SVAB

MACS RT

Mounting instructions

TILTROTATOR CONTROL, ATTACHMENT CONTROL, WHEEL AND TRACK STEERING

Revision I
Doc no.: DOC-0000327

CONTENTS

Ch. Contents **Page**

1. INTRODUCTION

MACS RT is an electronic control system for control of rotational and/or tilting units and their extra functions on excavators.

The system consists of:

- A cab module (GP1) that controls the supply of oil to the rotational and/or tilting unit.
- A rotational and/or tilting unit module (GP4) is mounted in the rotational and/or tilting unit, which controls its valves.
- A display (GPD) with a touch screen on which the user can view information and make certain modifications and adjustments.
- Grips with buttons and proportional rollers for control of the functions.

These mounting instructions are a guide to mounting a SVAB MACS RT system.
This control system has been especially introduced for the types of machine stated in chapter 3 below, and may not be used in any other way than indicated in these instructions.

This system is classified according to the machine directive as a partially complete machine, which means that the CE-marking on the products indicates that the system meets the requirements of the machine directive for integration in the machine or machines the system is intended for (see the chapter for areas of application). Under chapter 19 you will find information about how and what requirements the system fulfills on the condition that the parts are installed and used in the manner described. In addition to the machine directive, the CE-marking also shows that the directive for electromagnetic compatibility has been fulfilled. Regarding connection of hydraulics and the choice of valves for the functions that are described in these installation instructions, a risk assessment shall be performed for each individual machine model due to variations in the machines' hydraulic systems.

The system these instructions refers to is intended to be installed and used by experienced installation technicians/operators. If any uncertainties should arise regarding use, installation, understanding of the system or this document, stop installation work and contact the dealer for more information. You can prevent accidents by using common sense.

These installation instructions shall be used in the technical documentation that is the basis for or the machine's CE marking. The checklist on pages 72-73 must therefore be carried out carefully, filled in completely and signed by the installer responsible. Save this instruction with other technical documentation.

2. SAFETY

Read the installation instructions carefully before starting installation work. Follow the instructions and local provisions provided.

The system may only be joystick gripd by personnel trained for the machine.

Never carry out mounting work when the excavator is running.

Ensure that the hydraulic system is unpressurized and the electrical system unpowered before starting work on the system.

Check that hoses are the correct quality and that the hose connections are undamaged and correctly tightened. Hoses that become loose can cause serious injury.

Only use SVAB original parts. Damage or interrupted operation caused by parts other than
SVAB original parts are not covered by Warranty or product liability.

3. APPLICATION AREA

3.1 PERMITTED USE

APPROVED APPLICATION AREAS

If you are unsure whether the function is permitted to be controlled, you can always ask a technician at the system supplier.

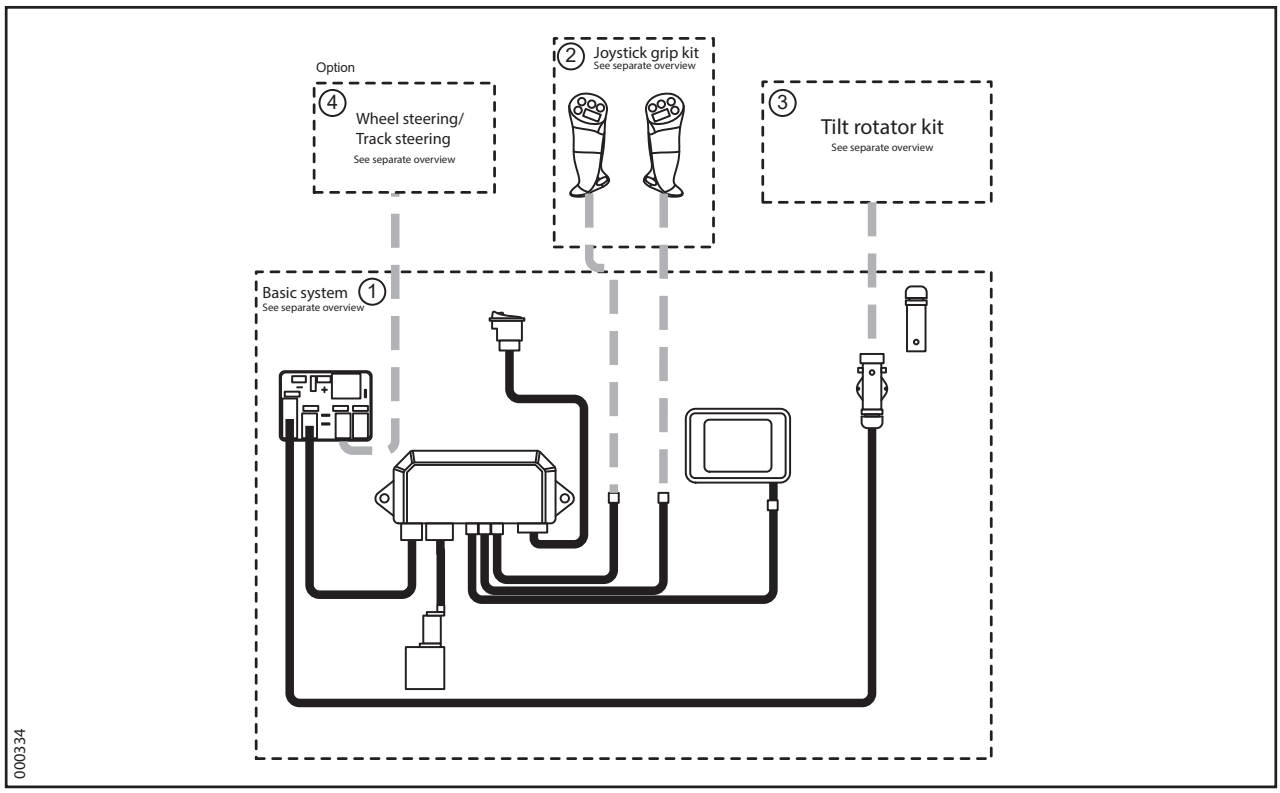
- *MACS RT may be used with excavators and tractor excavators/backhoes.*
- *Direct Proportional function med Performance level up to c per ISO13849-1.*
- *Pilot valve-controlled proportional function (functions that use a proportionally controlled pilot valve) with performance level up to c according to ISO 13849-1.*
- *Wheel steering function with performance level d, category 2 according to ISO 13849-1 for use at maximum speed of 20 km/h according to ISO 5010. Read more about this under "WHEEL STEERING (OPTION)" in the Driver's Manual.*
- *Track steering with utilization of direct acting proportional function as per the description above. Read more about this under "TRACK STEERING (OPTION)" in the Driver's Manual.*
- *Quick coupler lock with performance level d according to ISO 13849-1.*

3.2 PROHIBITED USE

MACS RT may only be used for approved applications areas and functions according to "Chapter 3.1 PERMITTED USE". SVAB is not responsible for damage or accidents that can occur due to prohibited use.

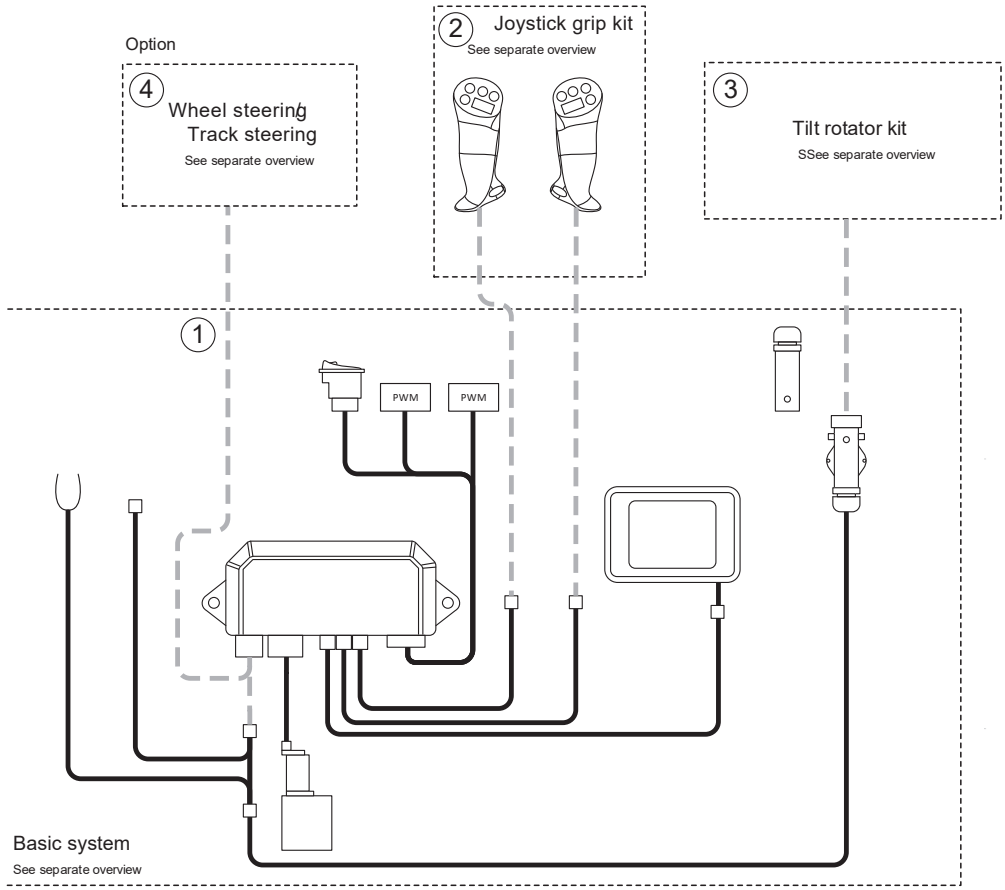
4. SYSTEM OVERVIEW

4.1 WITH CONNECTION UNIT



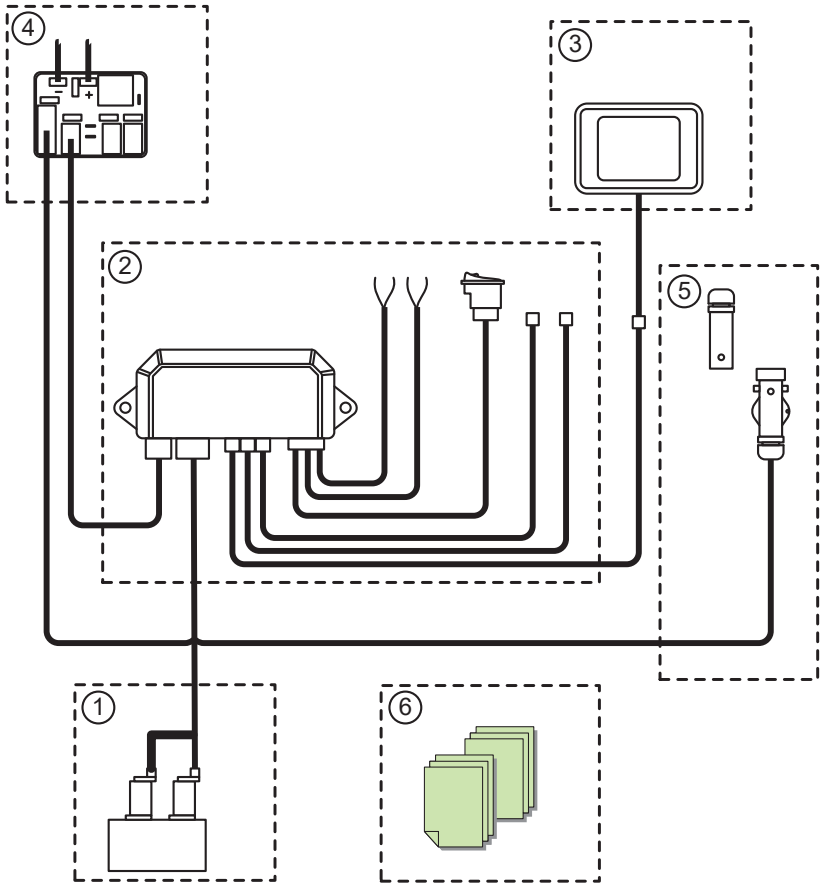
COMPONENT PARTS MACS RT		
Pos. no.	Description	Quantity
1	Machine kit Basic system Standard	1
2	Joystick grip kit	1
3	Tilt rotator kit	1
4	Track steering	1
4	Wheel steering kit	1

4.2 WITHOUT CONNECTION UNIT



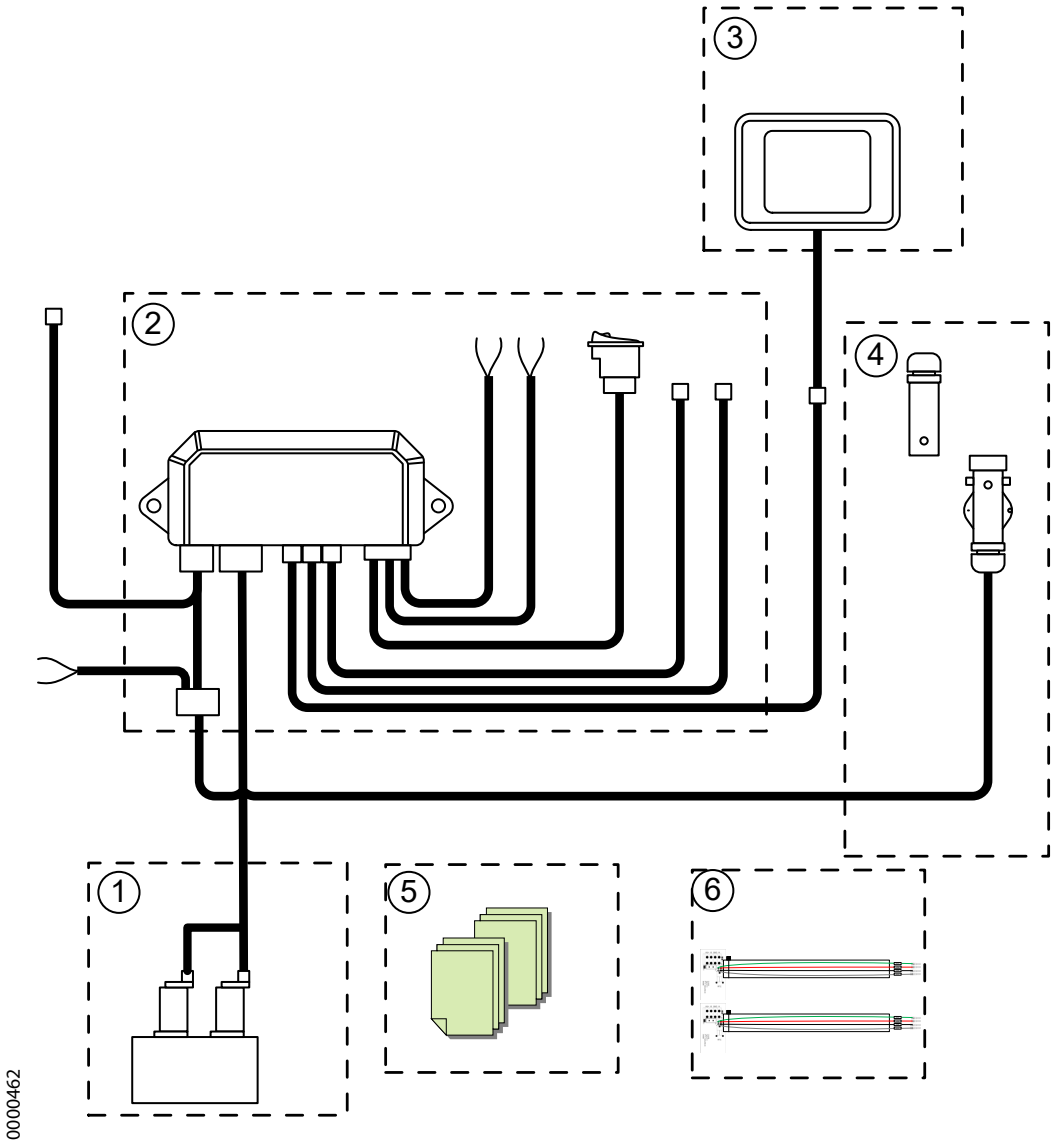
COMPONENT PARTS MACS RT		
Pos. no.	Description	Quantity
1	Machine kit Basic system Standard	1
2	Joystick grip kit	1
3	Tilt rotator kit	1
4	Track steering	1
4	Wheel steering kit	1

4.3 SYSTEM OVERVIEW BASIC SYSTEM, WITH CONNECTION UNIT



COMPONENT PARTS MACS RT BASIC SYSTEM		
Pos. no.	Description	Quantity
1	Pilot valve kit, double 12V/20bar	1
2	Cabin module kit, MACS RT	1
3	Display kit MACS RT	1
4	Connection unit kit MACS RT	1
5	Trunk cable kit MACS RT	1
6	Document	1

4.4 SYSTEM OVERVIEW BASIC SYSTEM, WITHOUT CONNECTION UNIT

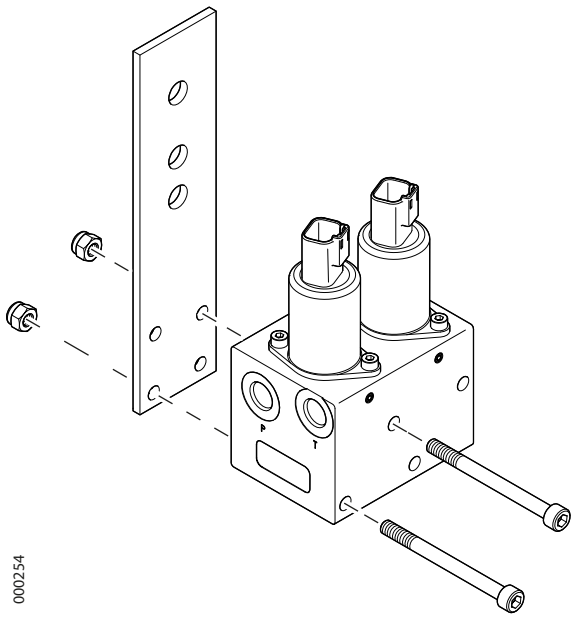


COMPONENT PARTS MACS RT BASIC SYSTEM		
Pos. no.	Description	Quantity
1	Pilot valve kit, double 12V/20bar	1
2	Cabin module kit, MACS RT	1
3	Display kit MACS RT	1
4	Trunk cable kit MACS RT	1
5	Document	1
6	PWM to analogue circuit board	2

5. INSTALLATION

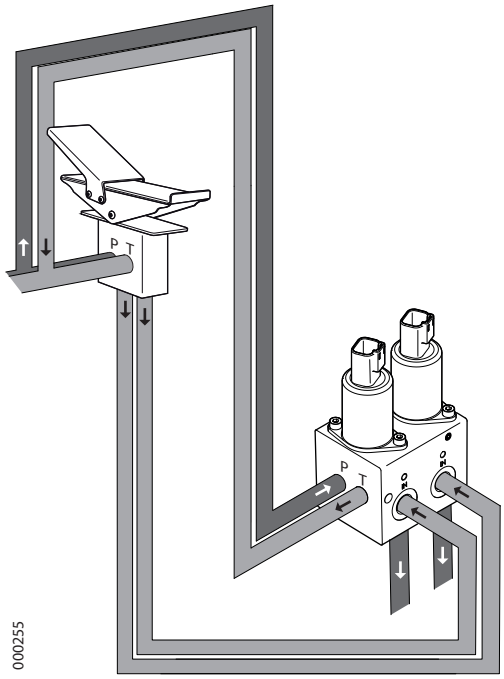
5.1 PILOT VALVE

01



Install the pilot valve using the mounting plate in a suitable location, close to any flow pedal or servo valve for control of the machine's extra hydraulics.

02



1) Connect the Pilot valve's P and T connections in parallel with the pedal/valve's P and T supply. This is done most easily via a T connection directly on the pedal/valve's input connections.

2) Connect two new hoses from the pedal/valve's outputs to the Pilot valve's ports marked IN. This is done to retain the original function in the pedal/valve.

NOTE!
Carefully check that the hose from the pedal is connected to in (ped) on the valve!
Incorrect connection can damage the valve!

(In those cases where the pedal/valve is not used/absent. Take care to unscrew the shuttles that are mounted in the bottom on both the Pilot valve's IN ports before these are sealed with a plug.)

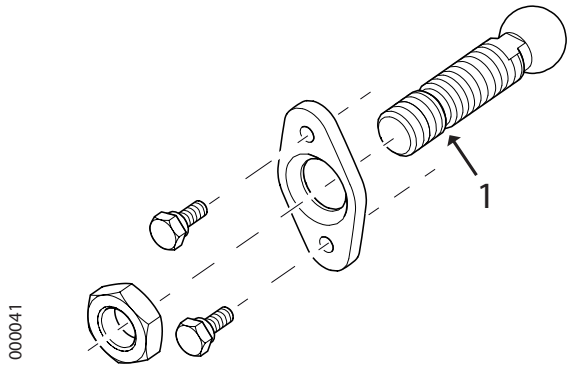
3) Finally connect the two hoses that were previously mounted on both the pedal/valve's outputs to the Pilot valve's outputs marked (Out1 and Out2).

The pilot valve is now connected in parallel with the pedal/valve and can now regulate the pilot pressure to both positions, just like the pedal/valve.

IMPORTANT!
When the hydraulic installation is complete, the machine's existing hydraulic diagram must be updated/ supplemented!

5.2 GRIP L8

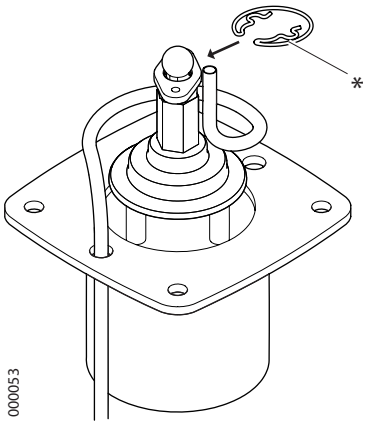
01



Dismantle the machine's existing joystick grip and note the routing and connections for the original wiring. This facilitates installation of SVAB Grip L8.

Thread the lock plate onto the adapter ball. Mount the joystick base locking nut and mount the ball in the joystick.
The adapter ball can be cut at the mark (1) to the desired length if necessary.

02



Install the joystick grip by tightening the screws that run through the locking plate in the joystick grip mounting. Ensure that the cable has slack inside the joystick, so that it is not stretched and does not come loose when the joystick is moved to its end position.
This is done by routing the cable the longest possible way into the mounting.

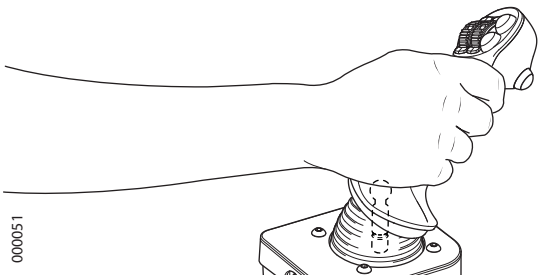
Mount the bellows holder and thread the bellows over. See supplied instructions.

*Available in several variants. Mounting instructions are supplied with each variant.

03

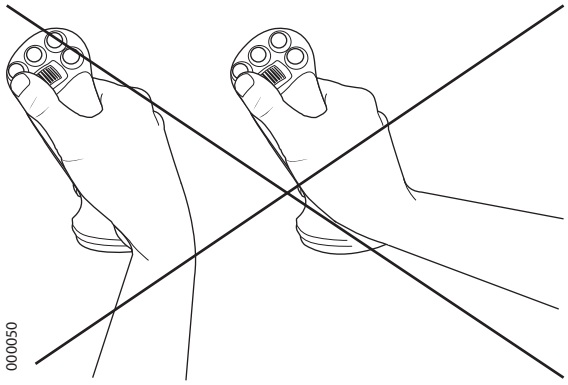
In order to achieve a good working environment and to prevent repetitive strain injuries, it is important for the joystick grip to be mounted correctly. If the joystick grip is also equipped with a dead man's grip, incorrect mounting will also have a negative impact on this function.

04



Note that the joystick must always be in its neutral position. The joystick grip must be tilted forward when mounted, so that the wrist is in a neutral (straight) position when gripping the joystick grip. Despite the fact that hands vary in size, this angle is approximately the same for everyone. When the wrist is in a neutral (straight) position, the angle formed by the joystick grip and the arm together should be between 100–110 degrees.

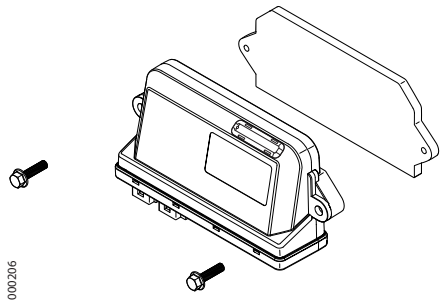
05



Do not mount in such a way that the wrist has to be angled. Incorrect mounting increases the pressure on the tendons running through the wrist, which can result in various strain injuries.

5.3 CABIN MODULE

01



The cabin module is installed in an appropriate location, using the mounting provided. Mounting plate and installation method can vary depending on the machine model.

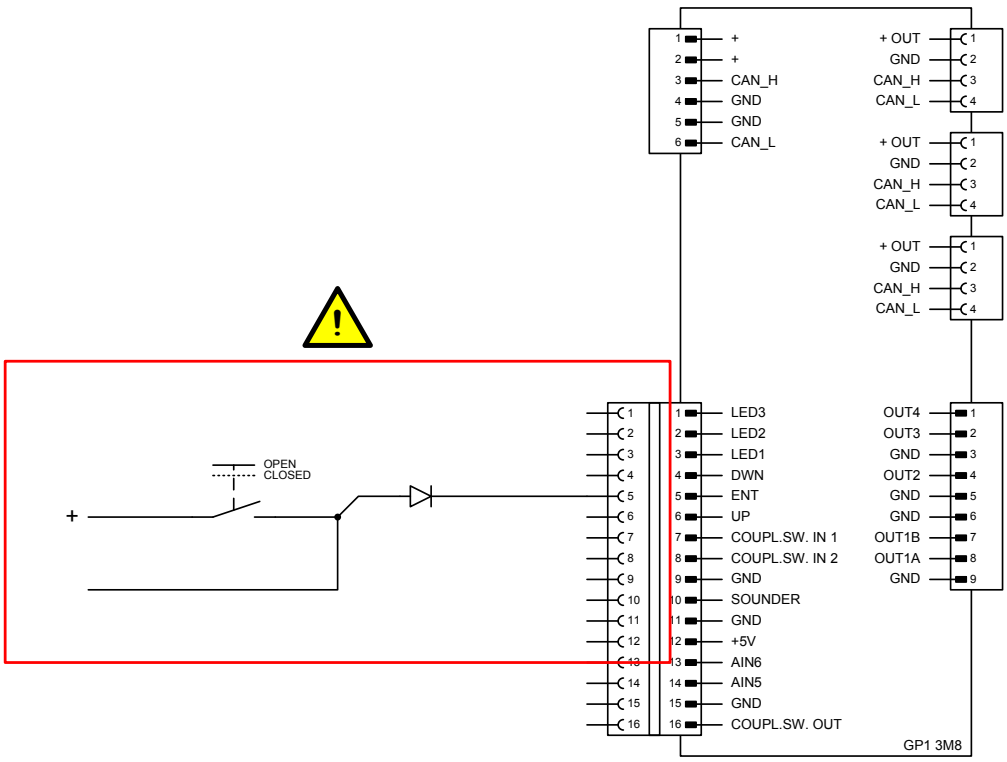
The cabin module should be installed in a protected location, so that the connection connections and connectors are not exposed to moisture or external impacts.

