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EN

FREE VERSION

User Manual

AC-1 SSL SENSORED

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APPROVAL SIGNS

COMPANY FUNCTION	INIZIALS	SIGN
GRAPHIC AND LAYOUT	FF	
PROJECT MANAGER	MI	
TECHNICAL ELECTRONIC MANAGER VISA	PP	
SALES MANAGER VISA	PN	

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1 INTRODUCTION

The AC1 SSL SENSORED inverter has been developed for applications such as electric transpallets, golf car, order pickers, sit on stackers with Asynchronous (AC) traction motors up to 2.5KW.
The AC1 SSL SENSORED can be supplied in two versions:
1) Sensored version using an Encoder (Sensor Bearing) in the Motor axle
2) SenseCoils version using special auxiliary windings in the motor.
Here the Sensored Version is descripted: it adopts an Encoder integrated in the Ball Bearing (Sensor Bearing).
The Encoder fills up the truck performance, respect to the Sensorless and Sense Coils versions, with lower minimum speed, the “stop on the ramp” service and a smoother inversion; on the other hand the reliability gets penalized by the fragile mechanics and inaccessible position of the Sensor Bearing.
The correct part number for the 24V AC1 SSL SENSORED with Encoder is FZ2018. The 36V has the part number FZ3010. The 48V part number is FZ5053.
AC1 has also a small brother controller called AC0, both are available in the Sensored version. The only differencies between AC1 and AC0 are the maximum current (250A vs. 150A) and the dimensions.
All the Zapi AC controllers have the CAN Bus communication peripheral and a Serial Link embedded: the SW for the communication via CAN Bus between the AC1 and the MDI-PRC has been already developed in a standard handling here descripted.
MDI-PRC is a Zapi module to be mounted on the dashboard of the truck to inform with a display about the state of the truck and provided with a Leds battery charge indicator. Besides, the MDI-PRC can drive four electrovalves (two proportional and two On/Off type) for an advanced hydraulics handling. MDI-PRC is the natural choice to fill the AC1’s services with those extra functions asked only on the high level trucks.
AC1 SSL has an additional analogue input (CNA #13) suited to receive a motor thermal sensor (KTY84-130).
The reference SW release for this manual is AC1TXXX   ZP1.07 .

2 SPECIFICATION

2.1 Technical specifications

Inverter for AC asynchronous 3-phase motors
Regenerative braking
Can-bus interface
Digital control using a microcontroller
Encoder Interface
Voltage: .... 24 – 36 - 48V
Maximum current (24V,36V): .... 250A (RMS) for 2'
Maximum current (48V):.. 215A (RMS) for 2'
Booster (24V, 36V):.. 270 (RMS) for 10 seconds
Operating frequency:.. 8kHz with center aligned PWM
External temperature range: .... -30°C ÷ 40°C
Maximum inverter temperature (at full power): .... 90°@24V, 78°C@48V

2.2 Block diagram

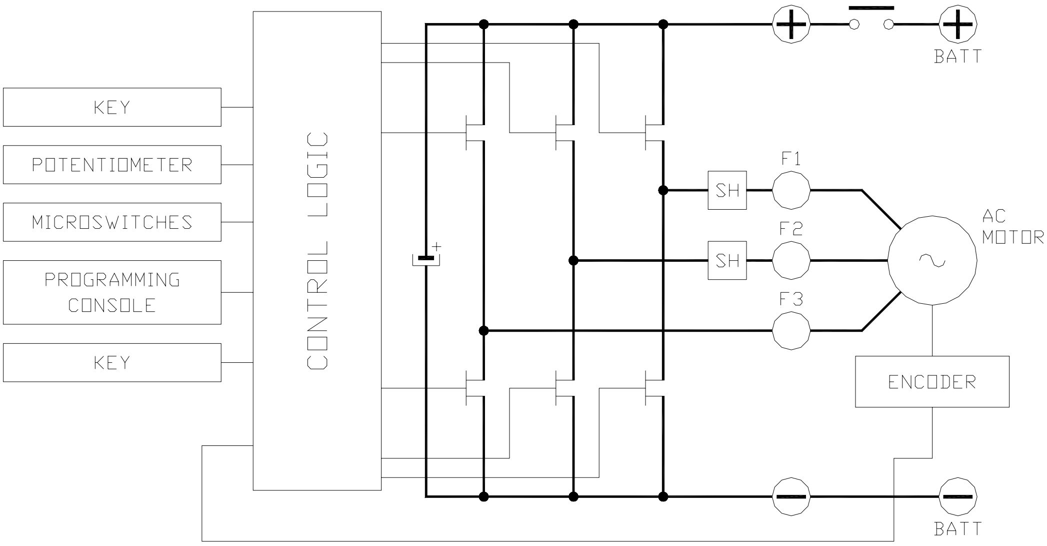


Figure 2–1

3 SPECIFICATION FOR THE INPUT DEVICES FILLING UP THE INSTALLATION KIT

The AC1 controller needs some external parts in order to work. The following devices complete the kit for the AC1 installation.

3.1 Microswitches

- The microswitches must have a contact resistance lower than 0.1Ω and a leakage current lower than 100µA.
- When full load connected, the voltage between the key switch contacts must be lower than 0.1V.
- The microswitches (if not otherwise noted) must connect or break a battery voltage to the inputs pins.

3.2 Accelerator unit

The accelerator unit can consist of a potentiometer or an Hall effect device.
It should be in a 3-wire configuration. The potentiometer is supplied through CNB#12 with about 12Vdc.
CPOT (CNB#10) signal ranges is from 0 to 10V.
Potentiometer value should be in the 0.5 - 10 KΩ range; generally, the load should be in the 1.5mA to 30mA range. Faults can occur if it is outside this range.

The standard connection for the potentiometer is the one in the Left side of Figure 3–1 (potentiometer on one end at rest) in combination with a couple of Travel demand switches. On request it is also possible the handling in the Right side of Figure 3–1 (potentiometer in the middle at rest) in combination with at least one Travel Demand switch. We strongly advice against the adoption of the Right side configuration without travel demand switch at all, because of a safety issue.

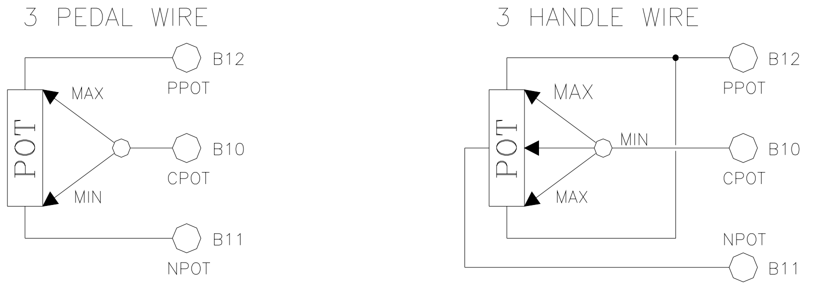


Figure 3–1

The Procedure for automatic potentiometer signal acquisition is carried out using the Hand Set. This enables adjustment of the minimum and maximum useful signal level (see paragraph 13.3 PROGRAM VACC function), in either direction.

3.3 Other analog control unit

Input CNA#18 is an analog input, whose typical application is a proportional command to enable a lifting and a lowering proportional Valves. It is possible to use this input for an alternative function is a proportional braking. It should be in a 3 wire configuration. Potentiometer value should be in the 0.5-10KΩ range. Generally, the load should be in the 1.5mA to 30 mA range.
The CPOTB (CNA#18) signal range is from 0 to 10V.

3.4 Analog motor thermal sensor input

Input CNA#13 is an analog input to receive an analog Thermal Sensor Model Philips KTY84-130 to measure the Motor Winding Temperature. This is a PTC polarized two terminals device: connect the positive end to CNA#13 and a the negative end to a minus battery voltage (e.g. CNA#8 or CNA#12).

3.5 Speed feedback

The motor control is based upon the motor speed feedback. The speed transducer is an incremental encoder, with two phases shifted at 90°. The encoder can be of different types:

- power supply: +5V or +12V
- electric output: open collector (NPN or PNP), push-pull.

The wished resolution must be specified when ordering the controller. The suggested resolution is from 32pulses/rev up to 64pulses/rev.
For more details about encoder installation see also chapter 8.4.

Note: The encoder resolution and the motor poles pair (the controller can handle), is specified in the home page display of the handset showing something like:

AC1T2AE ZP1.07

That means:
AC1T=AC1 traction controller
2= poles pair number
A= 32 pulses/rev encoder
E= identifier for an extended memory hardware release inside

The encoder resolution is given by the second-last letter in the following list:
A= 32 pulses/rev
K= 48 pulses/rev
B= 64 pulses/rev
C= 80 pulses/rev

4 PROTECTION FEATURES

The AC1 is protected against some controller injuries and mulfunctions. These are:

1) **Battery polarity inversion**
   It is necessary to fit a MAIN CONTACTOR to cut off the Battery Positive connection to protect the inverter against reverse battery polarity.
2) **Connection Errors**
   All inputs are protected against connection errors.
3) **Thermal protection**
   If the chopper temperature exceeds 90°C at 24V or 78°C at 48V, the maximum current is reduced in proportion to the thermal increase. The cut off temperature is 110°C at 24V or 103°C at 48V for the encoder release and 85° for the sense coils release.
4) **External agents**
   The inverter is protected against dust and the spray of liquid to a degree of protection meeting IP54.
5) **Low battery charge**
   In the encoder release, when the battery charge is low, the maximum speed is reduced to the 25% of the maximum programmed. The Lifting Operation inhibited.
6) **Protection against accidental Start up**
   A precise sequence of operations are necessary before the machine will start.
   The truck does not move if these operations are not carried out correctly. Requests for drive, must be made after closing the key switch.
7) **Protection against uncontrolled movements**
   If the main contactor is opened, it never closes if:
   - The Power unit is not functioning.
   - The Logic is not functioning perfectly.
   - The output voltage of the accelerator does not fall below a threshold is 1V higher than the minimum voltage value stored with the PROGRAM VACC operation.
   - A microswitch for a moving request in closed position.

   An important improvement against the uncontrolled movements is given by the Passive Emergency Cell (see paragraph 5.1 below).

5 ⚠ SAFETY AND PROTECTION

ZAPI controllers are designed according to the prEN954-1 specifications for safety related parts of control system and to UNI EN1175-1 norm.
The safety of the machine is strongly related to installation; length, layout and screening of electrical connections have to be carefully designed.
AC1 inverter electronic implements an hardware safety circuit, which is able to switch off the three phase Power Bridge stopping the machine via HARDWARE, that is bypassing the software control.
This safety Circuit is actuated releasing the Tiller Switch and the handling is descripted in detail in the next Paragraph (see paragraph 5.1 PASSIVE EMERGENCY CELL).
ZAPI is always available to cooperate with the customer in order to evaluate installation and connection solutions. Furthermore, ZAPI is available to develop new SW or HW solutions to improve the safety of the machine, according to customer requirements.
Machine manufacturer holds the responsibility for the truck safety features and related approval.

5.1 Passive emergency cell

The Tiller Switch input is processed by two separated devices: the uC and a PLD (GAL). When the Tiller Switch turns open, both, the uC and the PLD device switch off the power mosfets distinctly one from the other. The PLD does that with a delay of 800msec. So, this PLD is a separate device (distinct from the uC) that automatically prevent operation of the travel circuit when the operator leaves the truck.

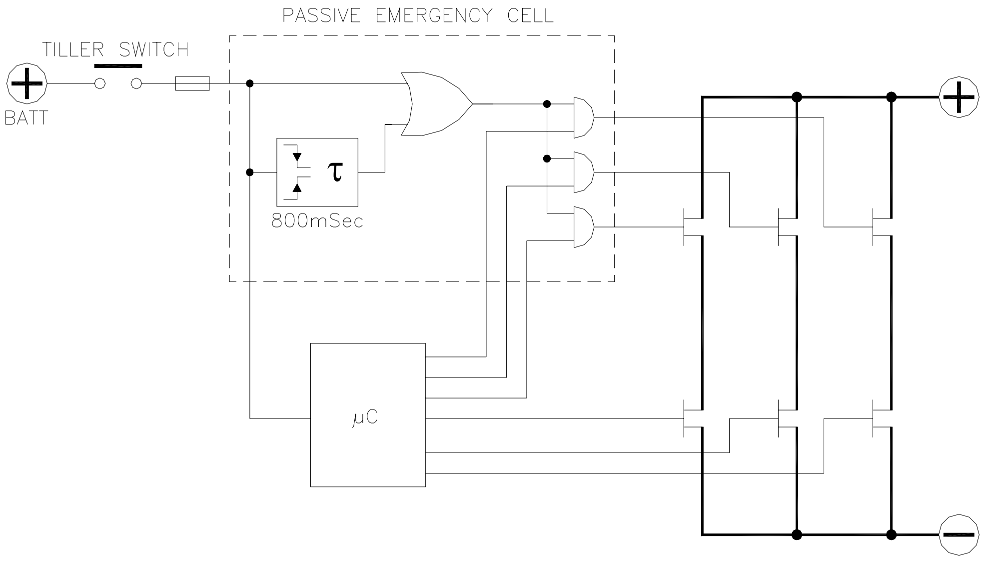


Figure 5–1

One of the reason for the adoption of this Passive Emergency cell is to comply with the EN1175-5.9.5: “A separate device indipendent of the speed control device (accelerator) shall automatically prevent operation of the travel circuit when the operator leaves the truck, e.g. seat switch, pedestrian tiller switch”. To be sure this separate device really prevent operation of the travel circuit, it is necessary a redundant device (togheter with the Elaboration Unit) reads this

separate device and stops the truck distinctly from the Elaboration Unit. This is exactly what the Passive Emergency Cell does.
In a system with a single microprocessor technology, the weak point is that just one unit (uC) processes the Inputs and decides alone to keep the motor moving or not. If this elaboration unit (uC) fails it is possible it keeps the motor moving against of the state of the commands. To avoid this risk, the Passive Emergency cell provides a further step of safety that is a redundancy in processing the motion request (Tiller or Seat Switch). In our controller the truck will be stopped, releasing the tiller, disregarding if the main Elaboration Unit (uC) is right working or not.

6 OPERATIONAL FEATURES

- Stable speed in every position of the accelerator.
- Regenerative release braking based upon deceleration ramps.
- Regenerative braking when the accelerator pedal is partially released (deceleration).
- Direction inversion with regenerative braking based upon deceleration ramp.
- Regenerative braking and direction inversion without contactors: only the main contactor is present.
- The release braking ramp can be modulated by an analog input, so that a proportional brake feature is obtained (this service is possible but the SW is not developed yet).
- Optimum sensitivity at low speed.
- Voltage boost at the start and with overload to obtain more torque (with current control).
- The inverter drives an electromechanical brake
- High efficiency of motor and battery due to high frequency commutations.
- Self diagnosis.
- Modification of parameters through the programming console.
- Internal hour-meter with values that can be displayed on the console.
- Memory of the last five alarms with relative hour-meter and temperature displayed on the console.
- Test function within console for checking main parameters.
- Speed control.
- Optimum behaviour an a slope due to the speed feedback:
    - the motor speed follows the accelerator, starting a regenerative braking if the speed overtakes the speed set-point.
    - the system can perform an electrical stop on a ramp (the machine is electrically hold on a slope) for a programmable time (see also 13.4 and 12.4.1.9 option STOP ON RAMP).

6.1 Diagnosis

The microprocessor continuously monitors the inverter and carries out a diagnostic procedure on the main functions. The diagnosis is made in 4 points:

- Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drives, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct.
- Standby diagnosis at rest that checks: phase's voltages, contactor driver, current sensor, can-bus interface.
- Diagnosis during operation that checks: contactor driver, current sensors, encoder, can-bus interface.
- Continuous diagnosis that check: temperature of the inverter, motor temperature.

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.

7 INSTALLATION SUGGESTIONS AND PRECAUTIONS

Read and respect the following suggestions to avoid problem during installation and in the definitive releasing.

7.1 Thermal consideration

- The heat generated by the power block must be dissipated. For this to be possible the compartment must be ventilated and the heat sink materials ample.
- The heat sink material and system should be sized on the performance requirement of the machine. Abnormal ambient air temperatures should be considered. In situations where either ventilation is poor, or heat exchange is difficult, forced air ventilation should be used.
- The thermal energy dissipated by the power block module varies and is dependent on the current drawn and the duty cycle.

7.2 General suggestion

- 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 (traction + lift. for ex.), 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 chopper 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, make tests with the wheels raised from the ground, in order to avoid dangerous situations due to connection errors.
- After the controller is switched off (key off), the Rail capacitor remains charged for some minutes; if you need to work on the inverter, discharge them using a 10Ω ÷ 100Ω resistance connected from the +Batt to the –Batt terminals in the controller side.
- Fit transient suppression devices to the horn, solenoid valves, and contactors not connected to the chopper such as those for activating the pump motor or steering motor.

7.3 Susceptibility and electromagnetic emission

Electromagnetic susceptibility and emission are strongly influenced by the installation. Special attention must be given to the lengths and the paths of the electric connections and the shields. This situation is beyond ZAPI's control. Therefore ZAPI declines any responsibility for non-compliance if correct testing is not made (the irradiated emission directive is EN50081-2).

7.4 Main contactor and key connection

- The connection of the main contactor can be carried out following the drawing in Figure 7–1.
- An intrinsic protection is present inside the logic when the voltage on the battery power connection overtakes the battery nominal voltage more than a certain percentage. Thank to this protection, it is allowed that the Main Contactor (or an emergency switch) breaks the Battery positive in every moment regardless of the state of the key (without this protection, if the Main Contactor breaks when a regenerative braking is in progress, the rail capacitor voltage increases and the overvoltage could damage the Power Mosfets).

