

EN



Operation & Maintenance Manual

NSS15N
NSS15NI
NSS20N

MCFE
Hefbrugweg 77,
1332 AM Almere,
The Netherlands

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- | | | | |
|-----------|---|------------------|---------------|
| 8 | WATCHDOG | (Alarm) | Stored |
| | <p>This is a safety related test. It is a self diagnosis test within the logic between Master and Slave microcontrollers.</p> <p>If fault persist replace the Combiac1 controller.</p> | | |
| 13 | EEPROM KO | (Warning) | Stored |
| | <p>It's due to a hardware or software defect of the non-volatile embedded memory supporting the controller parameters. This alarm does not inhibit the truck operations, but the truck will work with the default values.</p> <p>Try to execute a CLEAR EEPROM operation. Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to replace the Combiac1 controller. If the alarm disappears, the previously stored parameters will have been replaced by the default.</p> | | |
| 17 | LOGIC FAILURE #3 | (Alarm) | Stored |
| | <p>It's due to a hardware problem in the logic card circuit for high current protection.</p> <p>This type of fault is not related to external components; so, when it is present it is necessary to replace the Combiac1 controller.</p> | | |
| 18 | LOGIC FAILURE #2 | (Alarm) | Stored |
| | <p>It's due to a fault in the logic board which manages the phase's voltage feedback.</p> <p>This type of fault is not related to external components; so, when it is present it is necessary to replace the Combiac1 controller.</p> | | |
| 19 | LOGIC FAILURE #1 | (Alarm) | Stored |
| | <p>This fault is displayed when the controller detects an overvoltage or undervoltage condition. Overvoltage threshold is 45V; undervoltage threshold is 9V in the 24V controller.</p> <p>If fault displayed at startup or in standby; in this case it is due to an undervoltage, so it is important to check following:</p> | | |

232 **WRONG SET POINT** **(Alarm)** **Stored**

Cause:

This is a safety related test. The microprocessor has detected a wrong traction function set point.

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

233 **POWER MOS SHORT** **(Alarm)** **Stored**

Cause:

Before switching the main contactor on, the software checks the power bridge: it turns on alternatingly the low and high side power mosfets and expects the phase's voltage to decrease down to – BATT. If the phase's voltage does not follow the commands, this alarm occurs.

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

236 **CURRENT GAIN** **(Alarm)** **Stored**

Cause:

The maximum current gain parameters are at default values, which mean the maximum current procedure has not been carried out.

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

237 **ANALOG INPUT** **(Alarm)** **Stored**

Cause:

This alarm occurs when the conversion of the analog inputs gives frozen values.

If the alarm occurs permanently, it is necessary to replace the Combiac1 controller.

239 **PUMP WARNING** **(Warning)**

Cause:

This is a warning from the pump controller.

Connect the console to the pump controller and check the warning.

- 242 CURR. SENS. LOW (Alarm) Stored**
- Cause:
Pump chopper current sensor feedback is too low.
- Either whole pump motor is disconnected from the pump controller, or CombiAC1 controller is faulty and should be replaced.
- 243 EEP CHECKSUM (Alarm) Stored**
- Cause:
Fault in the internal EEPROM memory.
- Try first to clear EEPROM. If this operation does not help and the fault persists, it is an internal fault of the CombiAC1 controller, so it must be replaced.
- 244 RAM WARNING (Alarm) Stored**
- Cause:
Checksum of the ram failed.
- This is an internal fault of the Combiac1 controller, so it must be replaced.
- 245 WAITING FOR TRAC (Warning) Not showed on Display**
- Cause:
The pump controller receives from the CAN a message the traction controller is in fault condition and has to wait.
- Check with help of the CONSOLE, what is the fault in the traction controller.
- 246 EVP DRIVER KO (Alarm) Stored**
- The EVP (electro valve driver) is not able to drive the load.
- This is an internal fault of the Combiac1 controller, so it must be replaced.
- 247 EVP DRIV SHORTED (Alarm) Stored**
- Cause:
The EVP (electro valve driver) is shorted.

239 **WAITIN FOR TRAC** **(Warning)** **Not showed on Display**

Cause:

At key-on the EPS controller needs information from the traction controller to close the internal safety contacts and to turn onto operational mode. Until this information, this warning occurs. The steering is not activated and the safety relays remain open while this warning is present.

241 **ENCODER ERROR** **(Alarm)** **Stored**

NOT VALID FOR THIS APPLICATION!

This alarm occurs in application, when ENCODER CONTROL is set ON.

242 **Q LINE SENSOR** **(Alarm)** **Stored**

Cause:

This alarm can occur when the stepper motor channel on XA3A pin 12 is open.

Check the stepper motor wires and measure the D line resistance (must be close to 30 ohm between XA3A pin 8 and 12).

If the problem is not due to wiring, the stepper motor must be replaced.

243 **D LINE SENSOR** **(Alarm)** **Stored**

Cause:

This alarm can occur when the stepper motor channel on XA3A pin 10 is open.

Check the stepper motor wires and measure the Q line resistance (must be close to 30 ohm between XA3A pin 9 and 10).

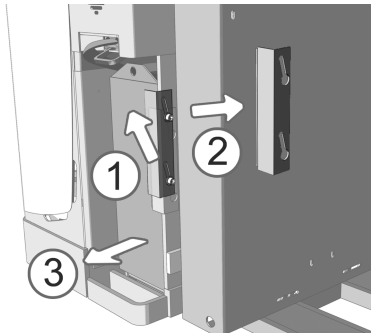
If the problem is not due to wiring, the stepper motor must be replaced.

244 **GAIN EEPROM KO** **(Warning)**

Cause:

The parameters to compensate values for the gain of the current are not in the memory any more.

It is necessary to replace the EPS controller.



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.

4.25	Outside width over forks	b5 [mm]	550 (570)	570
4.32	Ground clearance, center of wheelbase (forks lowered)	m2 [mm]	30	25
4.33	Working aisle width Ast ** (Ast3), pallet 1000x1200, load crosswise	Ast [mm]	2626 (2360)	2696 (2410)
4.34	Working aisle width Ast ** (Ast3), pallet 800x1200, load lengthwise	Ast [mm]	2569 (2410)	2627 (2640)
4.35	Turning radius (forks lowered, platform up/down)	Wa [mm]	1785	1865
5	PERFORMANCE			
5.1	Travel speed, laden/unladen	[km/h]	7,0 / 8,0	7,0 / 8,0
5.2	Lifting speed, laden/unladen	[m/s]	0,13 / 0,30	0,11 / 0,30
5.3	Lowering speed, laden/unladen	[m/s]	0,50 / 0,35	0,5 / 0,40
5.8	Gradeability, laden/unladen	[%]	7 / 10	6 / 10
5.10	Service brake		Electric	Electric
6	MOTORS			
6.1	Drive motor S2 60 min	[kW]	2.2	2.2
6.2	Lift motor S3 15%	[kW]	5.5	5.5
6.4	Battery voltage/capacity (5h)	[V/Ah]	24 / 375-500	24 / 375-500
6.5	Battery weight (min.)	[kg]	305-400	305-400
8	MISCELLANEOUS			
8.1	Speed control type		Stepless	Stepless
8.4**	Noise level at the driver's ear according to EN 12 053:2001 and EN ISO 4871, work sequence LpA	[dB (A)]	66	66
	Noise level at the driver's ear according to EN 12 053:2001 and EN ISO 4871, driving / lifting / engine idle LpA	[dB (A)]	70/69/53	70/69/53
	Whole body vibration according to EN 13 059:2002	[m/s ²]	0,4	0,4
	Hand-arm vibration according to EN 13 059:2002	[m/s ²]	< 2,5	< 2,5

