INDEX

⚠ =   The informations included into the marked paragraphs by this symbol are
        essential for the safety.

SIGNATURES TABLE

COMPANY DEPT. SERVICES	MANAGEMENT EXECUTIVE	
ENGINEERING SECTION EXECUTIVE		
EXPORT MANAGER		

1 INTRODUCTION

Within the ZAPIMOS family, the DUALAC2 inverter is the model suitable for control of pairs of 3.0kW to 7.0kW motors. The DUALAC2&HP can also control a DC-Series pump motor, up to 15kW. These controllers have been expressly designed for battery powered applications, traction and hydraulic functions. They are fit for electric trucks, utility cars, tractors.

2 SPECIFICATION

2.1 TECHNICAL SPECIFICATIONS - "DUALAC2"

Inverter for pairs of AC asynchronous 3-phase motors
Regenerative braking functions
Can-bus interface
Digital control based upon a microcontroller (one per each motor)
Voltage: .... 24 - 36 - 48 - 72 - 80V
Maximum current (24V): .... 350A (RMS) for 3' per each motor
Maximum current (36/48V): .... 275A (RMS) for 3' per each motor
Maximum current (72/80V): .... 200A (RMS) for 2' per each motor
Operating frequency: 8kHz
External temperature range: .... -30°C ÷ 40°C
Maximum inverter temperature (at full power): .... 75°C

BLOCK DIAGRAM
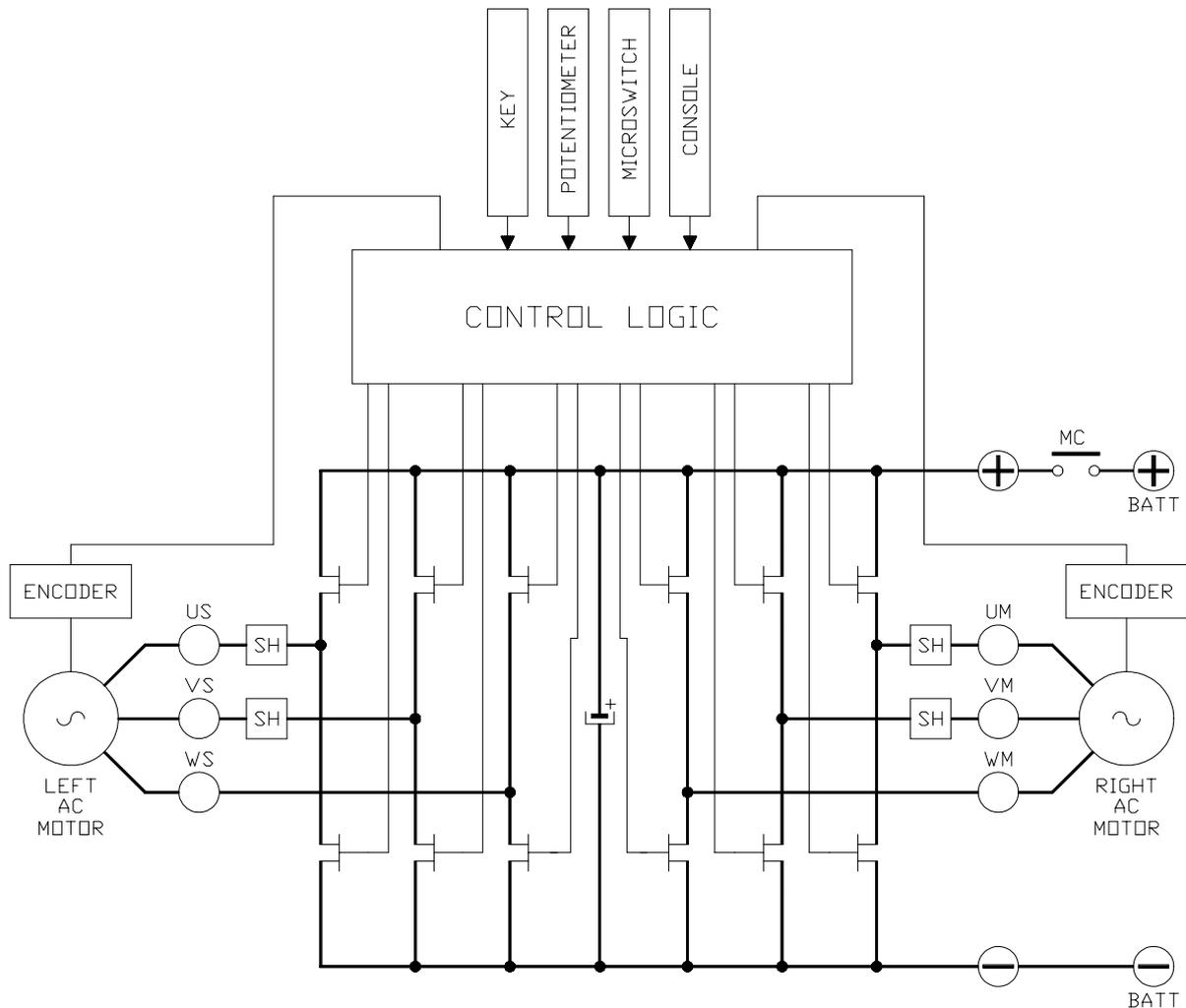
2.2 TECHNICAL SPECIFICATIONS - "DUALAC2&HP"

Inverter for pairs of AC asynchronous 3-phase motors plus chopper for DC series pump motor.
Regenerative braking functions
Can-bus interface
Digital control based upon a microcontroller (one per each AC motor)
Voltage: .... 24 - 36 - 48 - 72 - 80V
Maximum current (24V): .... 350A (RMS) for 3' per each motor
Maximum current (36/48V): .... 275A (RMS) for 3' per each motor
Maximum current (72/80V): .... 200A (RMS) for 2' per each motor
Chopper maximum current (24V): .... 500A for 2'
Chopper maximum current (36/48V): .... 420A for 2'
Chopper maximum current (72/80V): .... 300A for 2'
Operating frequency: 8kHz
External temperature range: .... -30°C ÷ 40°C
Maximum inverter temperature (at full power): .... 75°C

BLOCK DIAGRAM

BLOCK DIAGRAM CHOPPER
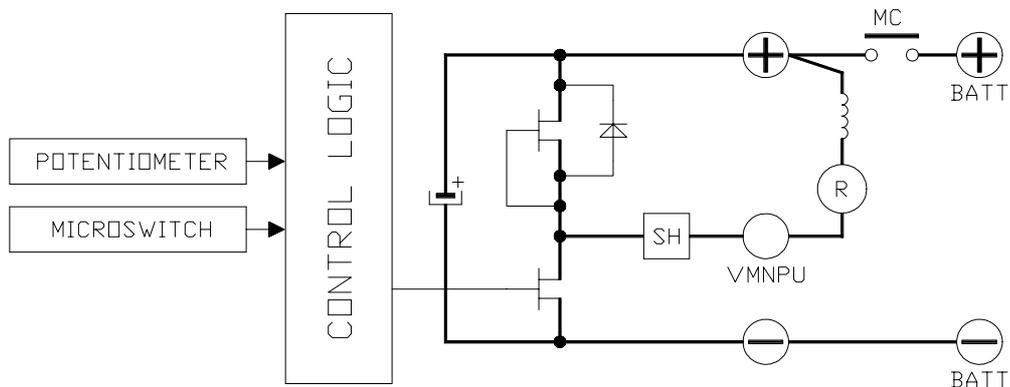
2.3 TECHNICAL SPECIFICATIONS - "DUALAC2 POWER"

Inverter for pairs of AC asynchronous 3-phase motors
Regenerative braking functions
Can-bus interface
Digital control based upon a microcontroller (one per each AC motor)
Voltage: .... 24 - 36 - 48 - 72 - 80V
Maximum current (24V): .... 450A (RMS) for 3' per each motor
Maximum current (36/48V): .... 350A (RMS) for 3' per each motor
Maximum current (72/80V): .... 275A (RMS) for 2' per each motor
Operating frequency: 8kHz
External temperature range: .... -30°C ÷ 40°C
Maximum inverter temperature (at full power): .... 75°C

BLOCK DIAGRAM

See chapter 2.1 - Block Diagram.

2.4 TECHNICAL SPECIFICATIONS - "DUALAC2&HP POWER"

Inverter for pairs of AC asynchronous 3-phase motors plus chopper for DC series pump motor
Regenerative braking functions
Can-bus interface
Digital control based upon a microcontroller (one per each AC motor)
Voltage: .... 24 - 36 - 48 - 72 - 80V
Maximum current (24V): .... 450A (RMS) for 3' per each motor
Maximum current (36/48V): .... 350A (RMS) for 3' per each motor
Maximum current (72/80V): .... 275A (RMS) for 2' per each motor
Chopper maximum current (24V): .... 500A for 2'
Chopper maximum current (36/48V): .... 420A for 2'
Chopper maximum current (72/80V): .... 300A for 2'
Operating frequency: 8kHz
External temperature range: .... -30°C ÷ 40°C
Maximum inverter temperature (at full power): .... 75°C

BLOCK DIAGRAM
See chapter 2.2 - Block Diagram.

2.5 CONTROL UNIT

2.5.1 Microswitches

- The microswitches must have a contact resistance lower than 0.1ohm 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 send a voltage signal to the microprocessor when a function request (for ex.: running request) is made.

2.5.2 Accelerator unit

The accelerator unit can consist of a potentiometer or an Hall effect device.
It should be in a 3-wire configuration.
CPOT (C21) signal ranges from 0 to 10V.
Potentiometer value should be in the 0.5 - 10 Kohm range; generally, the load should be in the 1.5mA to 30 mA range. Faults can occur if it is outside this range.
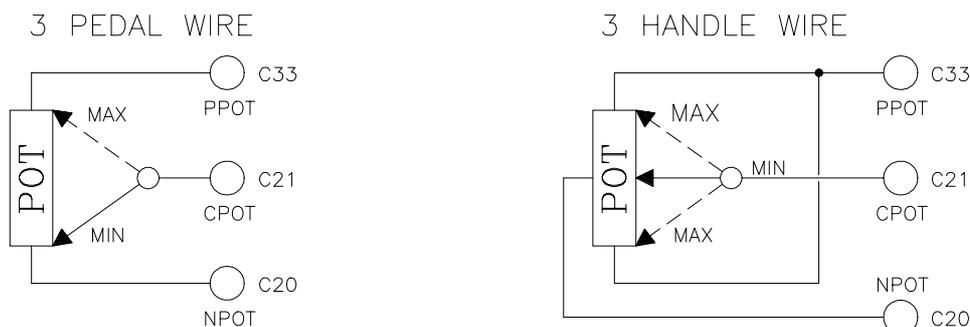
PPOT is the accelerator unit positive supply. It can be either a 5V output or a 10V output. The selection of the output voltage is made in the logic card by moving a jumper (factory set).

NPOT is the accelerator unit negative supply. This output is feedback to the µC A/D converter to test the continuity of the accelerator unit circuit (test of poti wire disconnection).

The Procedure for automatic potentiometer signal acquisition is carried out using the Console. This enables adjustment of the minimum and maximum useful signal level (PROGRAM VACC function), 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 sequence of procedure is described in the programming console manual.
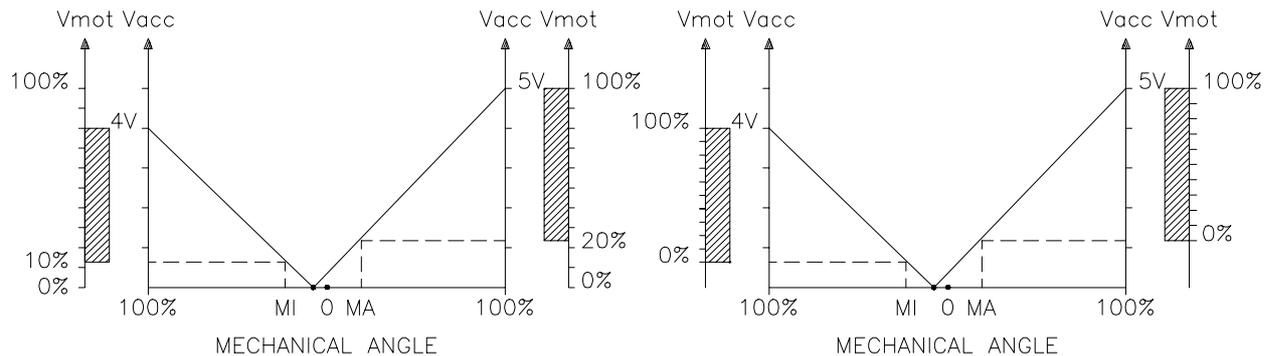
The two graphs show the output voltage from a non-calibrated potentiometer with respect to the mechanical "zero" of the control lever. MI and MA indicate the point where the direction switches close. 0 represents the mechanical zero of the rotation.

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.

2.5.3 Other analog control unit

1) Input C18 is an analog input, whose typical application is for proportional braking. It should be in a 3 wire configuration. Potentiometer value should be in the 0.5-10 Kohm range. Generally, the load should be in the 1.5mA to 30 mA range.
   The CPOTB (C18) signal range is from 0 to 5V or from 0V to 10V.

2) Connections C25 (PTHERMR) and C24 (NTHERMR) are used for the right motor thermal sensor. Connections C35 (PTHERML) and C34 (NTHERML) are used for the left motor thermal sensor. Sensors can be digital (on/off sensor, normally closed) or analog. See also chapter 5.4 for more explanation.

3) In the versions with integrated pump chopper (DUALAC2&HP and DUALAC2&HP POWER), it is possible to input to the controller an analog signal for proportional lifting. This input will be the output of a potentiometer (3 wires, resistance in the 1 to 10kohm range) or of a Hall Effect device; the load must be below 10mA. CPOTLIFT (D9) signal has to be within the 0 to 10V range.

2.5.4 Speed feedback

The traction motors 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

For more details about encoder installation see also chapter 4.6.

2.5.5 Steering angle transducer

Angular position of steered wheels is transduced to an electric information (voltage) by means of a potentiometer, with following characteristics:
- resistance in the 2kohm to 20kohm range;
- suggested rotation electric angle: at least 300°;
- positive supply: 5V or 10V;
- potentiometer has to be installed in a way that in the "zero" position (straight wheels), poti output voltage is in the middle of the electric range corresponding to a full left-to-right transition of the steered wheels;
- install the potentiometer in a way that, when truck turns right, poti output voltage increases;
- use "SET STEER MIN" and "SET STEER MAX" functions to record the extremes (minimum and maximum) of the potentiometer range; see chapter 5.4.
- use "SET STEER 0-POS" function to record the poti output when the steered wheels are straight; see chapter 5.4.
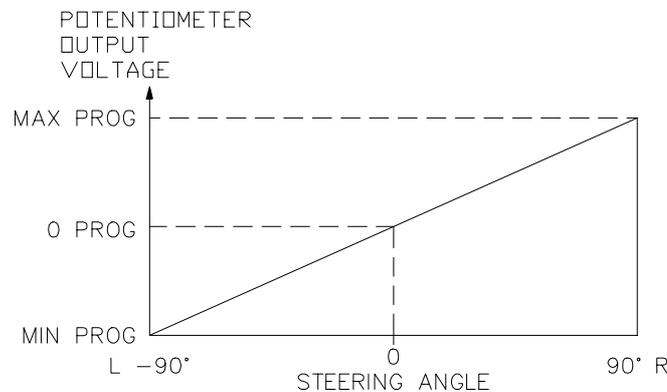
MOTOR MANAGEMENT TABLE
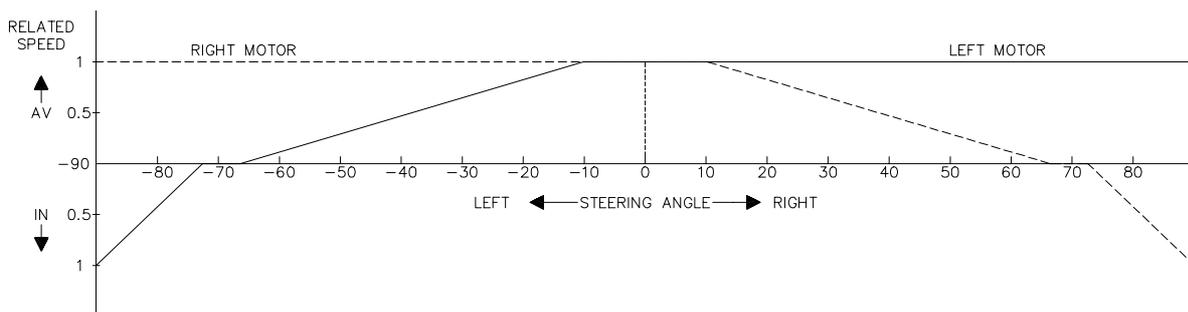
Potentiometer connections


```
C16 (PPOTST, 5/10V)
C17 (CPOTST)
C15 (NPOTST, -BATT)
```
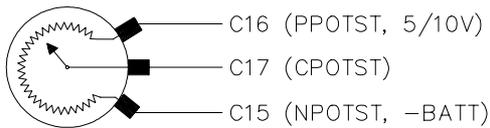
Steering table

The relationship between the two motors speed changes as a function of the steering angle and of the axle/wheeltrack ratio.

While the steering angle is an information coming from the trasducer (potentiometer), the axle/wheeltrack ratio is a constant characteristic of the truck that depends on his dimensions. Actually two steering tables are provided:

Option #1 = tables for 3 wheels trucks with **driving wheels counter-rotation** (the internal wheel inverts the direction).

Option #2 = tables for 4 wheels trucks without **driving wheels counter-rotation** (the internal wheel does not inverts the direction).

The truck data have to be communicated to Zapi, so that it is possible to put in the software the correct steering table.

