

12. Technical specifications

1	IDENTIFICATION		
1.3	Power source		Battery
1.4	Operating mode		Stand-on
1.5	Nominal capacity/load	Q [kg]	2000
1.6	Load center (COG)	c [mm]	600
1.8	Load wheel axel to fork face (forks lowered)	x [mm]	963*
1.9	Wheelbase (forks lowered)	y [mm]	1525*
2	WEIGHTS		
2.1	Truck weight (with nominal load & battery)	[kg]	2880
2.2	Axle loadings (with load and battery), drive/load side	[kg]	1800/1080
2.3	Axle loadings (without load/with battery), drive/load side	[kg]	220/660
3	WHEELS AND TYRES		
3.1	Tyres, material (R=rubber/Vul=Vulkollan) drive/load side		Vul/Vul
3.2	Load wheel dimensions (diameter x width)	[mm]	85x75
3.3	Drive wheel dimensions (diameter x width)	[mm]	250x100
3.4	Castor wheel dimensions (diameter x width)	[mm]	150x48
3.5	Number of the wheels (x=driven) drive/load side	[mm]	1x+1/4
3.6	Track width (centre of tyres), load side	b10 [mm]	375 (355,495)
3.7	Track width (centre of tyres), drive side	b11 [mm]	457
4	DIMENSIONS		
4.4	Lift	h3 [mm]	115
4.8	Platform height	h7 [mm]	239
4.15	Fork height, fully lowered	h13 [mm]	85
4.19	Overall lenght (platform up/down)	l1 [mm]	1915
4.20	Powerhead length (to fork face), platform up/down	l2 [mm]	763
4.21	Chassis (overall width)	b1/b2 [mm]	790
4.22	Fork dimensions (thickness/width/length)	s/e/l [mm]	50/165/1150
4.25	Outside width over forks	b5 [mm]	540 (520,680)
4.32	Ground clearance, center of wheelbase (forks lowered)	m2 [mm]	35
4.33	Working aisle width Ast, pallet 1000x1200, load crosswise	Ast [mm]	2577*
4.33	Working aisle width Ast3, pallet 1000x1200, load crosswise	Ast3 [mm]	2136*
4.34	Working aisle width Ast, pallet 800x1200, load lengthwise	Ast [mm]	2414*

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BACKWARD SWITCH

This test shows the status of the backward signal input to the controller at connector XA1 pins 7 or 8 depending on the truck direction for sit on models. For stand on models the accelerator voltage at connector XA1 pin 24 is varying from app. 0,98V in zero position increasing, in one direction to app. 1,78V and decreasing to app. 0,19V in the other direction depending on the truck direction for stand on models.

ON +VB = the backward travel request is active.

OFF GND = the backward travel request is not active.

FORWARD SWITCH

This test shows the status of the forward signal input to the controller at connector XA1 pins 7 or 8 depending on the truck direction for sit on models. For stand on models the accelerator voltage at connector XA1 pin 24 is varying from app. 0,98V in zero position increasing, in one direction to app. 1,78V and decreasing to app. 0,19V in the other direction depending on the truck direction for stand on models.

ON +VB = the backward travel request is active.

OFF GND = the backward travel request is not active.

CUTBACK SWITCH 2

This test shows the status of the CUTBACK SWITCH 2 at connector XA1 pin 6.

ON GND = the maximum speed is activated.

OFF +VB = the cutback speed 2 is activated.

CUTBACK SWITCH

This test shows the status of the CUTBACK SWITCH 1 at connector XA1 pin 11.

ON GND = the maximum speed is activated.

OFF +VB = the cutback speed 1 is not activated.

ENC SPEED

This test indicates the speed of the motor, expressed in the same units as the frequency; the information originates from the encoder bearing that is mounted inside the EPS motor. This is just for checking the encoder functionality.

MOTOR CURRENT

This test provides in real time the phase motor current A (RMS). (RMS refers to the method of measuring current).

MOTOR VOLTAGE

This test indicates the voltage supplied to the motor by the controller. It is expressed as a percentage of the full voltage (which depends on the battery voltage).

SAT FREQ HZ

This test provides the frequency during the constant voltage region.

FREQUENCY

This test indicates the frequency of the voltage and current that is supplied from the controller to the EPS motor.

MOTOR TEMPERAT.

This test provides the temperature (in °C) measured from an analogue sensor inside the motor. This temperature is used to raise a warning in the console, when the motor overtakes the MOTOR OVERTEMP setting. The resistance of the thermal sensor is 580 ohm at 20°C.

TEMPERATURE

This test provides the temperature (in °C) measured from the aluminium heat sink that holds the MOSFET devices.

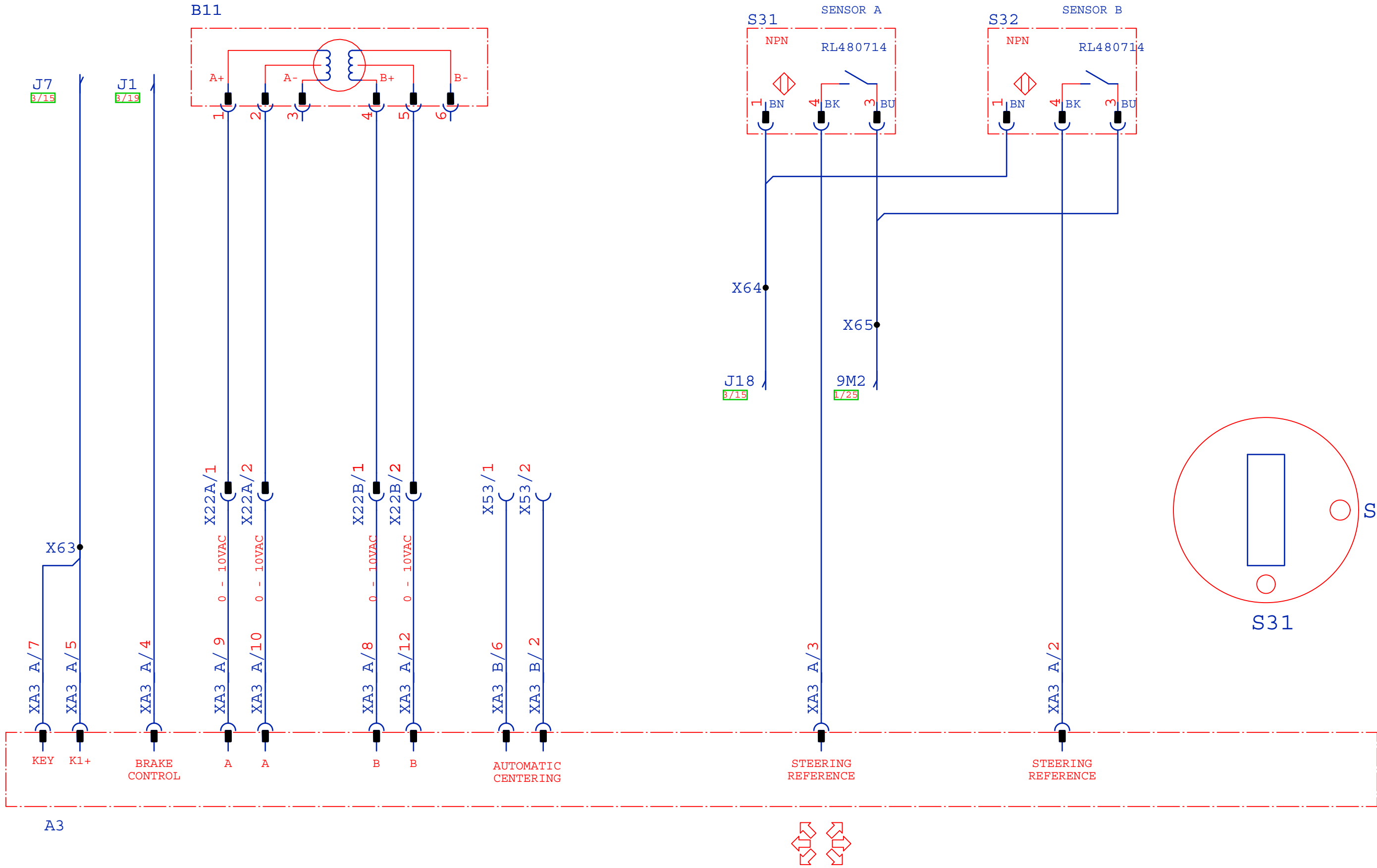
FEEDBACK ENC.

This test provides the voltage value with 2 decimal digits. Measurement (scaled in the range 0 – 5V dc) from the motor encoder.

STEERING WHEEL SENSOR

STEERING FEEDBACK SENSOR

STEERING FEEDBACK SENSOR



REV I DATE: 2011-05-12 CHANGE: S31 & S32 PINS



DATE: 2005-01-28

CIRCUIT DIAGRAM TS1130511

NPR20N, NPS20N, NO20NS
STEERING CIRCUIT

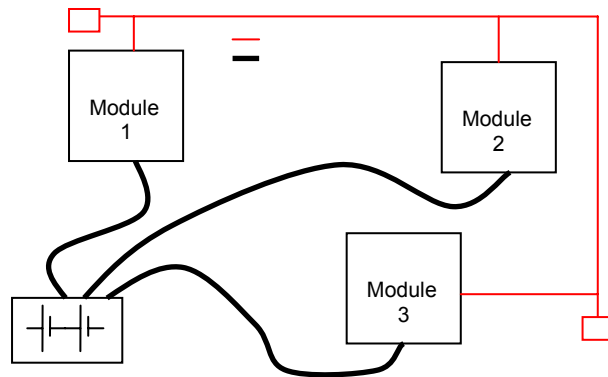
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Wrong Layout:

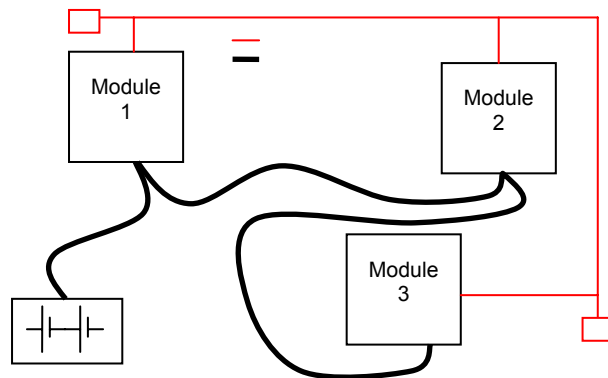


The red lines are can wires.
The black boxes are different modules, for example traction controller, pump controller and display connected by canbus.
The black lines are the power cables.

This is apparently a good layout, but can bring to errors in the can line.
The best solution depends on the type of nodes (modules) connected in the network.
If the modules are very different in terms of power, then the preferable connection is the daisy chain.



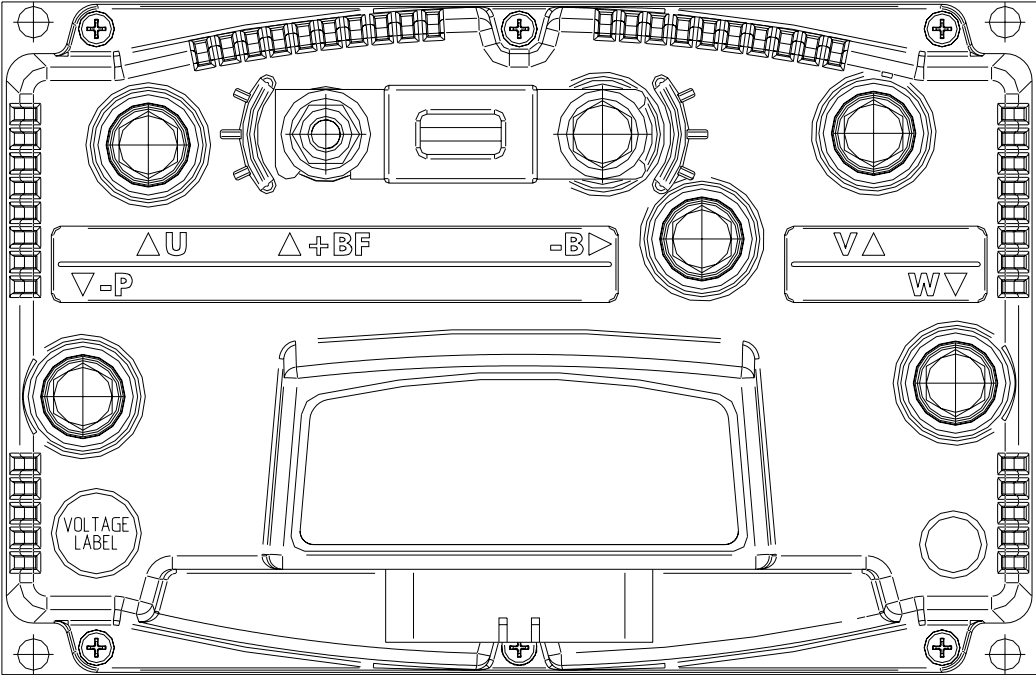
Correct Layout:



Note: Module 1 power > Module 2 power > Module 3 power

The chain starts from the –BATT post of the controller that works with the highest current, and the others are connected in a decreasing order of power.