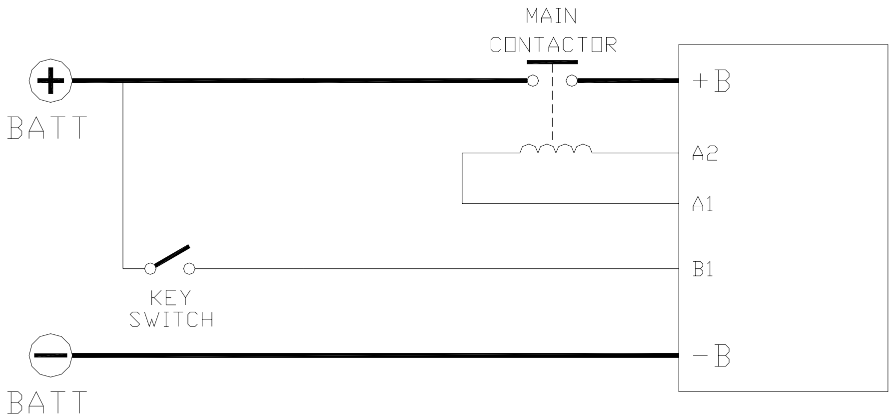


Figure 7–1

8 INSTALLATION

Install the controller with the base-plate on a flat metallic surface that is clean and unpainted. Apply a light layer of thermo-conductive grease between the two surfaces to permit better heat dissipation.
Ensure that the wiring of the cable terminals and connectors is carried out correctly.

8.1 Connection cables

For the auxiliary circuits, use cables at least 0.5mm² section.
For power connections to the motor and to the battery, use cables having section of 16 mm² (as a minimum).
For the optimum inverter performance, the cables to the battery should be run side by side and be as short as possible.

8.2 Contactors

Usually a main contactor is adopted to connect and cut off the battery to the controller. Depending on the setting of a parameter (see paragraph 12.4.1.10 option AUX VOLTAGE #1):

- the output which drives the main contactor coil is on/off (the coil is driven with the full battery voltage).
- the output which drives the main contactor coil is switched at high frequency (1 KHz) with a programmable duty cycle; this feature is useful to decrease the power dissipation of the contactor coil.

The EN1175 states the main Contactor is not mandatory (under proper conditions); anyway it is useful to protect the inverter against reverse battery polarity and to cut off the battery from the power mosfets when a failure in the three phase bridge occurs.

8.3 Fuses

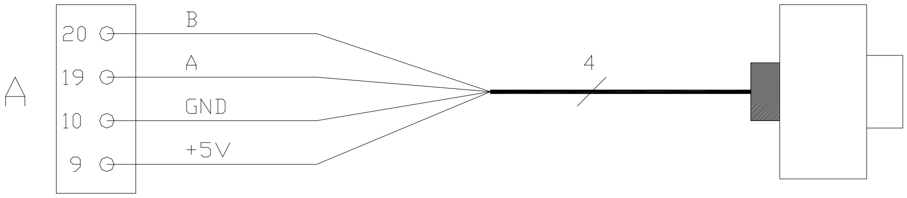
- Use a 6.3-10A Fuse for protection of the auxiliary circuits.
- For protection of the power unit, use a 180A -250A fuse in the Battery Positive connection. For special applications or requirements these values can be reduced.
- For Safety reasons, we recommend the use of protected fuses in order to prevent the spread of fused particles should the fuse blow.

8.4 Encoder installation

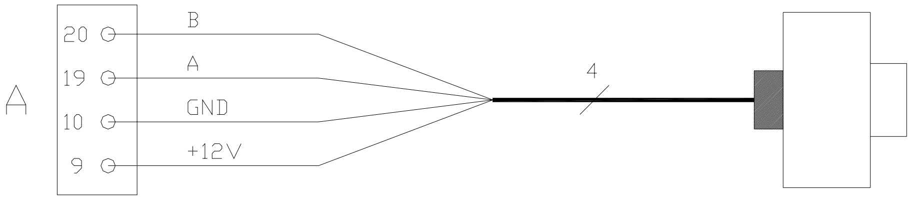
1) AC1 card is fit for different types of encoder. To control AC motor with Zapi inverter, it is necessary to install an incremental encoder with 2 phases shifted of 90°. The encoder power supply can be +5 or +12V. It can have different electronic output.

A9 +5V/+12V	positive of encoder power supply.
A10 GND	negative of encoder power supply.
A19 A	phase A of encoder.
A20 B	phase B of encoder.

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



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



VERY IMPORTANT
It is necessary to specify in the order the type of encoder used, in terms of power supply, electronic output and n° of pulses for revolution, because the logic unit must be set in the correct way by Zapi.
The n° of pulses revolution the controller can handle is given by the second-last letter in the software release name (see 3.5).

9 DESCRIPTION OF THE CONNECTORS

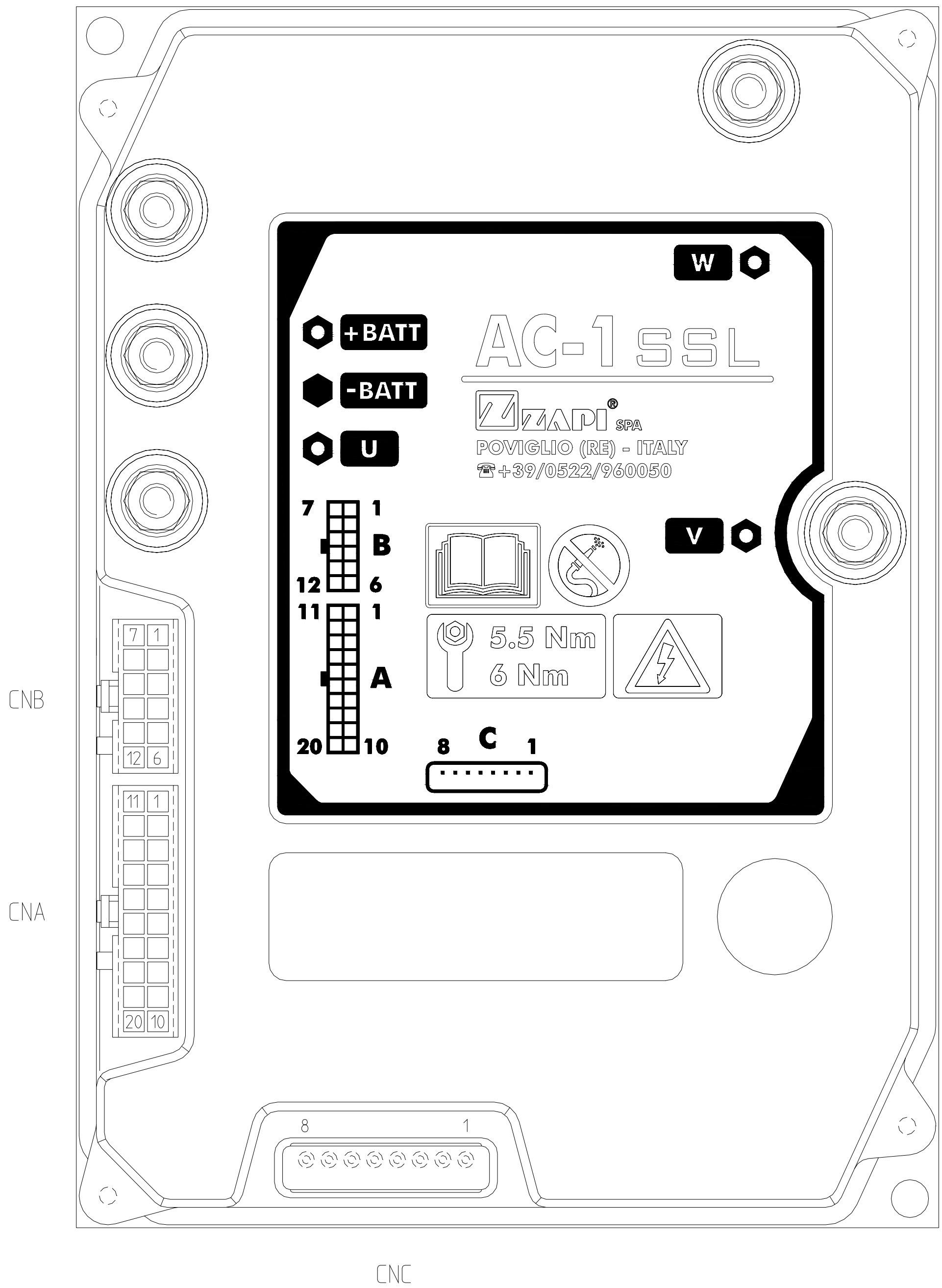


Figure 9–1

9.1 Connectors of the logic - Standard version with Encoder

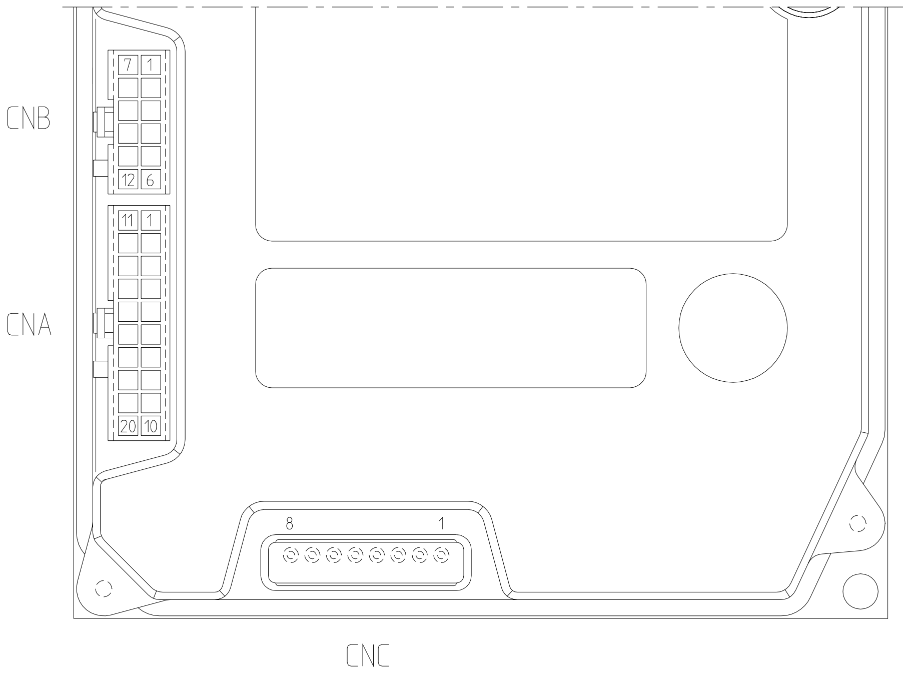


Figure 9–2

9.1.1 CNA connector

A1	NMC	Negative of main contactor coil.
A2	PMC	Positive of main contactor coil
A3	NBRAKE	Output for driving the electromechanical brake coil; drives the load to -Batt. Maximum current : 3A.
A4	NPC	Negative of pump contactor coil.
A5	PPC , PEV	Positive of pump contactor coil and lowering electrovalve coil.
A6	NEV	Negative of the lowering electrovalve coil.
A7	CAN-L	Low level CAN-BUS voltage I/O.
A8	NPOTB	-Batt.
A9	PENC	Encoder Positive Supply (+5 or +12Vdc)
A10	NENC	Encoder Negative Supply (GND to minus battery)
A11	HM	Output for driving an hourmeter; when the hourmeter is active this output provides a +Batt signal; 3A maximum current.
A12	-BATT	-Batt.
A13	THM	Motor thermal sensor input. The internal pull-up is a fixed 2mA (Max 5V) source current.
A14	SR2	Speed reduction 2 input. Active low (switch opened).
A15	SR1	Speed reduction 1 input. Active low (switch opened).
A16	+12V	This output provides a +12V signal for thr MDI PRC, if present; 100mA maximum current.
A17	CAN-H	High level CAN-BUS voltage I/O.

A18	CPOTB	Brake potentiometer wiper.
A19	ENC A	Encoder Channel A.
A20	ENC B	Encoder Channel B.

9.1.2 CNB connector

B1	KEY	Connected to the power supply through a microswitch (KEY) with a 6.3-10A fuse in series (this could be mounted on the AC1 cover).
B2	CM	Common of FW / BW / SR1 / SR2 / TILLER / H&S / BELLY / LIFTING / LOWERING microswitches. This connection supplies a key voltage level.
B3	TILLER	Tiller request input. Must be connected to the tiller microswitch, active high.
B4	H&S	Hard & Soft request input. Must be connected to the Hard & Soft microswitch, active high.
B5	BACKWARD	Backward direction request input. Must be connected to the backward direction microswitch, active high.
B6	FORWARD	Forward direction request input. Must be connected to the forward direction microswitch, active high.
B7	BELLY	Quick inversion function input; must be connected to the Belly microswitch; it is active high.
B8	LOWERING	Lowering request input, active high.
B9	LIFTING	Lifting request input, active high.
B10	CPOT	Accelerator potentiometer wiper.
B11	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
B12	PPOT	Potentiometer positive: 10V output; keep load > 1KΩ.

9.1.3 CNC connector

C1	PCLRXD	Positive serial reception.
C2	NCLRXD	Negative serial reception.
C3	PCLTXD	Positive serial transmission.
C4	NCLTXD	Negative serial transmission.
C5	GND	Negative console power supply.
C6	+12	Positive console power supply.
C7	FLASH	Must be connected to C8 for the Flash memory programming (if used).
C8	FLASH	Must be connected to C7 for the Flash memory programming (if used).

9.2 Connectors of the logic - MDI PRC Version with Encoder

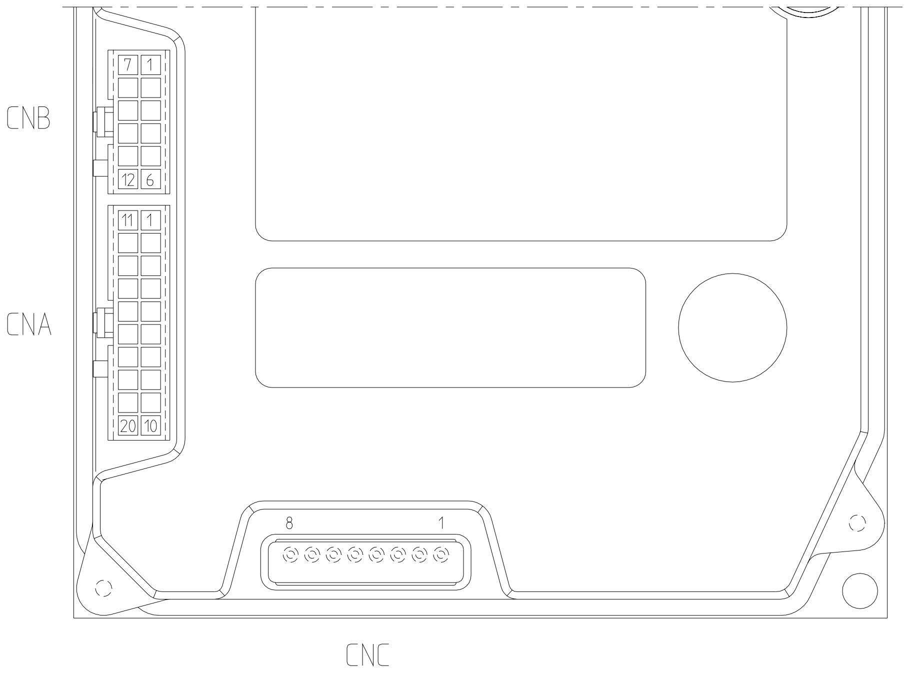


Figure 9–3

9.2.1 CNA connector

A1	NLC	Negative of main contactor coil.
A2	PMC	Positive of main contactor coil
A3	NBRAKE	Output for driving the electromechanical brake coil; drives the load to -Batt. Maximum current : 3A.
A4	NPC	Negative of pump contactor coil.
A5	PPC , PEV	Positive of pump contactor coil and of the auxiliary output load.
A6	NEV	Negative of the auxiliary output.
A7	CAN-L	Low level CAN-BUS voltage I/O.
A8	NPOTB	-Batt.
A9	PENC	Encoder Positive Supply (+5 or +12Vdc).
A10	NENC	Encoder Negative Supply (GND to minus battery).
A11	PEV (+B)	This output provides a +Batt for the electrovalves coils connected to the MDI PRC; 3A maximum current.
A12	-BATT	-Batt.
A13	THM	Motor thermal sensor input. The internal pull-up is a fixed 2mA (Max 5V) source current.
A14	LIFT AUX.	Auxiliary lifting request input, active high.
A15	LOW AUX.	Auxiliary lowering request input, active high.
A16	+12V	This output provides a +12V signal for the MDI PRC; 100mA maximum current.
A17	CAN-H	High level CAN-BUS voltage I/O.

A18	CPOTB	Proportional electrovalves potentiometer wiper.
A19	ENC A	Encoder Channel A.
A20	ENC B	Encoder Channel B.

9.2.2 CNB connector

B1	KEY	Connected to the power supply through a microswitch (KEY) with a 6.3-10A fuse in series (this can be mounted on the AC1 cover).
B2	CM	Common of FW / BW / LIFT AUX / LOW AUX / TILLER / H&S / BELLY / LIFTING / LOWERING microswitches. This connection supplies a key voltage level.
B3	TILLER	Tiller request input. Must be connected to the tiller microswitch, active high.
B4	H&S	Hard & Soft request input. Must be connected to the Hard & Soft microswitch, active high.
B5	BACKWARD	Backward direction request input. Must be connected to the backward direction microswitch, active high.
B6	FORWARD	Forward direction request input. Must be connected to the forward direction microswitch, active high.
B7	BELLY	Quick inversion function input; must be connected to the Belly microswitch; it is active high.
B8	LOWERING	Lowering request input, active high.
B9	LIFTING	Lifting request input, active high.
B10	CPOT	Accelerator potentiometer wiper.
B11	NPOT	Negative of accelerator unit, tested for wire disconnection diagnosis.
B12	PPOT	Potentiometer positive: 10V output; keep load > 1KΩ.