The correct table selection is done in the SET OPTION menu, see chapter 5.4.
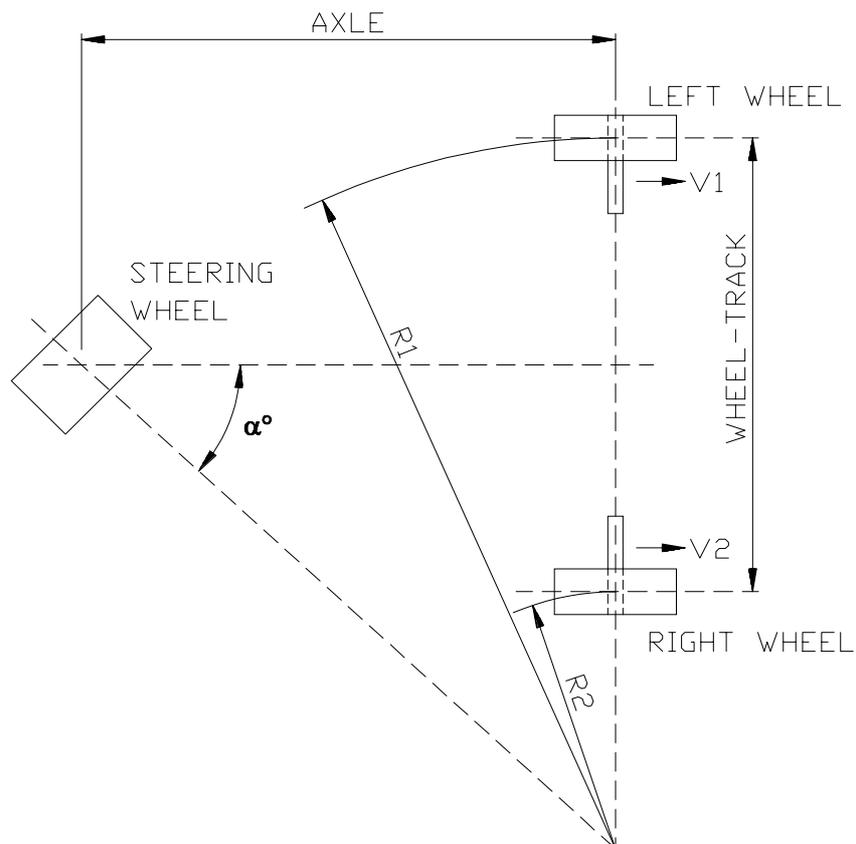
The relationship between the two motors speed is equal to the relationship between the two radius described during the curve.

2.6 PROTECTION FEATURES ⚠

- **Battery polarity inversion:**

  It is necessary to fit a MAIN CONTACTOR to protect the inverter against reverse battery polarity and for safety reasons.

- **Connection Errors:**

  All inputs are protected against connection errors.

- **Thermal protection**

  If the chopper temperature exceeds 75°C, the maximum current is reduced in proportion to the thermal increase. The temperature can never exceeds 100°C.

- **External agents:**

  The inverter is protected against dust and the spray of liquid to a degree of protection meeting IP54.

- **Protection against uncontrolled movements:**

  The main contactor will not close if:

  - The Power unit is not functioning.
  - The Logic is not functioning perfectly.
  - the output voltage of the accelerator does not fall below the minimum voltage value stored, with 1V added.
  - Running microswitch in closed position.

- **Low battery charge**:
  when the battery charge is low, the maximum current is reduced to the half of the maximum current programmed.

- **Protection against accidental Start up**

  A precise sequence of operations are necessary before the machine will start. Operation cannot begin if these operations are not carried out correctly. Requests for drive, must be made after closing the key switch

2.7 OPERATIONAL FEATURES

- Speed control.
- Optimum behaviour an a slope due to the speed feedback:
  - the motors 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 chapter 5.4)
- Stable speed in every position of the accelerator.
- Electronic differential feature with torque balance between external and internal wheel.
- 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.
- Optimum sensitivity at low speeds.
- Voltage boost at the start and with overload to obtain more torque (with current control).
- The inverter can drive an electromechanical brake
- Hydraulic steering function:
  - the traction inverter sends a "hydraulic steering function" request to the pump inverter on the can-bus line.
  - moreover , if the pump inverter is not present (for ex: tractor application), the traction inverter can manage an "hydraulic steering function" by driving a hydro contactor which drive a hydraulic steering motor (output C31).
- High efficiency of motor and battery due to high frequency commutations.
- 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.
- Diagnostic function with Zapi handset for checking main parameters.
- Built in BDI feature.
- Flash memory, sw downloadable via serial link and via CANBUS.
- Canopen interface available.

2.8 DIAGNOSIS

The microprocessors continually monitor the inverter and carry out a diagnostic procedure on the main functions. The diagnosis is made in 4 points

1) Diagnosis on key switch closing that checks: watchdog circuit, current sensor, capacitor charging, phase's voltages, contactor drivers, can-bus interface, if the switch sequence for operation is correct and if the output of accelerator unit is correct, correct synchronization of the two µCS, integrity of safety related inputs hardware.

2) Standby diagnosis at rest that checks: watchdog circuit, phase's voltages, contactor driver, current sensor, can-bus interface.

3) Diagnosis during operation that checks: watchdog circuits, contactor driver, current sensors, can-bus interface.

4) Continuos 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.

2.9 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.

2.10 GENERAL INSTRUCTIONS AND PRECAUTIONS ⚠

- Never connect SCR low frequency chopper with ASYNCHRONOUS INVERTER because the ASYNCHRONOUS filter 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 ASYNCHRONOUS from the battery.

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

- When the chopper is installed, make tests with the wheels raised from the ground, in order to avoid dangerous situations due to connection errors.

- After the chopper is switched off (key off), the filter capacitor remains charged for about 1 minute; if you need to work on the inverter, discharge them using a 10W ÷ 100W resistance connected from the +Batt to the -Batt.

2.11 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 noncompliance if correct testing is not made (the irradiated emission directive is EN50081-2).

2.12 MAIN CONTACTOR AND EMERGENCY SWITCH

- The connection of the battery line switches must be carried out following ZAPI instructions.

- If a mechanical battery line switch is installed, it is necessary that the key supply to the inverter is open together with power battery line; if not, the inverter may be damaged if the switch is opened during a regenerative braking.
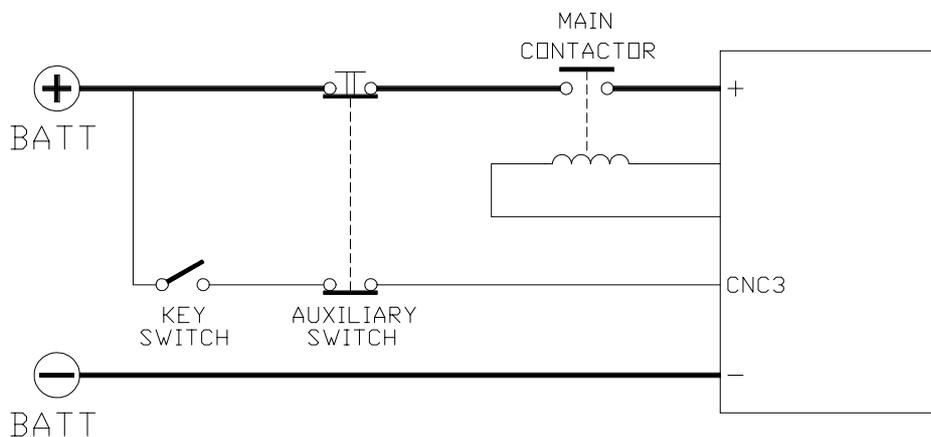
- An intrinsic protection is present inside the logic when the voltage on the battery power connection overtakes 40% more than the battery nominal voltage or if the key is switched off before the battery power line is disconnected.

3 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.

Dualac2 controller electronic implements double hardware circuit for four inputs: Seat (C5), Forward (C6), Reverse (C7), Accelerator Enable (C8).
These signals are input, through two hardware independent circuits, to both microcontrollers which implement a cross-check of the input status, thus preventing an abnormal behaviour due to a failure in the input hardware.

It is strongly suggested to connect the machine safety related devices to these four inputs, in order to increase machine safety.

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.

4 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.
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.

4.1 CONNECTION CABLES

For the auxiliary circuits, use cables of 0.5mm² section.
For power connections to the motor and to the battery, use cables having section of 35 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.

4.2 CONTACTORS

The main contactor must be installed. The LC coil driver is voltage controlled by means of a 1 khz PWM. The voltage applied to the coil can be adjusted by "Main Cont Voltage" parameter in Config/Adjustment menu. It has to be adjusted to the LC coil nominal voltage.

4.3 FUSES

- Use a 6.3A Fuse for protection of the auxiliary circuits.

- For protection of the power unit, refer to diagrams.. The Fuse value shown is the maximum allowable. 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.

4.4 DESCRIPTION OF CONNECTORS - "DUALAC2" AND "DUALAC2 POWER"

A1	CAN_H	High level CANBUS.
A2	CANT_H	CANBUS termination output, 120 ohm internally connected to CAN_H. Connect to CAN_L_OUT to insert the termination.
A3	CAN_POS	Positive of CAN circuit; to be used in case of optoisolated CANBUS.
A4	CAN_L_OUT	Low level CANBUS: to be used as repetition for CAN_L line or to be connected to CANT_H to insert termination resistance.
A5	CANT_L	CANBUS termination output, 120 ohm internally connected to CAN_L. Connect to CAN_H_OUT to insert the termination.
A6	CAN_L	Low level CANBUS.
A7	CAN_H_OUT	High level CANBUS: to be used as repetition for CAN_H line or to be connected to CANT_L to insert termination resistance.
A8	CAN_NEG	Negative of CAN circuit, to be used in case of optoisolated CANBUS.
B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console power supply.
B6	+12	Positive console power supply.
B7	FLASH	
B8	FLASH	

C1	PENC_R	Positive of right motor encoder power supply (+5V/+12V).
C2	NENC_R	Negative of right motor encoder power supply.
C3	KEY	Connected to +Batt trough a microswitch and a 10A fuse in series.
C4	CM	Common of FW / REV / HB / PB / SEAT / ENABLE microswitches.
C5	SEAT	Seat presence signal; active high.
C6	FORWARD	Forward direction request signal; active high.
C7	REVERSE	Reverse direction request signal; active high.
C8	ENABLE	Traction request signal; active high.
C9	PB	Pedal brake request signal; active high.
C10	SR/HB	Speed reduction signal or hand brake input; active low (microswitch open). See also chapter 5.4.
C11	PENC_L	Positive of left motor encoder power supply (+5V/+12V).
C12	NENC_L	Negative of left motor encoder power supply.
C13	PHA_R	Right motor encoder phase A.
C14	PHB_R	Right motor encoder phase B.
C15	NPOTST	Negative of steering potentiometer (-BATT).
C16	PPOTST	Positive of steering potentiometer (+5V/+12V).
C17	CPOTST	Steering potentiometer wiper signal.
C18	CPOTB	Brake potentiometer wiper signal.
C19	NPOTB	-BATT.
C20	NPOT	Negative of traction accelerator potentiometer, tested for wire disconnection diagnosis.
C21	CPOT	Traction potentiometer wiper signal.
C22	PHA_L	Left motor encoder phase A.
C23	PHB_L	Left motor encoder phase B.
C24	NTHERM_R	Negative of right traction motor temperature sensor.
C25	PTHERM_R	Right traction motor temperature signal.
C26	NLC	Output of main contactor coil driver (drives to -BATT).
C27	PLC	Positive of main contactor coil.
C28	NBRAKE	Output of electric brake coil; drives the load to -BATT, maximum current 3A.
C29	PBRAKE	Positive of the electromechanical brake coil.
C30	PAUX	Positive of auxiliary load.
C31	NAUX	Output of auxiliary load driver (drives to -BATT).
C32	-BATT	
C33	PPOT	Traction potentiometer positive, 5/10V output; use load > 1k ohm.
C34	NTHERM_L	Negative of left traction motor temperature sensor.
C35	PTHERM_L	Left traction motor temperature signal.

4.5 DESCRIPTION OF CONNECTORS - "DUALAC2&HP" AND "DUALAC2&HP POWER"

A1	CAN_H	High level CANBUS.
A2	CANT_H	CANBUS termination output, 120 ohm internally connected to CAN_H. Connect to CAN_L_OUT to insert the termination.
A3	CAN_POS	Positive of CAN circuit; to be used in case of optoisolated CANBUS.
A4	CAN_L_OUT	Low level CANBUS: to be used as repetition for CAN_L line or to be connected to CANT_H to insert termination resistance.
A5	CANT_L	CANBUS termination output, 120 ohm internally connected to CAN_L. Connect to CAN_H_OUT to insert the termination.
A6	CAN_L	Low level CANBUS.
A7	CAN_H_OUT	High level CANBUS: to be used as repetition for CAN_H line or to be connected to CANT_L to insert termination resistance.
A8	CAN_NEG	Negative of CAN circuit, to be used in case of optoisolated CANBUS.

B1	PCLRXD	Positive serial reception.
B2	NCLRXD	Negative serial reception.
B3	PCLTXD	Positive serial transmission.
B4	NCLTXD	Negative serial transmission.
B5	GND	Negative console power supply.
B6	+12	Positive console power supply.
B7	FLASH	
B8	FLASH	

C1	PENC_R	Positive of right motor encoder power supply (+5V/+12V).
C2	NENC_R	Negative of right motor encoder power supply.
C3	KEY	Connected to +Batt trough a microswitch and a 10A fuse in series.
C4	CM	Common of FW / REV / HB / PB / SEAT / ENABLE microswitches.
C5	SEAT	Seat presence signal; active high.
C6	FORWARD	Forward direction request signal; active high.
C7	REVERSE	Reverse direction request signal; active high.
C8	ENABLE	Traction request signal; active high.
C9	PB	Pedal brake request signal; active high.
C10	SR/HB	Speed reduction signal or hand brake input; active low (microswitch open). See also chapter 5.4.
C11	PENC_L	Positive of left motor encoder power supply (+5V/+12V).
C12	NENC_L	Negative of left motor encoder power supply.
C13	PHA_R	Right motor encoder phase A.
C14	PHB_R	Right motor encoder phase B.
C15	NPOTST	Negative of steering potentiometer (-BATT).
C16	PPOTST	Positive of steering potentiometer (+5V/+12V).
C17	CPOTST	Steering potentiometer wiper signal.
C18	CPOTB	Brake potentiometer wiper signal.
C19	NPOTB	-BATT.
C20	NPOT	Negative of traction accelerator potentiometer, tested for wire disconnection diagnosis.
C21	CPOT	Traction potentiometer wiper signal.
C22	PHA_L	Left motor encoder phase A.
C23	PHB_L	Left motor encoder phase B.
C24	NTHERM_R	Negative of right traction motor temperature sensor.
C25	PTHERM_R	Right traction motor temperature signal.
C26	NLC	Output of main contactor coil driver (drives to -BATT).
C27	PLC	Positive of main contactor coil.
C28	NBRAKE	Output of electric brake coil; drives the load to -BATT, maximum current 3A.
C29	PBRAKE	Positive of the electromechanical brake coil.
C30	PAUX	Positive of auxiliary load.
C31	NAUX	Output of auxiliary load driver (drives to -BATT).
C32	-BATT	
C33	PPOT	Traction potentiometer positive, 5/10V output; use load > 1k ohm.
C34	NTHERM_L	Negative of left traction motor temperature sensor.
C35	PTHERM_L	Left traction motor temperature signal.

D1	-BATT	Negative output.
D2	2ND	Second hydraulic speed input, active high.
D3	1ST	First hydraulic speed input, active high.
D4	ENABLE	Input for proportional lifting enable; active high.
D5	CMM	Common output of microswitches (+BATT).
D6	5TH	Fifth hydraulic speed input, active high.
D7	4TH	Fourth hydraulic speed input, active high.
D8	3RD	Third hydraulic speed input, active high.
D9	CPOTLIFT	Input for proportional lift potentiometer.
D10	-BATT	
D11	-BATT	
D12	-BATT	
D13	NPOTLIFT	Negative for proportional lift potentiometer.
D14	PPOTLIFT	Positive for proportional lift potentiometer (12V).

4.6 ENCODER INSTALLATION

1) Dualac2 and Dualac2&hp 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.

C11/C1:	+5V/+12V:	positive of encoder power supply.
C12/C2:	GND:	negative of encoder power supply.
C22/C13:	A:	phase A of encoder.
C23/C14:	B:	phase B of encoder.

2) Connection of encoder with open collector output; +5V power supply.
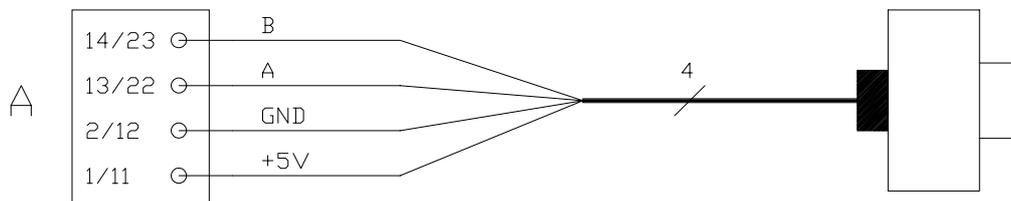
3) Connection of encoder with open collector output; +12V power supply.
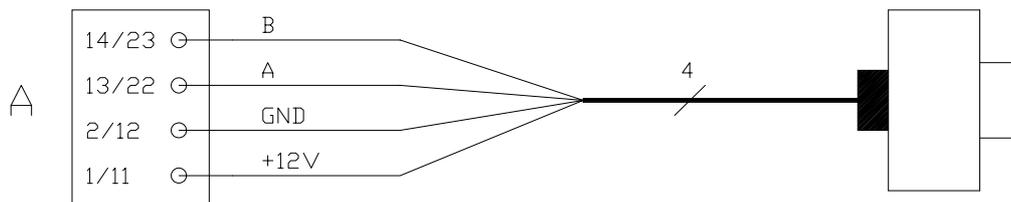
The encoder power supply voltage and output electronic has to be communicated to ZAPI in order to correctly set the selection jumpers in the logic card.

4.7 CANBUS CONNECTOR DESCRIPTION

Dualac2 Controller has a canbus interface, so it has been designed to work in a can network together with other electronic modules, exchanging informations over the canbus network.

Furthermore, the exchange of informations between master and slave microcontrollers is based on the canbus, as well.

Dualac2 also provides built-in can termination resistance, which can be connected in different ways, as described here following:

4.7.1 "Dualac2" Controller in stand-alone configuration
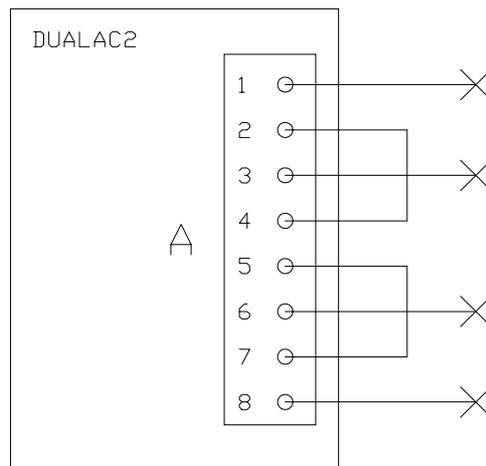
Bridge 2-4 and 5-7 connect both built-in 120 ohm can termination resistances.

