given with three digits only in order not to ocnfuse the light duty ZDK 250 with the heavy duty Z 2500 tail lifts.

| | Model | Capacity | | Lifting height | Cylinder configuration | System voltage |
|-------|-------|----------|---|----------------|------------------------|----------------|
| | ZDK | 250 | | 135 | MA | 12V |
| ZEPRO | | | — | / | | / |
| | | | | 155 | | 24V |

1.1.2 Main components

All variants of the Z 1500/2000 model family consist of the same main components shown in the figure below.

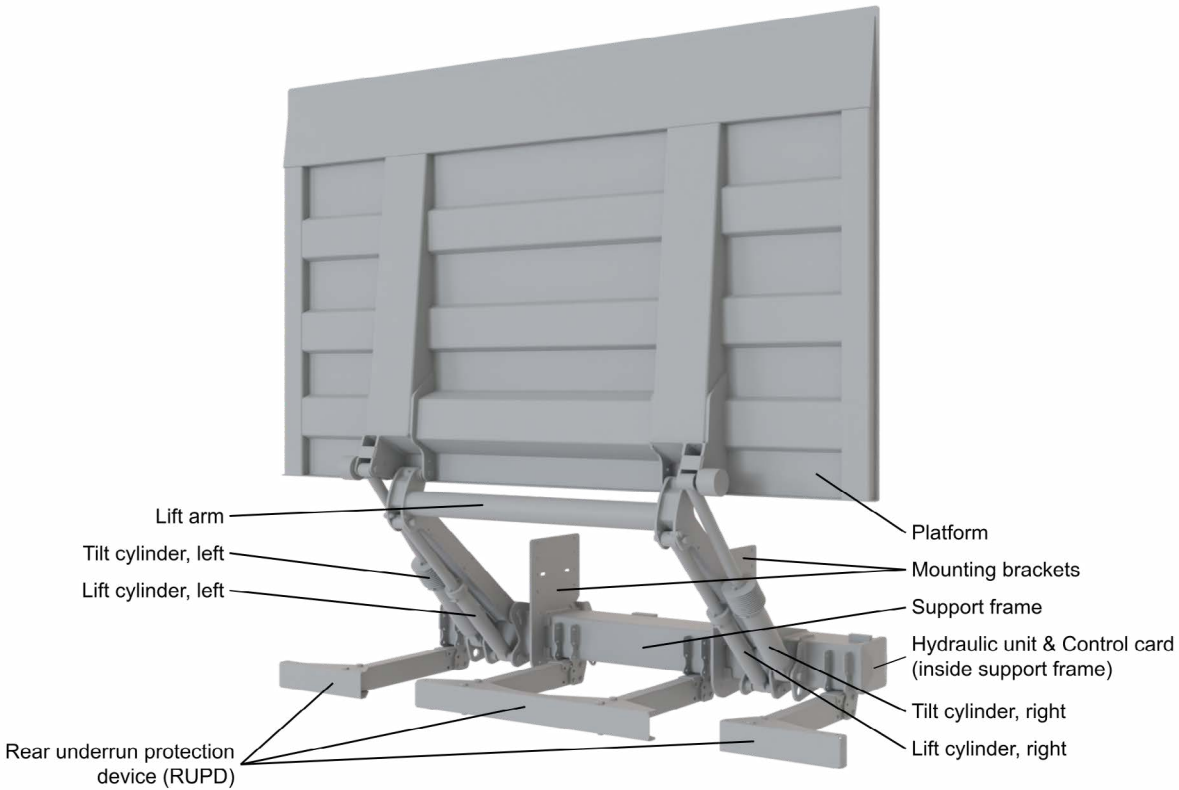


Fig 1. Main components for Z1500/2000

1.1.3 Cylinder configurations

The Z 1500/2000 is available with two cylinder configurations: MA and DA, denoting the following:

| Cyl. config. | Lift cylinders | Tilt cylinders |
|--------------|----------------|---------------------------|
| MA | Single acting | Double acting, adjustable |
| DA | Double acting | Double acting, adjustable |

A double acting cylinder uses hydraulic pressure for both extension and compression. A single acting cylinder, on the other hand, uses hydraulic pressure only in one direction and uses an outside force (gravity) in the other direction. Double acting tilt cylinders allow for more consistent operational speeds over a wide temperature range which is especially useful when opening and closing the platform against the box body in colder climate.

1.1.4 Auto tilt

A tail lift equipped with auto tilt functionality automatically tilts the platform down when the platform reaches the ground and then tilts is back up to horizontal without any additional input from the user other than keeping the lower/raise button pressed throughout the motion. The Z 1500/2000 can be equipped with two types of electrical auto tilt systems, one based on a digital auto tilt sensor and one based on an analog sensor. It can also be without any auto tilt functionality. Whether the tail lift is equipped with auto tilt functionality or not cannot be determined by reading the information on the type sign. Instead the type and number of sensors installed on the platform should be checked.

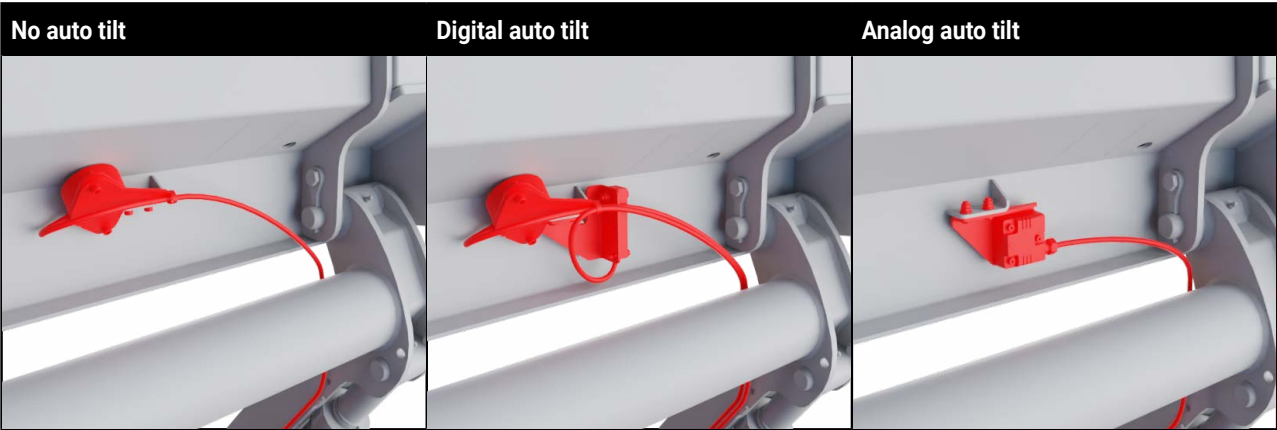
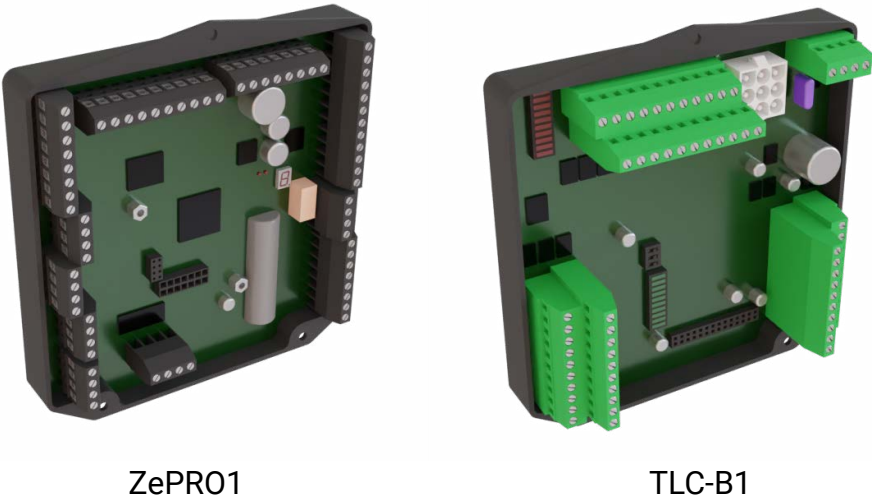


Fig 2. Angle sensor.

1.1.5 Control cards

The control card converts the inputs from the user and the sensors into outputs to the motor solenoid and the valves which accomplish the desired motion. The Z 1500/2000 can be equipped with one of two models of control cards, depending on market and required functionality. The first control card is the ZePRO1 control card which is an advanced processor based circuit card. The second is the simpler TLC B1 card which is based on solid state relay technology.

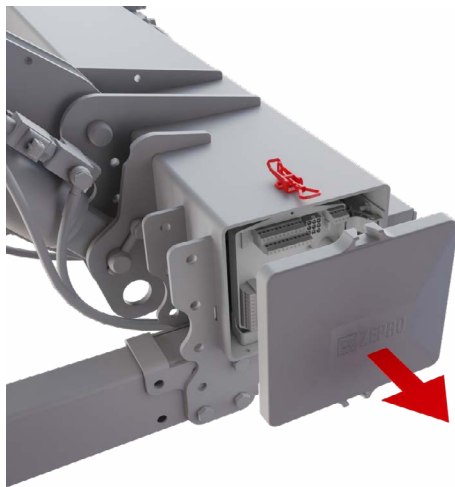


The cylinder configuration and the auto tilt functionality or lack there of has an impact on the software configuration of the control card required to operate the tail lift. Using a software configuration not meant for a particular cylinder configuration can lead to the tail lift nor functioning properly or in some cases, not functioning at all. Every card has a decal showing its configuration. On the ZePRO1 circuit card the configuration is also displayed every time the card is powered on, see "Startup sequence" on page 17 for details. On the TLC B1 card the configuration can be determined by examining the position of the three switches on the block in the middle of the card, see "2.2.6 Card configuration" on page 26 for details. The following table shows the required configurations for the different variants of the Z 1500/2000.

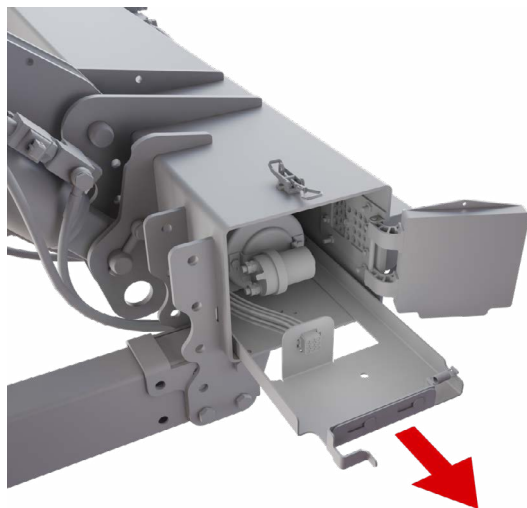
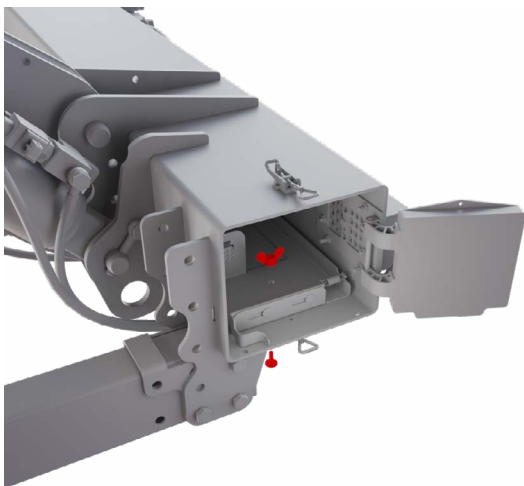
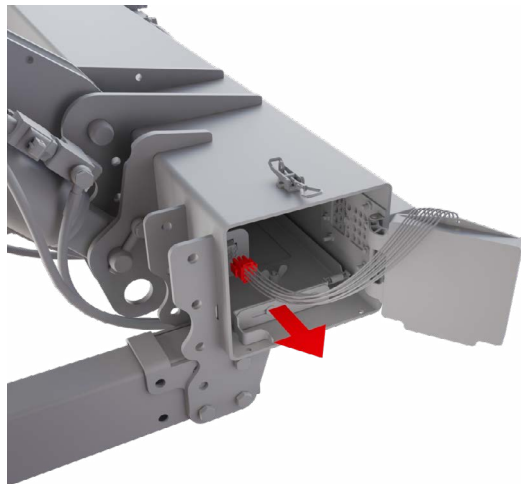
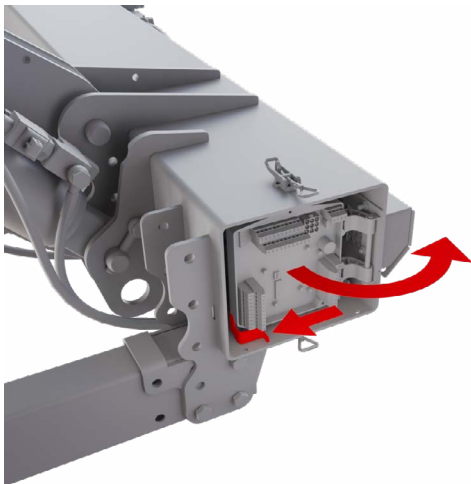
| Cylinder config. | Auto tilt | ZePRO1 config. | TLC-B1 config. |
|------------------|---------------------|----------------------------|-----------------------|
| MA | No | 14 | 000 |
| | Yes, digital | 14 | 000 |
| | Yes, analog | 14 (firmware 9.8 or later) | Not supported by card |
| DA | Not available on DA | 16 | Not supported by card |

1.2 Accessing the card and hydraulic unit

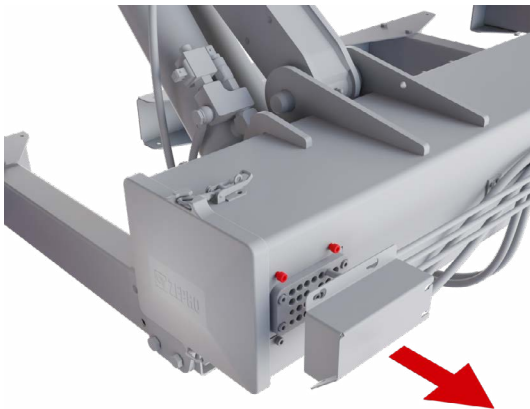
The control card and the hydraulic unit are housed inside the main support frame of the tail lift. The control card is accessed by unlocking the two locks on the top and the bottom of the support frame and removing the plastic cover.



With the cover removed, the hydraulic unit is accessed by swinging the card out of the way, disconnecting the quick connector for the cable harness, removing the securing nut for the hydraulic unit tray and sliding the tray out.



On the front of the support frame there is a cable grommet for cable pass-through from the outside to the inside of the tail lift. Cables going from the card to the sensors, control devices, cabin switch and outer valves are passed through the grommet. Access to the cable grommet is achieved by loosening the two screws holding the protective cover in place. Loosening the five screws in the rubber seal reduces its grip on the cables.

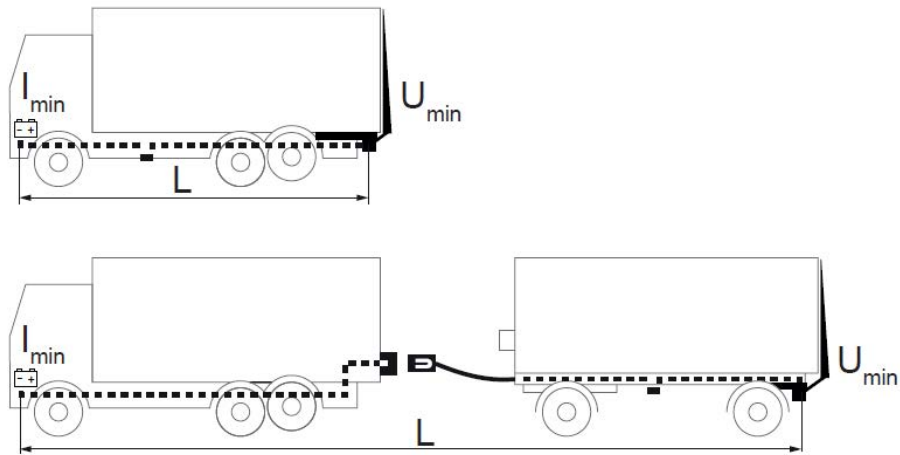


1.3 Battery and cable requirements

For proper function of the tail lift the electrical system needs to be sized per the following:

| Item | 12V | 24V |
|--|-------------------|-------------------|
| Minimum battery capacity (I_{min}) | 180Ah | 170Ah |
| Minimum voltage during operation (U_{min}) | 9V | 18V |
| Cross sectional area of power cable, length up to 8m | 35mm ² | 35mm ² |
| Cross sectional area of power cable, length 8-15m | 50mm ² | 35mm ² |
| Cross sectional area of power cable, length over 15m | Not possible | 50mm ² |

The given cross sectional areas are valid for copper cables. If other conductor material is used proper conversion needs to be made in order to properly size the connection. The total length of the cable is measured according to the following figure.



Some vehicle models have restrictions regarding the amount of current the lift can access from the existing battery. Some vehicle models do not fully charge the battery. It may therefore be necessary to switch to a battery and sometimes also to a charger with a larger capacity.

2 Control cards

2.1 ZePRO1 circuit card

2.1.1 Overview

The ZePRO1 control card can be split into different functional sections as shown in the following figure. In-depth explanations of each section are contained in the following chapters.

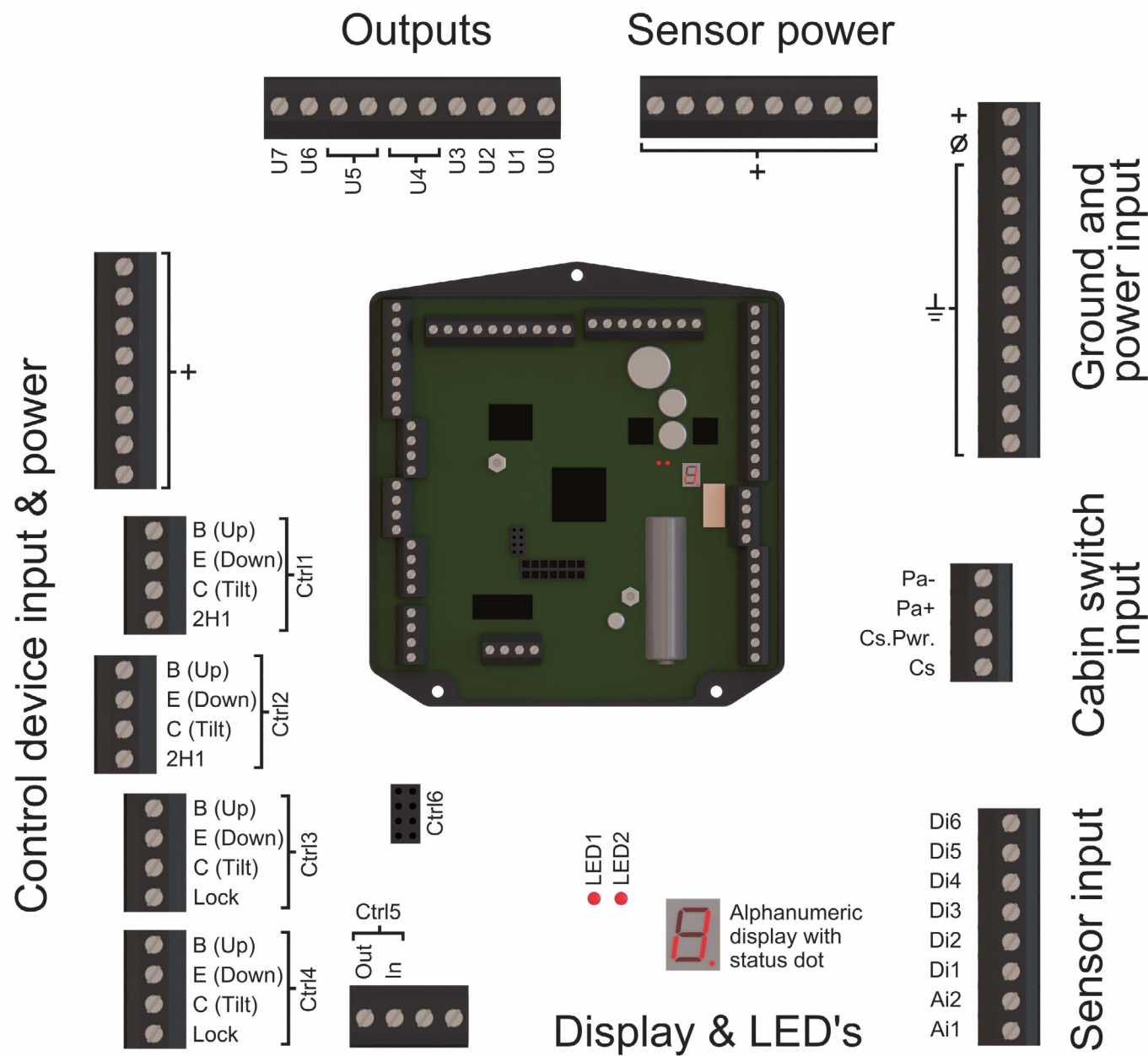
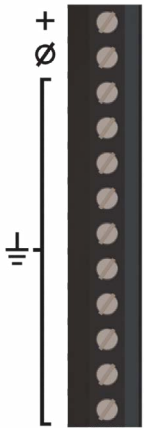


Fig 3. ZePRO1 control card

2.1.2 Ground and power input

The top pin of the ground and power input section is where the power supply for the card is located. The cable that is connected to this pin is secured by a 10A (24V models) or 15A (12V models) fuse and is drawing power from the motor solenoid. Without power to this pin, the card will not power on. The second pin is not used for anything and the remaining ten pins are all ground points used for sensors and control devices.

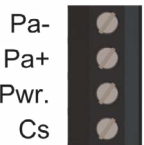


2.1.3 Cabin switch input

For countries where the EN 1756-standard is in effect, the tail lift shall be equipped with a system to prevent any unauthorized operation in the absence of the operator. This can be achieved by locking and unlocking with a code or an On/Off switch inside lockable driver's cab.

The Zepro solution consists of a cab switch, which when active, sends power to the CS pin in the cab switch section of the card. When the switch is in its "Off" position any inputs are disregarded and the tail lift is effectively locked.

On installations where the use of a cab switch is not possible due to absence of a driver's cab, the CS pin is powered directly from a power source through a 2-3A fuse and the tail lift is disabled by other means, a lockable power switch on the main battery cable for example.



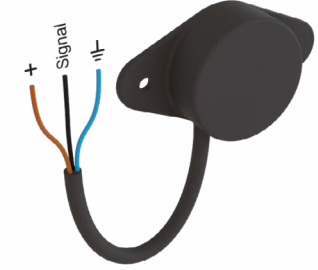
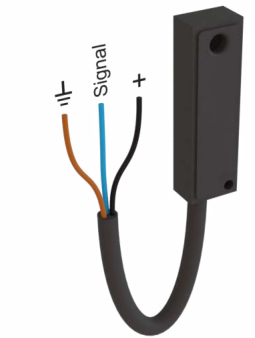
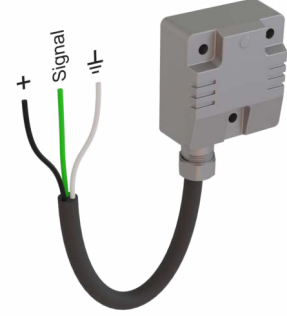
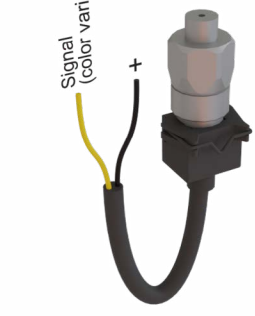
2.1.4 Sensor input

Sensors are used to provide added functionality when certain conditions are met, or limit certain functionality for safety reasons. The ZePRO1 control card has input pins for up to 6 digital sensors, Di1 through Di6, as well as 2 analog sensors, Ai1 and Ai2. The card can accommodate the sensors shown in the table. Different variants of the Z 1500/2000 use different types and number of sensors, see the functional descriptions and schematics chapter for more information.



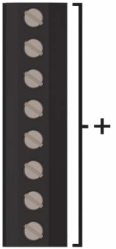
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| Type | Picture | Explanation |
|------------------------------------|---|---|
| Digital angle sensor (ball type) |  | <p>An angle sensor that uses an articulating ball to output an On/Off signal for certain angle ranges.</p> <p>Usually mounted on the platform and used to control the two hand safety requirement.</p> |
| Digital angle sensor (liquid type) |  | <p>A sensor that uses a fluid to measure the angle and outputs an On/Off signal for certain angle values. More accurate than the ball type sensor.</p> <p>Mounted on the platform on tail lifts equipped with digital auto tilt on which it is used to stop the auto tilt up motion of the platform when it reaches horizontal level.</p> |
| Analog angle sensor (Inclinometer) |  | <p>Advanced analog angle sensor that outputs 0-4,5 V depending on angle.</p> <p>Mounted on the platform on tail lifts equipped with analog auto tilt with angle setting function on which it is used to stop the auto tilt up motion of the platform when it reaches desired angle. It also controls the two hand safety requirement.</p> |
| Pressure sensor |  | <p>Outputs an On/Off signal if the pressure exceeds (rising pressure sensor) or falls below (falling pressure sensor) a predetermined value.</p> <p>It is most often used for the open platform alarm, in which case it is mounted on the positive hydraulic connection to the right tilt cylinder. It can also be used for the auto tilt function in which case it is mounted on the positive hydraulic connection to the right lift cylinder.</p> |

2.1.7 Sensor power

The sensor power block consists of 8 pins that output voltage to drive the sensors connected to the card.



2.1.6 Control device input and power

The control devices are connected to the control device input section and powered by the control device power section of the control card. They are used to input user comands into the control card so that they can be interpreted and executed. The control devices can be grouped into two groups depending on their functionality: primary and secondary devices. Primary devices can operate all functions of the tail lift including those that require two-handed operation for safety reasons. Secondary devices do not offer the possibility of two-handed operation and therefore unable to operate certain functions. The most common primary control devices for the Z 1500/2000 are shown below.

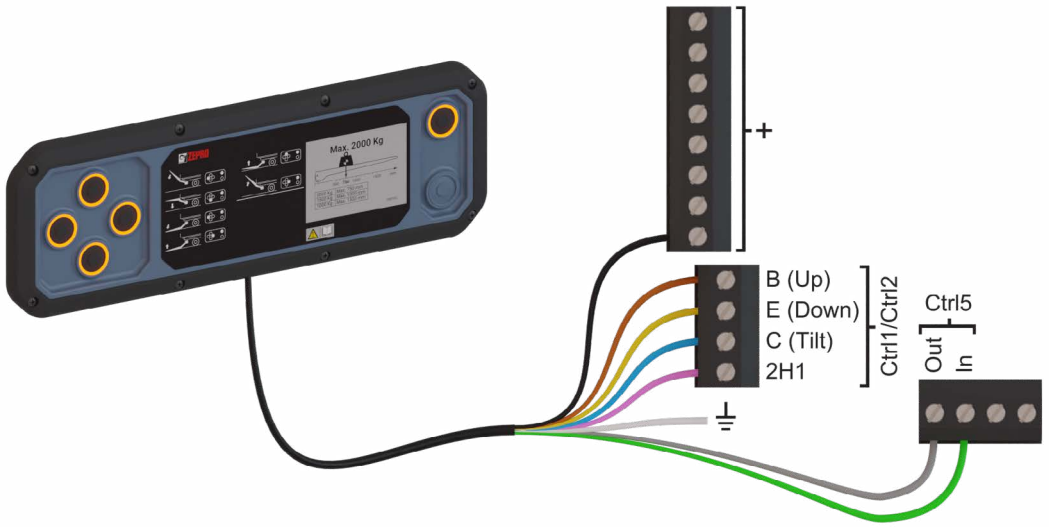


Fig 4. CD 19

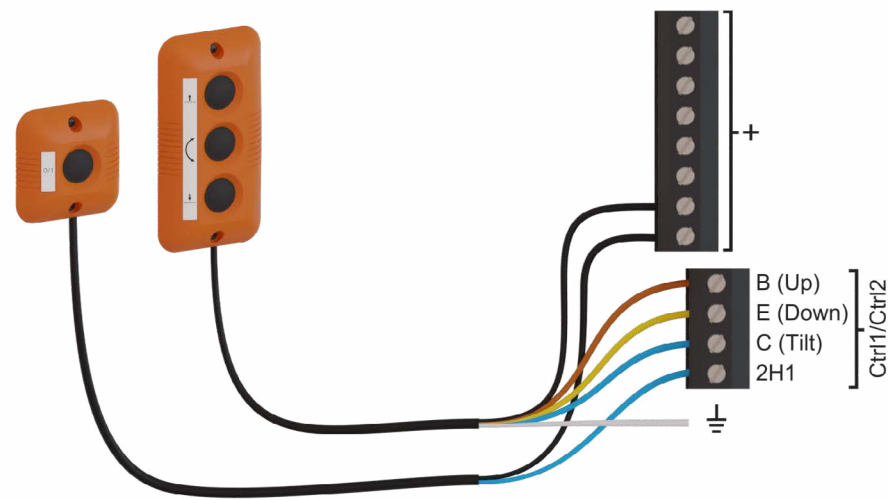


Fig 5. CD 1

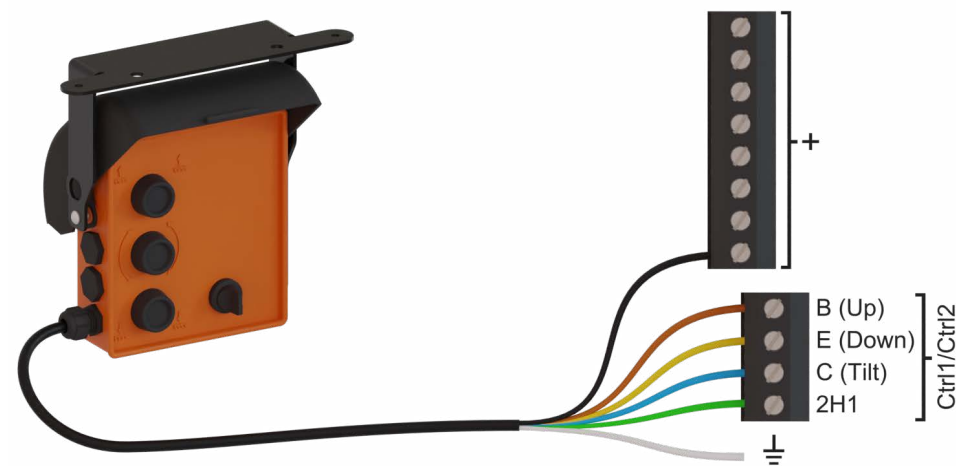


Fig 6. CD 3

The ZePRO1 control card has six control device inputs Ctrl 1 through Ctrl 6.