IMPORTANT!
Use existing holes and lead-throughs. New holes can compromise the existing CE marking.

02

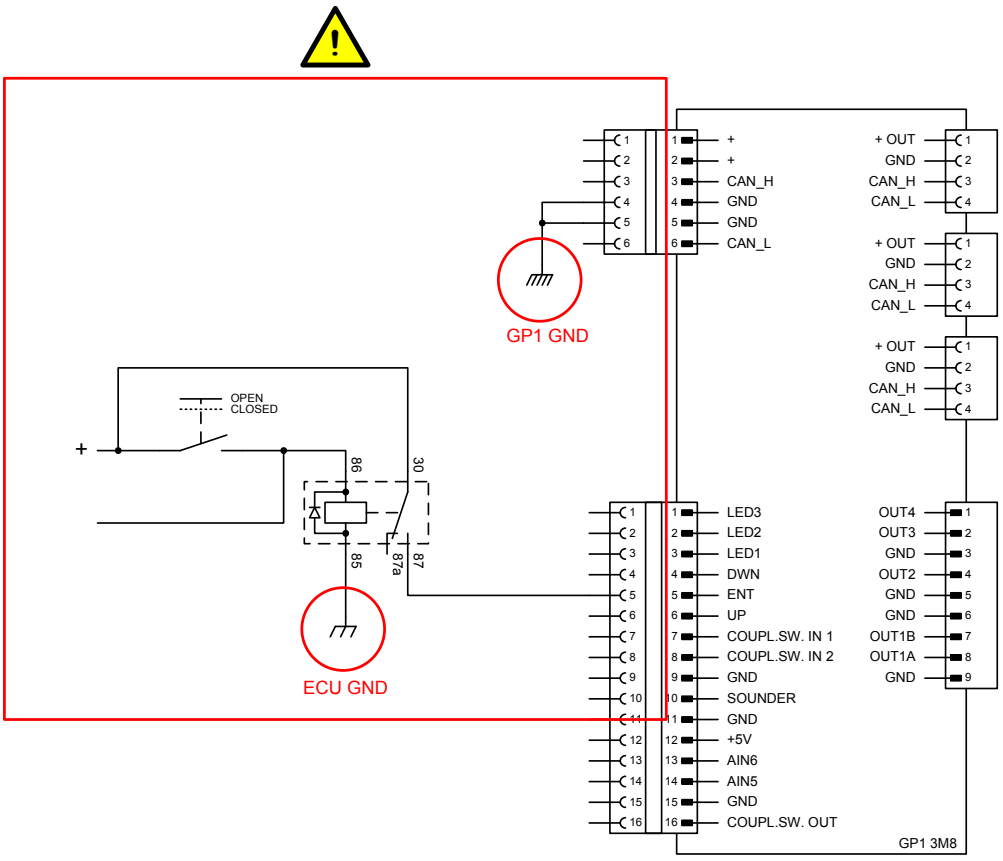
Gate signal

The signal for interrupting the hydraulic functions must be connected directly to the machine's original gate signal with a diode in series to protect the same against improper reverse voltages. This diode must not be removed or connected in a way other than per the following description.



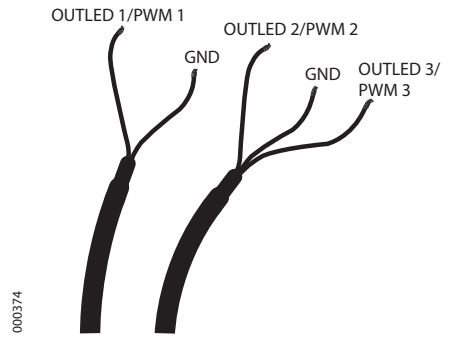
03 **Gate signal with relay**

The gate signal can also be connected via a relay in the following manner.
If the grounding connections to the machine's ECU and GP1 unit are connected to the same grounding point, it is important that the grounding connection to the relay solenoid is connected to the grounding point for the machine's ECU and not to the grounding point for the GP1 unit.



5.4 INSTALLATION PWM

01

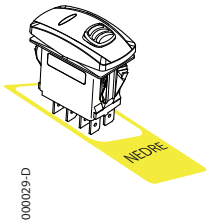


Connect the PWM output from the MACS system to the input on the machine's ECU where the original lever was previously connected.

IMPORTANT!
Ensure to reverse the positive and negative correctly!

5.5 QUICK COUPLER LOCK SWITCH

01



The tool lock switch is mounted in a spare location in the instrument panel, easily accessible to the machine operator.*.
(If using a Carling switch in SWF 511 mounting hole, use the MontageRam 200341 accessory)

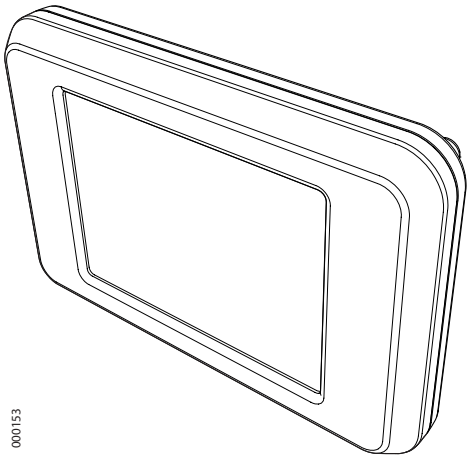
The panel switch for the quick coupler lock switch must be located so that it is not confused with other similar switches or switches with similar functions.
It must be equipped with a switch that can be locked in the off position.
The buzzer for indication of open shovel lock may not be plugged or removed. The signal must be clearly audible when normal work is underway.

Clearly mark this switch in the panel "Lower Tool mounting" and if the machine has an existing tool attachment the switch for it must be marked "Upper tool mounting".

*Available in several variants. Mounting instructions are supplied with each variant.

5.6 DISPLAY

01

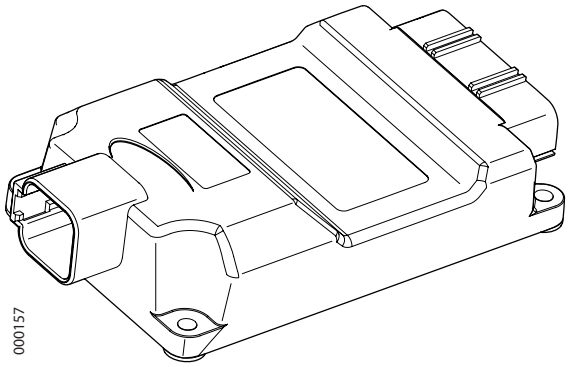


Install the display in a clearly visible position in the cab. The driver must have an unobstructed view of/reach to the display to be able to make adjustments and to see any error messages and system warnings.

Use the mounting or mounting plate supplied when installing the display. Mounting plate and installation method can vary depending on the machine model.

5.7 ROTOR /TILT MODULE (GP4)

01



The Rotor/tilt module (GP4) is installed and configured at the factory.

This unit controls the quick coupler lock valve in the rotational and/or tilting unit. It has full monitoring of the valve solenoid and interrupts the function if a fault is detected. For dependable function, it is recommended that the solenoid's rated voltage corresponds to the machine's system voltage.
The valve solenoid may only be connected to the outputs OUTCH and OUTCL, and may not be directly grounded in any other way.
The valve must be designed based on well-proven principles and/or be assessed as a well-proven component per ISO 13849-2 or an alternative method.

The hydraulic and mechanical construction for the quick coupler lock must be configured per EN474-1 Appendix B with well-proven components or based on well-proven principles per ISO 13849-2 or an alternative method.
Beside the function for the quick coupler lock described previously, this unit can be used for control of the rotational and/or tilting unit's valves. There are outputs for 4 bidirectional functions.

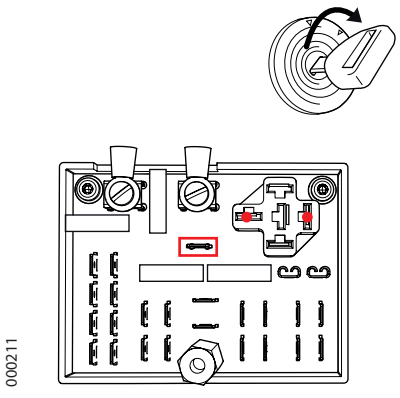
The rotational and/or tilting unit's functions may not be used for lifting people.

This unit also includes tilt sensors used for indication of the tilt of the shovel/tool in relation to the Earth's gravitation.
It also has 4 inputs that can be used for various sensors during for example, adjustment of the system.

6. ELECTRICAL INSTALLATION

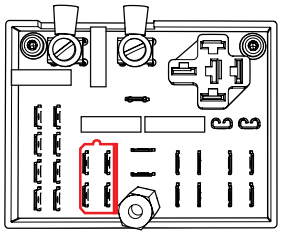
6.1 WITH CONNECTION UNIT

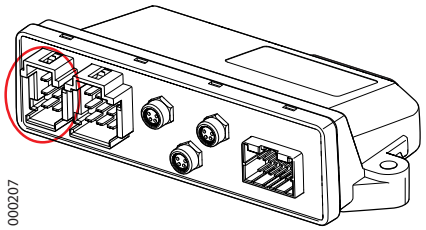
01



Connect positive and negative supply to the connection unit. In cases where the power supply is not controlled by the ignition switch, be sure to connect an ignition signal to the connection unit on the marked connection terminal. Also remove the bracket and install a relay in the relay socket (12V or 24V). The relay is not included in the standard kit.

02



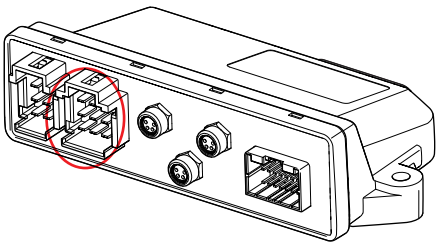


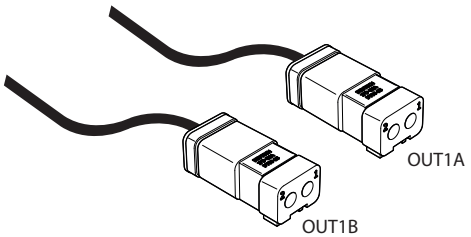
000207

CConnect the supply cable in the cabin module to the connector indicated. Ensure that the cable is routed through the cab to the connection unit in a suitable way and cut it to the required length. Connect according to the enclosed material and description. Connect the cable to the connection unit.

Remember to strain relieve the wiring!

03





000205

Connect the pilot valve* to the cabin module by connecting the wiring to the marked connector on the cabin module. Route the wiring through to the nearest lead-through, in a suitable way, and then out of the cab to the pilot valve.

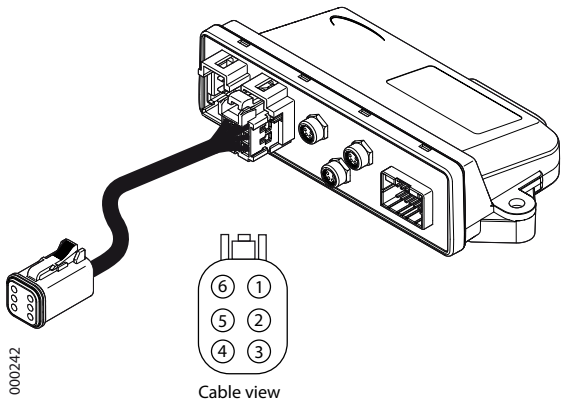
IMPORTANT!
Use existing holes and lead-throughs. New holes can compromise the machine's existing CE marking!

Connect the connector marked Out1A on the spool that affects the flow to the tilt rotator.

Remember to strain relieve the wiring both in the cab and outside!

*If a pilot valve is used

04



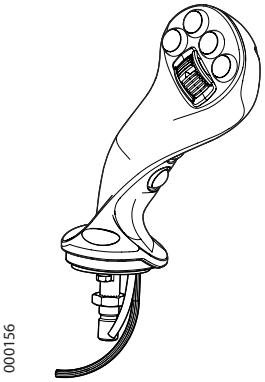
000242

Cable view

The image shows the positions of the configurable outputs 13 and 14 with associated ground connections.

1. OUT 2
2. OUT 3 (Output 13)
3. OUT 4 (Output 14)
4. GND
5. GND
6. GND

05



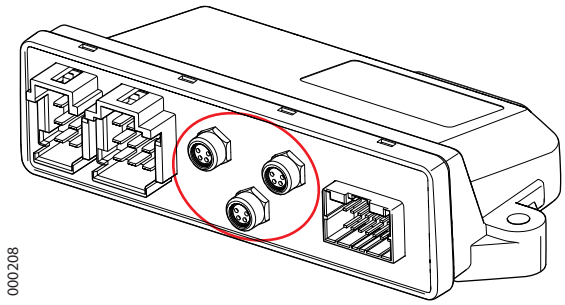
The wiring from the joystick grips is connected to any extension cables. Ensure that any joints end up in the armrest so that they are not exposed to external impact.

Route the cables along existing cable ducts and adapt the lengths so that they are sufficient for the seat's different limit positions.

Lines that are not connected to the system can be connected to original functions on the machine. What buttons and functions can be connected depends on the version of the joystick grip.

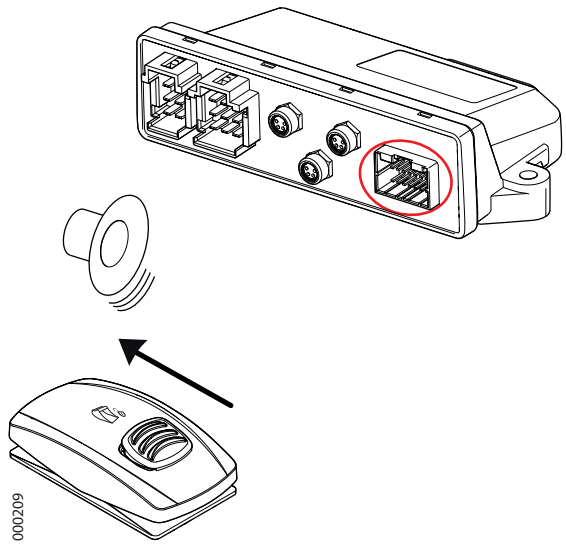
Further information about the installation is supplied with the joystick grips.

06



Connect the system joystick grip and display to the cabin module.
The units are connected to the cabin module's marked connectors (see image), so that the right joystick grip is connected to the right connector and the left to the left connector. There may be cable extensions and joints, depending on the size and version of the machine.
Also see supplied appendix.

07



Connect the distribution wiring to the marked connector in the cabin module. Route the wiring through the cab, in a suitable way, to a spare location in the machine control panel.

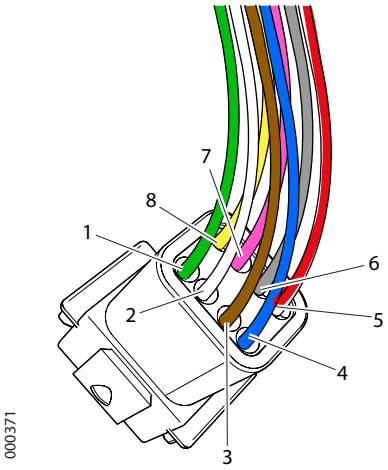
Remove the appropriate cover in the panel and thread the cable and connector up. Install the switch in the connector and then push the switch down into the panel.

The switch should be installed as close to the driver's seat as possible, partly for comfortable operation and partly so that the buzzer can be heard when the bucket lock is open.

Connect the line marked gate signal to the machine's safety gate so that a plus signal is given when the gate is in the closed position.

Connecting the gate signal is not a requirement but a possible safety requirement that can be used for wheel steering. In cases where this is not used, secure the cable concealed under one of the cab's panels.

08

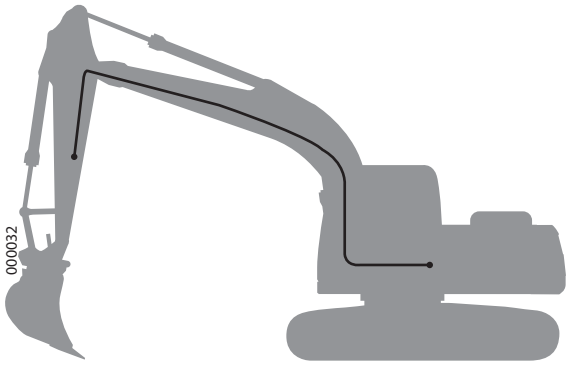


Connect the supplied connectors as illustrated.

1 - Green (CAN High)
2 - White (+)
3 - Brown (GND)
4 - Blue (Loop 1) Bucket lock interlock (Loop 1)
5 - Red (Loop 2) Bucket lock interlock (Loop 2)
6 - Grey (+)
7 - Pink (GND)
8 - Yellow (CAN Low)

Connect the machine cable to the Power/CAN cable

09



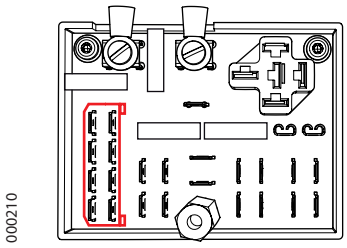
The trunk cable is installed so that it meets the tiltrotator's unit wiring on the stick. Then route into the cab to be connected to the supply cable.

NOTE!
Use existing holes and lead-throughs. New holes can compromise the existing CE marking.

Start by mounting the trunk cable connector on the stick. (One of SVAB's ready to use attachment plates is recommended). Remember that the connector is mounted at a suitable distance from the tiltrotator so that the unit cable reaches the connector, but is not so close to the tool that it risks ending up under water. In this connector there is also a function for interlocking the upper quick coupler lock on the machine when the tool is connected.

The trunk cable is then secured along the machine's stick and boom. Take care to route the cable so that it cannot be trapped/stretched and that the machine has a full range of movement.

10

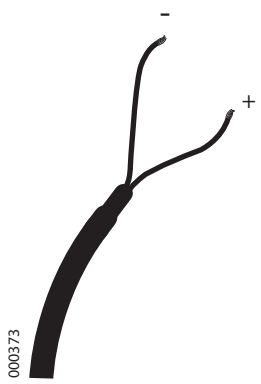


Insert the cable into the cab via a lead-through and route the cable to the connection unit. Cut off any excess cable and strip the cable.
Connect the cable to the connection unit, according to the enclosed description.

NOTE!
Take care to turn the connector as marked on the board.

6.2 WITHOUT CONNECTION UNIT

01



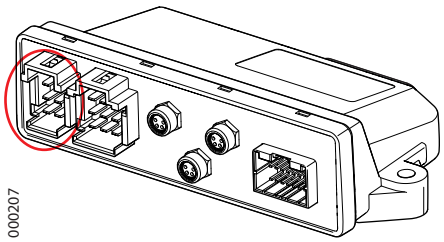
Connect the positive and negative supply from the wiring to the machine's positive and negative for tiltrotator control.

\+

Blue -

NOTE!
Ensure to fuse the system power supply with 10A!

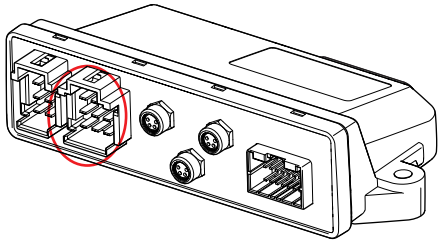
02

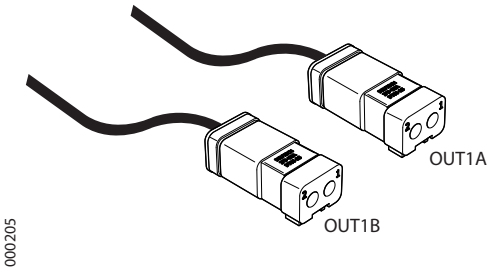


Connect the supply cable in the cabin module to the connector indicated. Ensure that the cable is routed through the cab in a suitable way.

Remember to strain relieve the wiring!

03





Connect the pilot valve* to the cabin module by connecting the wiring to the marked connector on the cabin module. Route the wiring through to the nearest lead-through, in a suitable way, and then out of the cab to the pilot valve.

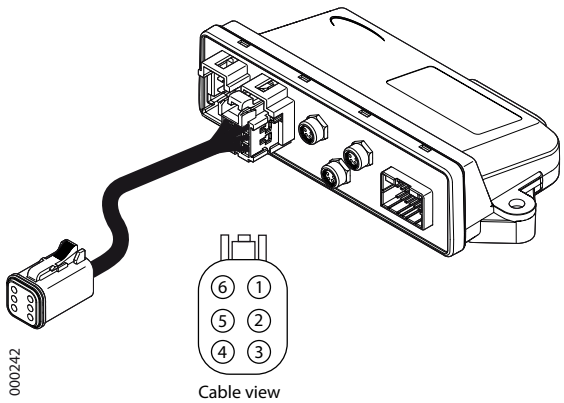
IMPORTANT!
Use existing holes and lead-throughs. New holes can compromise the existing CE marking.

Connect the connector marked Out1A on the spool that affects the flow to the tilt rotator.

Remember to strain relieve the wiring both in the cab and outside!

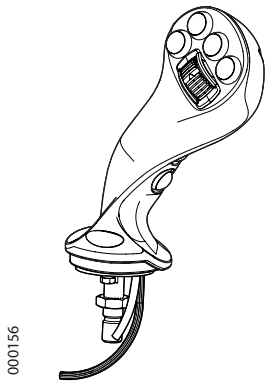
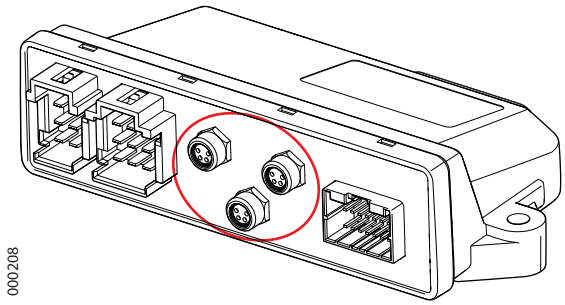
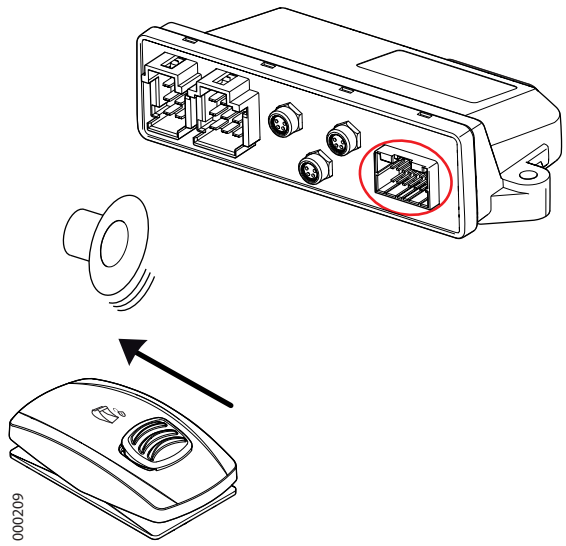
*If a pilot valve is used

04

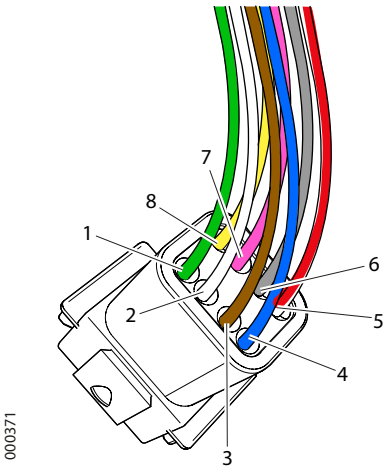


The image shows the positions of the configurable outputs 13 and 14 with associated ground connections.

1. OUT 2
2. OUT 3 (Output 13)
3. OUT 4 (Output 14)
4. GND
5. GND
6. GND

05  	The wiring from the joystick grips is connected to any extension cables. Ensure that any joints end up in the armrest so that they are not exposed to external impact. Route the cables along existing cable ducts and adapt the lengths so that they are sufficient for the seat's different limit positions. Lines that are not connected to the system can be connected to original functions on the machine. What buttons and functions can be connected depends on the version of the joystick grip. Further information about the installation is supplied with the joystick grips.
06  	Connect the system joystick grip and display to the cabin module. The units are connected to the cabin module's marked connectors (see image), so that the right joystick grip is connected to the right connector and the left to the left connector. There may be cable extensions and joints, depending on the size and version of the machine. Also see supplied appendix.
07  	Connect the distribution wiring to the marked connector in the cabin module. Route the wiring through the cab, in a suitable way, to a spare location in the machine control panel. Remove the appropriate cover in the panel and thread the cable and connector up. Install the switch in the connector and then push the switch down into the panel. The switch should be installed as close to the driver's seat as possible, partly for comfortable operation and partly so that the buzzer can be heard when the bucket lock is open. Connect the line marked gate signal to the machine's safety gate so that a plus signal is given when the gate is in the closed position. Connecting the gate signal is not a requirement but a possible safety requirement that can be used for wheel steering. In cases where this is not used, secure the cable concealed under one of the cab's panels.

08

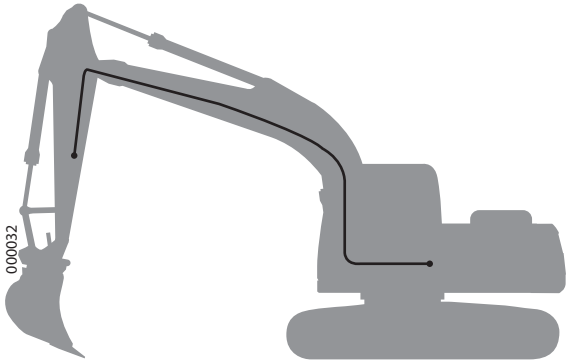


Connect the supplied connectors as illustrated.

1 - Green (CAN High)
2 - White (+)
3 - Brown (GND)
4 - Brown (Loop 1) Bucket lock interlock (Loop 1)
5 - White (Loop 2) Bucket lock interlock (Loop 2)
6 - Grey (+)
7 - Pink (GND)
8 - Yellow (CAN Low)

Connect the machine cable to the Power/CAN cable

09



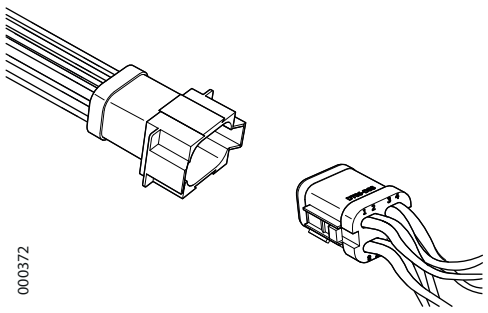
The trunk cable is installed so that it meets the tiltrotator's unit wiring on the stick. Then route into the cab to be connected to the supply cable.