4.7.2 "Dualac2" Controller is a termination module in the canbus net
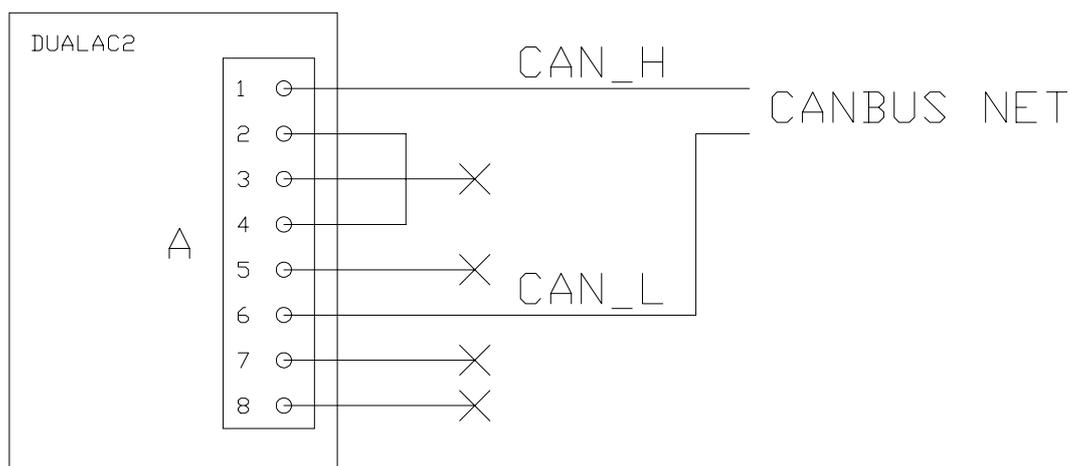
Bridge 2-4 connects one built-in 120 ohm can termination resistance, the second will be connected in another module of the canbus net.

4.7.3 "Dualac2" Controller is a repetition module in the canbus net
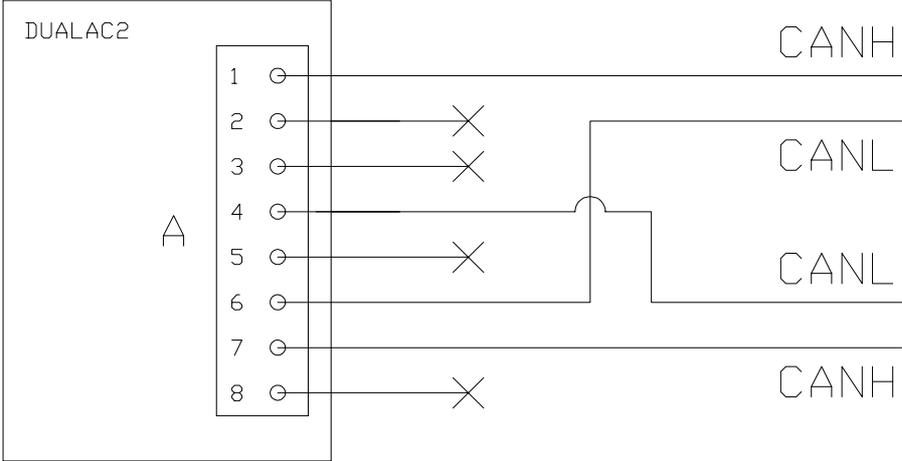
The canbus built-in termination resistances are not inserted.

4.8 DESCRIPTION OF POWER CONNECTIONS

4.8.1 "Dualac2"

View of the power bars:
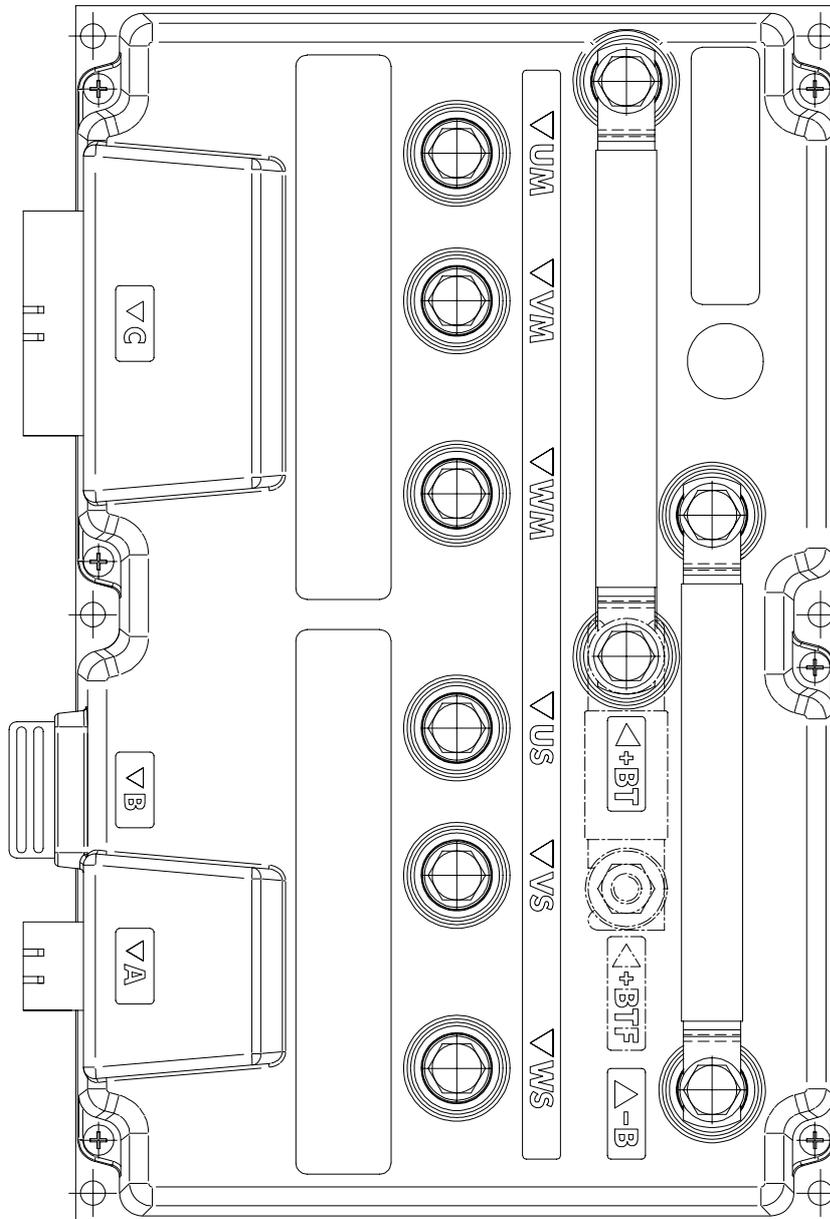
-B	Negative of the battery.
+BT	Positive of the battery; if the power fuse is not present, the positive cable coming from LC contact must be connected to this power connection.
+BTF	Positive of battery before power fuse, must be connected to positive cable coming from LC contact.
Um; Vm; Wm	Connection bars of the three right motors phases; follow this sequence and the indication on the motor.
Us; Vs; Ws	Connection bars of the three left motors phases; follow this sequence and the indication on the motor.

4.8.2 "Dualac2 Power"

View of the power bars:

-B	Negative of the battery.
+BT	Positive of the battery; if the power fuse is not present, the positive cable coming from LC contact must be connected to this power connection.
+BTF	Positive of battery before power fuse, must be connected to positive cable coming from LC contact.
Um; Vm; Wm	Connection bars of the three right motors phases; follow this sequence and the indication on the motor.
Us; Vs; Ws	Connection bars of the three left motors phases; follow this sequence and the indication on the motor.

4.8.3 "Dualac2&hp"

View of the power bars:

-B   Negative of the battery.

+BT   Positive of the battery; if the power fuse is not present, the positive
                      cable coming from LC contact must be connected to this power
                      connection.

+BTF	Positive of battery before power fuse, must be connected to positive cable coming from LC contact.
Um; Vm; Wm	Connection bars of the three right motors phases; follow this sequence and the indication on the motor.
Us; Vs; Ws	Connection bars of the three left motors phases; follow this sequence and the indication on the motor.
-P	Output of pump motor chopper.
+P	Pump chopper positive, if the power fuse is not present, the positive cable coming from LC contact must be connected to this power connection; also the pump motor positive cable must be connected to this power connection.
+BPF	Pump chopper positive before power fuse, must be connected to positive cable coming from LC contact.

4.8.4 "Dualac2&hp Power"

View of the power bars:

-B	Negative of the battery.
+BT	Positive of the battery; if the power fuse is not present, the positive cable coming from LC contact must be connected to this power connection.

+BTF	Positive of battery before power fuse, must be connected to positive cable coming from LC contact.
Um; Vm; Wm	Connection bars of the three right motors phases; follow this sequence and the indication on the motor.
Us; Vs; Ws	Connection bars of the three left motors phases; follow this sequence and the indication on the motor.
-P	Output of pump motor chopper.
+P	Pump chopper positive, if the power fuse is not present, the positive cable coming from LC contact must be connected to this power connection; also the pump motor positive cable must be connected to this power connection.
+BPF	Pump chopper positive before power fuse, must be connected to positive cable coming from LC contact.

4.9 MECHANICAL DRAWING

Dimensions of "Dualac2":

Dimensions of "Dualac2 Power":

Dimensions of "Dualac2&hp":

Dimensions of "Dualac2&hp Power":

DUAL AC2

DUAL AC2 CONTROLLER CONNECTORS:

CONN A = AMPSEAL - 8 POLES
CONN B = MOLEX SPOX - 8 POLES
CONN C = AMPSEAL - 35 POLES

DUALAC2 CONTROLLER FUNCTIONAL DRAWING — STANDALONE CONFIGURATION

	Data/Date	Tecnico/Technician	FF	File/File	Serie/Series	Disegno n./Drawing n.	Pagina/Page
ZAPI s.p.a. 42028 POVIGLIO–ITALY	01/04/03	Visto/Visa			AS	AE9ZP1DC	1.1
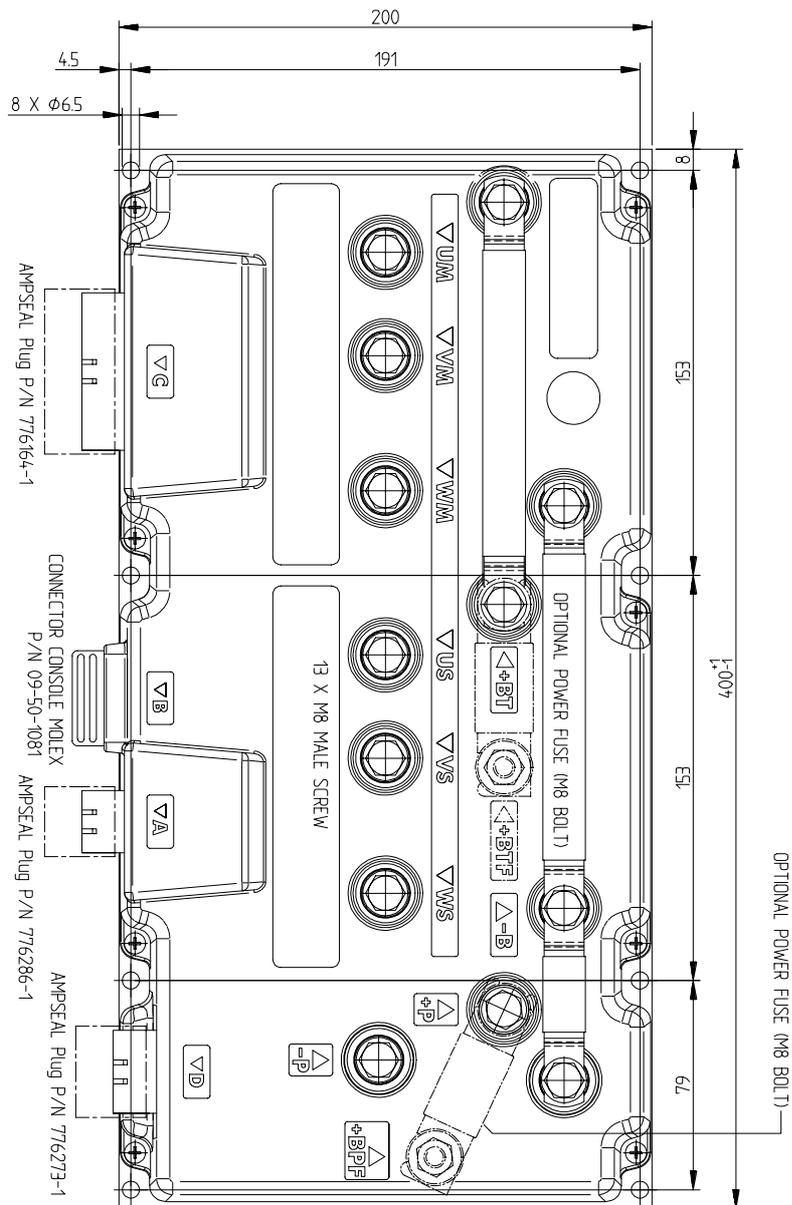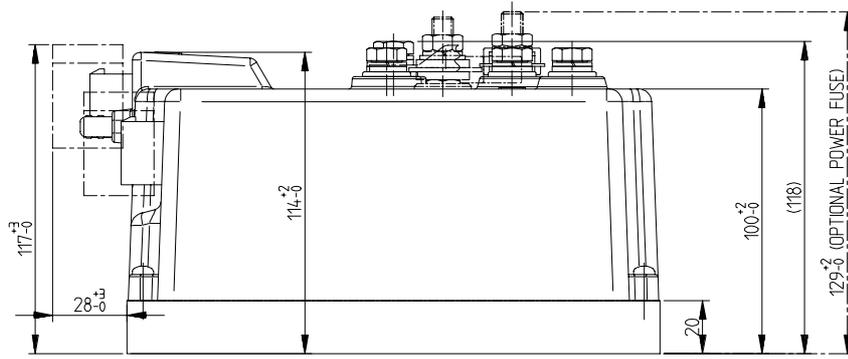
4.11 CONNECTION DRAWING - "DUALAC2&HP" AND "DUALAC2&HP POWER" STANDALONE

10A FUSE

DUALAC2 &HP

Connector	Pin	Signal
CMM	5	CMM
	2	2ND
	3	1ST
	4	LIFT ENABLE
	6	5TH
	7	4TH
		3RD

CND
9 CPOT LIFT
13 OPTIONAL POTI
14
1 -BATT
10 -BATT
11 -BATT
12 -BATT

CNA
1 CANH
2 CANT-H
3 CAN-POS
4 CANL-OUT
5 CANT-L
6 CANL
7 CANH-OUT
8 CAN-NEG

CNB
1
2
3
4 ZAPI HANDSET
5
6
7
8 FLASH PROGRAMMING

CNC
3 KEY SWITCH
5 SEAT
6 FW
10 HB
8 EN ACC
7 REV
9 PB
4 CMM
33 PPOT
21 CPOT — ACC POT — BRAKE POT
20 NPOT
18 CPOTBR
19 -BATT
31 NAUX
30 PAUX — AUX LOAD
28 NEB
29 PEB — EB COIL
27 PLC
26 NLC — LC COIL
16 PPOTST — STEER POT
15 NPOTST
17 CPOTST
32 -BATT

-P
+P
-B
US
VS
WS
+BT
UM
VM
WM

PUMP DC MOTOR

LEFT AC MOTOR
ENCODER

RIGHT AC MOTOR
ENCODER

CNC
PENC_L 11
NENC_L 12
PHA_L 22
PHB_L 23
PTHERM_L 35
NTHERM_L 34

CNC
PENC_R 1
NENC_R 2
PHA_R 13
PHB_R 14
PTHERM_R 25
NTHERM_R 24

DUALAC2&HP CONTROLLER CONNECTORS:

```
CONN A = AMPSEAL - 8 POLES
CONN B = MOLEX SPOX - 8 POLES
CONN C = AMPSEAL - 35 POLES
CONN D = AMPSEAL - 14 POLES
```

DUALAC2&HP CONTROLLER FUNCTIONAL DRAWING — STANDALONE CONFIGURATION

	Data/Date	Tecnico/Technician	FF	File/File	Serie/Series	Disegno n./Drawing n.	Pagina/Page
ZAPI s.p.a. 42028 POVIGLIO-ITALY	01/04/03	Visto/Visa			AS	AEAZP1BC	1.1

5 PROGRAMMING & ADJUSTMENTS USING DIGITAL CONSOLE

5.1 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 "B" connector of the inverter.