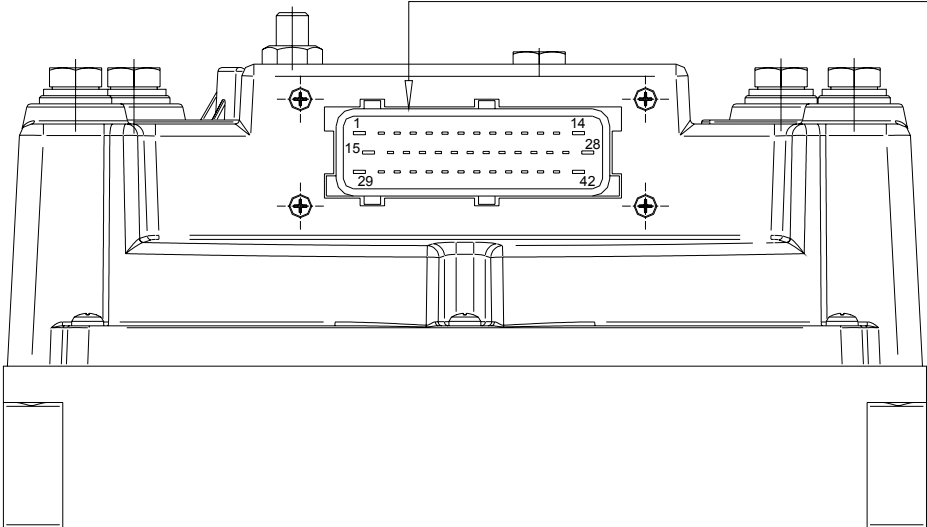
6 DESCRIPTION OF THE CONNECTORS



6.1 Connectors of the logic

AmpSaab version

AMP Junior Power Timer (SAAB CONN.)
42P Header CONNECTOR
(mate with housing receptacle P/N 1-0967281-1)

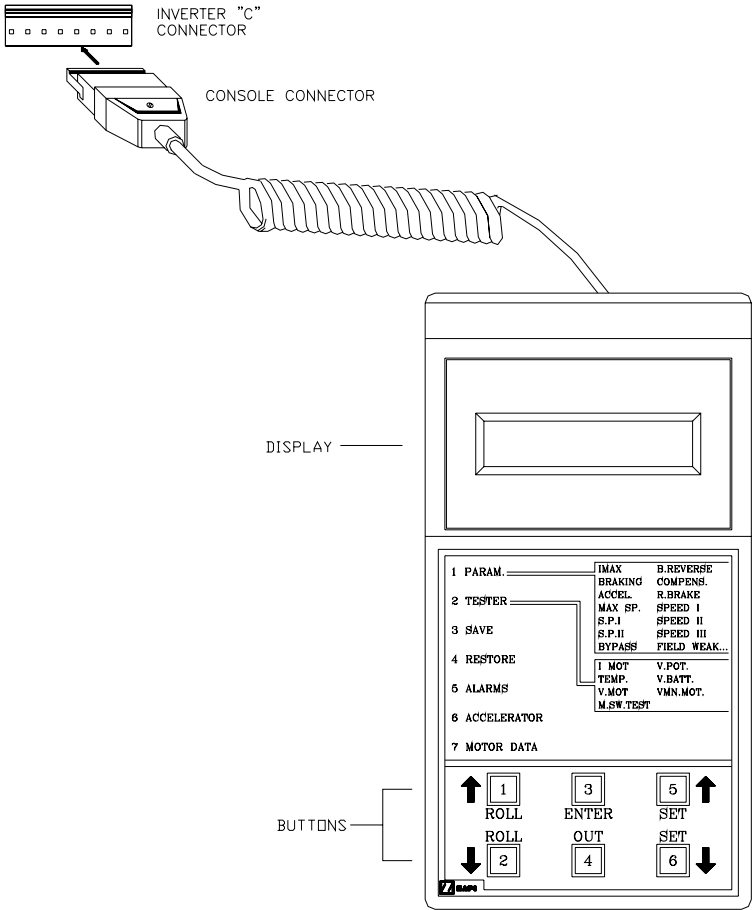


9 PROGRAMMING & ADJUSTMENTS USING DIGITAL CONSOLE

9.1 Adjustments via console

Adjustment of Parameters and changes to the inverter’s configuration are made using the Digital Console. The Console is connected to the CNA connector of the inverter.

9.2 Description of console (hand set) & connection



Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum Release Number: 3.02.

The section describes the Zapi hand set functions. Numbers inside the triangles correspond to the same number on the hand set keyboard buttons shown in the figure. The orientation of the triangle indicates the way to the next function.

1) ACCELER. DELAY

Seconds. It determines the acceleration ramp. The parameter sets the time needed to speed up the traction motor from 0Hz to 100Hz.

2) RELEASE BRAKING

Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

3) TILLER BRAKING

Seconds. It controls the deceleration ramp when the tiller is in braking position (released). The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz

4) INVERS. BRAKING

Seconds. It controls the deceleration ramp when the direction switch is inverted during travel. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

5) DECELERATION BRAKING

Seconds. It controls the deceleration ramp when the accelerator has turned down but not completely released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

6) SPEED LIMIT BRK

Seconds. It controls the deceleration ramp when a speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

7) CURVE BRAKING

Seconds. It controls the deceleration ramp when the curve cutback input becomes active. The parameter sets the time needed to decelerate from 100Hz to 0Hz.

8) MAX SPEED FWD

Percentage. It determines the maximum speed in forward direction.

9) MAX SPEED BWD

Percentage. It determines the maximum speed in backward direction.

10) CUTBACK SPEED 1

Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 1 (CUTBACK on CNA#11 in AmpSaab connector, CNA#6 in AmpSeal) is active. When set to 100% the speed reduction is ineffective.

11) CUTBACK SPEED 2

Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 2 is active. When set to 100% the speed reduction is ineffective.

9.5.5 Config menu “TESTER ” functions list

- 1) **MOTOR CURRENT**
Ampere. It is the current in the motor controlled by the slave of combiac1.
- 2) **MOTOR VOLTAGE**
It is the voltage of the motor controlled by the slave of combiac1, expressed in percentage of the maximum voltage.
- 3) **MOTOR POWER**
Watt. Estimate value of the traction motor power. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C).
- 4) **ENCODER**
Hz. Speed of the traction motor. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C)
- 5) **SLIP**
Hz. Estimate of traction motor slip. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C).
- 6) **MOTOR TEMPERATURE**
 $^{\circ}$ C. Measure of the pump motor temperature.
- 7) **LIFTING CONTROL**
Volt. Measure of the lift/lower potentiometer input (signal CPOTLIFT: CNA#25 in AmpSaab connector, CNA#30 in AmpSeal connector).
- 8) **HANDLE/SEAT SW**
On/off: it determines if the TILLER input is active or not (CNA#7 in AmpSaab, CNA#20 in AmpSeal).
- 9) **DIGITAL INPUT 1**
On/off : it determines if the input 1 is active or not (Lowering switch, CNA#5 in AmpSaab, CNA#20 in AmpSeal).
- 10) **DIGITAL INPUT 2**
On/off : it determines if the input 2 is active or not (Speed Reduction#1 switch, CNA#11 in AmpSaab, CNA#6 in AmpSeal).
- 11) **DIGITAL INPUT 3**
On/off : it determines if the input 3 is active or not (Forward switch, CNA#18 in AmpSaab, CNA#32 in AmpSeal).
- 12) **DIGITAL INPUT 4**
On/off : it determines if the input 4 is active or not (Reverse switch, CNA#19 in AmpSaab, CNA#31 in AmpSeal).
- 13) **DIGITAL INPUT 5**
On/off : it determines if the input 5 is active or not (CNA#20 in AmpSaab, CNA#19 in AmpSeal).

11.2 Master microcontroller alarms overview

Master error code	Related slave error code	Description	Effect	Machine status when the test is done	Restart procedure
Capacitor charge	Waiting for trac	Power capacitors voltage does not increase	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Vmn low	Waiting for trac	Motor output voltage lower than expected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Vmn high	Waiting for trac	Motor output voltage higher than expected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Power mos shorted	Waiting for trac	Short circuit on the power mosfets	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Coil short hw ko	Waiting for trac	Problem on the hardware circuit which manages shortcircuits on Lc/Eb coils	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Coil shorted	Waiting for trac	Shortcircuit on LC or EB coils	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Driver shorted	Waiting for trac	Driver of Lc coil is shorted, so it is not able to open the Lc	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Contacteur Driver	Waiting for trac	Driver of Lc coil is damaged (not able to close)	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Contacteur Open	Waiting for trac	The Lc coil has been driven but Lc does not close	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Contacteur closed	Waiting for trac	LC contact is stuck	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Aux driv. Shrt.	Waiting for trac	When the mos of EB is shorted	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, marcia	Valve or pump or traction request
Aux driver open	Waiting for trac	Driver of Eb coil is damaged (not able to close)	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Pos aux short	Waiting for trac	Output of built in Smart Driver, which supplies Eb coil positive, is high (= +batt) when the tiller switch is opened.	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Logic Failure #1	Waiting for trac	Overvoltage/Undervoltage condition has been detected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Logic Failure #2	Waiting for trac	Motor voltage feedback circuits are damaged	Valve, pump, traction stopped, Lc opened, Eb applied	stby, immediately after Lc closing	Valve or pump or traction request
Logic failure #3	Waiting for trac	Failure in the high current HW protection circuit	valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby	Valve or pump or traction request
Stby i high	Waiting for trac	In stby condition (no current applied to the motor) the current feedbacks are aout of permitted stby range	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby	Valve or pump or traction request
Wrong Set Battery	Waiting for trac	The battery voltage is too low or too high (< 0,8 Vbatt OR > 1,2 Vbatt)	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stand-by (only immediately after Lc closing)	Valve or pump or traction request
Analog input	Waiting for trac	Problem on the A/D conversion of Master uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Encoder Error	Waiting for trac	Problem on the encoder	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Tiller error	Waiting for trac	Input mismatch between hard&soft switch input and tiller input	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Watchdog	Waiting for trac	Master uC does not receive via canbus the correct stuffing bit from Slave uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Key re-cycle
Hw Fault	Waiting for trac	Master uC has detected that slave uC is not able to stop traction enable or EB-LC enable	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stand-by (only immediately after Lc closing)	Key re-cycle
No can msg N5	Waiting for trac	No can message from slave uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Key re-cycle
Wrong setpoint	Waiting for trac	Master uC has detected a Slave uC wrong hydraulic function setpoint	Valve, pump, traction stopped, Lc opened, Eb applied	continuous	Key re-cycle
Safety Feedback	Waiting for trac	Master uC has detected a problem on the feedback of EVP driver	Valve, pump, traction stopped, Lc opened, Eb applied	continuous	Key re-cycle
Vacc out of range	Waiting for trac	The voltage on Vacc is outside the range set with Program Vacc	Valve, pump, traction stopped, Eb applied	stby, traction	Program Vacc

Troubleshooting:

The alarm ends when the acquisition is done.

13) "PEDAL WIRE KO"

Cause:

The SW continuously checks for the connection of the two supply ends of the potentiometer in the accelerator. The test consists of reading the voltage drop on a sense diode, connected between NPOT (CNA#23 in AmpSaab connector) and GND and cascaded with the potentiometer: if the potentiometer gets disconnected on PPOT (CNA#26 in AmpSaab connector) or NPOT, no current flows in this sense diode and the voltage on the NPOT connection collapses down.

When the NPOT voltage is less than 0.3V this alarm occurs. This alarm occurs also when the NPOT voltage is higher than 2Vdc (to detect also the condition of a broken sense diode).

Troubleshooting:

Check the voltage on NPOT and the potentiometer connections.

14) "TILLER OPEN"

Cause:

Warning: when the tiller is released, after a fixed period of time of standby (30 seconds) the main contactor open.

Troubleshooting:

At the next travel request the warning disappear.

15) "CURRENT GAIN"

Cause:

The Maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.

Troubleshooting:

Ask the assistance of a Zapi technician to do the correct adjustment procedure of the current gain parameters.

16) "WAITING FOR NODE"

Cause:

The controller receives from the CAN the message that another controller in the net is in fault condition; as a consequence the traction controller itself cannot enter an operative status, but has to WAIT for the other controller coming out from the fault status.

12 RECOMMENDED SPARE PARTS

Part number	Description
C16506	FUSE PROT. 425A INTERAS60 (for 24v and 48v version)
C12505	AMPSAAB CONNECTOR 42 pins Female
C12532	AMPSEAL CONNECTOR 35 pins Female

3 FUNCTIONS OF THE EPS-AC0

The eps-ac0 controls a steer system for warehouse trucks. It executes the following functions:

- 1) Manual mode steering
- 2) Automatic Centering.

3.1 Manual Mode Steering

Manual mode steering requires a command sensor in the hand wheel. The hand wheel may be of two types:

- 1) Multiturn steering wheel without end-strokes.
- 2) Handlebar, tiller or joy-stick with end-strokes to limit the angle.

With a Multiturn steering wheel, the sensor in the hand-wheel shall be a stepper motor used as a tacho-generator (see Figure 3-1). Then the control will turn the steering motor moving at a speed proportional to the stepper motor speed (Open loop Mode).