NOTE!
Use existing holes and lead-throughs. New holes can compromise the existing CE marking.

Start by mounting the trunk cable connector on the stick. (One of SVAB's ready to use attachment plates is recommended). Remember that the connector is mounted at a suitable distance from the tiltrotator so that the unit cable reaches the connector, but is not so close to the tool that it risks ending up under water. In this connector there is also a function for interlocking the upper quick coupler lock on the machine when the tool is connected.

The trunk cable is then secured along the machine's stick and boom. Take care to route the cable so that it cannot be trapped/stretched and that the machine has a full range of movement.

10



Insert the cable into the cab via a lead-through and route the cable to the 8-pin connector on the supply cable.

7. INSTALLATION OF ELECTRO- HYDRAULIC QUICK COUPLER

If interlock is used and the machine is equipped with an electro-hydraulic quick coupler, the installation must be carried out so that the quick coupler is interlocked in tiltrotator mode. This is so that the incorrect quick coupler lock cannot be opened by accident.
In that there is no electrical contact with the tiltrotator, that disengaged before the tiltrotator is disconnected, the automatic profile change cannot be used.
See chapter 13.1 to activate the manual profile change.
Profile 5 can then be configured so that the electro-hydraulic quick coupler is allowed to open.

IMPORTANT!
The installer must deliver it with an instruction to the user in how the tiltrotator must be uncoupled, as this is machine specific.

IMPORTANT!
When interlocking the electro-hydraulic quick coupler, no buzzer function or other risk reducing function may be disabled and the interlock must only be installed after the necessary risk evaluation has been carried out and documented.

7.1 Installation cabling

The tiltrotator wiring needs to be adjusted when mounted on a system with electro-hydraulic quick coupler. It needs to be cut since it will be connected in two places, the upper part of the quick coupler and the lower part (tiltrotator part).	
01	Measure from the TR connection point to lower connection point of the quick coupler and from connection point upper part of quick coupler to ILME contactor on the stick. Cut 6-pos DT to suitable length.
02	Connect to optional connectors on upper part of quick coupler and to ILME-contactor on the stick. **Note!** Please see the documentation of the machine supplier for further information.
03	Connect to optional connectors on the lower part of the quick coupler and to the TR-module(GP4). **Note!** Please see the documentation of the machine supplier for further information.

The tiltrotator cable needs to be adjusted when connected to a quick coupler

8. DISPLAY FUNCTIONS

8.1 UNLOCKING SERVICE MENU

01

This is the first page in the Operator's menu.

The settings that can be made in each sub-menu are described in the user manual.

Press the arrow symbol in the lower right corner to browse to the next menu page.

02

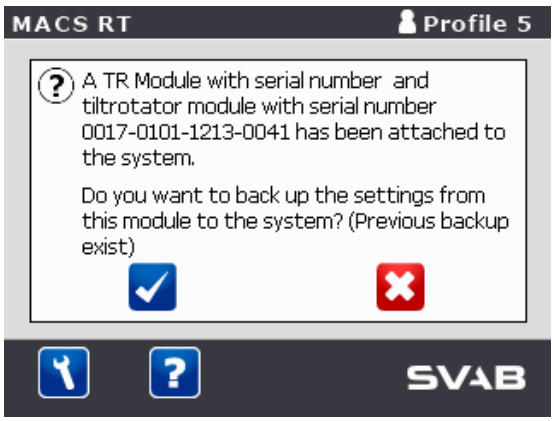
This is the second page in the Operator's menu, from which one goes into the Service menu.

Press between the symbols at the lower edge of the display (see the red marking in the image) and hold down for 3 seconds to enter the Service menu.

IMPORTANT!
In the service mode, settings can be adjusted that can pose a danger to both people and the machine. Settings may only be adjusted by trained service personnel.

8.2 ATTACHING THE TILTROTATOR

01



MACS RT asks the question in the event the operator wants to make a backup of the tiltrotator's settings if:

1. The system is connected to a new unidentified tiltrotator, or
2. if a change is made to another tiltrotator with MACS RT tiltrotator module.

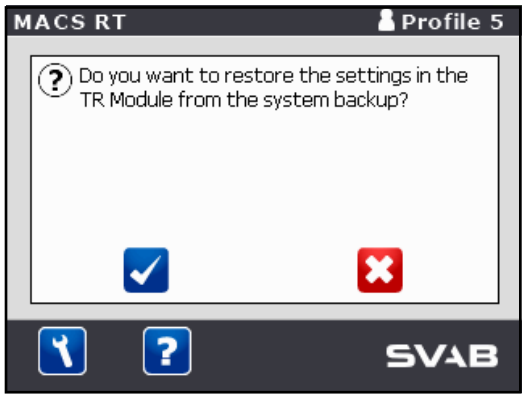
This allows a tiltrotator to be changed without further adjustments being required and the tiltrotator will therefore function exactly as before the replacement.

The system will warn if a previous backup is available from a previously connected tool.

In those cases where the connected tiltrotator is the unit that is usually used with the machine, it is recommended here that one approves the creation of a new back-up with the blue tick. A new box asks the operator for a confirmation that this back-up will be implemented and overwrite the already existing back-up.

After backing-up, the system will confirm that the connection to the tiltrotator is reset and inquire if the operator wishes to change profile.

02

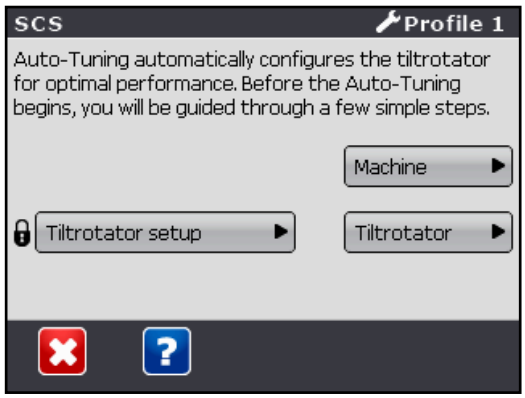


In the event that the tiltrotator module needs to be changed as a replacement part it is recommended that response to the question of backing-up is negative with a red cross.
(A back-up of the replaced module is already in the system).

The system then poses the subsequent question of whether the settings from the backup in the system should be restored to the new tiltrotator module. Confirm the restore by pressing the blue tick.

8.3 AUTO-TUNING

01



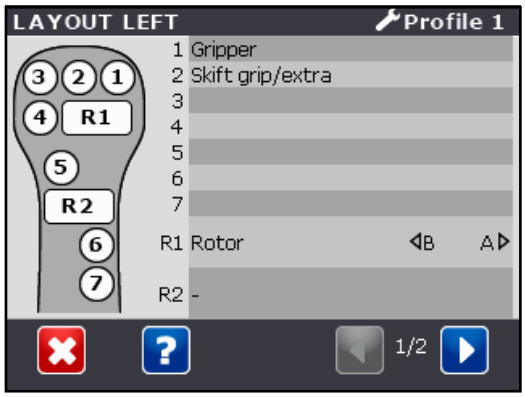
Unlock the service menu according to 9.1

Select SCS
Here you can select "Machine" to set the flow from the machine, or "Tiltrotator" to set what current is required to control the tiltrotator. Follow the instructions on the display.
You can also select "Tiltrotator setting" to set certain tiltrotator specific parameters, which are required for Auto-tuning to work.

The functions that are indicated with a padlock symbol require that the system is unlocked to continue, see chapter 12.1

8.4 SYSTEM CONFIGURATION

01



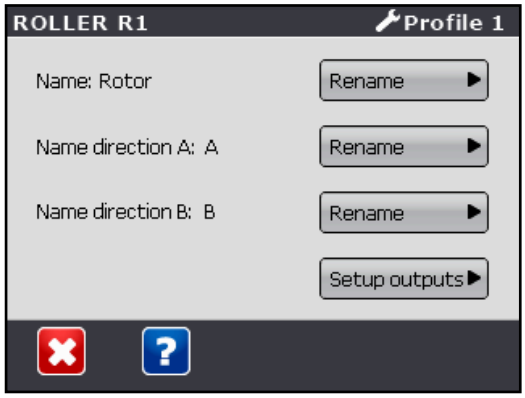
Unlock the service menu according to 9.1

Go back to page 1 using the left arrow and select Layout. Here there is an option to configure rollers and buttons to the desired function.

Select the desired function by pressing on the table line for the relevant button/roller. Depending on whether the button/roller is connected to the system there are several alternatives.

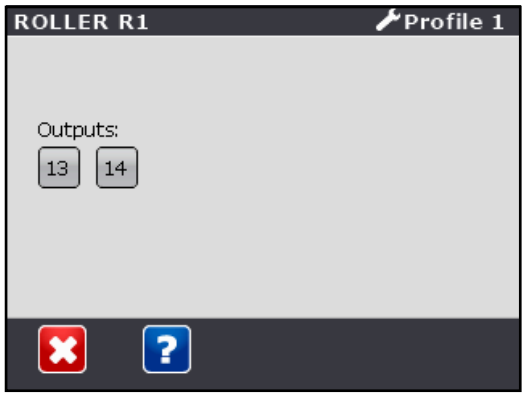
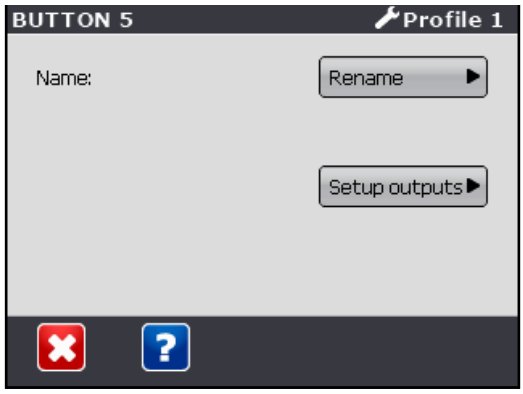
CAN connected buttons/rollers are white in the image and the others are grey. Layout for right joystick grip is on page 2.

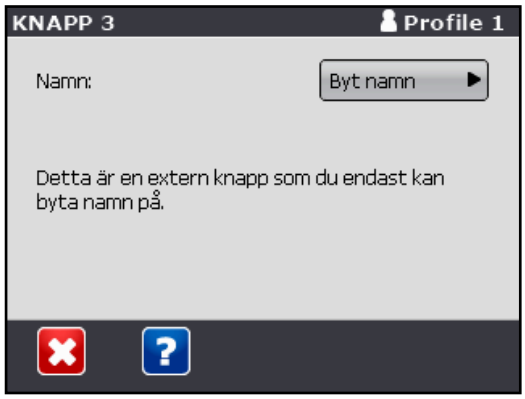
IMPORTANT!
If the joystick grip is configured in an another way than the original, a Layout sheet must always be printed, filled in and placed in the cab!
The sheet is available at svab.se under products\controls\SVAB Grip L8

<table>
<tr>
<td>04</td>
<td> 
</td>
<td>When one pushes a function's wrench button, one comes to a page where one can choose to rename the function and its directions, or continue to a page where one selects which extra outputs will be activated in conjunction with the function being run.

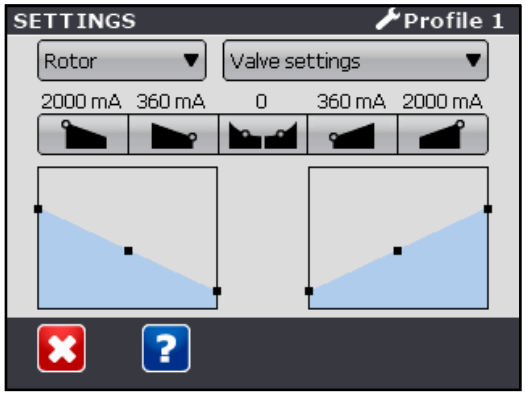
IMPORTANT!
The Joystick layouts describe for the driver which of the joysticks' rollers, buttons and switches control which functions on the tool or machine.

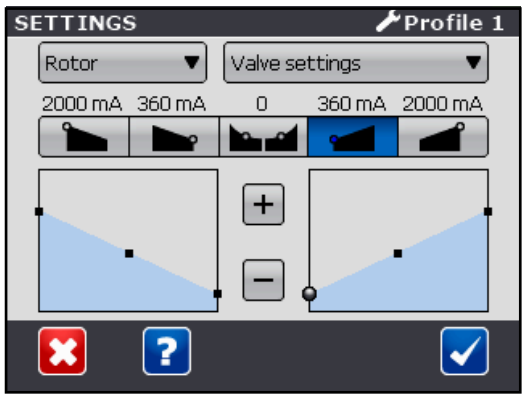
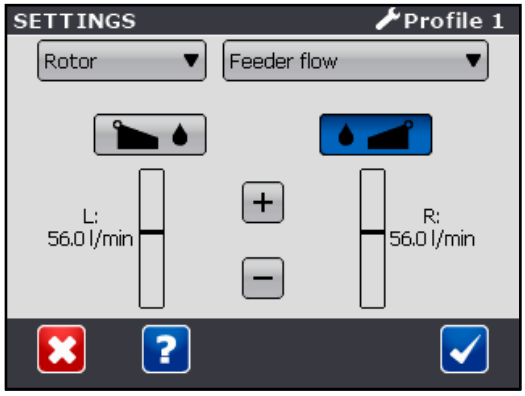
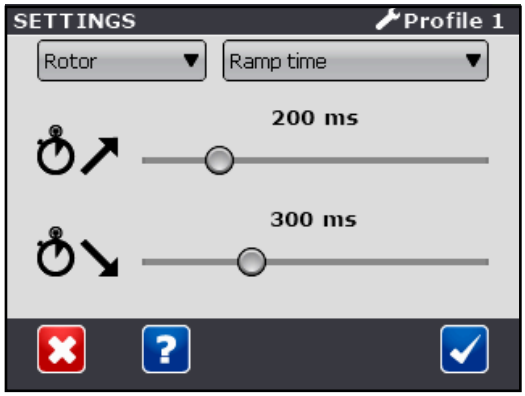
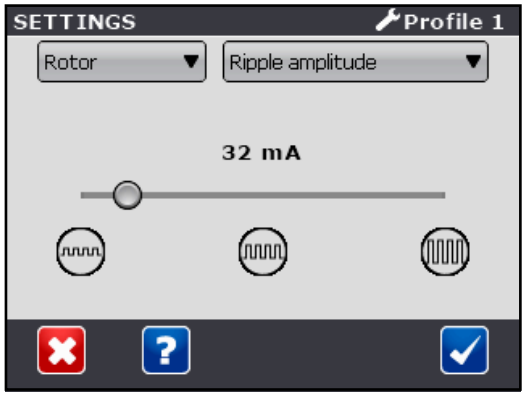
For safety, it is very important to state all functions/ methods of control in the layout!
If the system is set for several profiles, be careful to state the different settings for all profiles in the joystick layout.

NOTE!
Think about the language selection depending on which country the machine will be used in.</td>
</tr>
<tr>
<td>05</td>
<td> 
</td>
<td>Here one selects which outputs must be activated together with the selected main function. ”13” and ”14” each represent an output in the GP1 unit.</td>
</tr>
<tr>
<td>06</td>
<td> 
</td>
<td>By selecting a push button on the table row (image 01) that is connected to the joystick grip electronics (white), one comes to a page like this. Here one can rename the button function or go on to a new page to select which outputs the button must control.</td>
</tr>
</table>

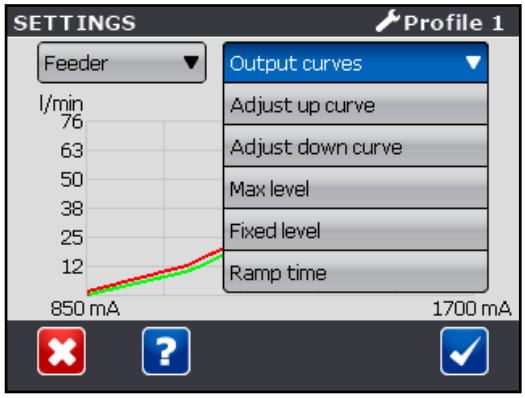
07	 	Here one can select which outputs must be activated together when the button is pressed. For each function in the dropdown menu, one must select whether the button should activate the function's A or B output. Selected functions are marked blue. ”13” and ”14” each represent an output in the GP1 unit. ”Feeder” activates the feeder valve for the set fixed level. This is not normally required if the button is to control a tiltrotator function, when feeding is requested through the tiltrotator function's flow setting. ”Pressurization of tool lock” is used if the push button must be used in the opening sequence together with the tool lock panel switch, usually together with ”Feeder”.
08		By selecting a push button in the table row (image 01) that is externally connected (grey), one can only name the button function.

8.5 VALVE SETTINGS

01		Unlock the service menu according to 9.1 Select ”Settings” In this mode there are two dropdown menus at the top, in the one on the left one selects which function one wants to configure, and in the one on the right one selects which settings one wants to change for the selected function. When a change is made one can test run it immediately, but the changes are not saved until the tick button in the bottom right hand corner is pressed (image 02). If one presses the cross in the bottom left corner one exits the mode. All settings that have not been saved using the tick button will be reset to the previous values.

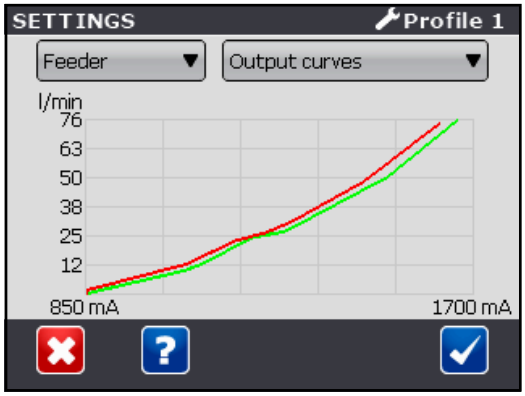
02		On the ”Valve settings” page one can set the starting and final current for the selected function. One can also set progressiveness and thereby affect the curve between start and end levels, so that one has more sensitive control of the function at low speeds. Select which setting you want to make by pressing the corresponding button in the row under the dropdown menus, then change the setting by pressing the buttons for + and -.
03		On the page for ”Feeder flow” one sets how large the oil flow the selected function should request when it is run at full speed. Select which setting you want to adjust by pressing the corresponding button under the dropdown menus, then adjust the value by pressing the buttons for + and -.
04		On the page for ”Ramp time” one sets how fast the function outputs should be permitted to change. One can set different values for up and down ramping.
05		On the page for "Ripple amplitude" one sets how large the superimposed current ripple should be. Too low a set value may mean that the valve has poor responsiveness, while too high a value can lead to vibrations from the machine's hydraulic system.

06



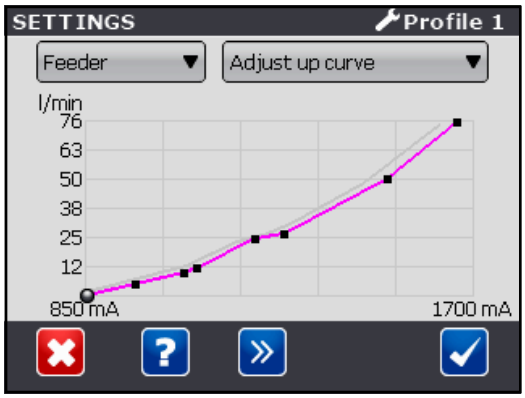
If "Feeder" is selected as function in the left dropdown menu there will be another version of the setting selection in the right dropdown menu.

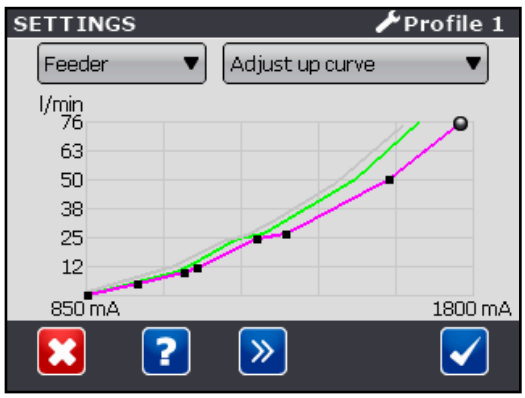
07



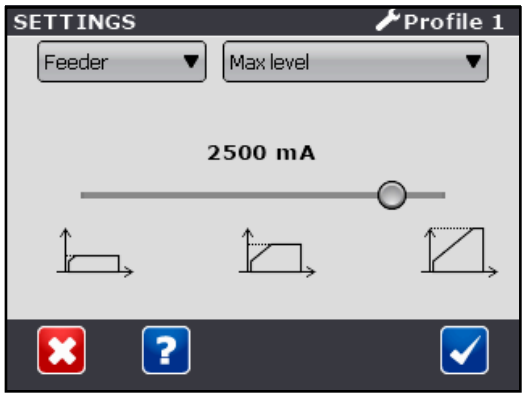
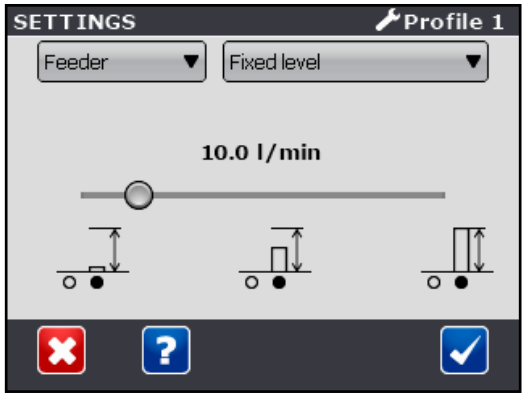
The page for "Output curves" is only an overview page – no settings can be changed here. The curves describe how much current will be ejected dependent on how great a flow is requested.
The green curve displays how the current is managed when one ramps from below and up, and the red curve displays how the current is managed when one ramps from above and down.

08





On the pages "Adjust up curve" and "Adjust down curve" one can edit the relevant curve.
Each curve consists of eight points that can be moved both regarding current and flow.
By pressing the >> button at the bottom in the center, we step between the different points to select which point must be moved. One can then press the graph's left or right section to move the point's current value, or the graph's upper and lower sections to move the point's flow value.
The original curves are displayed in the graph as references.

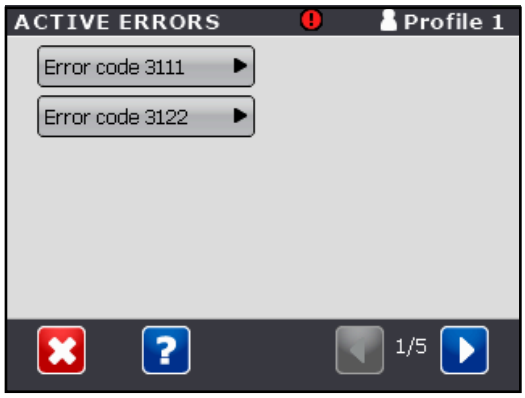
09		On the page for "Max level" one can set a new restriction for maximum output of the feeder.
10		On the page for "Fixed level" one can set how high flow is to be requested when one presses a push button that is configured for direct control of the feeder.

8.6 TROUBLESHOOT

01

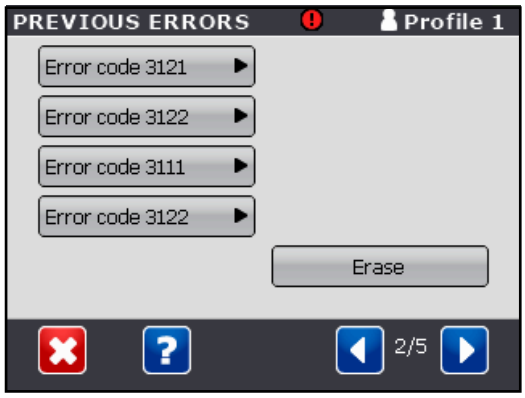
Select "Troubleshoot" on menu page 1.
"Troubleshoot" has several pages, which one can scroll between by pressing the arrows in the bottom right hand corner.

02



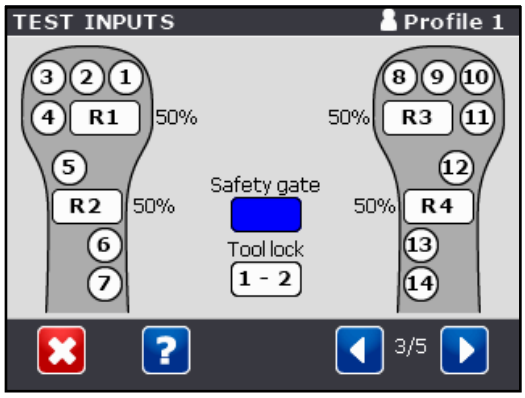
The first page shows which error codes are active at the moment. By pressing an error code button more information about the error is given.

03

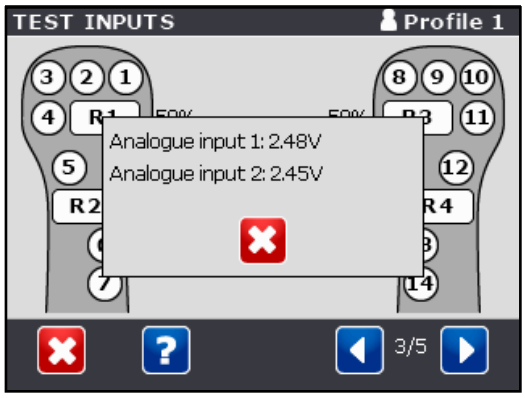
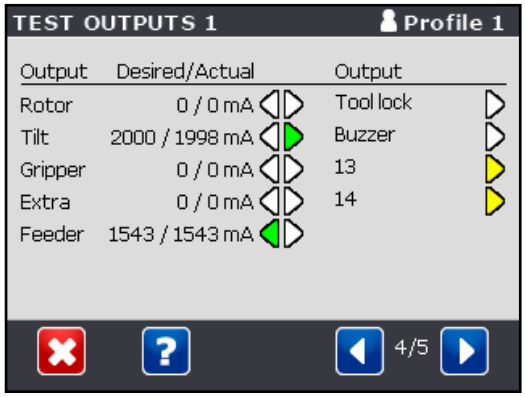


The second page displays which error codes have occurred and been stored since the last erasing. The error codes are displayed in the order that they occurred. More information is given if one clicks on the error code.

04

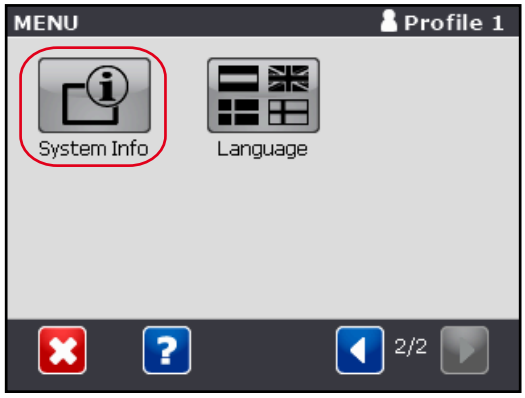


On the third page one can test the system input signals. By pulling on the rollers or pressing the buttons one can see if they are registered correctly by the system. Grey buttons are externally connected and cannot be tested in this mode.
The signal from the machine's safety gate and double pole tool lock switch is also shown in the center.