9.2.3 CNC connector

C1	PCLRXD	Positive serial reception.
C2	NCLRXD	Negative serial reception.
C3	PCLTXD	Positive serial transmission.
C4	NCLTXD	Negative serial transmission.
C5	GND	Negative console power supply.
C6	+12	Positive console power supply.
C7	FLASH	Must be connected to C8 for the Flash memory programming (if used).
C8	FLASH	Must be connected to C7 for the Flash memory programming (if used).

9.3 Description of power connections

View of the power bars:

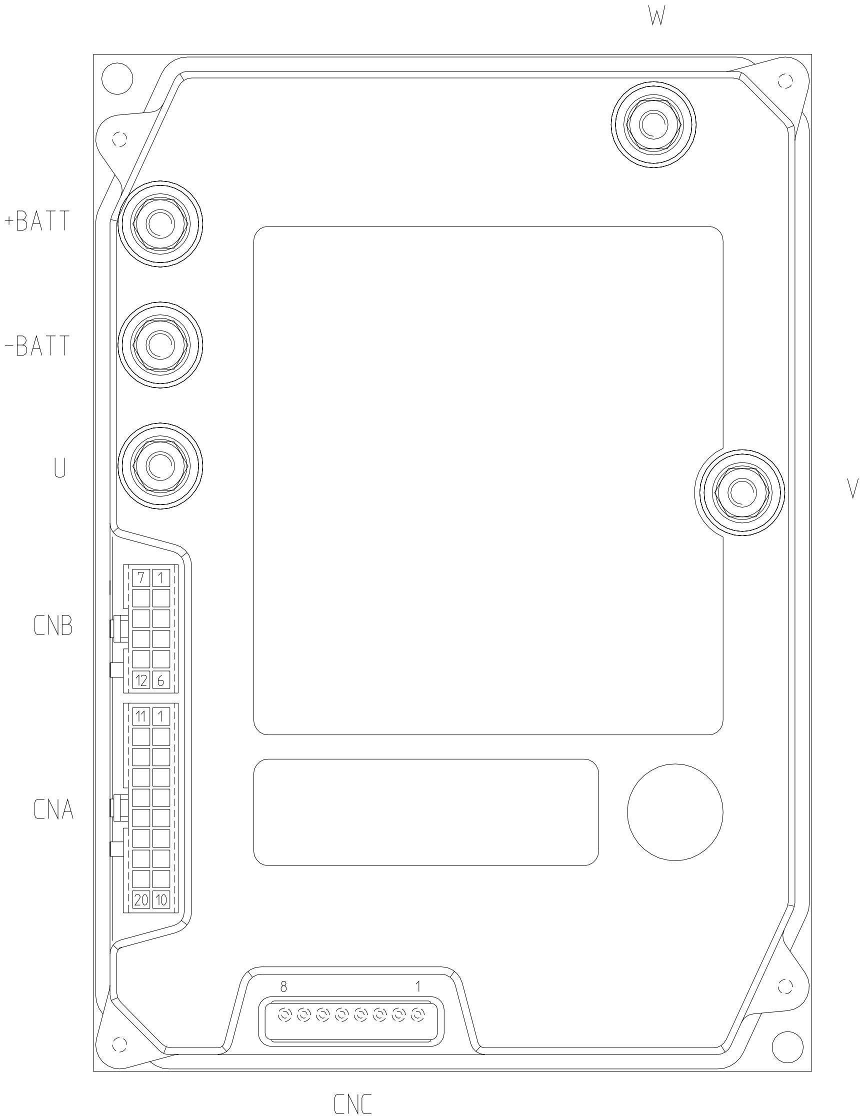


Figure 9–4

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

10 DRAWINGS

10.1 Mechanical drawing

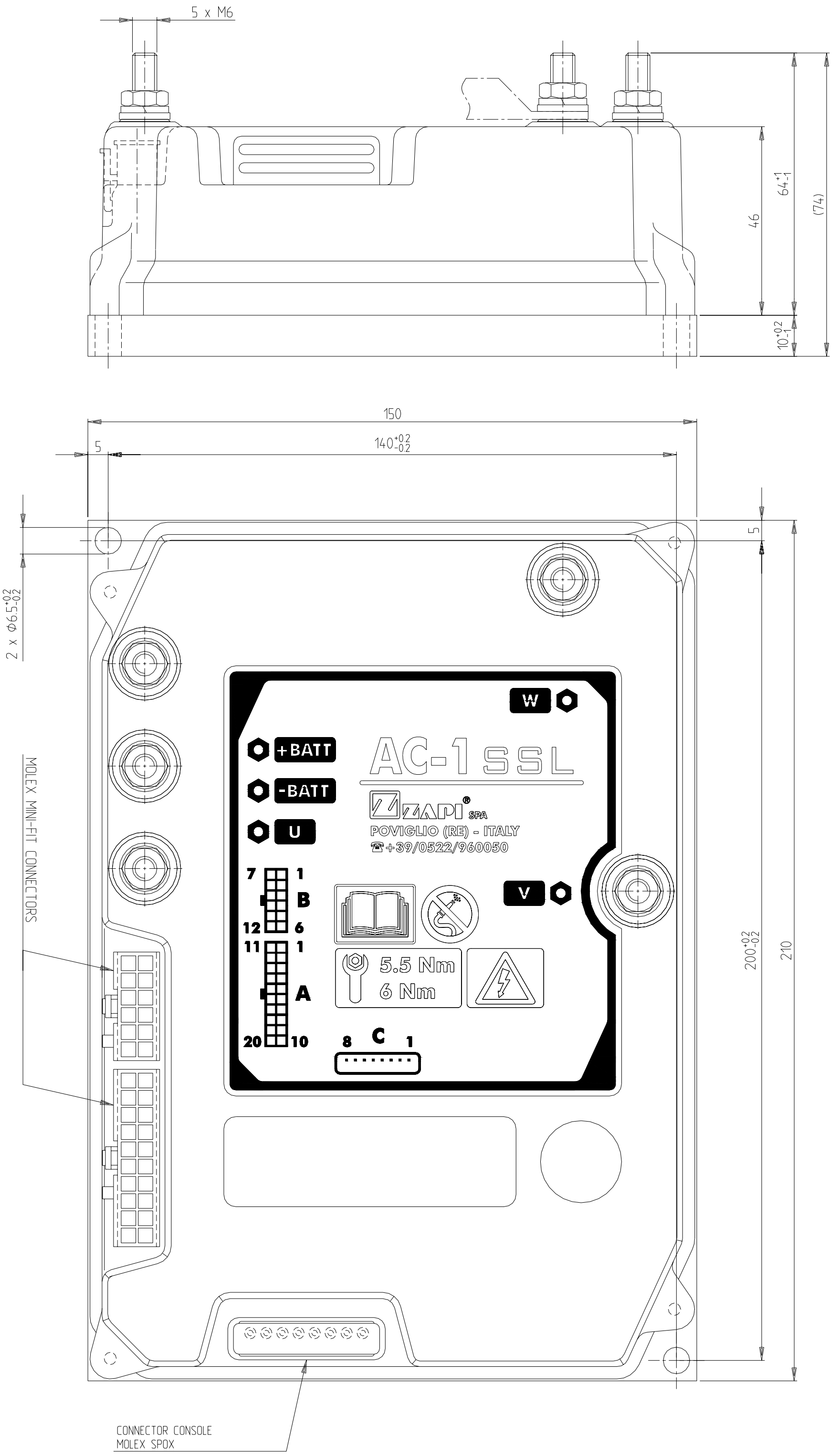


Figure 10–1

10.2 Connection drawing - Standard version with Encoder

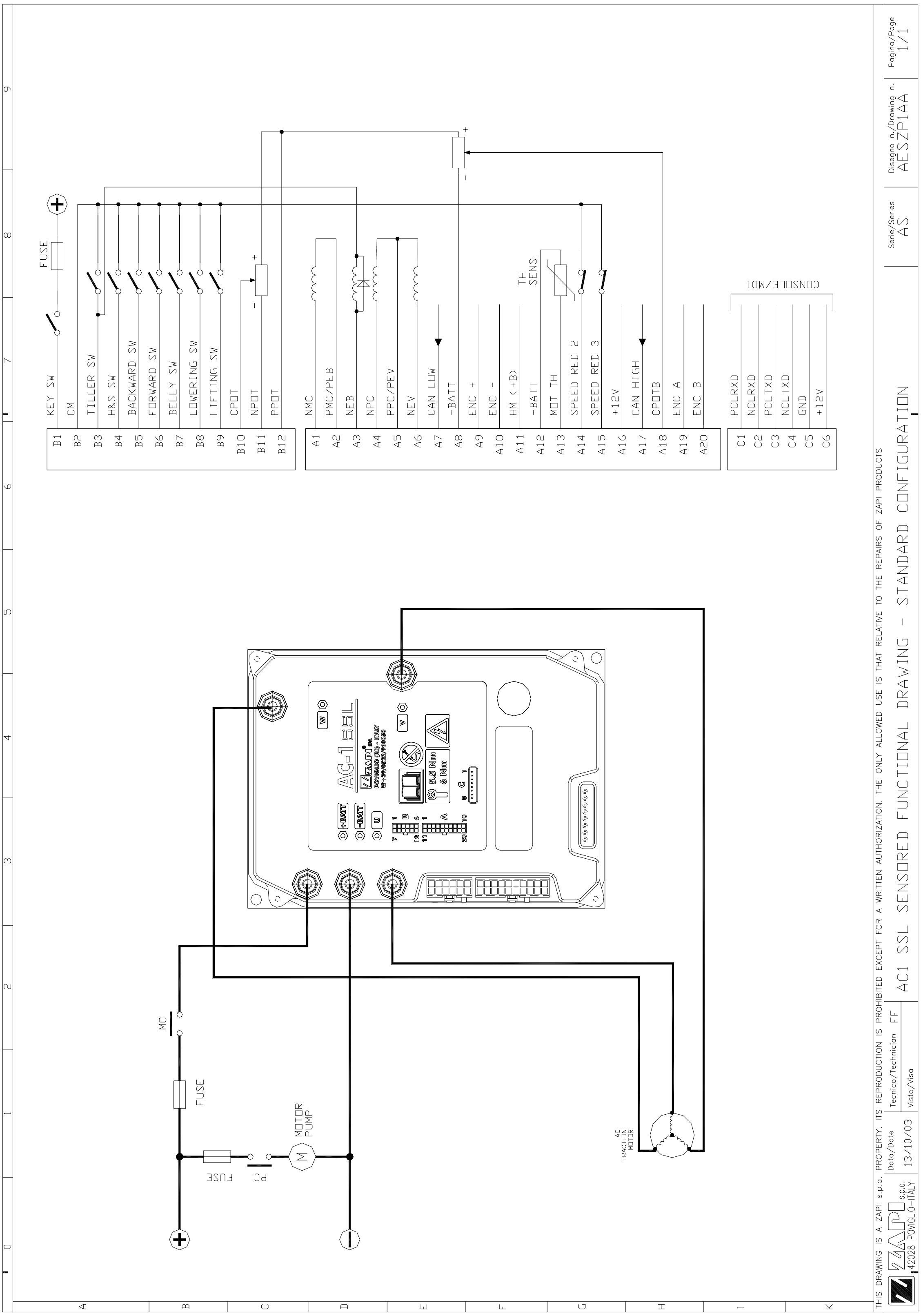


Figure 10–2

10.3 Connection drawing - MDI-PRC version with Encoder

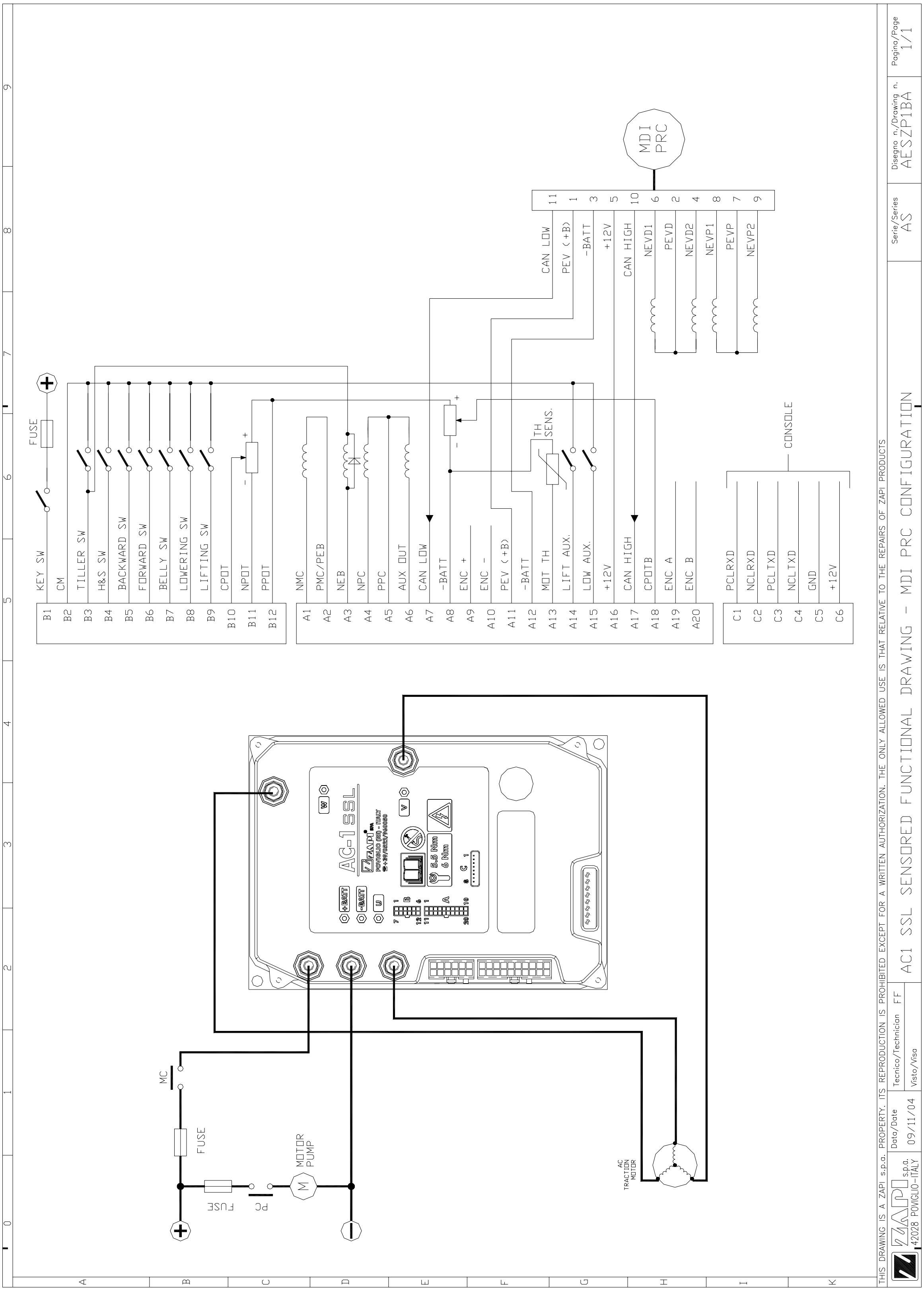


Figure 10–3

11 ONE SHOT INSTALLATION PROCEDURE

This section of the manual describes the basic connection procedure.
The truck needs (to move) a minimum I/O dotation that it is mandatory: this minimum dotation is listed in the Steps from 1 to 8 below.

Step1 Connect a potentiometer in the range 0.5K to 10Kohms, to modify the wished speed, between CNB#12, CNB#10, CNB#11.

Step2 Connect two travel demand switches. The FWD travel demand must be connected between a battery (key) voltage and CNB#6. The REV travel demand must be connected between a battery (key) voltage and CNB#5. Only one of them can be active at the same time. They become active when connected to a key voltage (the key voltage is supplied on the CNB#2 connection).

Step3 Connect a tiller (or seat) switch enabling/disabling the truck motion between CNB#3 and a key voltage. It becomes active, enabling the motion, when closed to a key voltage (the key voltage is supplied on the CNB#2 connection).

Step4 Connect the encoder in the motor shaft between CNA#9=VDD, CNA#10=GND, CNA#19=CHA, CNA#20=CHB. The VDD voltage may be 13V or 5V depending on a jumper inside the controller (see also 8.4).

Step5 Connect the plus battery voltage through a key switch at the KEY input CNB#1 (this is the input for the logic supply).

Step6 Connect the Main Contactor Coil to CNA#1 and CNA#2. The contactor must make and take the plus battery power cable to the +BATT power terminal of the AC1.

Step7 Connect the motor and the minus battery to the corresponding power terminals of the AC1.

Step8 Connect the Electromechanical Brake between CNA#3 and the tiller switch (when the tiller switch opens, the electromechanical brake gets de-energized braking the truck). A 3Ampere freeweeling diode (arc soppressor) with the anode to CNB#3 must be connected in parallel with the Electromechanical Brake Coil.

The Steps from 1 to 8 describe the installation operations that is mandatory to do in order your truck moves. Obviously the AC1 may execute a wider set of optional services as:

1) to handle some speed reductions requests
2) to handle a analog sensor inside the motor
3) to handle a proportional braking
4) to handle an On/Off forks lowering valve
5) to handle a pump contactor
6) to handle a belly switch and an Inching operative mode
7) to handle the communication via CAN Bus with our MDI-PRC
8) to handle a proportional input for the forks lifting/lowering

You must fill your I/O dotation with your optional functions. The optional functions are shown in the connecting drawing and descripted in detail inside this manual. The index may help you.

11.1 Sequence for Ac Inverter traction setting

This section of the manual describes the basic AC1 set-up procedure using the hand-set:
When the "Key Switch" is closed, if no alarms or errors are present, the Console Display will be showing the Standard Zapi Opening Display (Home Display).
For the setting of your truck, use the procedure below.
If you need to reply the same setting on different controller, use the Save and Restore sequence as descripted in the 13.1 and 13.2 paragraphs. Remember to re-cycle the Key Switch if you make any changes to the chopper's configuration.

Step1 Fill your setting with the Options you need (see paragraph 12.4.1).