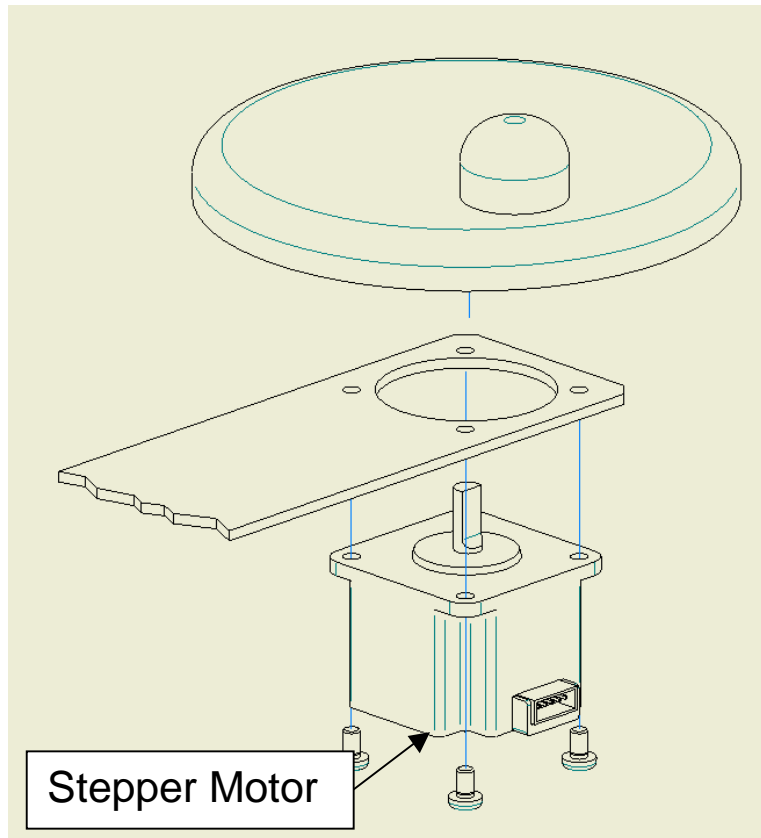


Figure 3-1

With a Handlebar (tiller or joy-stick), the sensor in the hand-wheel will be a twin pot (see Figure 3-2 below). Then the system works as a position control loop with a rigid correspondence between the angle of the handlebar and the angle of the steered wheel (Closed Loop Mode). In this case a feedback sensor on the steered wheel is mandatory.



Figure 4-8



Note: On request, it is possible to use the encoder for the motor control. In this case, the SW must know the encoder resolution together with the poles-pair number. The encoder resolution and the motor poles pair (the controller can handle), will be specified in the headline of the handset showing something like:

EPSAC0S2A ZP0.70

That means:

EPSAC0=Eps-ac0 steering controller

*S= Stepper motor
2= poles pair number
A= 32 pulses/rev encoder*

*ZP= SW release type Zapi
0.70= SW release number 0.70*

The command configuration is specified through the first letter after EPSAC0 in the following list:

*S= Stepper Motor
P= Twin Pot
C= via CAN Bus Position
D= via CAN Bus Speed*

The encoder resolution is given by the last letter before of the SW release in the following list:

8.2 General suggestion

For a proper installation take care of the following recommendations:



Never connect SCR low frequency chopper with AC Motor Inverter because the Rail capacitors alter the SCR choppers' work. If it is necessary to use two or more control units (e.g. traction + lift. + steering controller), they must belong to the ZAPIMOS family.



Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up".



During battery charge, disconnect the controller from the battery.



Supply the controller only with battery for traction; do not use a power supply.



When the inverter is installed, simulate a steering alarm and verify that both traction and electromechanical brake shall be de-energized in a very short time.



After the battery is disconnected, the Rail capacitor remains charged for some minutes; if you need to work on the inverter, discharge them using a $10 \Omega \div 100 \Omega$ resistance connected from the +Batt to the -Batt terminals in the controller side.



Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

8.3 Connection cables

- 1) For the auxiliary circuits, use cables at least 0.5 mm² section.
- 2) For power connections to the motor and to the battery, use cables having section of 4-6 mm² (as a minimum).
- 3) The power cables length must be as short as possible to minimize power losses.

9.1 Connectors of the logic

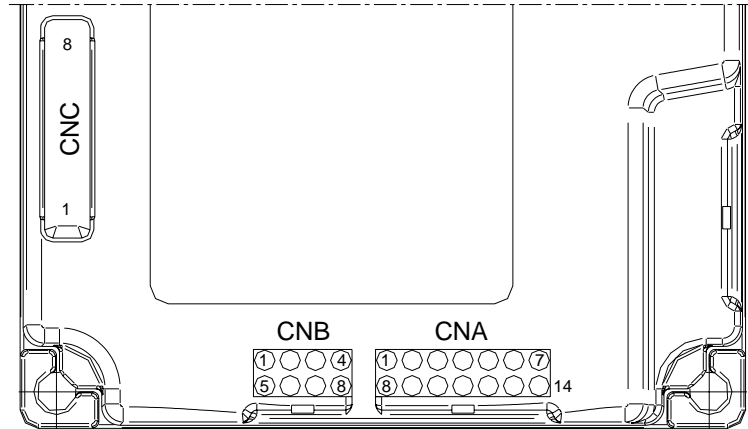


Figure 9–2

9.1.1 CNA connector

A1	DRIVE SWITCH	Traction Travel Demand Input.
A2	SW2	2 nd Toggle Switch or Left Limit Switch (LLS).
A3	SW1	1 st Toggle Switch or Right Limit Switch (RLS).
A4	NK1	Safety Switch Lower Voltage Point.
A5	K1	Safety Switch Higher Voltage Point.
A6	CANL	Can Bus Low.
A7	KEY	Key in (24-36 V _{batt}).
A8	CPOC2 / QL	2 nd SP POT Wiper or Stepper Motor Q line.
A9	CPOC1 / DL	1 st SP POT Wiper or Stepper Motor D line.
A10	NPOC	Twin SP POT Negative Supply (GND).
A11	GND	GND. Encoder Negative Supply
A12	GND	GND. SW1 & SW2 Negative.
A13	GND	GND. Motor Thermal Sensor Negative.
A14	CANH	Can Bus High.

9.1.2 CNB connector

B1	NPOT	FB POT Negative Supply.
B2	PPOT	FB POT Positive Supply.
B3	THMOT	Motor Thermal Sensor (KTY84-130) Input.
B4	+5VDC	Encoder Positive Supply.
B5	PPOC	Twin SP POT Positive Supply (5 Vdc).

11 SETTING THE EPS-AC0

11.1 Complete set-up description

This procedure shall be executed on the prototype after the installation procedure is completed (see topic 10). The complete set-up changes vs. the truck configuration. Seek your own configuration below:

11.1.1 Stepper Motor only

- Step1** Set the SET SAT FREQ adjustment to the corner frequency of the steering motor (see 12.4.2.7).
- Step2** Set OVERSAT FREQ adjustment in order the sum between SET SAT FREQ and OVERSAT FREQ gives the wished maximum steering motor speed (see 12.4.2.8).
- Step3** Set the NO LOAD CURRENT adjustments to the current the motor drains when lightened at the maximum flux (see 12.4.2.10).
- Step4** Set the steer sensitivity with the SPEED LIMIT and SENSITIVITY parameters (see 12.4.4.1-2).
- Step5** Set AUTO REQ TYPE in the set model menu to level 0 (no automatic function). (See 12.4.3.2).
- Step6** (CAN Based system only). Set the Dynamic Numbness in open loop (steering sensitivity reduces when the truck speed increases). Use parameters AUX FUNCTION#2 and AUX FUNCTION #3 (see 12.4.4.5-4).
- Step7** (No CAN Based system only). Connect a traction travel demand to CNA#1. It can be a tiller switch (or a dead-man or a seat switch). This operation supplies the information the truck is moving or not to stand-by the steer when the truck is standing.

11.1.2 Stepper Motor & AUTC

When the AUTC is required, it is necessary to carry out all the Steps in paragraph 11.1.1 together with the following:

- Step1** When the autocentering (AUTC) is required, it is necessary to contact a Zapi technician to decide the physical and the superior protocol layers for the AUTC demanding. (AUTC is a customized function that the eps-ac0 does not execute in its standard version).
One possible arrangement for the AUTC request could be a via CAN bus demanded centering.
- Step2** Turn the truck in the automatic centering mode, drive the truck and roll up and down the adjustment SET STEER 0-POS until the truck is straight travelling.
- Step3** Set the parameters KP, POS. ACCURACY, LEAD FB REGULAT and LAG FB REGULAT to avoid overshoot or damping during the centering operation (see paragraph 12.4.4).

11.1.3 RTC (Twin Pot) only

- Step1** Set the SET SAT FREQ adjustment to the corner frequency of the steering motor (see 12.4.2.7).
- Step2** Set OVERSAT FREQ adjustment in order the sum between SET SAT FREQ and OVERSAT FREQ gives the wished maximum steering motor speed (see 12.4.2.8).

1) HOUR COUNTER

This option specifies the hour counter mode. It can be set one of two:

- RUNNING: The counter registers travel time only.
- KEY ON: The counter registers when the "key" switch is closed.

2) MICRO CHECK

This option is useful to support debug and troubleshooting. It makes possible to inhibit the supervisor (Slave uC) operations and allows the system to run with just the Main uC. When entering this operating mode the safety contacts stay open. Therefore, traction shall be disabled. It can be set one of two:

- PRESENT: Default setting: enable the operations of the supervisor (Slave uC).
- ABSENT: Disable the operations of the supervisor (Slave uC). The safety contacts stay opened.

3) FEEDBACK DEVICE

This option specifies which kind of Feedback Sensor is adopted. Here is the feedback sensor list:

- OPTION #1: FB POT only.
The only feedback sensor is the potentiometer at the steered wheel. This setting must be temporary chosen for the set-up of the FB ENC & FB POT configuration (see below). After the set-up is ended, it is necessary to turn FEEDBACK DEVICE to OPTION #2 to get the steer working with FB ENC & FB POT.
- OPTION #2: FB POT & FB ENC.
This is the right setting when the encoder is chosen together with the FB POT. Pay attention, the set-up must be done with the FEEDBACK DEVICE to OPTION #1. When the set-up is finished, turn to OPTION #2. When the FEEDBACK DEVICE is OPTION #2 an automatic centering is always carried out at key-on.
- OPTION #3: FB POT & FB ENC & ONE TOGGLE SWITCH
This is the right setting when the encoder is chosen together with the FB POT and a straight ahead toggle switch (SW1). Pay attention, the set-up must be done with the FEEDBACK DEVICE to OPTION #1. When the set-up is finished, turn to OPTION #3. When the FEEDBACK DEVICE is OPTION #3 an automatic centering is always carried out at key-on.
- OPTION #4: FB ENC & ONE (or TWO) TOGGLE SWITCHES
This is the right setting when the FB POT is not present and two toggle switches are adopted (normally in the straight and 90 degrees angled positions of the steered wheel). At key on, an Automatic Centering operation is executed seeking the Toggle Switch signal (SW1 on CNA#3). When the Toggle Switch edge is met the Encoder counter is zeroed. The 2nd Switch (SW2 on CNA#2) is used to verify the encoder counter at 90° is matched with the SW2 transition.

4) LIMIT DEVICE

(Versions with FEEDBACK DEVICE to OPTION #1, 2, 3 only). When this option is set ON, the steered wheel angle will be limited using the feedback sensor value. It can be set one of two:

- ON: When the feedback sensor overtakes either the CW or the CCW limit (see 12.4.2.13-14, SET MAX FB POT, SET MIN

1) **SPEED LIMIT**

(Stepper Motor version only). Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is fast turning. By increasing the SPEED LIMIT value, the steering motor speed increases too. In practice, it sets the maximum motor speed when the steering wheel is fast turning.

2) **SENSITIVITY**

(Stepper Motor version only). Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is slow turning. By increasing the SENSITIVITY value, the steering motor speed increases too. In practice, it changes the sensitivity of the steering wheel when it is slow turning.

3) **CREEP SPEED**

Level 0 to 9. It sets a minimum amount of motor torque when the steering motor is slow turning. It is useful (together with the ANTIROLLBACK parameter, see 12.4.4.12) to neutralize the recall torque generated by the elastic tyre on the steered wheel.

4) **AUX FUNCTION #3**

Depending on the configuration, this parameter has different meaning.

RTC version:

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, this setting adjusts the maximum angle at full truck speed. When the truck speed increases, the maximum steered wheel angle reduces proportionally. When the truck is full speed the steered wheel angle is limited to a percentage of the absolute maximum steered wheel angle (i.e. 90 degrees) specified with this setting.

- LEVEL 0: Maximum steered angle at full truck speed is 73% (i.e. 66 degrees).
- LEVEL 1: Maximum steered angle at full truck speed is 66% (i.e. 59 degrees).
- LEVEL 2: Maximum steered angle at full truck speed is 59% (i.e. 53 degrees).
- LEVEL 9: Maximum steered angle at full truck speed is 10% (i.e. 9 degrees).

Each step has a weight of 7%.