() = with initial lift

* Side stabilizers lowered (option)

** Ast = Wa + R + 200, Ast3 = Wa - x + 16 + 200

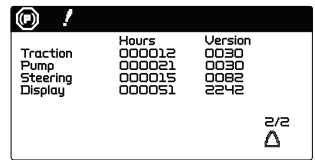
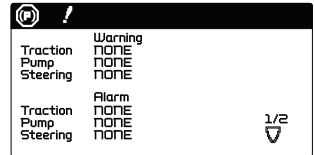
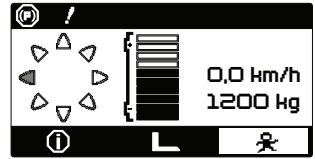
*** = TREV5400

**** = T6300

Manufacturer reserves the right to make technical changes.

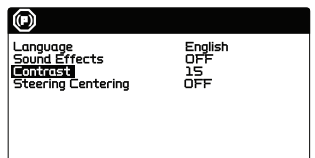
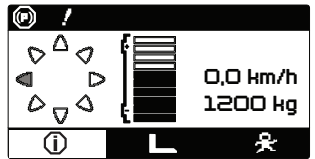
MESSAGE CENTER

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)
	Steering Centering	OFF/ON, automatically center the steering wheel when the truck is



controlled safety switch to close. Therefore, traction is disabled.
ABSENT: Inhibit supervisor microprocessor functions (Not in use!).
PRESENT: Enable diagnostic interaction between the main and supervisor microprocessors.
Factory default is "PRESENT". Do not change the default value!

ENCODER CONTROL

This parameter is not used in this application. Factory default value is "OFF". Do not change the default value!

FEEDBACK DEVICE

This parameter controls what kind of feed back device is used.
Factory default value is "OP #4". Do not change the default value!

AUTOCENTERING

This parameter controls the automatic steering centring at key-on. Value range setting:
ON: The steering centring is activated at key-on.
OFF: The steering centring is not activated at key-on.

RECOVERY AT REST

This parameter controls the steering recovery at rest, which is not used in this application. Factory default is "OFF". Do not change the default value!

AUX FUNCTION 1

This parameter sets the steering mode after the feedback signals has reached the final position. The steering motor is turned on when a travel demand is active.
Factory default setting is "0". Do not change the default value!

DIAG MOTOR TEMP

This parameter controls the steering motor overheating alarm (MOTOR TEMPERAT) enabling or disabling. ON: the detection of the alarm. OFF: Disables the detection of the alarm. Factory default setting is "ON". Do not change the default value!

SUBMENU: SET MODEL

SYSTEM CONFIG

6: Electric power steering controller
10: Encoder card

SUBMENU: SET OPTIONS

HOUR COUNTER

This parameter controls the how the operating time counter in the controller is activated. Value range setting:

RUNNING: The counter registers pump time only.

KEY ON: The counter registers when the “key switch is closed.

EVP TYPE

This parameter controls the type of valve used. Use setting “ANALOG”.

EV1 TYPE

This parameter controls the type of valve used. Use setting “DIGITAL”.

SET TEMPERATURE

This parameter is settled by the controller manufacturer. Do not change!

SIDE STABILIZER

This parameter controls the presence of side stabilizers. Value range setting:

ABSENT: Side stabilizers not present.

PRESENT: Side stabilizers present.

AUX OUTPUT #6

This parameter determines the purpose of output XA1/14. Value range setting:

0: Not in use.

1: Drive forward active.

2: Drive backward active.

3: Drive forward or backward active.

4: Lift active.

5: Lower active.

6: Lift or lower active.

7: Drive forward or backward or lift or lower active.

AUX OUTPUT #5

This parameter determines the purpose of output XA1/32. Value range setting:

0: Not in use.

BEAN PANEL

This parameter controls the presence of the so called bean panel (depending on truck model, see the actual parameter table).

Value range setting:

PRESENT: The bean panel is installed in the truck (see the actual parameter table).

ABSENT: The bean panel is not installed in the truck (see the actual parameter table).

DISPLAY

This parameter controls the presence of the display. Value range setting:

PRESENT: The display is installed in the truck (see the actual parameter table).

ABSENT: The display is not installed in the truck (see the actual parameter table).

Note! If the display is not working, the truck can be driven if the parameter is set to "ABSENT".

LOAD SENSOR

This parameter controls the presence of the load sensor. Value range setting:

PRESENT: The load sensor is installed in the truck.

ABSENT: The load sensor is not installed in the truck.

AUX INPUT #1

This parameter determines the purpose of input XA1/21. Value range setting:

0: Speed reduction.

1: Lift disabled.

2: Traction disabled.

3: Lift and traction disabled.

4: Output XA1/32 control + pump running with a certain speed/ramp.

AUX INPUT #6

This parameter determines the purpose of input XA1/6. Value range setting:

0: Speed reduction to 2,5 km/h.

1: Speed reductions to 2,5km/h + lift inhibit.

2: Speed reductions to 2,5km/h + lift inhibit with resetting.

SEAT LEVEL

This parameter controls the type of seat switch used in the application. Value range setting:

AUTO REQ TYPE	0	0	0	0								0		Factory setting
CONNECTED TO	EPS	EPS	EPS	EPS								EPS		2 = traction controller, 5 = pump controller, 6 = steering controller, 10 = encoder card
MODEL TYPE	x	x	x	x								x		
ADJUSTMENTS:												0		
ADJUSTMENT #01	0	0	0	0								0		Factory setting
SET CURRENT	0	0	0	0								0		Factory setting
ADJUSTMENT #02	x	x	x	x								90		Factory setting
ADJUSTMENT #03	x	x	x	x								x		Factory setting
ADJUSTMENT #04	x	x	x	x								x		Factory setting
SET BATTERY TYPE	24V	24V	24V	24V								24V		Factory setting
SET SAT. FREQ.	90 Hz	90 Hz	90 Hz	90 Hz								90Hz		Factory setting
OVERSAT FREQ.	1 Hz	1 Hz	1 Hz	1 Hz								1Hz		Factory setting
MAXIMUM SLIP	5,00 Hz	5,00 Hz	5,00 Hz	5,00 Hz								5Hz		Factory setting
AUX VOLTAGE #1	x	x	x	x								x		Factory setting
AUX VOLTAGE #2	x	x	x	x								x		Factory setting
NO LOAD CURRENT	24 A	24 A	24 A	24 A								24A		Factory setting
ZERO SP POT	x	x	x	x								x		Factory setting
SET STEER 0-POS.	x	x	x	x								x		Straight ahead steering position adjustment
SET STEER 180	x	x	x	x								x		Factory setting
SET ENC AT 180	x	x	x	x								x		Autoteaching sets this parameter. Value is about 1,6 - 1,7V
SET ENC AT 360	x	x	x	x								x		Autoteaching sets this parameter. Value is about 3,3 - 3,4V
SPECIAL ADJUST:												0		
SET TEMPERATURE	x	x	x	x								x		Factory setting
HIGH ADDRESS	0	0	0	0								0		Factory setting
DEBUG OUTPUT	15	15	15	15								15		Factory setting
HARDWARE SETTINGS:												0		
MAXIMUM CURRENT	50 A	50 A	50 A	50 A								50A		Factory setting
CAN BUS	PRESENT	PRESENT	PRESENT	PRESENT								PRESENT		Factory setting
SET HI RESOL AD	1	1	1	1								1		Factory setting
AUTOTEACHING	OFF	OFF	OFF	OFF								OFF	ON / OFF	OFF = Automatic teaching for steering disabled. ON = Automatic steer teaching activated on next truck startup.
AUX FUNCTION 11	5	3	5	5								x		Defines steering motor and feedback sensors positions

TESTER FUNCTIONS FOR THE TRACTION CONTROLLER

BATTERY VOLTAGE

This test indicates the current battery voltage with 1 decimal digit. Its accuracy depends on whether the parameter ADJUST BATTERY (under Adjustments) has been calibrated. This is a read only function.