5.2 DESCRIPTION OF CONSOLE & CONNECTION
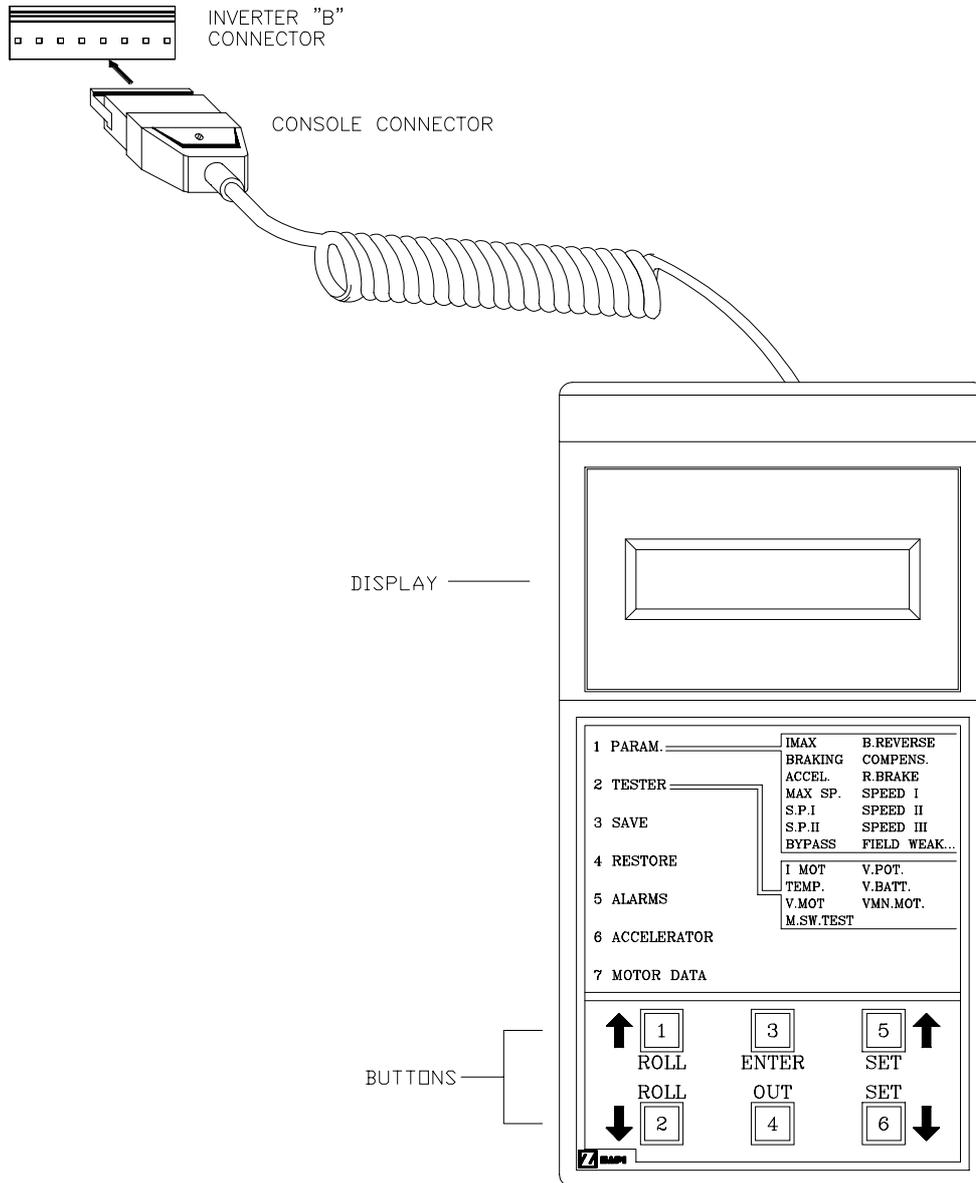
Digital consoles used to communicate with AC inverter controllers must be fitted with EPROM CK ULTRA, minimum "Release Number 3.02".

5.3 DESCRIPTION OF STANDARD CONSOLE MENU

5.3.1 "Dualac2" and "Dualac2 Power" menu configuration

5.3.1.a Master

```
                              HEADING

              MAIN MENU

PARAMETER          ACCELERATION DELAY  0÷9          SET MODEL      CONNECTED TO 3
CHANGE             RELEASE BRAKING     0÷9
                   INVERS. BRAKING     0÷9
                   PEDAL BRAKING       0÷9
                   SPEED LIMIT BRAKING 0÷9
                   BRAKE CUTBACK       0÷9           SET OPTIONS   HOUR COUNTER     RUNNING/KEY ON
                   MAX SPEED FORW      Hz                          BATTERY CHECK    ON/OFF
                   MAX SPEED BACK      Hz                          HYDRO KEY ON     ON/OFF
                   CURVE CUTBACK       %                           STOP ON RAMP     ON/OFF
                   FREQUENCY CREEP     Hz                          AUX INPUT #1     EXCLUSIVE HYDRO/OPTION #1
                   MAXIMUM CURRENT     0÷9                                          / CUTBACK SPEED
                   AUXILIARY TIME      Sec                         PEDAL BRAKING    ANALOG/DIGITAL
                                                                   SET TEMPERATURE  ANALOG/DIGITAL/NONE
                                                                   STEER TABLE      OPTION #1/OPTION #2

TESTER             MOTOR VOLTAGE       %           ADJUSTMENTS    SET POT BRK MIN      ...V
                   FREQUENCY           Hz                         SET POT BRK MAX      ...V
                   ENCODER             Hz                         SET BATTERY TYPE     48/72/80/96
                   SLIP VALUE          Hz                         ADJUST BATTERY       ...V
                   CURRENT RMS         A                          MAX STEER RIGHT      ...V
                   TEMPERATURE         ˚C                         MAX STEER LEFT       ...V
                   TEMPERATURE #1      ˚C                         SET STEER 0-POS      ...V
                   TEMPERATURE #2      ˚C                         SET STEER RIGHT      ...˚
                   ACCELERATOR         V                          SET STEER LEFT       ...˚
                   STEER ANGLE         ˚                          THROTTLE 0 ZONE      ...%
                   BRAKE PEDAL POTI    %                          THROTTLE X ZONE      ...%
                   INT WHEEL CUTB      %                          THROTTLE Y ZONE      ...%
                   SEAT SWITCH         ON/OFF                     ADJUSTMENT #02       1÷9
                   FORW. SWITCH        V                          ADJUSTMENT #01       1÷9
                   BACK SWITCH         V                          MAIN CONT VOLT       ...V
                   ENABLE SWITCH       ON/OFF                     AUX OUTPUT VOLT      ...V
                   BRAKE SWITCH        ON/OFF
                   CUTBACK SWITCH      ON/OFF
                   EXCLUSIVE HYDRO     ON/OFF
                   HAND BRAKE          ON/OFF
                   VOLTAGE BOOSTER     %
                   BATTERY VOLTAGE     V
                   BATTERY CHARGE      %

SAVE
PARAMETER

RESTORE
PARAMETER

ALARMS             CODE,
                   h, N˚, ˚C

PROGRAM            VACC SETTING    MIN/MAX
VACC

MOTOR DATA         NOT
                   AVAILABLE
```

5.3.1.b Slave

```
                              ┌──────────────┐
                              │   HEADING    │
                              └──────────────┘
                      ┌──────────────┐
                      │  MAIN MENU   │
                      └──────────────┘

┌──────────────┐   ┌──────────────┐        ┌──────────────┐   ┌──────────────┐
│  PARAMETER   │   │ NOT AVAILABLE │        │  SET MODEL   │   │ CONNECT TO 4 │
│   CHANGE     │   └──────────────┘        └──────────────┘   └──────────────┘
└──────────────┘

                                            ┌──────────────┐   ┌──────────────┐
                                            │ SET OPTIONS  │   │ NOT AVAILABLE│
                                            └──────────────┘   └──────────────┘
```

TESTER
MOTOR VOLTAGE	%
FREQUENCY	Hz
ENCODER	Hz
SLIP VALUE	Hz
CURRENT RMS	A
TEMPERATURE	°C
SEAT SWITCH	ON/OFF
FORW. SWITCH	V
BACK. SWITCH	ON/OFF
ENABLE SWITCH	ON/OFF
VOLTAGE BOOSTER	%
BATTERY VOLTAGE	V

ADJUSTMENTS
SET BATTERY TYPE	48/72/80/96
ADJUST BATTERY	...V
AUX OUTPUT VOLT	...V

SAVE PARAMETER

RESTORE PARAMETER

ALARMS — CODE, h, N°, °C

PROGRAM VACC — VACC SETTING   MIN/MAX

MOTOR DATA — NOT AVAILABLE

5.3.2 "Dualac2&hp" and "Dualac2&hp Power" menu configuration

5.3.2.a Master

```
                              ┌──────────────────┐
                              │     HEADING      │
                   ┌──────────┴──────┐           │
                   │    MAIN MENU    │           │
                   └─────────────────┘           │
        ┌──────────────────┐          ┌──────────────────┐
        │    PARAMETER     │          │    SET MODEL     │───┐
        │     CHANGE       │──┐       └──────────────────┘   │
        └──────────────────┘  │                    ┌─────────────────┐
                              │                    │ CONNECTED TO 3  │
                              │                    └─────────────────┘
```

PARAMETER CHANGE	
ACCELERATION DELAY	0÷9
RELEASE BRAKING	0÷9
INVERSION BRAKING	0÷9
PEDAL BRAKING	0÷9
SPEED LIMIT BRAKING	0÷9
BRAKE CUTBACK	0÷9
MAX SPEED FW	Hz
MAX SPEED REV	Hz
CURVE CUTBACK	%
FREQUENCY CREEP	Hz
MAXIMUM CURRENT	0÷9
AUXILIARY TIME	Sec

SET MODEL → CONNECTED TO 3

SET OPTIONS	
HOUR COUNTER	RUNNING/KEY ON
BATTERY CHECK	ON/OFF
HYDRO KEY ON	ON/OFF
STOP ON RAMP	ON/OFF
AUX INPUT #1	EXCLUSIVE HYDRO/OPTION #1 / CUTBACK SPEED
PEDAL BRAKING	ANALOG/DIGITAL
SET TEMPERATURE	ANALOG/DIGITAL/NONE
STEER TABLE	OPTION #1/OPTION #2

TESTER	
MOTOR VOLTAGE	%
FREQUENCY	Hz
ENCODER	Hz
SLIP VALUE	Hz
CURRENT RMS	A
TEMPERATURE	°C
TEMPERATURE #1	°C
TEMPERATURE #2	°C
ACCELERATOR	V
STEER ANGLE	°
BRAKE PEDAL POTI	%
INT WHEEL CUTB	%
SEAT SWITCH	ON/OFF
FORW. SWITCH	V
BACK SWITCH	V
ENABLE SWITCH	ON/OFF
BRAKE SWITCH	ON/OFF
CUTBACK SWITCH	ON/OFF
EXCLUSIVE HYDRO	ON/OFF
HAND BRAKE	ON/OFF
VOLTAGE BOOSTER	%
BATTERY VOLTAGE	V
BATTERY CHARGE	%

ADJUSTMENTS	
SET POT BRK MIN	...V
SET POT BRK MAX	...V
SET BATTERY TYPE	48/72/80/96
ADJUST BATTERY	...V
MAX STEER RIGHT	...V
MAX STEER LEFT	...V
SET STEER 0-POS	...V
SET STEER RIGHT	...°
SET STEER LEFT	...°
THROTTLE 0 ZONE	...%
THROTTLE X ZONE	...%
THROTTLE Y ZONE	...%
ADJUSTMENT #02	1÷9
ADJUSTMENT #01	1÷9
MAIN CONT VOLT	...V
AUX OUTPUT VOLT	...V

SAVE PARAMETER

RESTORE PARAMETER

ALARMS	CODE, h, N°, °C

PROGRAM VACC	VACC SETTING MIN/MAX

MOTOR DATA	NOT AVAILABLE

5.3.2.b Slave

```
                              ┌──────────────┐
                              │   HEADING    │
                              └──────────────┘
                    ┌──────────────┐
                    │  MAIN  MENU  │
                    └──────────────┘

┌──────────────┐   ┌─────────────────────────────┐   ┌──────────────┐   ┌──────────────────┐
│  PARAMETER   │   │ PUMP  ACCEL  DELAY   Sec    │   │  SET  MODEL  │   │ CONNECT  TO  4   │
│   CHANGE     │   │ PUMP  DECEL  DELAY   Sec    │   └──────────────┘   └──────────────────┘
└──────────────┘   │ SPEED  LIMIT         %      │
                   │ CREEP  SPEED         %      │
                   │ COMPENSATION         %      │
                   │ 1 ST  SPEED  FINE    %      │
                   │ 1 ST  SPEED  COMP    %      │   ┌──────────────┐   ┌──────────────────┐
                   │ 2 ND  SPEED  FINE    %      │   │ SET  OPTIONS │   │ NOT  AVAIBLE     │
                   │ 2 ND  SPEED  COMP    %      │   └──────────────┘   └──────────────────┘
                   │ 3 RD  SPEED  FINE    %      │
                   │ 3 RD  SPEED  COMP    %      │
                   │ 4 TH  SPEED  FINE    %      │
                   │ 4 TH  SPEED  COMP    %      │
                   │ 5 TH  SPEED  FINE    %      │
                   │ 5 TH  SPEED  COMP    %      │
                   │ HYDRO  SPEED  FINE   Hz     │
                   │ HYDRO  SPEED  COMP   Hz     │
                   │ HYDRO  TIME          Sec    │
                   │ PUMP  IMAX           0÷9    │
                   └─────────────────────────────┘
```

PARAMETER CHANGE

PUMP ACCEL DELAY	Sec
PUMP DECEL DELAY	Sec
SPEED LIMIT	%
CREEP SPEED	%
COMPENSATION	%
1 ST SPEED FINE	%
1 ST SPEED COMP	%
2 ND SPEED FINE	%
2 ND SPEED COMP	%
3 RD SPEED FINE	%
3 RD SPEED COMP	%
4 TH SPEED FINE	%
4 TH SPEED COMP	%
5 TH SPEED FINE	%
5 TH SPEED COMP	%
HYDRO SPEED FINE	Hz
HYDRO SPEED COMP	Hz
HYDRO TIME	Sec
PUMP IMAX	0÷9

SET MODEL — CONNECT TO 4

SET OPTIONS — NOT AVAIBLE

TESTER

MOTOR VOLTAGE	%
FREQUENCY	Hz
ENCODER	Hz
SLIP VALUE	Hz
CURRENT RMS	A
TEMPERATURE	°C
SEAT SWITCH	ON/OFF
FW SWITCH	ON/OFF
BACK SWITCH	ON/OFF
ENABLE SWITCH	ON/OFF
LIFT CONTROL	...V
LIFTING SWITCH	ON/OFF
1 ST SPEED SWITCH	ON/OFF
2 ND SPEED SWITCH	ON/OFF
3 RD SPEED SWITCH	ON/OFF
4 TH SPEED SWITCH	ON/OFF
5 TH SPEED SWITCH	ON/OFF
PUMP CURRENT	A
PUMP VMN	V
PUMP TEMPERATURE	°C
BATTERY VOLTAGE	V
VOLTAGE BOOSTER	V

ADJUSTMENTS

SET BATTERY TYPE	48/72/80/96
ADJUST BATTERY	...V
SET ACCELER MIN	...V
SET ACCELER MAX	...V
THROTTLE 0 ZONE	...%
THROTTLE X ZONE	...%
THROTTLE Y ZONE	...%
AUX OUTPUT VOLT	...V

SAVE PARAMETER

RESTORE PARAMETER

ALARMS — CODE, h, N°, °C

PROGRAM VACC — VACC SETTING MIN/MAX

MOTOR DATA — NOT AVAILABLE

5.4 FUNCTION CONFIGURATION

5.4.1 "Dualac2" and "Dualac2 Power" - Master

Using the CONFIG MENU of the programming console, the user can configure the following functions (see "OPERATIONAL FEATURE" chapter for an explanation of "hydraulic steering function") :

SUBMENU "SET OPTIONS"

1 HOUR COUNTER

- RUNNING: the counter registers travel time only.

- KEY ON: the counter registers when the "key" switch is closed.

2 BATTERY CHECK

- ON: the battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signalled and the maximum current is reduced to the half of the programmed value.

- OFF: the battery discharge level check is carried out but no alarm is signalled.

3 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.

4 STOP ON RAMP

- 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.

5 AUX INPUT #1

- EXCLUSIVE HYDRO: input C10 activates hydraulic steering function, output A31 is activated.

- OPTION #1:   input C10 is the input for an handbrake device, active low (open switch).

- CUTBACK SPEED: input C10 is the input for a speed reduction device, active low (open switch).

6 PEDAL BRAKING

- **ANALOG:** the mechanical brake pedal has a switch and a potentiometer installed. When the accelerator is released and the pedal brake is pushed the inverter performs an electrical braking whose intensity is proportional to the brake pedal potentiometer. The minimum intensity is established by the "Release braking" parameter, when the brake pedal is slightly pressed (brake switch close but brake potentiometer at the minimum). The maximum intensity is established by the "Pedal braking" parameter when the brake pedal is fully pressed (brake potentiometer at the maximum). In the middle positions, the electrical braking intensity is a linear function between minimum and maximum intensity.

- **DIGITAL:** The truck does not have a potentiometer installed on the mechanical brake pedal, but only a microswitch; when the accelerator pedal is released and the brake pedal is pushed (brake switch closed), the inverter performs an electrical braking following "Pedal braking" parameter.

7 SET TEMPERATURE

- **DIGITAL:** a digital (ON/OFF) motor thermal sensor is connected to C25 (C35) input.

- **ANALOG:** an analog motor thermal sensor is connected to C25 (C35) (the curve can be customized on a customer request).

- **NONE:** no motor thermal sensor switch is connected.

8 STEER TABLE
This parameter is used to set the correct steering table.

SUBMENU "ADJUSTEMENT"

1 SET POT BRK MIN: 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 chapter 6.3). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

2 SET POT BRK MAX: 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 chapter 6.3). This procedure must be carried out only if the "Pedal braking" option is programmed as "Analog".

3 SET BATTERY TYPE: selects the nominal battery voltage;

4 ADJUST BATTERY: fine adjustment of the battery voltage measured by the controller.

5 MAX STEER RIGHT: this is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned right (maximum of the steering poti range).

6 MAX STEER LEFT: this is the function to record in the controller EEPROM the steering poti output voltage when the wheels are fully turned left (minimum of the steering poti range).

7 SET STEER 0 POS: this is the function to record in the controller EEPROM the steering poti output voltage when the wheels are straight.

8 SET STEER RIGHT: this parameter sets the max steering angle in right direction.

9 SET STEER LEFT: this parameter sets the max steering angle in left direction.

10 THROTTLE 0 ZONE: establishes a deadband in the accelerator input curve (see also curve below).

11 THROTTLE X POINT: these parameter change the characteristic of the accelerator input curve.

12 THROTTLE Y POINT: these parameter change the characteristic of the accelerator input curve.
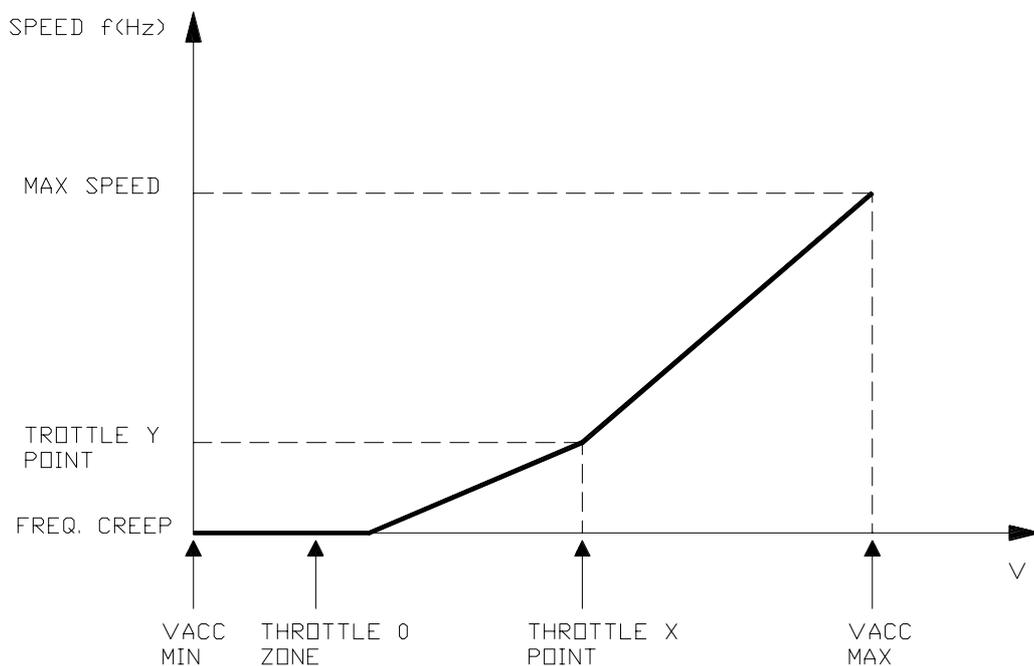
VACC MIN and VACC MAX are values programmable by the "Program Vacc" function.