Stepper Motor version:

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTION #3 does that but only when the steering wheel is **fast** turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #3 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #3 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the Dynamic Numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

10) MOTOR VOLTAGE

It is a percentage. 100% means the sine waves in the motor have the maximum PWM amplitude.

11) MOTOR CURRENT

Ampere value. Root Mean Square value of the line current in the motor.

12) ENC SPEED

Hertz value with 2 decimal digit. This is the speed of the motor measured with the encoder on the motor shaft.

13) ENDSTROKE CW

Provides real time the active state (ON) or not of the CW toggle switch (connected to CNA#3). It is On when CNA#3 is low (see 7.5).

14) ENDSTROKE ACW

Provides real time the active state (ON) or not of the CCW toggle switch (connected to CNA#2). It is On when CNA#2 is low (see 7.5).

15) CW LIMIT LEVEL

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON when FEEDBACK DEVICE is OPTION #1,2,3; 1ST ANGLE COARSE and 2ND ANGLE COARSE less than level 9 when FEEDBACK DEVICE is OPTION #4) and the FEEDBACK ENC overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active).

16) ACW LIMIT LEVEL

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON when FEEDBACK DEVICE is OPTION #1,2,3; 1ST ANGLE COARSE and 2ND ANGLE COARSE less than level 9 when FEEDBACK DEVICE is OPTION #4) and the FEEDBACK ENC is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active).

17) AUTO IN PROGRESS

Provides real time the information the eps-ac0 follows the manual command (AUTO IN PROGRESS is OFF) or is executing an automatic centering (AUTO IN PROGRESS is ON).

18) MM ALARM SWITCH

It is On when the safety contact belonging to the main uC is closed.

19) SM ALARM SWITCH

It is On when the safety contact belonging to the slave uC (supervisor) is closed.

20) TRUCK MOVING

It provides the state of the travel demand for driving the truck. This information is obtained either with the travel demands directly connected to CNA#1 or via CAN Bus (depending by the state of the CAN BUS setting see 12.4.5.2).

21) HIGH RESOL AD

It turns ON when the set point potentiometer is processed with a high resolution AD.

WHEEL ANGLE [degrees]	Admitted sector	Admitted FEEDBACK SECTOR
-22 to +22	1 st or 4 th	3.13 V or 1.88 V
+23 to +67	1 st	3.13 V
+68 to +112	1 st or 2 nd	3.13 V or 4.39 V
+113 to +157	2 nd	4.39 V
+158 to -158	2 nd or 3 rd	4.39 V or 0.62 V
-157 to -113	3 rd	0.62 V
-112 to -68	3 rd or 4 th	0.62 V or 1.88 V
-67 to -23	4 th	1.88 V

- Remedy: Check the potentiometer connected to CNB#6 is right working. If toggle switches are connected to CNA#2 and CNA#3, verify they are right working and the setting AUX FUNCTION 11 (see 12.4.1.9) is correct. Verify also the sensor bearing in the motor (encoder) has not a slip (the sensor bearing has two rings: one is connected to the rotor shaft; the other is connected to the motor frame. Check these two rings are strictly connected to their structure without slip.

6) STEER SENSOR KO

CAN Bus Code =84

- Cause: This alarm occurs if the command potentiometer (CPOC1 on CNA#9 or CPOC2 on CNA#8) changes with a jerk larger than MAX SP SLOPE (see 12.4.6.3). This alarm is used to catch a discontinuity in the voltages of the command potentiometer.
- Remedy: Change the twin pot.

7) JERKING FB POT

CAN Bus Code =223

- Cause: This alarm occurs if the feedback potentiometer (CPOT on CNB#6) changes with a jerk larger than 0.3 V in 16 msec. This alarm is used to catch a discontinuity in the voltages of the feedback potentiometer.
- Remedy: Change the feedback potentiometer.

8) FB POT LOCKED or FB SENS LOCKED

CAN Bus Code =222

- Cause: In application with a feedback potentiometer, this alarm occurs if the feedback potentiometer (CPOT on CNB#6) does not change (or changes in the opposite direction) its value even if commanded to change.
In application with toggle switches with ENCODER CONTROL to off, this alarm occurs if the feedback encoder counting does not change its value even if commanded to change.
- Remedy: In application with the feedback potentiometer, verify the feedback potentiometer is not mechanically loosened. Check there is not a mechanical block of the steered wheel.
Be sure the wiper has not reached its own electrical limit because of too much angle of the steered wheel.
Besides, this alarm may occur at the installation when the motor rotates in the wrong direction turning away from the wished

31

VMN HIGH

(Alarm)

Stored

Cause 1:

Before switching the main contactor on, the software checks the power bridge; it turns on alternatingly the low side and high side power mosfets and expects the phases to be lower than 1/2 V batt. If it is higher than this value, this alarm occurs.

Cause 2:

This alarm may occur also when the startup diagnosis is overcome and the main contactor is closed. In this condition, the phases voltages are expected to be lower than 1/2 V batt. If it is higher than this value, this alarm occurs.

a) If the alarm happens during start up (the main contactor does not close at all), check following:

- motor internal connections (ohmic continuity)
- motor power connections
- motor leakage to truck frame
- if the motor connections are OK, the fault is in the Combiac1 controller.

b) If the alarm occurs after closing the main contactor (the main contactor closes and then opens again), check following:

- motor connections
- if motor phases windings/cables have leakages towards truck frame
- that the main contactor closes properly, with a good contact
- if no faults are found, the fault is in the Combiac1 controller.

37

CONTACTOR CLOSED (Alarm)

Stored

Cause:

Before driving the main contactor coil, the controller checks that contactor not is stuck (closed). The controller drives the mosfets for some milliseconds, trying to discharge the capacitor bank. If they don't discharge, this alarm occurs.

Check following:

- main contactor tips
- if needed replace the main contactor

250 **THERMIC SENS KO** **(Warning)** **Stored**

Cause:

The output of the controller thermal sensor is out of range.

This type of fault is not related to external components; so, when it is present it is necessary to replace the Combiac1 controller.

251 **WRONG SET BAT.** **(Alarm)** **Stored**

At startup the controller check the battery voltage and verify that it is within a window around the nominal value.

a) Check that the controller SET BATTERY parameter value matches the battery nominal voltage.

b) Check that the TESTER MENU/ BATTERY VOLTAGE parameter shows same value as the battery voltage measured with a voltmeter. If it does not match; then do a "ADJUST BATTERY" function.

c) Replace the battery.

253 **SLIP PROFILE** **(Alarm)** **Stored**

Cause:

There is an error on the choice of the parameters of the slip profile.

Check in the HARDWARE SETTING menu the value of those parameters.

254 **AUX DRIV. SHRT.** **(Alarm)** **Stored**

The driver of the electromechanical brake is shorted.

a) Check if there is a short between XA1 pin 31 and XA1 pin 30.

b) The driver is damaged in the Combiac1 controller, which has to be replaced.

252 VALVE CONT DRV (Alarm) Stored

Cause:

This alarm occurs when one or more valve drivers are not able to drive the load.

This is an internal fault of the Combiac1 controller, so it must be replaced.

253 VALVE DRV SHORT (Alarm) Stored

Cause:

This alarm occurs when one or more valve drivers are shorted.

Check that there is no short between the negative of the coils and -BATT. Otherwise there is an internal fault of the Combiac1 controller, so it must be replaced.

254 VALVE COIL SHOR. (Alarm) Stored

Cause:

This alarm occurs when there is a short circuit in a valve coil.

a) If the fault is present at start up, it is the hardware overcurrent protection circuit which is damaged; the Combiac1 controller must be replaced.

b) If the fault is present only when the controller activates the outputs, the problem is in the harness or in the coils.

250	MICRO SLAVE	(Alarm)	Stored
	Cause: This alarm occurs when the internal microprocessor information does not match.		
	It is necessary to replace the EPS controller.		
251	KM OPEN	(Alarm)	Stored
	Cause: This alarm occurs when the microprocessor detects that the internal safety contact is open, when expected to be closed.		
	It is necessary to replace the EPS controller.		
252	KS OPEN	(Alarm)	Stored
	Cause: This alarm occurs when the microprocessor detects that the second internal safety contact is open, when expected to be closed.		
	It is necessary to replace the EPS controller.		
253	KM CLOSED	(Alarm)	Stored
	Cause: This alarm occurs when the microprocessor detects that the internal safety contact is closed, when expected to be open.		
	It is necessary to replace the EPS controller.		
254	KS CLOSED	(Alarm)	Stored
	Cause: This alarm occurs when the microprocessor detects that the second internal safety contact is closed, when expected to be open.		
	It is necessary to replace the EPS controller.		

Mast must be lowered to free-lift area, and truck switched Off/On. If fault continues, check the functionality of the free-lift sensor.

234 INPUT MISMATCH (Alarm) Stored

Cause:

This is a safety related test. The micro processor has detected a mismatch between analogy and digital information.

This is an internal fault of the Combiac1 controller, so it must be replaced.

235 HW FAULT VALVE (Alarm) Stored

Cause:

The micro processor has detected that the controller is not able to stop hydraulic valve functions.

This is an internal fault of the Combiac1 controller, so it must be replaced.

236 HARDWARE FAULT (Alarm) Stored

Cause:

The microprocessor has detected that the controller is not able to stop the traction.

This is an internal fault of the Combiac1 controller, so it must be replaced.

237 MASTER REDUCTION (Warning)

Cause:

This is information from traction controller side. There is some reduction active at the traction controller. Warning disappears when reduction is not active.

Connect handset to traction controller and check traction controller functionality.

219	STEPPER MOTOR MISM (Alarm)	Stored
	<p>Cause: This alarm occurs if the frequency and the amplitude of the voltages from the stepper motor lines are mismatched in between the D and Q line of the stepper motor.</p> <p>It is necessary to replace the EPS controller.</p>	
220	MOTOR LOCKED (Alarm)	Stored
	<p>Cause: This alarm occurs if the current in the steering motor stays close to the maximum current longer than 1 sec.</p> <p>Search for a mechanical problem locking the steering motor.</p>	
222	FB POT LOCKED (Alarm)	Stored
	<p>Cause: This alarm occurs if the feedback hall sensor or potentiometer does not change (or changes to opposite direction) value even if it is commanded to change.</p> <p>a) Check that feedback sensor is not mechanically loosened.</p> <p>b) Check that connectors and cables of feedback sensor are in order.</p> <p>b) Verify that motor phases are not wrong way, cables are installed in correct places.</p>	
223	JERKING FB POT (Alarm)	Stored
	<p>Cause: This alarm occurs if the feedback hall sensor or potentiometer voltage switching more than 0,3V in 16msec. This alarm is used to catch potentiometer discontinuities.</p> <p>Replace the feedback sensor.</p>	

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This parameter controls how this system is set up. Factory default setting is “0”, which means that this is a closed loop mode specification. The stepper motor is used as a tachogenerator to supply the wished steering motor speed.

This setting specifies that the feed back sensors are present.

The “FEEDBACK” device option specifies which kind of feedback sensor is adopted.

AUTO REQ TYPE

This parameter controls the type of automatic request. The standard version has no automatic function so this setting is not effective. Factory setting is “0”. Do not change the default value!

CONNECTED TO

Use this parameter to select the controller to access with the console. You can access any controller that is connected to the CAN bus. If there is a CAN BUS KO alarm active, you cannot select another controller. In this case, you must connect the console directly to the controller you wish to access.

In normal circumstances, you can choose the controller from the following options:

- 2: Traction motor controller
- 5: Pump motor controller
- 6: Electric power steering controller
- 10: Encoder card

MODEL TYPE

This parameter is not in use. Factory default setting is “0”. Do not change the default value!

SUBMENU: ADJUSTMENTS

ADJUSTMENT #01

This parameter supports the acquisition of the stator motor resistance and the current amplifier gain. Factory default setting is “0”. Do not change the default value!

SET CURRENT

This parameter is related to ADJUSTMENT #01 and SET CURRENT. Factory default setting is “0”. Do not change the default value!

ADJUSTMENT #02

1. Truck

General Information

Warehouse trucks are designed and manufactured to lift and transport materials indoors. Please read this manual before operating or performing maintenance on the truck. After reading this manual, store it in a safe, dry place for later use.

The truck conforms to the EN 1726-1 standard, ensuring its safety according to the EU machine directive 98/37/EC. The most important regulations and guidelines are mentioned in these instructions. As regulations vary from country to country, we expect you to familiarize yourself with the regulations and standards valid in your country. For further information on trucks or training, please contact our sales organization.

A truck may cause serious accidents unless you are sufficiently familiar with its operation and unless you know its operating and maintenance instructions. To order more copies of the instruction book, contact your dealer.

Electromagnetic compatibility

The truck conforms to the EN 12895 standard, ensuring its safety according to the EMC directive 89/336/EEC. The truck is designed for light and heavy industry use (EN 50081-1 and EN 50082-2).