05		Pressing one of the icons for the rollers brings up a window with detailed information about the analog signals.
06		On the fourth page one can see the status of the outputs. The arrows indicate which of the outputs' A or B outputs is active Green indication is displayed if no faults are detected, yellow is displayed if there is an open circuit in the output, and red is displayed if a short circuit is detected on the output. For the proportional outputs, the amount of requested current is also shown, as well as how much the system is actually using at present. If the system's PWM outputs are used, for example for connection directly to the machine computer, one can see status for these. See chapter 12.6 for configuration of the PWM outputs. When an extra module is connected, a page for the outputs' status appears.

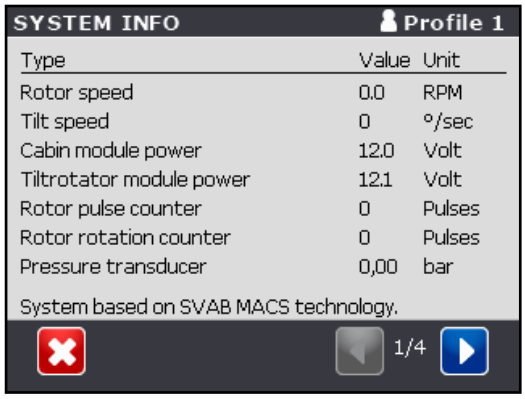
8.7 SYSTEM INFORMATION

01



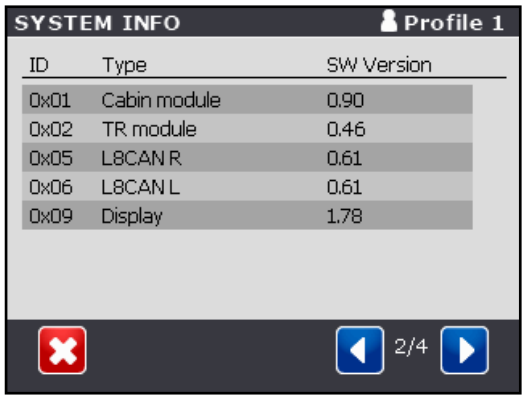
Select "System info" on menu page 2.
System info has several pages, which one can scroll between by pressing the arrows in the bottom right hand corner.

02



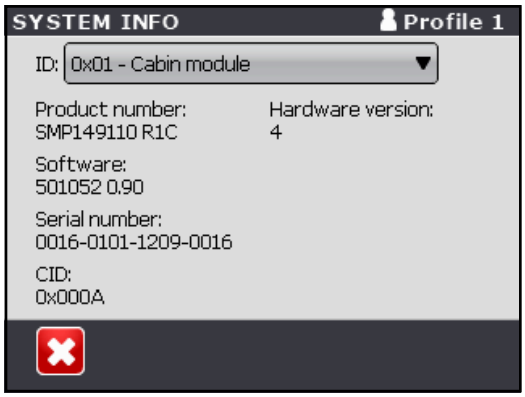
The first page shows various values from the system. What is displayed can vary based on the system's equipment.

03

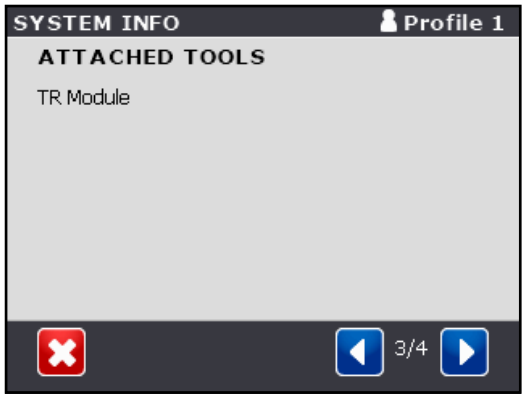
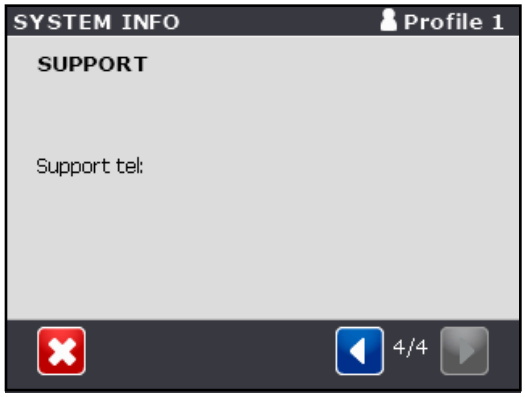
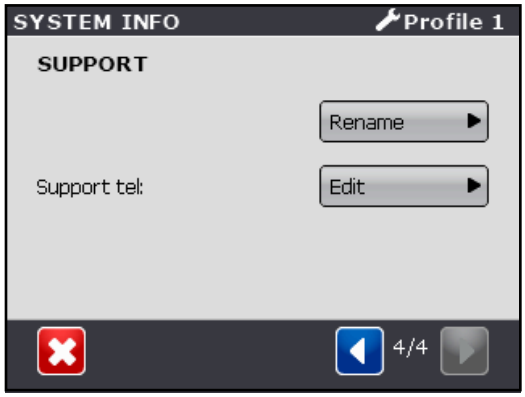


The second page displays a list of which CAN nodes are connected in the system. This displays CAN-ID, node type and software version.

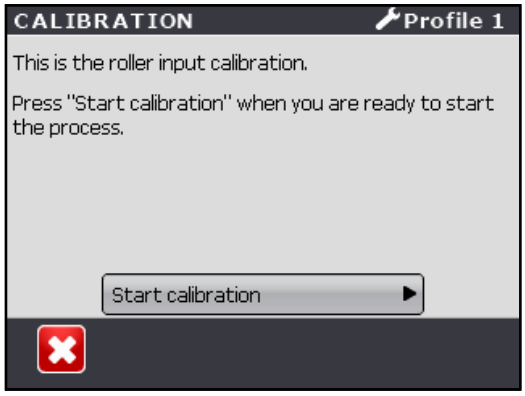
04



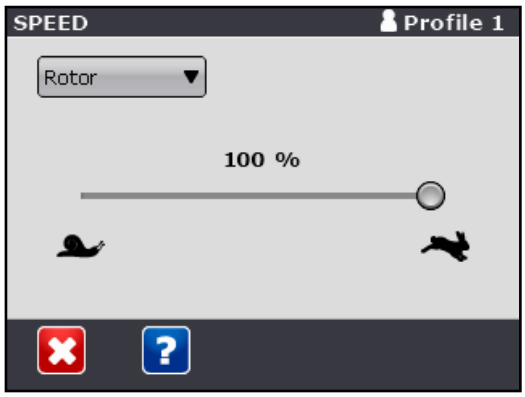
Pressing a row in the table displays detailed information about the selected unit, and one can also select to display detailed information about other units through the dropdown menu.

05		The third page lists the names of the attached tool.
06		The fourth page shows contact information for support issues.
07		When the system is set to service mode (see chap. 9.1), one can also change the contact information. If the support page is customer adapted, there are no buttons to edit and change name, which means that the information cannot be changed.

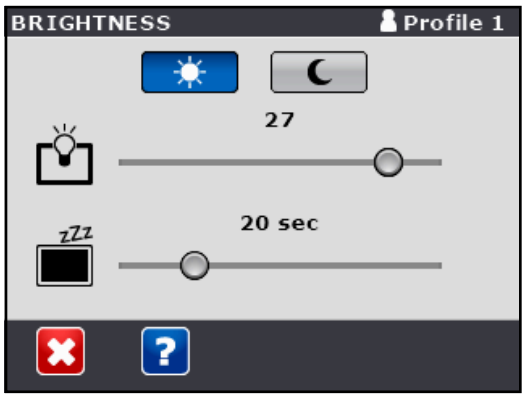
8.8 CALIBRATION

01		The calibration page is used to measure the rollers' analog signals so that the electronics can joystick grip them correctly. Unlock the service menu according to 9.1 Select ”Calibration” Follow the instructions on the screen. Note that one does not need to move all the rollers, just those one wants to recalibrate. Other rollers will retain their settings.

8.9 SPEED

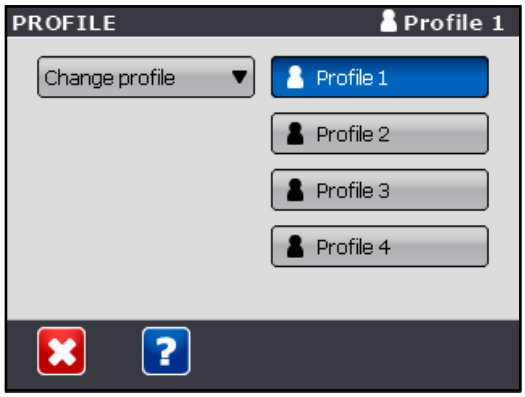
01		Select ”Speed” on menu page 1 (see image in chap.9.1). Here the user can easily set the speed of the tiltrotator functions. The function that must be adjusted is selected in the dropdown menu, and then the speed is set between 0-100% with the control. If you want a particular ratio between the speed of two hydraulic functions, for example between rotor and tilt, this can be set by adjusting individual settings under "Rotor" and "Tilt". For example, you can set "Rotor" to 70% and "Tilt" to 100%. When a change is made one can test run it directly, but the changes are not saved until the tick button in the bottom right hand corner is pressed.

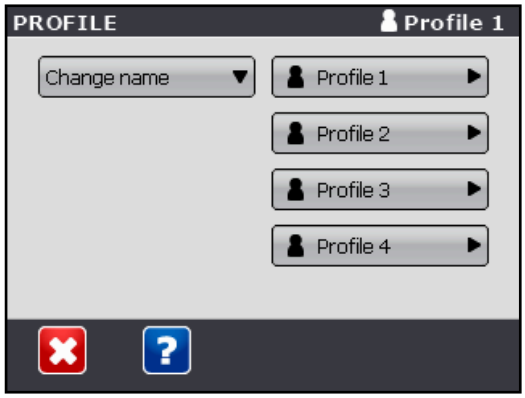
8.10 BRIGHTNESS

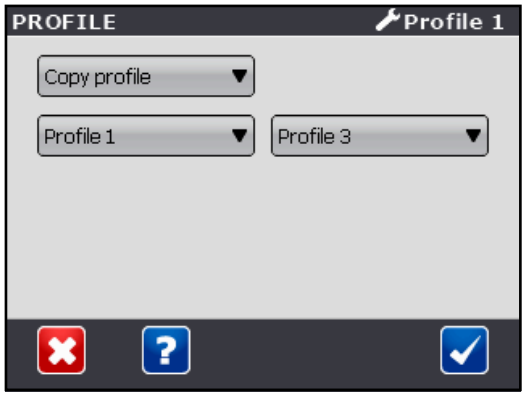
01		Select "Brightness" on menu page 1 (see image in chap.9.1). Here the user can set the strength of the display's background lighting, and how long time should pass before the system's screen saver function is activated. There are quick choice settings for different brightness levels between day and night mode.

8.11 PROFILE

01







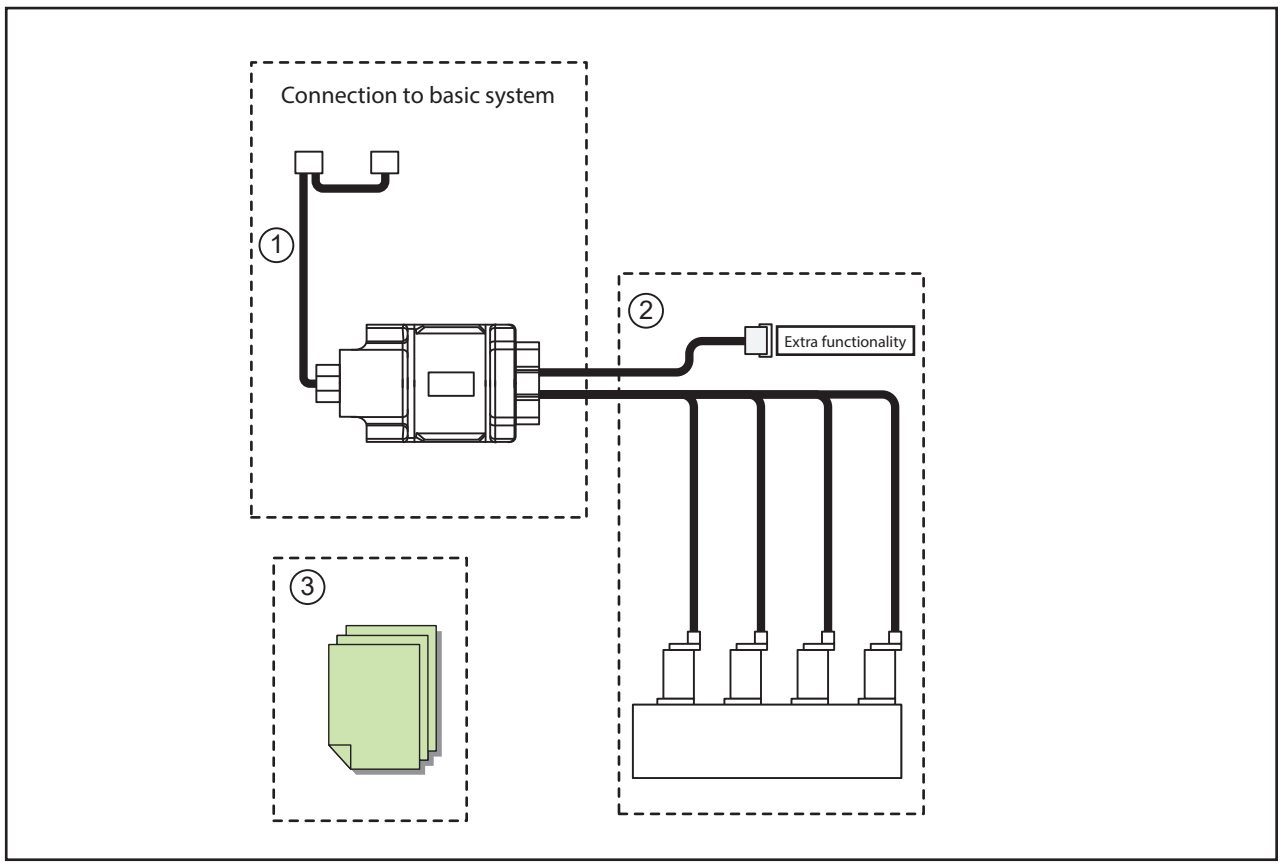
Select "Profile" on menu page 1 (see image in chap.9.1). In the dropdown menu, one can choose between three different actions (the last only accessible in service mode):

- Change profile - here the user can easily change between different settings by selecting one of the profiles to the right.
- Change name - give user specific names to the different profiles.
- Copy profile - copy all settings from one profile to another (only available in service mode).

9. OPTIONAL TRACK STEERING

For tracked excavators, the system can be expanded with a function for controlling the machine's tracks from the joysticks. The track steering function means that driving is steered, that is run both the tracks at the same time in the same direction with one roller and turn with the other.
The function can be distributed on rollers that are logical for this function, such as vertical rollers for driving and horizontal for turning, placed on different joystick grips. The function for track steering can be shifted so that these rollers can be used for other functions during excavation.
The function can be temporarily set in position for steering left and right track individually. See chapter 10.4

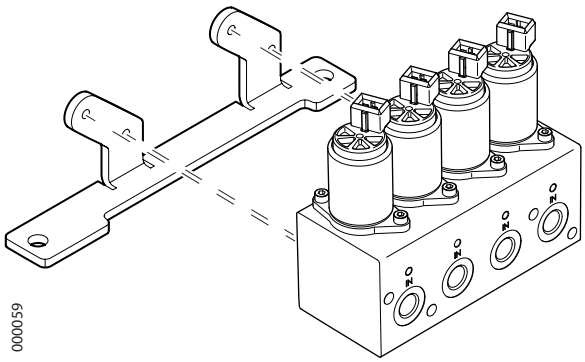
9.1 SYSTEM OVERVIEW TRACK STEERING



COMPONENT PARTS MACS RT TRACK STEERING		
Pos. no.	Description	Quantity
1	Track steering module kit MACS RT	1
2	Track steering valve kit MACS RT	1
3	Overview MACS RT Track steering	1

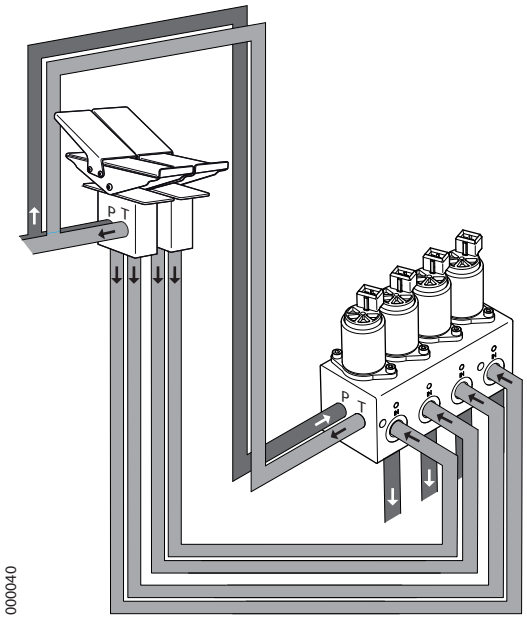
9.2 INSTALLATION WITH 4-VALVE PILOT

01



Use attachment plate with part no. 200409 to mount the pilot valve in a suitable location under the floor, close to the flow pedals. Here it is possible to use two attachment plates with part no. 200321 which is used for pilot valve and double pilot valve.

02



The pilot valve in this application is connected parallel with the machine's two operating pedals.

1) Connect the pilot valve's P and T connections to the Pedals' P and T supply.
This is done most easily via a T connection directly on the pedal's input connections.

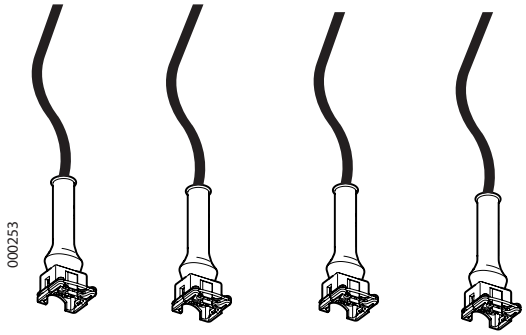
2) Connect the pedals' outputs in pairs on the pilot valve's input connections marked IN.
This is done to retain the original function in the operating pedals. For example, valves 1 and 2 are connected to the right track and valves 3 and 4 are connected to the left.

IMPORTANT!
Carefully check that the hoses from the pedal are connected to "IN" on the valve! Incorrect connection can damage the valve and cause uncontrolled movements of the tracks!

(In those cases where the machine's operating pedals are not used/absent: Take care to unscrew the shuttles that are mounted in the bottom on the pilot valve's IN ports before these are sealed with a plug.)

3) Finally connect the hoses that were previously mounted on the operating pedals' outputs to the pilot valve's outputs marked Out.

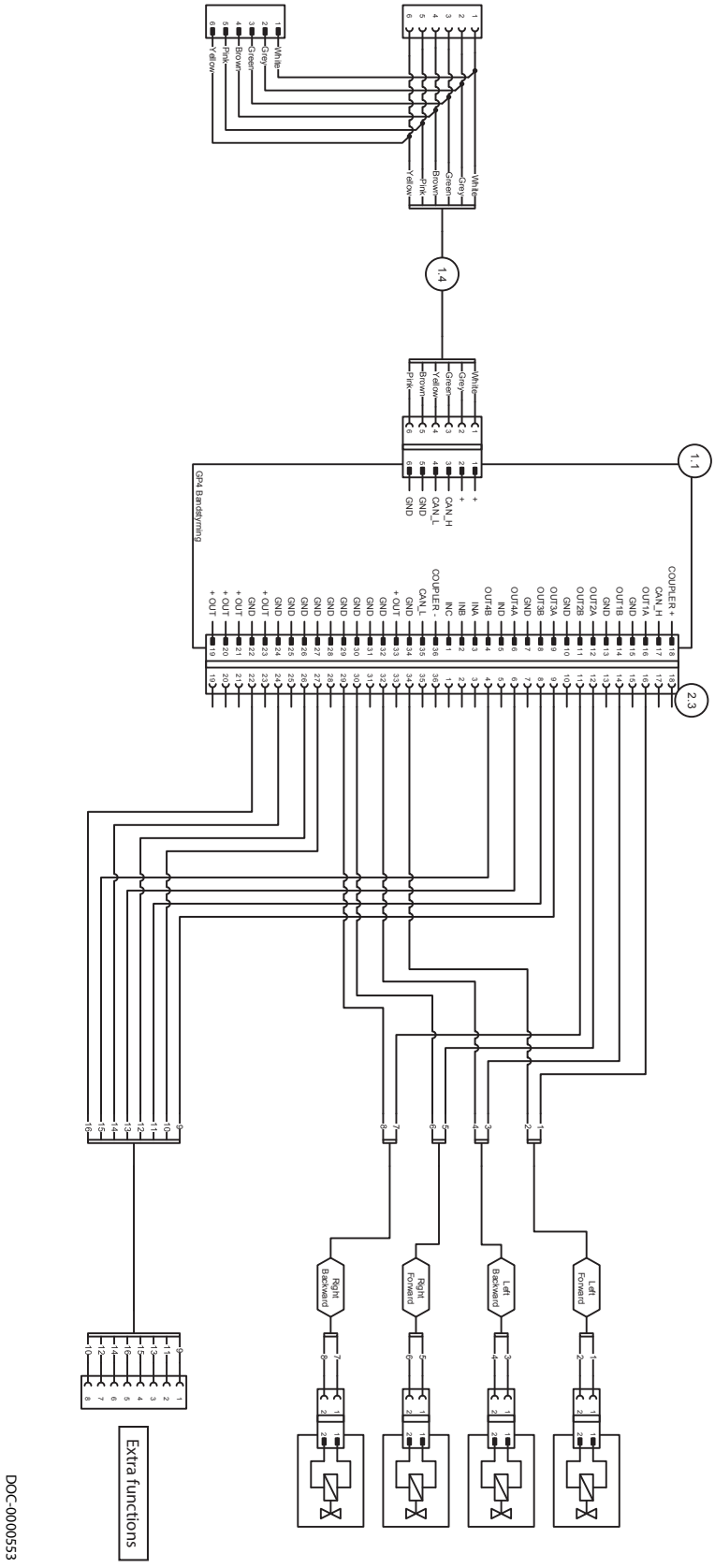
03



Finally, connect the distribution wiring that is marked with outputs and directions to the relevant solenoid coil on the pilot valve.

IMPORTANT!
When the hydraulic installation is complete, the machine's existing hydraulic diagram must be updated/ supplemented!

9.3 WIRING DIAGRAM TRACK STEERING



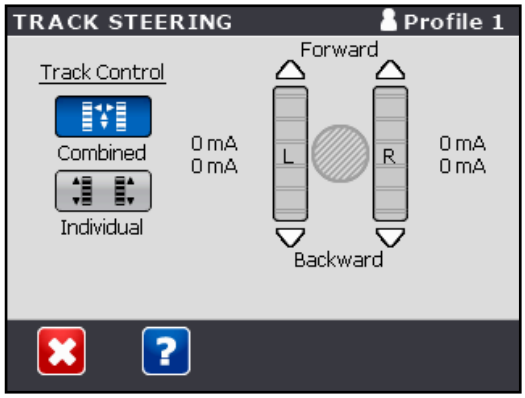
DOC-0000553

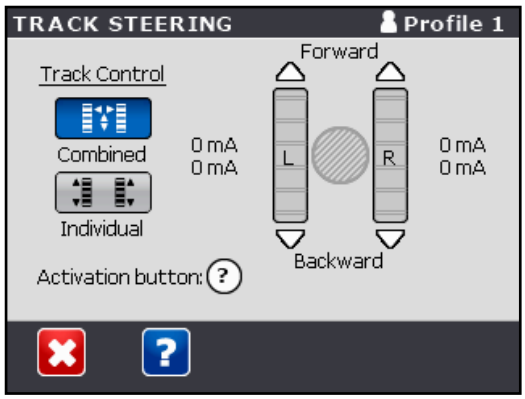
9.4 CONFIGURATION OF TRACK STEERING

01

If the system is equipped with a track steering module, an icon for settings for this will be displayed under the main menu.

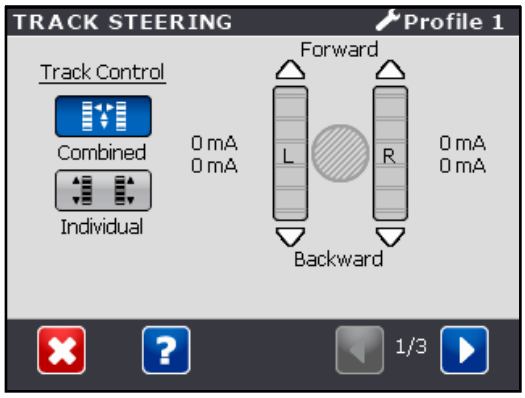
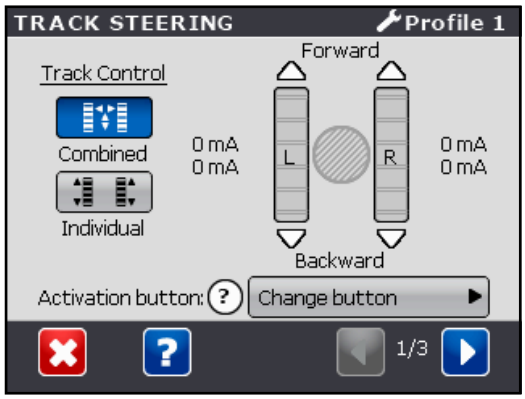
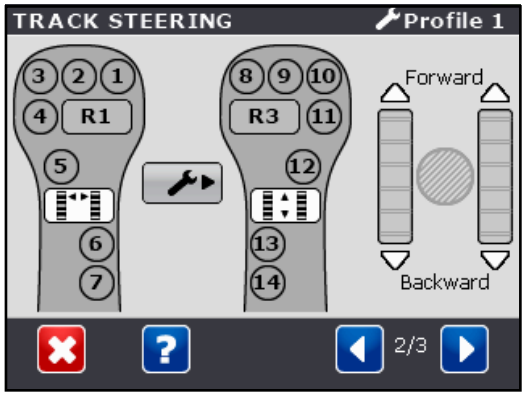
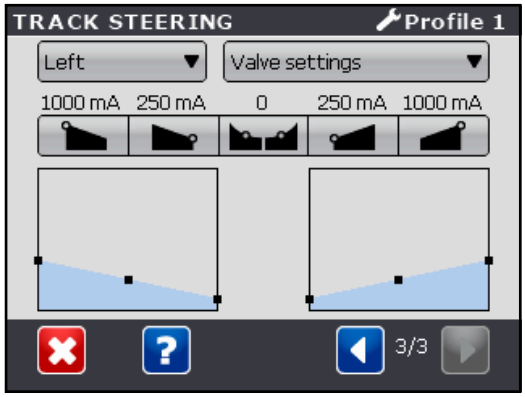
02





In the user mode, information is displayed about the present output status and the user is also given the option to temporarily change control of the track to individual steering.