Step2 Select the Battery Voltage. See paragraph 12.4.2.9 SET BATTERY TYPE.

Step3 Check the correct installation of all wires. Use the Console's TESTER function to assist.

Step4 Perform the accelerator signal acquisition procedure using the Console "PROGRAM VACC". Procedure is detailed on paragraph 13.3.

Step5 Set the "MAXIMUM CURRENT" Current, using the table on Chapter 12.4.3.31 (setting table of the "PARAMETER CHANGE" functions).

Step6 Set the ACCELERATION DELAY requirements for the machine. Test the parameters in both directions.

Step7 Set the FREQUENCY CREEP level starting from 0.6 Hz. The machine should just move when the accelerator microswitch is closed. Increase the Level accordingly.

Step8 Set the Speed Reductions as required. Use the parameters of the "cutback speed" family in the PARAMETER CHANGE menu to specify the reduced maximum truck speed as a percentage of the MAX SPEED FWD and MAX SPEED REV (see 12.4.3.9-10-11-12).

Step9 RELEASE BRAKING. Operate the machine at full speed. Release the accelerator pedal. Adjust the level to your requirement. If the machine is a forklift, check the performance with and without load.

Step10 INVERSION BRAKING. Operate the machine at 25% full speed. While traveling invert the Direction Switch. Set the suited Level of Inversion Braking. When satisfactory, operate the machine at Full Speed and repeat. If the machine is a Forklift, repeat the tests and make adjustments with and without load. The unladen full speed condition should be the most representative condition.

Step11 PEDAL BRAKING (If used). Operate the machine at full Speed. Release the accelerator pedal and press the Pedal Brake. Set braking level to your requirements.

Step12 Set the parameter MAX SPEED FORW.

Step13 Set the parameter MAX SPEED BACK (Reverse).

Step14 Test the truck on the maximum ramp specification at full load.

Step14 Make the choice for the truck behaviour on a slope (see chapter 13.4). If the "Stop on ramp" option is ON, set the desired value of "auxiliary time" parameter.

Can see also the Figure 12–6 for details on the settings. Programming & Adjustments using Digital Console.

12 PROGRAMMING &ADJUSTMENTS USING DIGITAL CONSOLE

12.1 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 CNC connector of the inverter.

12.2 Description of console (hand set) & connection

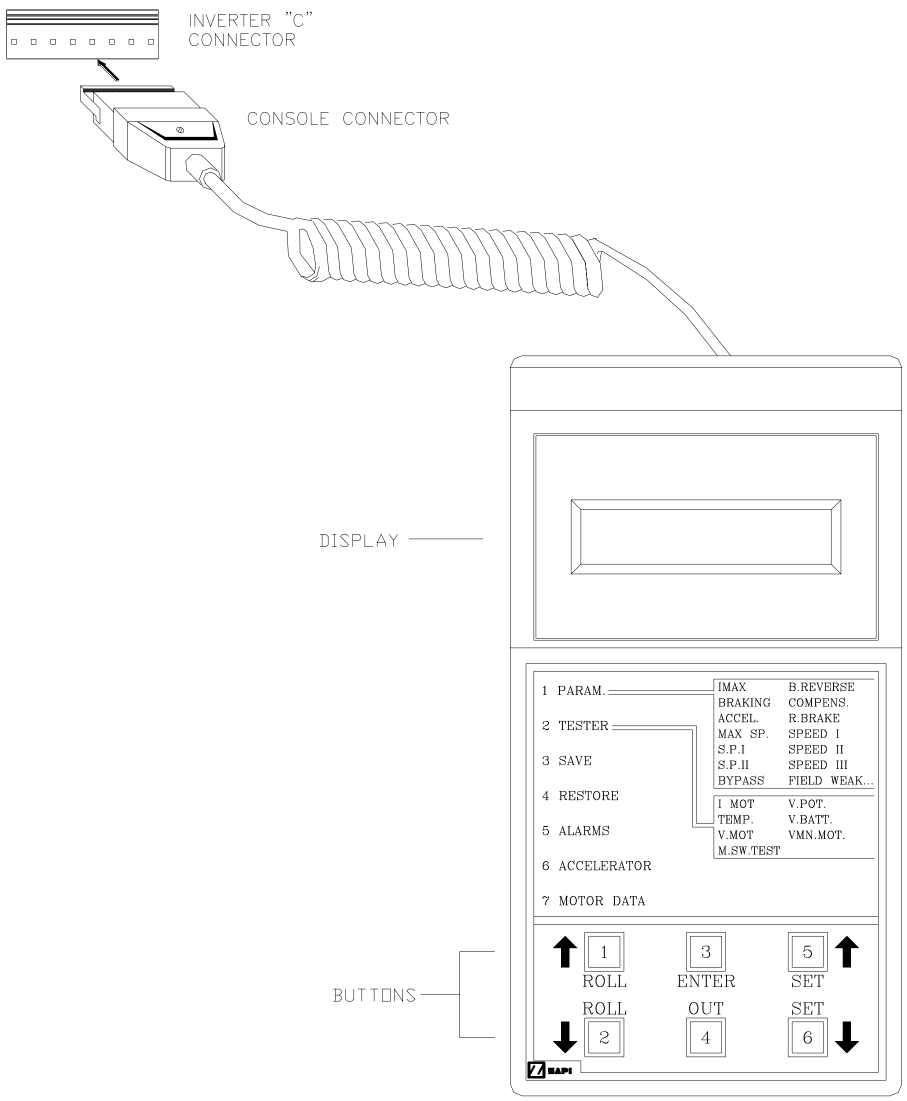


Figure 12–1

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 keybord buttons shown in the Figure 13–1. The orientation of the triangle indicates the way to the next function.

12.3 Description of standard console menu

12.3.1 Standard version

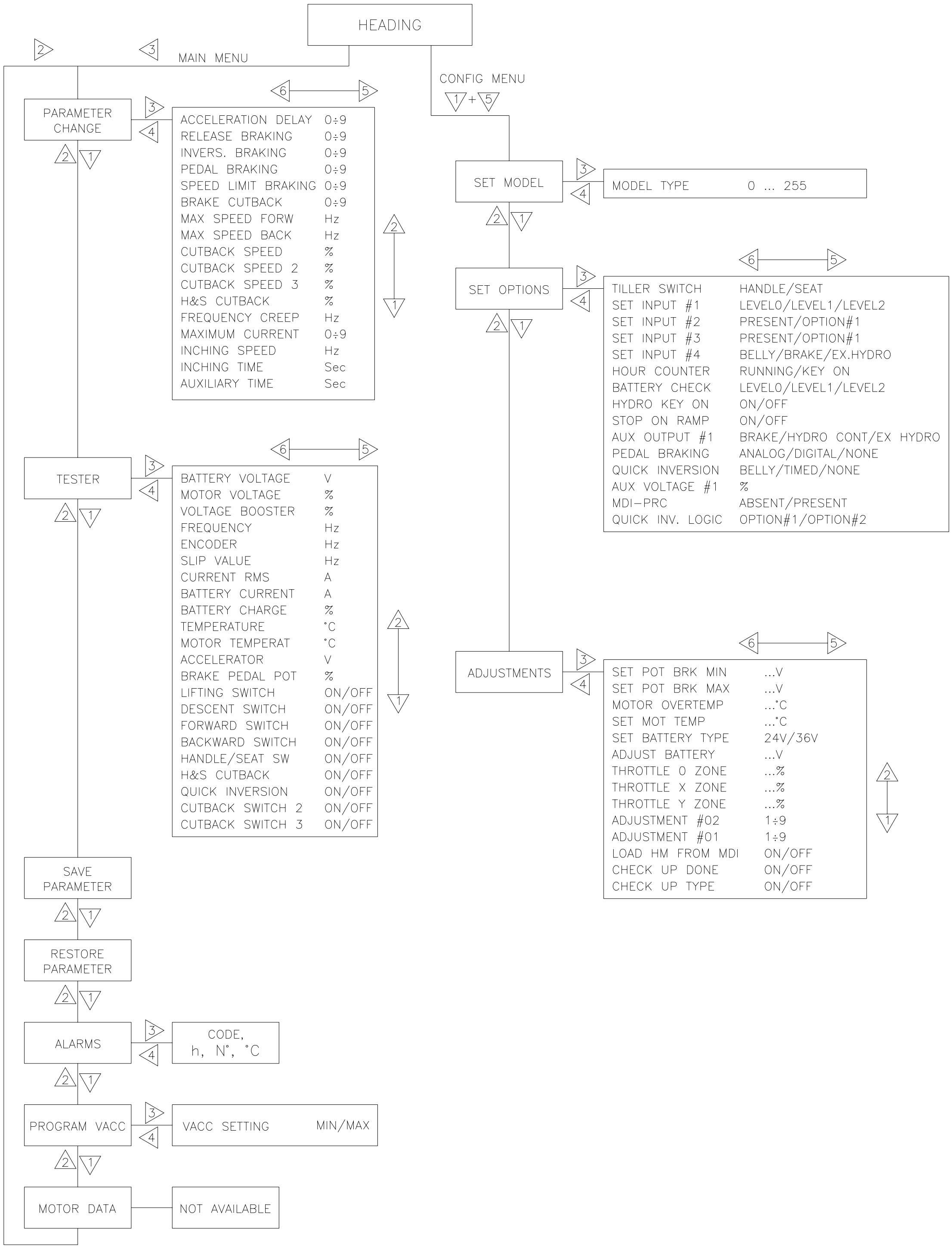


Figure 12–2

12.3.2 MDI PRC Version

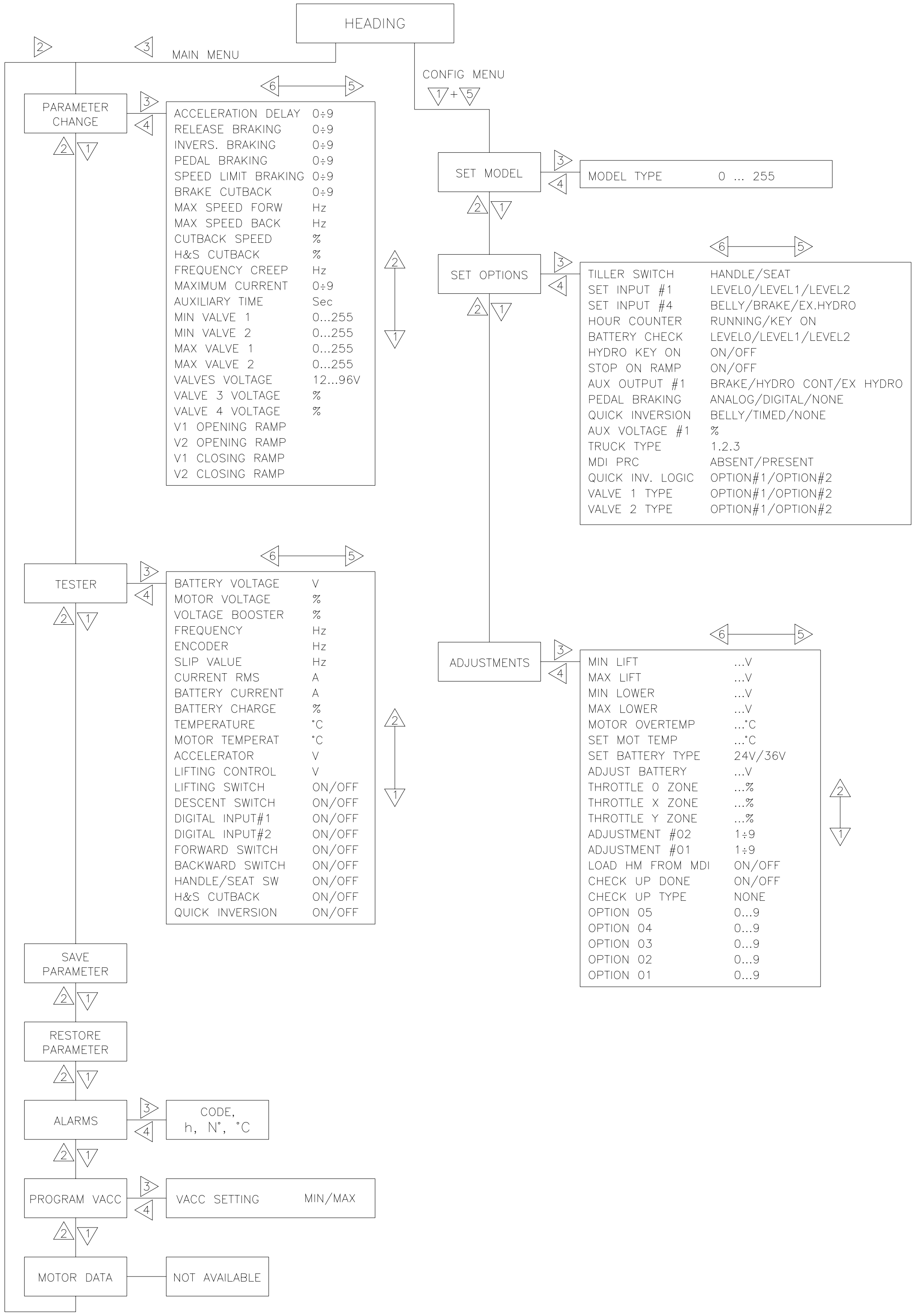


Figure 12–3

12.4 Function configuration

We will describe two configurations depending on the MDI-PRC setting (see 12.4.1.15):

1) STANDARD version (MDI-PRC Absent)
2) MDI-PRC version (MDI-PRC Present). In this case the drive control communicates with a MDI-PRC through the CAN BUS.

They have different list of settings (the Standard version has a reduced settings list). In the next we refer to a complete settings that is the sum of the settings list of both the above configurations. When the setting refers to only one configuration, it will be specified in the description.

12.4.1 Config menu “SET OPTIONS” functions list

To enter the CONFIG MENU it is necessary to push in the same time the right side top and left side top buttons. Then roll until the SET OPTION item appears on the hand set display. Push the ENTER button (see Figure 12–4).

Opening Zapi Display	AC1 ZP 1.00 24V 250A 00000
Push ROLL UP + SET UP simultaneously to enter CONFIG MENU	
The Display will show : SET MOODEL	CONFIG MENU SET MODEL
Press ROLL UP or ROLL DOWN button until SET OPTIONS menu appear.	
The Display will show : SET OPTIONS	CONFIG MENU SET OPTIONS
Press ENTER to go in the SET OPTIONS MENU	
The Display will show the first OPTION	HOURCOUNTER RUNNING
Press SET UP or SET DOWN button in order to modify the OPTION	
The Display will show the new option	HOURCOUNTER KEYON
Press OUT to exit the menu	
The Display will ask “ARE YOU SURE”.	ARE YOU SURE? YES=ENTER NO=OUT
Press ENTER for YES, or OUT for No	
The Display will show : SET OPTIONS	CONFIG MENU SET OPTIONS
Press OUT again. Display now will show the opening Zapi menu.	

Figure 12–4

1) TILLER SWITCH

This option handles the input CNB#3. This input opens when the operator leaves the truck (released). It is connected to a key voltage when the operator is present. There are two levels:

- HANDLE: CNB#3 is managed as tiller input (no delay when released).
- SEAT: CNB#3 is managed as seat input (with a delay when released).

2) SET INPUT #1

This setting handles the analog input CNA#13. It can be used one of three:

- Level 0: CNA#13 is managed as input for an analog motor thermal sensor KTY84-130.
- Level 1: CNA#13 is managed as a digital cutback speed input (SR#1).
- Level 2: CNA#13 is managed as a digital handbrake input.

When Level 1 or 2, this input must be connected to a -Batt voltage in order the selected function is not active; it must be opened to turn the selected function active.

3) SET INPUT #2

(Standard Version only). This option handles the digital input CNA#14. It can be used one of two:

- PRESENT: CNA#14 is managed as a cutback speed input (SR#2)
- OPTION #1: CNA#14 is managed as an inching forward input

The input CNA#14 can only be used as Aux Lifting request when the MDI-PRC is PRESENT.
This input must be connected to a Key voltage.
The SR#2 becomes active when CNA#14 is opened.
The inching forward becomes active when the CNA#14 is closed to a key voltage.

4) SET INPUT #3

(Standard Version only). This option handles the digital input CNA#15. It can be used one of two:

- - PRESENT: CNA#15 is managed as a cutback speed input (SR#3)
- - OPTION #1: CNA#15 is managed as an inching backward input

This input must be connected to a Key voltage.
The SR#3 becomes active when CNA#15 is opened.
The inching forward becomes active when the CNA#15 is closed to a key voltage.

5) SET INPUT #4

This option handles the digital input CNB#7. It can be used one of three:

- BELLY: CNB#7 is managed as a Belly Switch input.
- BRAKE: CNB#7 is managed as service brake input. This information can be used also to recognize when the operator is driving with a pressed pedal braking.
- EX.HYDRO: CNB#7 is managed as Exclusive Hydro.

This input must be connected to a Key voltage.
The Belly switch active level is specified on the QUICK INV LOGIC below.
The service brake or the exclusive hydro becomes active when CNB#7 is opened.

6) 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

7) BATTERY CHECK

This option specifies the handling of the low battery charge detection. It can be set one of three:

- Level 0: Nothing happens, the battery charge level is ignored.
- Level 1: A BATTERY LOW alarm is raised when the battery level is calculated being less than 10% of the full charge. A BATTERY LOW alarm inhibits the Lifting function.
- Level 2: A BATTERY LOW alarm is raised when the battery level is calculated being less than 10% of the full charge. A BATTERY LOW alarm reduces the maximum truck speed down to 24% of the full truck speed then, if the MDI-PRC is absent, inhibit the Lifting function.
- Level 3: Equivalent to Level 1: a BATTERY LOW alarm is raised when the battery level is calculated being less than 10% of the full charge. A BATTERY LOW alarm inhibits the Lifting function.