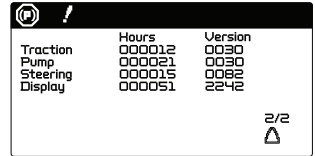
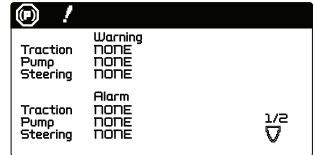
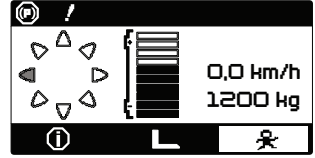
WARNING! *Do not make any modifications to the electric devices in the truck without the manufacturer's expressed permission. Modifications to electric devices may affect the electromagnetic compatibility and, therefore, reduce operational safety.*

Delivery

Before shipping, each truck is inspected carefully to make sure that the truck you receive is flawless and fully equipped. Nevertheless, check the truck immediately after receiving it for any damages that may have occurred during shipping.

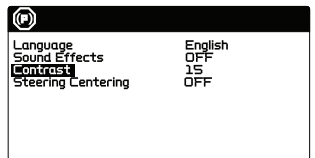
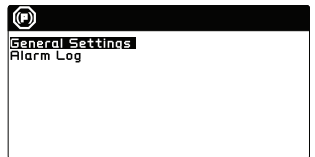
MESSAGE CENTER

Menu	Display	Description
MESSAGE CENTER (Press "ESC")		
Message center 1/2		Basic information about the truck's status:
	Warning	Last warning message (e.g. Incorrect start)
	Alarm	Last alarm message (e.g. Main contactor)
Message center 2/2		Basic information about the truck's status continues:
	Hours	Operational hours
	Version	Software version

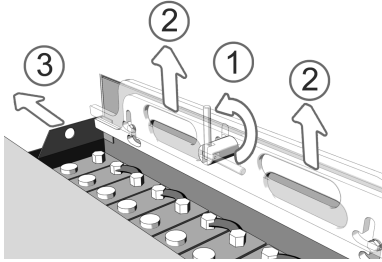


MAIN MENU

Menu	Setting	Description
MAIN MENU		
Main menu	General settings	List of operator adjustable settings for the display
	Alarm log	List of alarms
Main menu / General settings	Language	English / Finnish / French / German / Italian / Portuguese / Spanish / Swedish
	Sound Effects	OFF/ON
	Contrast	Display contrast setting 0-14 (default 13)



3. Replace the battery (3).



Acquiring a new battery

When acquiring a battery for the truck, take the following sections of standard EN 1175-1 into consideration:

- 5.1 Traction batteries (includes the requirements for the protective cover of the battery case, ventilation and interior surface treatment)
- 7.4 Minimum markings (includes the requirements for the truck battery plate).

The battery plate should give at least the following information:

- Manufacturer
- Type
- Serial number
- Nominal voltage
- Capacity (Ah / 5h)
- Service weight.

12. Technical specifications

1	IDENTIFICATION		
1.3	Power source		Battery
1.4	Operating mode		Stand-on
1.5	Nominal capacity/load	Q [kg]	2000
1.6	Load center (COG)	c [mm]	600
1.8	Load wheel axel to fork face (forks lowered)	x [mm]	963*
1.9	Wheelbase (forks lowered)	y [mm]	1525*
2	WEIGHTS		
2.1	Truck weight (with nominal load & battery)	[kg]	2880
2.2	Axle loadings (with load and battery), drive/load side	[kg]	1800/1080
2.3	Axle loadings (without load/with battery), drive/load side	[kg]	220/660
3	WHEELS AND TYRES		
3.1	Tyres, material (R=rubber/Vul=Vulkollan) drive/load side		Vul/Vul
3.2	Load wheel dimensions (diameter x width)	[mm]	85x75
3.3	Drive wheel dimensions (diameter x width)	[mm]	250x100
3.4	Castor wheel dimensions (diameter x width)	[mm]	150x48
3.5	Number of the wheels (x=driven) drive/load side	[mm]	1x+1/4
3.6	Track width (centre of tyres), load side	b10 [mm]	375 (355,495)
3.7	Track width (centre of tyres), drive side	b11 [mm]	457
4	DIMENSIONS		
4.4	Lift	h3 [mm]	115
4.8	Platform height	h7 [mm]	239
4.15	Fork height, fully lowered	h13 [mm]	85
4.19	Overall lenght (platform up/down)	l1 [mm]	1915
4.20	Powerhead length (to fork face), platform up/down	l2 [mm]	763
4.21	Chassis (overall width)	b1/b2 [mm]	790
4.22	Fork dimensions (thickness/width/length)	s/e/l [mm]	50/165/1150
4.25	Outside width over forks	b5 [mm]	540 (520,680)
4.32	Ground clearance, center of wheelbase (forks lowered)	m2 [mm]	35
4.33	Working aisle width Ast, pallet 1000x1200, load crosswise	Ast [mm]	2577*
4.33	Working aisle width Ast3, pallet 1000x1200, load crosswise	Ast3 [mm]	2136*
4.34	Working aisle width Ast, pallet 800x1200, load lengthwise	Ast [mm]	2414*

BACKWARD SWITCH

This test shows the status of the backward signal input to the controller at connector XA1 pins 7 or 8 depending on the truck direction for sit on models. For stand on models the accelerator voltage at connector XA1 pin 24 is varying from app. 0,98V in zero position increasing, in one direction to app. 1,78V and decreasing to app. 0,19V in the other direction depending on the truck direction for stand on models.

ON +VB = the backward travel request is active.

OFF GND = the backward travel request is not active.

FORWARD SWITCH

This test shows the status of the forward signal input to the controller at connector XA1 pins 7 or 8 depending on the truck direction for sit on models. For stand on models the accelerator voltage at connector XA1 pin 24 is varying from app. 0,98V in zero position increasing, in one direction to app. 1,78V and decreasing to app. 0,19V in the other direction depending on the truck direction for stand on models.

ON +VB = the backward travel request is active.

OFF GND = the backward travel request is not active.

CUTBACK SWITCH 2

This test shows the status of the CUTBACK SWITCH 2 at connector XA1 pin 6.

ON GND = the maximum speed is activated.

OFF +VB = the cutback speed 2 is activated.

CUTBACK SWITCH

This test shows the status of the CUTBACK SWITCH 1 at connector XA1 pin 11.

ON GND = the maximum speed is activated.

OFF +VB = the cutback speed 1 is not activated.

ENC SPEED

This test indicates the speed of the motor, expressed in the same units as the frequency; the information originates from the encoder bearing that is mounted inside the EPS motor. This is just for checking the encoder functionality.

MOTOR CURRENT

This test provides in real time the phase motor current A (RMS). (RMS refers to the method of measuring current).

MOTOR VOLTAGE

This test indicates the voltage supplied to the motor by the controller. It is expressed as a percentage of the full voltage (which depends on the battery voltage).

SAT FREQ HZ

This test provides the frequency during the constant voltage region.

FREQUENCY

This test indicates the frequency of the voltage and current that is supplied from the controller to the EPS motor.

MOTOR TEMPERAT.

This test provides the temperature (in °C) measured from an analogue sensor inside the motor. This temperature is used to raise a warning in the console, when the motor overtakes the MOTOR OVERTEMP setting. The resistance of the thermal sensor is 580 ohm at 20°C.

TEMPERATURE

This test provides the temperature (in °C) measured from the aluminium heat sink that holds the MOSFET devices.

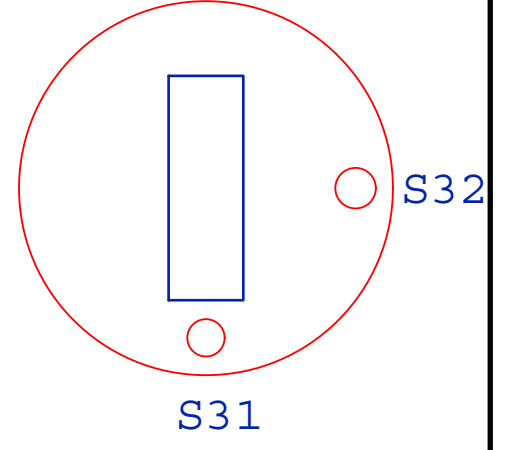
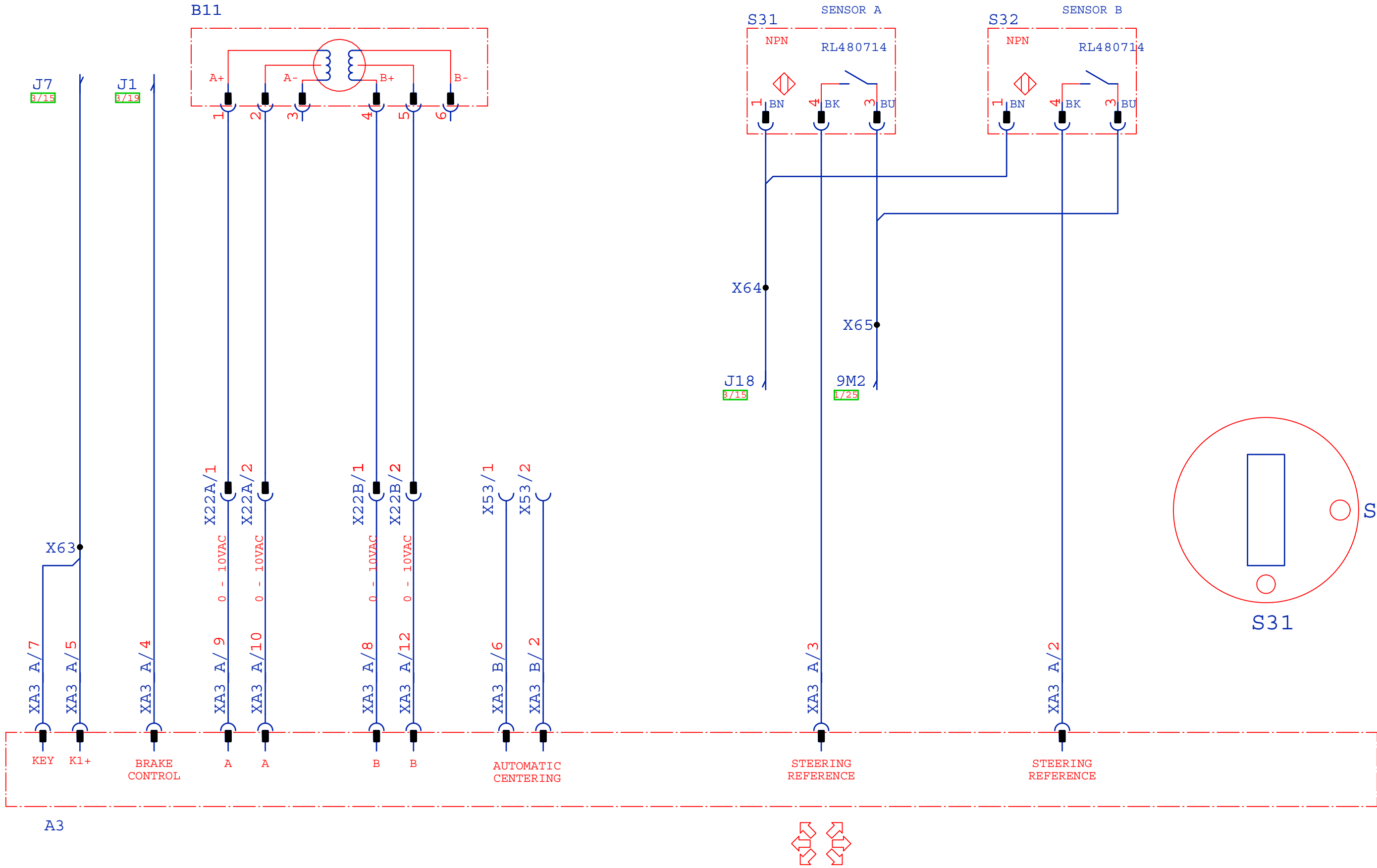
FEEDBACK ENC.

This test provides the voltage value with 2 decimal digits. Measurement (scaled in the range 0 – 5V dc) from the motor encoder.

STEERING WHEEL SENSOR

STEERING FEEDBACK SENSOR

STEERING FEEDBACK SENSOR



REV DATE: 2011-05-12
 CHANGE: S31 & S32 PINS



DATE: 2005-01-28

CIRCUIT DIAGRAM TS1130511

NPR20N, NPS20N, NO20NS
 STEERING CIRCUIT

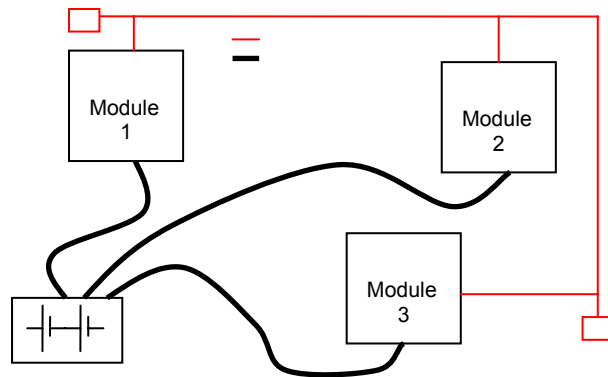
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Wrong Layout:

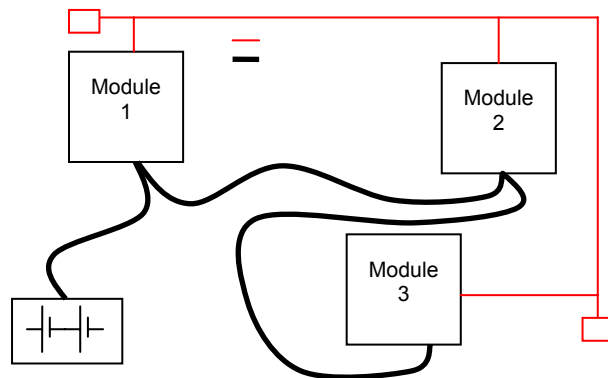


The red lines are can wires.
The black boxes are different modules, for example traction controller, pump controller and display connected by canbus.
The black lines are the power cables.