ANGLE SECTOR

This test indicates the sector (quadrant) according to the status of the EPS controller first toggle switch (S31 to connector XA3 A pin 3) and the second toggle switch (S32 to connector XA3 A pin 2) they must commute when the steered wheel is 90 degree.

STEER ANGLE

This test indicates the wheel angle in degrees calculated by the EPS controller.

SIDE STAB UP M

This test indicates the status of side stab up switch S4 (XA1 pin 38)

ON +VB = the side stab switch is active.

OFF GND = the side stab switch is not active.

LIFTING CUTOUT

This test indicates the status of lift stop switches S15 and S16 (XA1 pin 37)

ON +VB = the lift stop switch is active.

OFF GND = the lift stop switch is not active.

SIDE STAB DW M

This test indicates the status of side stab down switch S5 (XA1 pin 35)

ON +VB = the side stab switch is active.

OFF GND = the side stab switch is not active.

IN7 SWITCH

EV7

This test determines if the valve is open or closed.

ON +VB = the valve is open.

OFF GND = the valve is closed.

EV6

This test determines if the valve is open or closed, at connector XA1 pin 39.

ON +VB = the valve is open.

OFF GND = the valve is closed.

EV5

This test determines if the cooling fans are running or not, at connector XA1 pin 32.

ON +VB = the fan is running.

OFF GND = the fan is not running.

EV4

This test determines if the valve is open or closed, at connector XA1 pin 28.

ON +VB = the valve is open.

OFF GND = the valve is closed.

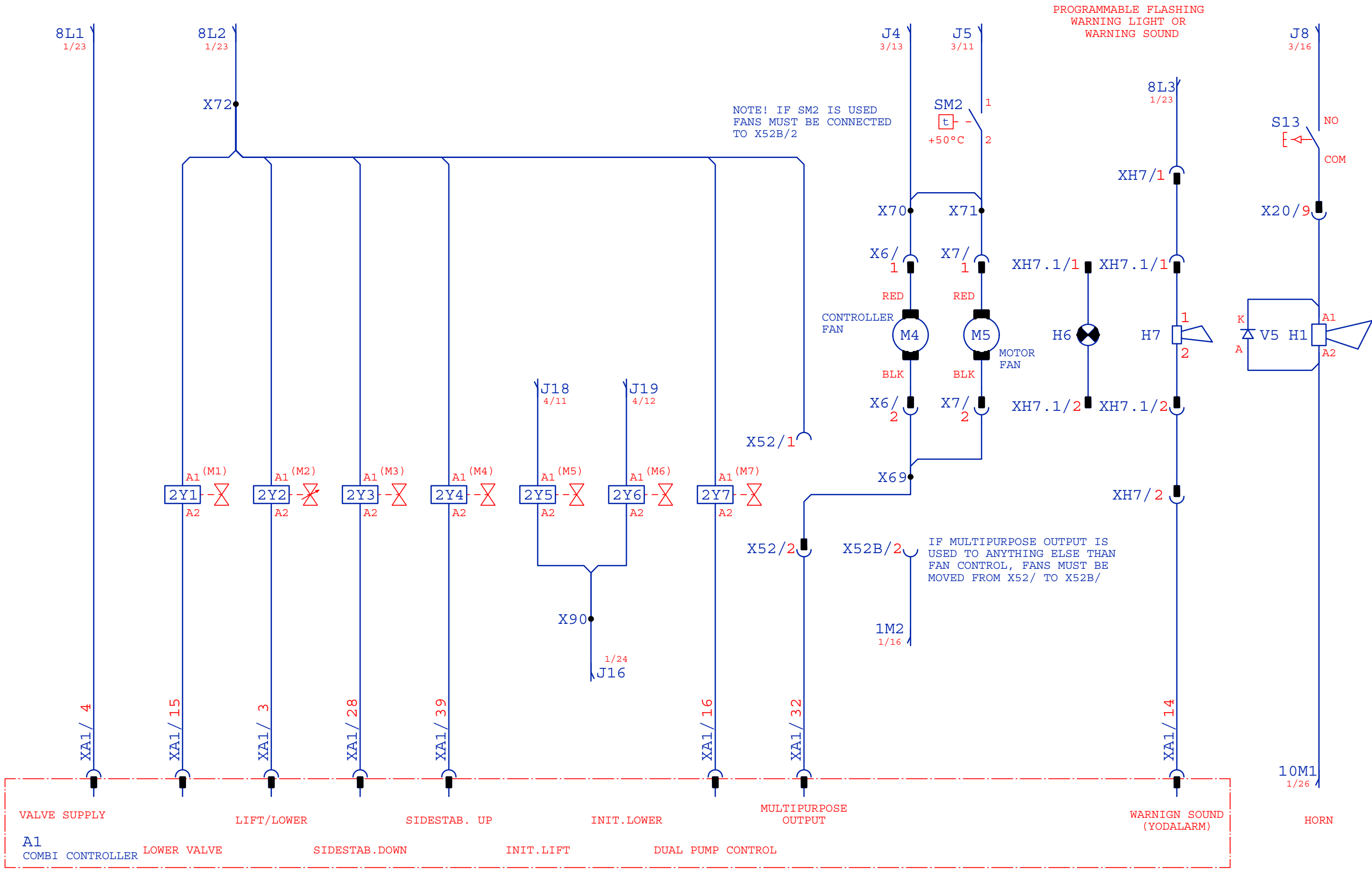
EV3

This test determines if the valve is open or closed, at connector XA1 pin 16.

ON +VB = the valve is open.

OFF GND = the valve is closed.