8) HYDRO KEY ON

- ON/OFF: If this option is programmed ON the traction inverter manages an hydraulic steering function when the "key" is switched ON (only if the AUX OUTPUT #1 option is programmed as HYDRO CONTACTOR or as EXCLUSIVE HYDRO).

9) STOP ON RAMP

Only when the encoder is present, it is possible to keep the truck on a ramp with a released tiller.

- ON: The stop on ramp feature (truck electrically hold on a ramp) is managed for a time established by AUXILIARY TIME parameter.
- OFF: the stop on ramp feature is not performed. That means the truck comes down slowly during the AUXILIARY TIME.

After this “auxiliary time”, if the electromechanical brake is applied, the 3-phase bridge is released; if the electromechanical brake is not present the truck comes down very slowly (see the AUX OUTPUT #1 option programmation and see also 13.4).

10) AUX OUTPUT #1

This option handles the digital output CNA#3. It can be used one of four:

- BRAKE: CNA#3 drives an electromechanical Brake.
- HYDROCONT:CNA#3 drives the contactor for a hydraulic steering function when the direction input or brake pedal input are active or a movement of the truck is detected.
- EX.HYDRO: CNA#3 drives the contactor for a hydraulic steering function when the exclusive hydro input is active (see 12.4.1.5 SET INPUT #4).
- FREE: CNA#3 is not used.

The current this output can sink is up to 3Adc.

11) PEDAL BRAKING

The analog input CNA#18 has one of two function:

- Pedal Braking Input

- Command input for lifting/lowering proportional valves in MDI-PRC version.

To turn from the first to the second function is just enough to set PEDAL BRAKING to NONE.
This option handles the analog input CNA#18 when used as pedal braking input:

- ANALOG: With this setting is possible to modulate the strenght of the braking when the accelerator is released. The strenght of the braking is proportional to the brake pedal potentiometer connected to this input.
  When the pedal potentiometer voltage is equal less than the SET POT BRK MIN (see 12.4.2.1) the minimum release braking strength is applied (following the RELEASE BRAKING setting).
  When the pedal potentiometer voltage is equal higher than the SET POT BRK MAX (see 12.4.2.2) the maximum release braking strength is applied (following the PEDAL BRAKING setting).
  In the intermediate position, the electrical braking strength is a linear function between the minimum (RELEASE BRAKING) and maximum (PEDAL BRAKING) intensity.
  When there is also a switch connected to the pedal braking (i.e. SET INPUT #4 to level BRAKE), it must be closed, otherwise the release braking is stuck to the minimum strength disregarding the pedal potentiometer position.
- DIGITAL: No pedal potentiometer is expected. Only when both the SET INPUT #4 is Level BRAKE and the brake switch connected to CNB#7 is closed, the release electrical braking follows the PEDAL BRAKING setting (maximum strength); in all of the other conditions the release electrical braking follows the RELEASE BRAKING setting (minimum strenght).
- NONE: The analog input CNA#18 is not used for the release braking modulation.

12) QUICK INVERSION

This option specifies the quick inversion mode when the SET INPUT #4 is set BELLY. It can be set one of three:

- NONE: The quick inversion function is not managed (no effect when CNB#7 switches over).
- TIMED: The quick inversion function is timed.
- BELLY: The quick inversion function is managed but not timed.

13) AUX VOLTAGE #1

This option specifies the percentage of the key voltage to be applied to the loads on CNA#1 (main contactor coil) and CNA#3 (electromechanical brake). The voltage modulation is got with a PWM at 1KHZ frequency. After an initial delay of about 1 sec in which the entire key voltage is applied to the loads, the PWM reduces the voltage at the loads down to the specified percentage.

14) QUICK INV LOGIC

This option specifies the active level for the Belly switch input (CNB#7)

- OPTION#1: The quick inversion is executed when CNB#7 is closed to a KEY voltage.
- OPTION#2: The quick inversion is executed when CNB#7 is opened from a KEY voltage.

15) MDI-PRC

This option specifies:

- PRESENT: The MDI-PRC is connected to the AC1 via the CAN Bus: the handling of the Hydraulics is specified on the TRUCK TYPE setting below.
- ABSENT: The MDI-PRC is not connected to the AC1: the TRUCK TYPE disappears from the SET OPTIONS function list.

16) VALVE 1 TYPE

(MDI-PRC version only). This option specifies the EVP1 type. The EVP1 is connected on the pin 8 of the MDI-PRC.

- OPTION#1: EVP1 is an On/Off valve.
- OPTION#2: EVP1 is a proportional valve.

17) VALVE 2 TYPE

(MDI-PRC version only). This option specifies the Electrovalove #2 type. The EVP2 is connected on the pin 9 of the MDI-PRC.

- OPTION#1: EVP2 is an On/Off valve.
- OPTION#2: EVP2 is a proportional valve

18) TRUCK TYPE

(MDI-PRC version only). This option specifies the hydraulics handling when the MDI-PRC is present:

- 1: Both the Main Lifting/Lowering pair (CNB#9 and CNB#8) and the Aux Lifting/Lowering pair (CNA#14 and CNA#15) are used to activate two Lifting/Lowering distinct circuits (double forks truck).
  Main Lifting enables both, the pump contactor on CNA#4 and a valve to re-direct the oil in the main hydraulics circuit connected to the pin #4 of the MDI-PRC.
  Main Lowering enables both, an On/Off descent valve on CNA#6 and a valve to re-direct the oil in the main hydraulics circuit connected to the pin#4 of the MDI-PRC.
  Aux Lifting enables both, the pump contactor on CNA#4 and a valve to re-direct the oil in the aux hydraulics circuit connected to the pin #6 of the MDI-PRC.
  Aux Lowering enables both, an On/Off descent valve on CNA#6 and a valve to re-direct the oil in the aux hydraulics circuit connected to the pin#6 of the MDI-PRC.
  The valves are all On/Off type; no proportionality at all.
- 2: Only the Main Lifting/Lowering pair (CNB#9 and CNB#8) is used to handle a fully Proportional function (there is one proportional valve connected to the pin#8 of the MDI-PRC used for both proportional Lifting and proportional Lowering).
  The CNB#9 input is the Lifting request to enable the pump contactor on CNA#4.
  The CNB#8 input is the Lowering request to enable the descent valve on CNA#6.

The CNA#18 potentiometer modulates the current in the proportional valve connected to the pin#8 of the MDI-PRC. This proportional valve is normally closed (oil does not pass-through when de-energized) and directly connected between the pump and the tank: to do a Lifting function the voltage into the Proportional Valve is turned fully On, to direct the oil into the tank before the pump contactor closes. Then the current in the Proportional Valve reduces (meanwhile the CNA#18 potentiometer increases) to accelerate the Lifting.To do a Lowering function, the current in the proportional valve progressively increases (meanwhile the CNA#18 potentiometer increases) to accelerate the Lowering.

- 3: Only the Main Lifting/Lowering pair (CNB#9 and CNB#8) is used to handle an On/Off Lifting and a proportional Lowering. (There is only one proportional valve connected to the pin#8 of the MDI-PRC to modulate the Lowering).
  The CNB#9 input is the Lifting request enabling the pump contactor on CNA#4.
  The CNB#8 input is the Lowering request to enable the On/Off descent valve connected on CNA#6.
  The CNA#18 potentiometer modulates the current in the lowering proportional valve (pin#8 MDI-PRC) when the Lowering request is active. To do a Lowering function, the current in the proportional valve progressively increases (meanwhile the CNA#18 potentiometer increases) to accelerate the Lowering.

12.4.2 Config menu “ADJUSTMENTS” functions list

To enter the CONFIG MENU it is necessary to push in the same time the right side top and left side top buttons. Then roll until the ADJUSTMENTS item appears on the hand set display. Push the ENTER button (see the Figure 12–5 below).

1) Opening Zapi Menu

2) Press Top Left & Right Buttons to enter CONFIG MENU

3) The Display will show: SET MODEL

4) Press ROLL UP button until ADJUSTMENTS MENU appears

5) ADJUSTMENTS appears on the display

6) Press ENTER to go into the ADJUSTMENTS MENU

7) The display will show: SET BATTERY TYPE

8) Press ROLL UP or ROLL DOWN button until the desired parameter is reached

9) The desired parameter is appears

10) Press SET UP or SET DOWN button to modify the adjustment

11) Press OUT

12) Press ENTER to confirm

13) Repeat the same from 5 to 12 points for the other adjustment

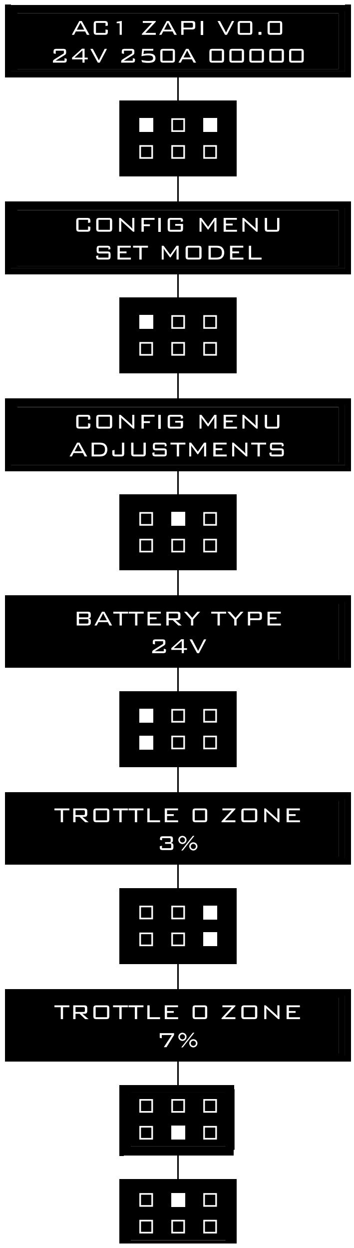


Figure 12–5

1) SET POT BRK MIN

(Standard version only). This setting records the minimum value of braking pedal potentiometer when the braking pedal switch is closed; the procedure is similar to the PROGRAM VACC function (see paragraph 13.3). This procedure must be carried out only if the PEDAL BRAKING option is programmed as ANALOG.

2) **SET POT BRK MAX**
(Standard version only). This setting records the maximum value of braking pedal potentiometer when the braking pedal is fully pressed; the procedure is similar to the PROGRAM VACC function (see paragraph 13.3). This procedure must be carried out only if the PEDAL BRAKING option is programmed as ANALOG.

3) **MIN LIFT**
(MDI-PRC version only). By entering this setting, the SW records the actual value of the CNA#18 potentiometer. The MIN LIFT setting must be Entered with the potentiometer in a position is a little bit ahead the main Lifting switch (CNB#9) turns closed.

4) **MAX LIFT**
(MDI-PRC version only). By entering this setting, the SW records the actual value of the CNA#18 potentiometer. The MAX LIFT setting must be Entered after the Lifting control Lever is pushed against the maximum limiting position.

5) **MIN LOWER**
(MDI-PRC version only). By entering this setting, the SW records the actual value of the potentiometer on CNA#18. The MIN LOWER setting must be Entered with the CNA#18 potentiometer in a position is a little bit ahead the Main Lowering switch (CNB#8) turns closed.

6) **MAX LOWER**
(MDI-PRC version only). By entering this setting, the SW records the actual value of the potentiometer on CNA#18. The MAX LOWER setting must be Entered after the Lowering control Lever moving the CNA#18 potentiometer is pushed against the maximum limiting position.

7) **MOTOR OVERTEMP**
With this setting, it is possible to raise a warning when the motor temperature overtakes a threshold specified by the MOTOR OVERTEMP value.

8) **SET MOTOR TEMP**
With this setting, it is possible to get a fine adjustment of the temperature of the motor measured by the controller.

9) **SET BATTERY TYPE**
Selects the nominal battery voltage.

10) **ADJUST BATTERY**
Fine adjustment of the battery voltage measured by the controller.

11) **THROTTLE 0 ZONE**
Establishes a deadband in the accelerator input curve (see also paragraph 13.5).

12) **THROTTLE X POINT**
These parameter, togheter with the THROTTLE Y POINT, changes the characteristic of the accelerator input curve (see also paragraph 13.5): when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the

maximum accelerator position but with two different slope (see also Figure 13–2).

13) THROTTLE Y POINT

These parameter, togheter with the THROTTLE X POINT, changes the characteristic of the accelerator input curve (see also paragraph 13.5): when the accelerator is de-pressed to X point per cent, the corresponding truck speed is Y point per cent of the Maximum truck speed. The relationship between the accelerator position and the truck speed is linear between the THROTTLE 0 ZONE and the X point and also between the X point and the maximum accelerator position but with two different slope (see also Figure 13–2).

14) ADJUSTMENT #01

Adjust the upper level of the battery charge table (Level 0 to 9). See paragraph 13.6 .

15) ADJUSTMENT #02

Adjust the lower level of the battery charge table (Level 0 to 9). See paragraph 13.6 .

16) LOAD HM FROM MDI

When set On, the HourMeter of the Controller is transferred and recorded on the HourMeter of the Standard MDI (connected on the Serial Link).

17) CHECK UP DONE

Turn it On when the asked Maintenance service has been executed to cancel the CHECK UP NEEDED warning.

18) CHECK UP TYPE

It specifies the handling of the CHECK UP NEEDED warning:

- NONE: No CHECK UP NEENED warning
- OPTION#1: CHECK UP NEENED warning on the hand set and MDI-PRC after 300 hours
- OPTION#2: Equal to OPTION#1 but Speed reduction after 340 hours
- OPTION#3: Equal to OPTION#2 but the truck definitively stops after 380 hours

19) OPTION 05

(MDI-PRC version only). This setting, togheter with the four settings below, specifies an offset for the MDI-PRC HourMeter. The MDI-PRC HourMeter will be the sum of the Controller HourMeter plus this offset. This offset value is 5 Digits with:

- OPTION 05 is the MSDigit
- OPTION 01 is the LSDigit

It is possible to change this offset only when the controller HourMeter is less than 10 Hours. (It is used when the controller is replaced with a new one to keep updated the Total Hours measurement of the truck. It is just enough to set the OPTION 01 to OPTION 05 with the Final HourMeters of the replaced Controller).

20) **OPTION 04**
(MDI-PRC version only). See OPTION 05.

21) **OPTION 03**
(MDI-PRC version only). See OPTION 05.

22) **OPTION 02**
(MDI-PRC version only). See OPTION 05.

23) **OPTION 01**
(MDI-PRC version only). See OPTION 05.

12.4.3 Main menu “PARAMETER CHANGE” functions list

To enter the MAIN MENU’ it is just necessary to push the ENTER button from the home display in the hand set.

1) Opening Zapi Menu	AC1 ZP 1.00 24V 250A 00000
2) Press ENTER to go into the General Menu	
3) The Display will show: PARAMETER CHANGE	MAIN MENU PARAMETER CHANGE
4) Press ENTER to go into the Parameter Change facility	
5) The Display will show the first parameter	ACC DELAY LEVEL = 5
6) Press either ROLL UP and ROLL DOWN to display the next parameter	
7) The names of the Parameters appear on the Display	RELEASE BRAKING LEVEL = 5
8) When desired Parameter appear, it’s possible to change the Level by pressing either SET UP or SET DOWN buttons.	
9) The Display will show the new level.	RELEASE BRAKING LEVEL = 2
10) When you are satisfied with the result of the changes you have made, press OUT.	
11) The Display asks: “ARE YOU SURE?”	ARE YOU SURE? YES=ENTER NO=OUT
12) Press ENTER to accept the changes, or press OUT to discard them.	
13) The Display will show	MAIN MENU PARAMETER CHANGE

Figure 12–6

1) ACCELER. DELAY
Level 0 to 9. It determines the acceleration ramp. At Level 9 the truck takes long time to accelerate.

2) RELEASE BRAKING
Level 0 to 9. It controls the deceleration ramp when the travel request is released. At Level 9 the truck brakes abrutly.

3) **INVERS. BRAKING**
Level 0 to 9. It controls the deceleration ramp when the direction switch is inverted during travel. At Level 9 the truck brakes abrutly.

4) **PEDAL BRAKING**
Level 0 to 9. It controls the deceleration ramp when the travel request is released and the brake pedal switch is pressed to its maximum. At Level 9 the truck brakes abrutly.

5) **SPEED LIMIT BRK**
Level 0 to 9. It controls the deceleration ramp when the accelerator has turned down but not completely released. At Level 9 the truck decelerate abrutly.

6) **BRAKE CUTBACK**
Level 0 to 9. It controls the deceleration ramp when a speed reduction input becomes active and the motor slows down. At Level 9 the truck decelerate abrutly.

7) **MAX SPEED FWD**
Tipically from 90Hz to 160Hz or something. It determines the maximum speed in forward direction.

8) **MAX SPEED BWD**
Tipically from 90Hz to 160Hz or something. It determines the maximum speed in backward direction.

9) **CUTBACK SPEED**
Tipically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 1 (SR#1 on CNA#13) is active. When set to 100% the speed reduction is ineffective.

10) **CUTBACK SPEED 2**
(Standard Version only). Tipically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 2 (SR#2 on CNA#14) is active. When set to 100% the speed reduction is ineffective.

11) **CUTBACK SPEED 3**
(Standard Version only). Tipically from 10% to 100%. It determines the percentage of the max speed applied when the cutback switch 3 (SR#3 on CNA#15) is active. When set to 100% the speed reduction is ineffective.

12) **HS CUTBACK**
Tipically from 10% to 100%. It determines the percentage of the max speed applied when the Hard & Soft function (H&S switch on CNB#4) is active. When set to 100% the speed reduction is ineffective.

13) **FREQUENCY CREEP**
Hz value. This is the minimum speed applied when the forward or reverse switch is closed, but the accelerator at its minimum.

14) **MAXIMUM CURRENT**
Level 0 to 9. This changes the maximum current of the inverter. At level 9 the nominal maximum current is supplied; at level 0 the current is almost half of its nominal value (see 12.4.3.31).