This is apparently a good layout, but can bring to errors in the can line.
The best solution depends on the type of nodes (modules) connected in the network.
If the modules are very different in terms of power, then the preferable connection is the daisy chain.



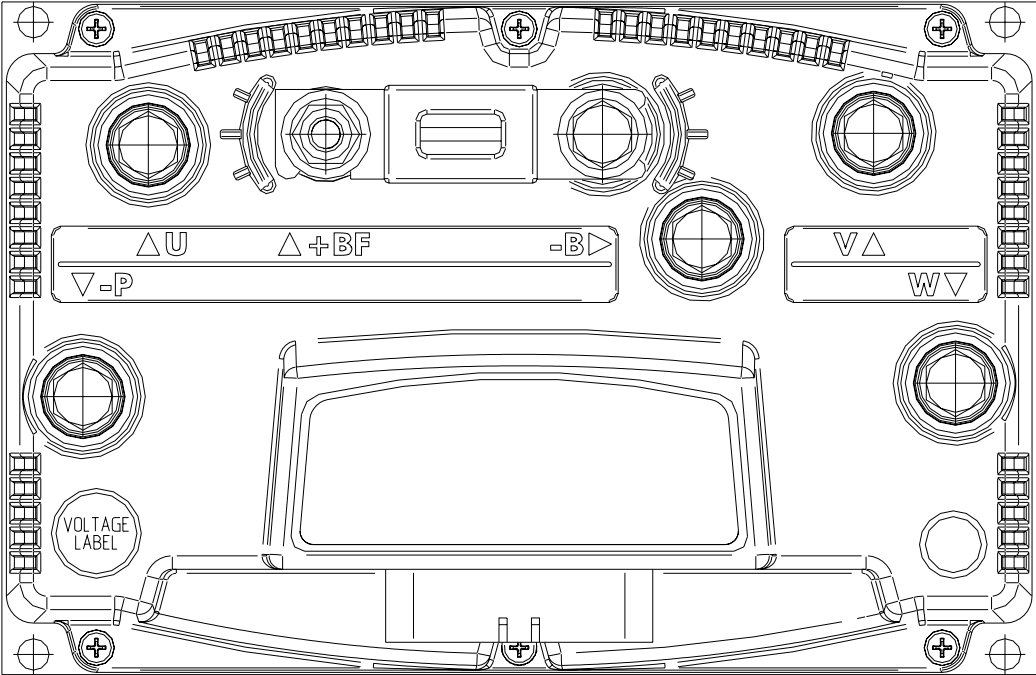
Correct Layout:



Note: Module 1 power > Module 2 power > Module 3 power

The chain starts from the –BATT post of the controller that works with the highest current, and the others are connected in a decreasing order of power.

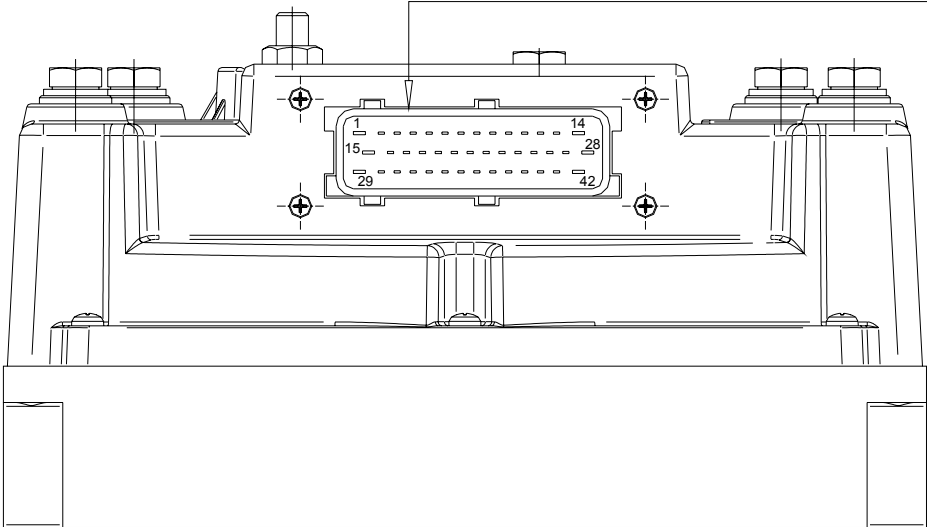
6 DESCRIPTION OF THE CONNECTORS



6.1 Connectors of the logic

AmpSaab version

AMP Junior Power Timer (SAAB CONN.)
42P Header CONNECTOR
(mate with housing receptacle P/N 1-0967281-1)

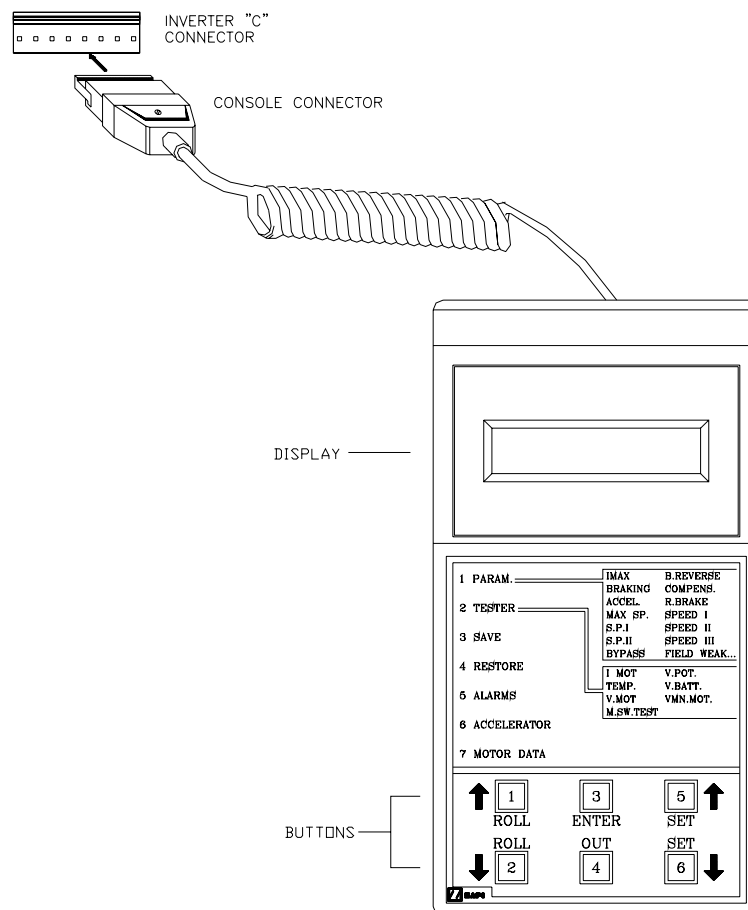


9 PROGRAMMING & ADJUSTMENTS USING DIGITAL CONSOLE

9.1 Adjustments via console

Adjustment of Parameters and changes to the inverter's configuration are made using the Digital Console. The Console is connected to the CNA connector of the inverter.

9.2 Description of console (hand set) & connection



Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum Release Number: 3.02.

The section describes the Zapi hand set functions. Numbers inside the triangles correspond to the same number on the hand set keyboard buttons shown in the figure. The orientation of the triangle indicates the way to the next function.

1) ACCELER. DELAY

Seconds. It determines the acceleration ramp. The parameter sets the time needed to speed up the traction motor from 0Hz to 100Hz.

2) RELEASE BRAKING

Seconds. It controls the deceleration ramp when the travel request is released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

3) TILLER BRAKING

Seconds. It controls the deceleration ramp when the tiller is in braking position (released). The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz

4) INVERS. BRAKING

Seconds. It controls the deceleration ramp when the direction switch is inverted during travel. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

5) DECELERATION BRAKING

Seconds. It controls the deceleration ramp when the accelerator has turned down but not completely released. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

6) SPEED LIMIT BRK

Seconds. It controls the deceleration ramp when a speed reduction has been activated. The parameter sets the time needed to decelerate the traction motor from 100Hz to 0Hz.

7) CURVE BRAKING

Seconds. It controls the deceleration ramp when the curve cutback input becomes active. The parameter sets the time needed to decelerate from 100Hz to 0Hz.

8) MAX SPEED FWD

Percentage. It determines the maximum speed in forward direction.

9) MAX SPEED BWD

Percentage. It determines the maximum speed in backward direction.

10) CUTBACK SPEED 1

Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 1 (CUTBACK on CNA#11 in AmpSaab connector, CNA#6 in AmpSeal) is active. When set to 100% the speed reduction is ineffective.

11) CUTBACK SPEED 2

Typically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 2 is active. When set to 100% the speed reduction is ineffective.

9.5.5 Config menu “TESTER ” functions list

- 1) MOTOR CURRENT**
Ampere. It is the current in the motor controlled by the slave of combiac1.
- 2) MOTOR VOLTAGE**
It is the voltage of the motor controlled by the slave of combiac1, expressed in percentage of the maximum voltage.
- 3) MOTOR POWER**
Watt. Estimate value of the traction motor power. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C).
- 4) ENCODER**
Hz. Speed of the traction motor. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C)
- 5) SLIP**
Hz. Estimate of traction motor slip. This parameter is used by Slave μ C in order to carry out safety checks on traction functions (managed by Master μ C).
- 6) MOTOR TEMPERATURE**
 $^{\circ}$ C. Measure of the pump motor temperature.
- 7) LIFTING CONTROL**
Volt. Measure of the lift/lower potentiometer input (signal CPOTLIFT: CNA#25 in AmpSaab connector, CNA#30 in AmpSeal connector).
- 8) HANDLE/SEAT SW**
On/off: it determines if the TILLER input is active or not (CNA#7 in AmpSaab, CNA#20 in AmpSeal).
- 9) DIGITAL INPUT 1**
On/off : it determines if the input 1 is active or not (Lowering switch, CNA#5 in AmpSaab, CNA#20 in AmpSeal).
- 10) DIGITAL INPUT 2**
On/off : it determines if the input 2 is active or not (Speed Reduction#1 switch, CNA#11 in AmpSaab, CNA#6 in AmpSeal).
- 11) DIGITAL INPUT 3**
On/off : it determines if the input 3 is active or not (Forward switch, CNA#18 in AmpSaab, CNA#32 in AmpSeal).
- 12) DIGITAL INPUT 4**
On/off : it determines if the input 4 is active or not (Reverse switch, CNA#19 in AmpSaab, CNA#31 in AmpSeal).
- 13) DIGITAL INPUT 5**
On/off : it determines if the input 5 is active or not (CNA#20 in AmpSaab, CNA#19 in AmpSeal).

11.2 Master microcontroller alarms overview

Master error code	Related slave error code	Description	Effect	Machine status when the test is done	Restart procedure
Capacitor charge	Waiting for trac	Power capacitors voltage does not increase	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Vmn low	Waiting for trac	Motor output voltage lower than expected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Vmn high	Waiting for trac	Motor output voltage higher than expected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Power mos shorted	Waiting for trac	Short circuit on the power mosfets	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Coil short hw ko	Waiting for trac	Problem on the hardware circuit which manages shortcircuits on Lc/Eb coils	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Coil shorted	Waiting for trac	Shortcircuit on LC or EB coils	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Driver shorted	Waiting for trac	Driver of Lc coil is shorted, so it is not able to open the Lc	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Contacteur Driver	Waiting for trac	Driver of Lc coil is damaged (not able to close)	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Contacteur Open	Waiting for trac	The Lc coil has been driven but Lc does not close	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Contacteur closed	Waiting for trac	LC contact is stuck	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Aux driv. Shrt.	Waiting for trac	When the mos of EB is shorted	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, marcia	Valve or pump or traction request
Aux driver open	Waiting for trac	Driver of Eb coil is damaged (not able to close)	Valve, pump, traction stopped, Lc opened, Eb applied	stby, traction	Valve or pump or traction request
Pos aux short	Waiting for trac	Output of built in Smart Driver, which supplies Eb coil positive, is high (= +batt) when the tiller switch is opened.	Valve, pump, traction stopped, Lc opened, Eb applied	start-up	Valve or pump or traction request
Logic Failure #1	Waiting for trac	Overvoltage/Undervoltage condition has been detected	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Logic Failure #2	Waiting for trac	Motor voltage feedback circuits are damaged	Valve, pump, traction stopped, Lc opened, Eb applied	stby, immediately after Lc closing	Valve or pump or traction request
Logic failure #3	Waiting for trac	Failure in the high current HW protection circuit	valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby	Valve or pump or traction request
Stby i high	Waiting for trac	In stby condition (no current applied to the motor) the current feedbacks are aout of permitted stby range	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby	Valve or pump or traction request
Wrong Set Battery	Waiting for trac	The battery voltage is too low or too high (< 0,8 Vbatt OR > 1,2 Vbatt)	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stand-by (only immediately after Lc closing)	Valve or pump or traction request
Analog input	Waiting for trac	Problem on the A/D conversion of Master uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Encoder Error	Waiting for trac	Problem on the encoder	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Tiller error	Waiting for trac	Input mismatch between hard&soft switch input and tiller input	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Valve or pump or traction request
Watchdog	Waiting for trac	Master uC does not receive via canbus the correct stuffing bit from Slave uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Key re-cycle
Hw Fault	Waiting for trac	Master uC has detected that slave uC is not able to stop traction enable or EB-LC enable	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stand-by (only immediately after Lc closing)	Key re-cycle
No can msg N5	Waiting for trac	No can message from slave uC	Valve, pump, traction stopped, Lc opened, Eb applied	start-up, stby, traction	Key re-cycle
Wrong setpoint	Waiting for trac	Master uC has detected a Slave uC wrong hydraulic function setpoint	Valve, pump, traction stopped, Lc opened, Eb applied	continuous	Key re-cycle
Safety Feedback	Waiting for trac	Master uC has detected a problem on the feedback of EVP driver	Valve, pump, traction stopped, Lc opened, Eb applied	continuous	Key re-cycle
Vacc out of range	Waiting for trac	The voltage on Vacc is outside the range set with Program Vacc	Valve, pump, traction stopped, Eb applied	stby, traction	Program Vacc

Troubleshooting:

The alarm ends when the acquisition is done.