	Truck types								NOTE
	NSSN	NSSN I-Mast	NSRN	NSRN I-Mast			Default	Adjustment range	
MAIN MENU/ PARAMETER CHANGE: DISPLAY SETS									
ACCELER. DELAY	1,4	1,4	1,4	1,4			1,4	0,1-5	Acceleration ramp. 0,1 = fastest
RELEASE BRAKING	1,6	1,6	1,6	1,6			1,6	0,1-5	Release braking. 0,1 = strongest
TILLER BRAKING	0,5	0,5	0,5	0,5			0,5	0,1-5	Braking ramp when safety pedal is released. 0,1 = strongest
INVERS. BRAKING	0,8	0,8	0,8	0,8			0,8	0,1-5	Inverse braking. 0,1 = strongest
DECEL. BRAKING	5	5	5	5			5	0,1-5	Deceleration ramp when speed is slowed down but not stopped. 0,1 = strongest
LOAD ACCEL DEL.	1,7	1,7	1,7	1,7			1,7	0,1-5	Acceleration ramp with maximum load. 0,1 = strongest
LOAD REL BRAKING	82	82	82	82			82	10-100%	Release braking with maximum load. 0,1 = strongest
LOAD TIL BRAKING	100	100	100	100			100	10-100%	Braking ramp with maximum load when safety pedal is released. 100 = strongest
LOAD INV. BRK.	70	70	70	70			70	10-100%	Inverse braking with maximum load. 0,1 = strongest
SPEED LIMIT BRK.	2	2	2	2			2	0,1-5	Deceleration ramp when speed reduction is activated. 0,1 = strongest
MAX SPEED FORW	100	100	100	100			100	10-100%	Maximum speed forward without load. 100% = fastest
MAX SPEED BACK	100	100	100	100			100	10-100%	Maximum speed backward without load. 100% = fastest
MAX SPD LOAD FWD	(71)	(71)	(70)	(70)			71	10-100%	Maximum speed forward with maximum load. 100% = fastest. Note! Do not exceed marked values for safety reasons
MAX SPD LOAD REV	(71)	(71)	(60)	(60)			71	10-100%	Maximum speed backward with maximum load. 100% = fastest. Note! Do not exceed marked values for safety reasons
CUTBACK SPEED 1	100	100	100	100			100	10-100%	Speed reduction 1. 100% = disabled
CUTBACK SPEED 2	100	100	100	100			100	10-100%	Speed Reduciton 2. 100% = disabled
CURVE CUTBACK	60	60	60	60			80	10-100%	Curve cutback speed. 100% = disabled
STEER DEAD ANGLE	1	1	1	1			1	0-9	Steering angle when pedestrian travel is allowed
FREQUENCY CREEP	0,6	0,6	0,6	0,6			0,6	0-10Hz	Truck minimum travel speed
MAXIMUM CURRENT	75	75	75	75			75	10-100%	Inverter maximum current
ACC SMOOTH	1	1	1	1			1	0-9	Acceleration ramp smoothness. 0 = no smoothness
INV SMOOTH	1	1	1	1			1	0-9	Direction change smoothness. 0 = no smoothness
STOP SMOOTH	10	10	10	10			10	0-100Hz	Truck travel speed when direction change smoothness ramp is stopped
BRK SMOOTH	1	1	1	1			1	0-9	Braking ramp smoothness. 0 = no smoothness
STOP BRK SMOOTH	3	3	3	3			3	0-100Hz	Truck travel speed when braking ramp smoothness ramp is stopped
LOAD SMOOTH ACC	1	1	1	1			1	0-9	Acceleration ramp smoothness with maximum ramp. 0 = no smoothness
LOAD INV SMOOTH	1	1	1	1			1	0-9	Direction change smoothness with maximum load. 0 = no smoothness
LOAD STOP SMOOTH	3	3	3	3			3	0-100Hz	Truck travel speed when direction change smoothness ramp is stopped with maximum load
MAX LOAD WEIGHT	77 = 1500kg	102 = 2000kg	62 = 1200kg 82 = 1600kg	102 = 2000kg			102	0-255	Maximum load teached value for the load weight display. Value is calculated by function $x/5000*255$ where x = maximum lifting capacity
SEAT MICRO DELAY	2	2	-	-			2	0-5s	Seat micro delay, for how long time it is possible to drive since seat micro switch is opened.
AUXILIARY TIME	0,8	0,8	0,8	0,8			0,8	0-5s	Brake delay, for how long time truck is held in place with motor until brake is released
TOP ABS HEIGHT	-	50	-	50			0	0-9	Encoder based total lift stop. 1 step = 40 pulses. 1 pulse = 3,65mm
HEIGHT REDUCTION	-	40	-	40			40	0-	0 = driving speed reduced to 2,5 km/h. Over the free lift area driving speed reduction curve selection. 1 = rough speed reduction, When setted same as TOP ABS HEIGHT --> no speed reduction



DATE:	
2006-11-27	

CIRCUIT DIAGRAM

TS1141211

NSS15N, NSS20N
HYDRAULICS, AUX. DEVICES

7 / 10	REV G
3-6968	

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1 INTRODUCTION

The COMBI AC1 inverter has been developed to perform all the electric functions that are usually presents in walkie trucks, stackers, low order pickers etc. The controller can perform the following functions:

- Controller for Ac 700W to 3.5Kw AC motors;
- Pump controller for series wounded DC motors up to 7,5 Kw.
- Drivers for ON/OFF electrovalves and for one proportional valve (electrodistributor)
- Can bus interface
- Interface for serial tiller head, canbus tiller or serial tiller
- Zapi patented sensorless control
- Flash memory.
- Double microcontroller (one for main tasks, one for safety related tasks)

4.2.5 Connection of the encoder

- 1) COMBI AC1 card is fit for different types of encoder. To control AC motor with Zapi inverter, it is necessary to install an incremental encoder with 2 phases shifted of 90°. The encoder power supply can be +5 or +12V. It can have different electronic output.

AMPSAAB VERSION

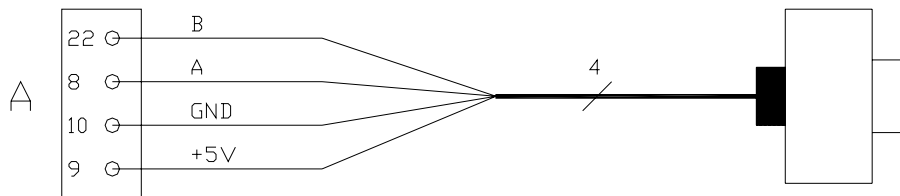
A9	+5V/+12V	positive of encoder power supply.
A10	GND	negative of encoder power supply.
A8	A	phase A of encoder.
A22	B	phase B of encoder.

AMPSEAL VERSION

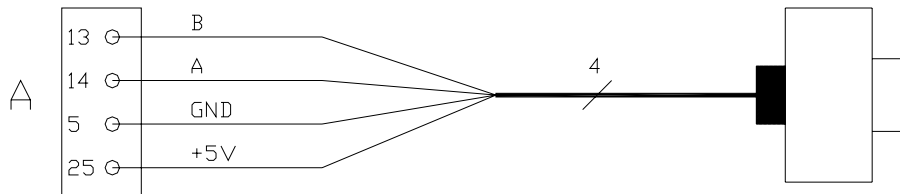
A25	+5V/+12V	positive of encoder power supply.
A5	GND	negative of encoder power supply.
A14	A	phase A of encoder.
A13	B	phase B of encoder.

- 2) Connection of encoder with open collector output; +5V power supply.

AMPSAAB VERSION

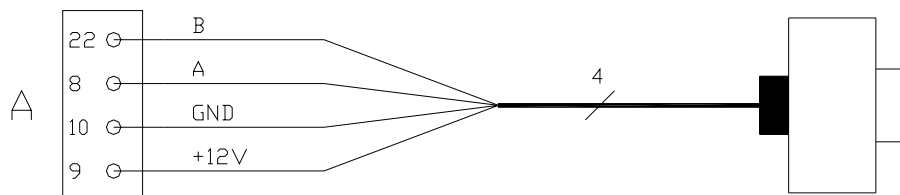


AMPSEAL VERSION



Connection of encoder with open collector output: +12V power supply.