If the system is configured with requirement for separate track steering activation, which pushbutton is selected for this is visible here.

03	 	In service mode, it is possible to scroll on to the configuration pages using the arrows in the bottom right corner.
04		Page two shows which rollers are configured for track steering. The button between the joystick grips takes the user to the Layout page, where the track steering rollers can be configured in the same way as the tiltrotator functions.
05		The valve settings for the outputs that control the right and left track are on page three. See chapter 9.5 for more information about these settings.

10. OPTIONAL WHEEL STEERING

NOTE!
Wheel steering is a safety function.
The installation must fulfill the requirements of ISO 5010. It is the responsibility of the installer to ensure that the requirements are fulfilled.

For wheeled excavators and backhoes, the system can be enhanced with a function for controlling the machine's wheel angle from the joystick. Wheel steering (alternative steering) is an important safety function on the machine and modifying the machine's original system can negatively affect the machine's steering properties in critical situations. It is important that this system is connected to the original system with as minor changes as possible. Install the control valve with hoses, couplings and connectors that do not affect the flow in the original circuit. Always use hydraulic couplings and hydraulic hoses that are properly dimensioned per branch standards.

For steering the wheels, a horizontal roller must always be used in the left grip.
This roller may not be shifted or used for other functions.
This function is approved for speeds up to 20 km/h and may not be used at higher speeds.
To help the operator from exceeding the permitted speed, it is recommended that gears that permit higher speeds be interlocked with the integrated interlocking function. A warning sticker however, shall be clearly visible in the cab to inform of this restriction.

There shall be a panel switch for deactivating the function when driving on public roads if so required. The panel switch for activation and deactivation of the wheel steering function must be of the spring-back type and be equipped with clear indication (lamp). Alternatively, a button with an integrated LED mounted in a grip can be used to deactivate and activate the function.

The control valve block for wheel steering must be equipped with a priority function so that the steering wheel always has full priority.
The wheel steering function shall also be controlled with two independent electrically controlled valves. A pressure switch for indication of prioritized steering wheel function must also be included in the system. This signal then interrupts the output to the valve when the steering wheel is used and deactivates the wheel steering function entirely if the steering wheel is still in use after 5 seconds
The hydraulic valves that are used for wheel steering must be designed based on well-proven principles and/or be assessed as well-proven components per ISO 13849-2 or an alternative method.

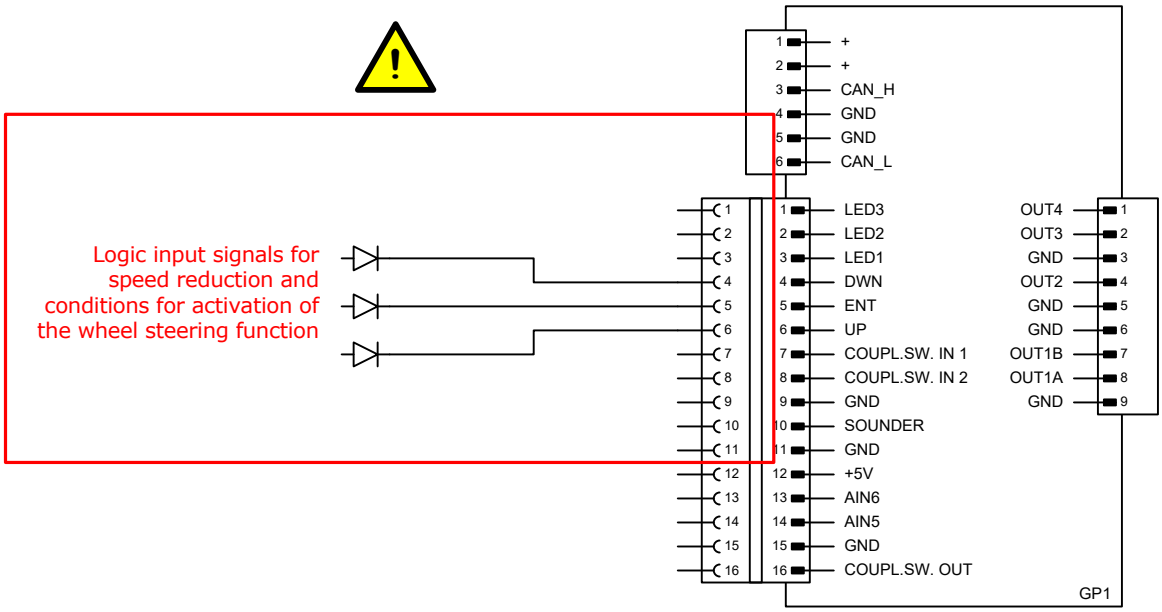
Evasive action testing per 10.4 in ISO5010:2007 shall be conducted with the wheel steering function on the machine type the system is planned to be used on, as well as the valve type or types that shall be able to be used.
This test determines the maximum permitted speed with activated wheel steering function. If this speed is below the machine's design speed, the speed must be limited using the interlocking function or in another way when the function is active.

The machine's gate, if any, must always interrupt the alternative steering. The gate signal can be connected and used by the interlocking function. If a rotational and/or tilting unit system with gate interlocking is equipped with this type of wheel steering function, the gate will by default, interlock wheel steering activation and interrupt the output to the wheel steering valve if it is opened. If it is not closed within 5 seconds, the wheel steering function will be fully deactivated.

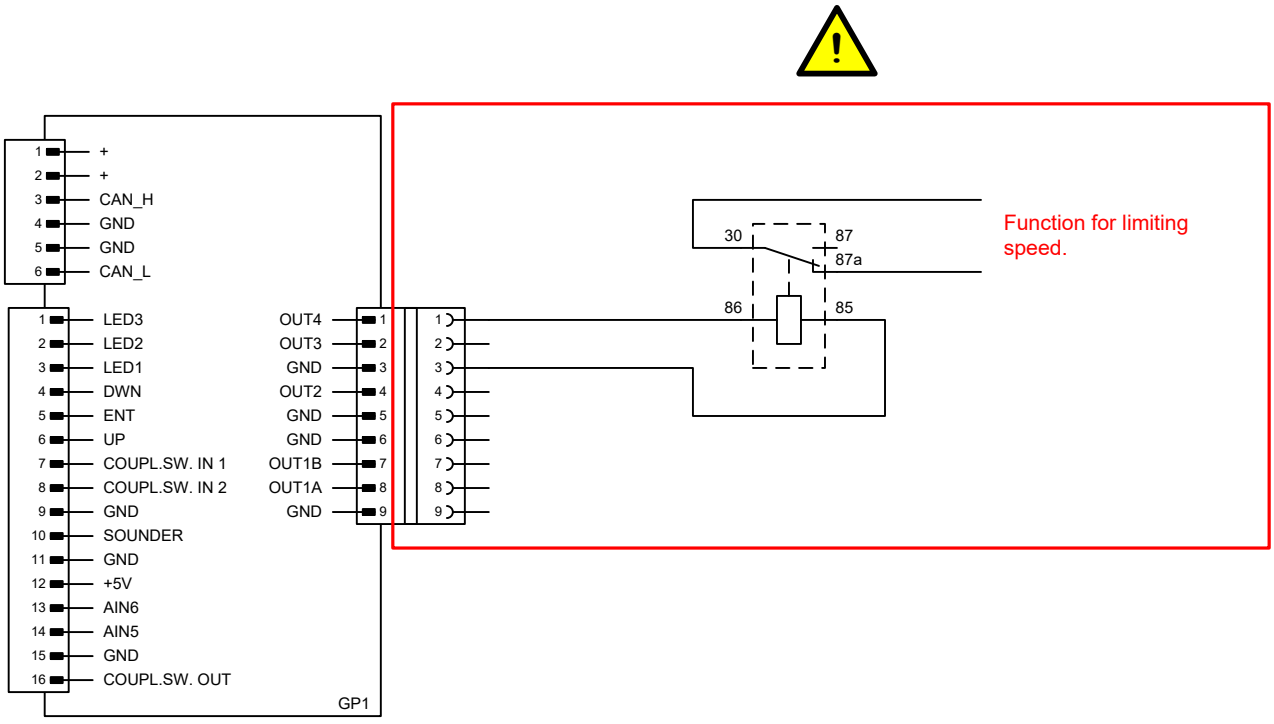
The interlocking function can be configured to joystick grip up to three logic signals so as to be able to limit the speed as close to the maximum permitted speed as possible and block activation of wheel steering when the speed is too high.
It can also be used to change the direction of the wheel steering function when one turns the seat to the back on for example, a backhoe or excavator loader. It is then important that all states that may not occur are configured to deactivate the wheel steering function and not permit activation of the same.
These signals are connected to the unit for wheel steering with diodes in series to protect against improper reverse voltages. These diodes must not be removed or connected in a way other than per the following description.

To inform the operator of which interlocks affect activation and deactivation of the alternative steering, a user instruction must be prepared as a complement to the ordinary manual.
This shall describe all of the interlocks that are specific for the machine time, such as how the speed interlock works and how it affects activation of the alternative steering function.

IMPORTANT!
Certain conditions may need to be satisfied in order to activate wheel steering. The conditions can vary between different machines and installations, and this must therefore be documented in the intended position in the driver's manual.
It is the responsibility of the system installer to fill these in before the machine is first used.



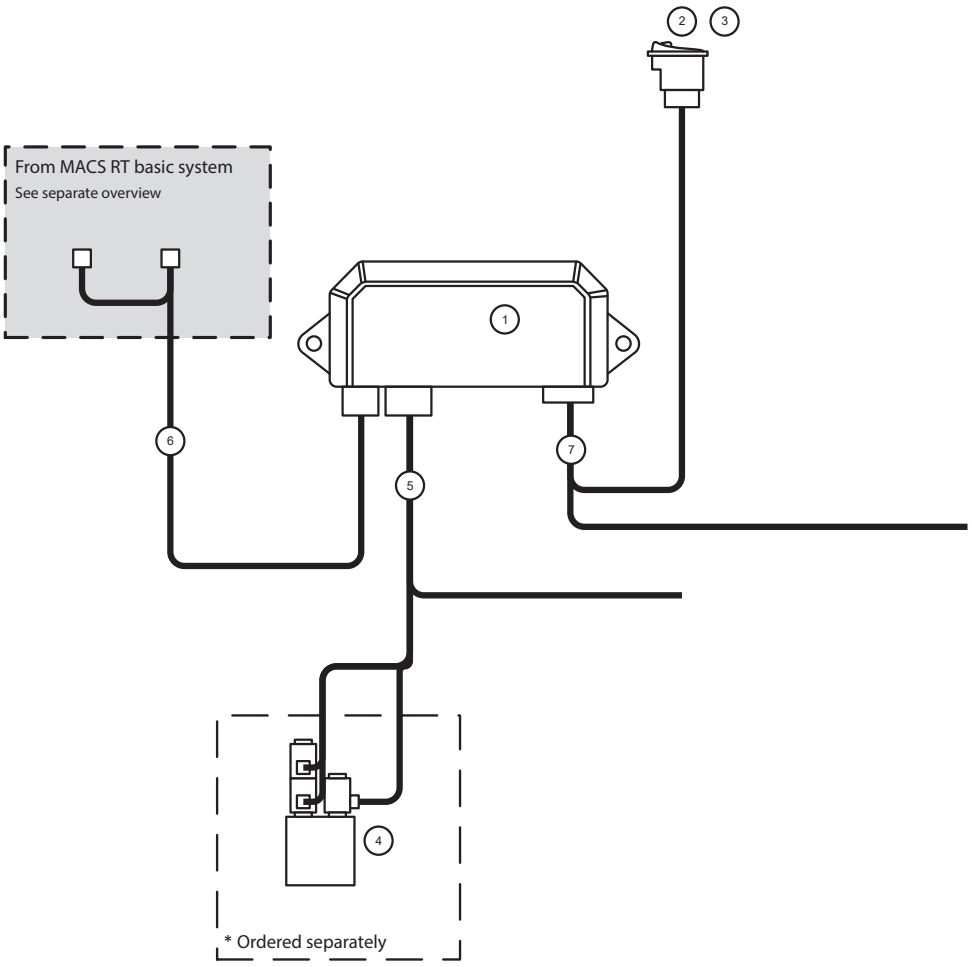
The interlock system consists of an output that shall be used to limit the speed to the maximum permitted speed when the wheel steering function is active. Use relays to isolate the signals as follows.



When a reference machine is equipped with this system and adjusted so that the steering function performs optimally and evasive action testing conducted, the adjusted values shall be saved. It shall be clearly stated in the installation instruction that these saved values are to be used as basic values for adjustment of this machine type.

For the alternative steering function, a GP1 (cab module) is used with special software. See chapter 16 TECHNICAL DATA for more information about this unit. Note that a unit intended for wheel steering may not be used for any other function.

10.1 SYSTEM OVERVIEW WHEEL STEERING

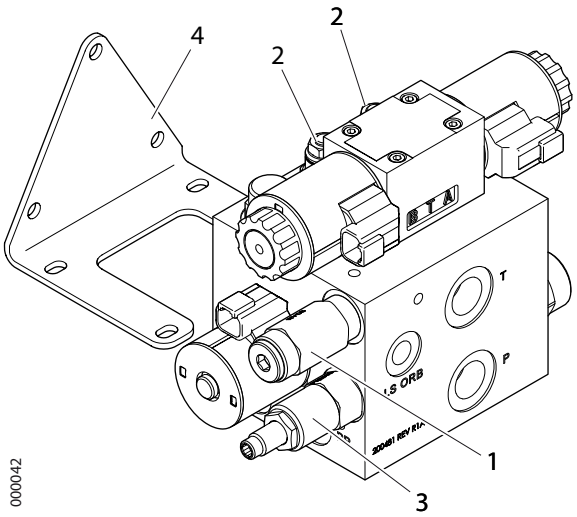


COMPONENT PARTS MACS RT WHEEL STEERING		
Pos. no.	Description	Quantity
1	GP1 MACS Exp. Wheelseer	1
2	Switch 2 position 1-(1) Contura V	1
3	Frame for Carling switch, SWF511	1
4*	Steering valve OC shut off 12/12 (CF)	1
4*	Steering valve OC shut off 12/24 (CF)	1
4*	Steering valve LS with shut off 12/12	1
4*	Steering valve LS with shut off 12/24	1
4*	Steering valve OC with shut off 12/12	1
4*	Steering valve OC with shut off 12/24	1
5	Valve wiring GP1 Wheel steering	1
6	Power/CAN cable GP1	1
7	Distribution wiring GP1 Wheel st. Deut	1

10.2 INSTALLATION WHEEL STEERING

10.2.1 LS CONTROLLED VALVE

01

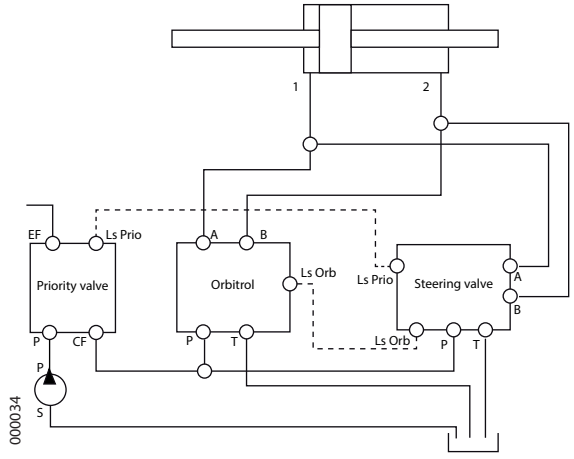


Install the valve as illustrated in the diagram below. Ideally, on mounting (4) 200539. After mounting the pressure limiter (1), load holding valves (2) and pressure reducer (3) are adjusted if necessary.

1. Pressure limiter - adjusts outgoing pressure from the valve outputs. This is done by removing the cover (a small amount of oil can run out) and screwing in the adjustment screw. Screw in the screw to increase the pressure.
2. Load holding valves – adjusted if there is noise caused by oscillations through the valve.
3. Pressure reducer - adjusts the pressure that is required to activate the integrated safety function (Shut off). Screw in the adjustment screw so that the safety function disengages when the steering wheel is operated.

NOTE!
If the solenoid coil comes loose it must not be retightened with a torque greater than max 4.1Nm

02



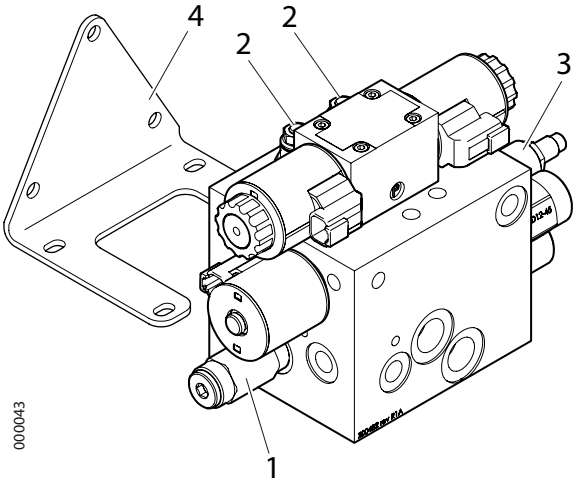
LS controlled valve

Connect the valve in parallel with the orbitrol. Connect the LS pressure between the orbitrol and priority valve in series through the steering valve, via marked ports.

Both outputs of the valve are connected in parallel to the original connections.

10.2.2 OC CONTROLLED VALVE

01

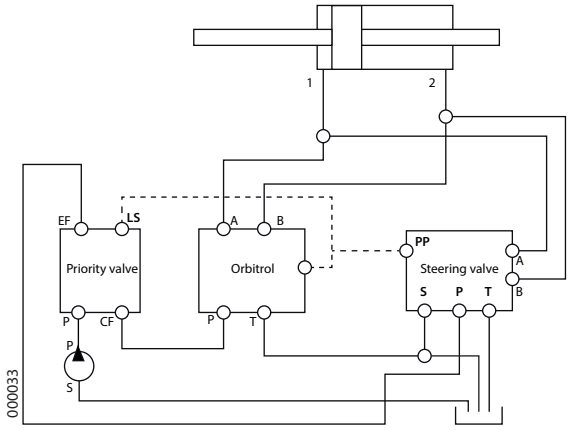


Install the valve as illustrated in the diagram below. Ideally, on mounting (4) 200539. After mounting, the pressure limiter (1), load holding valves (2) and pressure reducer (3) are adjusted if necessary.

1. Pressure limiter - adjusts outgoing pressure from the valve outputs. This is done by removing the cover and screwing in the adjustment screw inside. (A little oil may run out). Screw in the screw to increase the pressure.
2. Load holding valves – adjusted if there is noise caused by oscillations through the valve.
3. Pressure reducer - adjusts the pressure that is required to activate the integrated safety function (Shut off). Screw in the adjustment screw so that the safety function works when the steering wheel is operated.

NOTE!
If the solenoid coil comes loose it must not be retightened with a torque greater than max 4.1Nm

02

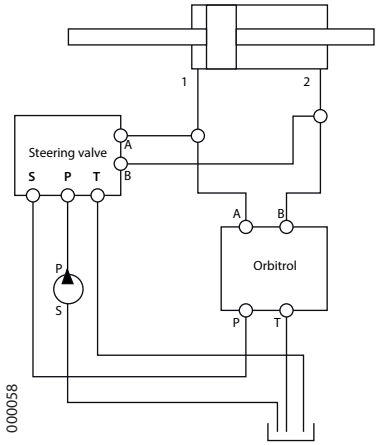


Open center steering valve (135004-XXXX)

Connect the valve in series between the priority valve residual flow (EF) and the orbitrol tank return (T). Use the LS signal between the orbitrol and the priority valve and connect it to the steering valve's pp-port to hydraulically shut off the steering valve when the steering wheel is used.
The valve's LS ports must be plugged.

Both outputs of the valve are connected in parallel to the original connections.

03

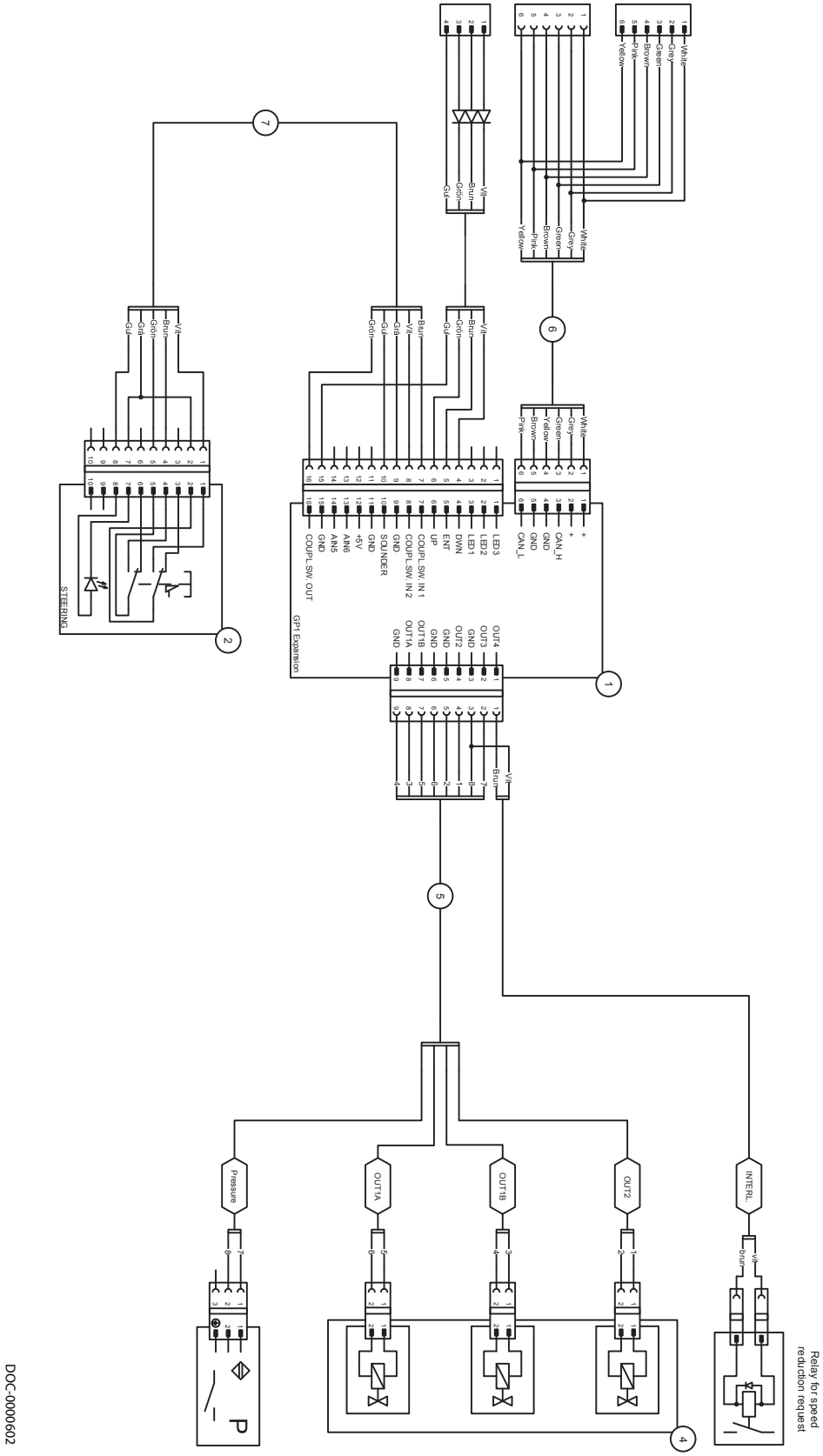


OC control valve and pump with fixed displacement

Connect the valve in series between the pump's and the orbitrol's pressure connection (P).
The integrated hydraulic shut off monitors the pressure that builds up on the secondary side of the steering valve (S).

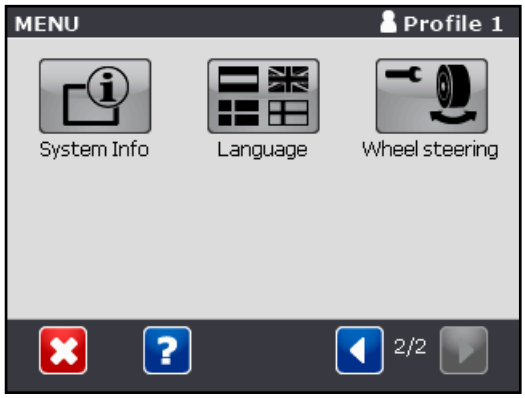
The valve's PP and LS connection must be plugged

10.3 WIRING DIAGRAM WHEEL STEERING



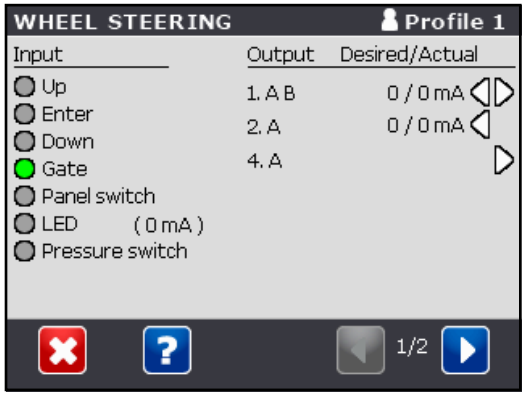
10.4 CONFIGURATION OF WHEEL STEERING

01



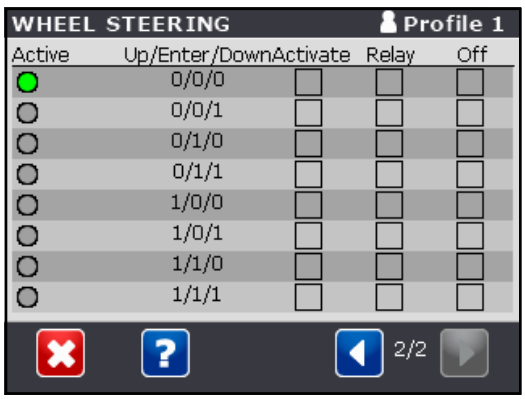
If the system is equipped with a wheel steering module an icon for settings for this will be displayed under the main menu.

02



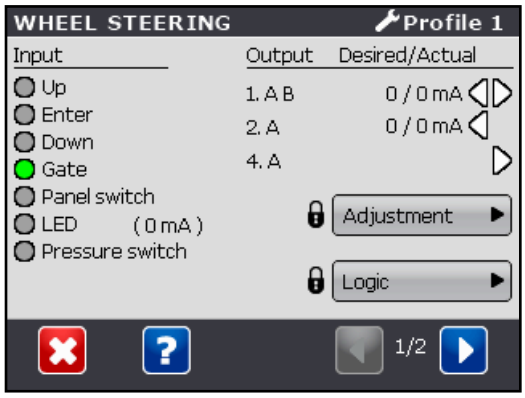
The first page in the user mode displays information about the present input and output status. The column for inputs can vary, depending on what type of activation the system is configured for.