13) "PEDAL WIRE KO"

Cause:

The SW continuously checks for the connection of the two supply ends of the potentiometer in the accelerator. The test consists of reading the voltage drop on a sense diode, connected between NPOT (CNA#23 in AmpSaab connector) and GND and cascaded with the potentiometer: if the potentiometer gets disconnected on PPOT (CNA#26 in AmpSaab connector) or NPOT, no current flows in this sense diode and the voltage on the NPOT connection collapses down.

When the NPOT voltage is less than 0.3V this alarm occurs. This alarm occurs also when the NPOT voltage is higher than 2Vdc (to detect also the condition of a broken sense diode).

Troubleshooting:

Check the voltage on NPOT and the potentiometer connections.

14) "TILLER OPEN"

Cause:

Warning: when the tiller is released, after a fixed period of time of standby (30 seconds) the main contactor open.

Troubleshooting:

At the next travel request the warning disappear.

15) "CURRENT GAIN"

Cause:

The Maximum current gain parameters are at the default values, which means the maximum current adjustment procedure has not been carried out yet.

Troubleshooting:

Ask the assistance of a Zapi technician to do the correct adjustment procedure of the current gain parameters.

16) "WAITING FOR NODE"

Cause:

The controller receives from the CAN the message that another controller in the net is in fault condition; as a consequence the traction controller itself cannot enter an operative status, but has to WAIT for the other controller coming out from the fault status.

12 RECOMMENDED SPARE PARTS

Part number	Description
C16506	FUSE PROT. 425A INTERAS60 (for 24v and 48v version)
C12505	AMPSAAB CONNECTOR 42 pins Female
C12532	AMPSEAL CONNECTOR 35 pins Female

3 FUNCTIONS OF THE EPS-AC0

The eps-ac0 controls a steer system for warehouse trucks. It executes the following functions:

- 1) Manual mode steering
- 2) Automatic Centering.

3.1 Manual Mode Steering

Manual mode steering requires a command sensor in the hand wheel. The hand wheel may be of two types:

- 1) Multiturn steering wheel without end-strokes.
- 2) Handlebar, tiller or joy-stick with end-strokes to limit the angle.

With a Multiturn steering wheel, the sensor in the hand-wheel shall be a stepper motor used as a tacho-generator (see Figure 3-1). Then the control will turn the steering motor moving at a speed proportional to the stepper motor speed (Open loop Mode).

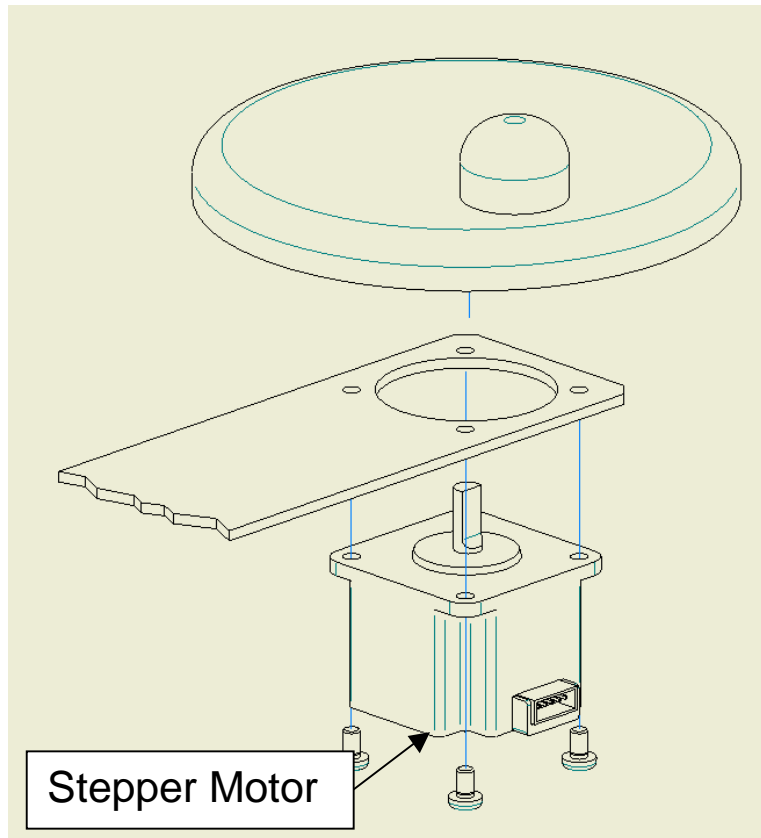


Figure 3-1

With a Handlebar (tiller or joy-stick), the sensor in the hand-wheel will be a twin pot (see Figure 3-2 below). Then the system works as a position control loop with a rigid correspondence between the angle of the handlebar and the angle of the steered wheel (Closed Loop Mode). In this case a feedback sensor on the steered wheel is mandatory.



Figure 4-8



Note: On request, it is possible to use the encoder for the motor control. In this case, the SW must know the encoder resolution together with the poles-pair number. The encoder resolution and the motor poles pair (the controller can handle), will be specified in the headline of the handset showing something like:

EPSAC0S2A ZP0.70

That means:

EPSAC0=Eps-ac0 steering controller

*S= Stepper motor
2= poles pair number
A= 32 pulses/rev encoder*

*ZP= SW release type Zapi
0.70= SW release number 0.70*

The command configuration is specified through the first letter after EPSAC0 in the following list:

*S= Stepper Motor
P= Twin Pot
C= via CAN Bus Position
D= via CAN Bus Speed*

The encoder resolution is given by the last letter before of the SW release in the following list:

8.2 General suggestion

For a proper installation take care of the following recommendations:



Never connect SCR low frequency chopper with AC Motor Inverter because the Rail capacitors alter the SCR choppers' work. If it is necessary to use two or more control units (e.g. traction + lift. + steering controller), they must belong to the ZAPIMOS family.



Do not connect the inverter to a battery with a nominal value different from the value indicated on the controller plate. If the battery value is greater, the MOS may fail; if it is lower, the control unit does not "power up".



During battery charge, disconnect the controller from the battery.



Supply the controller only with battery for traction; do not use a power supply.



When the inverter is installed, simulate a steering alarm and verify that both traction and electromechanical brake shall be de-energized in a very short time.



After the battery is disconnected, the Rail capacitor remains charged for some minutes; if you need to work on the inverter, discharge them using a $10 \Omega \div 100 \Omega$ resistance connected from the +Batt to the -Batt terminals in the controller side.



Take care all the inductive devices in the truck (horn, solenoid valves, coils, contactors) have a proper transient suppression device.

8.3 Connection cables

- 1) For the auxiliary circuits, use cables at least 0.5 mm² section.
- 2) For power connections to the motor and to the battery, use cables having section of 4-6 mm² (as a minimum).
- 3) The power cables length must be as short as possible to minimize power losses.

9.1 Connectors of the logic

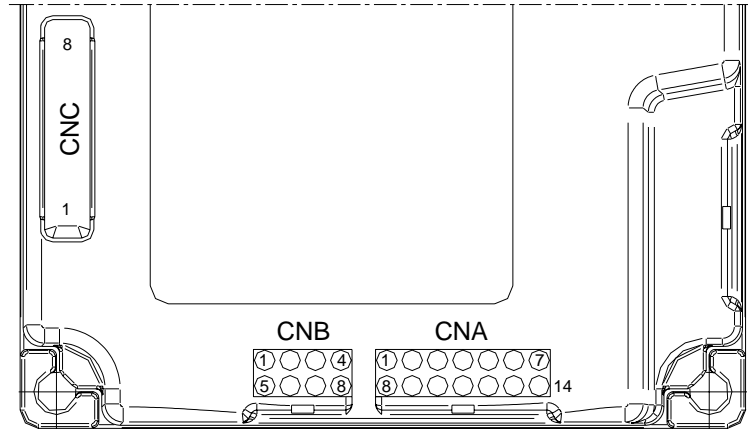


Figure 9–2

9.1.1 CNA connector

A1	DRIVE SWITCH	Traction Travel Demand Input.
A2	SW2	2 nd Toggle Switch or Left Limit Switch (LLS).
A3	SW1	1 st Toggle Switch or Right Limit Switch (RLS).
A4	NK1	Safety Switch Lower Voltage Point.
A5	K1	Safety Switch Higher Voltage Point.
A6	CANL	Can Bus Low.
A7	KEY	Key in (24-36 V _{batt}).
A8	CPOC2 / QL	2 nd SP POT Wiper or Stepper Motor Q line.
A9	CPOC1 / DL	1 st SP POT Wiper or Stepper Motor D line.
A10	NPOC	Twin SP POT Negative Supply (GND).
A11	GND	GND. Encoder Negative Supply
A12	GND	GND. SW1 & SW2 Negative.
A13	GND	GND. Motor Thermal Sensor Negative.
A14	CANH	Can Bus High.

9.1.2 CNB connector

B1	NPOT	FB POT Negative Supply.
B2	PPOT	FB POT Positive Supply.
B3	THMOT	Motor Thermal Sensor (KTY84-130) Input.
B4	+5VDC	Encoder Positive Supply.
B5	PPOC	Twin SP POT Positive Supply (5 Vdc).

11 SETTING THE EPS-AC0

11.1 Complete set-up description

This procedure shall be executed on the prototype after the installation procedure is completed (see topic 10). The complete set-up changes vs. the truck configuration. Seek your own configuration below:

11.1.1 Stepper Motor only

- Step1** Set the SET SAT FREQ adjustment to the corner frequency of the steering motor (see 12.4.2.7).
- Step2** Set OVERSAT FREQ adjustment in order the sum between SET SAT FREQ and OVERSAT FREQ gives the wished maximum steering motor speed (see 12.4.2.8).
- Step3** Set the NO LOAD CURRENT adjustments to the current the motor drains when lightened at the maximum flux (see 12.4.2.10).
- Step4** Set the steer sensitivity with the SPEED LIMIT and SENSITIVITY parameters (see 12.4.4.1-2).
- Step5** Set AUTO REQ TYPE in the set model menu to level 0 (no automatic function). (See 12.4.3.2).
- Step6** (CAN Based system only). Set the Dynamic Numbness in open loop (steering sensitivity reduces when the truck speed increases). Use parameters AUX FUNCTION#2 and AUX FUNCTION #3 (see 12.4.4.5-4).
- Step7** (No CAN Based system only). Connect a traction travel demand to CNA#1. It can be a tiller switch (or a dead-man or a seat switch). This operation supplies the information the truck is moving or not to stand-by the steer when the truck is standing.

11.1.2 Stepper Motor & AUTC

When the AUTC is required, it is necessary to carry out all the Steps in paragraph 11.1.1 together with the following:

- Step1** When the autocentering (AUTC) is required, it is necessary to contact a Zapi technician to decide the physical and the superior protocol layers for the AUTC demanding. (AUTC is a customized function that the eps-ac0 does not execute in its standard version).
One possible arrangement for the AUTC request could be a via CAN bus demanded centering.
- Step2** Turn the truck in the automatic centering mode, drive the truck and roll up and down the adjustment SET STEER 0-POS until the truck is straight travelling.
- Step3** Set the parameters KP, POS. ACCURACY, LEAD FB REGULAT and LAG FB REGULAT to avoid overshoot or damping during the centering operation (see paragraph 12.4.4).

11.1.3 RTC (Twin Pot) only

- Step1** Set the SET SAT FREQ adjustment to the corner frequency of the steering motor (see 12.4.2.7).
- Step2** Set OVERSAT FREQ adjustment in order the sum between SET SAT FREQ and OVERSAT FREQ gives the wished maximum steering motor speed (see 12.4.2.8).

1) HOUR COUNTER

This option specifies the hour counter mode. It can be set one of two:

- RUNNING: The counter registers travel time only.
- KEY ON: The counter registers when the "key" switch is closed.