15) INCHING SPEED

(Standard version only because the inching switches are used for the Lifting and Lowering switches in the MDI-PRC version). Hz value. It determines the speed when the "Inching function" is active (see 12.4.1.3-4 SET INPUT#2, SET INPUT#3).

16) INCHING TIME

(Standard version only because the inching switches are used for the Lifting and Lowering switches in the MDI-PRC version). Level 0 to 9. It determines the during time when the "Inching function" is active.

17) AUXILIARY TIME

Time units value (seconds). For the encoder version, it determines the time duration the truck is kept on the ramp if the STOP ON RAMP option is ON.

18) MIN VALVE 1

(MDI-PRC version only). 0 to 255 digit. This parameter determines the minimum voltage applied on the EVP1 when the position of the potentiometer on CNA#18 is at the minimum. This parameter is not effective if the EVP1 is programmed like a On/Off valve (see 12.4.1.16 – VALVE 1 TYPE). The EVP1 is connected on the pin 8 of the MDI-PRC (see TRUCK TYPE – 12.4.1.18 – for the handling).

19) MIN VALVE 2

(MDI-PRC version only). 0 to 255 digit. This parameter determines the minimum voltage applied on the EVP2 when the position of the potentiometer on CNA#18 is at the minimum. This parameter is not effective if the EVP2 is programmed like a On/Off valve (see 12.4.1.17 – VALVE 2 TYPE). The EVP2 is connected on the pin 9 of the MDI-PRC (see TRUCK TYPE – 12.4.1.18 – for the handling).

20) MAX VALVE 1

(MDI-PRC version only). 0 to 255 digit. This parameter determines the maximum voltage applied on the EVP1 when the position of the potentiometer on CNA#18 is at the maximum. If the EVP1 is programmed like a On/Off valve (see 12.4.1.16 – VALVE 1 TYPE), this parameter determines the fixed voltage applied on the electrovalve coil . The EVP1 is connected on the pin 8 of the MDI-PRC (see TRUCK TYPE – 12.4.1.18 – for the handling).

21) MAX VALVE 2

(MDI-PRC version only). 0 to 255 digit. This parameter determines the maximum voltage applied on the EVP2 when the position of the potentiometer on CNA#18 is at the maximum. If the EVP2 is programmed like a On/Off valve (see 12.4.1.17 – VALVE 2 TYPE), this parameter determines the fixed voltage applied on the electrovalve coil. The EVP2 is connected on the pin 9 of the MDI-PRC (see TRUCK TYPE – 12.4.1.18 – for the handling).

22) VALVES VOLTAGE

(MDI-PRC version only). A nominal Battery voltage from 12V to 120V. This parameter specifies the nominal voltage of the On/Off valves coil (EVD1 and EVD2 connected to pin #6 and pin#4 of the MDI-PRC). The MDI-PRC, supported by the AC1, is able to control Electrovalves at a nominal voltage lower than the Battery voltage. For example Battery to 48V and Valves to

24V: then it is necessary that the MDI-PRC generates an output voltage with a PWM tecnique never overtaking the 50% Duty Cycle to get the Valve's voltage less equal than 24V. Through this setting it is possible to take care the voltage on the EVD1 and EVD2 never overcomes the nominal voltage of the valves.

23) VALVE 3 VOLTAGE
(MDI-PRC version only). A percentage from 0% to 100%. This parameter determines the voltage applied to the EVD1 (this is connected on the pin #6 of the MDI-PRC) in percentage of the above VALVES VOLTAGE setting. The voltage applied to this electrovalve is a PWM tecnique generated by the MDI-PRC: the Duty Cycle is modulated in order that, the voltage applied to these On/Off valve, is the wished percentage of the VALVES VOLTAGE (e.g. Vbatt=48V, VALVES VOLTAGE=24V, VALVE 3 VOLTAGE=100% means the MDI-PRC generates a PWM with a 50% duty on the EVD1).

24) VALVE 4 VOLTAGE
(MDI-PRC version only). A percentage from 0% to 100%. This parameter determines the voltage applied to the EVD2 (this is connected on the pin #4 of the MDI-PRC) in percentage of the above VALVES VOLTAGE setting. The voltage applied to this electrovalve is a PWM tecnique generated by the MDI-PRC: the Duty Cycle is modulated in order that, the voltage applied to these On/Off valve, is the wished percentage of the VALVES VOLTAGE (e.g. Vbatt=48V, VALVES VOLTAGE=24V, VALVE 4 VOLTAGE=100% means the MDI-PRC generates a PWM with a 50% duty on the EVD2).

25) V1 OPENING RAMP
(MDI-PRC version only). A time units value (from 0.0 to 2.0 seconds). This parameter determines the ramp of voltage applied on the EVP1 (pin #8 MDI-PRC) in the opening transition (if proportional); this is the time necessary to go from the minimum to the maximum voltage. If the electrovalve is programmed like an On/Off valve this parameter is not effective.

26) V2 OPENING RAMP
(MDI-PRC version only). A time units value (from 0.0 to 2.0 seconds). This parameter determines the ramp of voltage applied on the EVP2 (pin #9 MDI-PRC) in the opening transition (if proportional); this is the time necessary to go from the minimum to the maximum voltage. If the electrovalve is programmed like an On/Off valve this parameter is not effective.

27) V1 CLOSING RAMP
(MDI-PRC version only). A time units value (from 0.0 to 2.0 seconds). This parameter determines the ramp of voltage applied on the EVP1 (pin #8 MDI-PRC) in the closing transition (if proportional); this is the time necessary to go from the maximum to the minimum voltage. If the electrovalve is programmed like an On/Off valve this parameter is not effective.

28) V2 CLOSING RAMP
(MDI-PRC version only). A time units value (from 0.0 to 2.0 seconds). This parameter determines the ramp of voltage applied on the EVP2 (pin #9 MDI-PRC) in the closing transition (if proportional); this is the time necessary to go from the maximum to the minimum voltage. If the electrovalve is programmed like an On/Off valve this parameter is not effective.

12.4.3.31 Setting table of the "PARAMETER CHANGE" functions

The following table shows the different values at which the parameters can be set.

PARAMETER	UNIT	PROGRAMMED LEVEL									
		0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
ACCELERATION DELAY (*)	Sec.	2.05	3.00	3.05	4.00	4.05	5.00	5.05	6.00	6.05	7.00
RELEASE BRAKING (**)	Sec.	5.05	5.00	4.05	4.00	3.05	3.00	2.05	2.00	1.05	1.00
INVERS BRAKING (**)	Sec.	5.05	5.00	4.05	4.00	3.05	3.00	2.05	2.00	1.05	1.00
PEDAL BRAKING (**)	Sec.	5.05	5.00	4.05	4.00	3.05	3.00	2.05	2.00	1.05	1.00
SPEED LIMIT BRAKING (**)	Sec.	8.09	8.03	7.07	7.01	6.06	6.00	5.05	4.09	4.04	3.08
BRAKE CUTBACK (**)	Sec.	5.05	5.00	4.05	4.00	3.05	3.00	2.05	2.00	1.05	1.00
MAX SPEED FW	Hz	65	80	95	110	125	140	155	170	185	200
MAX SPEED BW	Hz	65	80	95	110	125	140	155	170	185	200
CUTBACK SPEED	%Max Sp	10	15	20	25	37	50	62	75	87	100
CUTBACK SPEED 2	%Max Sp	10	15	20	25	37	50	62	75	87	100
CUTBACK SPEED 3	%Max Sp	10	15	20	25	37	50	62	75	87	100
H&S CUTBACK	%Max Sp	10	15	20	25	37	50	62	75	87	100
FREQUENCY CREEP	Hz	0.3	0.6	0.9	1.2	1.5	1.8	2.1	2.4	2.7	3.0
MAXIMUM CURRENT	%IMAX	47	53	58	64	70	76	82	88	94	100
INCHING SPEED	Hz	0	2	4	6	8	10	12	14	16	18
INCHING TIME	Sec.	0.02	0.05	1.00	1.04	1.08	2.03	2.07	3.01	3.06	4.00
AUXILIARY TIME	Sec.	0.0	0.2	0.4	0.8	1.0	1.5	2.0	3.0	4.0	5.0
MIN VALVE 1	This parameter can be adjusted from 1 to 255 with regulation of 1digit										
MIN VALVE 2	This parameter can be adjusted from 1 to 255 with regulation of 1digit										
MAX VALVE 1	This parameter can be adjusted from 1 to 255 with regulation of 1digit										
MAX VALVE 2	This parameter can be adjusted from 1 to 255 with regulation of 1digit										
VALVES VOLTAGE	V	12	24	36	48	60	72	80	96	120	120
VALVE 3 VOLTAGE	%V	10	20	30	40	50	60	70	80	90	100
VALVE 4 VOLTAGE	%V	10	20	30	40	50	60	70	80	90	100
V1 OPENING RAMP	Sec.	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
V2 OPENING RAMP	Sec.	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
V1 CLOSING RAMP	Sec.	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0
V2 CLOSING RAMP	Sec.	0.2	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.8	2.0

(*) The acceleration time shown is the time from 0 Hz to 100 Hz. This is the ideal ramp calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

(**) The braking feature is based upon deceleration ramps. The value shown in the table is the time to decrease the speed from 100 Hz to 0 Hz. This is the ideal ramps calculated by the software; the real ramp could change as a function of motor control parameter setting and, obviously, as a function of the load.

12.4.4 Zapi menu "HARDWARE SETTINGS" functions list

Confidential documentation.

12.4.5 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, 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: keep your hand off this setting.

2) **ADJUSTMENT#02**
   (Factory adjusted). % value. This is the Gain of the second Current Sensing Amplifier.
   NOTE: keep your hand off this setting.

12.4.6 Main menu "TESTER" functions list

The TESTER functions are a real time feedback measurements of the state of the controller. It is possible to know the state (active disactive) of the digital I/Os, the voltage value of the analog inputs and the state of the main variables used in the motor and hydraulics control. Enter the home page in the hand-set diplay and roll for the TESTER item.

1) **BATTERY VOLTAGE**
   Voltage value with 1 decimal digit. Battery voltage value measured at the key input CNB#1.

2) **MOTOR VOLTAGE**
   Percentage value. It is the voltage generated by the inverter expressed in per cent of the actual battery voltage. 100% means the sine wave width is close to the actual battery voltage; 0% means the sine wave width is null.

3) **VOLTAGE BOOSTER**
   Percentage value. It is the booster contribute to the voltage really supplied to the motor expressed in per cent of the actual battery voltage. (Note: when DC_LINK COMPENSATION is set ON, the VOLTAGE BOOSTER reading will not match perfectly the booster setting because this latest one is calculated respect to the nominal battery voltage; VOLTAGE BOOSTER is expressed respect to the actual battery voltage).

4) **FREQUENCY**
   Hz value with two decimal digit. This is the frequency of the sine waves the inverter is supplying.

5) **ENCODER**
   Hz value with two decimal digit. This is the speed of the motor measured with the encoder and expressed in the same unit of the FREQUENCY reading.

6) **SLIP VALUE**
Hz value with two decimal digit. This is the slip between the frequency and the speed of the motor (SLIP VALUE = FREQUENCY-ENCODER).

7) **COSFI**
From 0.00 to 1.00. This is a coarse extimation of the Power Factor (cosφ between the voltage and the current in the motor.

8) **CURRENT RMS**
Ampere value. Root Mean Square value of the line current in the motor.

9) **BATTERY CURRENT**
Ampere value. This is a coarse calculation (not a measurement) of the battery current.

10) **BATTERY CHARGE**
Percentage value. It supplies the residual charge of the battery as a percentage of the full charge level.

11) **TEMPERATURE**
°C value. This is the temperature of the inverter base plate. This temperature is used for the HIGH TEMPERATURE alarm detection (see 14.1.7.1).

12) **MOTOR TEMPERATURE**
°C value. This is the temperature of the motor windings picked up with an analog sensor inside the motor. Normally this sensor is a PTC Philips KTY84-130. This temperature is used only to raise a warning in the hand set when the motor temperature overtakes the MOTOR OVERTEMP setting.

13) **ACCELERATOR**
From 0.0V to 5.0V. The voltage on the wiper of the accelerator (CPOT on CNB#10) is halved inside the controller and then recorded on this reading. That means the actual wiper voltage is in the range 0 to 10V meanwhile the corresponding ACCELERATOR reading is in the range 0.0 to 5.0Vdc.

14) **BRAKE PEDAL POT**
(Standard Version only). From 0.0V to 5.0V. When the MDI-PRC is absent, the potentiometer connected to CPOTB on CNA#18 is used for a brake pedal sensor. The voltage on the wiper of this brake pedal potentiometer (CNA#18) is halved inside the controller and then recorded on this reading. That means the actual wiper voltage is in the range 0 to 10V meanwhile the corresponding BRAKE PEDAL POT reading is in the range 0.0 to 5.0Vdc.

15) **LIFTING SWITCH**
ON/OFF. This is the level of the CNB#9 digital input (Lifting request):
- ON +VB = When CNB#9 is closed to a battery (key) voltage, the Lifting request is Active.
- OFF GND= When CNB#9 is not connected to a battery (key) voltage (or it is connected to GND), the Lifting request is not active.

16) **DESCENT SWITCH**
ON/OFF. This is the level of the CNB#8 digital input (Lowering request):
- ON +VB = When CNB#8 is closed to a battery (key) voltage, the Lowering request is Active.

- OFF GND= When CNB#8 is not connected to a battery (key) voltage (or it is connected to GND), the Lowering request is not active.

17) FORWARD SWITCH

ON/OFF. This is the level of the CNB#6 digital input (Forward Travel demand):

- ON +VB = When CNB#6 is closed to a battery (key) voltage, the Forward Travel demand is Active.
- OFF GND= When CNB#6 is not connected to a battery (key) voltage (or it is connected to GND), the Forward Travel demand is not active.

18) BACKWARD SWITCH

ON/OFF. This is the level of the CNB#5 digital input (Backward Travel demand):

- ON +VB = When CNB#5 is closed to a battery (key) voltage, the Backward Travel demand is Active.
- OFF GND= When CNB#5 is not connected to a battery (key) voltage (or it is connected to GND), the Backward Travel demand is not active.

19) HANDLE/SEAT SW.

ON/OFF. This is the level of the CNB#3 digital input (Tiller or seat swit.):

- ON +VB = When CNB#3 is closed to a battery (key) voltage the driver has activated the tiller (motion enabled).
- OFF GND= When CNB#3 is not connected to a battery (key) voltage (or it is connected to GND), the driver has released the tiller (motion disabled).

20) H&S CUTBACK

ON/OFF. This is the level of the CNB#4 digital input (Hard & Soft request). With the H&S service is possible to turn the truck moving (at reduced speed) only by acting the H&S switch, and the accelerator, without to let down the tiller :

- ON +VB = When CNB#4 is closed to a battery (key) voltage, the H&S request is Active.
- OFF GND= When CNB#4 is not connected to a battery (key) voltage (or it is connected to GND), the H&S request is not active.

21) QUICK INVERSION

ON/OFF. This is the level of the CNB#7 digital input (the main function is Quick Inversion request when the SET INPUT #4 is set BELLY):

- ON GND= This reading means the Quick Inversion request is active.
- OFF +VB = This reading means the Quick Inversion request is not active

When QUICK INV LOGIC is set to OPTION#1 the quick inversion request is active when CNB#7 is connected to a battery (key) voltage.
When QUICK INV LOGIC is set to OPTION#2 the quick inversion request is active when CNB#7 is not connected to a battery (key) voltage.
This input CNB#7 has alternative functions depending on the setting of SET INPUT #4. In these cases:
SET INPUT#4 is set BRAKE:

QUICK INVERSION reading becomes ON when the brake pedal switch closes and connects the CNB#7 input to a key voltage.

SET INPUT#4 is set EX. HYDRO:

QUICK INVERSION reading becomes ON when the Exclusive Hydro Microswitch switch closes and connects the CNB#7 input to a key voltage.

22) **CUTBACK SWITCH 2**

(Standard version only). ON/OFF. This is the level of the CNA#14 digital input (When the MDI-PRC is not present, and SET INPUT #2 is set PRESENT, this is the Speed Reduction #2 request):

- ON GND = When CNA#14 is not closed to a battery (key) voltage (or connected to GND) the SR#2 request is active.
- OFF +VB = When CNA#14 is closed to a battery (key) voltage the SR#2 request is not active.

This input CNA#14 has the alternative function of Inching Forward request when the SET INPUT #2 is set to OPTION#1. Then the Inching Forward request turns active (meanwhile this CUTBACK SWITCH 2 reading turns ON) when the CNA#14 closes to a battery (key) voltage.

23) **CUTBACK SWITCH 3**

(Standard versione only). ON/OFF. This is the level of the CNA#15 digital input (When the MDI-PRC is not present, and the SET INPUT #3 is set PRESENT, this is the Speed Reduction #3 request):

- ON GND = When CNA#15 is not closed to a battery (key) voltage (or connected to GND) the SR#3 request is active.
- OFF +VB = When CNA#15 is closed to a battery (key) voltage the SR#3 request is not active.

This input CNA#15 has the alternative function of Inching Backward request when the SET INPUT #3 is set to OPTION#1. Then the Inching Backward request turns active (meanwhile this CUTBACK SWITCH 3 reading turns ON) when the CNA#15 closes to a battery (key) voltage.

24) **LIFTING CONTROL**

(MDI-PRC Version only). From 0.0V to 5.0V. When the MDI-PRC is present, the potentiometer connected to CPOTB on CNA#18 is used for a proportional control of the hydraulics. The voltage on the wiper of this potentiometer (CNA#18) is halved inside the controller and then recorded on this reading. That means the actual wiper voltage is in the range 0 to 10V meanwhile the corresponding LIFTING CONTROL reading is in the range 0.0 to 5.0Vdc.

25) **DIGITAL INPUT #1**

(MDI-PRC version only). ON/OFF. This is the level of the CNA#14 digital input (when the MDI-PRC is present this input is an Auxiliary (2nd) Lifting request):

- ON +VB = When CNA#14 is closed to a battery (key) voltage the Aux Lifting request is active.
- OFF GND = When CNA#14 is not closed to a battery (key) voltage (or it is connected to GND) the Aux Lifting request is not active.