AMPSAAB VERSION



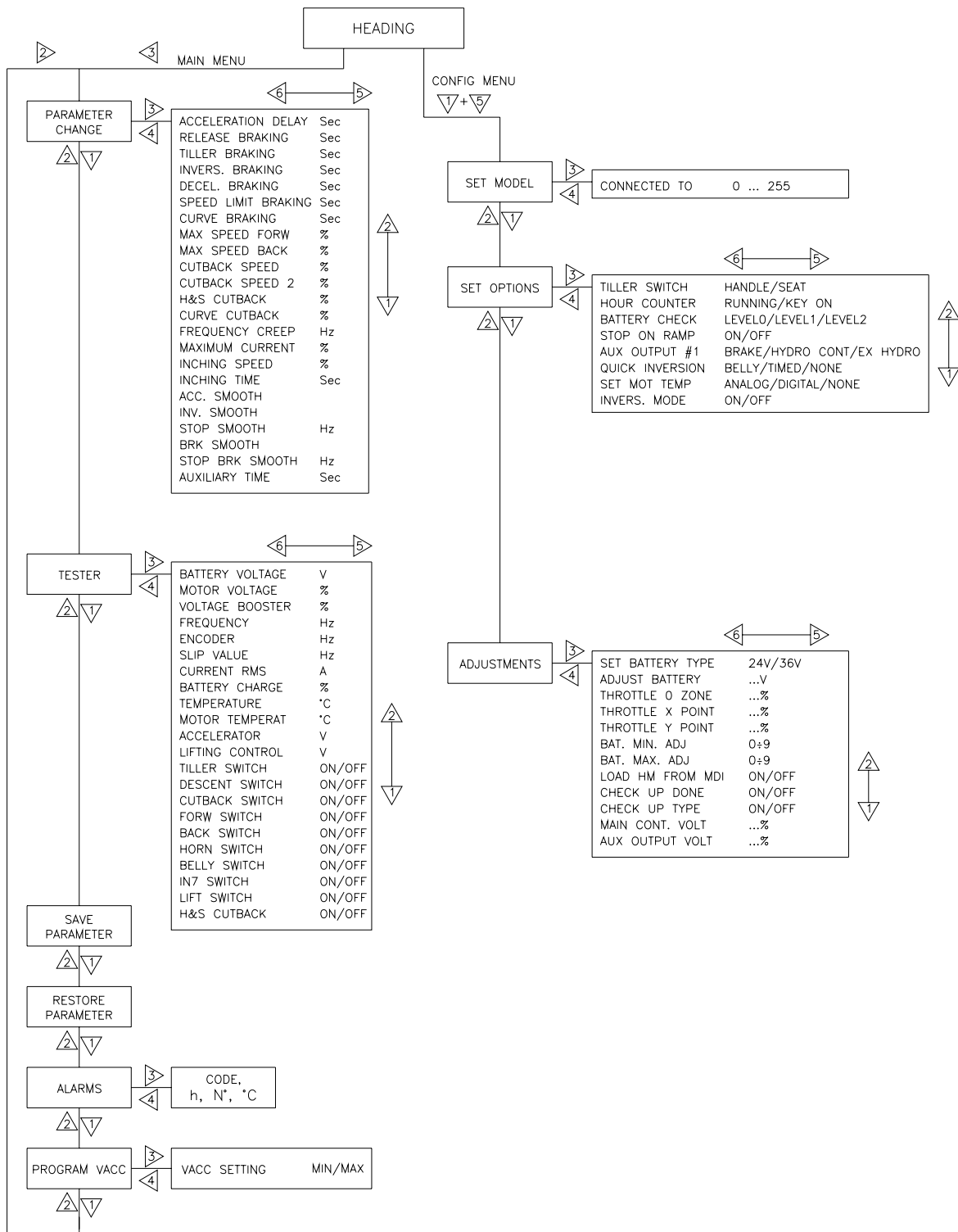
A18	FW	Forward switch input, active high (+VB).
A19	BACK	Reverse switch input, active high (+VB).
A20	IN5	Input of the switch DIGITAL INPUT # 5.
A21	HORN	Horn switch input, active high (+VB).
A22	ENC B	Traction motor encoder phase B.
A23	NPOT	Negative of the accelerator potentiometer, tested for wire disconnection diagnosis.
A24	CPOTTR	Accelerator potentiometer wiper.
A25	CPOTL	Lift potentiometer wiper.
A26	PPOT	Positive of the potentiometers; 10 volts output; keep load > 1kohm
A27	CANH	High level CAN-BUS voltage I/O.
A28	NEV4	Output of the electrovalve 4 driver (driving to –Batt).
A29	NCLRXD	Negative serial reception pin.
A30	PEB	Positive of the electromechanical brake coil.
A31	NEB	EB coil driver output; pwm controlled 2A continuous (driving to –Batt).
A32	NEV5/HORN OUT	Output of the electrovalve 5/horn driver (driving to –Batt).
A33	BELLY	Quick inversion function input, must be connected to the belly microswitch. It is active high (+VB).
A34	IN7	Input of the switch DIGITAL INPUT # 7.
A35	IN8	Input of the switch DIGITAL INPUT # 8.
A36	LIFT SW	Lift request switch input, active high (+VB).
A37	LIFTING CUTOUT	Lift stop input. Active low.
A38	IN12	Input of the switch DIGITAL INPUT # 12.
A39	NEV6	Output of the electrovalve 6 driver (driving to –Batt).
A40	BOOTSTRAP	Flash memory bootstrap.
A41	GND	Negative of the lift potentiometer.
A42	CANL	Low level CAN-BUS voltage I/O.

6.1.2 CNA connector: AmpSeal version

The connector used is an AMPSEAL plug 35 pins

A1	TILLER	Tiller microswitch input, active high (+VB).
A2	PEB	Positive of the electromechanical brake.
A3	PAUX	Positive supply for electrovalves. This input has to be supplied with positive taken after main contactor and should be used to supply all electrovalves.
A4	NEB	EB coil driver output; pwm controlled 2A continuous (driving to –Batt).
A5	NENC	Negative of the Encoder
A6	CUTBACK	Speed reduction switch input #1. Active low (switch opened).
A7	BELLY	Quick inversion function input, must be connected to the belly microswitch. It is active high (+VB).