2) MICRO CHECK

This option is useful to support debug and troubleshooting. It makes possible to inhibit the supervisor (Slave uC) operations and allows the system to run with just the Main uC. When entering this operating mode the safety contacts stay open. Therefore, traction shall be disabled. It can be set one of two:

- PRESENT: Default setting: enable the operations of the supervisor (Slave uC).
- ABSENT: Disable the operations of the supervisor (Slave uC). The safety contacts stay opened.

3) FEEDBACK DEVICE

This option specifies which kind of Feedback Sensor is adopted. Here is the feedback sensor list:

- OPTION #1: FB POT only.
The only feedback sensor is the potentiometer at the steered wheel. This setting must be temporary chosen for the set-up of the FB ENC & FB POT configuration (see below). After the set-up is ended, it is necessary to turn FEEDBACK DEVICE to OPTION #2 to get the steer working with FB ENC & FB POT.
- OPTION #2: FB POT & FB ENC.
This is the right setting when the encoder is chosen together with the FB POT. Pay attention, the set-up must be done with the FEEDBACK DEVICE to OPTION #1. When the set-up is finished, turn to OPTION #2. When the FEEDBACK DEVICE is OPTION #2 an automatic centering is always carried out at key-on.
- OPTION #3: FB POT & FB ENC & ONE TOGGLE SWITCH
This is the right setting when the encoder is chosen together with the FB POT and a straight ahead toggle switch (SW1). Pay attention, the set-up must be done with the FEEDBACK DEVICE to OPTION #1. When the set-up is finished, turn to OPTION #3. When the FEEDBACK DEVICE is OPTION #3 an automatic centering is always carried out at key-on.
- OPTION #4: FB ENC & ONE (or TWO) TOGGLE SWITCHES
This is the right setting when the FB POT is not present and two toggle switches are adopted (normally in the straight and 90 degrees angled positions of the steered wheel). At key on, an Automatic Centering operation is executed seeking the Toggle Switch signal (SW1 on CNA#3). When the Toggle Switch edge is met the Encoder counter is zeroed. The 2nd Switch (SW2 on CNA#2) is used to verify the encoder counter at 90° is matched with the SW2 transition.

4) LIMIT DEVICE

(Versions with FEEDBACK DEVICE to OPTION #1, 2, 3 only). When this option is set ON, the steered wheel angle will be limited using the feedback sensor value. It can be set one of two:

- ON: When the feedback sensor overtakes either the CW or the CCW limit (see 12.4.2.13-14, SET MAX FB POT, SET MIN

- 1) **SPEED LIMIT**
(Stepper Motor version only). Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is fast turning. By increasing the SPEED LIMIT value, the steering motor speed increases too. In practice, it sets the maximum motor speed when the steering wheel is fast turning.
- 2) **SENSITIVITY**
(Stepper Motor version only). Level 0 to 9. It determines the scaling factor between the speed of the steering wheel and the speed of the steering motor but only when the steering wheel is slow turning. By increasing the SENSITIVITY value, the steering motor speed increases too. In practice, it changes the sensitivity of the steering wheel when it is slow turning.
- 3) **CREEP SPEED**
Level 0 to 9. It sets a minimum amount of motor torque when the steering motor is slow turning. It is useful (together with the ANTIROLLBACK parameter, see 12.4.4.12) to neutralize the recall torque generated by the elastic tyre on the steered wheel.
- 4) **AUX FUNCTION #3**
Depending on the configuration, this parameter has different meaning.

RTC version:

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, this setting adjusts the maximum angle at full truck speed. When the truck speed increases, the maximum steered wheel angle reduces proportionally. When the truck is full speed the steered wheel angle is limited to a percentage of the absolute maximum steered wheel angle (i.e. 90 degrees) specified with this setting.

- LEVEL 0: Maximum steered angle at full truck speed is 73% (i.e. 66 degrees).
- LEVEL 1: Maximum steered angle at full truck speed is 66% (i.e. 59 degrees).
- LEVEL 2: Maximum steered angle at full truck speed is 59% (i.e. 53 degrees).
- LEVEL 9: Maximum steered angle at full truck speed is 10% (i.e. 9 degrees).

Each step has a weight of 7%.

Stepper Motor version:

Level 0 to 9. This setting performs the Dynamic Numbness compensation: it consists of a reduction in the steer sensitivity when the truck is driving at high speed. To get this goal, it is necessary to attenuate the scaling factor between the speed of the steering wheel and the speed of the steering motor. AUX FUNCTION #3 does that but only when the steering wheel is **fast** turning. This attenuation must be proportional to the drive speed. At full drive speed the attenuation of the scaling factor is maximum.

AUX FUNCTION #3 to Level 0 means no attenuation of the scaling factor with the truck speed.

AUX FUNCTION #3 to Level 9 means maximum attenuation of the scaling factor with the truck speed.

Obviously, to perform the Dynamic Numbness compensation, it is necessary to know the drive speed and so the eps-ac0 must be CAN Bus connected.

10) MOTOR VOLTAGE

It is a percentage. 100% means the sine waves in the motor have the maximum PWM amplitude.

11) MOTOR CURRENT

Ampere value. Root Mean Square value of the line current in the motor.

12) ENC SPEED

Hertz value with 2 decimal digit. This is the speed of the motor measured with the encoder on the motor shaft.

13) ENDSTROKE CW

Provides real time the active state (ON) or not of the CW toggle switch (connected to CNA#3). It is On when CNA#3 is low (see 7.5).

14) ENDSTROKE ACW

Provides real time the active state (ON) or not of the CCW toggle switch (connected to CNA#2). It is On when CNA#2 is low (see 7.5).

15) CW LIMIT LEVEL

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON when FEEDBACK DEVICE is OPTION #1,2,3; 1ST ANGLE COARSE and 2ND ANGLE COARSE less than level 9 when FEEDBACK DEVICE is OPTION #4) and the FEEDBACK ENC overtakes the superior limit for the steered wheel angle limitation, the steered wheel angle will be limited and CW LIMIT LEVEL turns ON (active).

16) ACW LIMIT LEVEL

When the maximum angle limitation via feedback sensors is enabled (option LIMIT DEVICE to ON when FEEDBACK DEVICE is OPTION #1,2,3; 1ST ANGLE COARSE and 2ND ANGLE COARSE less than level 9 when FEEDBACK DEVICE is OPTION #4) and the FEEDBACK ENC is lower than the inferior limit for the steered wheel angle limitation, the steered wheel angle will be limited and ACW LIMIT LEVEL turns ON (active).

17) AUTO IN PROGRESS

Provides real time the information the eps-ac0 follows the manual command (AUTO IN PROGRESS is OFF) or is executing an automatic centering (AUTO IN PROGRESS is ON).

18) MM ALARM SWITCH

It is On when the safety contact belonging to the main uC is closed.

19) SM ALARM SWITCH

It is On when the safety contact belonging to the slave uC (supervisor) is closed.

20) TRUCK MOVING

It provides the state of the travel demand for driving the truck. This information is obtained either with the travel demands directly connected to CNA#1 or via CAN Bus (depending by the state of the CAN BUS setting see 12.4.5.2).

21) HIGH RESOL AD

It turns ON when the set point potentiometer is processed with a high resolution AD.

WHEEL ANGLE [degrees]	Admitted sector	Admitted FEEDBACK SECTOR
-22 to +22	1 st or 4 th	3.13 V or 1.88 V
+23 to +67	1 st	3.13 V
+68 to +112	1 st or 2 nd	3.13 V or 4.39 V
+113 to +157	2 nd	4.39 V
+158 to -158	2 nd or 3 rd	4.39 V or 0.62 V
-157 to -113	3 rd	0.62 V
-112 to -68	3 rd or 4 th	0.62 V or 1.88 V
-67 to -23	4 th	1.88 V

- Remedy: Check the potentiometer connected to CNB#6 is right working. If toggle switches are connected to CNA#2 and CNA#3, verify they are right working and the setting AUX FUNCTION 11 (see 12.4.1.9) is correct. Verify also the sensor bearing in the motor (encoder) has not a slip (the sensor bearing has two rings: one is connected to the rotor shaft; the other is connected to the motor frame. Check these two rings are strictly connected to their structure without slip.

6) STEER SENSOR KO

CAN Bus Code =84

- Cause: This alarm occurs if the command potentiometer (CPOC1 on CNA#9 or CPOC2 on CNA#8) changes with a jerk larger than MAX SP SLOPE (see 12.4.6.3). This alarm is used to catch a discontinuity in the voltages of the command potentiometer.
- Remedy: Change the twin pot.

7) JERKING FB POT

CAN Bus Code =223

- Cause: This alarm occurs if the feedback potentiometer (CPOT on CNB#6) changes with a jerk larger than 0.3 V in 16 msec. This alarm is used to catch a discontinuity in the voltages of the feedback potentiometer.
- Remedy: Change the feedback potentiometer.

8) FB POT LOCKED or FB SENS LOCKED

CAN Bus Code =222

- Cause: In application with a feedback potentiometer, this alarm occurs if the feedback potentiometer (CPOT on CNB#6) does not change (or changes in the opposite direction) its value even if commanded to change.
In application with toggle switches with ENCODER CONTROL to off, this alarm occurs if the feedback encoder counting does not change its value even if commanded to change.
- Remedy: In application with the feedback potentiometer, verify the feedback potentiometer is not mechanically loosened. Check there is not a mechanical block of the steered wheel.
Be sure the wiper has not reached its own electrical limit because of too much angle of the steered wheel.
Besides, this alarm may occur at the installation when the motor rotates in the wrong direction turning away from the wished

came. This parameter is specified as a percentage of the maximum current.
Value range setting:
0 – 100%

LAG FB REGULAT.

This parameter controls the smooth movement of the low pass filter to the next commanded position. The derivate contribute generates dither that is possible to reduce by increasing this adjustment. Obviously this adjustment influences the stability of the closed loop and so different setting must be empirically tried to avoid oscillation. Value range setting:
0: is for the smallest low pass filter.
9: is for the largest low pass filter.
Intermediate levels are for proportionally increasing filtering.

LEAD FB REGULAT.

This parameter controls the derivative (D) contribute of a PD (position feed back system) control law. It is useful to neutralize the overshoot of the pursuing. By increasing this parameter the steering motor will break in advance in respect to the commanded position and so avoiding overcoming the commanded position and making gradually approached. Value range setting:
0: is for the smallest derivative contributes.
9: is for the largest derivative contributes.
Intermediate levels are for proportionally increasing derivative contributes.

Config Menu: Set options

HOUR COUNTER

This parameter controls how the operating times counter in the electric power steering controller (EPS) is activated.
RUNNING: Counts operating time for this controller (i.e. the effective operating time)
KEY ON: Counts operating time constantly while the main key switch is turned on.

Note that both controllers in the truck have an individual operating time counter.

The value of these counters can be read with the console.

MICRO CHECK

This parameter controls to inhibit the operation of the supervisor microprocessor and to allow the system to run with only the main microprocessor. This operating mode does not allow the supervisor –

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- Fork height (3), optional.
Height is displayed when the forks are above free lift range.
- Speed display (4)
- Weight display (5), optional.
Weight is displayed when the forks are in free lift range.
- Performance mode selection (6)
- Lifting height preselection (7), optional
- Information menu (8)
- Travel direction display (9)
- Crawling mode symbol (10).

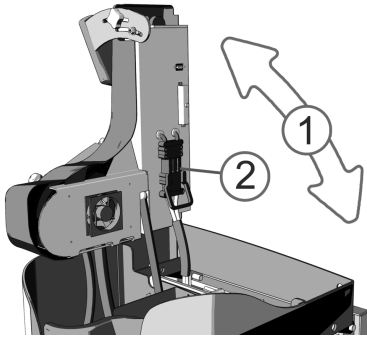
7. Batteries

Only appointed and trained personnel may replace and recharge batteries. Individuals maintaining batteries must have sufficient protective clothing and eye gear.

- Do not handle naked flame in the vicinity of batteries because of a risk of explosion.
- Do not smoke when working with batteries.
- Do not leave tools or other metal implements on top of the battery. Sparking or a short-circuit may cause the battery to explode.
- When batteries are recharged, the cell plugs must be closed firmly to prevent splashing of battery fluid.
- Battery fluid is a corrosive acid solution; avoid getting it on the skin or in the eyes. Battery fluid develops an explosive gas at the end phase of recharging. Therefore, make sure that the battery has sufficient ventilation (this does not apply to maintenance-free batteries).
- Always perform a complete battery charging, as repeated partial charging may reduce the battery life.

Recharging the battery

Make sure that the charger is the appropriate model and that the battery has sufficient ventilation.



The truck is equipped with a removable recharging plug.

1. Park the truck in a reserved recharging place.
2. Switch off the power from the truck.
3. Raise the cover on top of the battery (1).
4. Make sure that the charger has been switched off.
5. Remove the recharging plug (2) and connect it to the charger.
6. Switch on the charger.

After recharging

1. Switch off the charger.
2. Disconnect the recharging plug from the charger. Grab the handle; do not pull the cables.
3. Check the battery according to the battery manufacturer's maintenance instructions.
4. Fasten the recharging plug.
5. Close the cover on top of the battery.

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