26) **DIGITAL INPUT #2**

(MDI-PRC version only). ON/OFF. This is the level of the CNA#15 digital input (when the MDI-PRC is present this input is an Auxiliary (2nd) Lowering request):

- ON +VB = When CNA#15 is closed to a battery (key) voltage the Aux Lowering request is active.

- OFF GND = When CNA#15 is not closed to a battery (key) voltage (or it is connected to GND) the Aux Lowering request is not active.

13 OTHER FUNCTIONS

13.1 Description of console “SAVE” function

The SAVE function allows the operator to transmit the Parameter values and Configuration data of the chopper 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 chopper using the RESTORE function.
The data that is available via the SAVE function is as follows:

- 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.

Opening Zapi Display	AC1 ZAPI V0.0 24V 250A 00000
Press ENTER to go into the General menu	
The Display will show :	MAIN MENU PARAMETER CHANGE
Press ROLL UP or ROLL DOWN button until SAVE PARAM. appears on the display	
The Display will show :	MAIN MENU SAVE PARAMETERS
Press ENTER to go into the SAVE function	
If this facility has been used before the type of chopper data stored appears on the top Main with a 2 digit reference	SELECT: MOD. 00 FREE
Keep pressing either ROLL UP or ROLL DOWN keys until the second Main indicates a FREE storage facility	
	SELECT: MOD. 01 FREE
Press ENTER to commence SAVE routine	
You can see the items that are being stored whilst the SAVE routine is happening	READING ... ACCEL. DELAY (ECC.)
When finished, the Console shows :	SELECT: MOD. 01 FREE

Press OUT to return to the Opening Zapi Display	

NOTE: in reality the SAVE and RESTORE function requires the Windows PC-Console.

13.2 Description of console “RESTORE” function

The RESTORE PARAM function allows transfer of the Console’s stored data into the memory of the chopper. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. function.
The data that is available via the RESTORE PARAM. function is as follows :
- All Parameter Values (PARAMETER CHANGE).
- Options (SET OPTIONS)
- The level of the Battery (ADJUST BATTERY)

ATTENTION: When the RESTORE operation is made, all data in the chopper memory will be written over and replace with data being restored.
Flow Chart showing how to use the RESTORE function of the Digital Console.

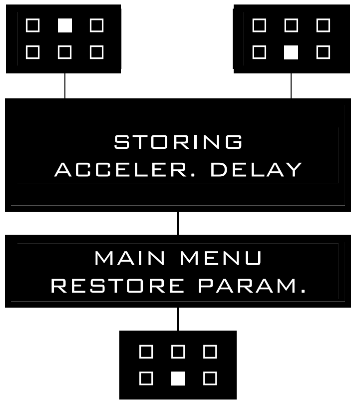
Opening Zapi Display	AC1 ZAPI V0.0 24V 250A 00000
Press ENTER to go into the General menu	
The Display will show :	MAIN MENU PARAMETER CHANGE
Press ROLL UP or ROLL DOWN button until SAVE PARAM. appears on the display	
The Display will show :	MAIN MENU RESTORE PARAM.
Press ENTER to go into the RESTORE PARAM. function	
The Display shows the type of Model stored, with a Code Number	SELECT : MOD. 00 AC1 ZAPI V1
Keep pressing either ROLL UP and ROLL DOWN buttons until the desired model appears on the Display	
	SELECT : MOD. 00 AC1 ZAPI V1
Press ENTER to commence the Restore operation	
The Display will ask “ARE YOU SURE”.	ARE YOU SURE? YES=ENTER NO=OUT

Press ENTER for YES, or OUT for No

You can see the items that are being stored in the chopper memory whilst the RESTORE routine is happening

When finished, the Console shows :

Press OUT to return to the Opening Zapi Display



NOTE: in reality the SAVE and RESTORE function requires the Windows PC-Console.

13.3 Description of console “PROGRAM VACC” function

This enables adjustment of the minimum and maximum useful signal level, in either direction. This function is unique when it is necessary to compensate for asymmetry with the mechanical elements associated with the potentiometer, especially relating to the minimum level.

The two graphs show the output voltage from a non-calibrated potentiometer with respect to the mechanical “zero” of the control lever. MI and MA indicate the point where the direction switches close. 0 represents the mechanical zero of the rotation.
The Left Hand graph shows the relationship of the motor voltage without signal acquisition being made. The Right Hand Graph shows the same relationship after signal acquisition of the potentiometer.

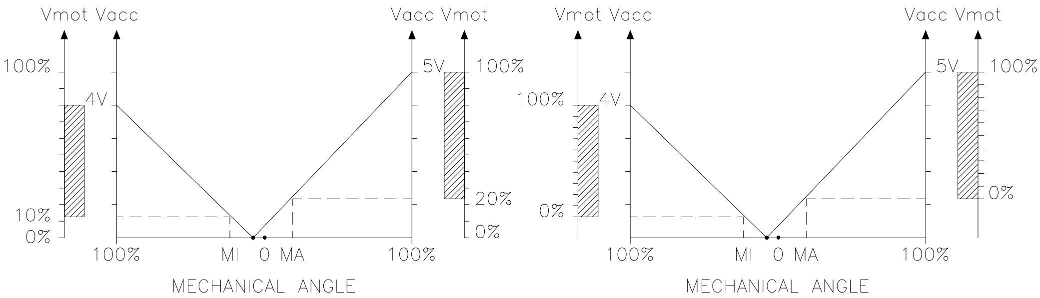
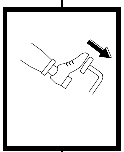


Figure 13–1

This function looks for and remembers the minimum and maximum potentiometer wiper voltage over the full mechanical range of the pedal. It enables compensation for non symmetry of the mechanical system between directions. The operation is performed by operating the pedal after entering the PROGRAM VACC function.

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

Opening Zapi Display	AC1 ZAPI V0.0 24V 250A 00000
Press ENTER to go into the General menu	
The Display will show :	MAIN MENU PARAMETER CHANGE
Press ROLL UP or ROLL DOWN button until PROGRAM VACC the display	
The Display will show :	MAIN MENU PROGRAM VACC
Press ENTER to go into the PROGRAM VACC function	
The Display will show the minimum and maximum values of potentiometer wiper output. Both directions can be shown	VACC SETTING 4.8 4.8
Press ENTER to clear these values. Display will show 0.0	
Select Forward Direction, close any interlock switches that may be in the system	MIN VACC MAX 0.0 - 0.0
Slowly depress the accelerator pedal (or tiller butterfly) to its maximum value. The new minimum and maximum voltages will be displayed on the Console plus an arrow indicating the direction.	
Select the Reverse Direction and repeat Item 10	MIN VACC MAX 0.6 ↑ 4.4
When finished , press OUT	
The Display will ask : ARE YOU SURE ?	ARE YOU SURE YES=ENTER NO=OUT
Press ENTER for yes, or OUT for NO	
When finished, the Console shows :	MAIN MENU PROGRAM VACC
Press OUT to return to the Opening Zapi Display	

13.4 Shortform table of the aux output #1 setting

The AUX OUTPUT #1 setting specifies the handling of the CNA#3 output and the STOP ON RAMP service (when the encoder is used). This handling is summarized in the table below.

AUX OUTPUT	STOP ON RAMP	A3 OUTPUT	BEHAVIOUR ON A SLOPE
BRAKE	ON	-Drives the coil of a electromagnetic brake.	"The truck is electrically hold on a slope; when the time set by ""auxiliary time"" parameter is elapsed the brake is applied and the 3-phase bridge is released. Do not use this combination if the negative brake is not installed."
BRAKE	OFF	-Drives the coil of a electromagnetic brake.	"The truck is not electrically hold on a slope, but comes down very slowly; when the time set by ""auxiliary time"" parameter is elapsed, the brake is applied and the 3-phase bridge is opened. Do not use this combination if the negative brake is not installed."
HYDRO CONT.	ON	-Drives the coil of a hydraulic steering contactor.	"The truck is electrically hold on a slope; when the time set by ""auxiliary time"" parameter is elapsed, the truck comes down very slowly, till the flat is reached. "
HYDRO CONT.	OFF	-Drives the coil of a hydraulic steering contactor.	The truck is not electrically hold on a slope, but comes down very slowly till the flat is reached.
EXCL. HYDRO	ON	-Drives the coil of a hydraulic steering contactor.	"The truck is electrically hold on a slope; when the time set by ""auxiliary time"" parameter is elapsed, the truck comes down very slowly, till the flat is reached. "
EXCL. HYDRO	OFF	-Drives the coil of a hydraulic steering contactor.	The truck is not electrically hold on a slope, but comes down very slowly till the flat is reached.

13.5 Description of the throttle regulation

This regulation applies a not linear relationship between the position of the accelerator and the speed of the truck. The main goal is to increase the resolution for the speed modulation when the truck is slow moving.
Three ajustments are used for the throttle regulation:
1) THROTTLE 0 ZONE
2) THROTTLE X POINT
3) THROTTLE Y POINT

THROTTLE 0 ZONE: the speed of the truck remains at frequency creep meanwhile the voltage from the accelerator potentiometer is lower than this percentage of the MAX VACC setting. This adjustment define the width of a dead zone close to the rest position (see Figure 13–2 below).

THROTTLE X POINT & THROTTLE Y POINT: the speed of the truck grows up with a fixed slope (linear relationship) from the THROTTLE 0 ZONE up to THROTTLE X POINT. This slope is defined by the matching between the X point percentage of the MAX VACC setting with the Y point percentage of the full truck speed.
From the X point up to the MAX VACC point, the slope of the relationship between the truck speed and the accelerator position is different (see Figure 13–2 below) to match the full speed in the truck with the MAX VACC voltage in the accelerator position.

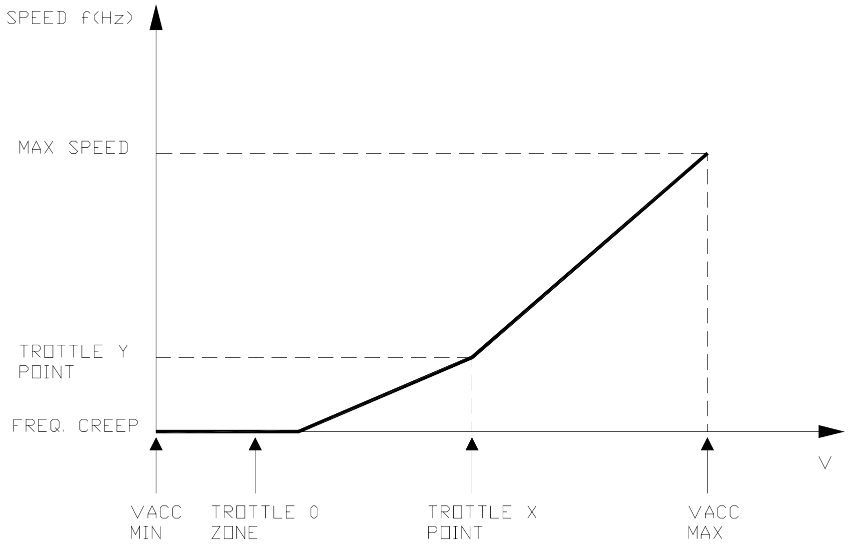


Figure 13–2

13.6 Description of the battery charge detection setting

The Battery Charge detection uses two setting that specify the Full Charge Voltage Level (100%) and the Discharge Voltage Level (10%). These two settings are the ADJUSTMENT#01 and the ADJUSTMENT#02 (see 12.4.2.14 and 12.4.2.15). It is possible to adapt the Battery Charge Detection to your specific battery, by changing the above two settings (e.g. if the Battery Discharged Detection occurs when the battery is not totally discarghed, it is necessary to reduce the ADJUSTMENT #02 setting as indicated in the Figure 13–3 below).

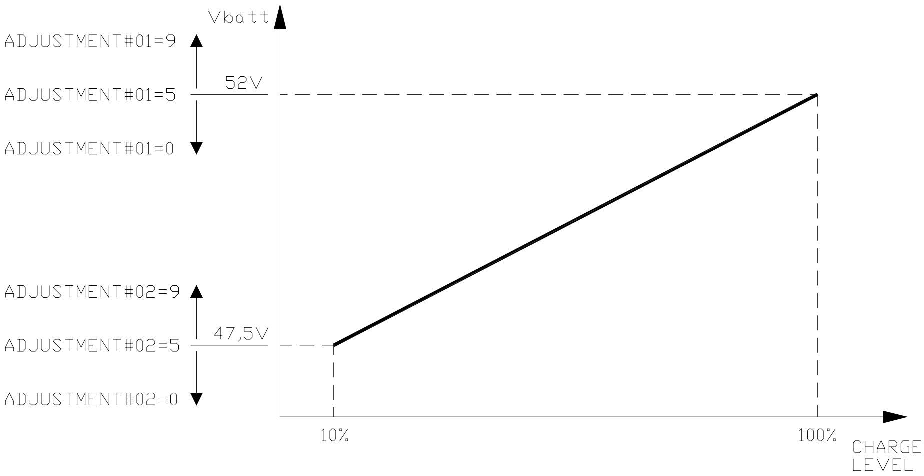


Figure 13–3

14 AC1 ALARMS LIST

The ALARMS logbook in the MAIN MENU' records the alarms of the controller. It has a FIFO (First Input First Output) structure that means the oldest alarm is lost when the database is full and a new alarm occurs. The logbook is composed of five locations getting possible to stack five different type of alarms with the following information:
1) The alarm code
2) The times that each alarm occurs consecutively
3) The Hour Meter value when the latest event of every alarm occured
4) And the inverter temperature when the latest event of every alarm occured.
This function permits a deeper diagnosis of problems as the recent history can be revisited.
The MDI-PRC code is the corresponding number with which the alarm is signalled on the MDI-PRC display.

14.1 Main menu "ALARMS" list

To Enter the MAIN MENU' push the Enter button at the Home Page of the hand set display and Roll for the ALARMS item. Here is the ALARMS list:

14.1.1 One Blink Alarms

1) **WATCH DOG**

MDI-PRC Code = 8

- Cause: It occurs when the embedded WATCH DOG protection is not able either to cut off the power stage when not triggerd or it is not able to activate the power stage when triggered.
- Remedy: Verify the motor is connected and the continuity of the three motor phases. If the alarm occurs permanently, it is necessary to substituite the controller.

2) **EEPROM KO**

MDI-PRC Code = 13

- Cause: It occurs due to a HW or SW defect of the non-volatile embedded memory supporting the controller regulations.
- Remedy: Try to execute a CLEAR EEPROM operation. This consists of Entering the ALARMS item in the MAIN MENU'. Push at the same time the two right side buttons to enter the hidden ZAPI MENU'. Roll up and Down until the CLEAR EEPROM appears on the hand set display. Push Twice the Enter Button. Switch the key off and on to check the result. If the alarm occurs permanently, it is necessary to substituite the controller.

3) **LOGIC FAILURE #1**

MDI-PRC Code = 19

- Cause: It occurs when the battery voltage overtakes 45V (when the battery is 24V) or 47.5V (when the battery is 36V). It also occurs when the supply voltage inside the logic falls less than 11Vdc.
- Remedy: Normally the overvoltage occurs due to the regenerative braking energy increasing the battery voltage; the undervoltage of the logic supply, can be due to a depletion in the key voltage

(e.g. when the pump inrush current makes the battery temporary collapsed).
So first of all check for your failure mode then contact the Zapi technician to look for a countermeasure.
As a matter of fact this alarm may occurs also for a HW failure and, in this case, it is necessary to substituite the Controller.

4) LOGIC FAILURE #2

MDI-PRC Code = 18

- Cause: It occurs when the circuit, to compensate for the dead times of the sine waves, is failed.
- Remedy: It is necessary to substituite the Controller.

5) LOGIC FAILURE #3

MDI-PRC Code = 17

- Cause: It occurs when the circuit to limitate via HW the current peak in the controller is active.
- Remedy: It is probably a power failure or a logic failure. If it occurs permanently it is necessary to substituite the Controller.

6) CHECK UP NEEDED

MDI-PRC Code = 99

- Cause: This is just a warning to call for the time programmed maintanance.
- Remedy: It is just enough to turn the CHECK UP DONE option to level ON (see 12.4.2.17) after the maintanance is executed.

14.1.2 Two Blinks Alarms

1) INCORRECT START

MDI-PRC Code = 79

- Cause: This is just a warning for an incorrect starting sequence.
- Remedy: The possble reasons for this alarm are (use the readings in the TESTER to facilitate the troubleshooting):
  a) A travel demand active at key on
  b) The tiller switch active at key-on
  c) The H&S input active at key-on
  d) The Quick inversion active at key-on
  A failure in the logic is possible too. When all of the above conditions were checked and nothing was found, substituite the controller.

2) FORW+BACK

MDI-PRC Code = 80

- Cause: This alarm occurs when both the travel demands (Fwd and Bwd) are active at the same time.
- Remedy: Check the wiring of the Fwd and Bwd travel demand inputs (use the readings in the TESTER to facilitate the troubleshooting).
  A failure in the logic is possible too. When you have verified the travel demand switches are fine working and the wiring is right, it is necessary to substituite the controller.

3) HANDBRAKE

MDI-PRC Code = 71

- Cause: This alarm occurs when the operator try to travel with the handbrake active.

- Remedy: Check the handbrake switch and its wiring to CNA#13. The handbrake switch must be connected between CAN#13 and GND voltage. When it is closed to GND the handbrake is considered active. A failure in the logic is possible too. In this case it is necessary to substituite the controller.

4) **LIFT+LOWER**

MDI-PRC Code = 90

- Cause: This alarm occurs when both a Lifting request and a Lowering request are active at the same time.
- Remedy: If the MDI-PRC is absent, check only the wiring of the main Lifting/Lowering pair (CNB#8 and CNB#9); if the MDI-PRC is present check also the wiring of the Aux Lifting/Lowering pair (CNA#14 and CNA#15). (Use the readings in the TESTER to facilitate the troubleshooting).
  A failure in the logic is possible too. When you have verified the Lifting/Lowering switches are fine working and the wiring is right, it is necessary to substituite the controller.