03



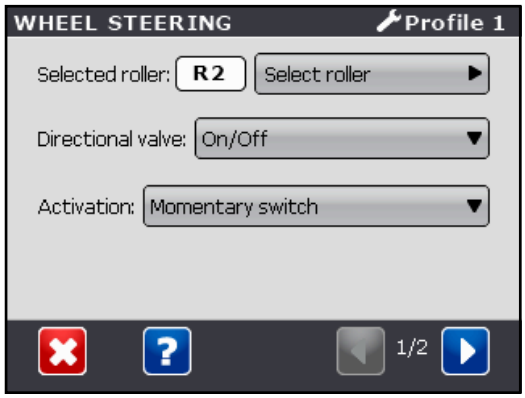
The first page in the user mode displays how the system is configured, regarding the three configurable input signals. Each row corresponds to a possible combination of the three input signals, and to the extreme left, what combination is active at present is displayed.
The check boxes display for each combination if it should be permitted to activate wheel steering, if the relay must be activated when the wheel steering is active, and if the wheel steering function must be deactivated when the input signals are in this position.

04



In service mode it is possible to advance from the first page to "Adjustment" or "Logic".
To access both these functions the system must be unlocked, see chapter 9.1.

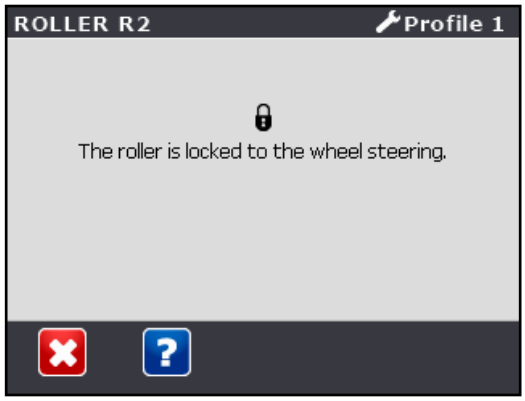
05



Under the logic settings, one can select which roller will control the wheel steering.

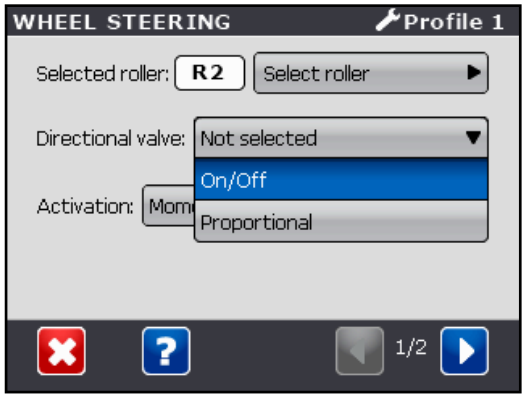
By pressing the "Select roller" tab, one progresses to the Layout page. There, one can configure which roller should be used for the wheel steering, in a similar way to other functions. (See chap. 9.4.)

06



Note that the wheel steering function can only be configured when one has reached the Layout page via the wheel steering page. If one goes to the Layout page directly from the main menu, the roller that is selected to control the wheel steering will not be configurable.

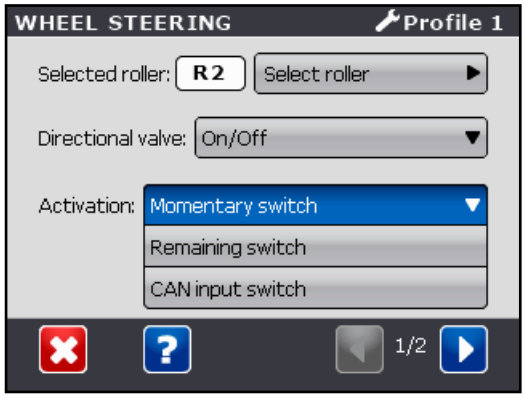
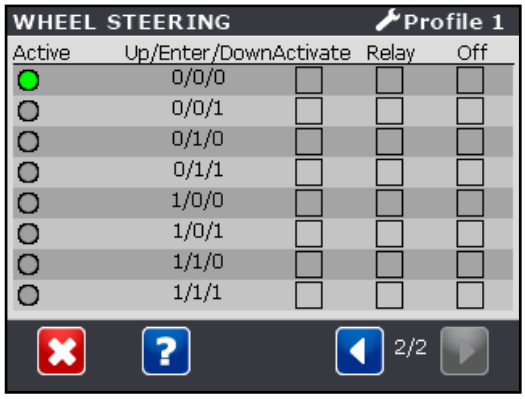
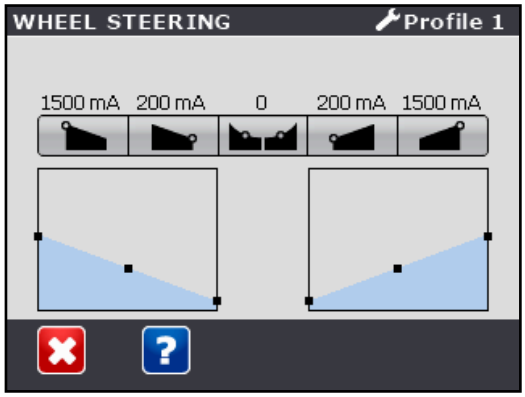
07



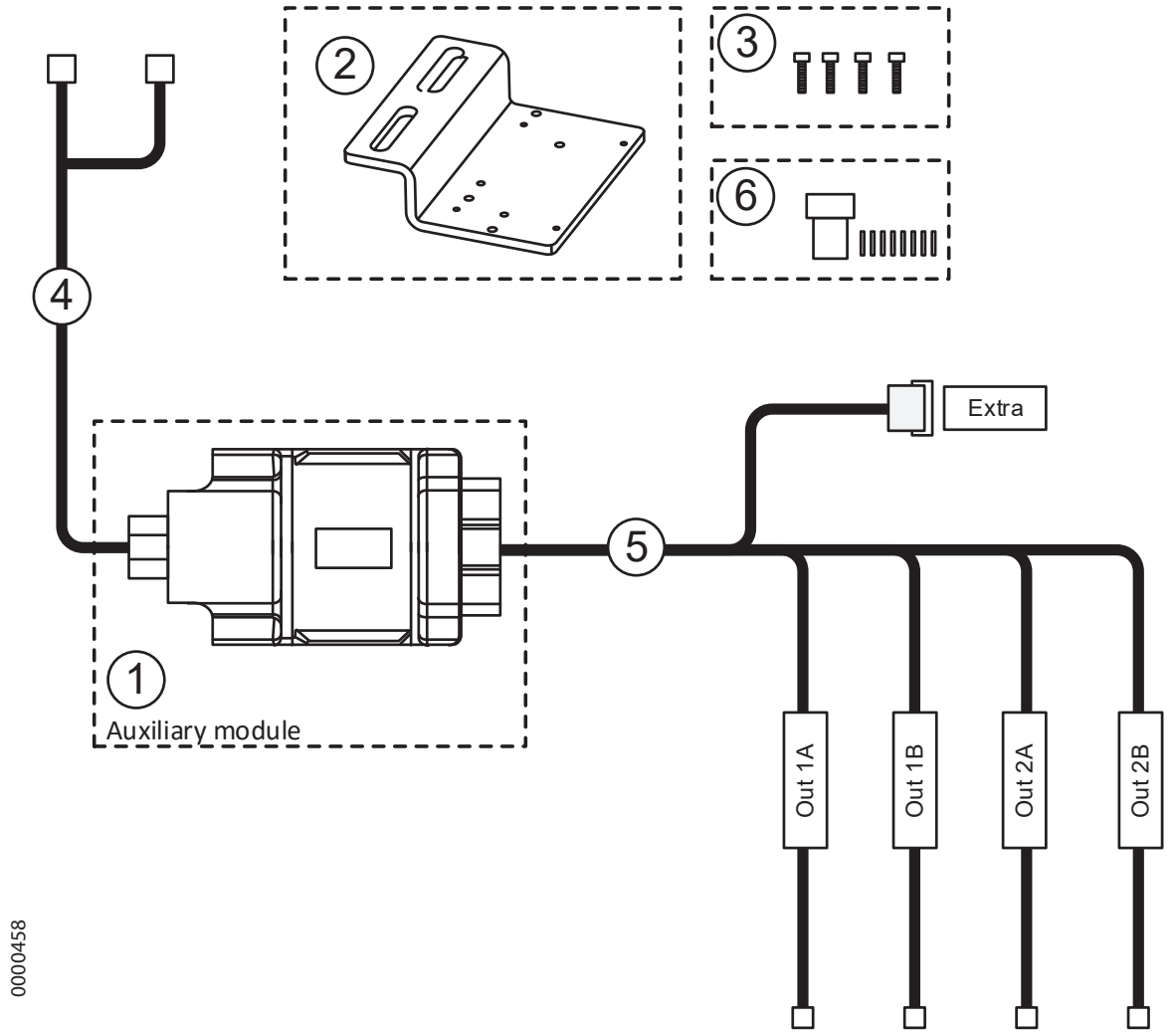
The system can be configured to use one of two different basic types of hydraulic valves, which is set by stating what type of valve controls the wheels' steering direction:

• **On/Off**
The speed of the wheel steering is controlled by a single action valve, and the steering direction is controlled by a double action on/off valve.

• **Proportional**
The speed and direction of the wheel steering is controlled by a double action proportional valve, combined with an on/off valve for safety.

08		The system can be configured for different types of input signals for wheel steering activation: • **Momentary switch** Must be selected if a return sprung panel switch with light indication is installed. • **Remaining switch** Must be selected if a remaining panel switch with light indication is installed. • **CAN input switch** Must be selected if a button with light indication in a CAN connected joystick grip is used. One must then make a choice of which joystick grip button applies.
09		On the second page of the logic configuration there is the same view as in the user mode second page, see image 03 in this chapter, but here one can make changes in the settings by clicking the relevant check box.
10		When one enters ”Adjustment” there is the option to adjust the proportional valve's current levels, see chapter 7.5.
11		On the operating side, there will be an indication displayed when the wheel steering function is active.

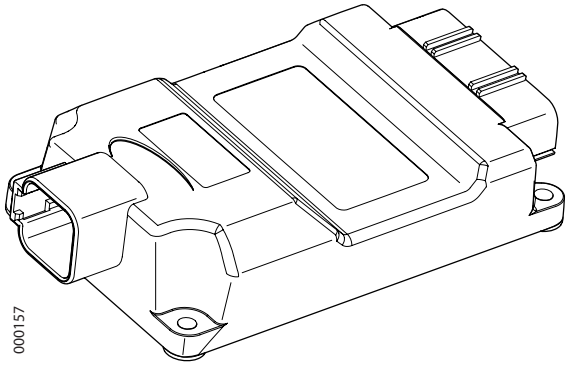
11. AUXILIARY KIT



COMPONENT PARTS MACS RT AUXILIARY KIT		
Pos. no.	Description	Quantity
1	Auxiliary module MACS RT	1
2	Mounting plate GP4 Track steering	1
3	Screw MRTF M4x12 flange	4
4	Cable measurement/CAN junction GP1-GP4	1
5	Distribution wiring GP4 Track steering	1
6	Connector Deutsch male 8-pin sealed	1

11.1 HYDRAULIC INSTALLATION FOR AUXILIARY KIT

01



Install the auxiliary module in a suitable location with the aid of the enclosed attachment plate.

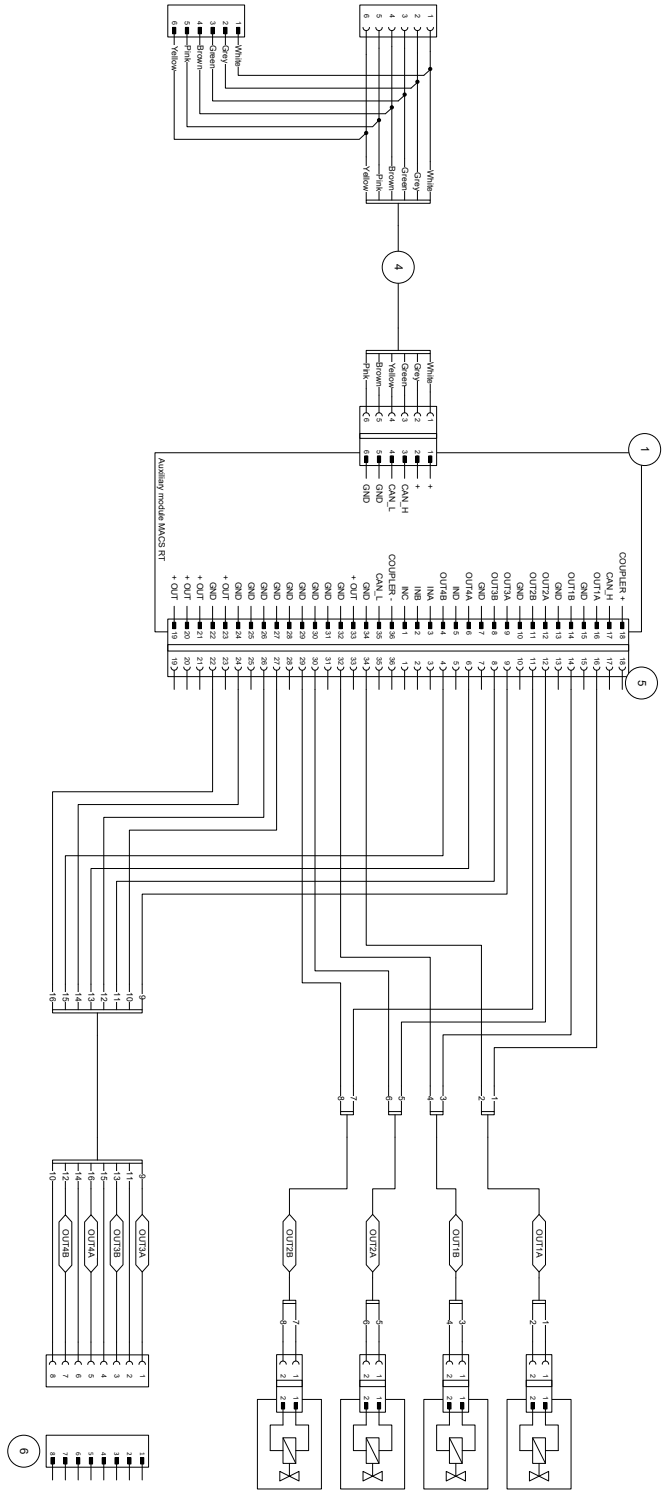
Connect the Power/CAN cable to the cab module's Power/CAN cable, and then connect it to the Auxiliary module.

Finally connect the distribution wiring to the valves that are to be controlled, making sure that the connections are paired (e.g. Out3A together with Out3B) for each function that is to be controlled.
Depending on the position of the valve in relation to the auxiliary module, you can either use the short cables for Out1 and Out2, or connect to Out3/Out4 in the 8-pin Deutsch connector.

When the system is started up, the Auxiliary outputs can be configured in the same way as the other functions in the system, e.g. so that they appear under Layout and Settings.

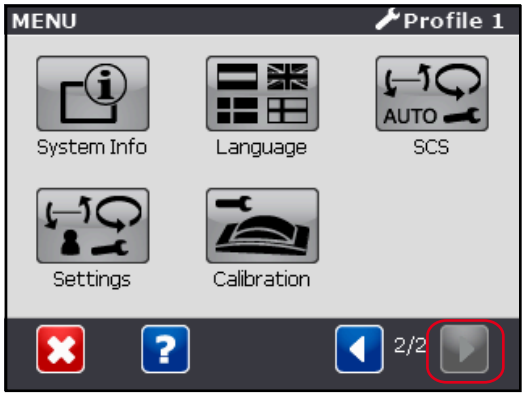
11.2 WIRING DIAGRAM AUXILIARY KIT

0000461



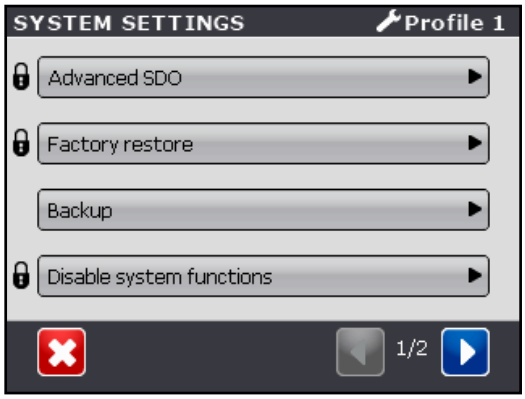
12. SYSTEM SETTINGS

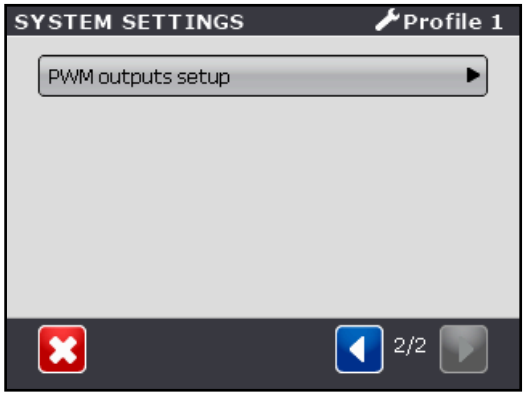
01



Unlock the service menu according to chapter 9.1. Select the last page in the main menu and then press the grayed out right arrow in the lower right corner, hold for five seconds.

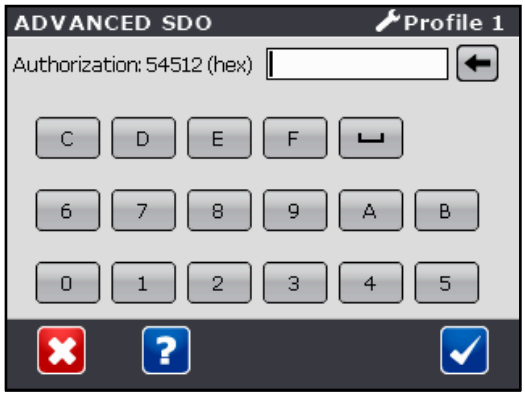
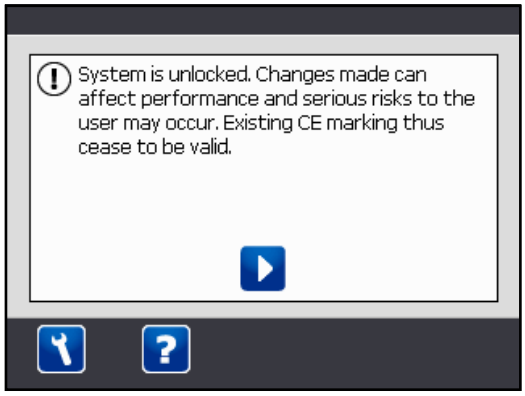
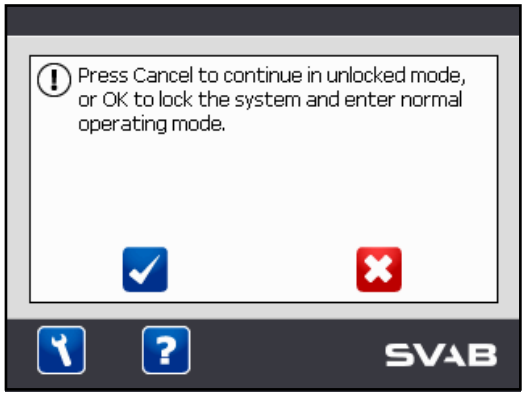
02





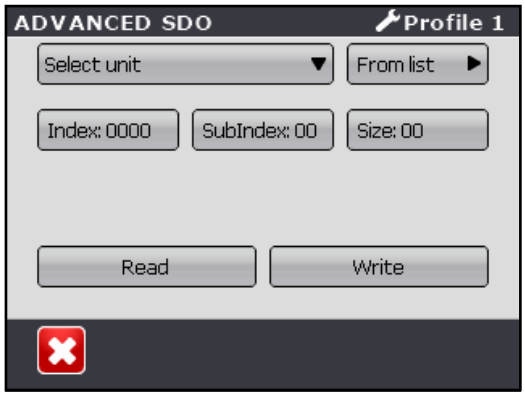
A hidden menu with a number of options is now displayed. Those buttons that have a padlock symbol beside them require that the system is unlocked by an authorization before one can enter.

12.1 AUTHORIZATION TO UNLOCK THE SYSTEM

01		The authorization is based on a random value that is different from instance to instance, and this code demands a correct response code. Contact SVAB to obtain the codes.
02		That the system is unlocked means that one can enter all locations that require authorization. After a restart, the system remains unlocked but the user is informed of this and is also given the option of locking the system again. All functions in the system are blocked until the message is responded to.
03		

12.2 ADVANCED SDO

01



The system contains a lot of parameters and diagnostic values that do not have space in the normal interface. Usually these are joystick gripd from a PC connection, but, if there is not one available, they can be accessed through the Advanced SDO mode.

WARNING!
Like many powerful tools, one can easily cause great damage with Advanced SDO, if one does not have full control over what one is doing. Only use this mode in consultation with SVAB.

12.3 FACTORY SETTINGS

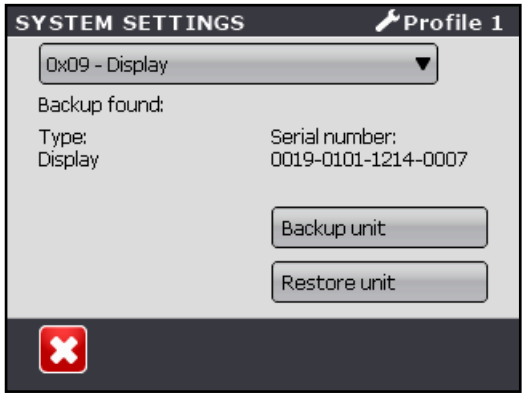
01

The function "Factory Restore" can be used to restore the factory settings in a unit. These settings are stored in the relevant unit. All changes that have been made in the different profiles will be reset.

Select which unit is to be restored in the dropdown menu. If the unit has saved settings there is a button to restore them. There is also a button to overwrite the saved settings, which may be needed in conjunction with updating certain units, but otherwise this is not recommended.

12.4 BACKUP

01

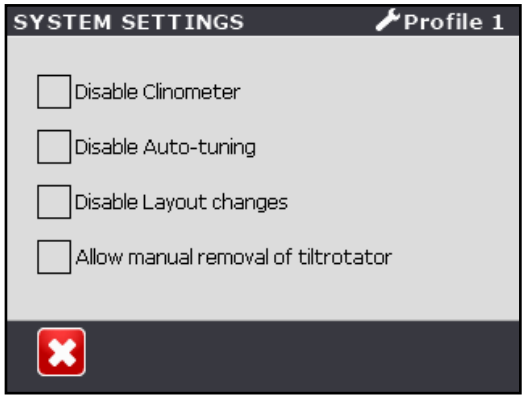


This mode can be used if one wants to save or restore a unit's configuration. In this case the settings are saved in another unit in the system, and can therefore be used to restore the system's configuration if one replaces one unit with a replacement part unit.

Select which unit is to be backed up or restored in the dropdown menu. If there are saved settings for the selected unit number there is a button to restore them. There is also a button to overwrite the stored settings.

12.5 DISABLE SYSTEM FUNCTIONS

01



Here one can choose to activate or deactivate certain functions in the system, so that they cannot be reached from the main menu.

• "Disable Clinometer" removes the option to go into angular gauge mode. This can be useful when the tiltrotator module is not installed in a position where it can detect the relevant angles.

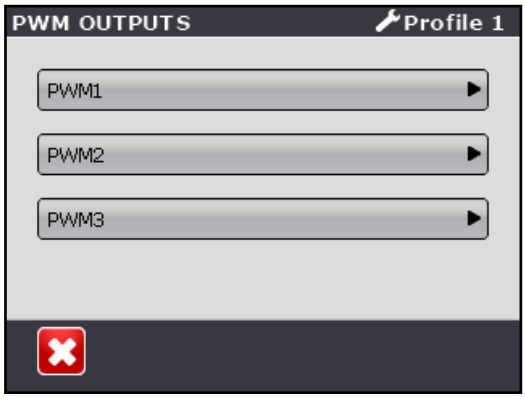
• "Disable Auto-tuning" removes the option of running the system's self-calibration. This can be appropriate if the necessary sensors are missing for example.

• "Disable Layout changes" removes the possibility of configuring the system through the Layout page, even if one is in service mode.

• "Permit manual disengagement of tiltrotator" adds an icon in the main menu to enter the fifth profile manually, see chapter 10.1

12.6 PWM OUTPUTS SETUP

01



The system has three digital outputs that can be configured to send out pulse width modulated signals (PWM). These can be connected to the machine's ECU to control the original functions, and also to use an original function to control the oil flow to the tiltrotator.

When one selects "PWM outputs set-up" in the system setting menu, one must select which of the three outputs is to be configured.
See data sheet for MACS Cab Module

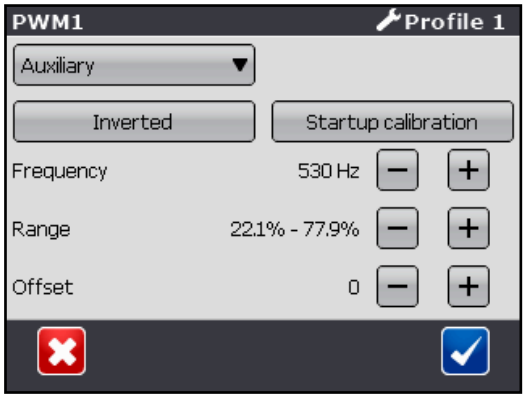
02

Each output can be set to three different basic modes: Disabled– the output is not in PWM mode, but is at a constant level.

Auxiliary – the output can be configured to be controlled by a roller in the same way as the normal tiltrotator functions.

Feeder – the output takes over the feeder function from the current output that normally manages the feed to supply the tiltrotator with oil.

03



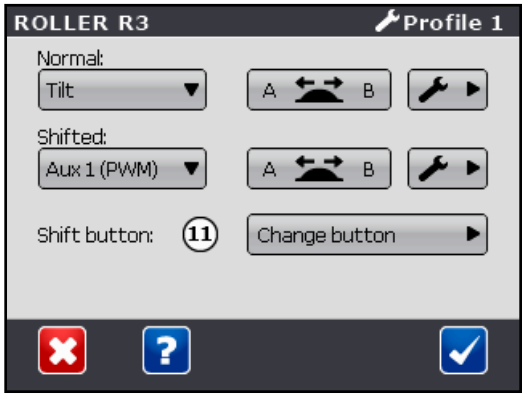
If one selects Auxiliary or Feeder, a number of setting options appear.

Inverted – Changes the direction of the output signal.

Startup calibration – If this option is activated the output will, for a short period, send the max and min values in conjunction with first activation of the output. This is required to obtain repeatability in the output types when the signal is connected to certain types of ECU.