- Ctrl 1 - Input for a primary control device. Can control all tail lift functions apart from slide in / slide out.
- Ctrl 2 - Input for a primary control device. Same functionality as Ctrl 1.
- Ctrl 3 - Input for a secondary control device such as radio control device with externally mounted receiver.
- Ctrl 4 - Input for a secondary control device such as in-box mounted device with a spiral cable.
- Ctrl 5 - Input used for the slide out / slide in functionality of sliders. Not used on the Z 1500/2000.
- Ctrl 6 - Input used for the receiver of the radio control device. Same functionality as Ctrl 3.

The most common secondary control devices for the Z 1500/2000 are shown below.

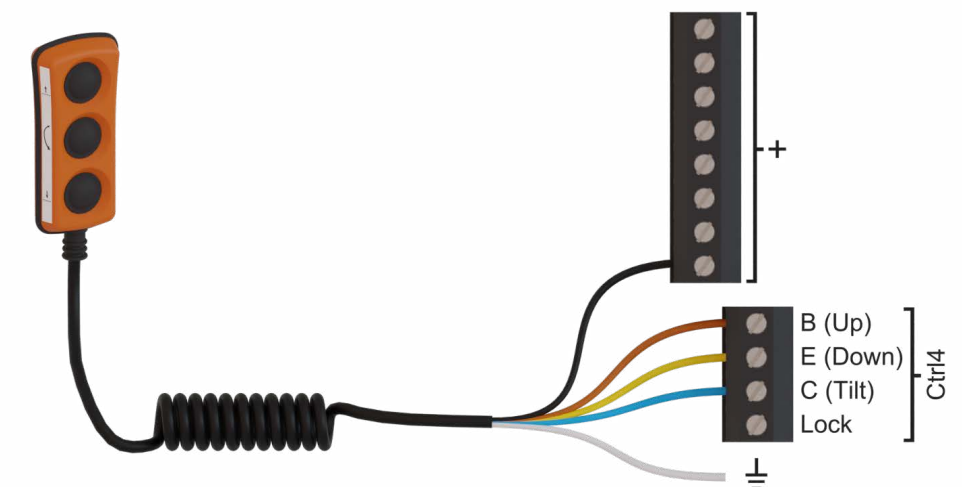


Fig 7. CD 9

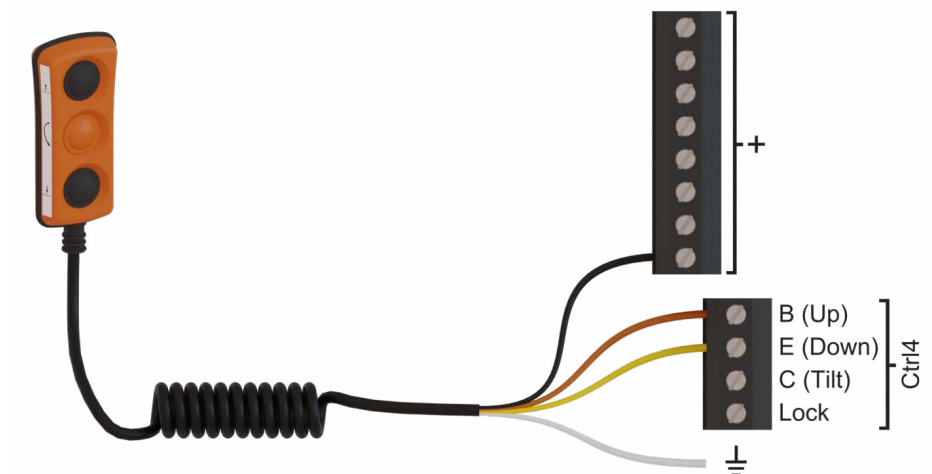


Fig 8. CD 10

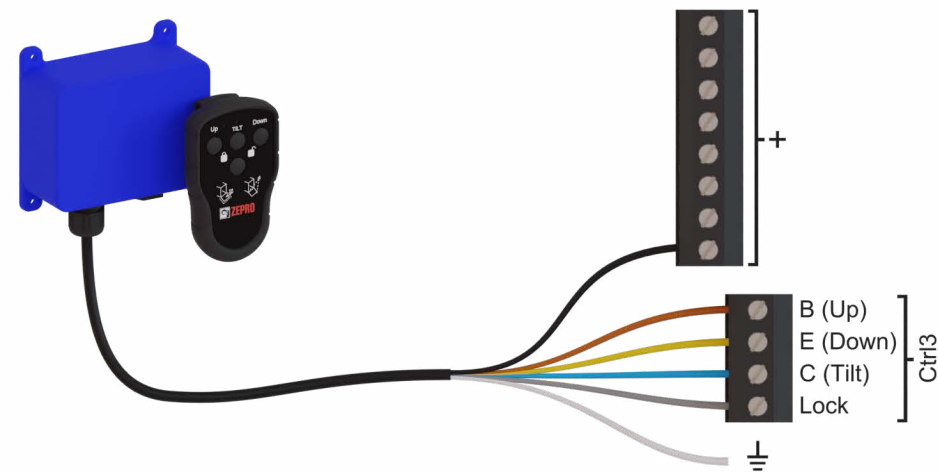


Fig 9. CD 11



Fig 10. Receiver module is mounted directly on the control board.

2.1.8 Display and LED's

The control card is equipped with two LED's and an alphanumeric display with a status point on the lower right corner which provide useful information about the system.

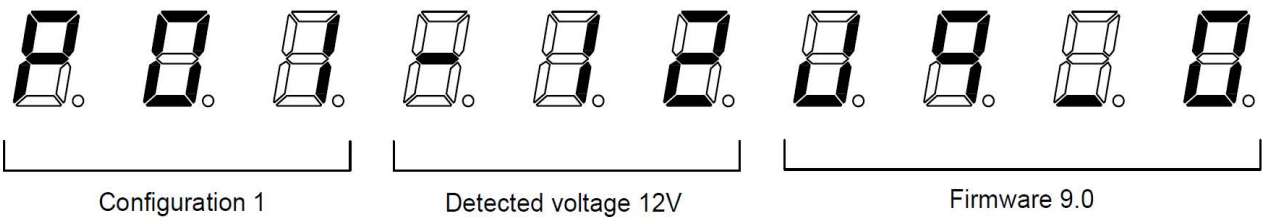
- The status dot has three states:
- Off: no supply voltage to control card.
- On: supply voltage is available but the cabin switch is switched off.
- Flashing: supply voltage is available and the cabin switch is switched on. The card is awaiting input signal.

When a button press is being registered by the card, LED1 is lit and when the signal from the control device and sensors is registered and approved by the card, LED2 is lit to indicate an active output.



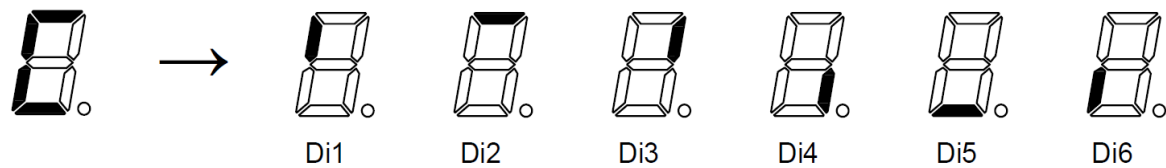
Startup sequence

Every time the card is switched on, either by turning the cabin switch off and then back on or by cutting the power to the lift and turning it back on, a startup sequence is displayed on the display. The software configuration is displayed first, followed by the detected voltage and the firmware version number. It is crucial that the software configuration is the correct one for the tail lift it is installed on, see the software configurations chapter for more information.



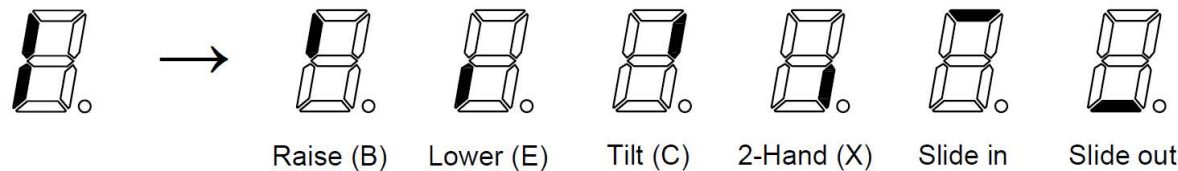
Sensor input indication

As long as no buttons are pressed and no faults are detected, the display will show the sensors that are active at the time. This is displayed by the letter “C” followed by lit sector(s) corresponding to a sensor input as shown below. Note that more than one sensor can be active at the same time in which case more than one sector will be lit at the same time.



Control unit input indication

When a button is pressed on a control unit this is indicated on the display. The active control unit (1-6) is shown first, followed by the active button according to the figure below. If more than one button is pressed at the same time, the sectors denoting all pressed buttons will lit up at the same time.



Once a button has been released, the control system for the current control device is locked for a while to ensure that no other person operates the lift from another control device. The current control device number (1-7) will flash on the display while the control system is locked to it. This primarily applies to radio and coil control devices, as other control devices have such a short locking period that there is hardly time to see the indication.

The number will stop flashing when one of the current control device buttons is pressed. If the control card has been without voltage and receives the voltage again when the CS (cabin switch) is switched on, “7” will flash on the display and the control card is locked until the Off/On on the CS is operated.

Fault indication

When the ZePRO1 control card detects a fault, it displays a fault code on the display to assist troubleshooting. The fault code consists of a letter followed by a two digit number. The letter indicates the type of fault and the number provides additional information about the fault.

If the card detects several faults, they are prioritised in the following order: L/H, E, F, U and A. When the cabin switch is turned off, the system scrolls through a list of the last five errors detected before the display turns off after approx. 5 minutes when the control card goes into sleep mode.

All fault codes can be reset manually by switching the cabin switch (if present) off and then back on again.

A - Internal fault

Fault code A is displayed when the control card has detected an internal fault. In some cases the tail lift can be used as normal when this code is displayed as long as it functions correctly. If the lift is not functioning correctly however, the control card needs to be replaced.

E - System locked

Fault code E is displayed when the control card is locked by a control device equipped with a locking function, most commonly a radio control device or a spiral cable control device. The number following the letter identifies the card input that the device used to lock the system is connected to. For example E1 indicates Ctrl1, E2 indicates Ctrl2 and so on.

Once a spiral control device equipped with a locking function has been used, the control system is locked to the current control device until it is unlocked manually with the respective control device's unlock button. The radio control device is also equipped with a locking function. The control system can then be locked/unlocked by pressing and holding the lock/unlock button. In the event of a fault in the remote control, it can be unlocked by turning the cabin switch off and then back on.

The fault code resets automatically if the control system has not received a signal from the relevant control device for 6 minutes.

F - Output short circuit

Fault code F is displayed when the card detects an unusually high current draw through one of the outputs which implies a short circuit on that output. The number following the letter identifies the output in question with 0-7 denoting output U1 through U7, the number 8 denoting the control device output section and the number 9 denoting the sensor power output section.

The fault code is reset automatically when/if the card can detect normal current draw through the output.

H - High voltage

Fault code H is displayed when the card detects an input voltage that is higher than expected. The number following the H indicates the measured voltage. For example, H32 means that the measured voltage is 32 Volts.

The fault code resets automatically once the voltage becomes acceptable again.

L - Low voltage

Fault code L is displayed when the card detects an input voltage that is lower than expected. The number following the L indicates the measured voltage. For example, L9 means that the measured voltage is 9 Volts.

The fault code resets automatically once the voltage becomes acceptable again.

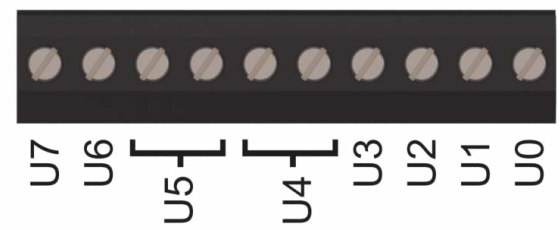
U - Output not connected

Fault code U is displayed when the card powers an output with nothing connected to it. The number 0-7 following the letter U identifies the output in question, U0 through U7.

The fault code is reset automatically when/if the card can detect normal current draw through the output.

2.1.9 Outputs

The output section is used for power delivery to the solenoid and the valve coils. It consists of 10 pins in total out of which four are interconnected in two pairs for cases where two coils need the same signal. The U0 output is reserved for the motor solenoid. U1-U3 are usually used for valves V1, V2 and V3. U4 and U5 are usually used for the safety valves on the tilt and lift cylinders and the remaining output pins are used for additional valves. See the functional descriptions and schematics chapter for more information.



2.2 TLC B1 relay card

2.2.1 Overview

The TLC B1 control card can be split into different functional sections as shown in the following figure. In-depth explanations of each section are contained in the following chapters.

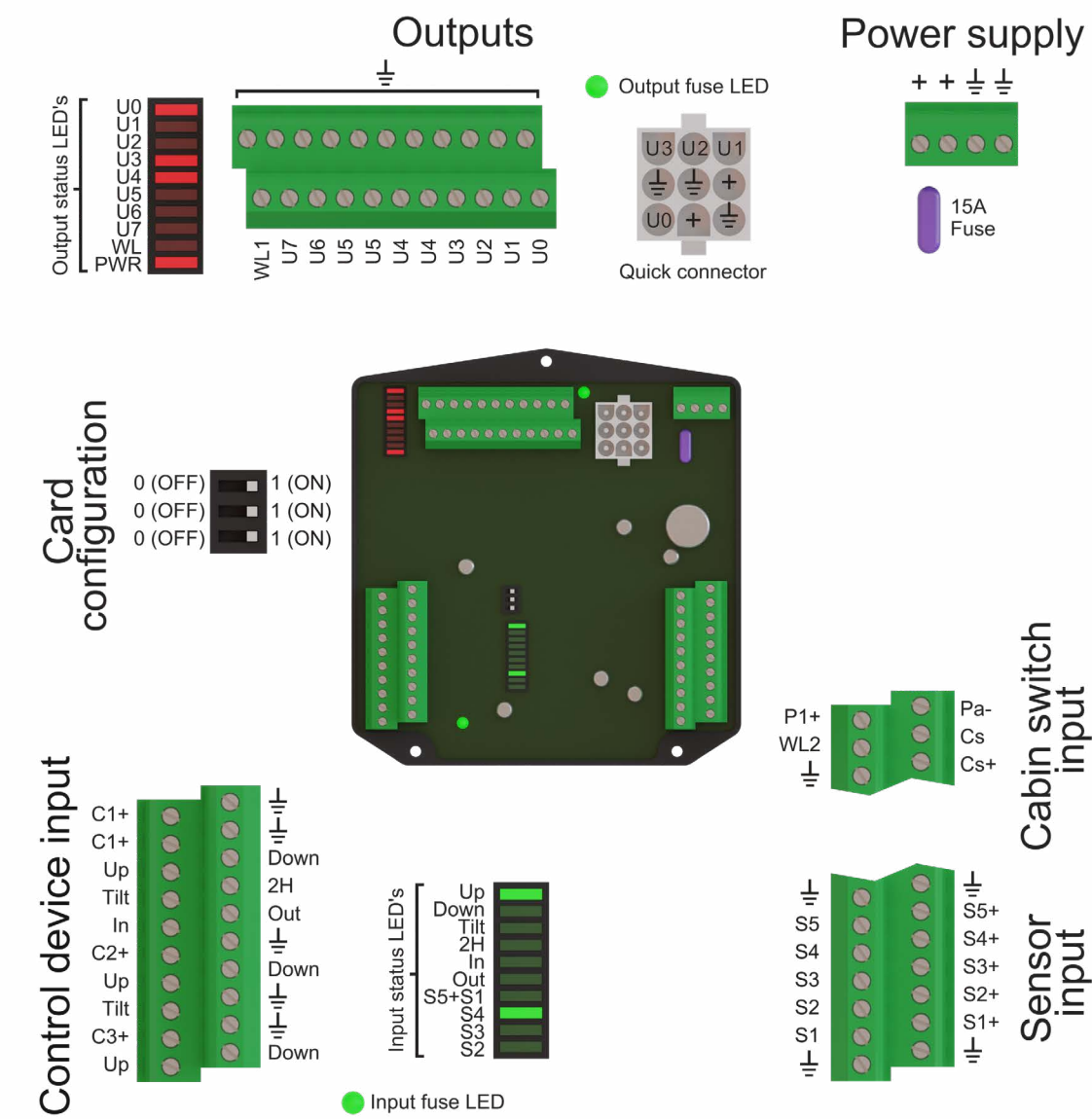


Fig 11. TLC B1 control card

2.2.2 Power supply

The control card is powered through the power supply block in the top right corner of the card and is protected by the 15A fuse right beneath it.

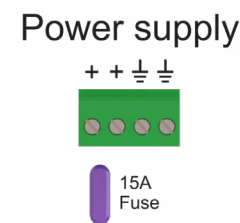


Fig 12. Supply socket protected with 15A fuse.

2.2.3 Cabin switch input

For countries where the EN 1756-standard is in effect, the tail lift shall be equipped with a system to prevent any unauthorized operation in the absence of the operator. This can be achieved by locking and unlocking with a code or an On/Off switch inside lockable driver's cab.

The Zepro solution consists of a cab switch, which when active, sends power to the CS pin in the cab switch section of the card. When the switch is in its "Off" position any inputs are disregarded and the tail lift is effectively locked.

On installations where the use of a cab switch is not possible due to absence of a driver's cab, the CS pin is powered directly from a power source through a 2-3A fuse and the tail lift is disabled by other means, a lockable power switch on the main battery cable for example.

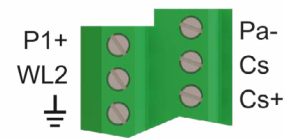


Fig 13. Supply socket for the cabin switch

2.2.4 Sensor input

Sensors are used to provide added functionality when certain conditions are met or limit certain functionality for safety reasons. The TLC B1 control card has input pins for up to 4 different sensors, S2 through S5. The S1 input is used to power the S5 so together they act as a single input. The S1+S5 input is most often used for the auto tilt functionality on some variants.

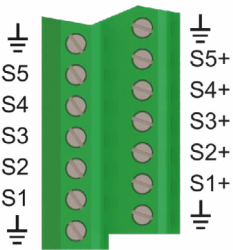
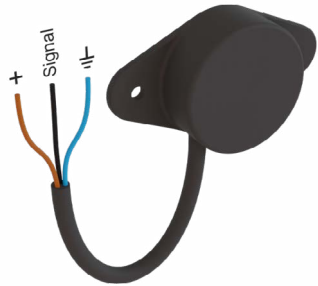
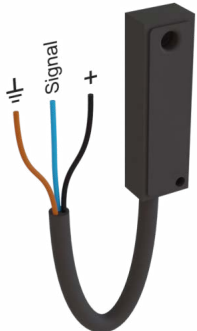
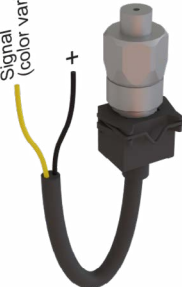


Fig 14. Supply socket for different sensors

The TLC B1 card can accommodate the sensor types shown in the table below. Different variants of the Z 1500/2000 use different types and number of sensors depending on functionality. See the functional descriptions and schematics chapter for connection information.

| Type | Picture | Explanation |
|------------------------------------|---|---|
| Digital angle sensor (ball type) |  | <p>An angle sensor that uses an articulating ball to output an On/Off signal for certain angle ranges.</p> <p>Usually mounted on the platform and used to control the two hand safety requirement.</p> |
| Digital angle sensor (liquid type) |  | <p>A sensor that uses a fluid to measure the angle and outputs an On/Off signal for certain angle values. More accurate than the ball type sensor.</p> <p>Mounted on the platform on tail lifts equipped with digital auto tilt on which it is used to stop the auto tilt up motion of the platform when it reaches horizontal level.</p> |
| Pressure sensor |  | <p>Outputs an On/Off signal if the pressure exceeds (rising pressure sensor) or falls below (falling pressure sensor) a predetermined value.</p> <p>It is most often used for the open platform alarm, in which case it is mounted on the positive hydraulic connection to the right tilt cylinder. It can also be used for the auto tilt function in which case it is mounted on the positive hydraulic connection to the right lift cylinder.</p> |

2.2.5 Control device input

The control devices are connected to the control device input section and powered by the control device power section of the control card. They are used to input user commands into the control card so that they can be interpreted and executed. The control devices can be grouped into two groups depending on their functionality: primary and secondary devices. Primary devices can operate all functions of the tail lift including those that require two-handed operation for safety reasons. Secondary devices do not offer the possibility of two-handed operation and are therefore unable to operate certain functions. The most common primary control devices for the Z 1500/2000 are shown below.



Fig 15. CD 19



Fig 16. CD 1

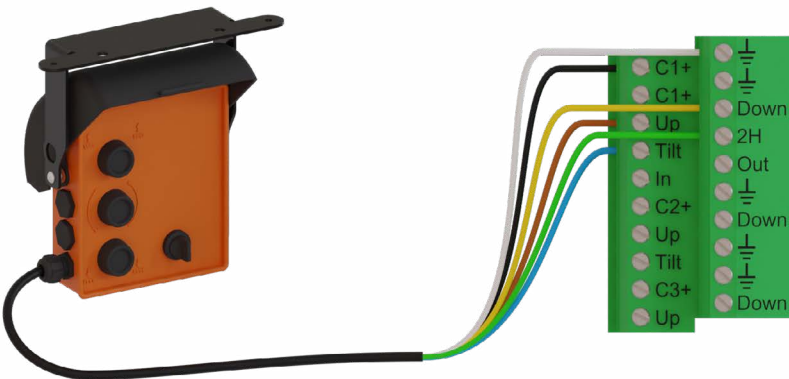


Fig 17. CD 4

The most common secondary control devices for the Z 1500/2000 are shown below.

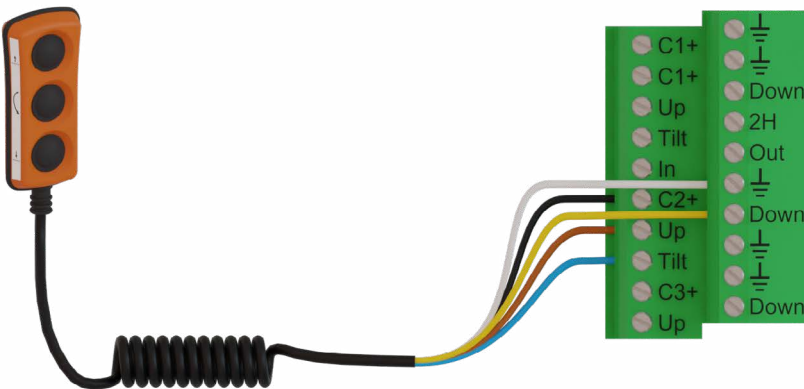


Fig 18. CD 9

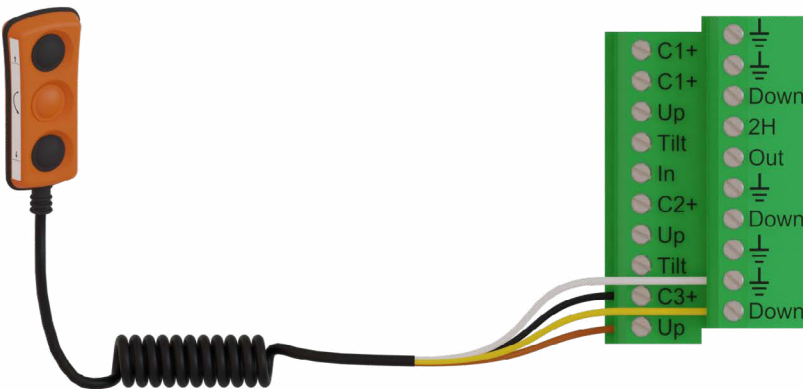


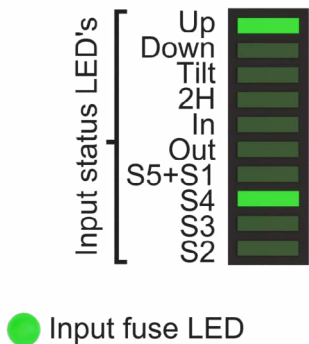
Fig 19. CD 10



Fig 20. CD 11

Right next to the control device input block, there is a single LED and a strip with ten LED's. The single LED is the status light for the input fuse. Unlit LED means a short circuit or that the card is switched off. Lit LED means that there is voltage to the output section.

The LED strip indicates that the card is receiving a signal from a sensor and/or a control device. Each function has its own dedicated LED on the strip. Sensors S2 through S4 have their own dedicated LED's as well while S5 and S1 are grouped together into one LED.



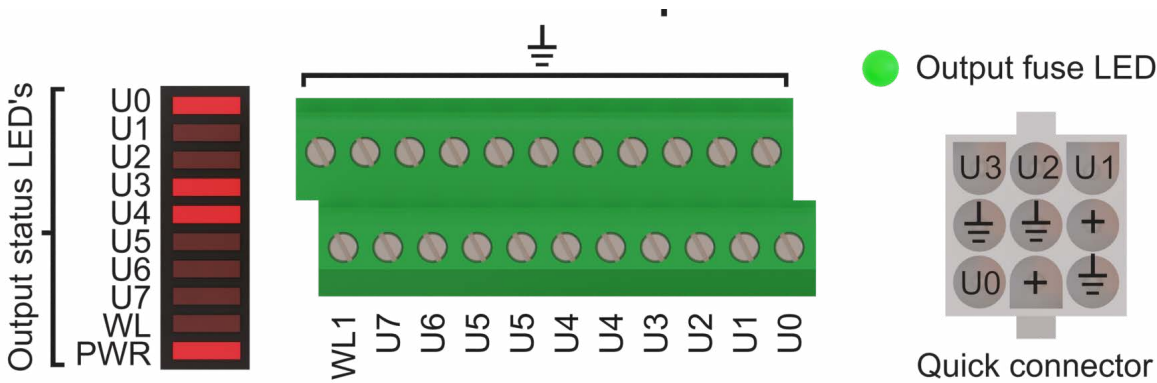
2.2.6 Card configuration

The card configuration block is a block with three two-position switches that determine the configuration of the card. A switch is in its ON-position when pushed to the right side of the slot and in its OFF-position when pushed to the left. For the Z 1500/2000 tail lift family, only the 000 configuration is used which means that all three switches are in their OFF-positions as shown below.



2.2.7 Outputs

The output section is used for power delivery to the solenoid and the coils that control the valves and thereby the motion of the tail lift. The output block consists of 22 pins in total split into 2 rows. The top row consists of 11 ground points used for the coils and the solenoid. Four of these pins are interconnected in two pairs for cases where two coils need the same signal. The bottom row consists of 11 pins for power delivery to the coils, solenoid and in some cases warning lights. On the right side of the output block there is a square white quick connector that is sometimes used for output to U0 through U3 instead of the output pins on the output block. To the right of the output block there is a single LED used for output fuse status indication. It lights up green when there is voltage to outputs. Unlit LED means a short circuit or that the relay card is switched off. To the left of the output block there is a LED strip with 10 LED's used for active output indication. The bottom LED lights up when the control card is powered. It should stay lit constantly during normal operation. The top 9 LED's are used to indicate active output with each output having its own dedicated LED.