9.3.2 Master: AmpSeal version



PARAMETER	UNIT	PROGRAMMED LEVEL									
		0	1	2	3	4	5	6	7	8	9
ACCELERATION DELAY	Sec.	From 0 to 10 sec., resolution of 0.1									
RELEASE BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
TILLER BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
INVERSION BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
SPEED LIMIT BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
INVERSION BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
DECELERATION BRK.	Sec.	From 0 to 10 sec., resolution of 0.1									
SPEED LIMIT BRK.	Sec.	From 0 to 10 sec., resolution of 0.1									
CURVE BRAKING	Sec.	From 0 to 10 sec., resolution of 0.1									
MAX SPEED FW	%	From 0% to 100%, resolution of 1%									
MAX SPEED BW	%	From 0% to 100%, resolution of 1%									
CUTBACK SPEED 1	%Max Sp	From 0% to 100%, resolution of 1%									
CUTBACK SPEED 2	%Max Sp	From 0% to 100%, resolution of 1%									
H&S CUTBACK	%Max Sp	From 0% to 100%, resolution of 1%									
CUTBACK SPEED 3	%Max Sp	From 0% to 100%, resolution of 1%									
FREQUENCY CREEP	Hz	From 0.6 to 4.0 Hz, resolution of 0.1 Hz									
MAXIMUM CURRENT	%IMAX	From 0% to 100%, resolution of 1%									
INCHING SPEED	%Max Sp	From 0% to 100%, resolution of 1%									
INCHING TIME	Sec.	From 0 to 10 sec., resolution of 0.1									
STOP SMOOTH	Hz	From 3 to 20 Hz, resolution of 1Hz									
STOP BRAKE SMOOTH	Hz	From 3 to 20 Hz, resolution of 1Hz									
AUXILIARY TIME	Sec.	From 0 to 10 sec., resolution of 0.1									

9.4.4 Zapi menu “SPECIAL ADJUSTMENTS” functions list

Note: the below set-up description is for skilled persons only: if you aren't, please keep your hands off. To enter this Zapi hidden menu a special procedure is required. Ask for this procedure, directly to a Zapi technician.

In the SPECIAL ADJUSTMENTS functions list, there are factory adjusted parameters only.

1) ADJUSTMENT #01

(Factory adjusted). % value. This is the Gain of the first Current Sensing Amplifier.

NOTE: only Zapi technicians should change this value

2) ADJUSTMENT#02

(Factory adjusted). % value. This is the Gain of the second Current Sensing Amplifier.

NOTE: only Zapi technicians should change this value

3) SET TEMPERATURE

Set the temperature offset to have the correct value reading. This is a fine calibration of the controller temperature sensor.

10 OTHER FUNCTIONS

10.1 Description of console “SAVE” function

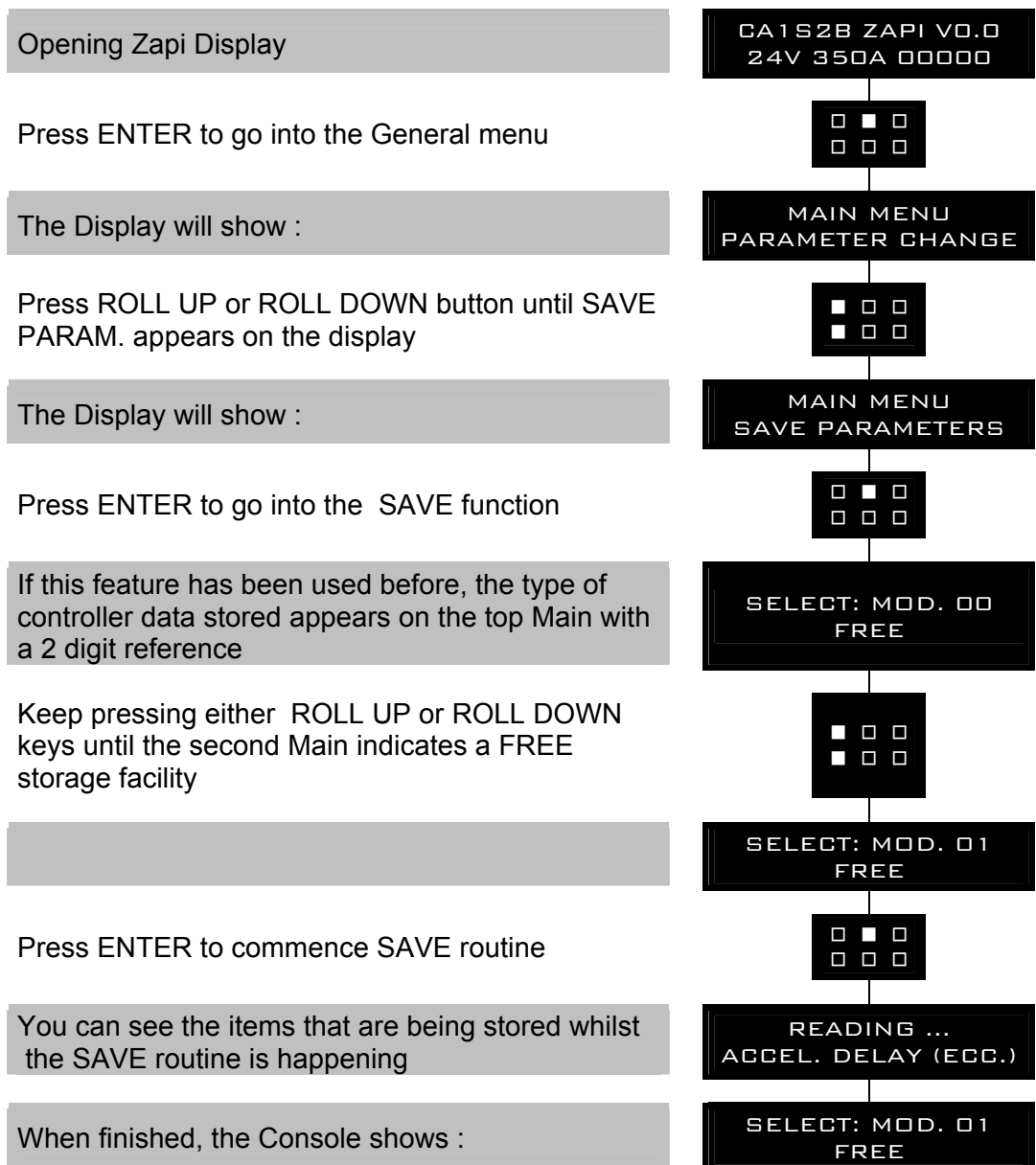
The SAVE function allows the operator to transmit the Parameter values and Configuration data of the controller into the Console memory. It is possible to load 64 different programmes.

The information saved in the Console memory can then be reloaded into another controller using the RESTORE function.

The data that is available via the SAVE function are listed here below:

- All Parameter Values (PARAMETER CHANGE).
- Options (SET. OPTIONS).
- The Level of the Battery (ADJUST BATTERY).

Flow Chart showing how to use the SAVE function of the Digital Console.



- If no problem are found on the motors, the problem is inside the controller.
- 3) “VMN HIGH”
- Cause 1:
Before switching the LC on, the software checks the power bridge: it turns on alternately the Low side Power Mosfets and expects the phases voltage to decrease down to -BATT. If the phases voltage do not decrease, this alarm occurs.
- Cause 2:
This alarm may occur also when the start up diagnosis is overcome, and so the LC is closed. In this condition, the phases’ voltages are expected to be lower than 1/2 Vbatt. If it is higher than that value, fault status is entered.
- Troubleshooting:
- A) If the problem occurs at start up (the LC does not close at all), check:
 - Motor internal connections (ohmic continuity)
 - Motor power cables connections
 - If the motor connection are OK, the problem is inside the controller
 - B) If the problem occurs after closing the LC (the LC closed and then opens back again), check:
 - Motor connections
 - If motor phases windings/cables have leakages towards truck frame
 - If no problem are found on the motors, the problem is inside the controller
- 4) “POWER MOS SHORTED”
- Cause: Before switching the LC on, the software checks the power bridge: it turns on alternately the Low side and High side Power Mosfets and expects the phases voltage to decrease down to –BATT (increase up to +Batt). If the phases voltage do not follow the commands, this alarm occurs.
- Troubleshooting:
This type of fault is not related to external components; replace the controller.
- 5) “COIL SHORT HW KO”
- Cause:
The hardware circuits which manages short circuits protection of LC and EB coils has a problem.
- Troubleshooting:
This type of fault is not related to external components; replace the controller.
- 6) “COIL SHORTED”
- Cause:
This alarm occurs when there is a short circuit of one of the coils connected to outputs of the Combiac1 (LC coil or EB coil). After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
- Troubleshooting:
- A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
 - B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.
- 7) “DRIVER SHORTED”
- Cause:

11.7 Analysis and troubleshooting of Slave alarms

1) "EVP DRIVER SHORTED"

Cause:

The EVP driver is shorted.