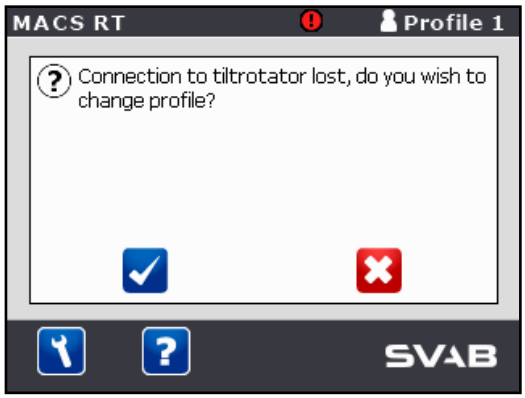
Frequency – Sets the signal's PWM frequency.
Range – Sets the signal's operating range.

Offset – To compensate for any rise and fall times that affect the read off of the signal one can apply an offset that extends or shortens the active part of the signal. Set this value so that the signal is read off as 50% when it is in neutral mode.

04		When an output is configured as an Auxiliary it can be selected like any other function in the Layout page's rolling configuration, see chapter 9.4.

13. PROFILE 5

01



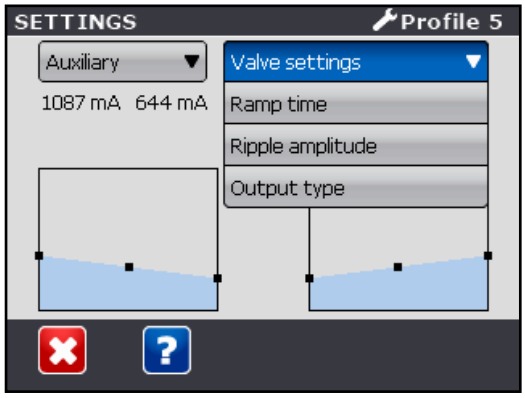
In tiltrotator mode there are four different profiles that the user can choose between, but the system also contains a fifth profile that can be used in those modes when a tiltrotator is not connected.

When the tiltrotator module is disconnected from the system a pop-up asks if one wants to change profile, if one confirms this the system goes to the fifth profile.

The green LED in the cabin module will change from a fixed glow to a flashing light to indicate that this mode is active.

In this mode the system can be configured to control the machine function that normally feeds oil to the tiltrotator. Which roller will control this is configured from the Layout page as normal.

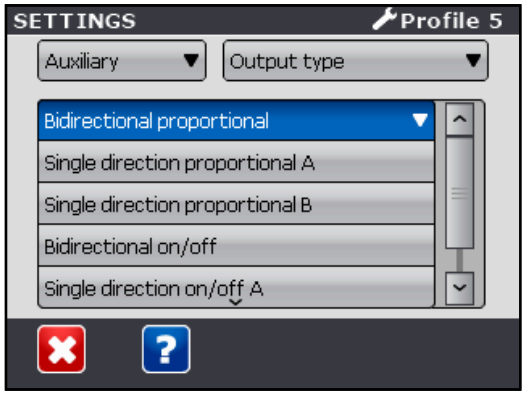
02



The following settings can be made under "Settings":
- Valve settings
- Ramp time
- Ripple amplitude
- Output type

The first three are made in the same way as the tiltrotator's valves, see chapter 9.5 for more information.

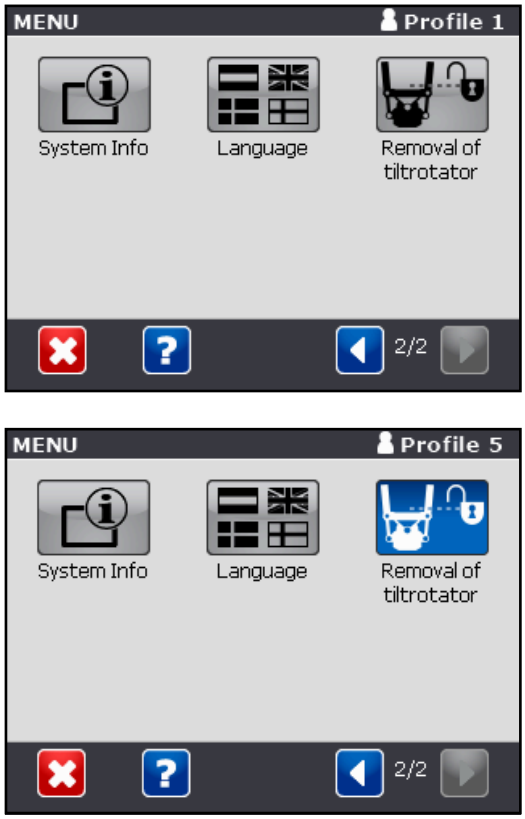
03



"Output type" indicates how the system must control current to the valve. Select which mode is suitable for the machine equipment in the dropdown menu.

13.1 MANUAL CHANGE TO PROFILE 5

01



In certain installations there may be a need to be able to change to Profile 5 manually. For example, if the tiltrotator module is installed in such a way that it cannot be removed together with the tiltrotator, or if the machine has an electro-hydraulic quick coupler, where there is a condition that the system is in Profile 5 in order to activate the quick coupler.
One can then activate the function "Permit manual disconnection of the tiltrotator". A new icon now appears in the main menu, where the user can manually activate or deactivate Profile 5 mode.

14. COMMISSIONING

For your system to function on the machine on which it is installed, all units must be correctly configured and all parameters must be correctly set.

Each unit is loaded with a configuration that determines what the unit shall do in the system.
It is advisable that all configuration is conducted in collaboration with SVAB to facilitate installation and commissioning. The unit module must be equipped with a configuration adapted for the tiltrotator it shall be mounted in. There it is then determined which functions it shall control as well as other parameters that are specific for a tiltrotator model.

To set all parameters necessary for correctly controlling the rotational and/or tilting unit, one can adjust the values in the configuration on a rotational and/or tilting unit and then use the configuration as a standard configuration for the tiltrotator model.
You can also, which is advisable, conduct a factory calibration by complementing any final testing equipment with tools for this if such are available on the production line.

In the configuration for the cab module, you connect the functions in the grips with the functions that are in the rotational and/or tilting unit, as well as any wheel or track steering units. To download a configuration, there is a tool called Fieldtool, which is a PC-based communications program. In addition to a computer, an interface for connecting the computer to the CAN bus in the system is also needed. The configuration files follow the XML format and can be easily edited with a text editing program on the computer. You can also create a configuration file that applies for an entire system if this is preferred.

When the system is configured in this way, as the first measure on the machine, one must set the parameters for sending out the right amount of oil to the rotational and/or tilting unit (feed). The system can set this automatically by running the function for self-calibration from the display unit.

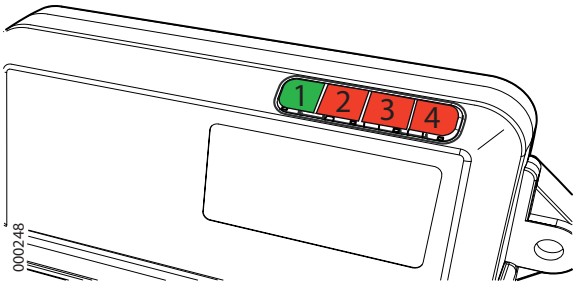
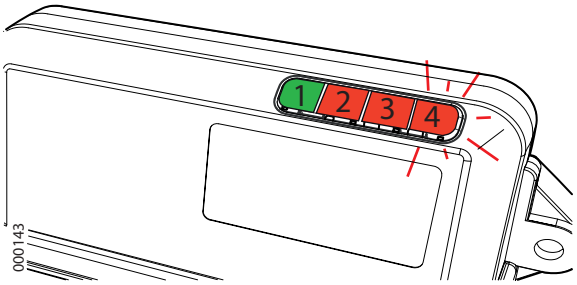
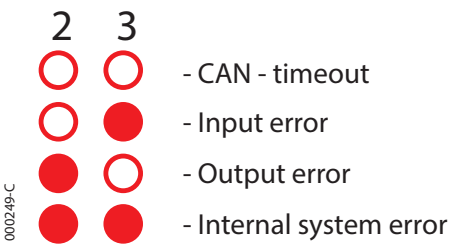
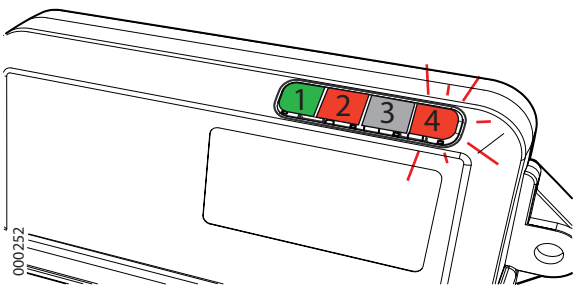
The track steering unit is delivered with a standard configuration. The system automatically detects when such a unit is connected and one can then make the necessary settings directly on the display unit.

IMPORTANT!
Be extra observant of the machine's movements when starting for the first time after installation! A safety distance of at least 10 m around the machine is recommended.

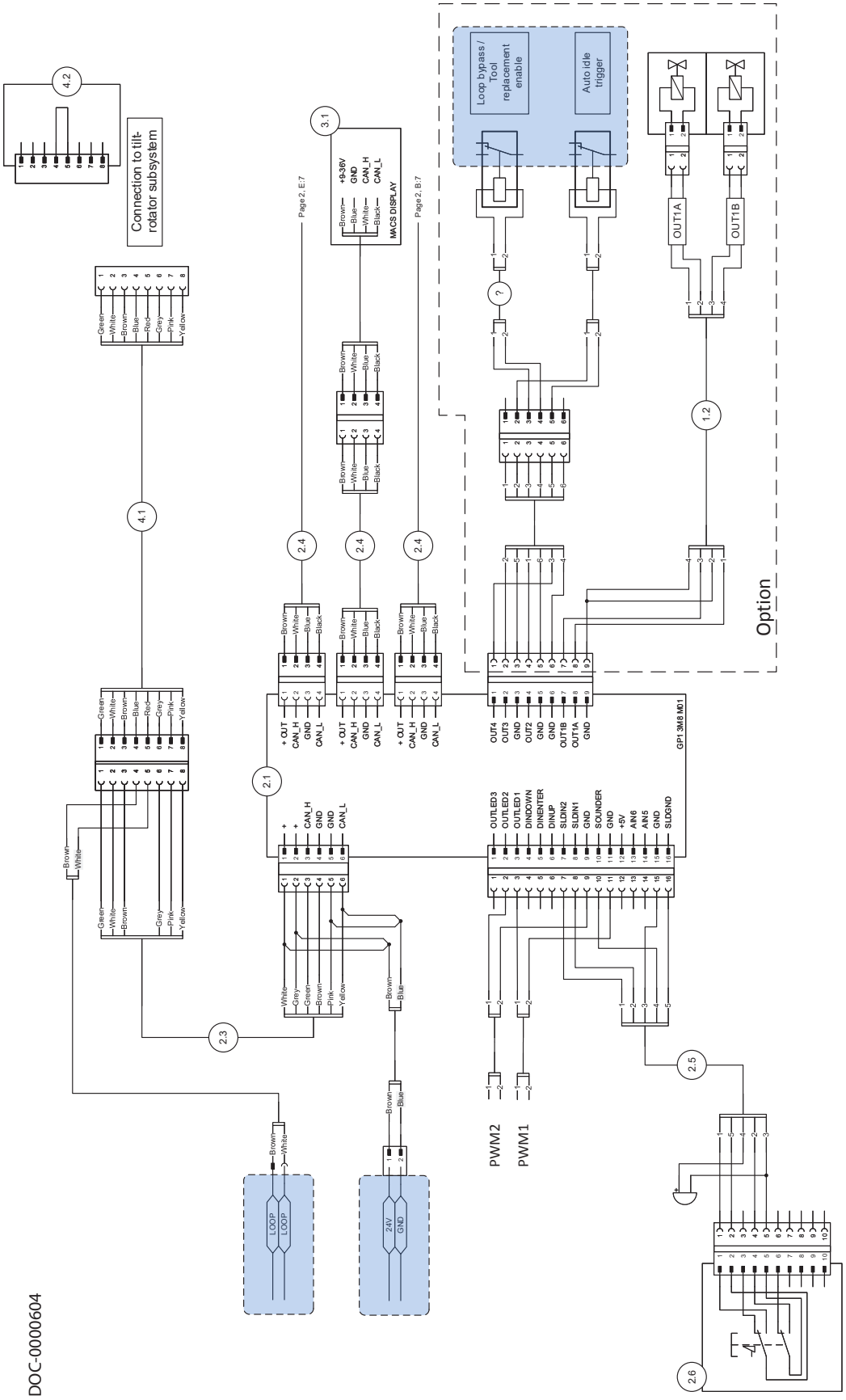
15. TROUBLESHOOT

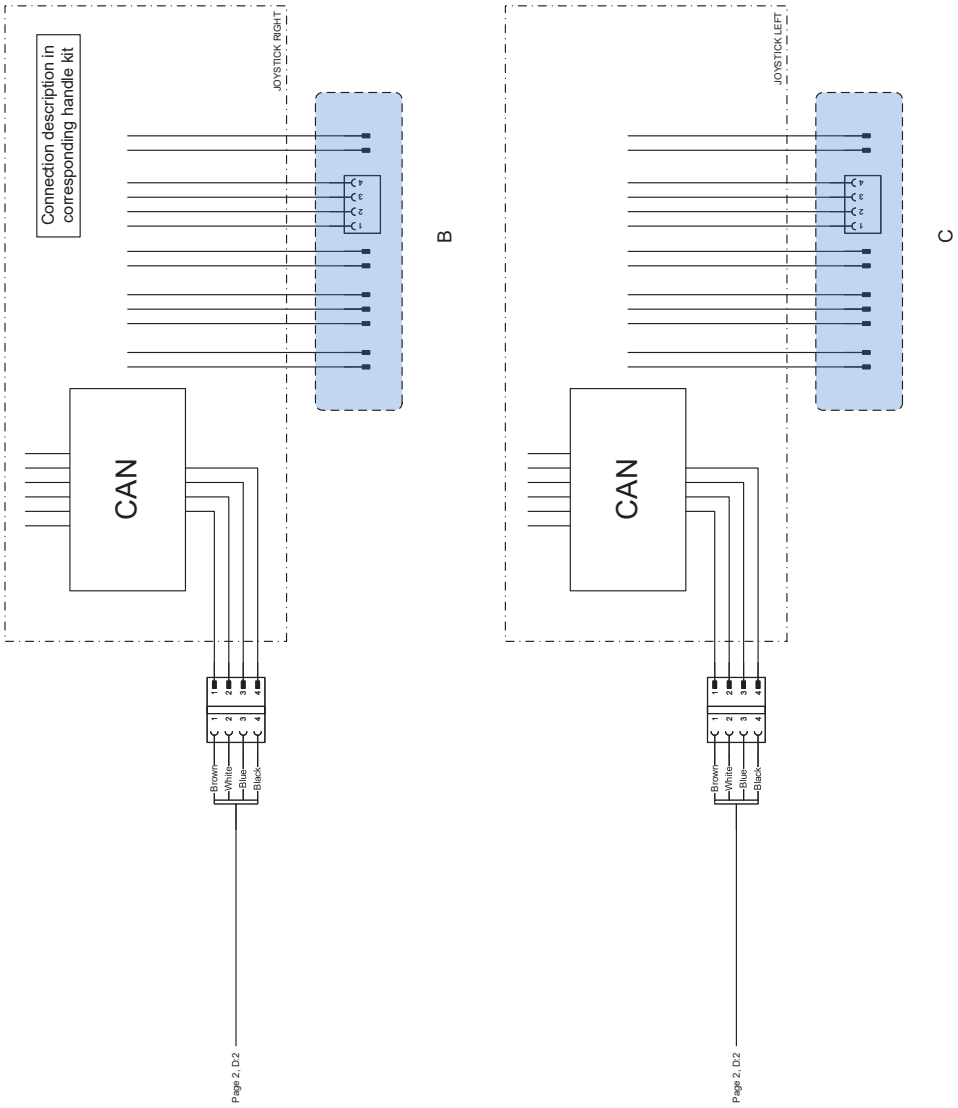
15.1 GP1

If the touch screen is damaged or absent, you can troubleshoot the system using the GP1 unit's LEDs.
The GP1 unit must be easily accessible in the machine's cab.

01 	The green LED (1) indicates that the GP1 unit is running. Normal operation is signified by the LED lighting with a steady glow. If it is flashing, this means that the slope hydraulics mode is activated.
02 	If a fault arises, LEDs 2 and 3 show the type of fault with a steady glow (see image below): LED 4 shows which unit and which function the fault applies to. The LED flashes in 2 different ways. Distinct flashes indicate the unit in which the fault is located: 1 distinct flash = GP1 (Cabin module) 2 distinct flashes = GP4 (Tiltorator module) 4 distinct flashes = Wheel (extra GP1 unit) or track steering (extra GP4 unit) 5 distinct flashes = Right joystick 6 distinct flashes = Left joystick 9 distinct flashes = Touch screen Toned flashes indicate the function to which the fault relates.
03 	In the event of "CAN timeout", "Input signal fault" or "Output fault", you should check that the unit's connectors are properly connected and that the unit's wiring is not damaged. In the event of "Internal system fault" or if you cannot rectify the fault yourself, you should contact SVAB Hydraulik.
04 	Example: If LED 1 and 2 light and 3 is extinguished, this indicates an output fault. If one then counts the number of distinct flashes on LED 4, one can see which unit is affected. 2 distinct flashes show e.g. that it is the tiltrotator module GP4 (see the above list). Three toned flashes correspond to the third output in tilt module, which is the grip function.

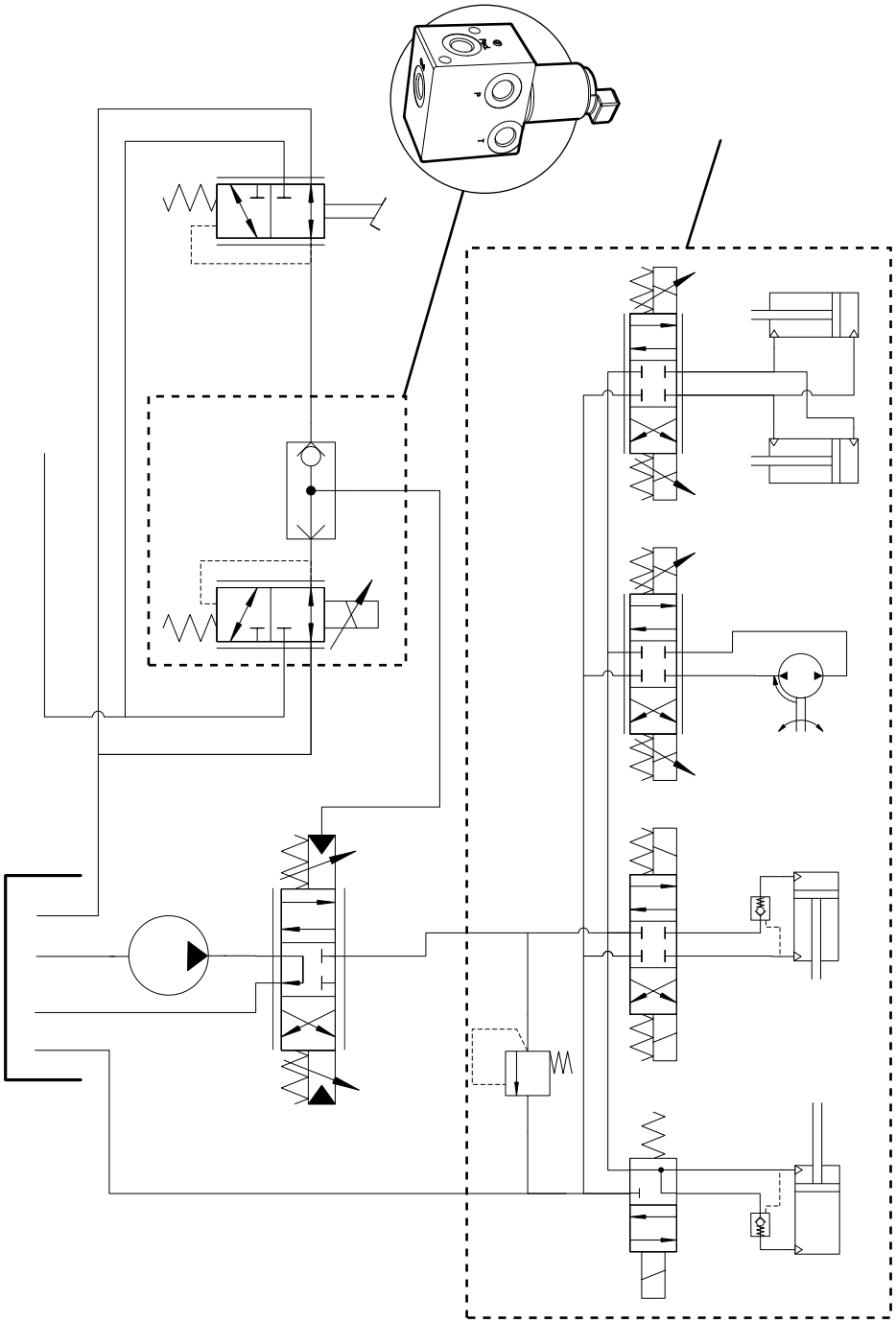
16. WIRING DIAGRAM




Connection description in corresponding handle kit
JOYSTICK RIGHT
CAN
B
Brown
White
Blue
Black
Page 2, D:2
JOYSTICK LEFT
CAN
C
Brown
White
Blue
Black
Page 2, D:2

DOC-0000604

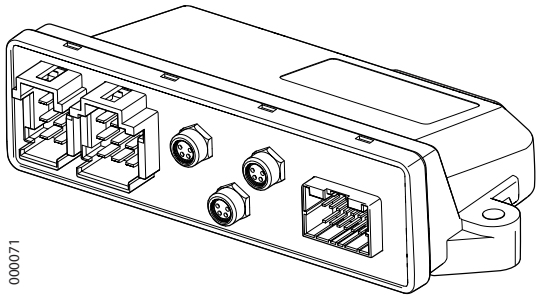
17. HYDRAULIC DIAGRAM (outline diagram)



18. TECHNICAL DATA

MACS Cab Module DATA SHEET

GP1 CAN (3xM8)



Description

The GP1 Cab Module is designed as an universal central controller for earth-moving machinery. It features functions for controlling a few hydraulic valves and provides three M8 connectors to connect different low power CAN-bus-connected units such as joysticks, display or CAN gateway.

Technical data

Nominal Voltage	12 and 24 V
Supply voltage, permissible range	8 to 36 V
Electromagnetic compatibility	Acc. To ISO 13766:2006
Operating temperature	-40 to +70 °C
Storage temperature	-40 to +85 °C
Case material	PA6 30GF
Weight	220 g
Degree of protection	Min. IP 50 with assembled mating connectors
CAN termination resistance	600 Ω

Current consumption

Standby, 12 V system	Up to 170 mA
Standby, 24 V system	Up to 80 mA
Max. load	10 A
External fuse in supply path	Max. 10 A

Analog inputs

Permissible range	Full supply range
Measuring range	0 to 5 V
Input series resistance	10 kΩ
Resolution	10 Bit

Digital inputs

Permissible range	Full supply range
Input type	Configurable for both active high and active low signals.
Input series resistance	10 kΩ

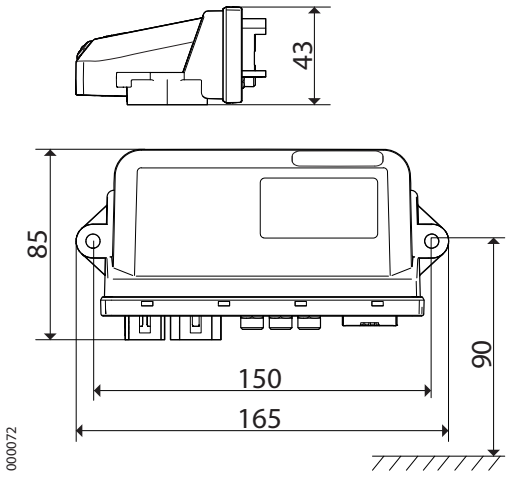
Mounting instructions

Place the unit inside the cabin on a flat surface. Make sure that the LED indicators are visible for maintenance.

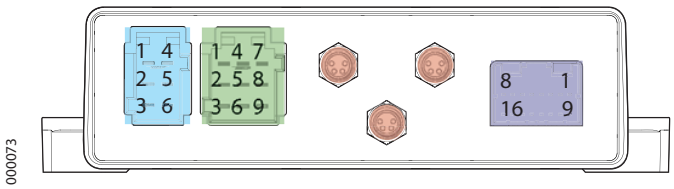
Use the attachment mounting plate if drilled holes or screws are not permitted on the safety cage.
When mounting on the plate, self-tapping screws are preferred. When mounting on plastic panels, body washers and screws are recommended (M6).

Make sure the unit is safely positioned so that risks for impact injuries to the operator are eliminated. Also make sure that screws of correct lengths are used so they do not protrude and consequently lead to lacerations.
Strain relief the wiring harnesses if necessary.

Dimensions



Connections



Supply Connector (Tyco JPT2.8 6-way)		
1	+ IN	Supply voltage
2	+ IN	Supply voltage
3	CAN_H	CAN High
4	GND	Supply and CAN GND
5	GND	Supply and CAN GND
6	CAN_L	CAN Low

The voltage supply circuit should be divided equally on both connections. CAN-bus-connected units must use the same GND reference.

Valve Connector (Tyco JPT2.8 9-way)		
1	OUT 4	Output 4
2	OUT 3	Output 3
3	GND	GND for outputs
4	OUT 2	Output 2
5	GND	GND for outputs
6	GND	GND for outputs
7	OUT 1B	Output 1B
8	OUT 1A	Output 1A
9	GND	GND for outputs

Outputs 1 to 2
Current-regulated high-side outputs, max. current 2.75 A. Designed for proportional control of inductive loads. Out 1´s A and B ports used for bidirectional valves. Protected for over-current conditions.

Outputs 3 to 4
High-side switch, max. current 2.5 A. Designed for switching inductive loads. Protected for over-current conditions.

M8 Connectors (Standard M8 4-way female connector)		
1 (Brown)	+UT	+ Supply output
2 (White)	CAN_H	CAN High
3 (Blue)	GND	GND
4 (Black)	CAN_L	CAN Low

+ Supply output
Not current limited, internally connected to supply input.
Used for supplying external low consumption units, e.g. joystick handles or a display unit. CAN-bus-connected units must use the same GND reference.

I/O Connector (Tyco Multi-Lock 040 16-way male connector)		
1	OUTLED3	Digital output LED3/PWM3
2	OUTLED2	Digital output LED2/PWM2
3	OUTLED1	Digital output LED1/PWM1
4	DINDOWN	Digital input DINDOWN
5	DINENTER	Digital input DINENTER
6	DINUP	Digital input DINUP
7	SLDIN2	Digital input SLDIN2
8	SLDIN1	Digital input SLDIN1
9	GND	Signal GND
10	SOUNDER	Digital Output BUZZER
11	GND	Signal GND
12	+5V	+5V Output
13	AIN6	Analog Input 6
14	AIN5	Analog Input 5
15	GND	Signal GND
16	SLDGND	Pulsed GND SLDGND

Output LED1 to LED3
Digital 5 V high-side switches, max. current 50 mA.
Can be used as configurable PWM outputs.