13 ADJUSTMENT #01: adjust the upper level of the battery discharge table.

14   ADJUSTMENT #02:   adjust the lower level of the battery discharge table.
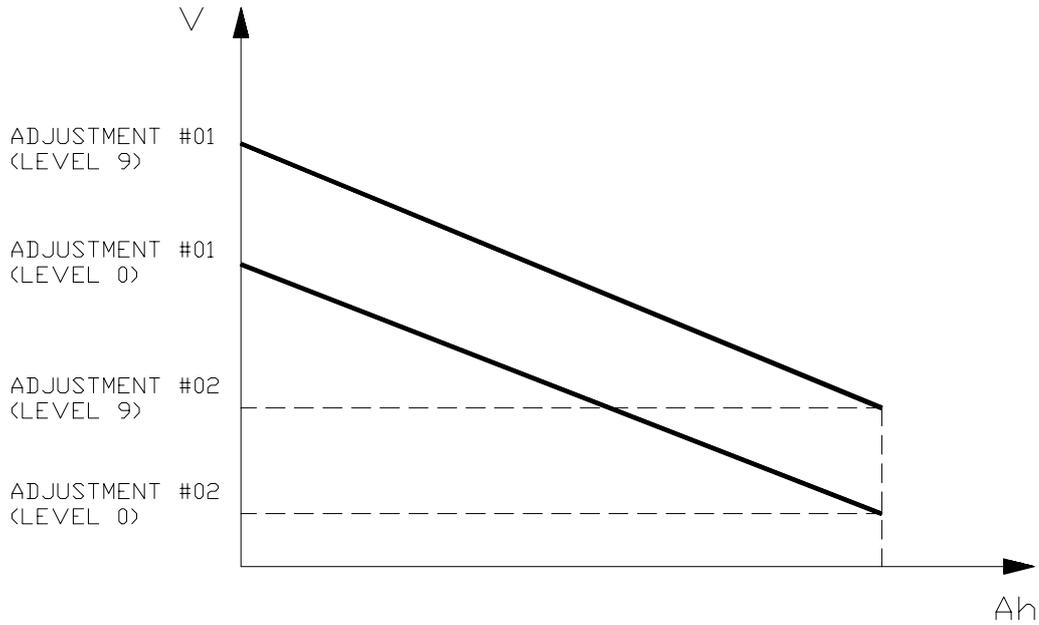
15   MAIN CONT VOLTAGE: this parameters adjusts the Line contactor coil voltage
                         (PWM output C26)

16   AUX OUTPUT VOLTAGE: this parameters adjusts the Electric brake coil voltage
                         (PWM output C28).

5.4.2 "Dualac2" and "Dualac2 Power" - Slave

Using the config menu of the programming console, the user can configure the following functions.

SUBMENU "SET OPTIONS"

Not available.

SUBMENU "ADJUSTEMENT"

1 SET BATTERY TYPE: selects the nominal battery voltage;

2 ADJUST BATTERY: fine adjustment of the battery voltage measured by the controller.

3 AUX OUPUT VOLTAGE: this parameter adjust the voltage of the auxiliary output coil (hydraulic steering contactor coil), PWM output A31.

5.4.3 "Dualac2&hp" and "Dualac2&hp Power" - Master

See chapter 5.4.1.

5.4.4 "Dualac2&hp" and "Dualac2&hp Power" - Slave

Using the config menu of the programming console, the user can configure the following functions.

SUBMENU "SET OPTIONS"

Not available.

SUBMENU "ADJUSTEMENT"

1 SET BATTERY TYPE: selects the nominal battery voltage;

2 ADJUST BATTERY: fine adjustment of the battery voltage measured by the controller.

3 SET ACCELER MIN: This parameter is used to adjust minimum value of the lift potentiometer. Press ENTER, pull the lever till the lift switch closes, then record the value (OUT --> ENTER).

4 SET ACCELER MAX: This parameter is used to adjust maximum value of the lift potentiometer. Press ENTER, pull the lever to the maximum, then record the value (OUT --> ENTER).

5 THROTTLE 0 ZONE: establishes a deadband in the lifting accelerator input curve (see also curve below).

6 THROTTLE X POINT: these parameter change the characteristic of the lifting accelerator input curve.

7 THROTTLE Y POINT: these parameter change the characteristic of the lifting accelerator input curve.

8 AUX OUPUT VOLTAGE: this parameter adjust the voltage of the auxiliary output coil (hydraulic steering contactor coil), PWM output A31.

Flow chart showing how to make changes to OPTION Menu.

1) Opening Zapi Menu

DISPLAY →
```
┌─────────────────────────┐
│   DUALAC2  ZAPI  V0.0    │
│     48V  350A  00000     │
└─────────────────────────┘
```

2) Press Top Left & Right Buttons to enter SET Menu.

KEYBOARD →

3) The Display will show: SET MODEL

```
┌─────────────────────────┐
│      CONFIG  MENU        │
│       SET  MODEL         │
└─────────────────────────┘
```

4) Press ROLL UP or ROLL DOWN button until SET MODEL Menu appears.

5) SET OPTIONS appears on the display.

```
┌─────────────────────────┐
│      CONFIG  MENU        │
│       SET  OPTIONS       │
└─────────────────────────┘
```

6) Press ENTER to go into the SET MODEL Menu.

7) The display will shows the first OPTION.

```
┌─────────────────────────┐
│      HOUR  COUNTER       │
│        RUNNING           │
└─────────────────────────┘
```

8) Press ROLL UP or ROLL DOWN button until desired OPTION appears

9) Desired OPTION appears.

```
┌─────────────────────────┐
│     BATTERY  CHECK       │
│          OFF             │
└─────────────────────────┘
```

10) Press SET UP or SET DOWN button in order to modify the changes.

11) New OPTION appears.

```
┌─────────────────────────┐
│     BATTERY  CHECK       │
│          ON              │
└─────────────────────────┘
```

12) Press OUT to exit the Menu.

13) Confirmation request appears.

```
┌─────────────────────────┐
│     ARE  YOU  SURE?      │
│  YES = ENTER  NO = OUT   │
└─────────────────────────┘
```

14) Press ENTER to accept the changes, or press OUT if you do not accept the changes.

15) SET OPTIONS Menu appears.

```
┌─────────────────────────┐
│      CONFIG. MENU        │
│       SET  OPTIONS       │
└─────────────────────────┘
```

16) Press OUT again. Display now show the Opening Zapi Menu.
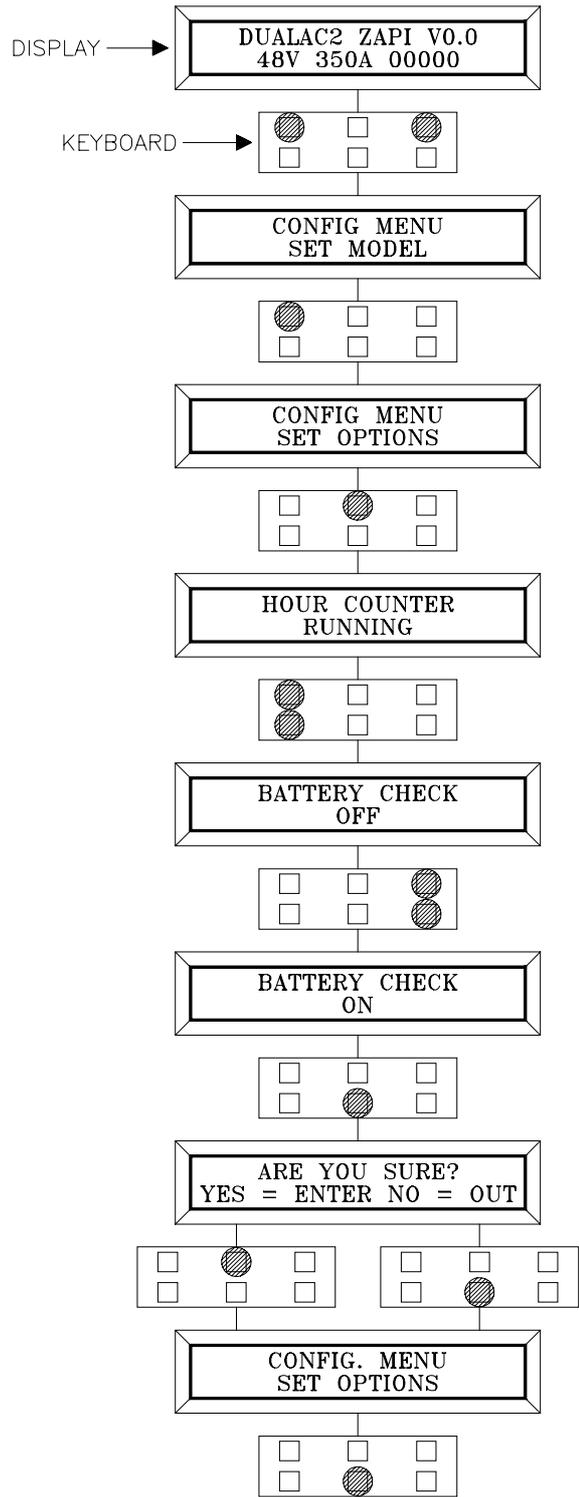
Flow chart showing how to make changes to ADJUSTMENT Menu

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 or ROLL DOWN button until ADJUSTMENTS Menu appears.

5) ADJUSTMENTS appears on the display.

6) Press ENTER to go into the ADJUSTMENTS Menu.

7) The display will shows 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.

DISPLAY

```
DUALAC2 ZAPI V0.0
48V 350A 00000
```

KEYBOARD

```
CONFIG MENU
SET MODEL
```

```
CONFIG MENU
ADJUSTMENT
```

```
SET POT BRK MIN
0.0V
```

```
THROTTLE 0 ZONE
3%
```

```
THROTTLE 0 ZONE
7%
```
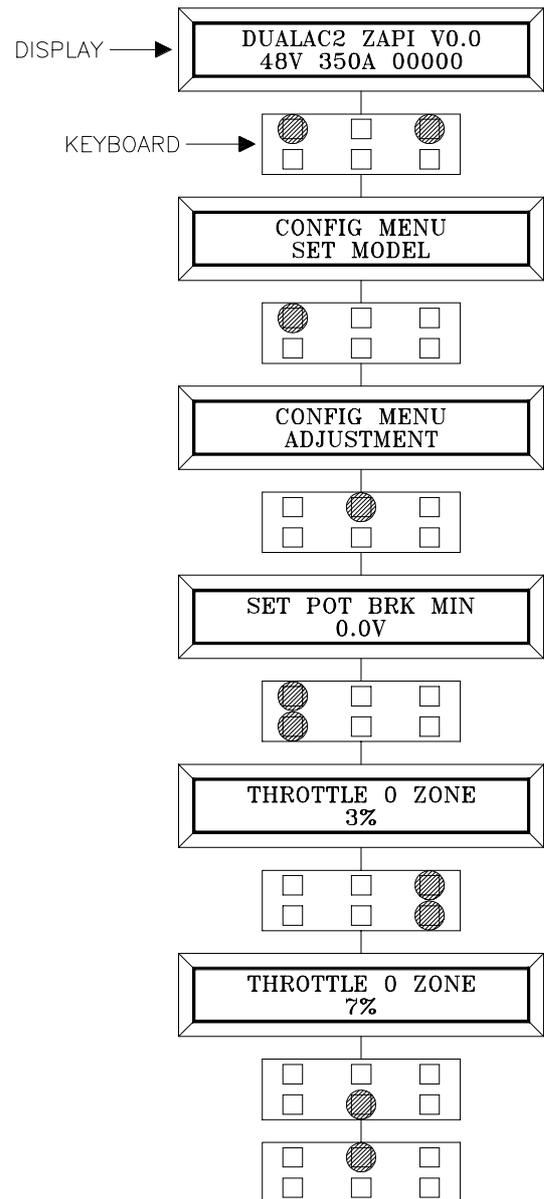
Flow chart showing how to use the SET BATTERY TYPE adjustment

1) Opening Zapi Menu

DISPLAY ➤
```
┌─────────────────────────┐
│  DUALAC2  ZAPI  V0.0    │
│  48V  350A  00000       │
└─────────────────────────┘
```

2) Press Top Left & Right Buttons to enter CONFIG Menu.

KEYBOARD ➤

3) The Display will show: SET MODEL

```
┌─────────────────────────┐
│     CONFIG  MENU        │
│     SET  MODEL          │
└─────────────────────────┘
```

4) Press ROLL UP button until ADJUSTMENTS. menu appears.

5) ADJUSTMENTS appears on the display.

```
┌─────────────────────────┐
│     CONFIG  MENU        │
│     ADJUSTMENT          │
└─────────────────────────┘
```

6) Press ENTER to go into the ADJUSTMENTS Menu and use ROLL UP/DOWN buttons to final the SET BATTERY TYPE parameter.

7) The display will show: SET BATTERY TYPE.

```
┌─────────────────────────┐
│   SET  BATTERY  TYPE    │
│        80V              │
└─────────────────────────┘
```

8) Press SET UP to choose nominal value of the battery.

9) New battery value appears.

```
┌─────────────────────────┐
│   SET  BATTERY  TYPE    │
│        48V              │
└─────────────────────────┘
```

10) Press OUT.

11) Confirmation request appears.

```
┌─────────────────────────┐
│     ARE  YOU  SURE?     │
│ YES = ENTER  NO = OUT   │
└─────────────────────────┘
```

12) Press ENTER to accept the changes, or press OUT if you do not accept the changes.

13) Press OUT. Display now shows the Opening Zapi Menu.
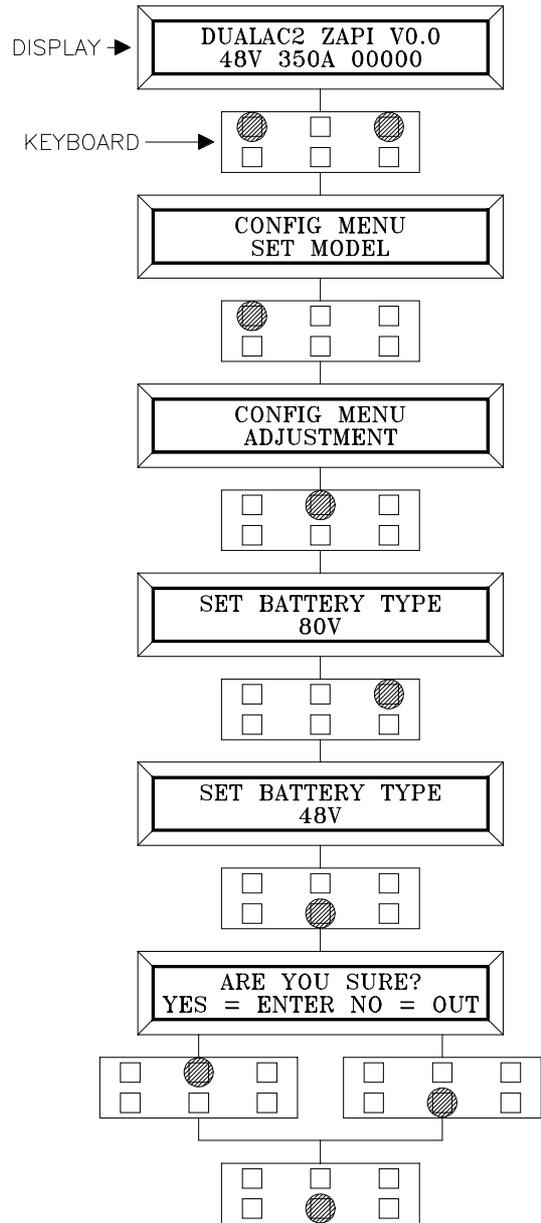
Flow chart showing how to carry out ADJUSTMENT BATTERY operation by console.

1) Opening Zapi Menu

DISPLAY →

```
DUALAC2 ZAPI V0.0
48V 350A 00000
```

2) Press Top Left & Right Buttons to enter CONFIG Menu.

KEYBOARD →

3) The Display will show: SET MODEL

```
CONFIG MENU
SET MODEL
```

4) Press ROLL UP button until ADJUSTMENT Menu appears.

5) ADJUSTMENTS appears on the display.

```
CONFIG MENU
ADJUSTMENT
```

6) Press ENTER to go into the ADJUSTMENTS Menu.

7) The display will show the first OPTION.

```
SET POT BRK MIN
0.0V
```

8) Press ROLL UP or ROLL DOWN button until desired OPTION appears

9) ADJUST BATTERY appears.

```
ADJUSTMENT BATTERY
82.1V
```

10) Press SET UP or SET DOWN button in order to increase or decrease respectively. Set the value read by an external voltmeter.

— +
— –

11) Battery value appears on the display.

```
ADJUSTMENT BATTERY
84.5V
```

12) Press OUT to exit the Menu.

13) Confirmation request appears.

```
ARE YOU SURE?
YES = ENTER NO = OUT
```

14) Press ENTER to accept the changes, or press OUT if you do not accept the changes.