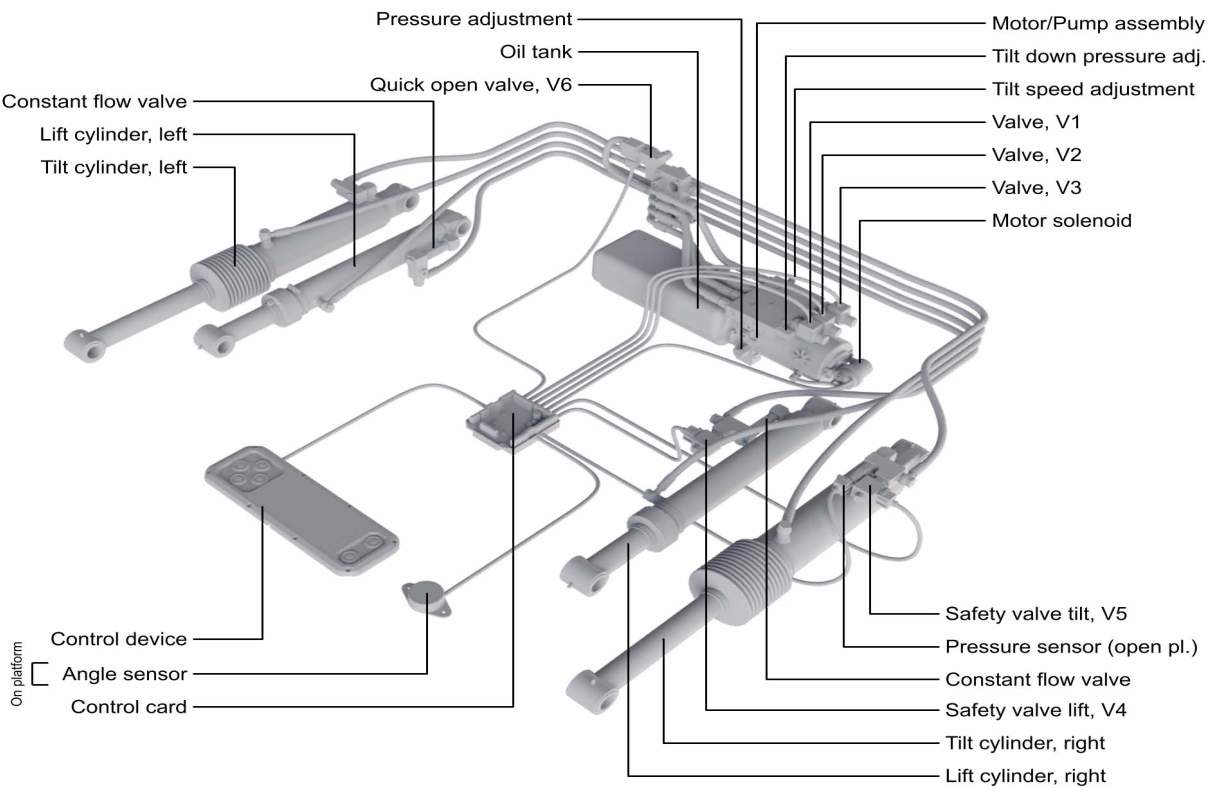


3 Functional descriptions and schematics

3.1 Z 1500/2000 MA (ZDK 250)

3.1.1 Description

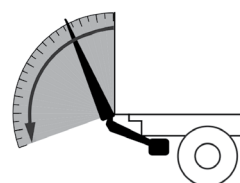
The Z 1500/2000 MA variant is a tail lift with double acting tilt cylinders, single acting lift cylinders and no auto tilt functionality. It is equipped with a quick opening valve that increases the opening speed of the platform.



Sensors used

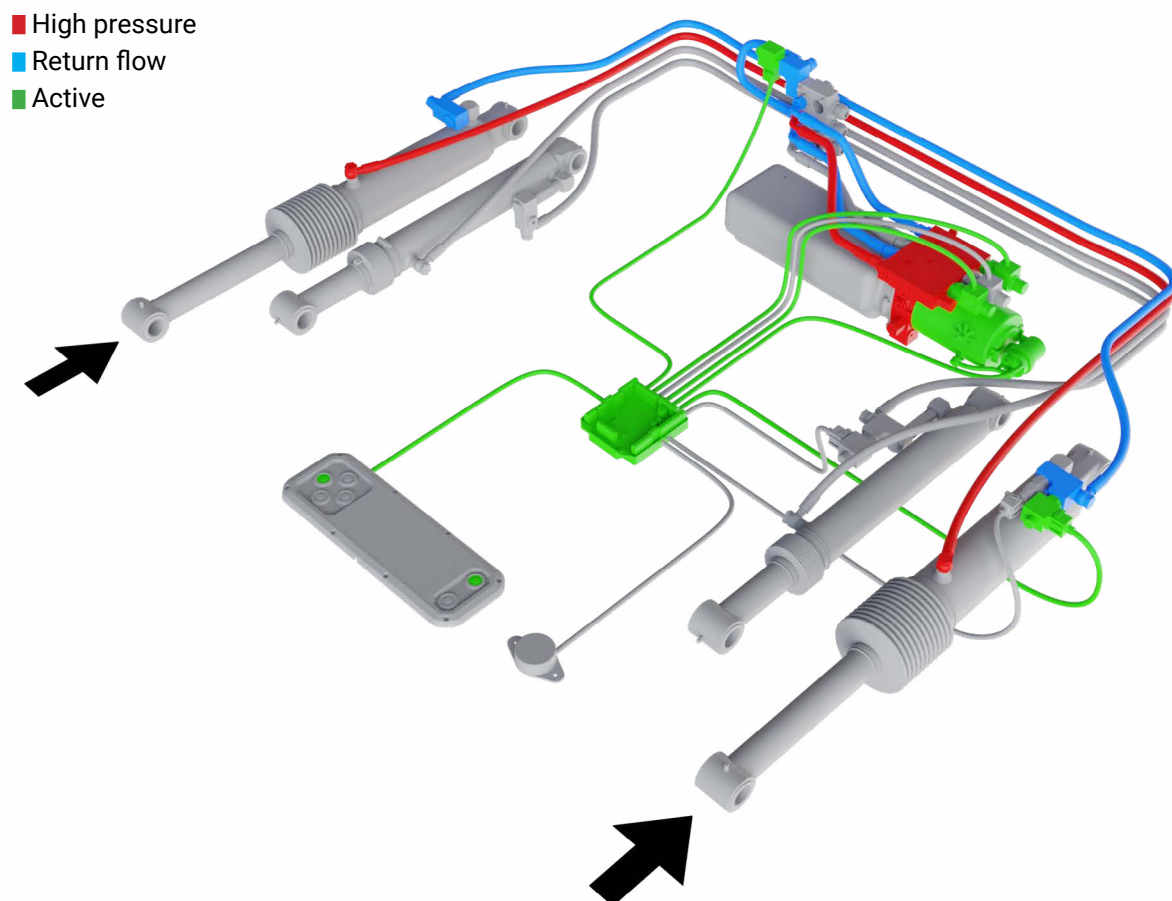
Angle sensor located on the platform used for the safety requirement for two hand operation when opening and closing against the boxy body. The sensor is inactive when the platform angle is within 45 degrees from vertical and within this range the two hand control is required. If the platform is closer to horizontal, the sensor is active and the requirement is removed. This sensor is connected to Di3 on ZePRO1 and to S3 on TLC-B1.

Pressure sensor located on the positive hydraulic feed to the tilt cylinder used to activate the open platform alarm. The sensor is active when the pressure drops below 60 bar which enables the Pa+ and Pa- pins on cabin switch section of the control card. This sensor is connected to Di4 on the ZePRO1 card and to S4 on the TLC-B1 card.

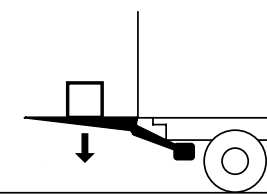
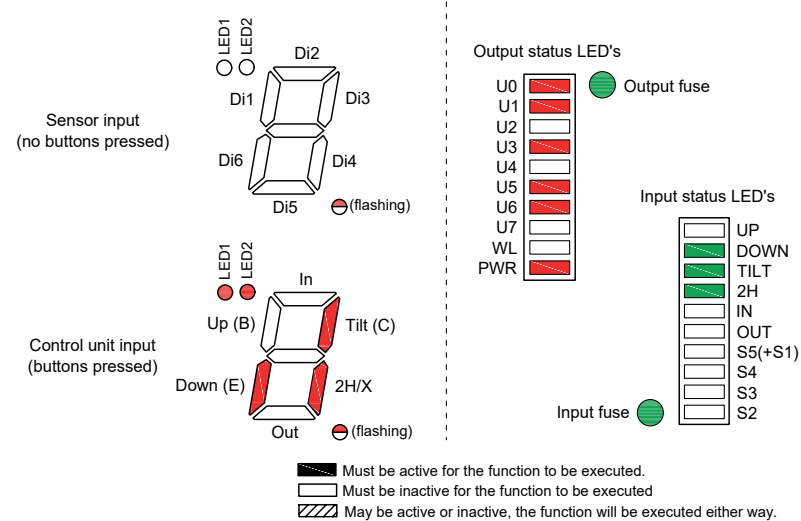


Z 1500/2000 MA (ZDK 250)
Function: quick open

| | |
|----------------|--|
| Description: | Platform opening from fully closed against box body to horizontal. |
| Control input: | Down + Tilt + 2H. Available on primary control devices only. |
| Sensor input: | None required for function. |

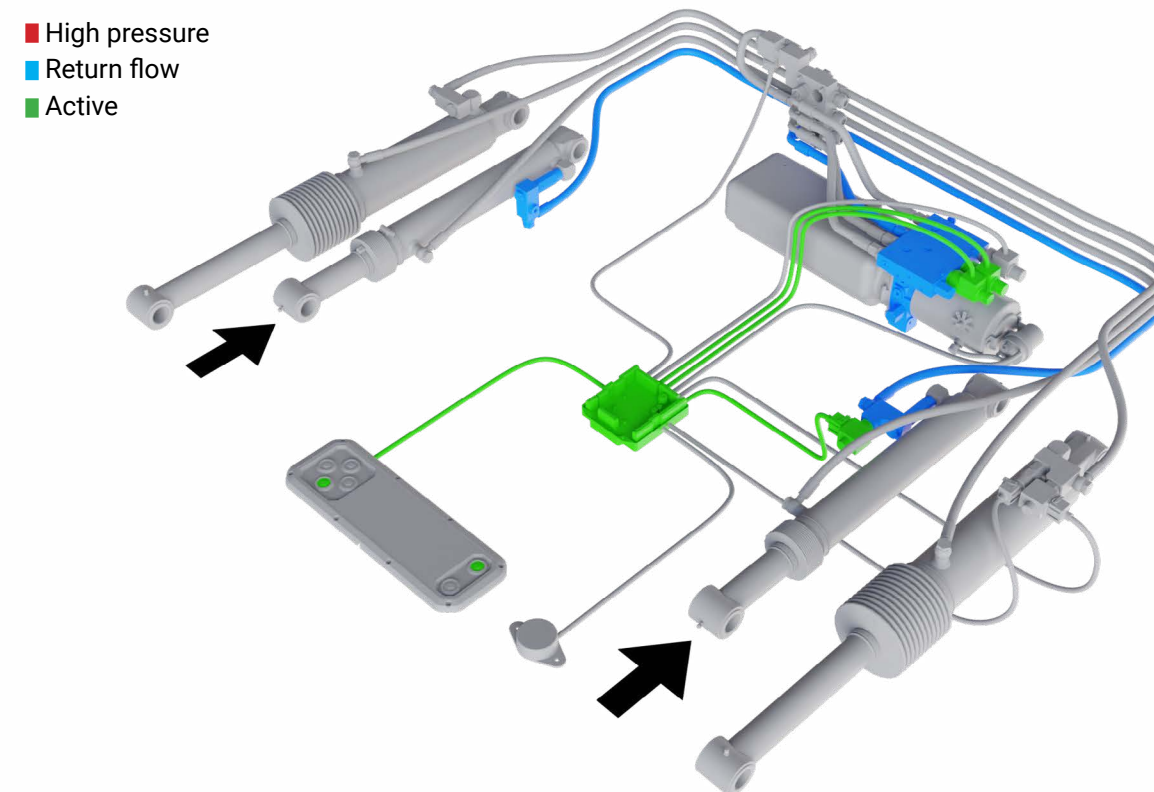


Card indication
ZePRO1 : TLC-B1

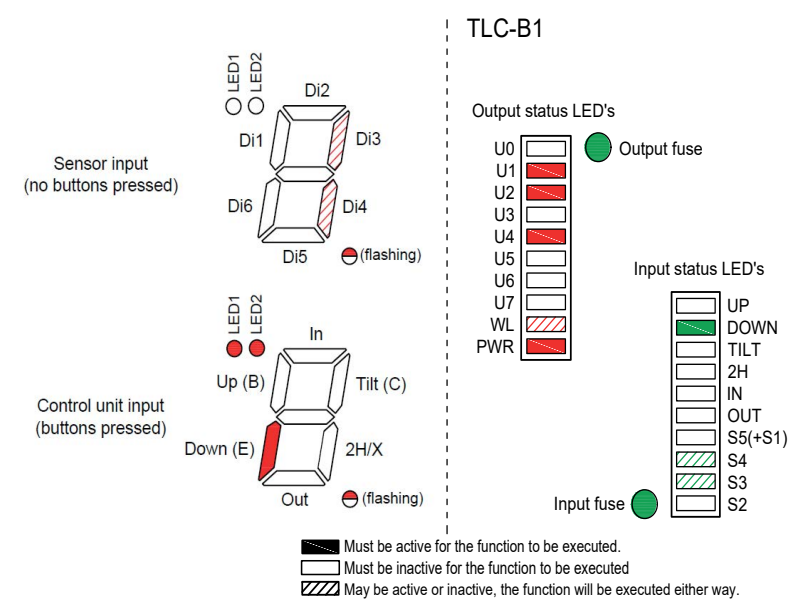


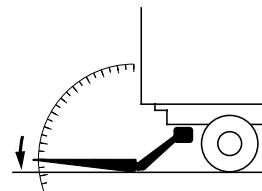
Z 1500/2000 MA (ZDK 250)
Function: lower

- Description: Vertical platform lowering.
- Control input: Down. Available on all control devices.
- Sensor input: None required for function.



Card indication

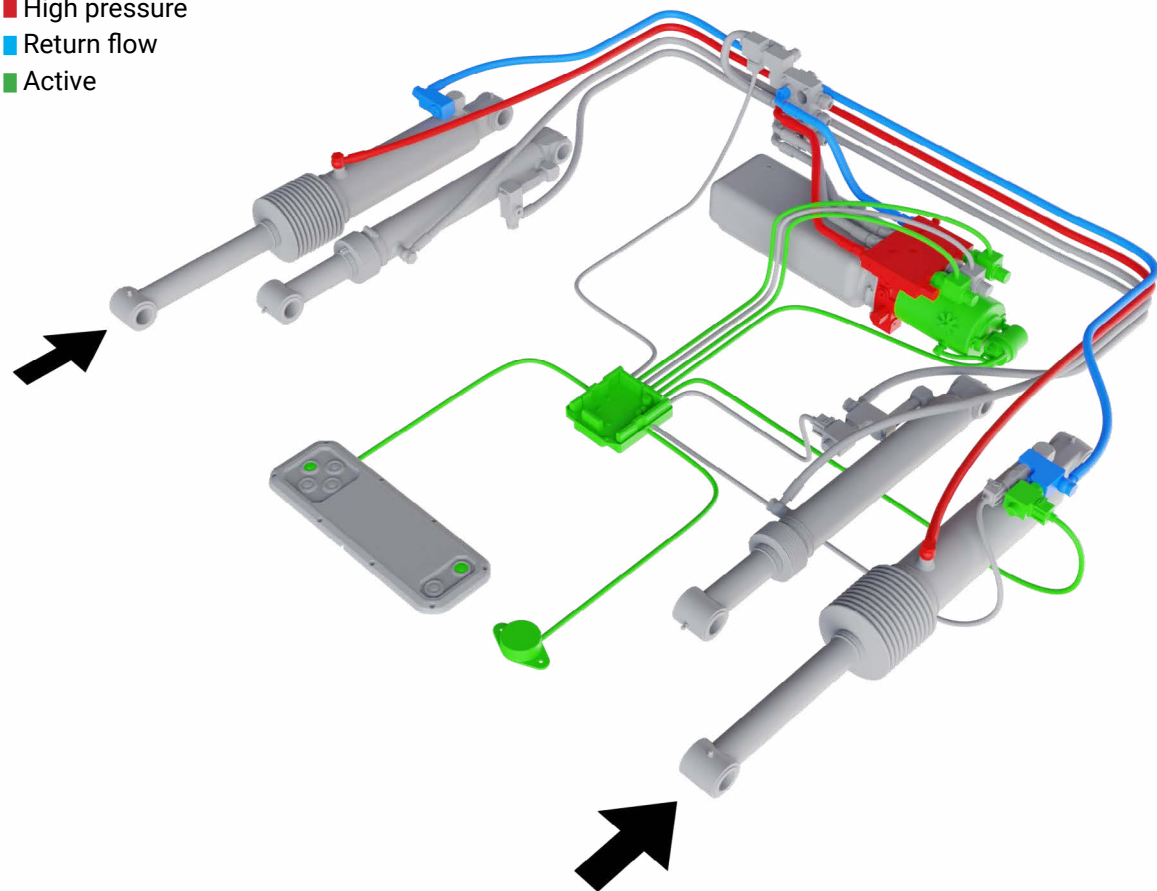




Z 1500/2000 MA (ZDK 250)
Function: tilt down

Description: Tilting down within +45/-10 degrees from horizontal.
Control input: Down + Tilt. Available on all control devices.
Sensor input: Active angle sensor on platform.

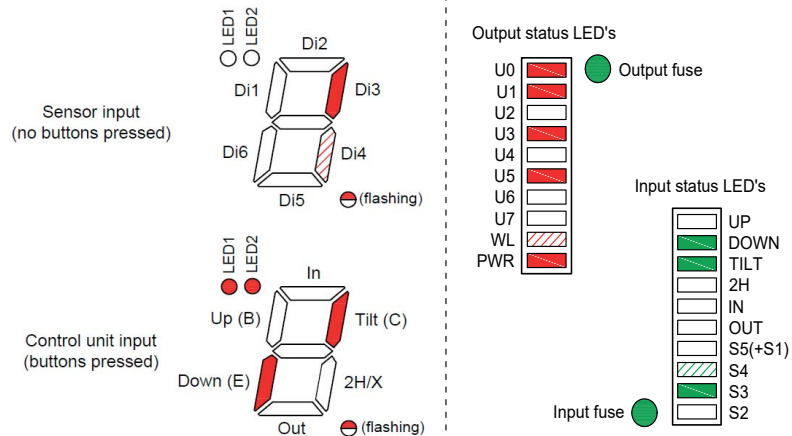
■ High pressure
■ Return flow
■ Active

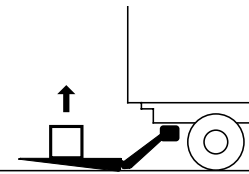


Card indication

ZePRO1

TLC-B1



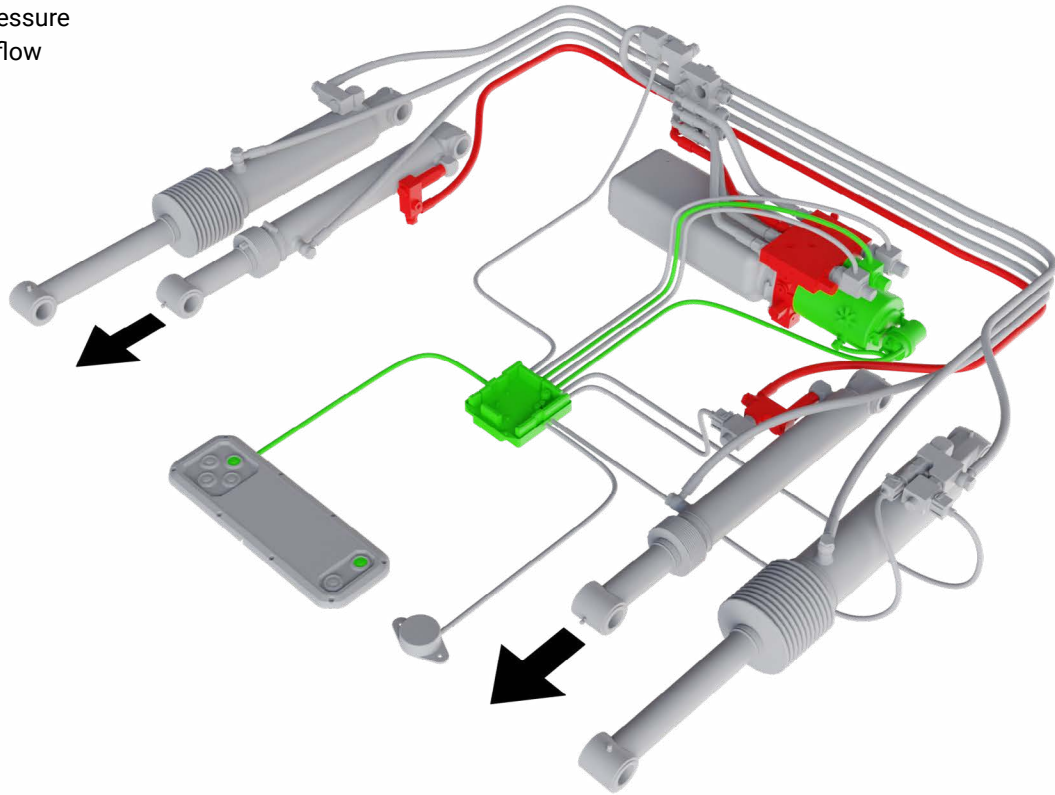


Z 1500/2000 MA (ZDK 250)

Function: raise

Description: Vertical platform raising.
Control input: Up. Available on all control devices.
Sensor input: None required for function.

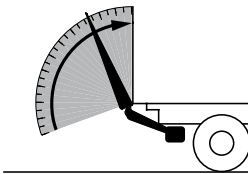
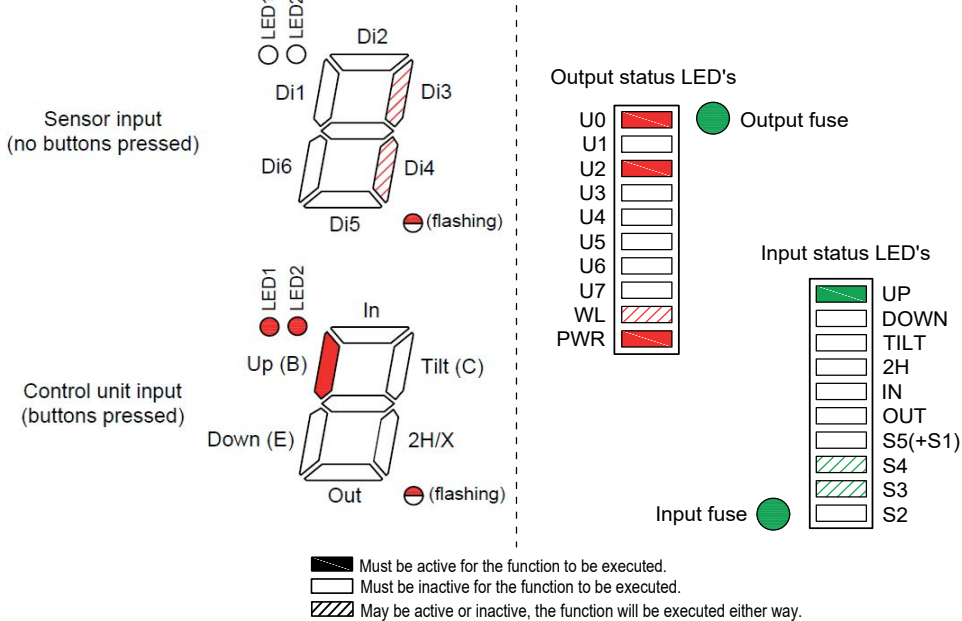
■ High pressure
■ Return flow
■ Active



Card indication

ZePRO1

TLC-B1

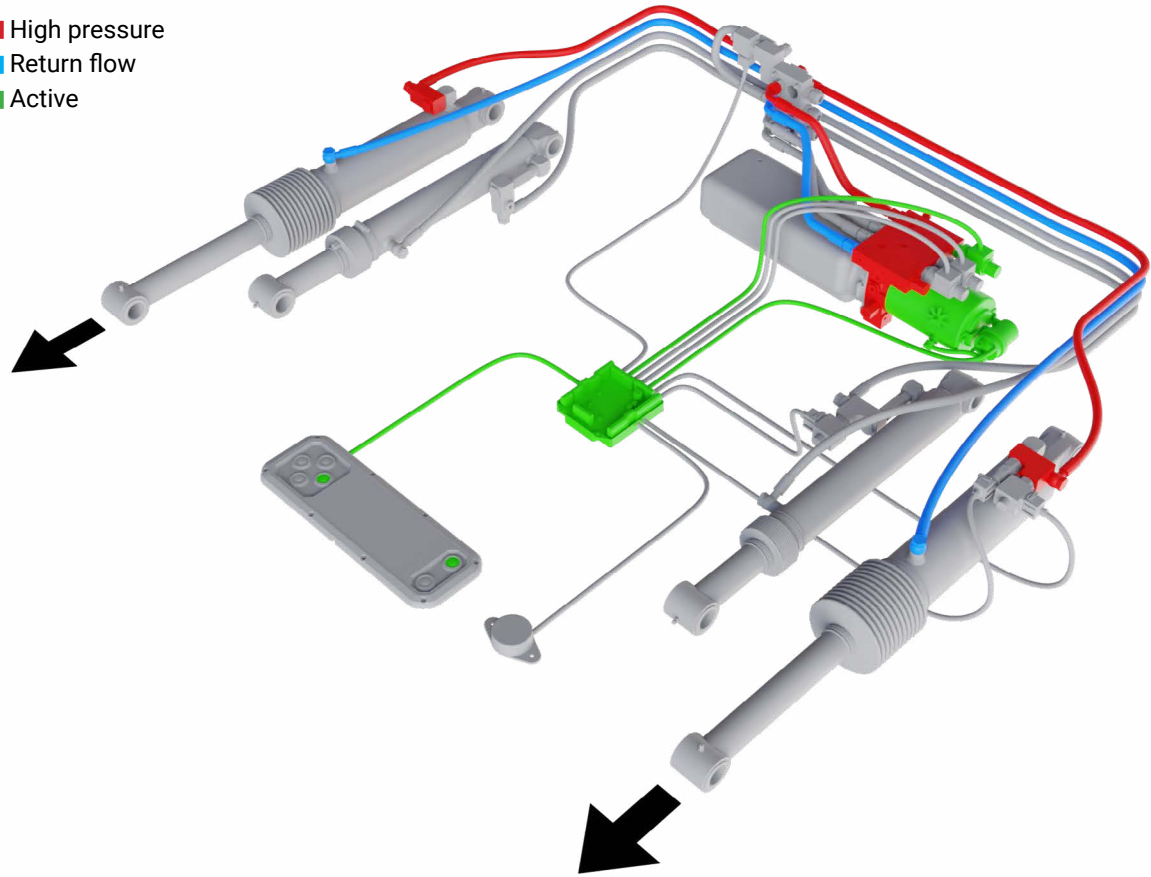


Z 1500/2000 MA (ZDK 250)

Function: close

Description: Closing fully against the box body.
Control input: Up + Tilt + 2H. Available on primary control devices only.
Sensor input: None required for function.