Troubleshooting:

Check if there is a short or a low impedance between the negative of the coil and –BATT. Otherwise the driver circuit is damaged and the controller must be replaced.

2) "PUMP VMN LOW"

Cause:

The pump motor output is lower than expected, considering the pwm applied.

Troubleshooting:

A) If the problem occurs at start up (the LC does not close at all), check:

- Motor internal connections (ohmic continuity)
- Motor power cables connections
- If the motor connection are OK, the problem is inside the controller

B) If the problem occurs after closing the LC (the LC closed and then opens back again), check:

- Motor connections
- If motor windings/cables have leakages towards truck frame
- If no problem are found on the motors, the problem is inside the controller

C) If the alarm occurs during motor running, check:

- Motor connections
- If motor windings/cables have leakages towards truck frame
- That the LC power contact closer properly, with a good contact
- If no problem are found on the motors, the problem is inside the controller.

3) "PUMP VMN HIGH"

Cause:

This test is carried out when the pump motor is turning (pwm applied). The pump motor output is higher than expected, considering the pwm applied.

Troubleshooting: it is suggested to check:

A) Motor connections

B) If motor windings/cables have leakages towards truck frame

C) If no problem are found on the motors, the problem is inside the controller

4) "ANALOG INPUT"

Cause:

This alarm occurs when the A/D conversion of the analog inputs gives frozen value, on all of the converted signals, for more than 400msec. The goal of this diagnosis is to detect a failure of the A/D converter or a problem in the code flow that omits the refreshing of the analog signal conversion.

Troubleshooting:

If the problem occurs permanently it is necessary to substitute the controller.

5) "LOGIC FAILURE #1"

Cause:

This fault is displayed when the controller detects an overvoltage or



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User Manual

EPS-AC0



3.3 Operational features

A list of eps-ac0 operational features follows below:

- 1) Static sensitivity boost in open loop (steering sensitivity increases for a slow moving steering wheel).
- 2) Static numbness in closed loop (steering sensitivity decreases for handle steer close to the straight-ahead direction).
- 3) Dynamic Numbness in open loop (steering sensitivity reduces when the truck speed increases).
- 4) Dynamic Numbness on request in closed loop (steering sensitivity reduces when the truck speed increases).
- 5) Truck speed reduces when the steering angle increases.
- 6) Alignment at the rest position in open loop application (to avoid the drift of the steered wheel when travelling with released steering wheel).
- 7) Embedded PID algorithm for closed loop application (Twin Pot).
- 8) Embedded PID algorithm for automatic functions (AUTC).
- 9) Special Debugging & Troubleshooting system makes easier the fault catching.
- 10) Possibility to run in a stand-alone (not CAN Bus supported) configuration.
- 11) Motor control may be performed with or without encoder. Default choice is without encoder. The adoption of a cheap and low-resolution encoder is possible.
- 12) Redundant processing (two microprocessors aboard) fulfils the Category #3 requirement including the set-point comes via CAN Bus from a remote unit.
- 13) Redundant set point and feedback sensors fulfil the Category #3 requirement.
- 14) Redundant safety-contact fulfils the Category #3 requirement in a stand-alone configuration.

3.4 Diagnosis

According to EN1175, most of the diagnoses deenergize steer and traction in less than 100 msec. Few secondary alarm conditions require longer time for detection. They too deenergize steer and traction: it is better to have delayed alarm than no alarm at all.

Diagnosis is provided in two ways. The digital console can be used, which gives a detailed information about the failure; the failure code is also sent on the Can-Bus.

5 AUTC MODE

Eps-ac0 may perform an automatic centering operation (AUTC).

AUTC means the steered wheel shall be aligned straight-ahead following a centering request. The centering request can be provided via CAN Bus. As alternative, it is possible to use wired requests. For example:

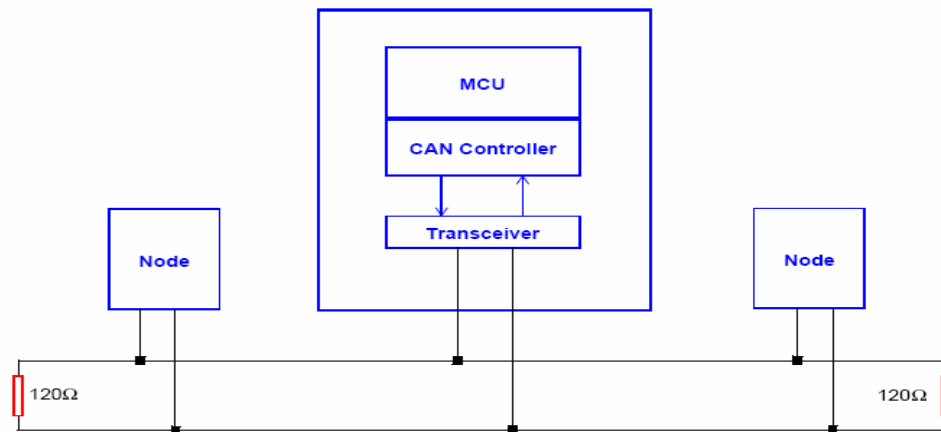
- 1) in a configuration with feedback pot and feedback encoder, it is possible to use inputs CNA#3 and CNA#2 for the centering request (redundancy is recommended).
- 2) in a configuration with toggle switches and feedback encoder, when input CNA#1 is not used, it is possible to use inputs CNB#6 and CNA#1 for the centering request (redundancy is recommended).

In case of AUTC a customized software must be developed.

8.6 Installation of a CAN Communication System



CAN stands for Controller Area Network. It is a communication protocol for real time control application. CAN operates at data rate of up to 1 Megabits per second. It was invented by the German company Bosch to be used in the car industry to permit communication among the various electronic modules of a vehicle, connected as illustrated in the figure below:



The best cable for can connections is the twisted pair; if it is necessary to increase the immunity of the system to disturbances, a good choice would be to use a cable with a shield connected to the frame of the truck. Sometimes it is sufficient a simple double wire cable or a duplex cable not shielded.

In a system like an industrial truck, where power cables carry hundreds of Ampere, there are voltage drops due to the impedance of the cables, and that could cause errors on the data transmitted through the can wires.



The eps-ac0 drains low level of current and so low section cables (4 mm²) are adopted for the power connections. This could be a drawback: in fact, a low section cable has higher reactance (impedance) than a wide section cable. As a consequence the noise generated on the minus battery cable, by the CAN lines switching, will be a wide amplitude spike. So, when it is possible, we suggest to use a (as short as possible) cable of a wide section for the minus battery connection, even for the eps-ac0 and the other low current units in the system.



VERY IMPORTANT: The eps-ac0 has the 120 ohms termination resistance aboard.