15) ADJUSTMENTS Menu appears.

```
CONFIG. MENU
ADJUSTMENT
```

16) Press OUT. Display now show the Opening Zapi Menu.
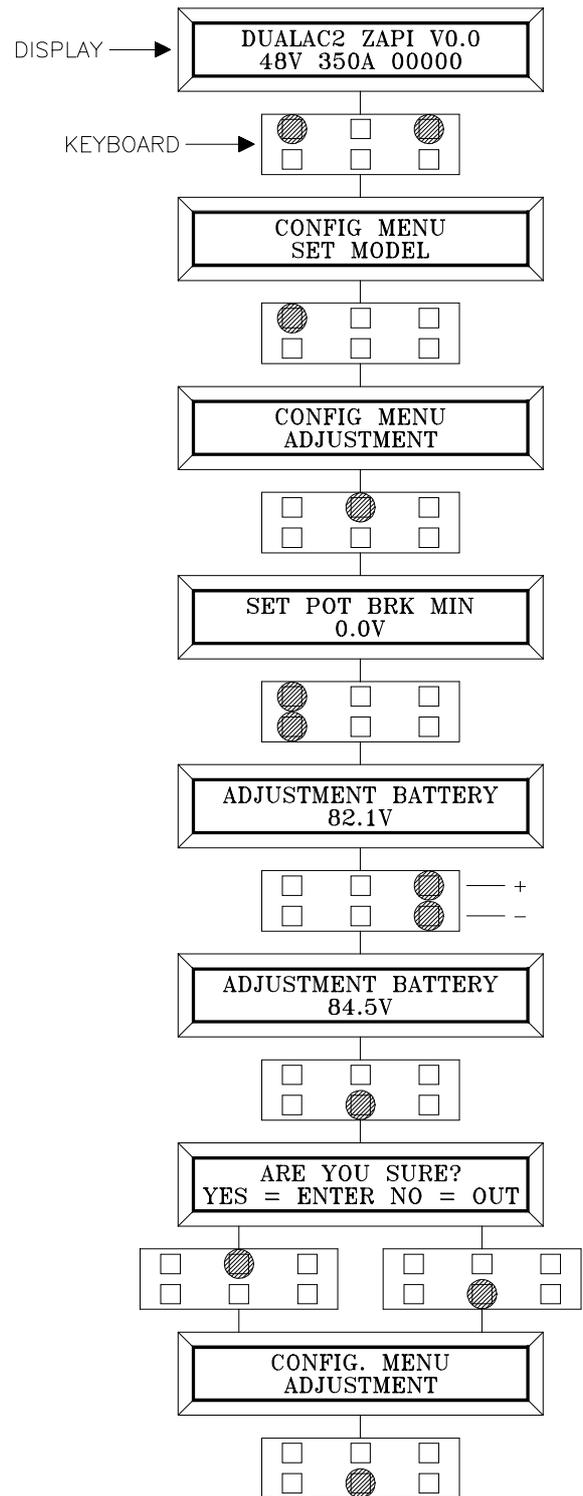
5.5 PARAMETER REGULATION

5.5.1 "Dualac2" - Master

The following parameters can be modified:

1	ACC DELAY:	determines the acceleration ramp.
2	RELEASE BRAKING:	controls the deceleration ramp when the travel request is released.
3	INVERSION BRAKING:	controls the deceleration ramp when the direction switch is inverted during travel.
4	PEDAL BRAKING:	determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.
5	SPEED LIMIT BRAKING:	deceleration ramp when the pedal position is changed but not completely released.
6	BRAKE CUTBACK:	determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.
7	MAX SPEED FORWARD:	determines the maximum speed in forward direction.
8	MAX SPEED BACKWARD:	determines the maximum speed in backward direction.
9	CURVE CUTBACK:	Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction (3 wheels truck, steering angle greater than roughly 67°); or when the maximum steering angle is reached (4 wheels truck, the internal wheel is stopped). In intermediate steering angles, the speed setpoint will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.
10	CUTBACK SPEED:	speed reduction when the cutback switch is active.
11	FREQUENCY CREEP:	minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.
12	MAXIMUM CURRENT:	this changes the maximum current of the inverter.
13	AUXILIARY TIME:	determines the time that the truck is hold on the ramp if the "stop on ramp" option is ON.

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.	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
RELEASE BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
INVERSION BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
PEDAL BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
SPEED LIMIT BRAKING (**)	Sec.	8.9	8.3	7.7	7.1	6.6	6.0	5.5	4.9	4.4	3.8
BRAKE CUTBACK (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
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
CURVE CUTBACK	%	10	15	20	25	38	50	63	75	87	100
CUTBACK SPEED	%	10	15	20	25	38	50	63	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
MAXIMUM CURRENT	% IMAX	43	50	56	62	68	75	81	87	94	100
AUXILIARY TIME	Sec.	0	0.2	0.4	0.8	1	1.5	2	3	4	5

(*)   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.

5.5.2 "Dualac2" - Slave

The menu is not available.

5.5.3 "Dualac2&hp" - Master

The following parameters can be modified:

1	ACC DELAY:	determines the acceleration ramp.
2	RELEASE BRAKING:	controls the deceleration ramp when the travel request is released.
3	INVERSION BRAKING:	controls the deceleration ramp when the direction switch is inverted during travel.
4	PEDAL BRAKING:	determines the deceleration ramp when the travel request is released and the brake pedal switch is closed.
5	SPEED LIMIT BRAKING:	deceleration ramp when the pedal position is changed but not completely released.
6	BRAKE CUTBACK:	determines the deceleration ramp when the speed reduction input becomes active and the motor slow down.
7	MAX SPEED FORWARD:	determines the maximum speed in forward direction.
8	MAX SPEED BACKWARD:	determines the maximum speed in backward direction.
9	CURVE CUTBACK:	Speed reduction when the truck is doing a curve. The parameter sets the speed setpoint when the truck driving wheels are running in opposite direction (3 wheels truck, steering angle greater than roughly 67°); or when the maximum steering angle is reached (4 wheels truck, the internal wheel is stopped). In intermediate steering angles, the speed setpoint will be within a range between the straight wheel speed and the CURVE CUTBACK SPEED.
10	CUTBACK SPEED:	speed reduction when the cutback switch is active.
11	FREQUENCY CREEP:	minimum speed when the forward or reverse switch is closed, but the accelerator is on a minimum position.
12	MAXIMUM CURRENT:	this changes the maximum current of the inverter.
13	AUXILIARY TIME:	determines the time that the truck is hold on the ramp if the "stop on ramp" option is ON.

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.	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5
RELEASE BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
INVERSION BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
PEDAL BRAKING (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
SPEED LIMIT BRAKING (**)	Sec.	8.9	8.3	7.7	7.1	6.6	6.0	5.5	4.9	4.4	3.8
BRAKE CUTBACK (**)	Sec.	5.5	5	4.5	4	3.5	3	2.5	2	1.5	1
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
CURVE CUTBACK	%	10	15	20	25	38	50	63	75	87	100
CUTBACK SPEED	%	10	15	20	25	38	50	63	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
MAXIMUM CURRENT	% IMAX	43	50	56	62	68	75	81	87	94	100
AUXILIARY TIME	Sec.	0	0.2	0.4	0.8	1	1.5	2	3	4	5

(*)   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.

5.5.4 "Dualac2&hp" - Slave

Here following the list of parameters which can be set in this menu:

1   PU. ACCELER. DELAY: acceleration ramp of pump motor.

2   PU. DECELER. DELAY: deceleration ramp of pump motor.

3   SPEED LIMIT: determines the maximum lifting speed (per cent of voltage applied to the motor) with a potentiometer control, when the potentiometer is at the maximum of the programmed range.

4   CREEP SPEED: determines the minimum lifting speed (per cent of voltage applied to the motor) with a potentiometer control, when the potentiometer is at the minimum of the programmed range.

5	COMPENSATION:	this parameter sets the voltage compensation (ΔV) applied to the motor when the proportional lifting function is active. The value of this ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV will be increased.
6	1ST SPEED FINE:	this parameter sets the pump motor speed (voltage applied to the motor) when the 1st speed request is active.
7	1ST SPEED COMP:	this parameter sets the voltage compensation (ΔV) applied to the motor when the 1st speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.
8	2ND SPEED FINE:	this parameter sets the voltage compensation (ΔV) applied to the motor when the 2nd speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.
9	2ND SPEED COMP:	this parameter sets the voltage compensation (ΔV) applied to the motor when the 2nd speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.
10	3RD SPEED FINE:	this parameter sets the voltage compensation (ΔV) applied to the motor when the 3rd speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.
11	3RD SPEED COMP:	this parameter sets the voltage compensation (ΔV) applied to the motor when the 3rd speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

12 4TH SPEED FINE: this parameter sets the voltage compensation (ΔV) applied to the motor when the 4th speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

13 4TH SPEED COMP: this parameter sets the voltage compensation (ΔV) applied to the motor when the 4th speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

14 5TH SPEED FINE: this parameter sets the voltage compensation (ΔV) applied to the motor when the 5th speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

15 5TH SPEED COMP: this parameter sets the voltage compensation (ΔV) applied to the motor when the 5th speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

16 HYDRO SPEED FINE: this parameter sets the pump motor speed (voltage applied to the motor) when the hydraulic steering function request is active.

17 HYDRO SPEED COMP: this parameter sets the voltage compensation (ΔV) applied to the motor when the hydro speed request is active. The value of ΔV applied to the motor is a function of the motor current. Aim of this function is to reduce, as for as possible, the speed change when the motor is loaded. Increasing the parameter, the ΔV is increased.

18 HYDRO TIME: hydraulic steering function delay.

19 PUMP IMAX: the maximum current of pump chopper.

The following table shows all the values of parameters.

PARAMETER	UNIT	PROGRAMMED LEVEL									
		0	1	2	3	4	5	6	7	8	9
PUMP ACCELER DELAY (*)	Sec.	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	3.5
PUMP DECELER DELAY (**)	Sec.	0.2	0.4	0.6	0.8	1	1.5	2	2.5	3	3.5
SPEED LIMIT	%	0 - 100									
CREEP SPEED	%	0 - 100									
COMPENSATION	%	0 - 100									
1ST SPEED FINE	%	0 - 100									
1ST SPEED COMP	%	0 - 100									
2ND SPEED FINE	%	0 - 100									
2ND SPEED COMP	%	0 - 100									
3RD SPEED FINE	%	0 - 100									
3RD SPEED COMP	%	0 - 100									
4TH SPEED FINE	%	0 - 100									
4TH SPEED COMP	%	0 - 100									
5TH SPEED FINE	%	0 - 100									
5TH SPEED COMP	%	0 - 100									
HYDRO SPEED FINE	%	0 - 100									
HYDRO SPEED COMP	%	0 - 100									
HYDRO TIME	Sec.	0 - 25.5									
PUMP IMAX	%IMAX	50	55	61	66	72	77	83	88	94	100

(*)   The acceleration time shown is the theoretical time to change from 0V to full voltage applied to the motor. This is an ideal ramp, the real ramp can change as a function of the load.

(**)   The deceleration feature is based upon deceleration ramps. The value shown in the table is the time to decrease the voltage applied to the motor from 100% down to 0%.

After changing a parameter, press ENTER to confirm data when requested by the message on the console. Parameters modified and optimized on one unit can be stored by the Zapi Pc-console (SAVE) and then downloaded (RESTORE) to another controller, thus allowing fast and standardized settings (see Pc-console manual for details).
Flow Chart showing how to make Parameter changes using Digital Console fitted with Eprom CK ULTRA.

1) Opening Zapi Display.

DISPLAY →
```
┌──────────────────────┐
│  DUALAC2  ZAPI  V0.0  │
│  48V  350A  00000     │
└──────────────────────┘
```

2) Press ENTER to go into the General Menu.

KEYBOARD →

3) The Display will show :
```
┌──────────────────────┐
│     MAIN  MENU        │
│  PARAMETER  CHANGE    │
└──────────────────────┘
```

4) Press ENTER to go into the Parameter Change facility.

5) The Display will show the first parameter.
```
┌──────────────────────┐
│    ACCEL.  DELAY      │
│    LEVEL  =  4        │
└──────────────────────┘
```

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 the desired Parameter appears, the Display will show a Level Number that will be between 0 and 9. Press either PARAM (Top Right) or SET (Bottom Right)buttons to change the Level value.

9) The Display will show the New Level.
```
┌──────────────────────┐
│  RELEASE  BRAKING     │
│    LEVEL  =  6        │
└──────────────────────┘
```

10) When you are satisfied with the results 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 if you do not wish to accept the changes and wish to make further modifications to the parameters.
```
┌──────────────────────┐
│     MAIN  MENU        │
│  PARAMETER  CHANGE    │
└──────────────────────┘
```

13) The Display will show :
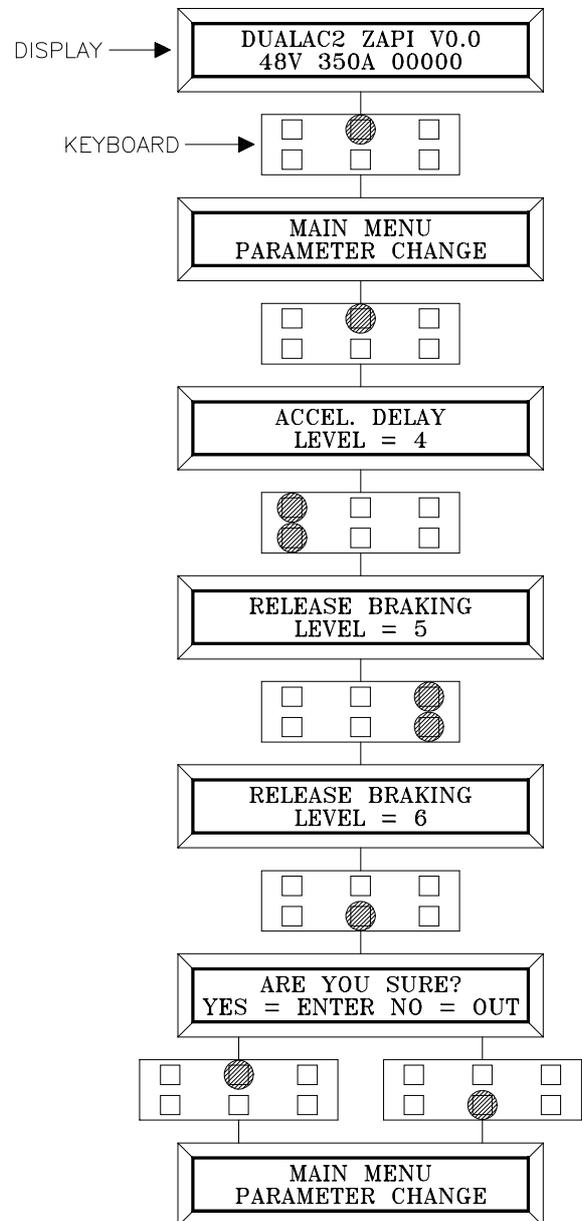
5.6 PROGRAMMING CONSOLE FUNCTIONS

5.6.1 Functional configuration (see 5.4)

5.6.2 Parameter programming (see 5.5)

5.6.3 "Dualac2" and "Dualac2 Power" Tester: user can verify the state of the following parameters:

MASTER	SLAVE
motor voltage (%)	motor voltage (%)
frequency (Hz)	frequency (Hz)
encoder (Hz)	encoder (Hz)
slip value (Hz)	slip value (Hz)
current rms (A)	current rms (A)
temperature (°C)	temperature (°C)
temperature #1 (°C)	seat switch (ON/OFF)
temperature #2 (°C)	forw. switch (ON/OFF)
accelerator (V)	back. switch (ON/OFF)
steer angle (°)	enable switch (ON/OFF)
brake pedal poti (%)	voltage booster (%)
int wheel cutback (%)	battery voltage (V)
seat switch (ON/OFF)	
forw. switch (ON/OFF)	
back. switch (ON/OFF)	
enable switch (ON/OFF)	
brake switch (ON/OFF)	
cutback switch (ON/OFF)	
exclusive hydro (ON/OFF)	
hand brake (ON/OFF)	
voltage booster (%)	
battery voltage (V)	
battery charge (%)	

5.6.4 "Dualac2&hp" and "Dualac2&hp Power" Tester: user can verify the state of the following parameters:

MASTER	SLAVE
motor voltage (%)	motor voltage (%)
frequency (Hz)	frequency (Hz)
encoder (Hz)	encoder (Hz)
slip value (Hz)	slip value (Hz)
current rms (A)	current rms (A)
temperature (°C)	temperature (°C)
temperature #1 (°C)	seat switch (ON/OFF)
temperature #2 (°C)	forw. switch (ON/OFF)
accelerator (V)	back. switch (ON/OFF)
steer angle (°)	enable switch (ON/OFF)
brake pedal poti (%)	lift control (V)
int wheel cutback (%)	lifting switch (ON/OFF)
seat switch (ON/OFF)	1st speed switch (ON/OFF)
forw. switch (ON/OFF)	2nd speed switch (ON/OFF)
back. switch (ON/OFF)	3rd speed switch (ON/OFF)
enable switch (ON/OFF)	4th speed switch (ON/OFF)
brake switch (ON/OFF)	5th speed switch (ON/OFF)
cutback switch (ON/OFF)	pump current (A)
exclusive hydro (ON/OFF)	pump vmn (V)
hand brake (ON/OFF)	pump temperature (°C)
voltage booster (%)	battery voltage (V)
battery voltage (V)	voltage booster (%)
battery charge (%)	

5.6.5 Save function (for storing data) --> only with Pc-console

5.6.6 Restore function (for downloading parameters to another controller) --> only with Pc-console

5.6.7 Display of the last 5 alarms including hour-meter value and temperature at the moment of the alarm.

5.6.8 Accelerator range programming

Records the minimum and maximum useful accelerator stroke values for both direction of running.

5.6.9 See the console manual for a detailed description of function and parameters.

5.7 SEQUENCE FOR AC INVERTER TRACTION SETTING

When the "Key Switch" is closed, if no alarms or errors are present, the Console Display will be showing the Standard Zapi Opening Display.
If the controller is not configured to your requirements, follow the sequence detailed here following. Remember to re-cycle the Key Switch if you make any changes to the chopper's configuration.

1) Select the Options required. See Chapter 5.4.

2) Select and set the Battery Voltage. See Chapter 5.4.

3) Confirm correct installation of all wires. Use the Console's TESTER function to assist.

4) Perform the accelerator signal acquisition procedure using the Console "PROGRAM VACC". Procedure is detailed on Chapter 6.3.

5) Perform the steering potentiometer signal acquisition, using the parameters in "Adjustment" menu (see Chapter 5.4).
    Remember: turning the wheel to right direction, voltage has to increase.

6) Set the maximum steering angles, right and left direction; use the parameters in "Adjustment" menu (see Chapter 5.4).

7) Set the "MAXIMUM CURRENT" Current, using the table on Chapter 4.5 , 4.6.