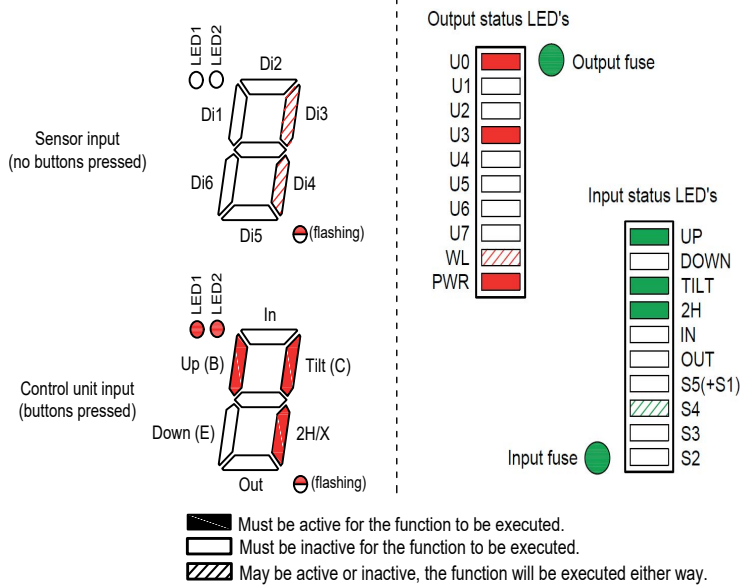
■ High pressure
■ Return flow
■ Active



Card indication

ZePRO1

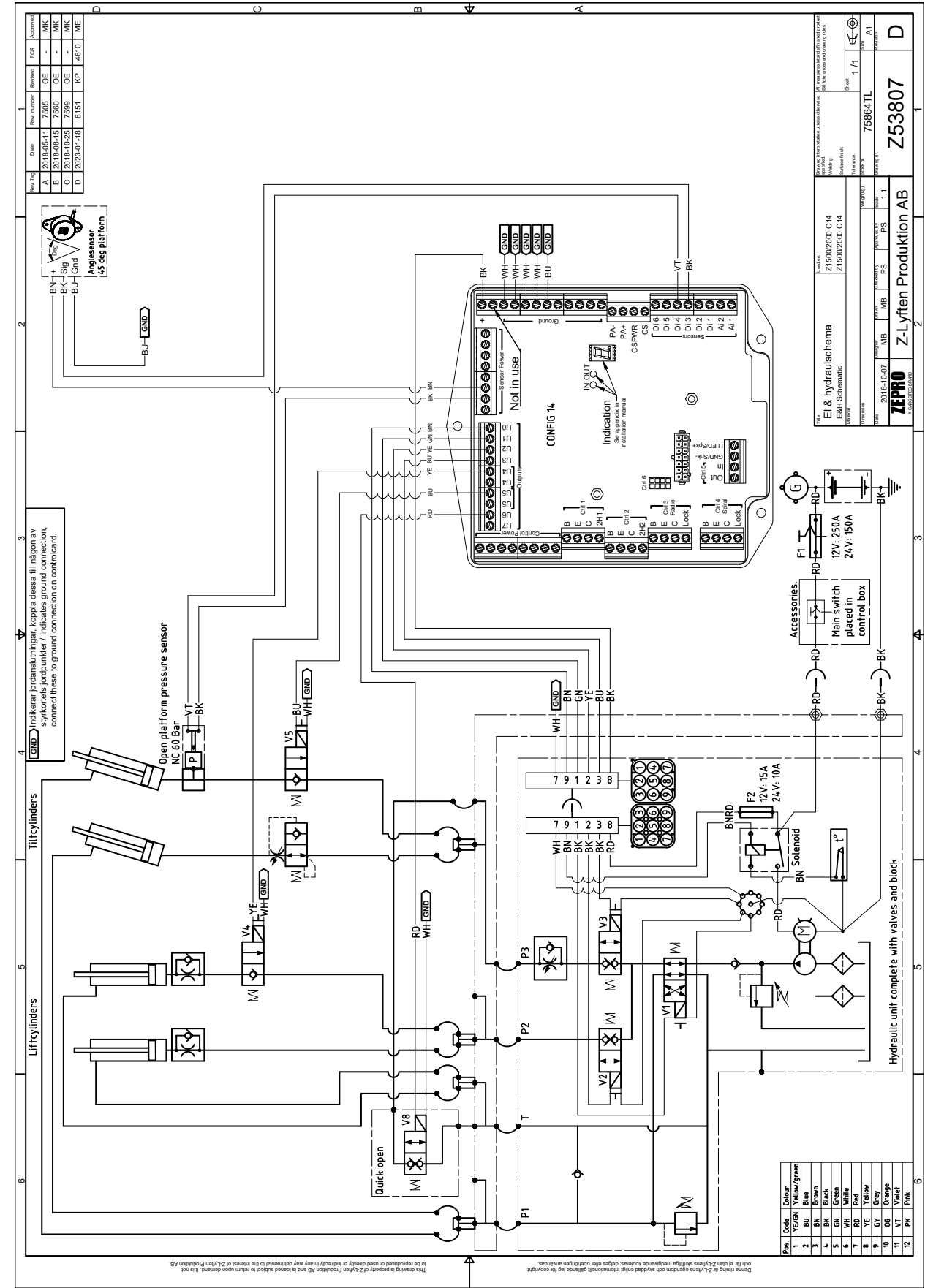
TLC-B1



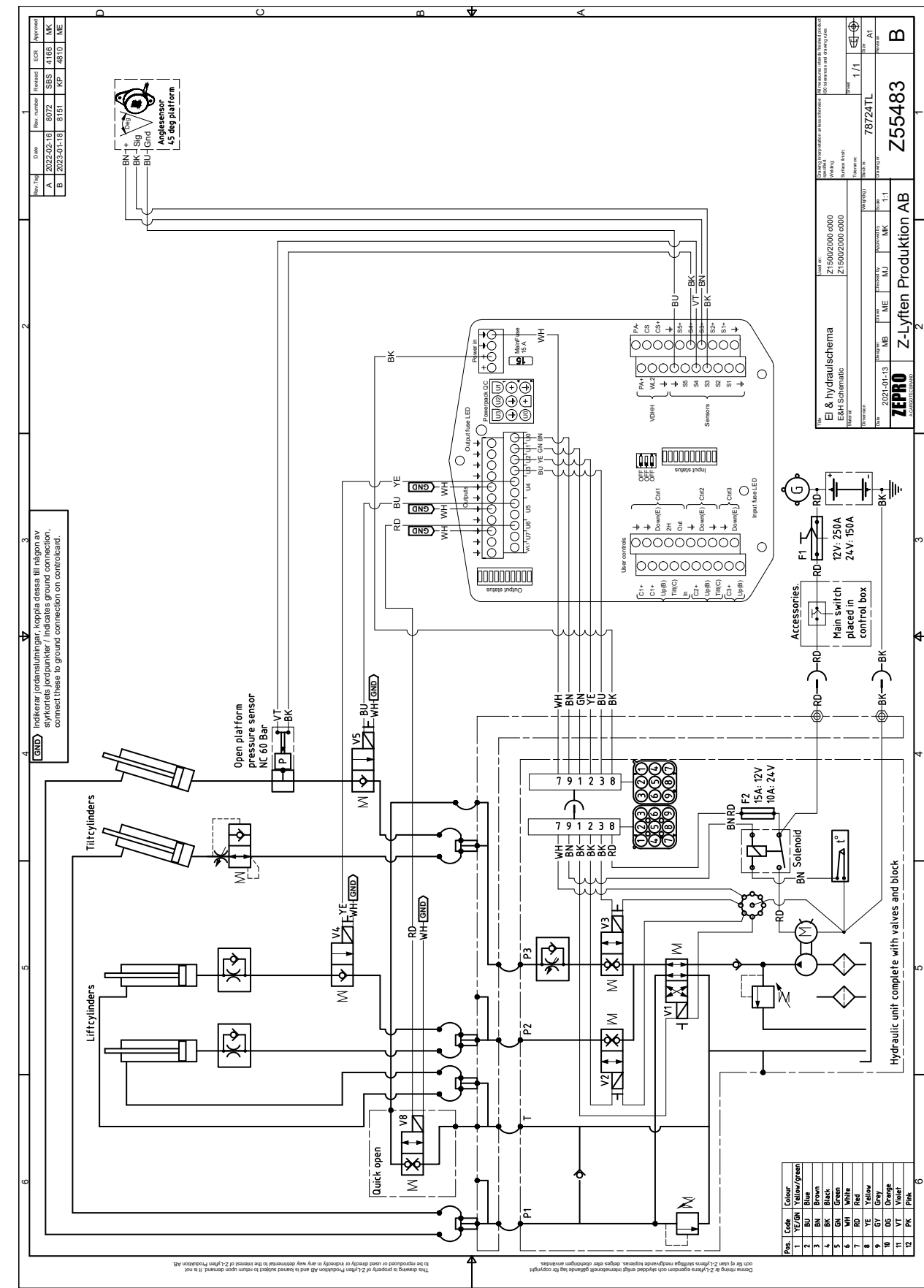
3.1.2 Summary of active valves Z 1500/2000 MA

| | Motor Soleonid | Valve 1 | Valve 2 | Valve 3 | Safety Valve lift, V4 | Safety Valve lift, V5 | Quick Open Valve, V6 |
|---------------|-------------------|------------|------------|------------|-----------------------------|-----------------------------|-------------------------|
| Open | ✓ | ✓ | | ✓ | | ✓ | |
| Quick Open | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Lower | | ✓ | ✓ | | ✓ | | |
| Tilt Down | ✓ | ✓ | | ✓ | | ✓ | |
| Tilt up | ✓ | | | ✓ | | | |
| Raise | ✓ | | ✓ | | | | |
| Close | ✓ | | | ✓ | | | |

3.1.3 Z 1500/2000 MA (ZDK 250) schematic, ZePRO1



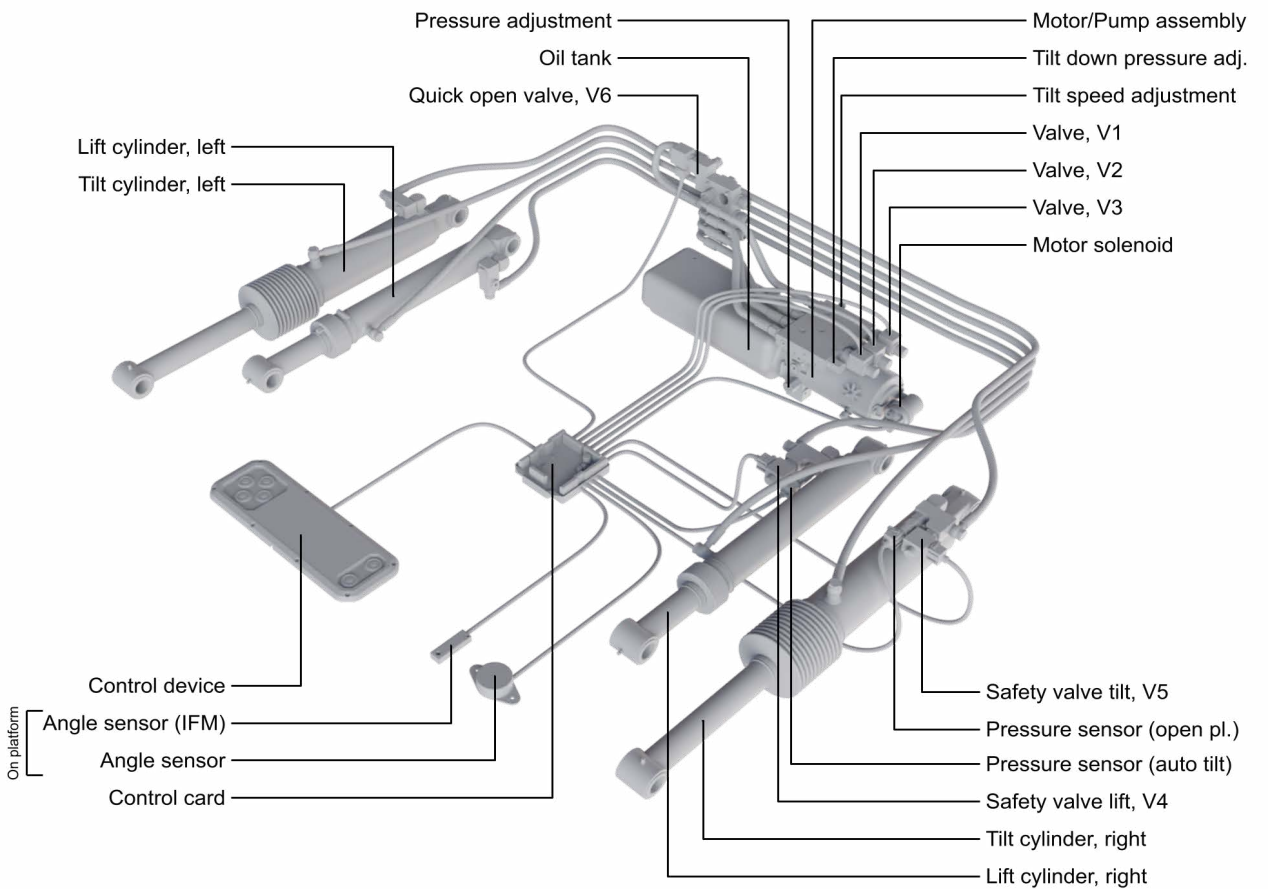
3.1.4 Schematic Z 1500/2000 MA (ZDK 250) TLC-B1



3.2 Z 1500/2000 MA with digital auto tilt

3.2.1 Description

The Z 1500/2000 MA with digital auto tilt is a variant with double acting tilt cylinders and single acting lift cylinders. It is equipped with a quick opening valve that increases the opening speed of the platform. It is also equipped with digital auto tilt functionality with adjustable auto tilt angle that is adjusted by physically changing the angle on the IFM sensor.



Sensors used

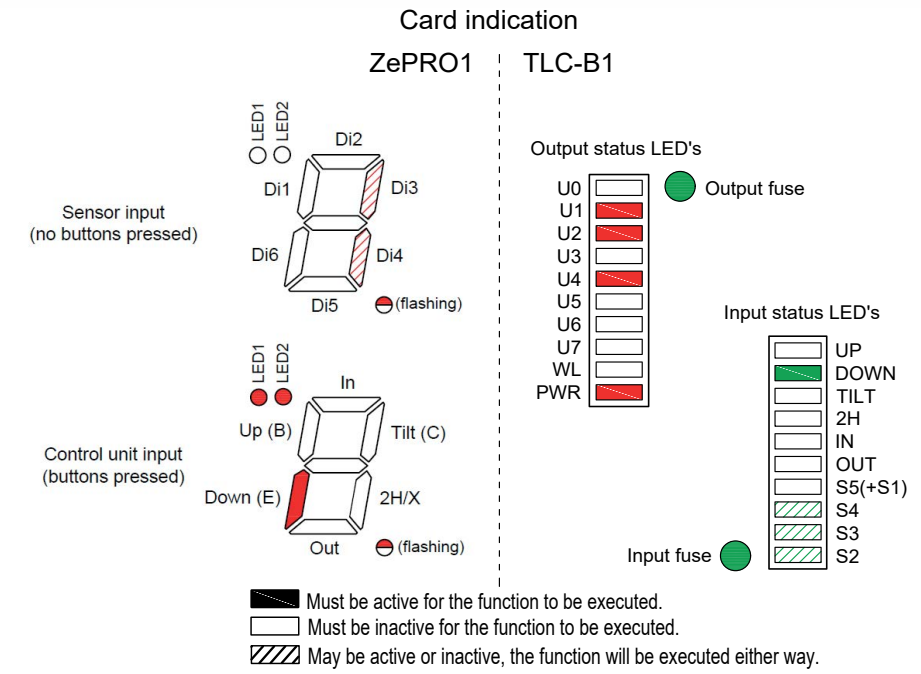
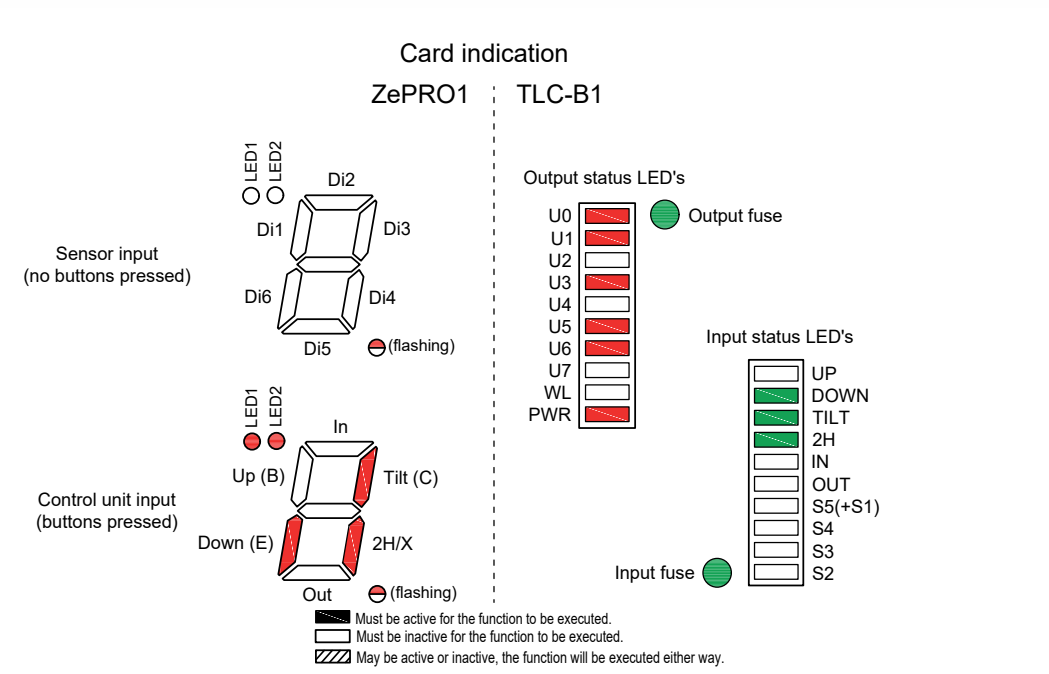
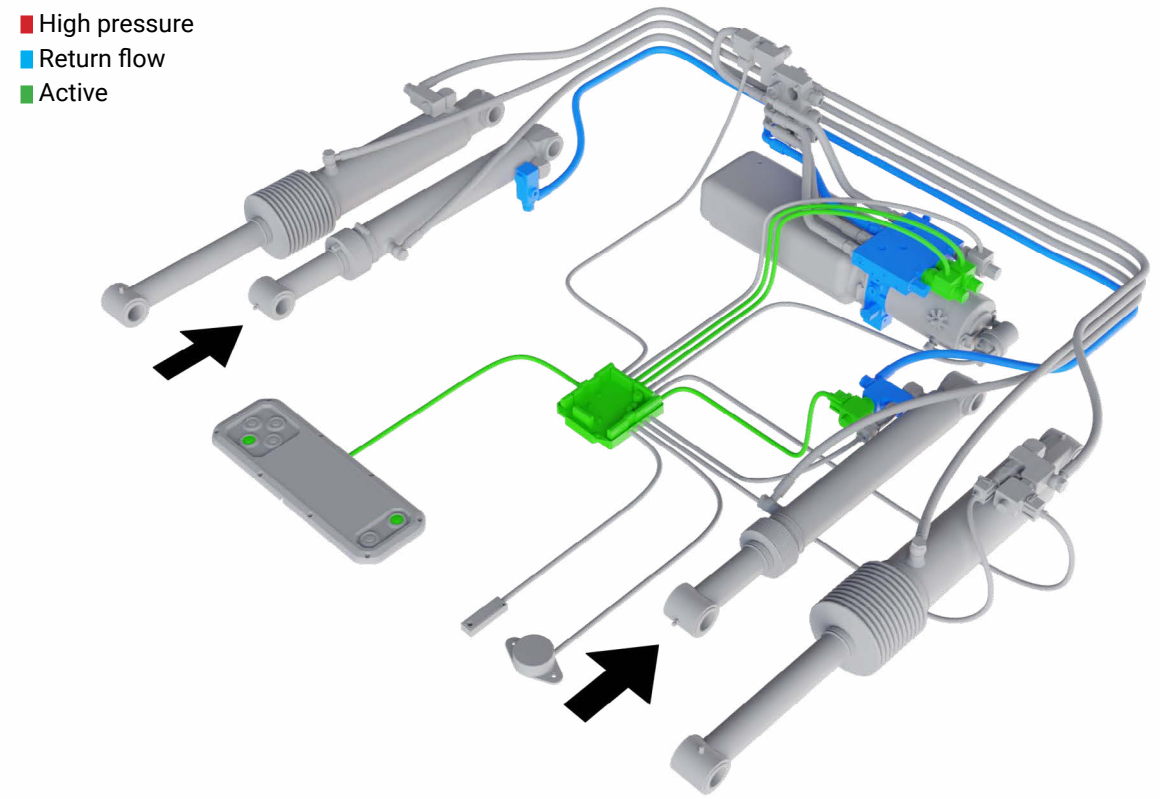
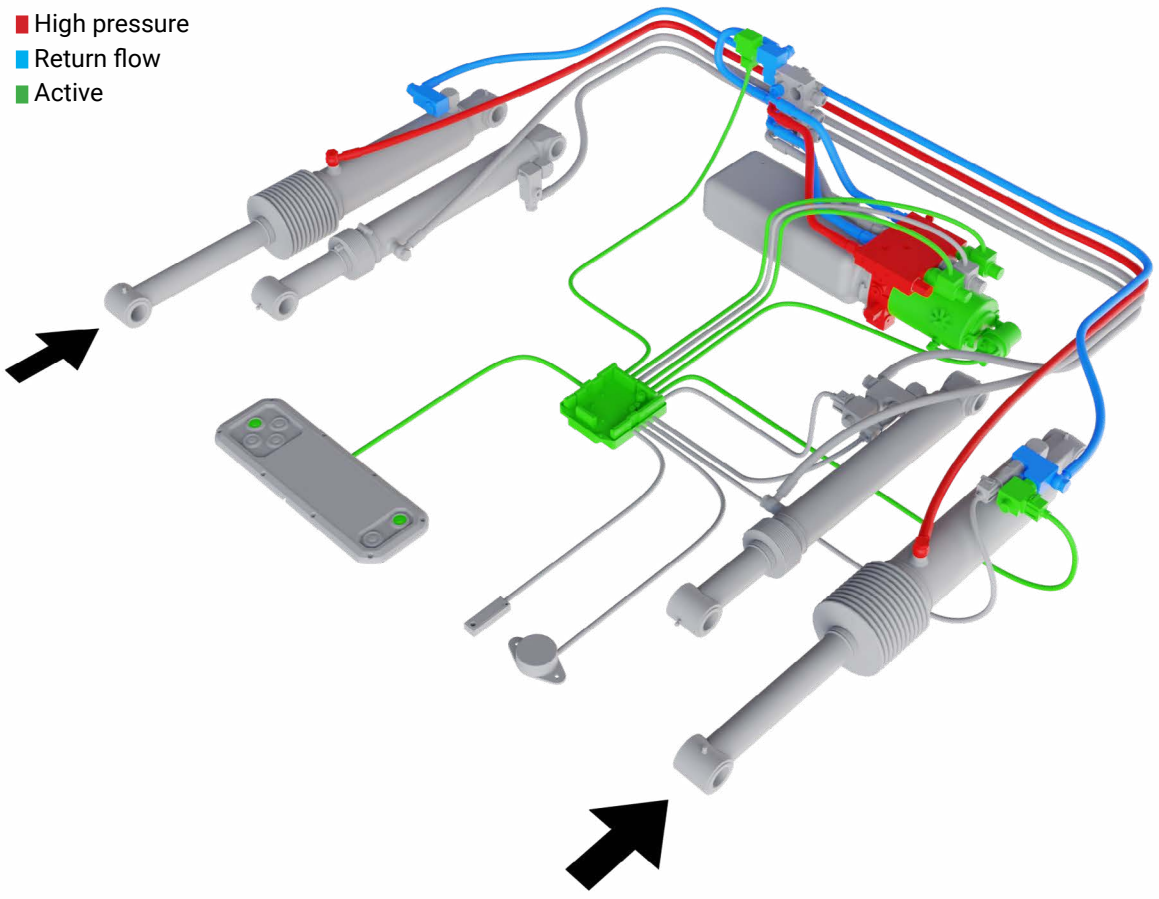
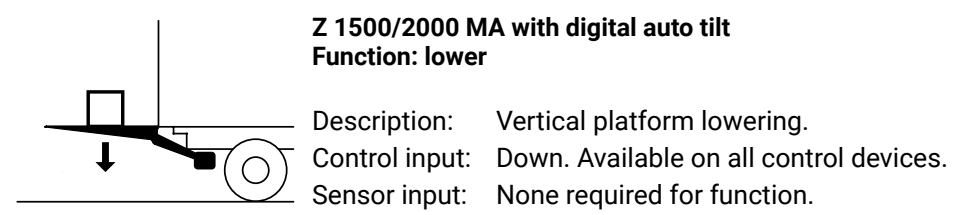
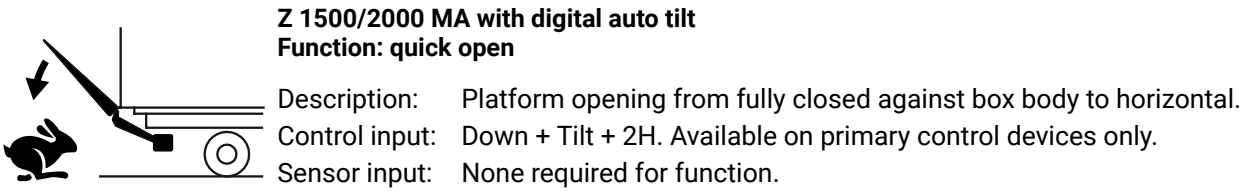
Angle sensor located on the platform used for the safety requirement for two hand operation when opening and closing against the boxy body. The sensor is inactive when the platform angle is within 45 degrees from vertical and within this range the two hand control is required. If the platform is closer to horizontal, the sensor is active and the requirement is removed. This sensor is connected to Di3 on ZePRO1 and to S3 on TLC-B1.

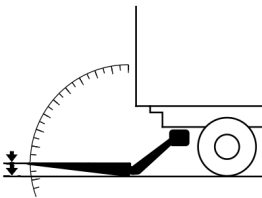
Pressure sensor located on the positive hydraulic feed to the tilt cylinder used to activate the open platform alarm. The sensor is active when the pressure drops below 60 bar which enables the Pa+ and Pa- pins on cabin switch section of the control card. This sensor is connected to Di4 on the ZePRO1 card and to S4 on the TLC-B1 card.

Liquid-type angle sensor located on the platform used to control the auto tilt functionality. The sensor is activated when the platform is tilted down from horizontal and remains active until the platform is tilted back to horizontal. This sensor is connected to Di2 on ZePRO1 and to S2 on TLC-B1.

Pressure sensor located on the positive hydraulic feed to the lift cylinder. The sensor is used to sense when the platform reaches the ground level at which point the auto tilt down function is activated. The sensor is activated when the pressure in the hydraulic line drops below 2,5 bar. This sensor is connected to Di5 on ZePRO1 and to S5 on TLC-B1

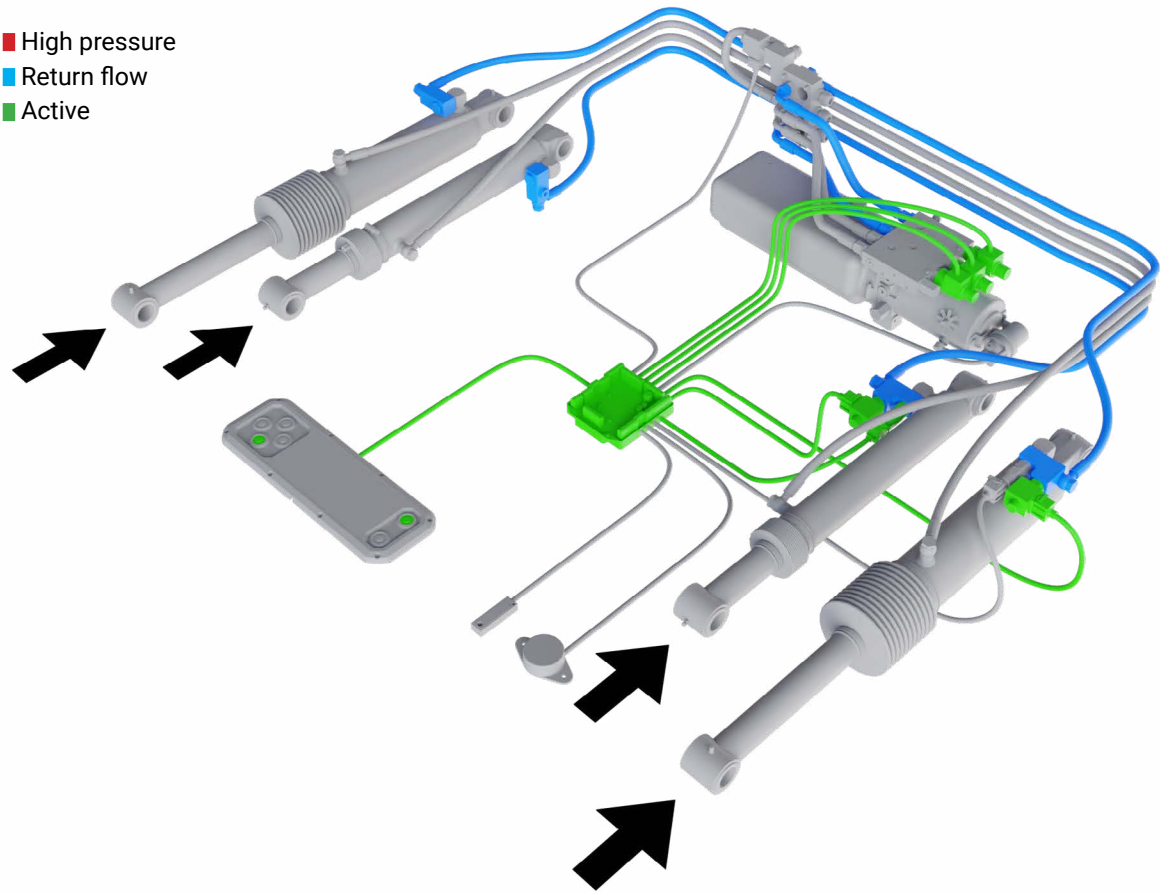
For proper auto tilt function, the Di1 is bridged to sensor power on ZePRO1. On TLC-B1, S3 is bridged to S3+.