9.2 Description of power connections

View of the power bars:

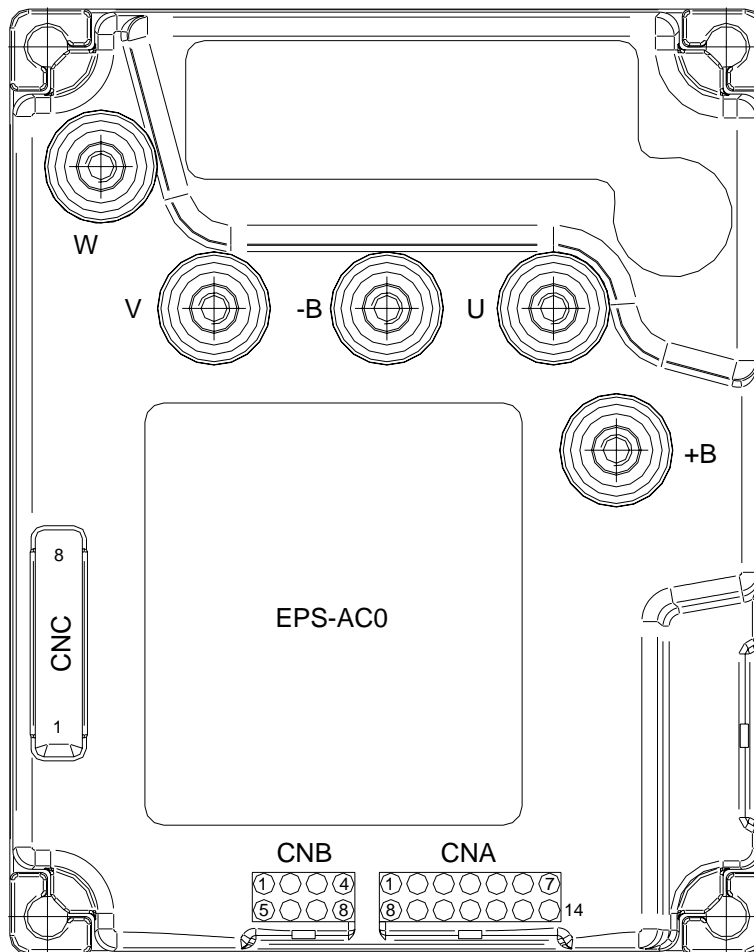


Figure 9-3

- | | |
|---------|--|
| -B | Negative of the battery. |
| +B | Positive of the battery. |
| U; V; W | Connection bars of the three motor phases; follow this sequence and the indication on the motor. |

11.2.2 Stepper Motor & AUTC

When the Automatic Centering (AUTC) is required on a truck working open loop in manual mode (stepper motor), it is necessary to guide the truck in automatic mode and to perform the following steps:

Step1 Roll-up or down the adjustments SET STEER 0-POS to get the truck straight travelling when automatic centered.

11.2.3 RTC only or RTC & AUTC

In a truck working closed loop in manual mode (with a Twin Pot connected on the Return To Center handlebar) with or without the AUTC function, it is necessary to perform the following steps:

Step1 Release the handlebar in its straight-ahead rest position and acquire the adjustments ZERO SP POT (to record the rest twin pot voltage).

Step2 Roll-up or down the adjustments SET STEER 0-POS to get the truck straight travelling when the handlebar is straight ahead.

matched with the actual encoder resolution.

11) ORIENT THE WHEEL

(only when FEEDBACK DEVICE is OPTION #4). Option ORIENT THE WHEEL is used only when AUTOCENTERING is ON to specify the steered wheel orientation at the initial automatic alignment. It gets the steered wheel oriented at the straight ahead position (null WHEEL ANGLE) or to the 180 degrees position (depending by this setting).

12) POT UP SW1 EDGE

(only when FEEDBACK DEVICE is OPTION #3). It is possible to reverse the turning direction of the steered wheel during the initial alignment. To do that an OPTIONS called POT UP SW1 EDGE is supplied. When it is ON, the steered wheel seeks the falling edge during an initial automatic rotation in the direction of an increasing FB POT. When it is OFF, the steered wheel seeks the falling edge during an initial automatic rotation in the direction of a decreasing FB POT. (A properly setting of POT UP SW1 EDGE is required to avoid EPS NOT ALIGN alarm).

correspondence between the steering motor speed and the angle error between the actual commanded position and the latest steady state position of the steered wheel: when this angle error is wider than the angle specified with this setting, there will be no clamp on the steering motor speed (full speed steering motor is SET SAT FREQ plus OVERSAT FREQ); when this angle error is smaller than 40% of the angle specified with this setting, the maximum Numbness will be applied. This parameter sets the angle, between the commanded position and the latest steady state position, at which the steering motor speed gets its maximum value (SET SAT FREQ plus OVERSAT FREQ).

- LEVEL 0: No Numbness if the angle between tiller and latest steady state is higher than 5°.
- LEVEL 1: No Numbness if the angle between tiller and latest steady state is higher than 11°.
- LEVEL 2: No Numbness if the angle between tiller and latest steady state is higher than 17°.
- LEVEL 9: No Numbness if the angle between tiller and latest steady state is higher than 60°.

Each step has a weight of 6 degrees.

9) DYNAM NUMB SPEED

Level 0 to 9. This parameter handles the Dynamic Numbness vs. the Steering Error for RTC and AUTC functions. This functions applies a linear correspondence between the steering motor speed and the angle error between the actual commanded position and the latest steady state position of the steered wheel. This parameter sets the percentage of the full steering motor speed is applied when in the full Dynamic Numbness. The full steering motor speed is the sum of the SET SAT FREQ and OVERSAT FREQ settings. When the angle between the actual commanded position and the latest steady state position is less than 40% of the DINAM NUMB ANG setting, the Full Dynamic Numbness vs. the Steering Error is applied and the steering speed is clamped to the DYNAM NUMB SPEED percentage below.

- LEVEL 0: At full Dynamic Numbness, the steering motor frequency is clamped to 40% (maximum Numbness).
- LEVEL 1: At full Dynamic Numbness, the steering motor frequency is clamped to 46%.
- LEVEL 2: At full Dynamic Numbness, the steering motor frequency is clamped to 53%.
- LEVEL 9: At full Dynamic Numbness, the steering motor frequency is clamped to 100% (no Numbness).

Each step more has a weight of 6.6 %.

10) COMPENSATION

Level 0 to 2. This parameter applies a compensation for the drops in the motor connections to have a real Emf/f control law.

- LEVEL 0: No compensation.
- LEVEL 1: Compensate the drop on power mosfets and cables.
- LEVEL 2: Compensate the drop on power mosfet, cables and motor resistance.

COMPENSATION to LEVEL 2 is strongly suggested (the correct setting of the motor resistance is required when COMPENSATION is set to LEVEL 2-see 13.1).

the full drive speed. It is used for the dynamic numbness (i.e. the steering sensitivity reduces when the truck speed increases).

26) ENC COUNT AT 360

(only when FEEDBACK DEVICE is OPTION #4). This reading shows the encoder counting between two falling edges on the straight ahead switch. It must be meant as the encoder counting corresponding to a steered wheel revolution. It is scaled in the range 0 to ± 5 V with the meaning that 5 V corresponds to an encoder counting of 2^{15} events. The ENC COUNT AT 360 absolute value can be recorded on the adjustment SET ENC AT 360.

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