8) Set the Acceleration Delay requirements for the machine. Test the parameter setting in both directions.

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

10) Set the Speed Reductions as required. Make adjustments to "CUTBACK SPEED" Check the performance with the accelerator pedal totally depressed. If the machine is a forklift, check the performance with and without load.

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

12) INVERSION BRAKING. Operate the machine at 25% full speed. Whilst traveling INVERT the Direction Switch. Set a soft 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.

13) 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.

14) Set "MAX SPEED FORW".

15) Set "MAX SPEED BACK" (Reverse).

16) Make the choice for the truck behaviour on a slope (see chapter 5.4). If the "Stop on ramp" option is ON, set the desired value of "auxiliary time" parameter.

5.8 TESTER: DESCRIPTION OF THE FUNCTION

The most important input or output signals can be measured in real time using the TESTER function of the console. The Console acts as a multimeter able to read voltage, current and temperature. In the following chapter a list of relative measurements for different configurations.

5.8.1 "Dualac2" and "Dualac2 Power" - Master

1) **MOTOR VOLTAGE:** this is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

2) **FREQUENCY:** this is the frequency of the voltage and current supplied to the motor.

3) **ENCODER:** this is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

4) **SLIP VALUE:** this is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

5) **CURRENT RMS:** Root Mean Square value of the motor current.

6) **TEMPERATURE:** the temperature measured on the aluminum heat sink holding the MOSFET devices.

7) **TEMPERATURE #1:** this is the temperature of the right motor; if the option is programmed "None" (see chapter 5.4.a) it shows 0°.

8) **TEMPERATURE #2:** this is the temperature of the left motor; if the option is programmed "None" (see chapter 5.4.a) it shows 0°.

9) **ACCELERATOR:** the voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the Left Hand Side of the Console Display and the value in percentage is shown on the Right Hand Side.

10) **STEER ANGLE:** this is the indication of the angular position of the steered wheel.

11) **BRAKE PEDAL POTI:** voltage of the brake potentiometer's wiper (CPOTB). The parameter is active only if the PEDAL BRAKING parameter is set ANALOG (see chapter 5.4.).

12) **INTERNAL WHEEL CUTBACK:** this is the indication of the speed reduction applied to the internal wheel; in other words, it shows the ratio of the two speeds.

13) **SEAT SWITCH:** the level of the Seat Microswitch digital input.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

14) **FORWARD SWITCH:** the level of the Forward direction digital input FW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

15) BACKWARD SWITCH: the level of the Reverse direction digital input BW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

16) ENABLE SWITCH: the level of the Enable digital input:

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

17) BRAKE SWITCH: the level of the Pedal Brake Microswitch.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

18) CUTBACK SWITCH: the level of the Speed Reduction Microswitch.

ON / GND = input active, switch opened.

OFF / +VB = input non active, switch closed.

19) EXCLUSIVE HYDRO: status of the exclusive hydro switch.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

20) HAND BRAKE: the level of the Handbrake Microswitch.

ON / GND = input active, switch opened.

OFF / +VB = input non active, switch closed.

21) VOLTAGE BOOSTER: this is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

22) BATTERY VOLTAGE: level of battery voltage measured at the input of the key switch.

23) BATTERY CHARGE: the percentage Charge level of the battery.

5.8.2 "Dualac2" and "Dualac2 Power" - Slave

1) MOTOR VOLTAGE: this is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

2) FREQUENCY: this is the frequency of the voltage and current supplied to the motor.

3) ENCODER: this is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

4) SLIP VALUE: this is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

5) CURRENT RMS: Root Mean Square value of the motor current.

6) TEMPERATURE: the temperature measured on the aluminum heat sink holding the MOSFET devices.

7) SEAT SWITCH: the level of the Seat Microswitch digital input.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch opened.

8) FORWARD SWITCH: the level of the Forward direction digital input FW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch opened.

9) BACKWARD SWITCH: the level of the Reverse direction digital input BW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch opened.

10) ENABLE SWITCH: the level of the Enable digital input:

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

11) VOLTAGE BOOSTER: this is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

12) BATTERY VOLTAGE: level of battery voltage measured at the input of the key switch.

5.8.3 "Dualac2&hp" and "Dualac2&hp Power" - Master

1) MOTOR VOLTAGE: this is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

2) FREQUENCY: this is the frequency of the voltage and current supplied to the motor.

3) ENCODER: this is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

4) SLIP VALUE: this is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

5) CURRENT RMS: Root Mean Square value of the motor current.

6) TEMPERATURE: the temperature measured on the aluminum heat sink holding the MOSFET devices.

7) TEMPERATURE #1: this is the temperature of the right motor; if the option is programmed "None" (see chapter 5.4.a) it shows 0°.

8) TEMPERATURE #2: this is the temperature of the left motor; if the option is programmed "None" (see chapter 5.4.a) it shows 0°.

9) ACCELERATOR: the voltage of the accelerator potentiometer's wiper (CPOT). The voltage level is shown on the Left Hand Side of the Console Display and the value in percentage is shown on the Right Hand Side.

10) STEER ANGLE: this is the indication of the angular position of the steered wheel.

11) BRAKE PEDAL POTI: voltage of the brake potentiometer's wiper (CPOTB). The parameter is active only if the PEDAL BRAKING parameter is set ANALOG (see chapter 5.4.).

12) INTERNAL WHEEL CUTBACK: this is the indication of the speed reduction applied to the internal wheel; in other words, it shows the ratio of the two speeds.

13) SEAT SWITCH: the level of the Seat Microswitch digital input.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

14) FORWARD SWITCH: the level of the Forward direction digital input FW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

15) BACKWARD SWITCH: the level of the Reverse direction digital input BW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

16) ENABLE SWITCH: the level of the Enable digital input:

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

17) BRAKE SWITCH: the level of the Pedal Brake Microswitch.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

18) CUTBACK SWITCH: the level of the Speed Reduction Microswitch.

ON / GND = input active, switch opened.

OFF / +VB = input non active, switch closed.

19) EXCLUSIVE HYDRO: status of the exclusive hydro switch.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch opened.

20) HAND BRAKE: the level of the Handbrake Microswitch.

ON / GND = input active, switch opened.

OFF / +VB = input non active, switch closed.

21) VOLTAGE BOOSTER: this is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

22) BATTERY VOLTAGE: level of battery voltage measured at the input of the key switch.

23) BATTERY CHARGE: the percentage Charge level of the battery.

5.8.4 "Dualac2&hp" and "Dualac2&hp Power" - Slave

1) **MOTOR VOLTAGE:** this is the voltage supplied to the motor by the inverter; it is expressed as a percentage of the full voltage (which depends of the battery voltage).

2) **FREQUENCY:** this is the frequency of the voltage and current supplied to the motor.

3) **ENCODER:** this is the speed of the motor, expressed in the same unit of the frequency; this information comes from the speed sensor.

4) **SLIP VALUE:** this is the difference of speed between the rotating field and the shaft of the motor, expressed in the same unit of the frequency.

5) **CURRENT RMS:** Root Mean Square value of the motor current.

6) **TEMPERATURE:** the temperature measured on the aluminum heat sink holding the MOSFET devices.

7) **SEAT SWITCH:** the level of the Seat Microswitch digital input.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

8) **FORWARD SWITCH:** the level of the Forward direction digital input FW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

9) **BACKWARD SWITCH:** the level of the Reverse direction digital input BW.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

10) **ENABLE SWITCH:** the level of the Enable digital input:

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

11) **LIFT CONTROL:** voltage of the lifting potentiometer (CPOT LIFT).

12) **LIFTING SWITCH:** status of the lifting switch.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

13) **1 ST SPEED SWITCH:** status of the first speed switch of the hydraulic system.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

14) **2 ND SPEED SWITCH:** status of the second speed switch of the hydraulic system.

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

15) **3 RD SPEED SWITCH:** status of the third speed switch of the hydraulic system..

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

16) **4 TH SPEED SWITCH:** status of the fourth speed switch of the hydraulic system..

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

17) **5 TH SPEED SWITCH:** status of the fifth speed switch of the hydraulic system..

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

18) **HYDRO SPEED REQ.:** status of the hydro speed request of the hydraulic system..

ON / +VB = input active, switch closed.

OFF / GND = input non active, switch open.

19) **PUMP CURRENT:** current of the pump motor.

20) **PUMP VMN:** voltage between pump chopper output and -BATT.

21) **PUMP TEMPERATURE:** temperature of pump chopper power section.

22) VOLTAGE BOOSTER: this is the booster of the voltage supplied to the motor in load condition; it is expressed in a percentage of the full voltage.

23) BATTERY VOLTAGE: level of battery voltage measured at the input of the key switch.

Flow Chart showing how to use the TESTER function of the Digital Console.
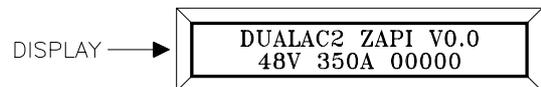
1) Opening Zapi Display.

DISPLAY ⟶

```
DUALAC2 ZAPI V0.0
48V 350A 00000
```

2) Press ENTER to go into the General menu.

KEYBOARD ⟶

3) The Display will show :

```
MAIN MENU
PARAMETER CHANGE
```
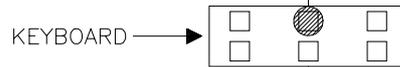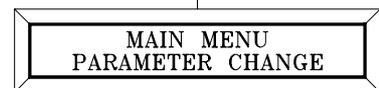
4) Press ROLL UP or ROLL DOWN button until TESTER MENU appear on the display.
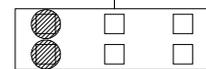
5) The Display shows :

```
MAIN MENU
TESTER
```
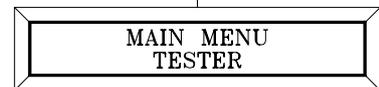
6) Press ENTER to go into the TESTER function.
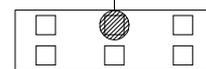
7) The first variable to be tested is shown on the Display.

```
MOTOR VOLTAGE
%
```
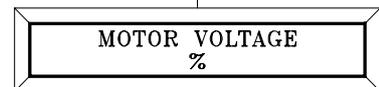
8) Press either ROLL UP or ROLL DOWN buttons until your desired variable for measurement appears on the Display.

```
FREQUENCY
Hz
```
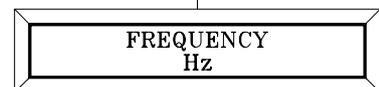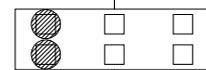
9) When you have finished, Press OUT.
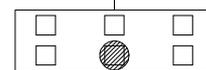
10) The Display shows :

11) Press OUT again and return to Opening Zapi Display.

```
MAIN MENU
TESTER
```

Remember it is not possible to make any changes using TESTER. All you can do is measure as if you were using a pre-connected multimeter.

6 OTHER FUNCTIONS

6.1 SAVE AND RESTORE FUNCTION

SAVE function allows to transfer controller parameters to the Pc console memory. With this function, a copy of the controller set of parameters can be retained in a Pc and downloaded to another controller (see RESTORE).

RESTORE function allows to download controller parameters from the Pc console memory to the controller Eeprom. Thus a copy of the parameters stored in a Pc can be downloaded in a controller avoiding the parameter setting operation.

For more details, please refer to Pc console manual.

6.2 DESCRIPTION OF ALARMS MENU

The microprocessor in the controller records the last five Alarms that have occurred. Items remembered relative to each Alarm are : the code of the alarm, the number of times the particular Alarm occurred, the Hour Meter count, and the chopper temperature.
This function permits a deeper diagnosis of problems as the recent history can now be accessed.

Flow Chart showing how to use the ALARMS function via the Digital Console.

1) Opening Zapi Display.

DISPLAY →
```
┌─────────────────────────┐
│   DUALAC2  ZAPI  V0.0    │
│   48V  350A  00000       │
└─────────────────────────┘
```

2) Press ENTER to go into the General menu.

KEYBOARD →

3) The Display will show :
```
┌─────────────────────────┐
│      MAIN  MENU          │
│   PARAMETER  CHANGE      │
└─────────────────────────┘
```
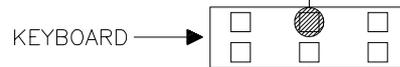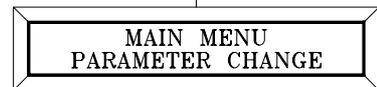
4) Press ROLL UP or ROLL DOWN button until PARAMETER CHANGE appears on the display.
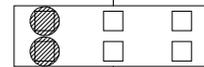
5) The Display will show:
```
┌─────────────────────────┐
│      MAIN  MENU          │
│        ALARMS            │
└─────────────────────────┘
```
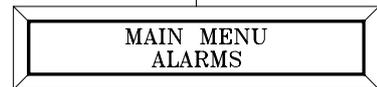
6) Press ENTER to go into the ALARMS function.
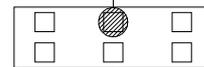
7) The Display will show the most recent Alarm.
```
┌─────────────────────────┐
│         CODE             │
│   00005   #02   20°C     │
└─────────────────────────┘
```
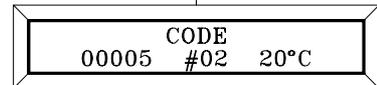
8) Each press of the ROLL UP button brings up following Alarms. Pressing ROLL DOWN returns to the most recent.
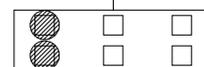
9) If an Alarm has not occurred, the Display will show: ALARM NULL.
```
┌─────────────────────────┐
│         CODE             │
│   00007   #03   18°C     │
└─────────────────────────┘
```
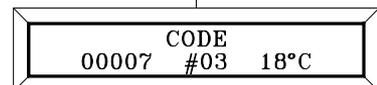
10) When you have finished looking at the Alarms, press OUT to exit the ALARMS menu.
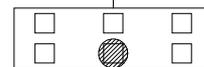
11) The Display will ask CLEAR LOGBOOK ?
```
┌─────────────────────────┐
│     CLEAR  LOGBOOK?      │
│  YES  =  ENTER  NO  =  OUT │
└─────────────────────────┘
```
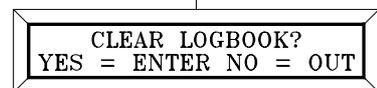
12) Press ENTER for yes, or OUT for NO.

13) Press OUT to return to the Opening Zapi Display.

6.3 DESCRIPTION OF CONSOLE PROGRAM VACC FUNCTION

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.

1) Opening Zapi Display.

DISPLAY →
```
┌─────────────────────────┐
│   DUALAC2 ZAPI V0.0      │
│     48V 350A 00000       │
└─────────────────────────┘
```

2) Press ENTER to go into the General Menu.

KEYBOARD →

3) The Display will show :
```
┌─────────────────────────┐
│      MAIN  MENU          │
│   PARAMETER  CHANGE      │
└─────────────────────────┘
```

4) Press ROLL UP or ROLL DOWN button until PROGRAM VACC appears on the display.

5) The Display will show :
```
┌─────────────────────────┐
│      MAIN  MENU          │
│    PROGRAM  VACC         │
└─────────────────────────┘
```

6) Press ENTER to go into the PROGRAM VACC routine.

7) The Display will show the minimum and maximum values of potentiometer wiper output.
    Both directions can be shown.
```
┌─────────────────────────┐
│      VACC  SETTING       │
│   4.8             4.8    │
└─────────────────────────┘
```

8) Press ENTER to clear these values.
    Display will show 0.0.

9) Select Forward Direction, close any interlock switches that may be in the system.
```
┌─────────────────────────┐
│  MIN   VACC    MAX       │
│  0.0    –       0.0      │
└─────────────────────────┘
```

10) 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.

11) Select the Reverse Direction and repeat Item 10.
```
┌─────────────────────────┐
│  MIN   VACC    MAX       │
│  0.6    ↑       4.4      │
└─────────────────────────┘
```

12) When finished , press OUT.

13) The Display will ask : ARE YOU SURE ?.
```
┌─────────────────────────┐
│     ARE  YOU  SURE       │
│  YES = ENTER NO = OUT    │
└─────────────────────────┘
```

14) Press ENTER for yes, or OUT for NO.