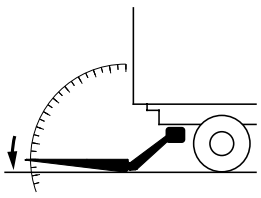
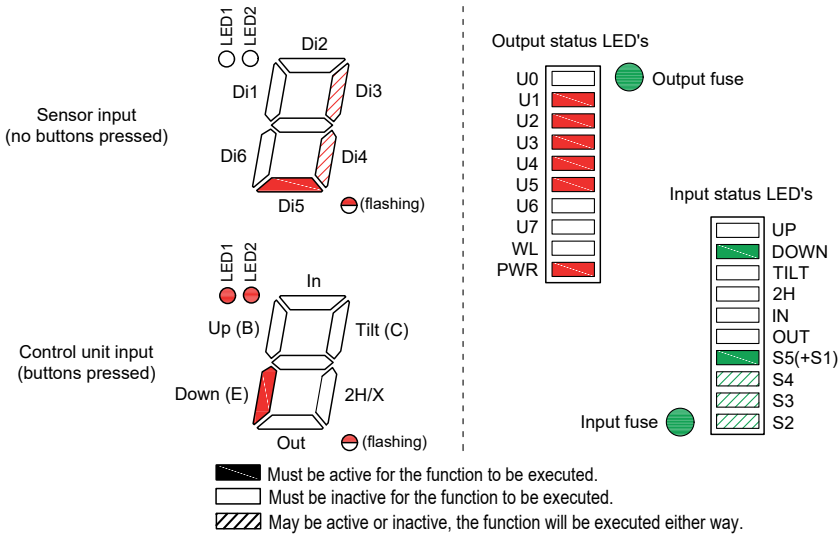
Z 1500/2000 MA with digital auto tilt
Function: auto tilt down

Description: Automatic down tilting of the platform once ground level has been reached.
Control input: Down. Available on all control devices.
Sensor input: Active pressure sensor on lift cylinder.



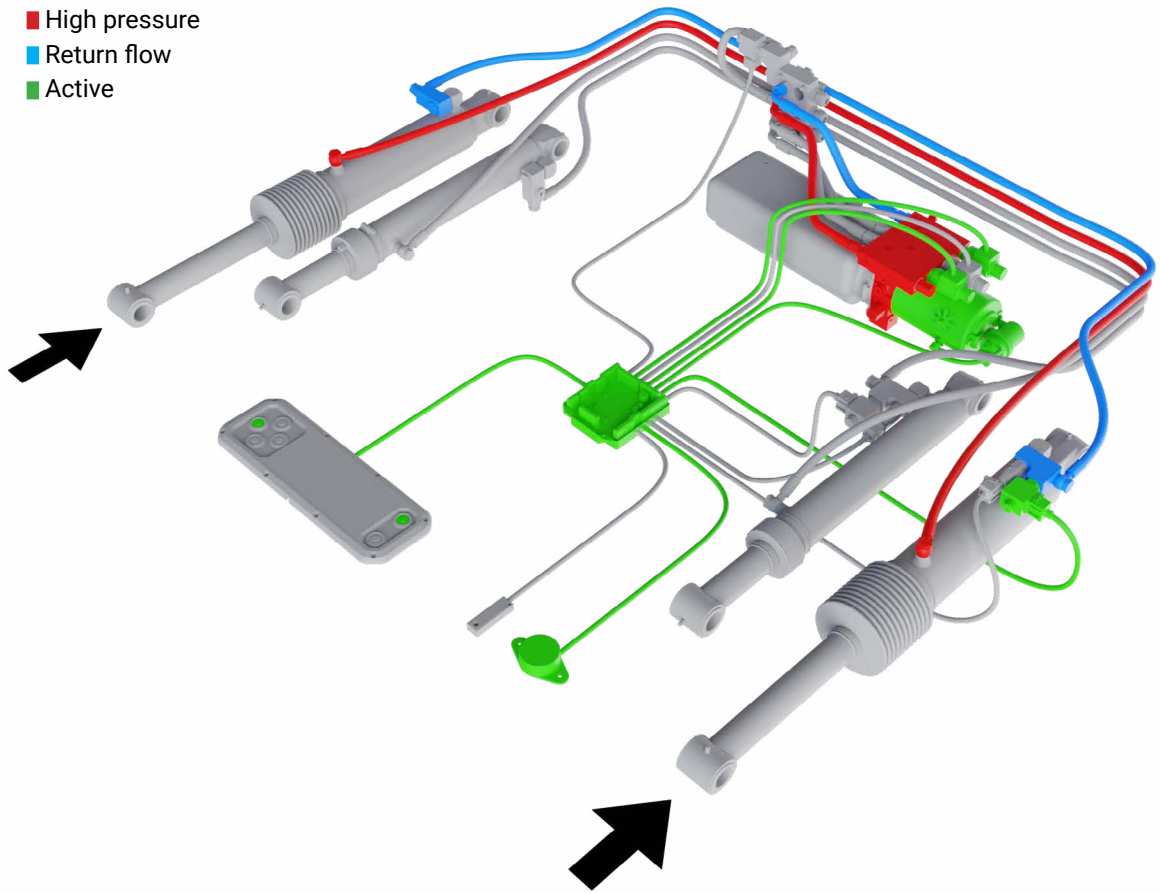
■ High pressure
■ Return flow
■ Active

Card indication
ZePRO1 **TLC-B1**



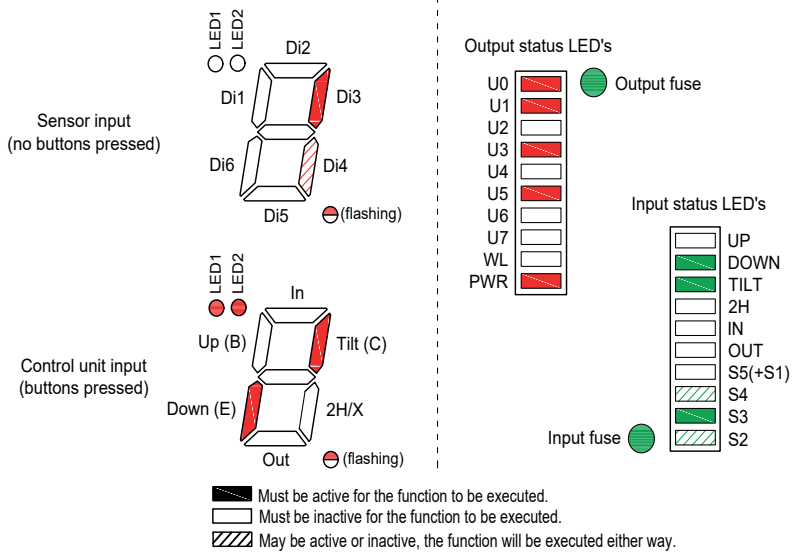
Z 1500/2000 MA with digital auto tilt
Function: manual tilt down

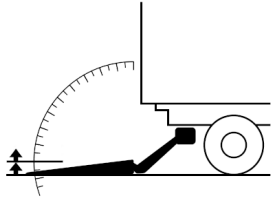
Description: Tilting down within +45/-10 degrees from horizontal.
Control input: Tilt + Down + 2H button on all control devices.
Sensor input: Active angle sensor on platform.



■ High pressure
■ Return flow
■ Active

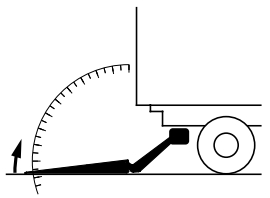
Card indication
ZePRO1 **TLC-B1**





Z 1500/2000 MA with digital auto tilt
Function: auto tilt up

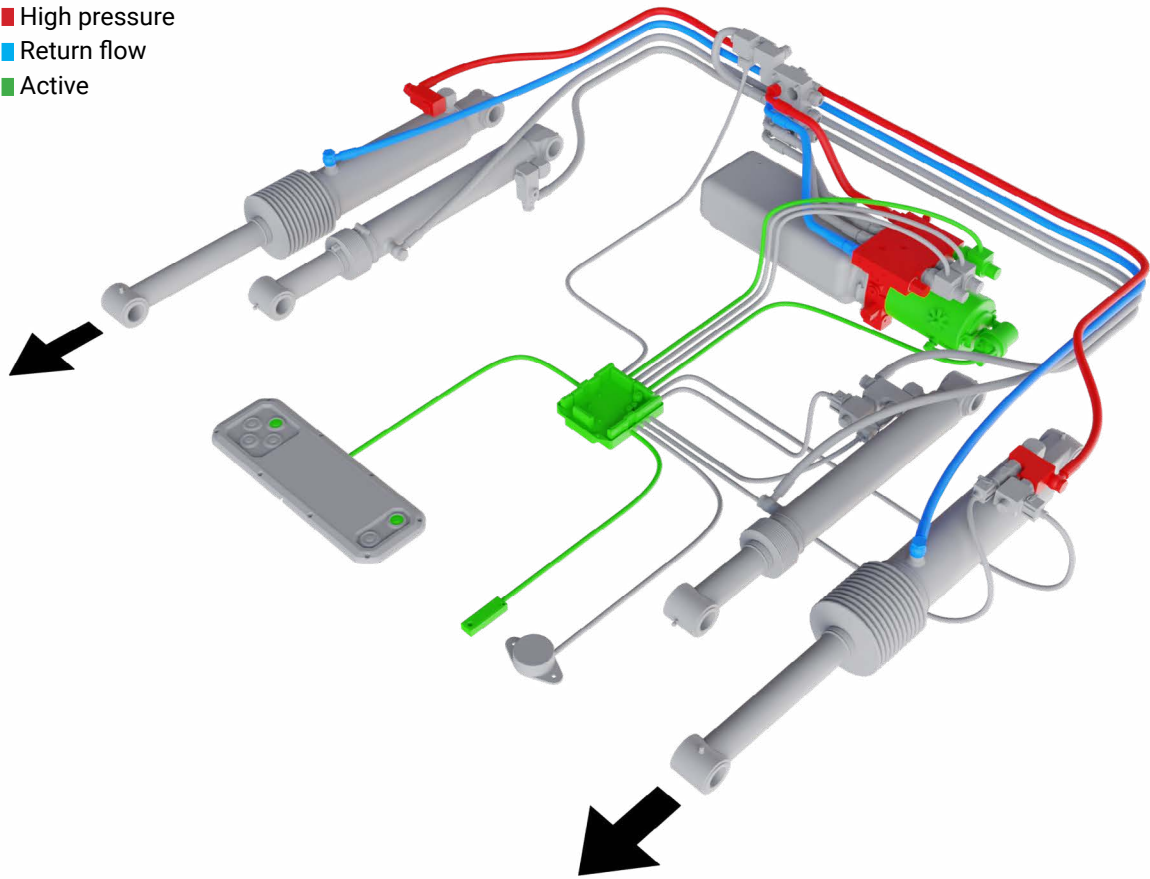
Description: Automatic up tilting of the platform until it is tilted back to horizontal.
Control input: Up. Available on all control devices.
Sensor input: Active IFM type angle sensor on platform.



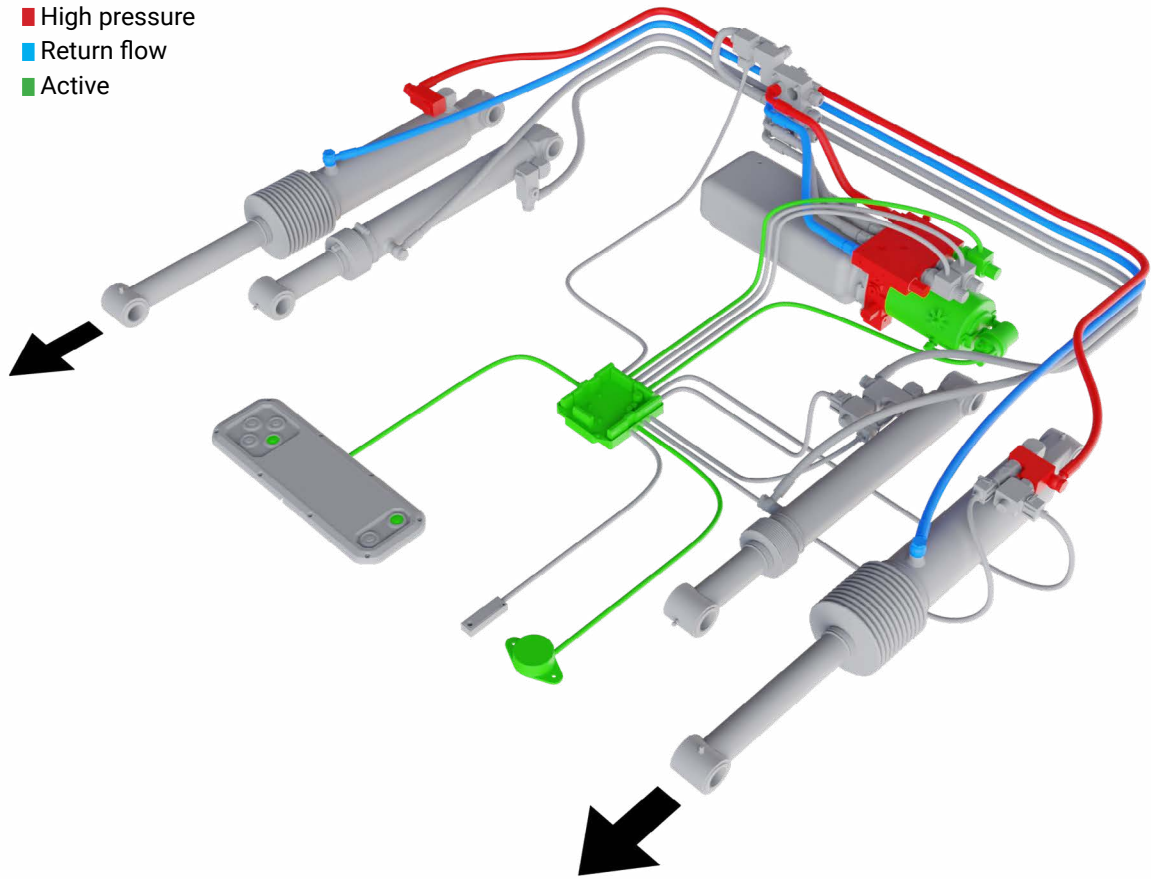
Z 1500/2000 MA with digital auto tilt
Function: manual tilt up

Description: Tilting up within +45/-10 degrees from horizontal.
Control input: Tilt + Up on any of the connected control devices.
Sensor input: Active angle sensor on platform.

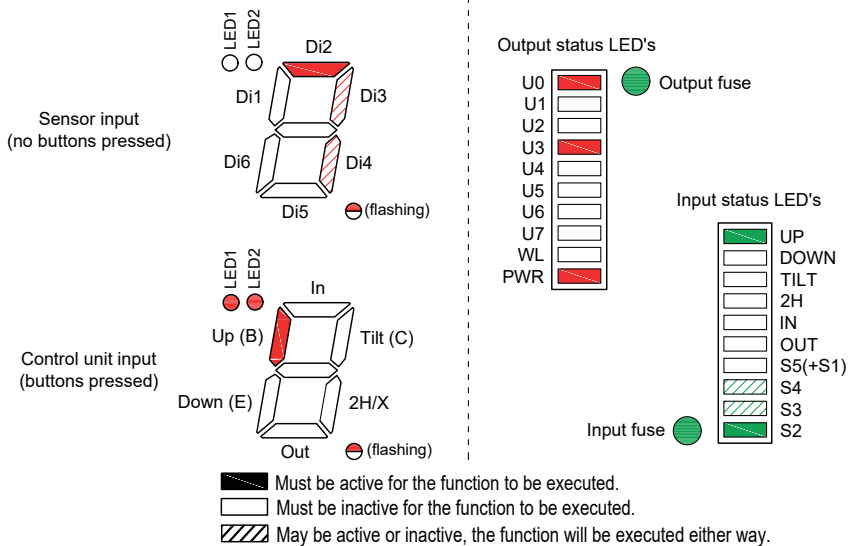
■ High pressure
■ Return flow
■ Active



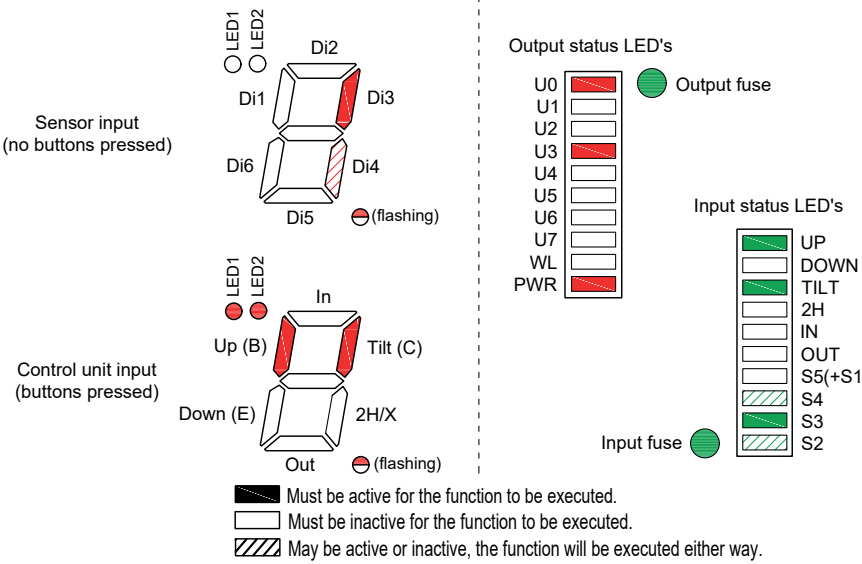
■ High pressure
■ Return flow
■ Active

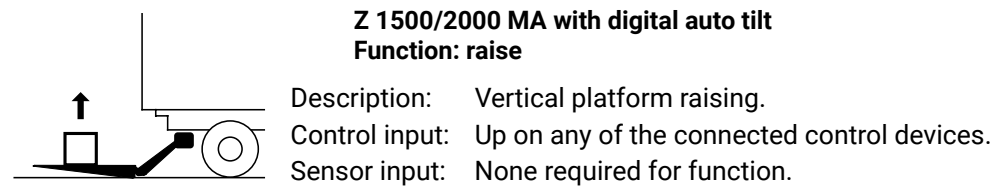


Card indication
ZePRO1 **TLC-B1**

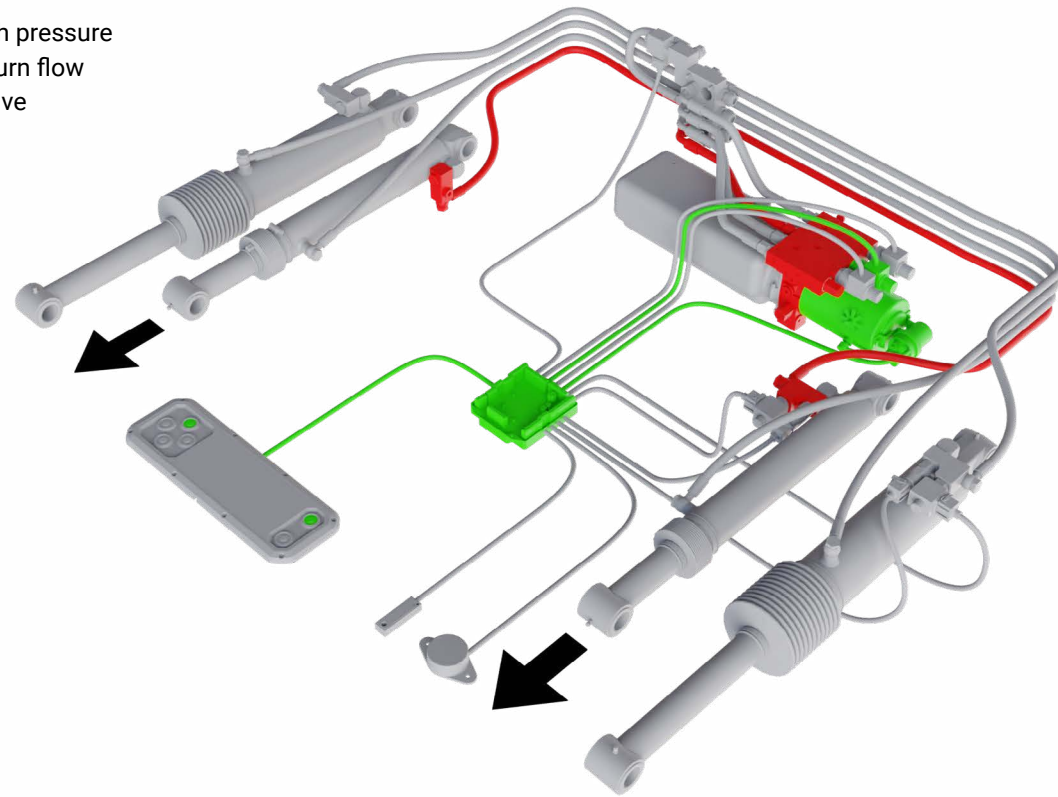


Card indication
ZePRO1 **TLC-B1**

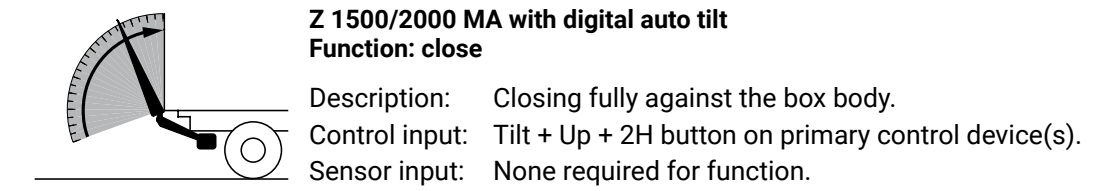
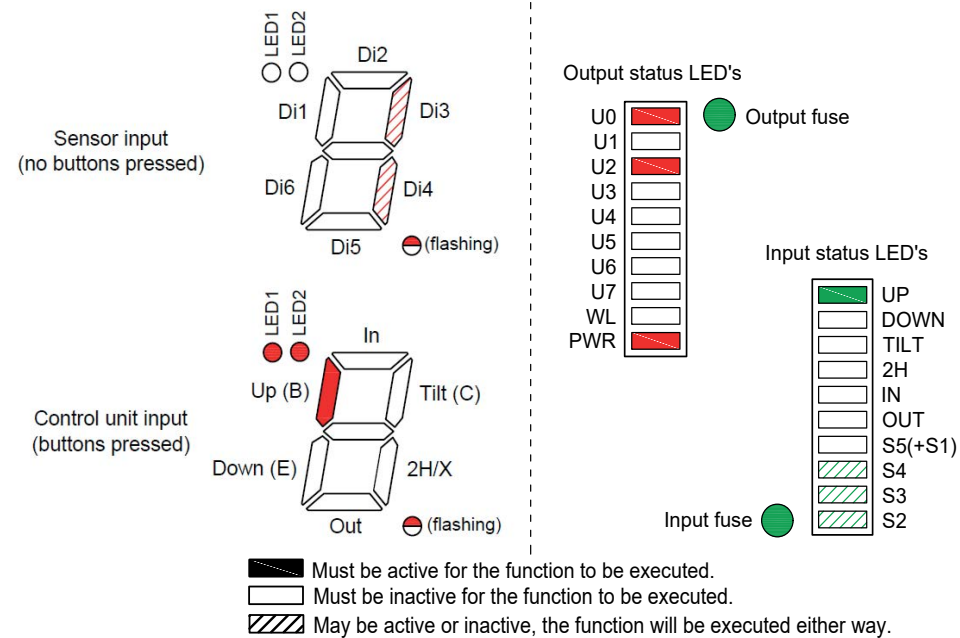