Input DINUP to DINDOWN
Digital inputs.

Input SLDIN1 to SLDIN2
Digital inputs designed for controlling quick coupler function but can also be used as general digital inputs.

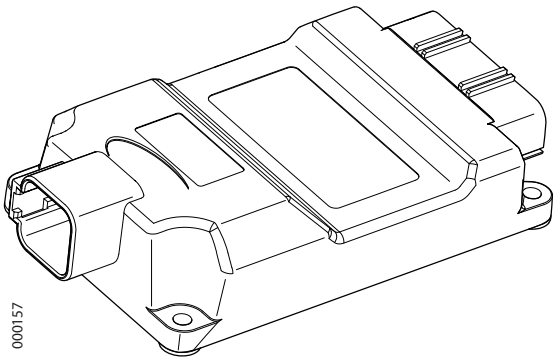
GND SLDGND
Pulsed digital GND connection for use with quick coupler inputs.
Max. current 50 mA.

Output BUZZER
PWM switched 5V high-side output for electromagnetic buzzers or LEDs. Max. output current 50 mA. Over-current protected. Min. output current 9 mA.
Open load detection. PWM frequency 2400 Hz. 50 % duty cycle.

Analog Input 5 to 6
Analog voltage inputs. Forms axis 5 when used as dual signal input.

+5 V output
Current-limited 5 V output for supplying sensors and potentiometers. Max. output current 140 mA (distributed on all +5 V outputs).

MACS GP4 Module DATA SHEET



Description

The GP4 Unit Module is designed as a universal valve controller for earth-moving machinery. It features functions for controlling up to four bidirectional hydraulic valves and contains signal I/O for handling commonly used sensor signals and can also interact with other CAN-bus-connected modules. It also features 3D angle sensing for indication of e.g. bucket angles.

Technical data

Nominal Voltage	12 and 24 V
Supply voltage, permissible range	8 to 36 V

Current consumption

Standby, 12 V system	Up to 120 mA
Standby, 24 V system	Up to 105 mA
Loaded	Max. 10 A
Fuse external in supply path	Max. 10 A
Electromagnetic compatibility	Acc. To ISO 13766:2006
Operating temperature	-40 to +70 °C
Storage temperature	-40 to +85 °C
Case material	PA66 25GF
Degree of protection	IP 67 with assembled mating connectors
CAN termination resistance	120 Ω

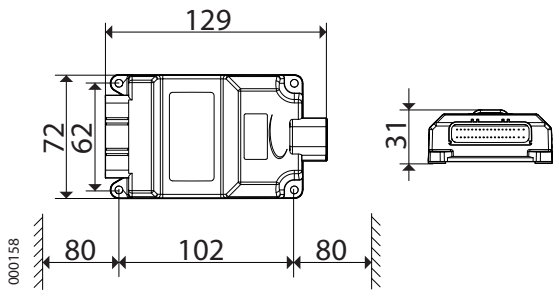
Analog voltage inputs

Permissible range	Full supply range
Measuring range	0 to 5 V
Input series resistance	10 kΩ
Resolution	10 Bit

Digital inputs

Permissible range	Full supply range
Input load resistance	10 kΩ

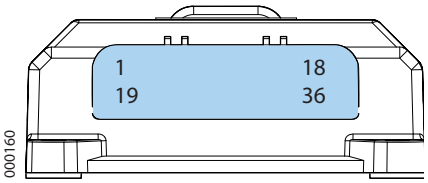
Dimensions



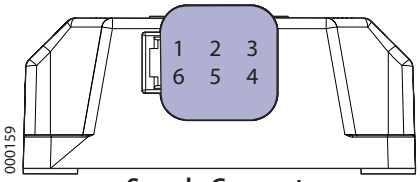
Mounting instructions

Place the GP4 unit module on a flat surface in the tilting part of the unit with a unit connector to the left seen from the cab and with the logotype upwards. Use four M5 screws for the attachment. Make sure that the cables are routed so that there is minimal risk for wear and tear. Cables mounted together with hydraulic lines should be dimensioned and adapted for that environment.

⚠ Make sure the unit is safely positioned so that risks for impact injuries to the operator are eliminated. Also make sure screws of correct lengths are used so they do not protrude and consequently lead to lacerations.



Unit Connector



Supply Connector

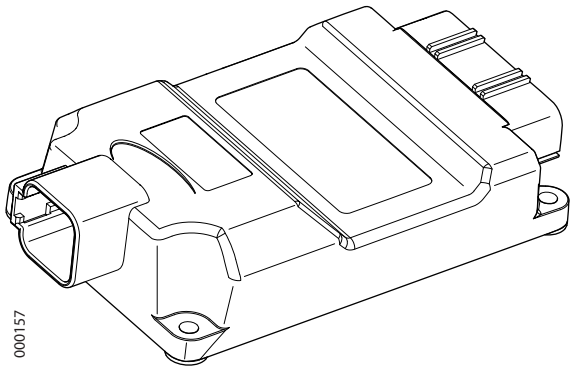
Unit Connector (JST WPZ 36-way)		
1	INC	Input C
2	INB	Input B
3	INA	Input A
4	OUT4B	Output 4B
5	IND	Input D
6	OUT4A	Output 4A
7	GND	GND
8	OUT3B	Output 3B
9	OUT3A	Output 3A
10	GND	GND
11	OUT2B	Output 2B
12	OUT2A	Output 2A
13	GND	GND
14	OUT1B	Output 1B
15	GND	GND
16	OUT1A	Output 1A
17	CAN_H	CAN High
18	OUTCH	Coupler output +
19	+UT	+ Supply output
20	+UT	+ Supply output
21	+UT	+ Supply output
22	GND	GND for output 4B
23	+UT	+ Supply output
24	GND	GND for output 4A
25	GND	GND
26	GND	GND for output 3B
27	GND	GND for output 3A
28	GND	GND
29	GND	GND for output 2B
30	GND	GND for output 2A
31	GND	
32	GND	GND for output 1B
33	+UT	+ Supply output
34	GND	GND for output 1A
35	CAN_L	CAN Low
36	OUTCL	Coupler output -

Input A to B
Digital pulse signal inputs. Active high signals (PNP) required.
Input C to D
Can be configured as either analog voltage or analog current inputs.
Output 1 to 4
Current-regulated high-side outputs, max. current 2.75 A. Designed for proportional control of inductive loads. A and B ports used for bidirectional valves. Protected for over-current conditions. Open load detection.
Coupler output
High- and low-side switches, max. current 2.5 A. Designed for switching the inductive solenoid for the quick coupler function.
Protected for over-current conditions. Open load cross detection.
+ Supply outputs
Current-limited positive supply output for supplying aggregate sensors. Max. output current 140 mA (divided out on all + supply outputs).

Supply Connector (Deutsch DTF13 6-way)		
1	+IN	Supply voltage
2	+IN	Supply voltage
3	CAN_H	CAN High
4	CAN_L	CAN Low
5	GND	Supply and CAN GND
6	GND	Supply and CAN GND

The voltage supply circuit should be distributed equally on both connections.
CAN-bus-connected units must use the same GND reference.

MACS GP4 Reduced DATA SHEET



Description

The GP4 Unit Module is designed as a universal valve controller for earth-moving machinery. It features functions for controlling up to four bidirectional hydraulic valves and contains signal I/O for handling commonly used sensor signals and can also interact with other CAN-bus-connected modules.

Technical data

Nominal Voltage	12 and 24 V
Supply voltage, permissible range	8 to 36 V

Current consumption

Standby, 12 V system	Up to 120 mA
Standby, 24 V system	Up to 105 mA
Loaded	Max. 10 A
Fuse external in supply path	Max. 10 A
Electromagnetic compatibility	Acc. To ISO 13766:2006
Operating temperature	-40 to +70 °C
Storage temperature	-40 to +85 °C
Case material	PA66 25GF
Degree of protection	IP 67 with assembled mating connectors
CAN termination resistance	120 Ω

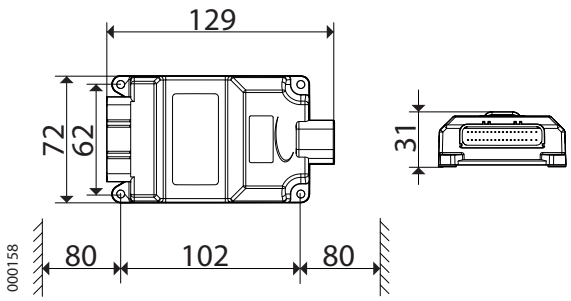
Analog voltage inputs

Permissible range	Full supply range
Measuring range	0 to 5 V
Input series resistance	10 kΩ
Resolution	10 Bit

Digital inputs

Permissible range	Full supply range
Input load resistance	10 kΩ

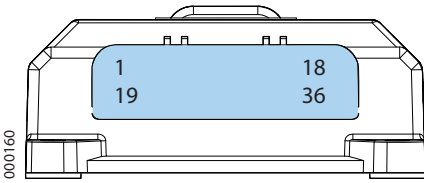
Dimensions



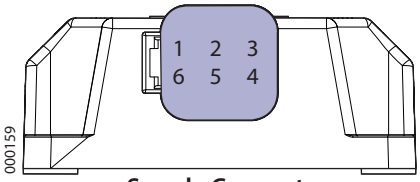
Mounting instructions

Use four M5 screws for the attachment. Make sure that the cables are routed so that there is minimal risk for wear and tear. Cables mounted together with hydraulic lines should be dimensioned and adapted for that environment.

⚠ Make sure the unit is safely positioned so that risks for impact injuries to the operator are eliminated. Also make sure screws of correct lengths are used so they do not protrude and consequently lead to lacerations.



Unit Connector



Supply Connector

Unit Connector (JST WPZ 36-way)		
1	INC	Input C
2	INB	Input B
3	INA	Input A
4	OUT4B	Output 4B
5	IND	Input D
6	OUT4A	Output 4A
7	GND	GND
8	OUT3B	Output 3B
9	OUT3A	Output 3A
10	GND	GND
11	OUT2B	Output 2B
12	OUT2A	Output 2A
13	GND	GND
14	OUT1B	Output 1B
15	GND	GND
16	OUT1A	Output 1A
17	CAN_H	CAN High
18	OUTCH	Coupler output +
19	+UT	+ Supply output
20	+UT	+ Supply output
21	+UT	+ Supply output
22	GND	GND for output 4B
23	+UT	+ Supply output
24	GND	GND for output 4A
25	GND	GND
26	GND	GND for output 3B
27	GND	GND for output 3A
28	GND	GND
29	GND	GND for output 2B
30	GND	GND for output 2A
31	GND	
32	GND	GND for output 1B
33	+UT	+ Supply output
34	GND	GND for output 1A
35	CAN_L	CAN Low
36	OUTCL	Coupler output -

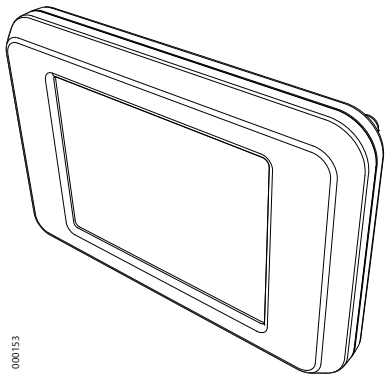
Input A to B
Digital pulse signal inputs. Active high signals (PNP) required.
Input C to D
Can be configured as either analog voltage or analog current inputs.
Output 1 to 4
Current-regulated high-side outputs, max. current 2.75 A. Designed for proportional control of inductive loads. A and B ports used for bidirectional valves. Protected for over-current conditions. Open load detection.
Coupler output
High- and low-side switches, max. current 2.5 A. Designed for switching the inductive solenoid for the quick coupler function.
Protected for over-current conditions. Open load cross detection.
+ Supply outputs
Current-limited positive supply output for supplying aggregate sensors. Max. output current 140 mA (divided out on all + supply outputs).

Supply Connector (Deutsch DTF13 6-way)		
1	+IN	Supply voltage
2	+IN	Supply voltage
3	CAN_H	CAN High
4	CAN_L	CAN Low
5	GND	Supply and CAN GND
6	GND	Supply and CAN GND

The voltage supply circuit should be distributed equally on both connections.
CAN-bus-connected units must use the same GND reference.

MACS Display Module DATA SHEET

GPD



Description

The GPD Display module is designed to be used as an information display or a service tool for the MACS system in earth-moving machinery. It has a big 3,2" TFT color display with touch panel and features functions for showing bucket angles, making fast automatic adjustments, showing warning and error indication, troubleshooting and can also interact with other CAN-bus-connected units.

Technical data

Nominal Voltage	12 and 24 V
Supply voltage, permissible range	8 to 36 V

Current consumption

Standby, 12 V system	Up to 205 mA
Standby, 24 V system	Up to 85 mA
Fuse external in supply path	Max. 10 A
Electromagnetic compatibility	Acc. To ISO 13766:2006
Operating temperature	-40 to +70 °C
Storage temperature	-40 to +85 °C
Case material	ABS
Weight	150 g
Degree of protection	IP 50
CAN termination resistance	600 Ω

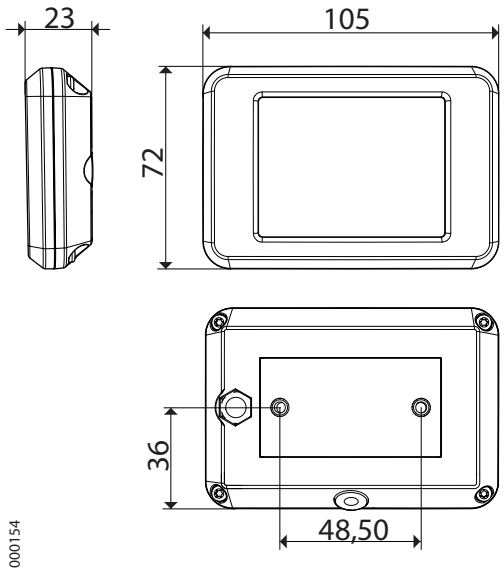
Mounting instructions

Contact SVAB for more information about available attachments.

Ordering information

With M8 cabling 1 m. GPD Cable	149003
With integrated M8 connector GPD M8	149005

Dimensions

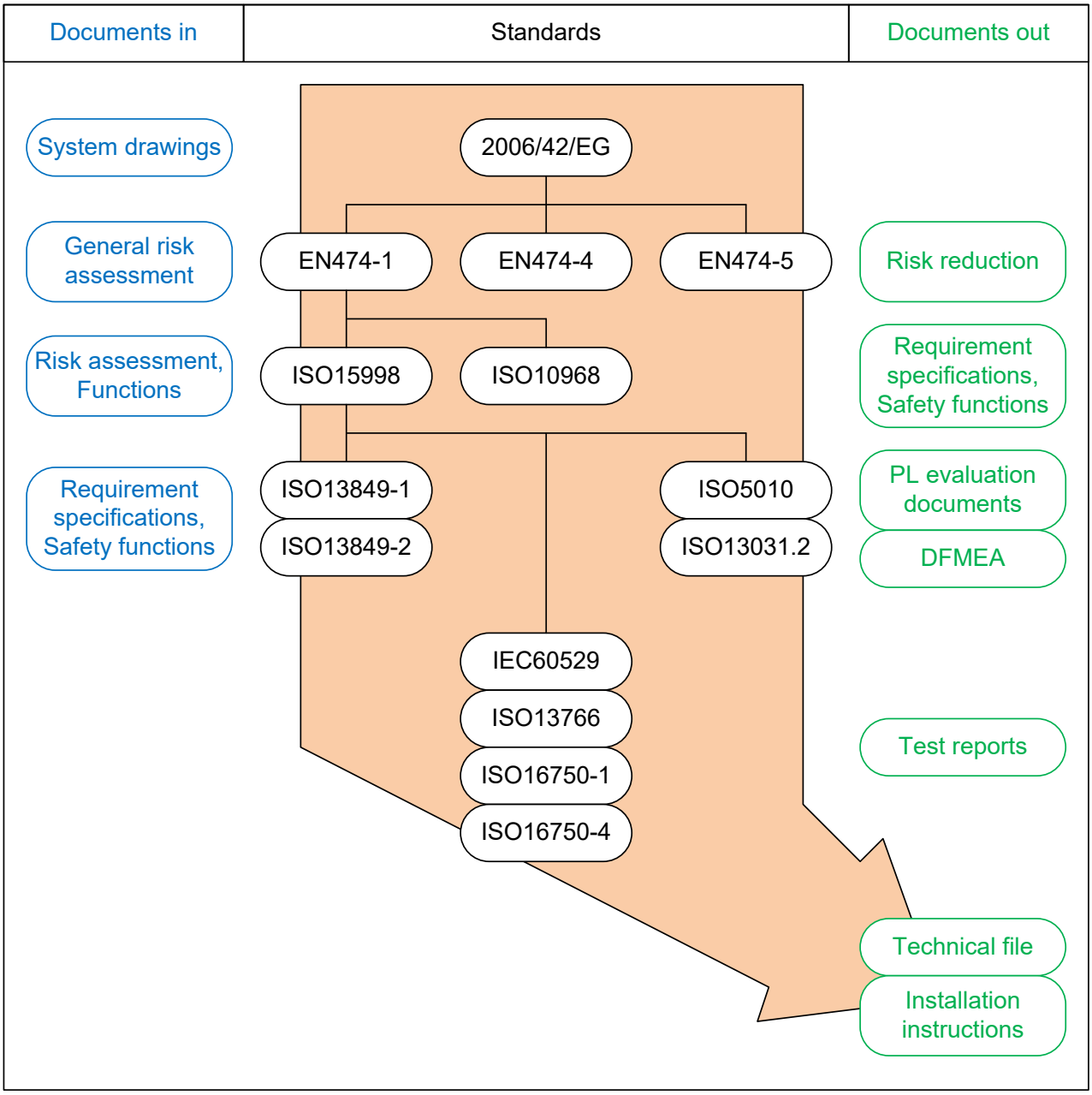


Connections

M8 Connector (standard M8 4-pole female connector)		
1	(Brown) +IN	+ Supply voltage
2	(White) CAN_H	CAN High
3	(Blue) GND	GND
4	(Black) CAN_L	CAN Low
CAN bus connected units must use the same GND reference.		

19. MACHINERY DIRECTIVE, (2006/42/EC)

19.1 OVERVIEW



19.2 STANDARDS

This is a list of the standards used, wholly or in part depending on application and relevance, throughout the development process for the system described in this document.

EN474-1:2006+A1:2009 Earth-moving machinery – Safety – Part1: General requirements
EN474-4:2006+A2:2012 Earth-moving machinery – Safety – Part4: Requirements for backhoe loaders
EN474-5:2006+A2:2012 Earth-moving machinery – Safety – Part5: Requirements for hydraulic excavators
C standards for earth-moving machines

ISO15998:2008 Earth-moving machinery - Machine-control systems (MCS) using electronic components - Performance criteria and tests for functional safety

ISO13849-1:2008 Safety of machinery - Safety-related parts of control systems - Part 1: General principles for design
ISO13849-2:2008 Safety of machinery - Safety-related parts of control systems - Part 2: Validation

ISO13766:2006 Earth-moving machinery - Electromagnetic compatibility

ISO16750-1:2006 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 1: General
ISO16750-4:2010 Road vehicles - Environmental conditions and testing for electrical and electronic equipment - Part 4: Climatic loads
Parts of these standards are used in combination with the requirements placed in ISO15998 to create a combined test for temperature, humidity and vibration.

IEC60529 Degrees of protection provided by enclosures (IP code)

ISO/CD13031.2 Earth-moving machinery — Quick couplers — Safety

ISO5010:2007 Earth-moving machinery - Rubber-tyred machines - Steering requirements

ISO10968:2004 Earth-moving machinery - Operator's controls

19.3 APPLICABLE APPROVED FUNCTIONS

The system has been carefully analyzed and validated using the above-mentioned standards and is assessed as approved for the following machine functions.

Direct proportional function with performance level up to c per ISO 13849-1.
Feed Proportional function (functions that use a proportionally controlled pilot valve) with performance level up to c per ISO 13849-1.
Wheel steering function with performance level d, category 2 according to ISO 13849-1 for use at maximum speed of 20 km/h according to ISO 5010.
Track steering with utilization of direct proportional function as per the description above.
Quick coupler lock with performance level d according to ISO 13849-1.

19.4 DOCUMENTATION

The technical file that is required per the Machinery Directive includes all relevant documentation regarding the above-mentioned safety functions, e.g.:

System drawings and specifications
General risk assessment for complete system
Risk assessments for each safety function that denote performance level
Risk reduction
Requirement specifications for each safety function
Test reports
PL evaluation for each safety function
DFMEA for each safety function

All of these documents can include company-sensitive information and therefore cannot be distributed.
They are however, available for examination upon reasonable request.

19.5 MANUFACTURING SPECIFICATIONS

Product:

MACS RT, with products per 112049 Installation Instructions, MACS RT

Product description:

Control system for rotational and/or tilting units, wheel steering and track steering for earth-moving machinery

Applied basic health and safety requirements:

For use of this product, the following basic health and safety requirements per directive 2006/42/EC have been applied.

1.1.3 Materials and products
1.2 Control systems
1.3.4 Risks in conjunction with surfaces, edges or angles
1.4.2.2 Interlocked openable guards
1.5.1 Electrical supply
1.5.2 Static electricity
1.5.3 Power supply other than electrical
1.5.4 Installation faults
1.5.5 Extreme temperatures
1.6.2 Access to workstations and service locations used for maintenance
1.6.3 Disconnection of power sources
1.6.4 Operator actions
1.7.1 Information and warnings on the machine
1.7.1.1 Information and information devices
1.7.1.2 Warning devices
1.7.3 Marking of machines
1.7.4.1 General principles for configuration of the user instructions
1.7.4.3 Sales support materials

Standards:

During development of this product, the following harmonizing standards have been used: EN474-1:2006+A1:2009. Moreover, standard ISO 5010:2007 has been used regarding “additional steering control elements” and “steering system with electrical/electronic transfer device”.

The manufacturer’s name and address:
SVAB Hydraulik AB
Ulvsättersgatan 2
694 35 HALLSBERG
Sweden
Telephone: +46 (0)582 15230 Fax: +46 (0)582 15232
E-mail: info@svab.see website: www.svab.se

20. CHECKLIST

IMPORTANT!
Be extra observant of the machine's movements when starting for the first time after installation! A safety distance of at least 10 m around the machine is recommended.

Before going through the checklist, ensure that the machine:
- has been started
- the safety gate is closed
- is in excavation mode (not in transport mode)
- has the tiltrotator installed on the machine's tool mounting.
- check that hydraulic hoses are correctly routed and properly secured, and that hose protection is mounted on hoses that can be subjected to wear.
- check that all oil levels are within the recommended parameters. Fill if necessary according to the machine instructions.

CHECKLIST			
Hydraulic installation			
1	Check that the system's hydraulic components are correctly connected and that all couplings are correctly tightened.		
2	Check that all hoses are routed so there is no danger of damage from the movements of the machine.		
3	Check that no oil leakage occurs with the machine at full revs.		
4	Check that the machine's existing hydraulic diagram is updated after the installation.		
Electrical installation			
1	Check that cables are correctly routed and properly secured, and that cable protection is mounted where cables can be subjected to wear.		
2	Check that the system is correctly connected according to the electrical diagram.		
3	Check that the system is correctly fused.		
4	Check that supply cables are not routed close to fuel lines.		
5	Check that no holes or other modifications are made on the shovel boom or on the cab's ROPS structure.		
6	Check that no cables or units are blocking the machine's emergency exits.		
7	Check that all plates, interior components, buttons and other parts that have been removed are correctly refitted and in working order.		
Testing/adjustment			
1	Check that the maximum hydraulic pressure is adjusted to maximum permitted pressure for the applicable tiltrotator.		
2	Check that the machine is correctly adjusted and approved by a person other than the installation technician.		
3	Check that all functions operate smoothly and responsively, and with the intended/preferred direction of travel.		
4	Check that the user manual accompanies the machine upon delivery to the end-user.		
5	Check that the lever function overview accompanies the machine upon delivery to the end-user.		
6	Check that the tiltrotator is coupled to free return		
Safety functions (These must always be checked and approved by a person other than the installation technician).			
1	Check that the user instructions for alternative steering accompany the machine upon delivery to the end-user.		
2	Check that the upper tool lock interlock functions correctly (according to the risk assessment that was made for the relevant installation).		
3	Check that the lower tool lock functions correctly (upon activated function, the buzzer sounds).		
4	Check that the gate catch function works correctly and stops all added functions.		
5	Check that the machine's steering wheel steering has full priority over the alternative steering function. (Activate the alternative steering and steer in any direction with the roller. At the same time, grasp the steering wheel and steer in the opposite direction. The machine's wheels shall now respond to the steering wheel. If the steering wheel is released, the machine's wheels must stop). Repeat and test the function in the other direction.		

TURN

6	Check that the machine does not go faster than the maximum permitted speed with activated alternative steering.		
7	Check that the alternative steering function is correctly adjusted and agrees with the points in the installation instructions. Record the set values here: Start level, right: End level, right: Start level, left: End level, left: Progressiveness:		

Restore the machine to drivable condition and ensure that no tools are left in the machine.

When the checklist has been gone through thoroughly, filled in completely and any errors corrected, it must be signed, below, by the installer responsible.
Save this checklist with other technical documentation.

Machine model:	Serial number:
Signature:	Date:
Signature (safety functions):	Date:

21. DECLARATION OF INCORPORATION

SVAB
Precision Control Systems

Declaration of incorporation

According to EC Directive 2006/42/EC for machinery (Appendix IIB)

The manufacturer's name and address:
SVAB Hydraulik AB
Ulvsättersgatan 2
69491 Hallsberg
Sweden

We hereby give assurance, that the partially complete machine as described below

Article number: 150119, 150120, 150121 and 150133

Product description: MACS RT

fulfils the basic health and safety requirements of EC Directive 2006/42/EC, as far as products supplied by us permit, within the framework of the following harmonized standards:
EN12100:2010
EN474-1:2006+A1:2009
EN474-5:2006+A1:2009

Furthermore, we give assurance that the relevant technical documentation has been produced in accordance with section B of Appendix VII.
The partially completed machine also meets the requirements of EC Directive 2014/30/EU in relation to electromagnetic compatibility.

We commit to providing, on specific request by national authorities, relevant information about the partially completed machine.

The partially completed machine must not be put into operation, until the complete machine it is intended for incorporation within has been declared to conform with the regulations of Directive 2006/42/EC for machinery and until an EC declaration of conformity has been made, in accordance with Appendix IIA.

Person authorized to compile the relevant technical documentation:
Name: Magnus Sandgren
Address: SVAB Hydraulik, Ulvsättersgatan 2, SE-69491 Hallsberg

Hallsberg 2016-06-09

Fredrik Eriksson, CEO


SVAB
Excavator Control Systems