15) Press OUT again to return to the Opening Zapi Menu.
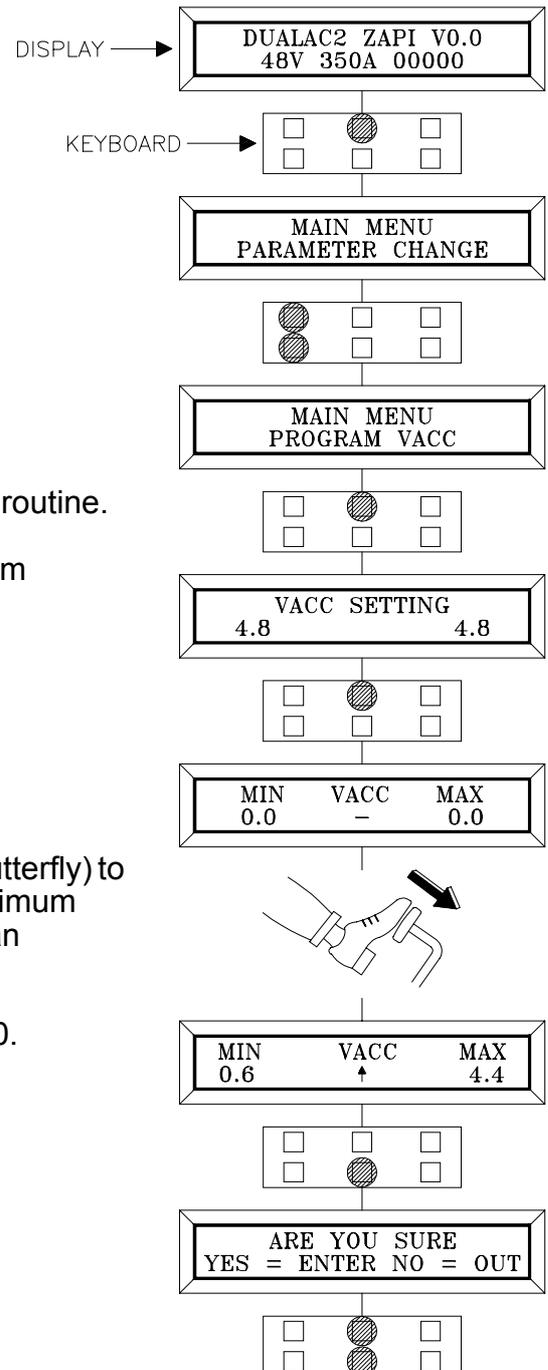
7 "DUALAC2" AND "DUALAC2&HP" INVERTER DIAGNOSTIC

7.1 TRACTION RELATED FAULT CODES

Code	ALARM STRING	Master	Slave	CONTROLLER STATUS			DESCRIPTION	Condition that has to occur to come out from alarm status
				Init	Stby	Motor running		
8	"WATCHDOG"	X	X	X	X	X	Alarm: the Watchdog circuit has been triggered	-If the alarm is present in Init status,remove the alarm condition -If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
17	"LOGIC FAILURE#3"	X	X		X		Alarm: failure in over-load protection hw circuit	To remove alarm condition + activation of traction request
18	"LOGIC FAILURE#2"	X	X	X			Alarm: failure in U,V,W voltage feedback circuit	To remove alarm condition + activation of traction request
19	"LOGIC FAILURE#1"	X		X	X	X	Alarm: an overvoltage or undervolt. condition has been detected	To recycle the key switch
30	"VMN LOW"	X	X	X	X	X	Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	-If the alarm is present in Init status,remove the alarm condition -If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
31	"VMN HIGH"	X	X	X	X		Alarm: wrong voltage on motor power outputs; failure in the power section or in the mosfet driver circuit or in the motor	-If the alarm is present in Init status,remove the alarm condition -If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request

Code	ALARM STRING	Master	Slave	CONTROLLER STATUS			DESCRIPTION	Condition that has to occur to come out from alarm status
				Init	Stby	Motor running		
53	"STBY I HIGH"	X	X	X	X		Alarm: wrong voltage in the current sensor feedback circuit	-If the alarm is present in Init status, remove the alarm condition -If the alarm has occurred in stby or running mode, it is necessary to remove alarm condition and to activate a traction request
60	"CAP CHARGE"	X	X	X			Alarm: power capacitor voltage does not increase when the key is turned ON; failure in the power section, or in the Logic PCB, or in the driver PCB, or in the motor	To remove alarm condition
74	"DRIVER SHORTED"	X		X	X	X	Alarm: line contactor coil driver is shorted	-If the alarm is present in Init status, remove the alarm cause -If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
75	"CONTACTOR DRIVER"	X			X	X	Alarm: line contactor coil driver is open (not able to drive the coil to the correct voltage)	To remove alarm cause and to activate traction request
76	"COIL SHORTED"	X		X	X	X	Alarm: -Init: the LC and EB coil driver protection circuit is damaged - Stby or running: short on LC coil or EB coil	-If the alarm is present in Init status, remove the alarm cause -If the alarm has occurred in stby or running mode, it is necessary to remove alarm cause and to activate traction request
37	"CONTACTOR CLOSED"	X		X			Alarm: line contactor power contact is stuck	To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key

Code	ALARM STRING	Master	Slave	CONTROLLER STATUS			DESCRIPTION	Condition that has to occur to come out from alarm status
				Init	Stby	Motor running		
38	"CONTACTOR OPEN"	X		X			Alarm: line contactor power contact does not pull-in	To remove alarm cause within a timeout; if the timeout is elapsed, it is necessary to re-cycle the key
82	"ENCODER ERROR"	X	X			X	Alarm: motor speed sensor (encoder) does not work properly	To recycle the key
84	"STEER SENSOR KO"	X		X	X	X	Alarm: steering poti signal out of range	To remove alarm cause
86	"PEDAL WIRE KO"		X	X	X	X	Alarm: fault in accelerator negative (NPOT) input circuit	To remove alarm cause and activate a traction request
245	"WRONG SET BATTERY"	X		X			Alarm: the battery voltage does not correspond to "SET BATTERY" programmation	To remove alarm cause
246	"SLAVE KO"	X		X	X	X	Alarm: Master µC detects a Slave µC malfunctioning	To recycle the key
247	"MASTER KO"		X	X	X	X	Alarm: Slave µC detects a Master µC malfunctioning or a mismatch between inputs status and Master commands (via Canbus)	To recycle the key
250	"INPUT MISMATCH"		X	X	X	X	Alarm: Slave µC has detects a mismatch between inputs status and the input status transmitted via Canbus by Master µC	To recycle the key
253	"AUX OUTPUT KO"	X		X	X	X	Alarm: EB coil driver shorted or open	-If the alarm is present in Init status, remove the alarm cause -If the alarm has occured in stby or running mode, it is necessary to remove alarm cause and to activate traction request

Code	ALARM STRING	Master	Slave	CONTROLLER STATUS			DESCRIPTION	Condition that has to occur to come out from alarm status
				Init	Stby	Motor running		
13	"EEPROM KO"	X		X	X	X	Warning: Eeprom fault, controller will use default parameters	To remove Warning cause
61	"HIGH TEMPERA-TURE"	X	X	X	X	X	Warning: Master or Slave or both temperature higher than 75°C	To remove Warning cause
65	"MOTOR TEMPERA-TURE"	X		X	X	X	Warning: right or left or both motors temperature high	To remove Warning cause
66	"BATTERY LOW"	X		X	X	X	Warning: battery charge level below 20%	To remove Warning cause
78	"VACC NOT OK"	X		X	X		Warning: accelerator signal (CPOT) voltage higher than VACC MIN +1V while the traction enable switch is open	To remove Warning cause
79	"INCORRECT START"	X		X	X	X	Warning: wrong traction request sequence	To remove Warning cause
80	"FORWARD + BACKWARD"	X		X	X	X	Warning: forward and reverse inputs are both active	To remove Warning cause
249	"THERMIC SENSOR KO"	X	X	X	X	X	Warning: Master or slave temperature sensor is out of range	To remove Warning cause
251	"WAITING FOR NODE#4"	X		X	X	X	Warning: Master µC signals that Slave µC is in alarm status	To remove Warning cause
251	"WAITING FOR NODE#3"		X	X	X	X	Warning: Slave µC signals that Master µC is in alarm status	To remove Warning cause
241	"NO CAN MESSAGE #4"	X		X	X	X	Alarm: Master has lost Can communication with the Slave	To remove Alarm cause
247	"NO CAN MESSAGE #3"		X	X	X	X	Alarm: Slave has lost Can communication with the Master	To remove Alarm cause

7.2 ANALYSIS OF TRACTION RELATED ALARMS DISPLAYED ON CONSOLE

1. WATCH DOG
   It is a self-diagnosing test within the logic between Master and Slave µcontrollers. This alarm could also be caused by a canbus malfunctioning, which blinds Master-Slave communication. So, before replacing the controller, check the canbus.

2. LOGIC FAILURE #3
   Fault in the hardware section of the logic board which manages the hardware current protection. Replace the logic board.

3. LOGIC FAILURE #2
   Fault in the hardware section of the logic board which manages the phase' s voltage feedback. Replace the logic board.

4. LOGIC FAILURE #1
   This alarm signals that the undervoltage / overvoltage protection interrupt has been triggered. Two possible reasons:

   a. A real undervoltage / overvoltage situation happened.

   b. Fault in the hardware section of the logic board which manages the overvoltage protection. Replace the logic card.

5. VMN LOW, VMN HIGH
   The test is carried out during initial diagnosis and in standby.
   Possible causes:

   a. problem with the motor connections or the motor power circuit; check if the 3 phases are correctly connected; check if there's a dispersion of the motor to truck frame.

   b. fault in the inverter power section, replace the controller.

6. STBY I HIGH
   The µCs verify if the feedback of current sensors device output is within the zero current window. Possible causes of the alarm:

   a. current sensor failure;

   b. failure in the logic card: first replace the logic card; if the defect persists, replace the power unit.

7. CAPACITOR CHARGE
   Follows the charging capacitor system:
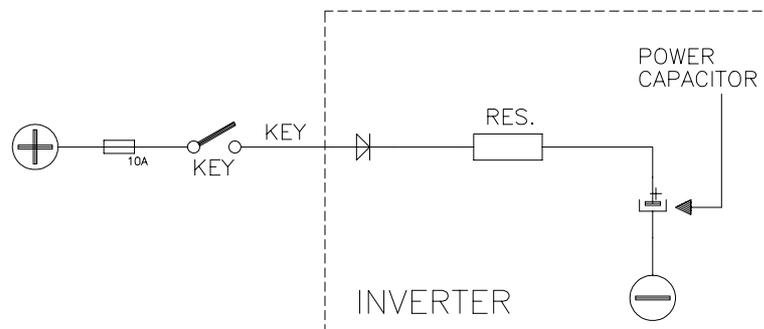
   When the key is switched ON, the inverter tries to charge the capacitor through a power resistance, and check if the capacitor are charged within a timeout. If they do not charge, an alarm is signalled; the main contactor is not closed.

Possible reasons:

a) the charging resistance is opened.

b) The charging circuit has a failure.

c) There is a problem in the power section.

8. MAIN CONTACTOR ALARMS
   COIL SHORTED:
   When the key is switched ON the μController checks the LC coil driver shortcircuit protection hardware. If it does not react in a correct way to the μC stimulus, the alarm is signalled. Replace the logic board. When the fault occurs while the LC is closed, the alarm signals a shortcircuit across LC coil.
   Check if there are external shortcircuit and if the ohmic value of the MC coil is correct; otherwise replace the logic.
   DRIVER SHORTED:
   When the key is switched ON, the μC checks that the LC coil driver is not shorted; if it is, this alarm is signalled. Preliminary, check if there is an external short or low impedance pull-down between NLC (C26) and -BATT. If no external causes can be found out, replace the controller.
   CONTACTOR DRIVER:
   When the initial diagnosis is finished, the traction logic closes the LC and checks the voltage on the Drain of the driver. If this is not low , the driver is not able to close an alarm is signalled. Replace the logic.
   CONTACTOR OPEN:
   The main contactor coil has been driven by the logic board, but the contactor does not close. Two possible reasons:

   a) the wires to the coil are interrupted or not well connected.

   b) the contact of the contactor is not properly working (does not pull-in).

   CONTACTOR CLOSED:
   Before driving the LC coil, the controller checks if the LC contact is stuck. The controller drives the bridge for a while, trying to discharge the capacitor bank. If they don't discharge, the fault condition is entered. It is suggested to check the contactor contact, if it is mechanically stuck.

9. ENCODER ERROR
   This alarm is signalled in following condition: the frequency supplied to the motor is higher than 20 Hz, and the signal feedback from the encoder has a jump higher than 20 Hz in few tens millisecond. This condition clearly shows a malfunctioning of the encoder signal. It is suggested to preliminary check the encoder wiring; if no fault is found in the wiring it is necessary to replace the encoder.

10. STEER SENSOR KO

This is an alarm which signals an out of range of the steering potentiometer signal. The fault condition is entered in these two following conditions:

- the "Set steer 0 pos" (straight wheels programmation) parameter is wrong (lower than "Set steer min" or higher than "Set steer max").
- the feedback signal of the steering potentiometer is outside the window defined by "Set steer min" and "Set steer max" parameters.

In the first case, repeat the steering potentiometer acquisition. In the second case, check the steering poti and its wiring. Eventually, repeat again the steering potentiometer acquisition.

11. PEDAL WIRE KO

This alarm is signalled if a fault is detected in the accelerator unit wiring (NPOT or PPOT cable is interrupted).

12. WRONG SET BATTERY

When the key is turned ON, the controller check the battery voltage and compares it with the "SET BATTERY" parameter setting. If the actual value is 20% higher or lower than nominal value, the fault condition is entered.

Replace the battery with a correct battery.

13. SLAVE KO

Slave and Master µCs perform a cross-check in order to verify their functionality. If the MASTER detects SLAVE µC malfunctioning, it brings the controller in a safe status opening the power bridge and the Line Contactor.

14. MASTER KO

Slave and Master µCs perform a cross-check in order to verify their functionality. There are two conditions under which slave enters this fault condition:

- the SLAVE µC receives incoherent can message from the MASTER µC
- the SLAVE µC compares the inputs status and the related MASTER operations, and find they are not coherent.

In both cases, the SLAVE brings the controller to a safe status opening the power bridge and the Line contactor.

15. INPUT MISMATCH

Safety related inputs (Fw direction, Rev direction, accelerator ENABLE, SEAT switch) are input to both microcontrollers by independent hw circuit. The two µCs read these inputs and compare by exchanging related status on the canbus. If the SLAVE µC finds a mismatch between its inputs and MASTER inputs, it brings the controller to a safe status opening the power bridge and the Line contactor.

16. AUX OUTPUT KO

The µP checks the driver of the electromechanical brake coil. If the status of the driver output does not correspond to the signal coming from the µP, the alarm is signalled. It is suggested to preliminary check if there is an external short or low impedance pull-down between NAUX (C31) and -BATT. If no external cause can be found, replace the logic card.

17. EEPROM KO

Fault in the area of memory in which the adjustment parameters are stored; this alarm does not inhibits truck operation, but the controller will use default parameters. If the defect persists when the key is switched OFF and ON again, replace the logic. If the alarm disappears, remember that the parameters stored previously have been cancelled and replaced by the default values.

18. HIGH TEMPERATURE

Master or Slave or both temperatures are greater than 75°C. The maximum current is reduced proportionally to the temperature increase. At 100°C the max current of both inverter is reduced to zero.

If the alarm is signalled when the controller is cold:

a) thermal sensor failure;

b) failure in the logic card.

19. MOTOR TEMPERATURE

This warning is signalled if right or left or both motors temperature switches open (digital sensor) or if the analog signals overtakes the cut off level. If it happens when the motor is cold, check the wiring. If all is ok, replace the logic board.

20. BATTERY LOW

If the "battery check" option is ON, a battery discharge algorithm is carried out. When the charge level is 20% , this alarm is signalled and the current is reduced to the half of the programmed level.

21. VACC NOT OK

The test is made in standby. This alarm indicates that the accelerator voltage is 1V greater than the minimum value programmed by the PROGRAM VACC function. Possible causes:

a. the potentiometer is not correctly calibrated;

b. the potentiometer is defective.

22. INCORRECT START

This alarm signals an incorrect starting sequence. Possible causes:

a. Fw or Rev or Enable microswitch failure;

b. error in sequence made by the operator;

c. incorrect wiring;

d. if the default persists after checking the harness, replace the logic.

23. FORW + BACK

The test is carried out continuously. An alarm is signalled when a double running request is made simultaneously. Possible causes:

a. defective wiring;

b. running microswitch failure;

c. incorrect operation;

d. if the defect persists, replace the logic.

24. THERMIC SENSOR KO

The range of inverter temperature sensor is always checked and a warning is signalled if it is out of range.

When this alarm is signalled, the maximum current of the controller is reduced to halt.

25. WAITING FOR NODE #4

The Slave has detected a failure, the Master cannot close the main contactor because of the alarm status of the Slave (which the Master knows by the CAN-BUS line). The failure must be looked for in the Slave controller, use the remote console to get connection to the Slave µC.

26. WAITING FOR NODE #3

The Master µC has detected a fault condition, the Slave is aware of this thanks to canbus communication; it cannot drive the motor until the Master has resolved its problem. The fault has to be looked for in the Master.

27. NO CAN MESSAGE #4

Master (node #3) signals that it has lost can communication with the Slave (node #4). This fault could be determined by a problem in the truck canbus line or by an internal problem in the controller logic card.

It is suggested to preliminary check canbus connection.

28. NO CAN MESSAGE #3

Slave (node #4) signals that it has lost can communication with the Master (node #3). This fault could be determined by a problem in the truck canbus line or by an internal problem in the controller logic card.

It is suggested to preliminary check canbus connection.

7.3 PUMP RELATED FAULT CODES

Code	ALARM STRING	Master	Slave	CONTROLLER STATUS			DESCRIPTION	Condition that has to occur to come out from alarm status
				Init	Stby	Motor running		
28	"PUMP VMN LOW"		X	X	X	X	Alarm: wrong voltage output of pump chopper; the motor voltage feedback is not coherent with applied PWM	-If the alarm is present in Init status,remove the alarm cause -If the alarm has occurred in stby or running mode, it is necessary to remove the fault cause and to activate a function request
56	"PUMP STBY I HIGH"		X	X	X		Alarm: in stby condition (no PWM applied to pump chopper), the pump current sensor feedback is out of the zero current window	-If the alarm is present in Init status,remove the alarm cause -If the alarm has occurred in stby or running mode, it is necessary to remove the fault cause and to activate a function request
242 Slave	"PUMP TEMPERAT."		X	X	X	X	Warning: the pump chopper temperature is higher than 75°C	To remove warning cause
242 Master	"PUMP"	X		X	X	X	Warning: Master controller signals that Slave μC has detected a fault in the pump chopper	To remove warning cause
243	"PUMP INC. START"		X	X	X		Warning: pump incorrect start sequence	To remove warning cause
244	"PUMP VACC MOTOR"		X	X	X		Warning: pump accelerator voltage is 1V greater than the minimum value programmed	To remove warning cause

7.4 ANALYSIS OF PUMP RELATED ALARMS DISPLAYED ON CONSOLE

1. PUMP VMN LOW
   The pump chopper power output is feedback to the µC. If this feedback voltage is not coherent with the applied PWM, this fault condition is signalled. There could be many causes:
   - failure in the pump chopper power section
   - failure in the pump chopper driving section
   - failure in the pump chopper voltage feedback circuit
   - dispersion in the pump motor to truck frame.

2. PUMP STBY I HIGH
   The pump chopper current sensor feedback is out of the zero-current window while no PWM is applied to the pump chopper. The most likely cause is a failure in the current sensor.

3. PUMP TEMPERATURE
   Pump chopper temperature is higher than 75°C, maximum current is proportionally reduced. If the alarm is present when the controller is cold, there is a failure in the temperature sensor or in the feedback circuit.

4. PUMP
   This is a warning in the MASTER controller, which inform that the SLAVE is in a pump chopper related fault condition.

8 RECOMMENDED SPARE PARTS FOR INVERTER

Part Number	Description
C16507	Protected 500A strip Fuse.
C16505	Protected 355A strip Fuse.
C16520	6.3A 20mm Control Circuit Fuse
C29523	SW 180 80V Single Pole Contactor
C29522	SW 180 48V Single Pole Contactor
C29508	SW 180 24V Single Pole Contactor

9 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDI-CATED

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

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.

ZAPI

ELECTRONIC INDUSTRIAL DEVICES

42028 - POVIGLIO - (R.E.) - Via Parma, 59 - ITALIA
Tel. +39 0522 960050 (r.a.) - Fax +39 0522 960259 - e-mail: zapi@zapispa.it

DUALAC2 INVERTER
OPERATING HANDBOOK
AND FUNCTION DESCRIPTION