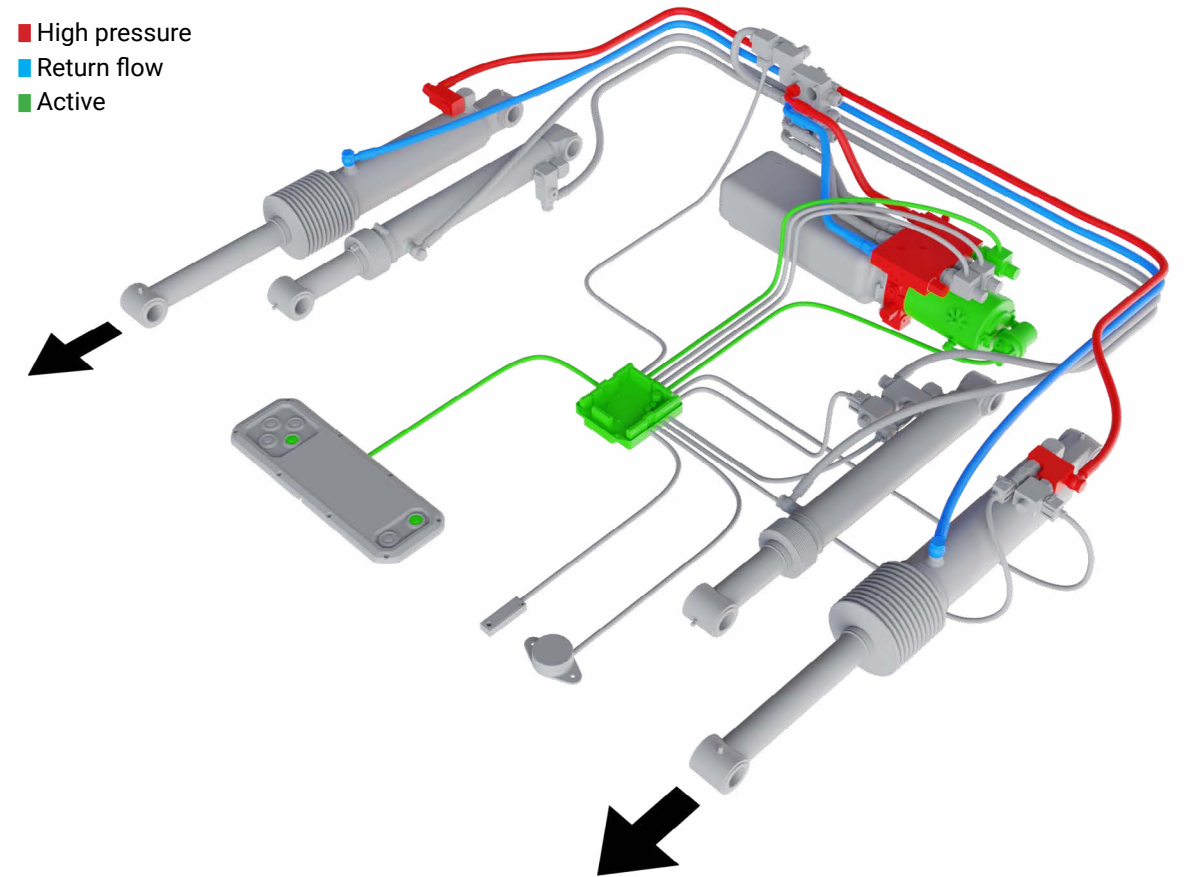
■ High pressure
■ Return flow
■ Active



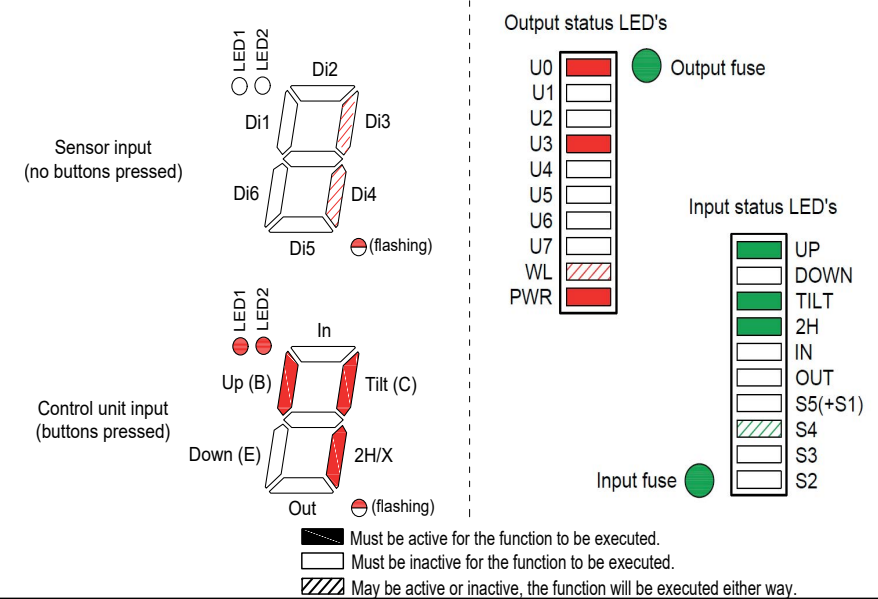
Card indication
ZePRO1 TLC-B1



■ High pressure
■ Return flow
■ Active



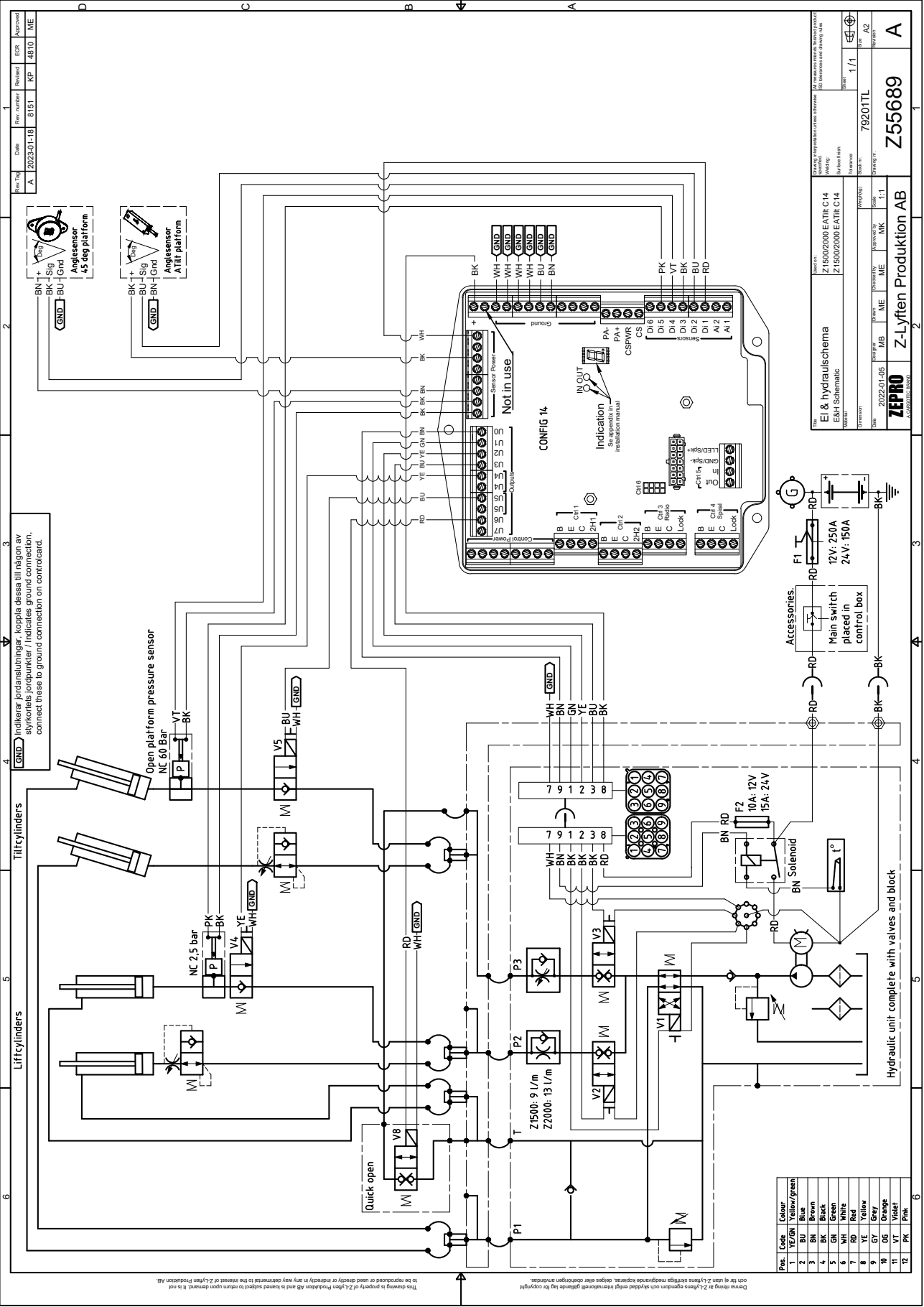
Card indication
ZePRO1 TLC-B1



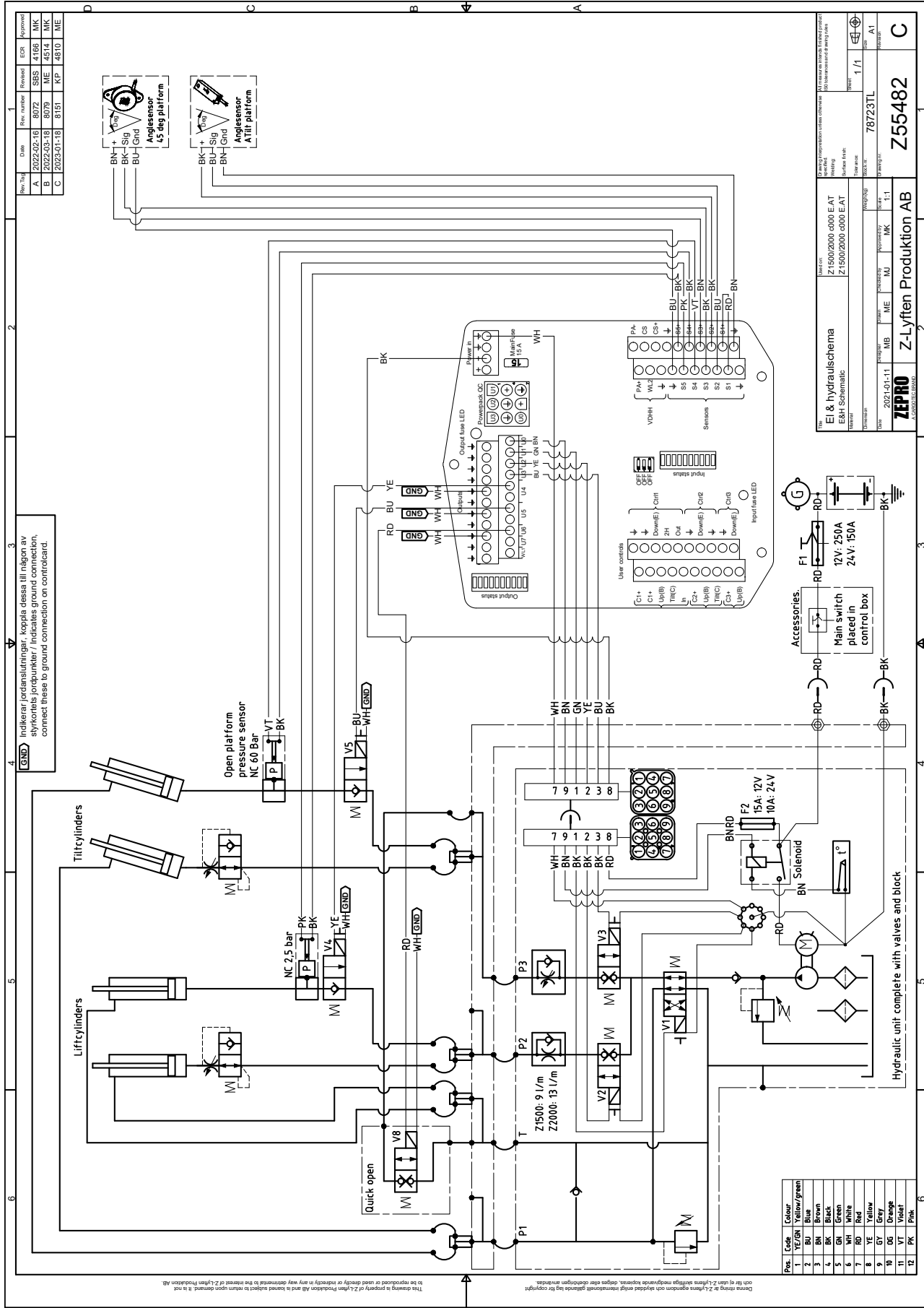
3.2.2 Summary of active valves Z 1500/2000 MA digital auto tilt

| | Motor Soleonid | Valve 1 | Valve 2 | Valve 3 | Safety Valve lift, V4 | Safety Valve lift, V5 | Quick Open Valve, V6 |
|-------------------|-------------------|------------|------------|------------|-----------------------------|-----------------------------|-------------------------|
| Open | ✓ | ✓ | | ✓ | | ✓ | |
| Quick Open | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Lower | | ✓ | ✓ | | ✓ | | |
| Auto tilt down | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Tilt Down | ✓ | ✓ | | ✓ | | ✓ | |
| Auto tilt up | ✓ | | | ✓ | | | |
| Tilt up | ✓ | | ✓ | | | | |
| Raise | ✓ | | | | | | |
| Close | ✓ | | | ✓ | | | |

3.2.3 Schematic Z 1500/2000 MA with digital auto tilt, ZePRO1



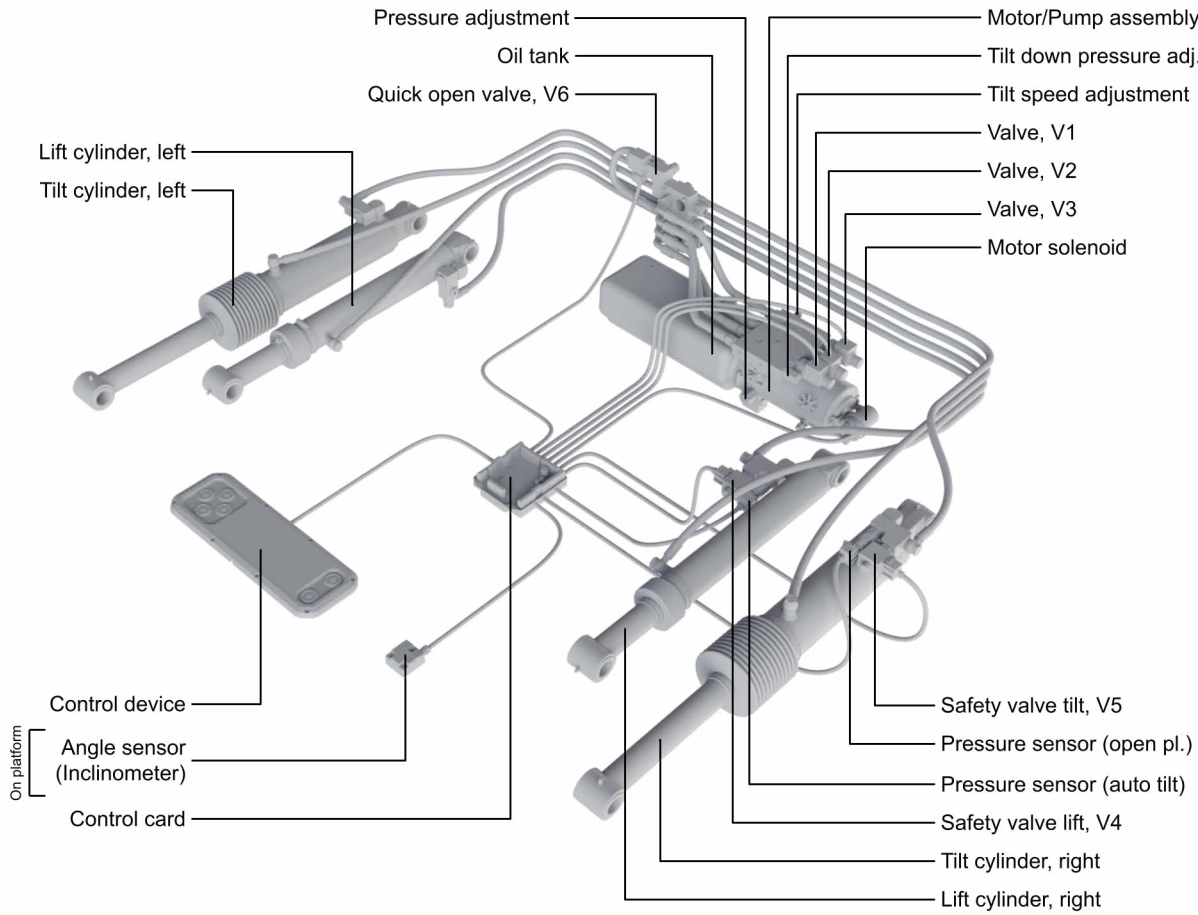
3.2.4 Schematic Z 1500/2000 MA with digital auto tilt, TLC-B1



3.3 Z 1500/2000 MA with analog auto tilt

3.3.1 Description

The Z 1500/2000 MA with analog auto tilt is a variant with double acting tilt cylinders and single acting lift cylinders. It is equipped with a quick opening valve that increases the opening speed of the platform. It is also equipped with analog auto tilt functionality with angle setting which allows the user to manually set the auto tilt angle that the platform returns to during the auto tilt motion.



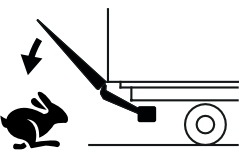
Sensors used

Inclinometer-type angle sensor located on the platform used both for the two hand safety requirement and for the advanced auto tilt functionality. The sensor outputs an analog signal between 0 and 4,5V depending on its angle and is connected to the Ai1 input on the ZePRO1 card.

Pressure sensor located on the positive hydraulic feed to the tilt cylinder used to activate the open platform alarm. The sensor is active when the pressure drops below 60 bar which enables the Pa+ and Pa- pins on cabin switch section of the control card. This sensor is connected to Di4 on the ZePRO1 card.

Pressure sensor located on the positive hydraulic feed to the lift cylinder. The sensor is used to sense when the platform reaches the ground level at which point the auto tilt down function is activated. The sensor is activated when the pressure in the hydraulic line drops below 2,5 bar. This sensor is connected to Di5 on the ZePRO1 card.

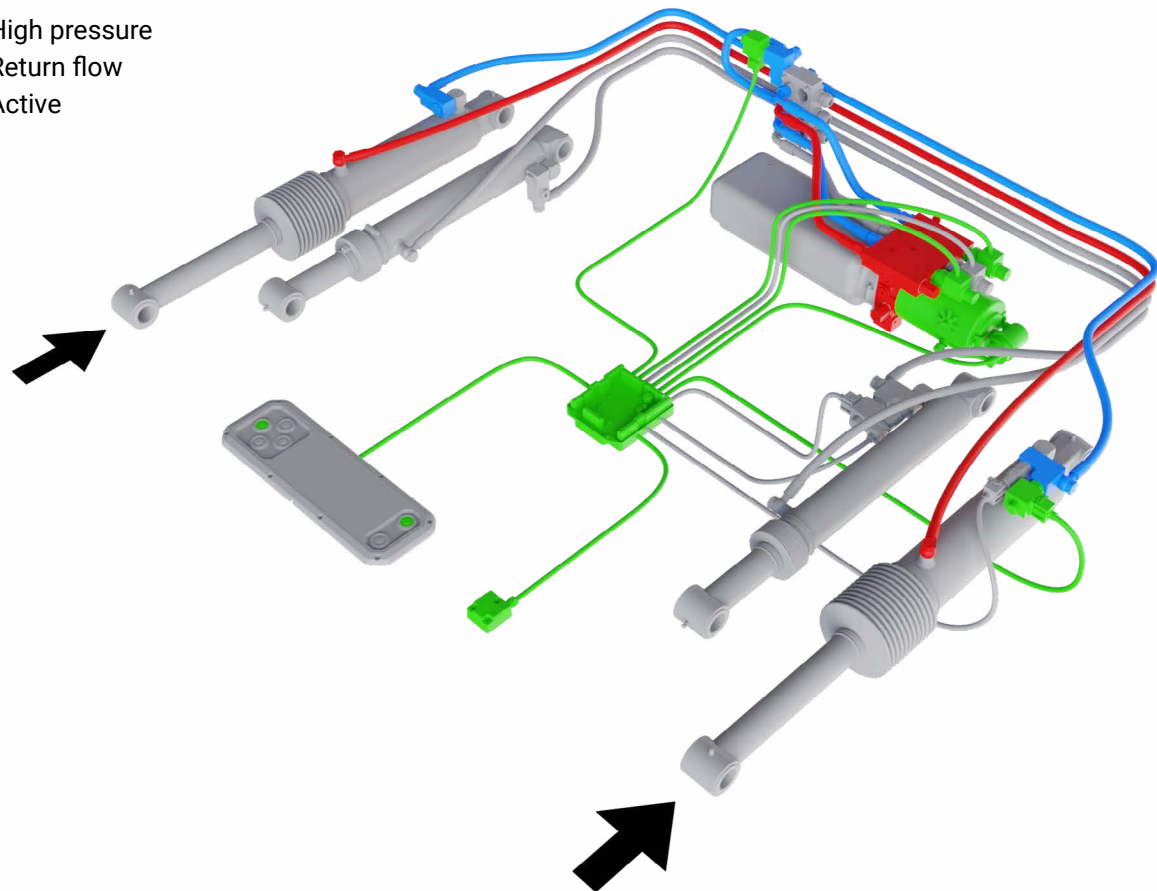
The Di1 input is bridged to sensor power for this configuration.



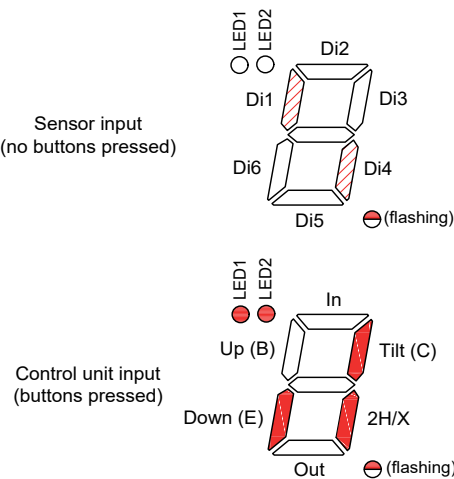
Z 1500/2000 MA with analog auto tilt
Function: quick open

Description: Platform opening from fully closed against box body to horizontal.
Control input: Down + Tilt + 2H. Available on primary control devices only.
Sensor input: Inclinator voltage ~ 2,0-3,2V

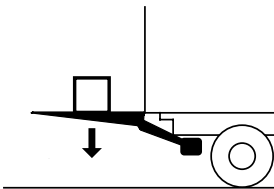
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



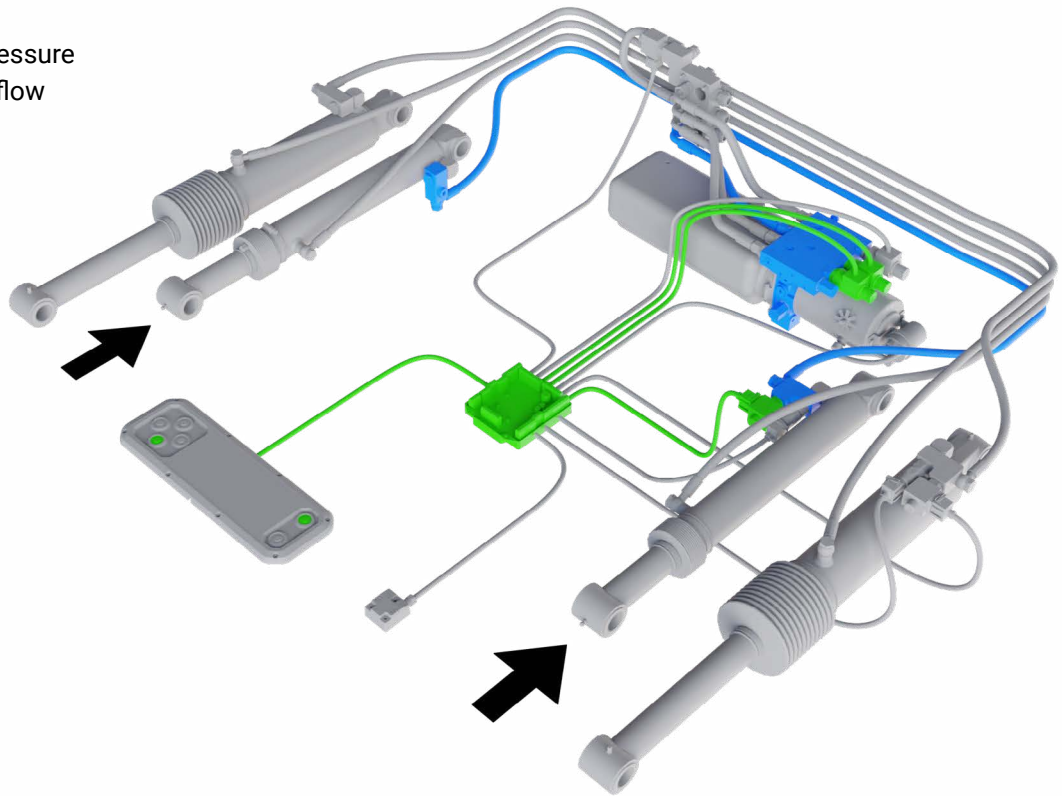
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



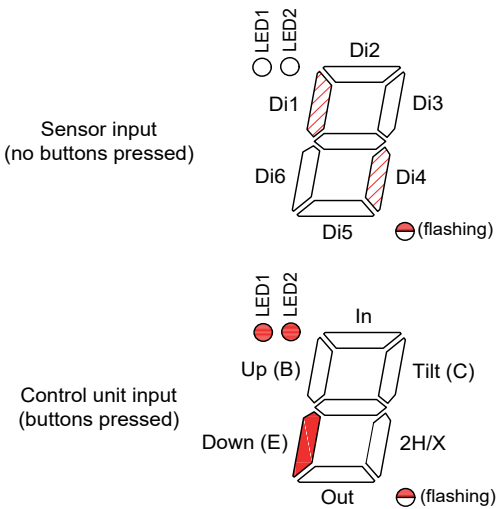
Z 1500/2000 MA with analog auto tilt
Function: lower

Description: Vertical platform lowering.
Control input: Down. Available on all control devices.
Sensor input: None required for function.

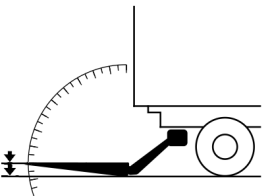
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



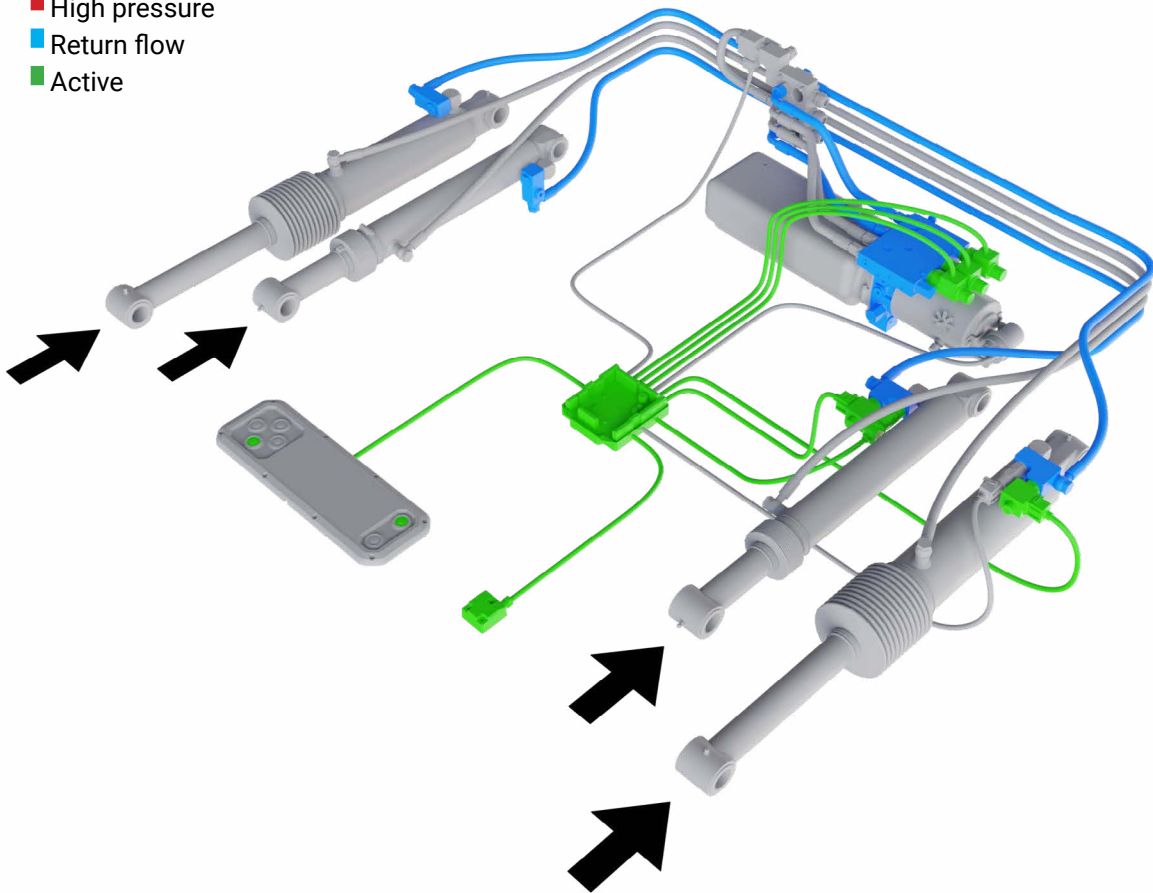
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



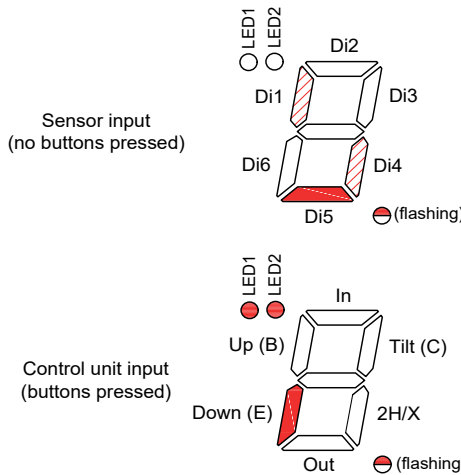
Z 1500/2000 MA with analog auto tilt
Function: auto tilt down

Description: Automatic down tilting of the platform once ground level has been reached.
Control input: Down. Available on all control devices.
Sensor input: Active pressure sensor on lift cylinder. Inclinator voltage ~ 1,7-2,5V.

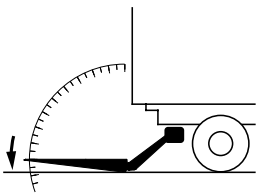
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



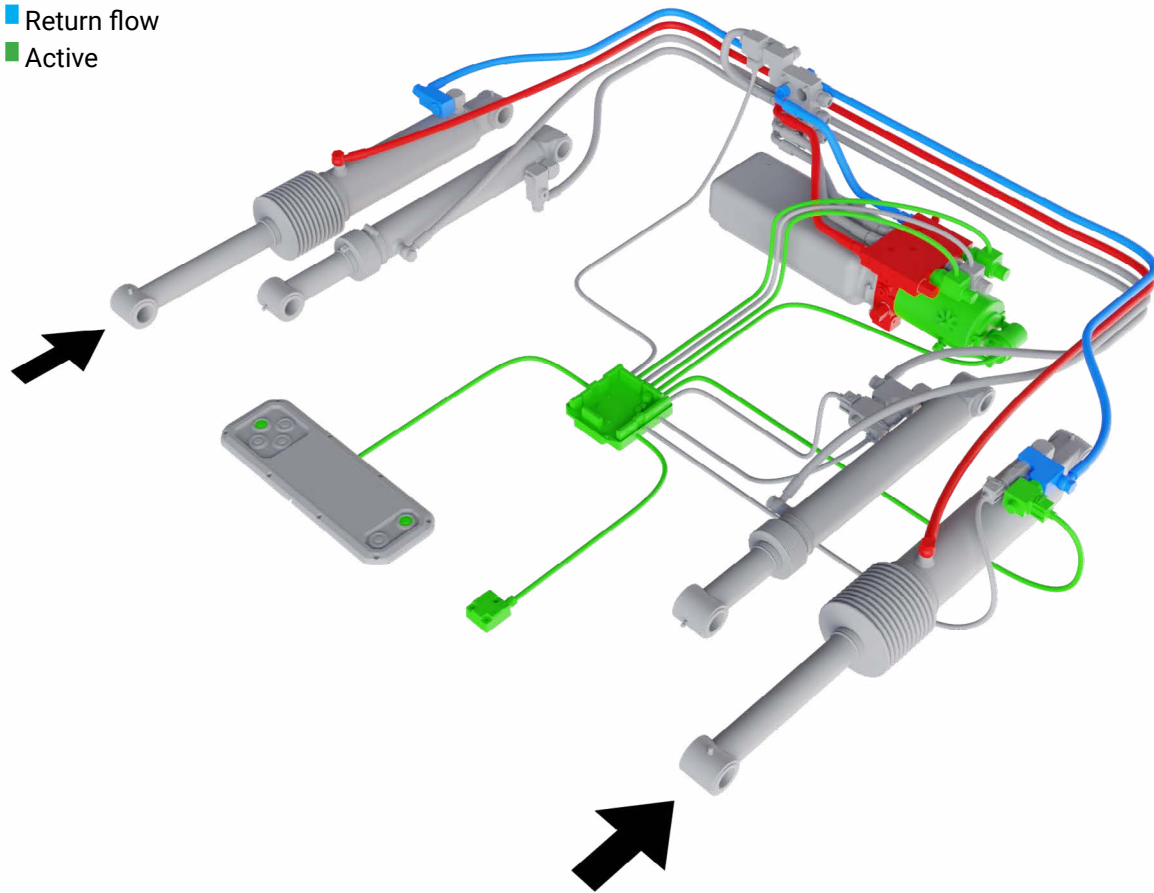
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



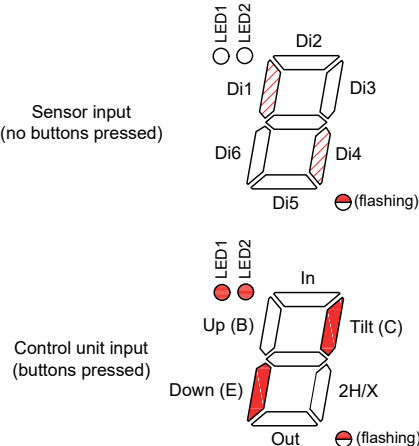
Z 1500/2000 MA with analog auto tilt
Function: manual tilt down

Description: Tilting up within +45/-10 degrees from horizontal.
Control input: Tilt + Up. Available on all control devices.
Sensor input: Inclinator voltage ~ 1,7-2,1V.