5) **LIFT LOW ACTIVE**

MDI-PRC Code = 91

- Cause: This is just a warning when a Lifting/Lowering request is active at key-on.
- Remedy: The possible reasons for this alarm are (use the readings in the TESTER to facilitate the troubleshooting):
  - When MDI_PRC is absent: at least one between LIFTING SWITCH (CNB#9) or DESCENT SWITCH (CNB#8) active at key on.
  - When TRUCK TYPE is Level=1: at least one between LIFTING SWITCH (CNB#9), DESCENT SWITCH (CNB#8), DIGITAL INPUT#1 (CNA#14) or DIGITAL INPUT#2 (CNA#15) active at key-on.
  - When TRUCK TYPE is Level=2: at least one between LIFTING SWITCH (CNB#9) or DESCENT SWITCH (CNB#8) active at key-on.
  - When TRUCK TYPE is Level=3: at least one between LIFTING SWITCH (CNB#9) or DESCENT SWITCH (CNB#8) active at key-on.

  A failure in the logic is possible too. When all of the above conditions were checked and nothing was found, substituite the controller.

14.1.3 Three Blinks Alarms

1) **CAPACITOR CHARGE**

MDI-PRC Code = 60

- Cause: In working condition, a resistance connected between the key and the Rail Capacitors, keeps the Rail Capacitors charged before the Main Contactor closes.When the voltage on the Rail Capacitors (measured on the phase V) is low and does not increase when the main contactor is opened this alarm occurs.
- Remedy: Three possibilities:
  - Another device, connected in parallel with the Rail Capacitors, has a failure
  - At least a motor phase is not connected to the controller or broken.

- A Power failure or a Logic Failure occured in the controller. In this case it is necessary to substituite the controller.

2) VMN HIGH

MDI-PRC Code = 31

- Cause: Before to switch the main contactor on, the SW turns on sequencely the Bottom side Power Mosfets and expects the phase V voltage falls to GND value. If the phase V remains high level this alarm occurs.
- Remedy: Two possibilities:
  - At least a motor phase is not connected to the controller or broken.
  - A Power Failure (e.g. a Bottom side Power Mosfet opened) or a Logic Failure occured in the controller. In this case it is necessary to substituite the controller

3) VMN LOW

MDI-PRC Code = 30

- Cause: Before to switch the main contactor on, the SW turns on sequencely the Top side Power Mosfets and expects the phase V voltage increases toward the rail capacitor value. If the phase V does not increases this alarm occurs.
  This alarm may occur also when the initial diagnosis is overcome, and so the Main Contactor is expected to be closed.Then, when the operator asks the truck moving but the +Batt terminal of the controller is lower voltage than the Battery voltage, this alarm occurs (Main Contactor has lost the contactation although it is closed).
- Remedy: If the problem occurs before the Main Contactor closes, probably a Power failure (e.g. a Bottom side Power Mosfet short circuited or a Top side Power Mosfet broken) or a Logic Failure occured in the controller. If the problem occurs when the operator turns the truck moving the problem is the Battery positive is not connected to the +Batt terminal of the controller (check the continuity of the main contactor).
  If the problem occurs permanently it is necessary to substituite the controller.

14.1.4 Four Blinks Alarms

1) VACC NOT OK

MDI-PRC Code = 78

- Cause: The test is made at key-on and after 20sec that both the travel demands have turned disactive. This alarm occurs if the ACCELERATOR reading in the TESTER menu' is higher than 1.0V (it means the wiper of the potentiometer is higher than 2Vdc) when the accelerator is released.
- Remedy: Check the mechanical calibration and the functionality of the potentiometer.

2) PEDAL WIRE KO

MDI-PRC Code = 86

- 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 (CNB#11) and GND and cascaded

with the potentiometer: if the potentiometer gets disconnected on PPOT or NPOT, no current flow 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).

- Remedy: Check the voltage on NPOT (CNB#11) and the potentiometer connections.

3) **PROGRAM LIFT LEVER**

MDI-PRC Code = 55

- Cause: The SW continuously matches the potentiometer connected to CNA#18 with the Main Lifting/Lowering pair request (CNB#9 and CNB#8).
When the TRUCK TYPE is set 2, the alarms occurs in the following conditions:
  - If both the Main Lifting and Main Lowering request are disactive and the potentiometer voltage is higher than 60mV over either the MIN LIFT or the MIN LOWER (see 12.4.2.3 and 12.4.2.5) setting.
  - If the Main Lifting request is active and the potentiometer voltage is higher than 200mV over the MAX LIFT setting (see 12.4.2.4).
  - If the Main Lowering request is active and the potentiometer voltage is higher than 200mV over the MAX LOWER setting (see 12.4.2.6).
  - If the MIN LIFT setting is higher than the MAX LIFT setting.
  - If the MIN LOWER setting is higher than the MAX LOWER setting.

  When the TRUCK TYPE is set 3, the alarms occurs in the following conditions:
  - If the Main Lowering request is disactive and the potentiometer voltage is higher than the MIN LOWER (see 12.4.2.5) setting.
  - If the MIN LOWER setting is higher than the MAX LOWER setting.
- Remedy: Check the Main Lifting/Lowering pair (CNB#8 and CNB#9) and the voltage on the potentiometer connected to CNA#18. (Use the readings LIFTING SWITCH, DESCENT SWITCH and LIFTING CONTROL in the TESTER to facilitate the troubleshooting).

14.1.5 Five Blinks Alarms

1) **ENCODER ERROR**

MDI-PRC Code = 70

- Cause: Two consecutive readings of the encoder speed are too much different in between: because of the inertiality of the system it is not possible the encoder changes its speed a lot in a short period. Probably an encoder failure has occured (e.g. one or two channels of the encoder are corrupted or disconnected).
- Remedy: Check both the electric and the mechanical encoder functionality. Frequently we experienced one of the two Sensor bearing’s ring, slips inside its seat raising this alarm condition. Also the electromagnetic noise on the sensor bearing can be a cause for the alarm.

2) STBY I HIGH

MDI-PRC Code = 53

- Cause: This diagnosis is executed only when the main contactor is opened and asked to be closed (e.g. at key on or when the main contactor is opened and a new motion request turns active). Then the outputs of the Current amplifiers must be in a narrow window close to 2.5Vdc (from 2.26V to 2.74V). Otherwise this STBY I HIGH alarm occurs.
- Remedy: If the alarm occurs permanently, it is necessary to substituite the controller.

14.1.6 Six Blinks Alarms

1) COIL SHORTED

MDI-PRC Code = 76

- Cause: This alarm occurs when there is an overload on one of the following connections: CNA#1, CNA#3, CNA#4 and CNA#6. Typically the problem is due to a short circuit of one of the coils conneted to these outputs. After the overload has removed, the alarm exits automatically by releasing and then enabling a travel demand.
- Remedy: Check the coils of the main contactor (CNA#1), of the electromechanical brake (CNA#3), of the pump contactor (CNA#4), of the Aux valve (CNA#6).

2) CONTACTOR DRIVER

MDI-PRC Code = 75

- Cause: This alarm occurs when the voltage on the Main Contactor is smaller than expected: this means that the Main Contactor Coil has a null voltage when supplied.
- Remedy: Check the coils of the Main Contactor (CNA#1) is not short circuited. If it isn't, probably it is necessary to substituite the controller because the driver of the Main Contactor is broken.

3) DRIVER SHORTED

MDI-PRC Code = 74

- Cause: This alarm occurs when the voltage on the Main Contactor is higher than expected: this means that the Main Contactor Coil has a high voltage although it is not supplied.
- Remedy: Probably it is necessary to substituite the controller because the driver of the Main Contactor is short circuited.

4) AUX OUTPUT KO

MDI-PRC Code = 16

- Cause: This alarm occurs when the feedforward PWM generated by the controller to supply the Electromechanical Brake and the actual feedback voltage on the Electromechanical Brake are not matched in between. The diagnosis is made only when the Tiller Switch is active.
  Then:
  a) When the feedforward PWM is less than 10% of the battery voltage, the Actual voltage on the Electromechanical Brake is expected low. If it is higher than 14V it means the Electromechanical Brake never Brakes the truck (probably

the Driver of the Elecromechanical Brake is short circuited) and this alarm occurs.

b) When the feedforward PWM is higher than 70% of the battery voltage, the Actual voltage on the Electromechanical Brake is expected high. If it is lower than 14V it means the Electromechanical Brake always gets the truck Braked (probably the Driver of the Elecromechanical Brake is opened) and this alarm occurs.

- Remedy: Probably it is necessary to substituite the controller because the driver of the Electromechanical Brake has a failure.

5) MDI VALVE2 SHORT

MDI-PRC Code = 70

- Cause: This alarm occurs on the MDI-PRC and the information is transferred via CAN Bus to the AC1.
- Remedy: See 14.2 and the manual of the MDI-PRC.

6) MDI NEVP1 NOT OK

MDI-PRC Code = 90

- Cause: This alarm occurs on the MDI-PRC and the information is transferred via CAN Bus to the AC1.
- Remedy: See 14.2 and the manual of the MDI-PRC.

7) MDI PEV NOT OK

MDI-PRC Code = 89

- Cause: This alarm occurs on the MDI-PRC and the information is transferred via CAN Bus to the AC1.
- Remedy: See 14.2 and the manual of the MDI-PRC.

8) MDI DRV 2 OPEN

MDI-PRC Code = 75

- Cause: This alarm occurs on the MDI-PRC and the information is transferred via CAN Bus to the AC1.
- Remedy: See 14.2 and the manual of the MDI-PRC.

9) MDI DRV 2 SHORT

MDI-PRC Code = 74

- Cause: This alarm occurs on the MDI-PRC and the information is transferred via CAN Bus to the AC1.
- Remedy: See 14.2 and the manual of the MDI-PRC.

10) INPUT ERROR #1

MDI-PRC Code = 92

- Cause: This alarm occurs when the PLD device has a failure. The PLD device is used for both, the Passive Emergency Cell (see 5.1) and a Multiplexer on the Main Lifting/Lowering requests. This Multiplexer exits the Lifting and the Not Lifting level on two distinct addresses. When the Lifting and the Not Lifting outputs have the same Logic Level the PLD device has failed and this alarm occurs.
- Remedy: It is necessary to substituite the controller.

11) ANALOG INPUT

MDI-PRC Code = 96

- 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.

- Remedy: If the problem occurs permanently it is necessary to substituite the controller.

14.1.7 Seven Blinks Alarms

1) **HIGH TEMPERATURE**

MDI-PRC Code = 61

- Cause: This alarm occurs when the temperature of the base plate is higher than 90° at 24V or 78° at 48V. Then the maximum current decreases proportionally with the temperature increases from 90°(78°) up to 110°(103°). At 103° the Current is limited to 0 Amps.
- Remedy: Improve the air cooling of the controller.

2) **MOTOR TEMPERAT**

MDI-PRC Code = 65

- Cause: This is just a warning with no effect on the truck performance. It occurs when the temperature of the motor winding overtakes the MOTOR OVERTEMP setting.
- Remedy: Check the thermal sensor inside the motor (use the MOTOR TEMPERATURE reading in the TESTER menu). If the sensor is OK, improve the air cooling of the motor.

3) **THERMIC SENS KO**

MDI-PRC Code = 73

- Cause: When the output of the thermal sensor on the base plate is higher than 4.95V or lower than 0.1V , the sensor is assumed failed and this alarm occurs.
- Remedy: It is necessary to substituite the controller.

14.1.8 Eigth Blinks Alarms

1) **CAN BUS KO**

MDI-PRC Code = 67

- Cause: It occurs if the controller does not receive any message from the CAN Bus line.
- Remedy: First of all, check the wiring. If it is OK , try to disconnect one to one the module connected to the CAN Bus and check if this alarm disappears. When you are quite sure the problem is in the present module, it is necessary to substituite the controller.

14.1.9 No Blink Alarms

1) **STOP TOP**

MDI-PRC Code = Null

- Cause: This is just a warning to inform the Passive Emergency Cell (see 5.1) operates. The Passive Emergency Cell operates when the controller takes longer than 800msec, after the tiller was released, to reduce the frequency in the motor, close to zero. The Passive Emergency Cell siwtches off the Top Side Power Mosfets (this is the reason for the name) of the three phase bridge.
- Remedy: The controller exits automatically this warning when the operator turns the truck moving.

2) **WRONG CONFIG**

MDI-PRC Code = 1

- Cause: It occurs the first time a controller is switched on when the non volatile eeprom memory is not initialized yet. Then it is necessary to specify if the controller is AC0 or AC1 type (see AC TYPE 0 in the hidden hardware setting Zapi menu). If the alarm is present, by switching off the key the AC TYPE 0 setting will be turned automatically On (and the controller is specified to be an AC0). The AC TYPE 0 setting can be changed only when a WRONG CONFIG alarm is present. If it is not present it is necessary to clear the eeprom memory in order the WRONG CONFIG alarm occurs.
- Remedy: The AC TYPE 0 setting must be factory adjusted and so this alarm never should happen when the controller is on the field. So ask for the assistance of a Zapi technicians when this alarm occurs.

3) **WAITING FOR NODE**

MDI-PRC Code = Null

- Cause: The controller expects to receive a messagge from a remote module via CAN Bus. When this messagge is not received after a time out this alarm occurs.
- Remedy: Check the communication via CAN between the controller and the other modules.

4) **CURRENT SENS KO**

MDI-PRC Code = 94

- Cause: This alarm occurs when the procedure for the maximum current set-up is in progress.
- Remedy: The maximum current set-up is factory adjusted and so this alarm never should happen when the controller is on the field. So ask for the assistance of a Zapi technicians when this alarm occurs.

14.1.10 Thirty Two Blinks Alarms

1) **BATTERY LOW**

MDI-PRC Code = Local

- Cause: It occurs when the battery charge is calculated being less than 10% of the full charge and the BATTERY CHECK setting is other than 0.
- Remedy: Get the battery charged.

14.2 MDI-PRC “ALARMS” List

When the Controller communicates with the MDI-PRC, the alarm condition is represented on the MDI-PRC in a Numeric form is:
Source Device Code and Alarm Code.
The Source Device Code we are interesting in are:
16: This is a local MDI-PRC alarm
02: This is a Traction Controller (AC1) alarm

The Alarm Code List Sourced by the Controller (Source Device Code 02) is the following:

1: WRONG CONFIG
8: WATCH DOG
13: EEPROM KO
16: AUX OUTPUT KO
17: LOGIC FAILURE #3
18: LOGIC FAILURE #2
19: LOGIC FAILURE #1
30: VMN LOW
31: VMN HIGH
53: STBY I HIGH
55: PROGRAM LIFT LEVER
60: CAPACITOR CHARGE
61: HIGH TEMPERATURE
65: MOTOR TEMPERAT
67: CAN BUS KO
70: ENCODER ERROR
71: HANDBRAKE
73: THERMIC SENS KO
74: DRIVER SHORTED
75: CONTACTOR DRIVER
76: COIL SHORTED
78: VACC NOT OK
79: INCORRECT START
80: FORW+BACK
86: PEDAL WIRE KO
90: LIFT+LOWER
91: LIFT LOW ACTIVE
92: INPUT ERROR #1
94: CURRENT SENS KO
96: ANALOG INPUT
97: OVERLOAD
99: CHECK UP NEEDED

The Alarm Code List Sourced by the MDI-PRC (Source Device Code 16) is the following:

67:	CAN BUS KO	The Can Bus communication is broken
70:	MDI VALVE2 SHORT	At least one of the On/Off Valves Coil is shorted

74:	MDI DRV2 SHORT	At least one On/Off driver on pin#4 and #6 is shorted
75:	MDI DRV2 OPEN	At least one On/Off driver on pin#4 and #6 is opened
89:	MDI PEV NOT OK	The Positive Supply for the Valves is missing
90:	MDI NEVP1 NOT OK	At least one Proportional Valve driver on pin#8 and #9 is shorted

Example: 02A79 is an INCORRECT START alarm on the AC1.

15 RECOMMENDED SPARE PARTS

Part number	Description
C29508	SW 180 24V Single Pole Contactor

16 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDICATED

Check the wear and condition of the Contactors' moving and fixed contacts. Electrical Contacts should be checked every **3 months.**

Check the wear and condition of the electromechanical brake. According with the ISO 6292 the electromechanical brake must be able to lock the truck in the worst case in terms of admitted gradient and load. The truck manufacturer has to take care the ISO 6292 is fullfilled with a suited maintenance scheduling.

Check the Foot pedal or Tiller microswitch. Using a suitable test meter, confirm that there is no electrical resistance between the contacts by measuring the volt drop between the terminals. Switches should operate with a firm click sound. Microswitches should be checked every **3 months.**

Check the Battery cables, cables to the chopper, and cables to the motor. Ensure the insulation is sound and the connections are tight.
Cables should be checked every **3 months.**

Check the mechanical operation of the pedal or tiller . Are the return springs ok. Do the potentiometers wind up to their full or programmed level.
Check every **3 months.**

Check the mechanical operation of the Contactor(s). Moving contacts should be free to move without restriction.
Check every **3 months.**

Checks should be carried out by qualified personnel and any replacement parts used should be original. Beware of NON ORIGINAL PARTS.
The installation of this electronic controller should be made according to the diagrams included in this Manual. Any variations or special requirements should be made after consulting a Zapi Agent. The supplier is not responsible for any problem that arises from wiring methods that differ from information included in this Manual.

During periodic checks, if a technician finds any situation that could cause damage or compromise safety, the matter should be bought to the attention of a Zapi Agent immediately. The Agent will then take the decision regarding operational safety of the machine.

Remember that Battery Powered Machines feel no pain.

NEVER USE A VEHICLE WITH A FAULTY ELECTRONIC CONTROLLER