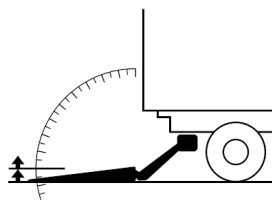
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



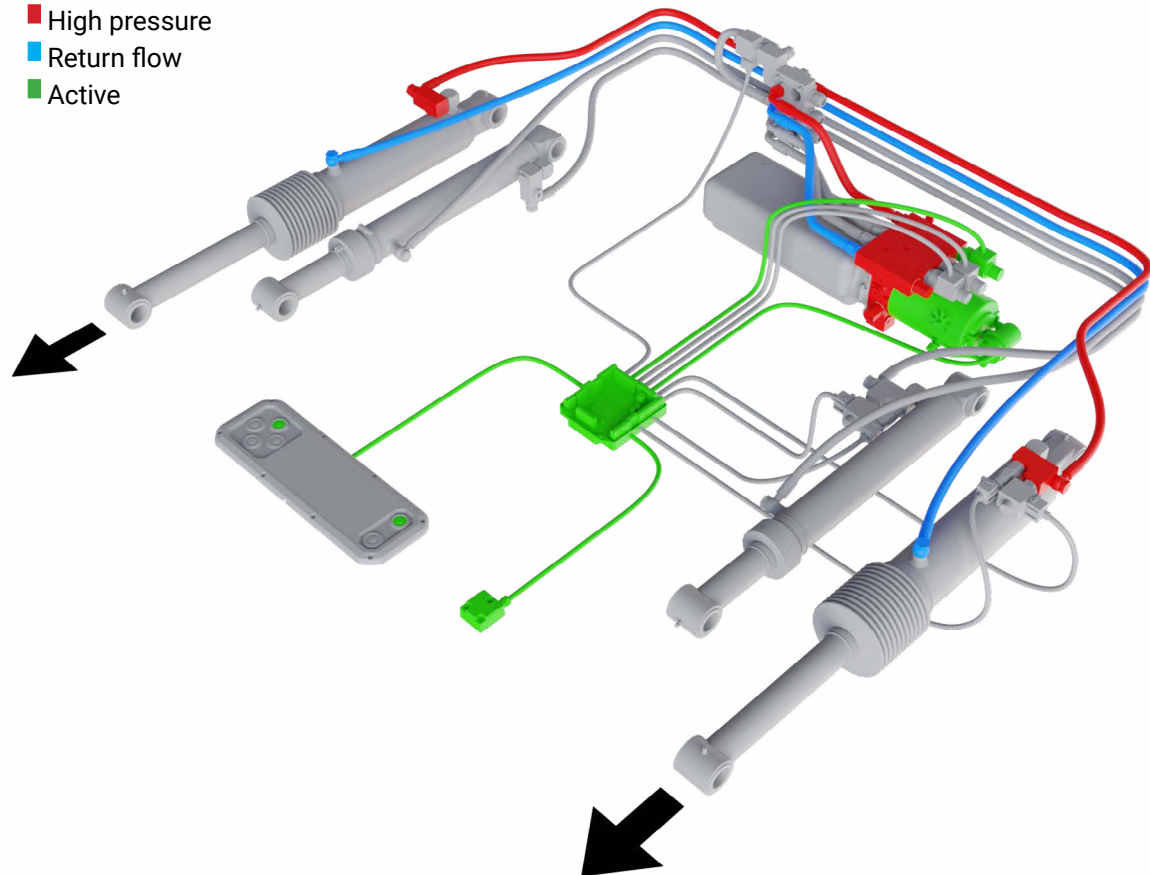
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



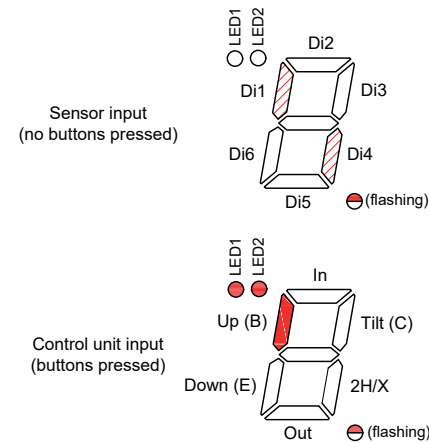
Z 1500/2000 MA with analog auto tilt
Function: auto tilt up

Description: Automatic up tilting of the platform untill it is tilted back to the saved angle.
Control input: Up. Available on all control devices.
Sensor input: Inclinometer voltage ~ 1,7-2,0V.

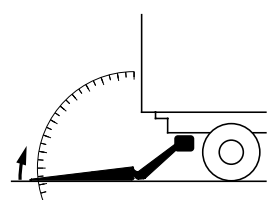
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



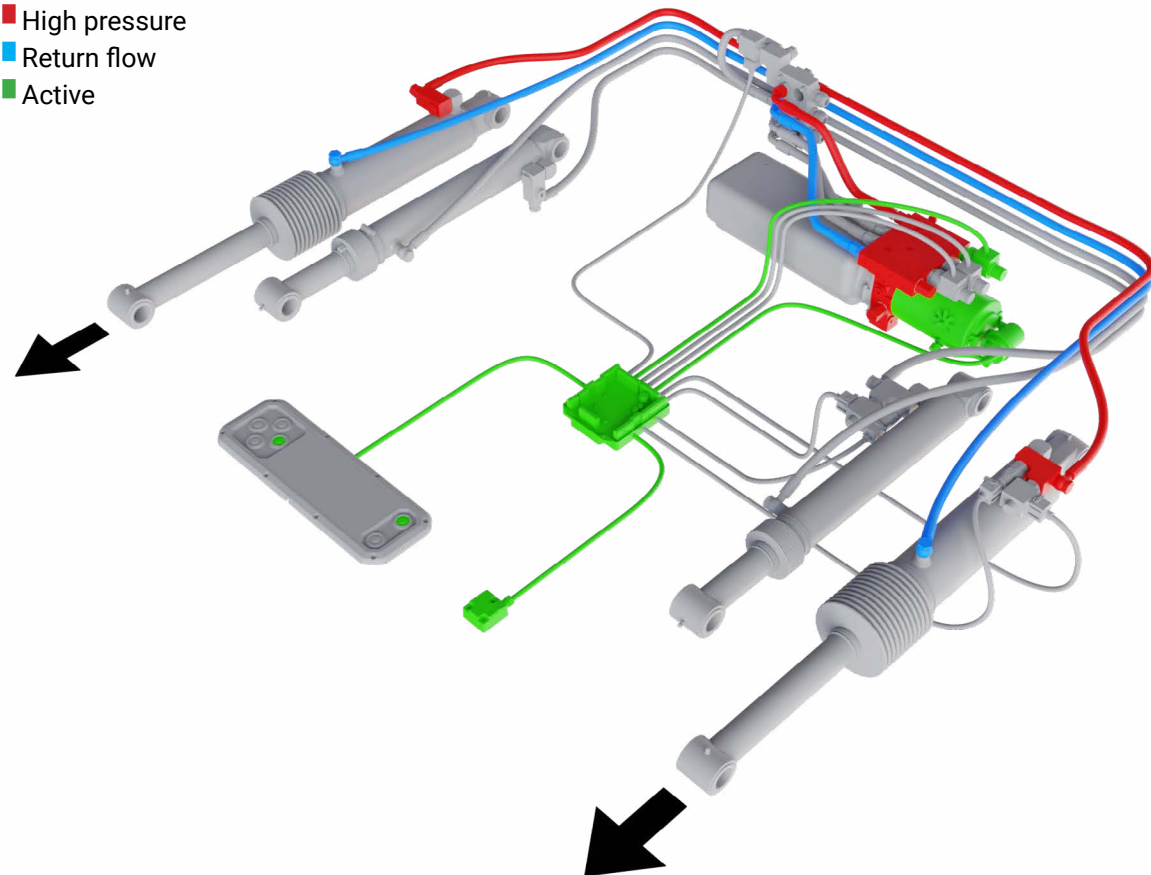
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



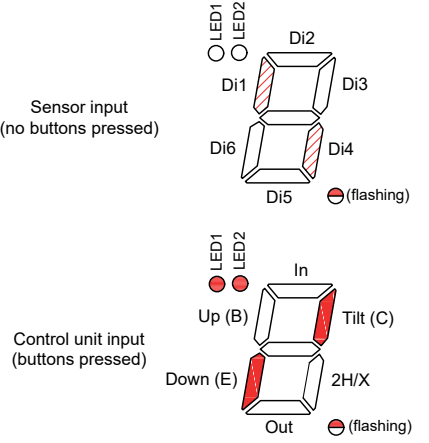
Z 1500/2000 MA with analog auto tilt
Function: manual tilt up

Description: Tilting up within +45/-10 degrees from horizontal.
Control input: Tilt + Up. Available on all control devices.
Sensor input: Inclinometer voltage ~ 1,7-2,1V.

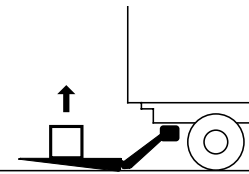
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



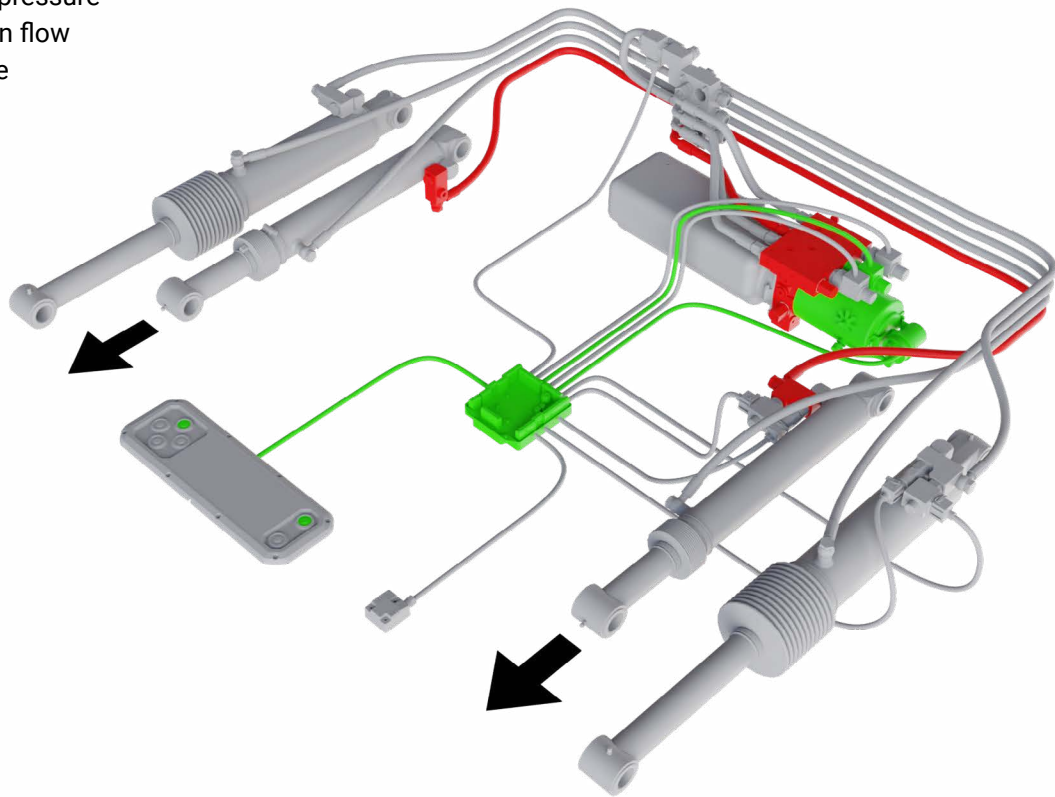
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



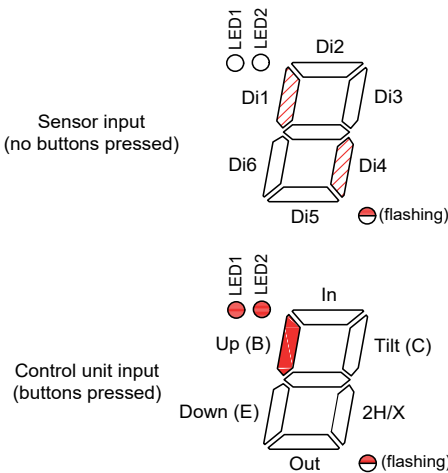
Z 1500/2000 MA with analog auto tilt
Function: raise

Description: Vertical platform raising.
Control input: Up. Available on all control devices.
Sensor input: None required for function.

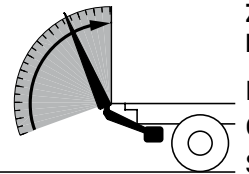
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



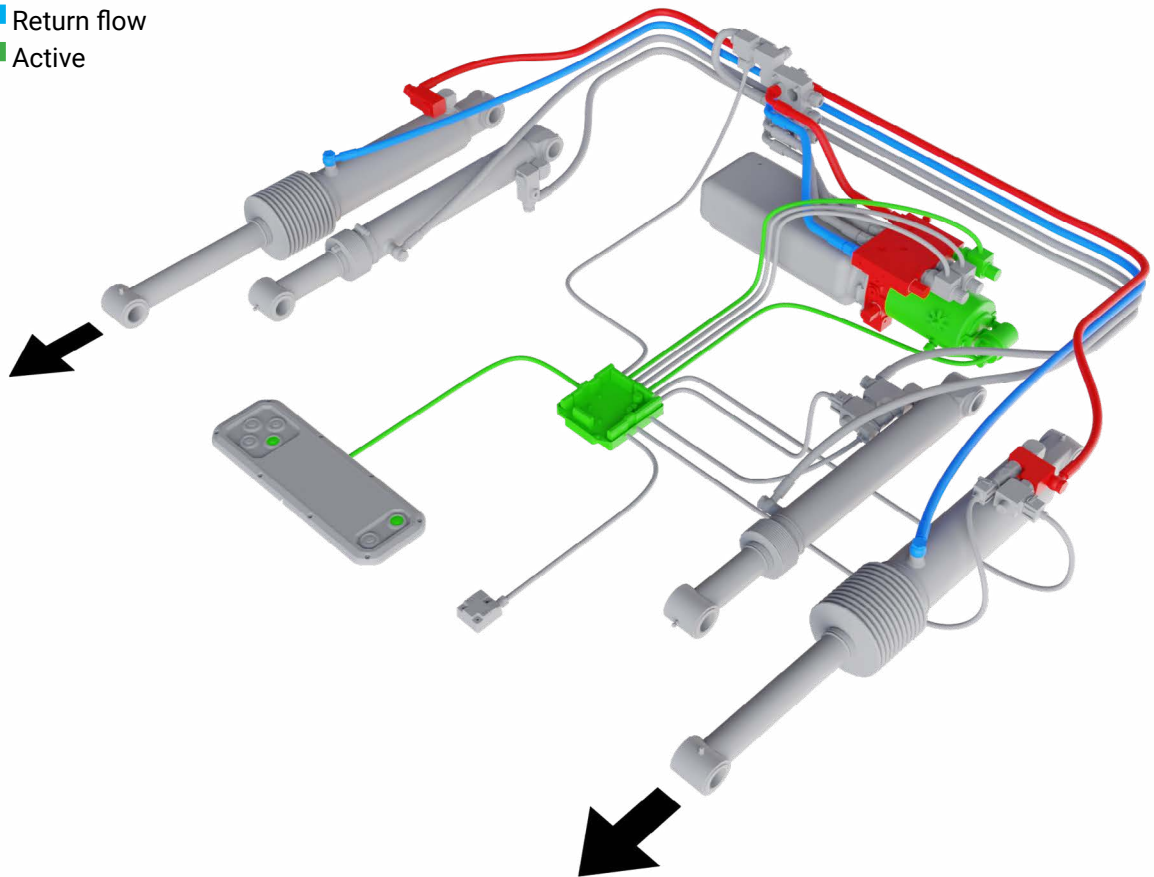
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



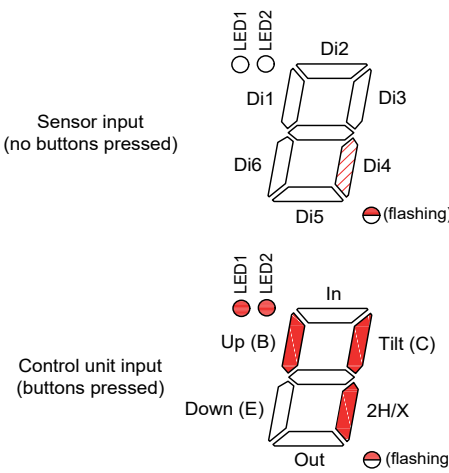
Z 1500/2000 MA with analog auto tilt
Function: close

Description: Closing fully against the box body.
Control input: Tilt + Up + 2H. Available on primary control devices only.
Sensor input: None required for function.

■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1

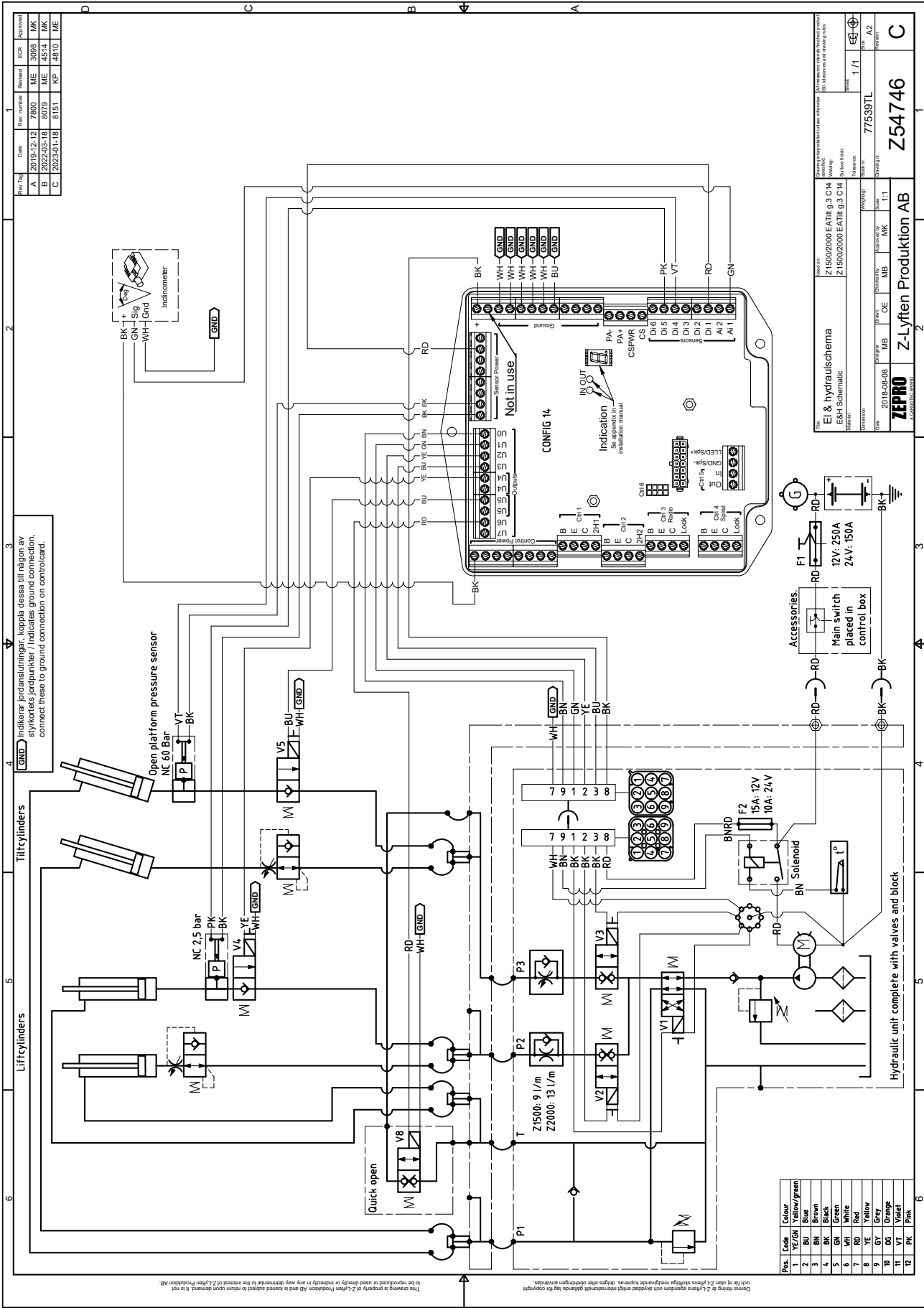


■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.

3.3.2 Summary of active valves Z 1500/2000 MA analog auto tilt

| | Motor Soleonid | Valve 1 | Valve 2 | Valve 3 | Safety Valve lift, V4 | Safety Valve lift, V5 | Quick Open Valve, V6 |
|-------------------|-------------------|------------|------------|------------|-----------------------------|-----------------------------|-------------------------|
| Open | ✓ | ✓ | | ✓ | | ✓ | |
| Quick Open | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Lower | | ✓ | ✓ | | ✓ | | |
| Auto tilt down | | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Tilt Down | ✓ | ✓ | | ✓ | | ✓ | |
| Auto tilt up | ✓ | | | ✓ | | | |
| Tilt up | ✓ | | | ✓ | | | |
| Raise | ✓ | | ✓ | | | | |
| Close | ✓ | | | ✓ | | | |

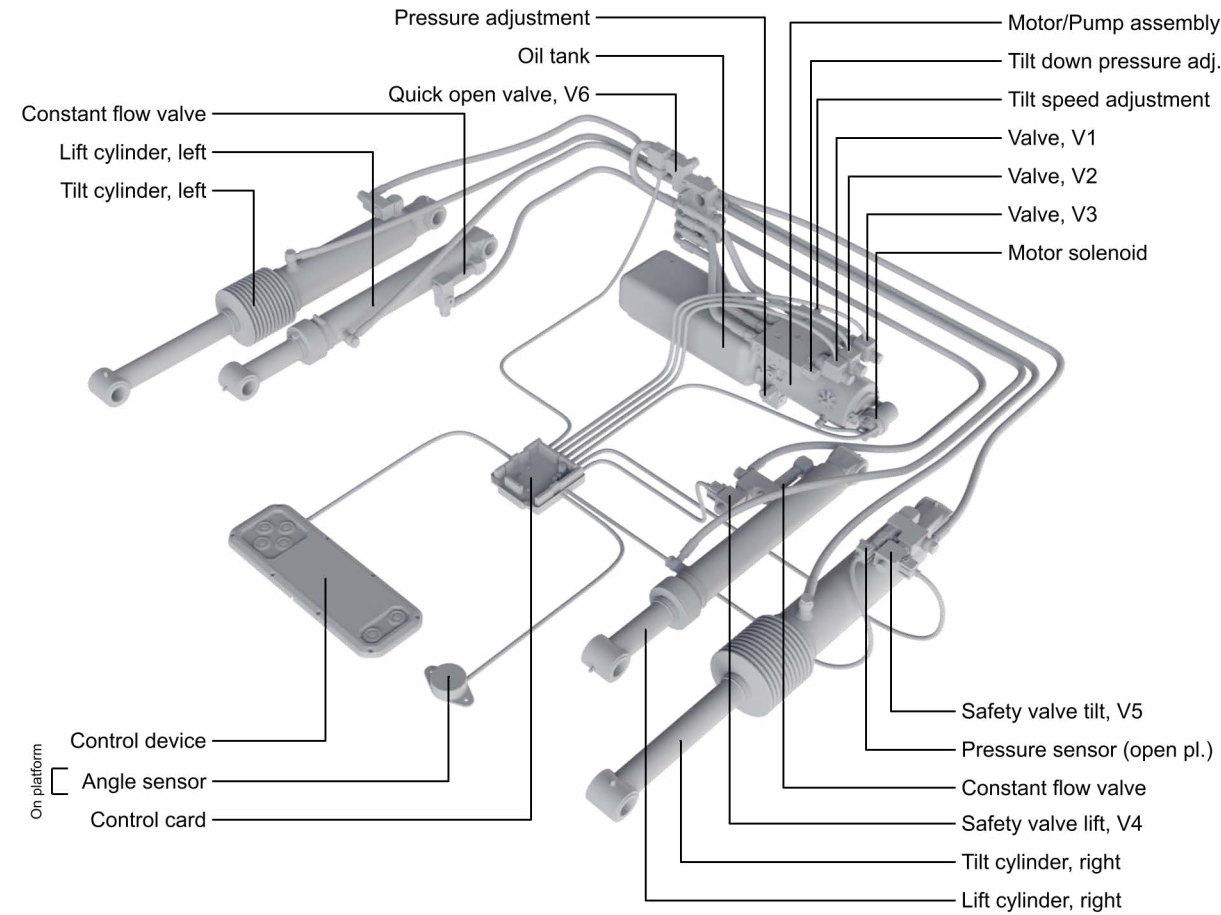
3.3.3 Schematic Z 1500/2000 MA with analog auto tilt



3.4 Z 1500/2000 DA

3.4.1 Description

The Z 1500/2000 DA is a variant with double acting tilt cylinders and double acting lift cylinders. It is equipped with a quick opening valve that increases the opening speed of the platform. It has no auto tilt functionality.



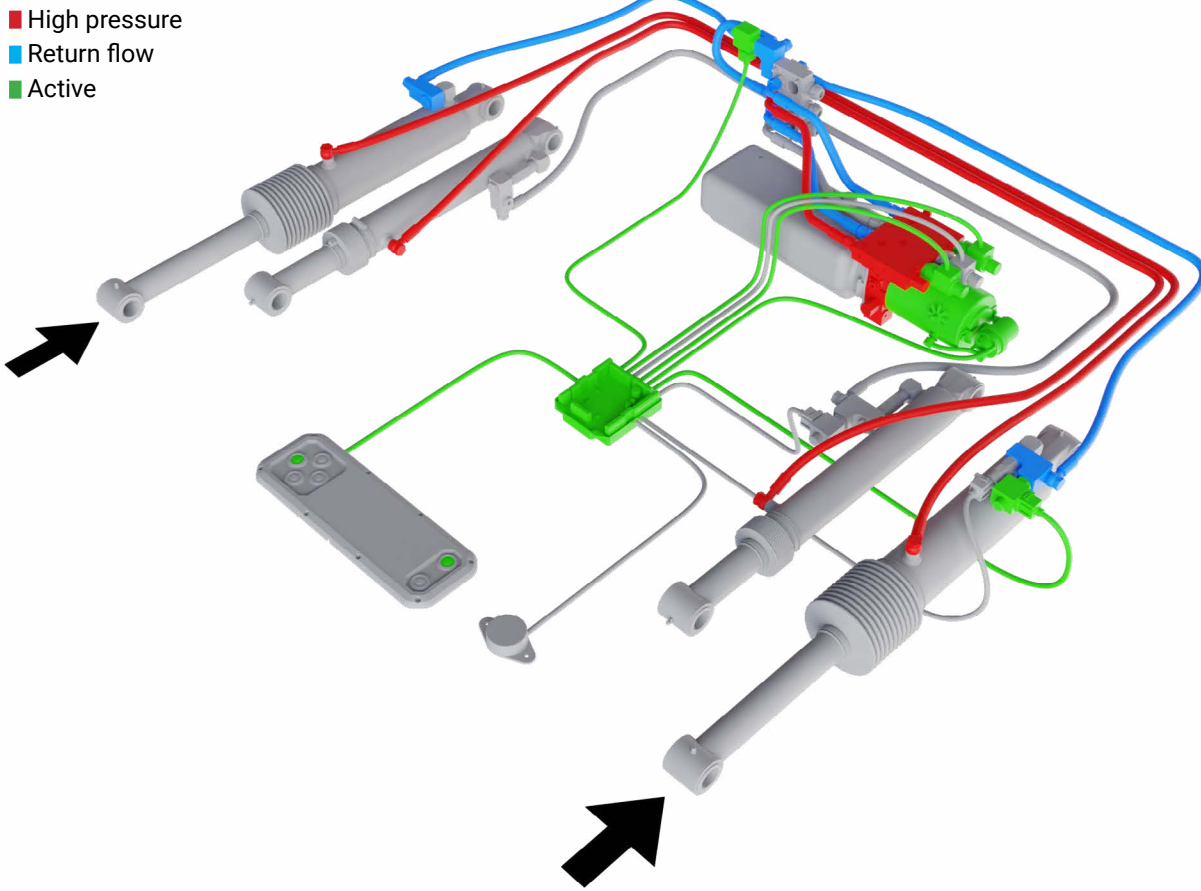
Sensors used

Angle sensor located on the platform used for the safety requirement for two hand operation when opening and closing against the boxy body. The sensor is inactive when the platform angle is within 45 degrees from vertical and within this range the two hand control is required. If the platform is closer to horizontal, the sensor is active and the requirement is removed. This sensor is connected to Di3 on ZePRO1.

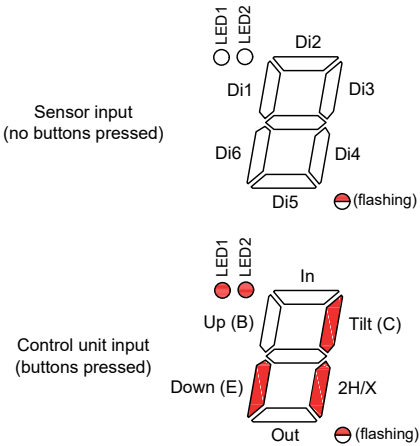
Pressure sensor located on the positive hydraulic feed to the tilt cylinder used to activate the open platform alarm. The sensor is active when the pressure drops below 60 bar which enables the Pa+ and Pa- pins on cabin switch section of the control card. This sensor is connected to Di4 on the ZePRO1

Z 1500/2000 DA Function: quick open

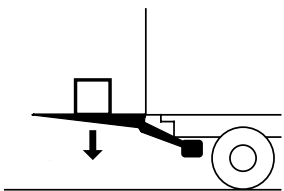
Description: Platform opening from fully closed against box body to horizontal.
Control input: Down + Tilt + 2H. Available on primary control devices only.
Sensor input: None required for function.



Card indication ZePRO1



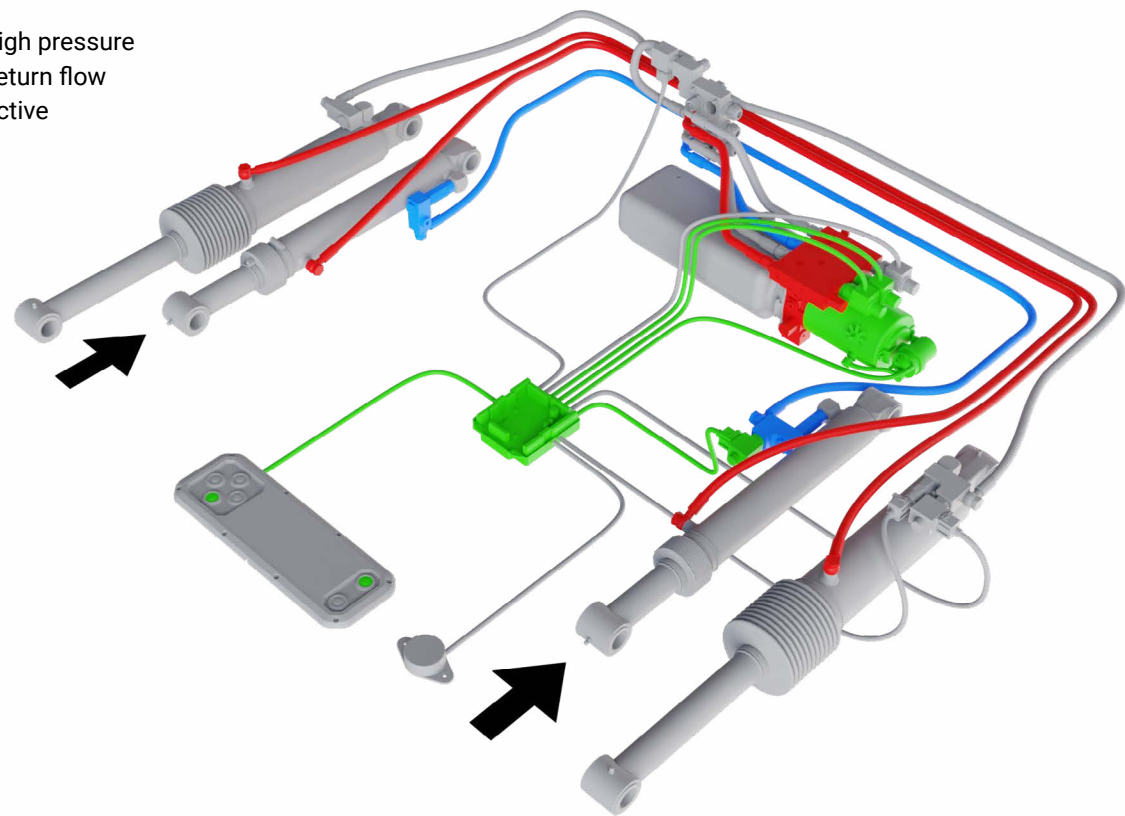
Must be active for the function to be executed.
Must be inactive for the function to be executed.
May be active or inactive, the function will be executed either way.



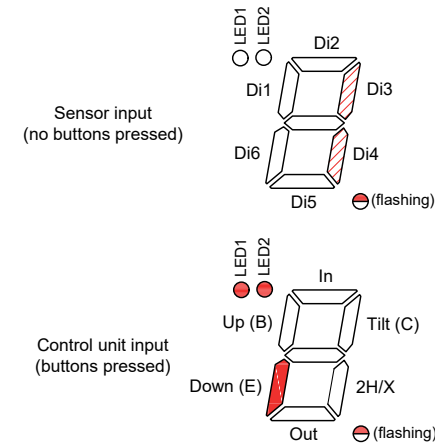
Z 1500/2000 DA
Function: lower

Description: Vertical platform lowering.
Control input: Down. Available on all control devices.
Sensor input: None required for function.

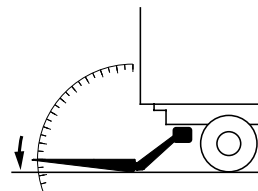
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1



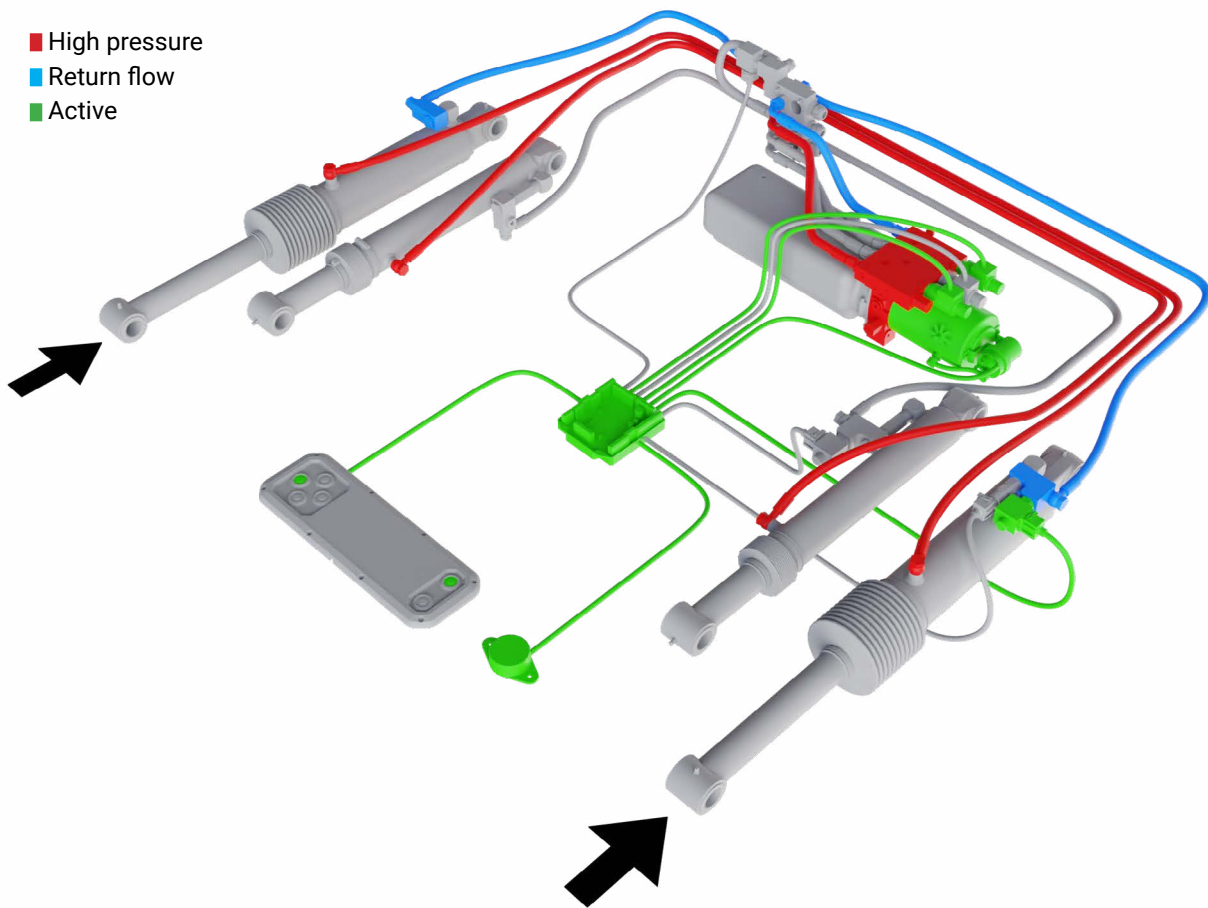
■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.



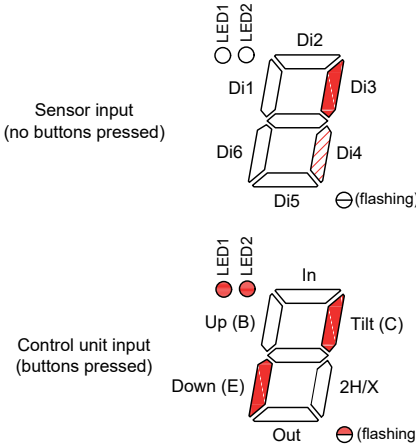
Z 1500/2000 DA
Function: tilt down

Description: Tilting down within +45/-10 degrees from horizontal.
Control input: Down + Tilt. Available on all control devices.
Sensor input: Active angle sensor on platform.

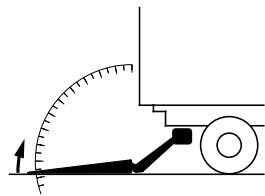
■ High pressure
■ Return flow
■ Active



Card indication
ZePRO1

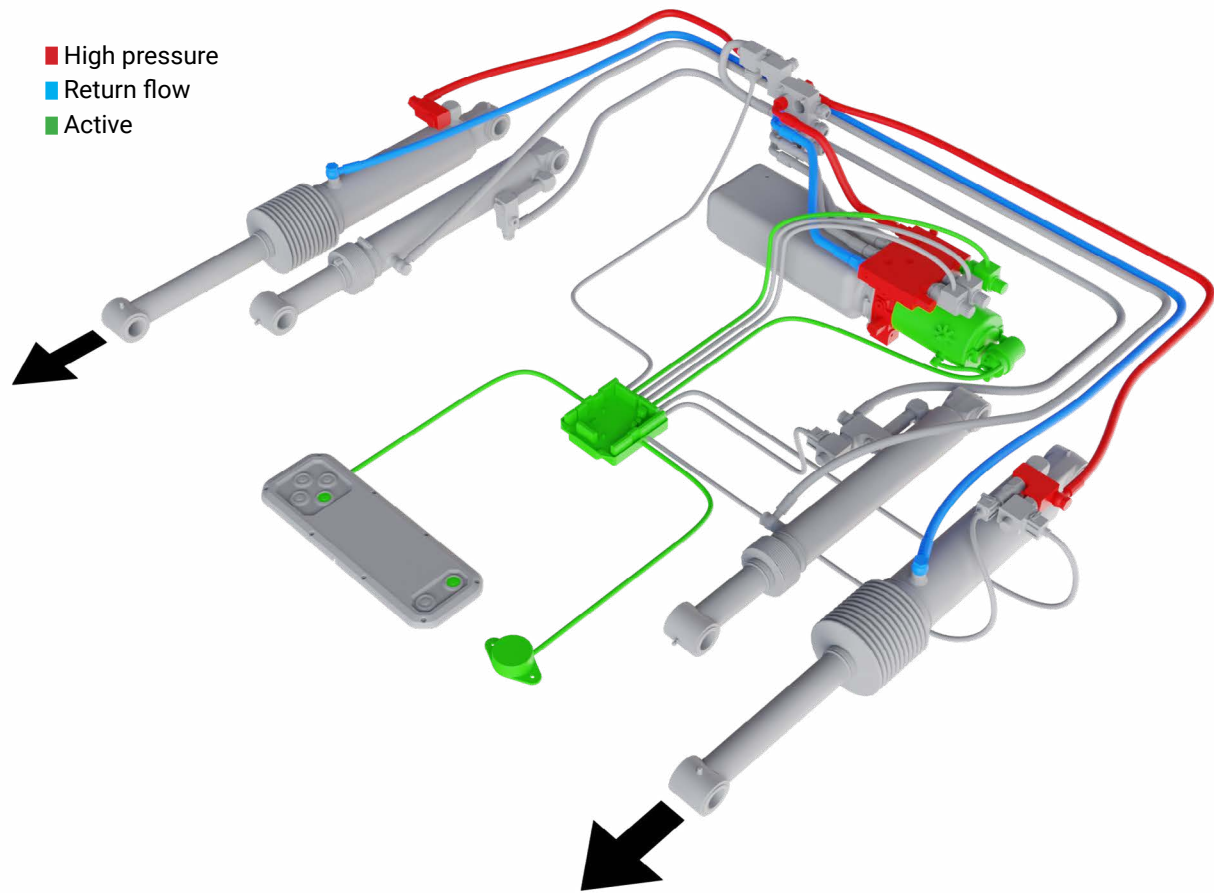


■ Must be active for the function to be executed.
□ Must be inactive for the function to be executed.
▨ May be active or inactive, the function will be executed either way.

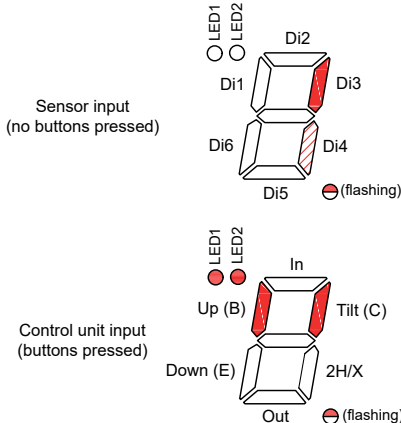


Z 1500/2000 DA
Function: tilt up

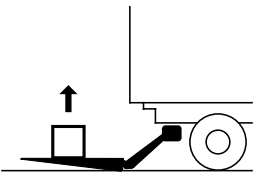
Description: Tilting up within +45/-10 degrees from horizontal.
Control input: Up + Tilt. Available on all control devices.
Sensor input: Active angle sensor on platform.



Card indication
ZePRO1

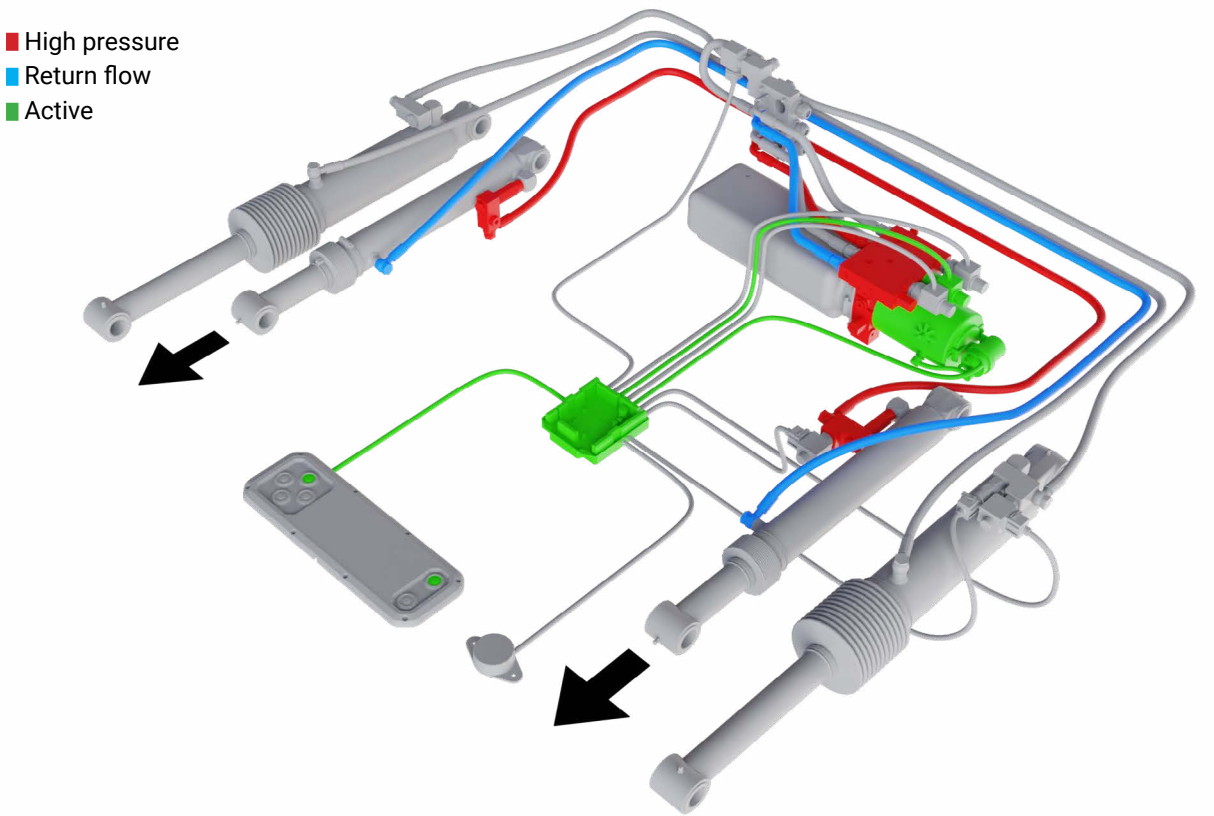


Must be active for the function to be executed.
Must be inactive for the function to be executed.
May be active or inactive, the function will be executed either way.

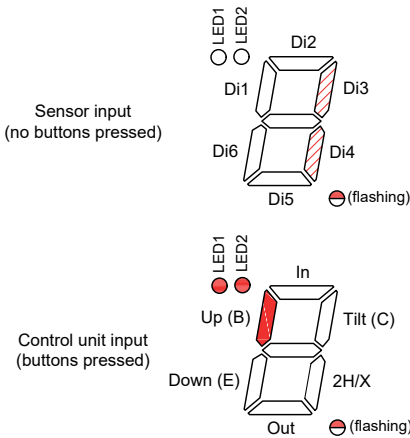


Z 1500/2000 DA
Function: raise

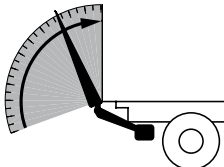
Description: Vertical platform raising.
Control input: Up. Available on all control devices.
Sensor input: None required for function.



Card indication
ZePRO1

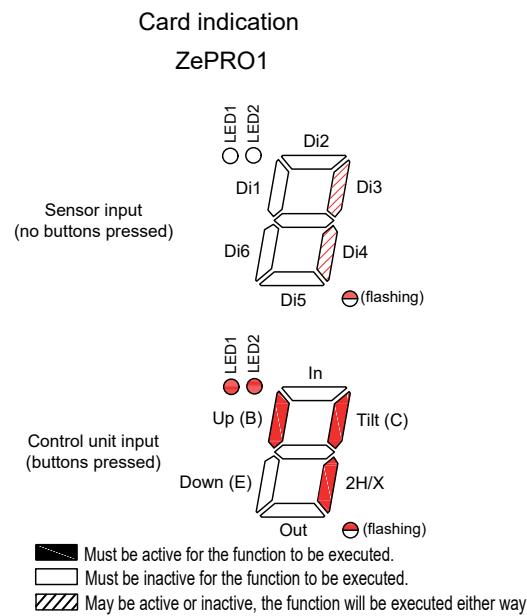
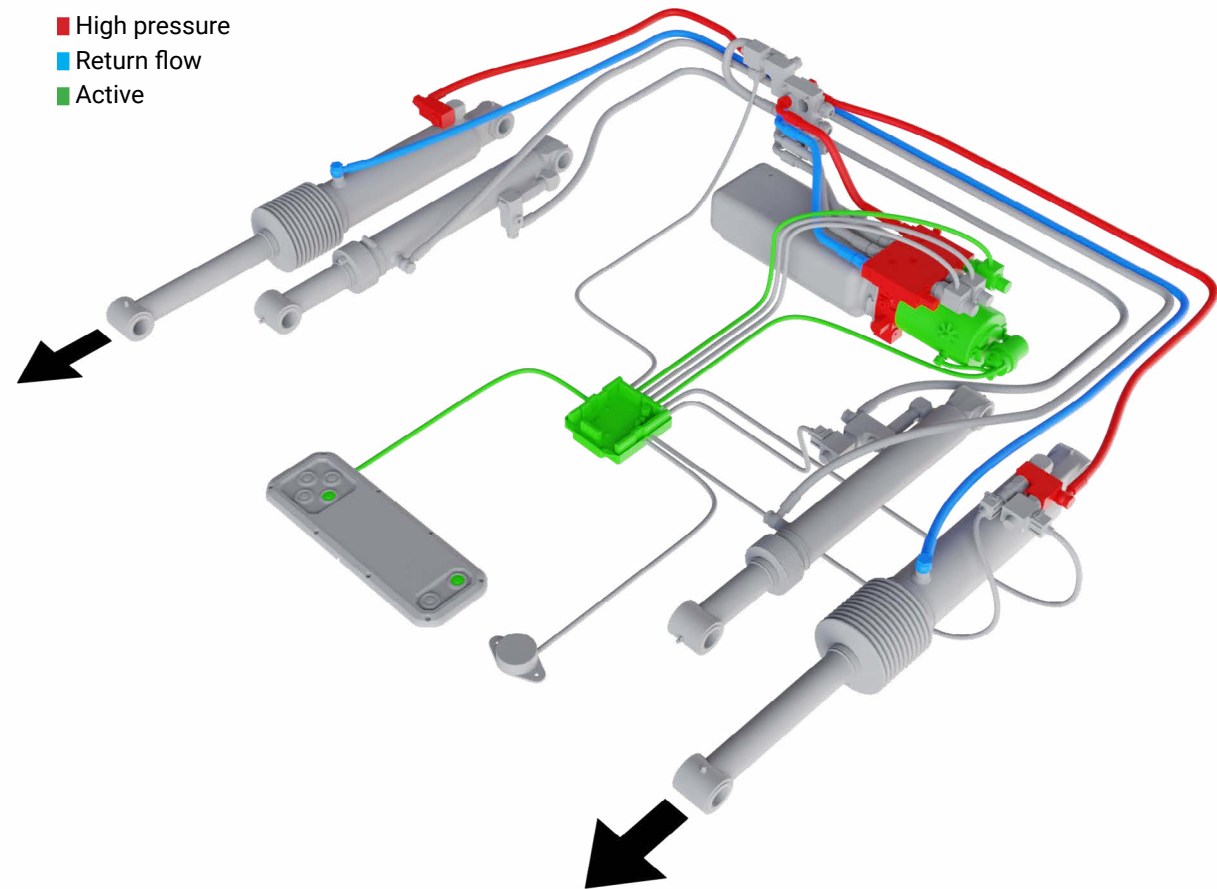


Must be active for the function to be executed.
Must be inactive for the function to be executed.
May be active or inactive, the function will be executed either way.



Z 1500/2000 DA
Function: close

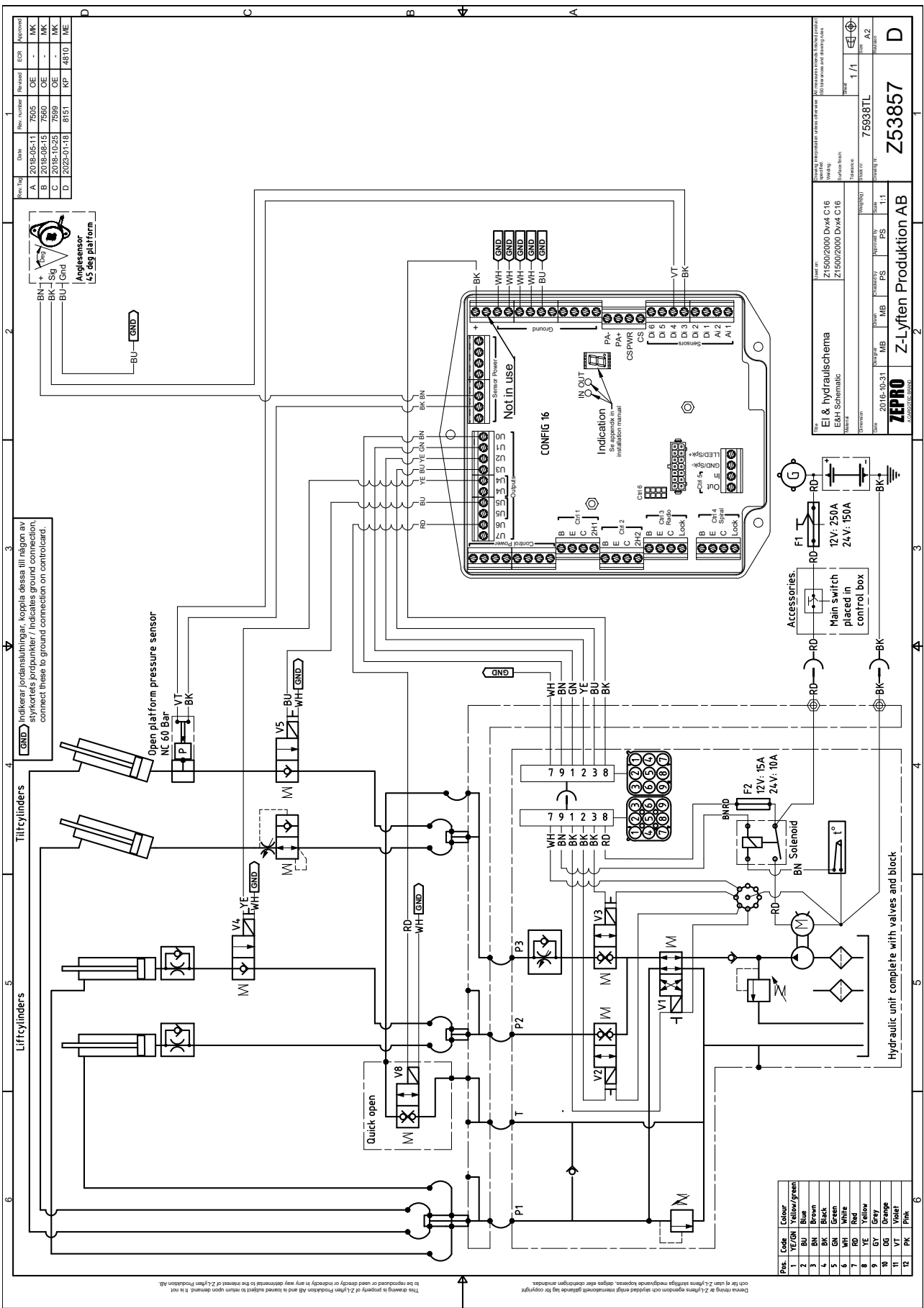
Description: Closing fully against the box body.
Control input: Up + Tilt + 2H. Available on primary control devices only.
Sensor input: None required for function.



3.4.2 Summary of active valves Z 1500/2000 DA

| | Motor Soleonid | Valve 1 | Valve 2 | Valve 3 | Safety Valve lift, V4 | Safety Valve lift, V5 | Quick Open Valve, V6 |
|---------------|-------------------|------------|------------|------------|-----------------------------|-----------------------------|-------------------------|
| Open | ✓ | ✓ | | ✓ | | ✓ | |
| Quick Open | ✓ | ✓ | | ✓ | | ✓ | ✓ |
| Lower | ✓ | ✓ | ✓ | | ✓ | | |
| Tilt Down | ✓ | ✓ | | ✓ | | ✓ | |
| Tilt up | ✓ | | | ✓ | | | |
| Raise | ✓ | | ✓ | | | | |
| Close | ✓ | | | ✓ | | | |

3.4.3 Schematic Z 1500/2000 DA



4 Troubleshooting

4.1 Causes of malfunctions

There are three categories of issues that can lead to a malfunctioning tail lift: electrical, hydraulic and mechanical. Electrical issues are fairly common and include but are not limited to damaged wiring, sensors, magnets and solenoids. Control card failures also fall in this category but are very rare in normal circumstances. Hydraulic issues include stuck or damaged valves and other oil flow obstructions or leaks within the hydraulic system. Mechanical issues include bent, seized or damaged structural components and are the least common of the three and the most easily detectable.

4.2 Troubleshooting strategy

Since the control card is a central part of the system and is responsible for turning the input signals into usable output signals which drive the desired function of the tail lift, it is the best starting point for the troubleshooting process. Following the steps listed below when troubleshooting is recommended.

Step 1: Control card power

Is the card powered on?

No: there is an issue with the power supply to the card. The fuse on the power cable to the card might be tripped or the wiring is damaged or disconnected.

Yes: the card is powered on, proceed to next step.

Step 2: Control device inputs

Is the card indicating the correct control device inputs as shown in the functional description?

No: there is an electrical issue with the control device or with the wiring between the device and the control card.

Yes: the card is receiving the correct inputs, proceed to next step.

Step 3: Sensor inputs

Is the card indicating the correct sensor inputs as shown in the functional description?

No: there is an electrical issue with a sensor or with the wiring between the sensor and the control card.

Yes: the card is receiving the correct inputs, proceed to next step.

Step 4: Outputs

Is the card indicating the correct outputs as shown in the functional description?

No: there is an issue with the control card. It might be damaged or of a wrong configuration.

- Yes:** the card is sending the correct output signals but there is
- a) an electrical issue such as a damaged magnet, solenoid, motor or damaged wiring to those components,
 - b) a hydraulic issue such as a stuck valve, a leakage or an obstruction of the oil flow or
 - c) a mechanical issue such as a stuck, bent or in other way damaged structure.

Note that the troubleshooting steps listed above require the tail lift to be powered on and the cabin switch (if present) to be in the "ON" position. If the tail lift is completely dead, use a multimeter to troubleshoot the power supply starting at the tail lift and moving towards the battery. Possible causes include but are not limited to a dead battery, a tripped fuse or disconnected or damaged power and/or ground cables.



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