ZAPI® S.p.A.

ELECTRONIC • OLEODYNAMIC • INDUSTRIAL EQUIPMENTS CONSTRUCTION

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EN

User Manual

VCM ZAPI 2uC

NOTES LEGEND

The symbol aboard is used inside this publication to indicate an annotation or a suggestion you should pay attention.

The symbol aboard is used inside this publication to indicate an action or a characteristic very important as for security. Pay special attention to the annotations pointed out with this symbol.

Contents

APPROVAL SIGNS

COMPANY FUNCTION	INITIALS	SIGN
PROJECT MANAGER		
TECHNICAL ELECTRONIC MANAGER VISA		
SALES MANAGER VISA		

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1 INTRODUCTION

The Vehicle Control Master is an intelligent module designed to provide a central control of multiple vehicle functions.
The high number of I/Os accommodates a large number and wide range of vehicle controls and sensors.
It can easily work in conjunction with Zapi motor controllers and other CAN devices.

The VCM offers many digital and analog inputs for interfacing with microswitches or potentiometers. Moreover it has an interesting feature, which are not in many small I/O cards:
it has a double-microcontroller structure with 2 CAN communication ports that make the VCM ideal for a safe single-point “Master” control.

The VCM has also many outputs in order to control proportional hydraulic valves, PWM voltage controlled loads or other loads.

The VCM small package offers a high flexibility for placement in complex machines and it has a very high IP protection too.

Features include:

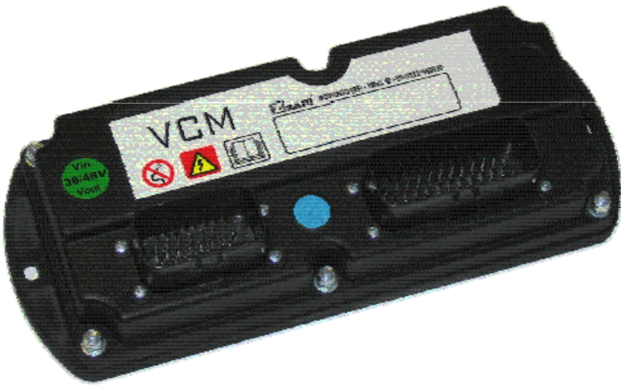
- 16 bits microcontroller for main functions 384+ Kbytes embedded Flash memory
- 16 bits microcontroller for safety functions, 384+ Kbytes embedded Flash memory
- Up to 11 active high digital inputs
- Up to 10 analog inputs with 10 bit resolution
- 2 incremental encoder interfaces
- 2 CAN communication ports that allow interconnection to a wide range of devices, including ZAPI AC controllers
- Standard communication: CIA, CANopen
- Communication speed up to 500Kbit/sec
- 11 and 29 bits communication supported
- +12V output supply (up to 500mA)
- +5V output supply (up to 150mA)
- 8 power outputs with precise current feedback to control proportional hydraulic valves (up to 2A per output)
- 1 power output PWM current control up to 4Amps
- 3 PWM voltage control outputs
- Built-in freewheeling diodes
- Different built-in programmable levels for dither amount & frequency
- Real-time clock
- Overload protection, short circuit protection and open load protection
- ESD protection
- Operating ambient temperature range from -40°C to + 40°C
- Sealed connectors (35 pins Ampseal + 23 pins Ampseal)
- IP65 rated

– Easy access to service, status and diagnostic information

The VCM can be supplied in two different configurations:

- Standard Version 36/48V, 80V, with a 35 poles Ampseal connector
- Premium Version 36/48V, 80V, with an additional second 23 poles Ampseal connectors, enhanced I/O

STANDARD VERSION



PREMIUM VERSION

2 SPECIFICATION

2.1 Technical specifications VCM Standard

Voltage [V]... 36, 48, 80V
Digital inputs [n°]..7
Analog inputs [n°]...2
Proportional Output for external loads [n°]...8
PWM Voltage Controlled Output for external loads [n°]..2
+12V output supply [n°]..1
+5V output supply [n°]...1
CAN Interface[n°]...2
IP Protection...IP65
External Operating temperature range.. -40°C;+50°C

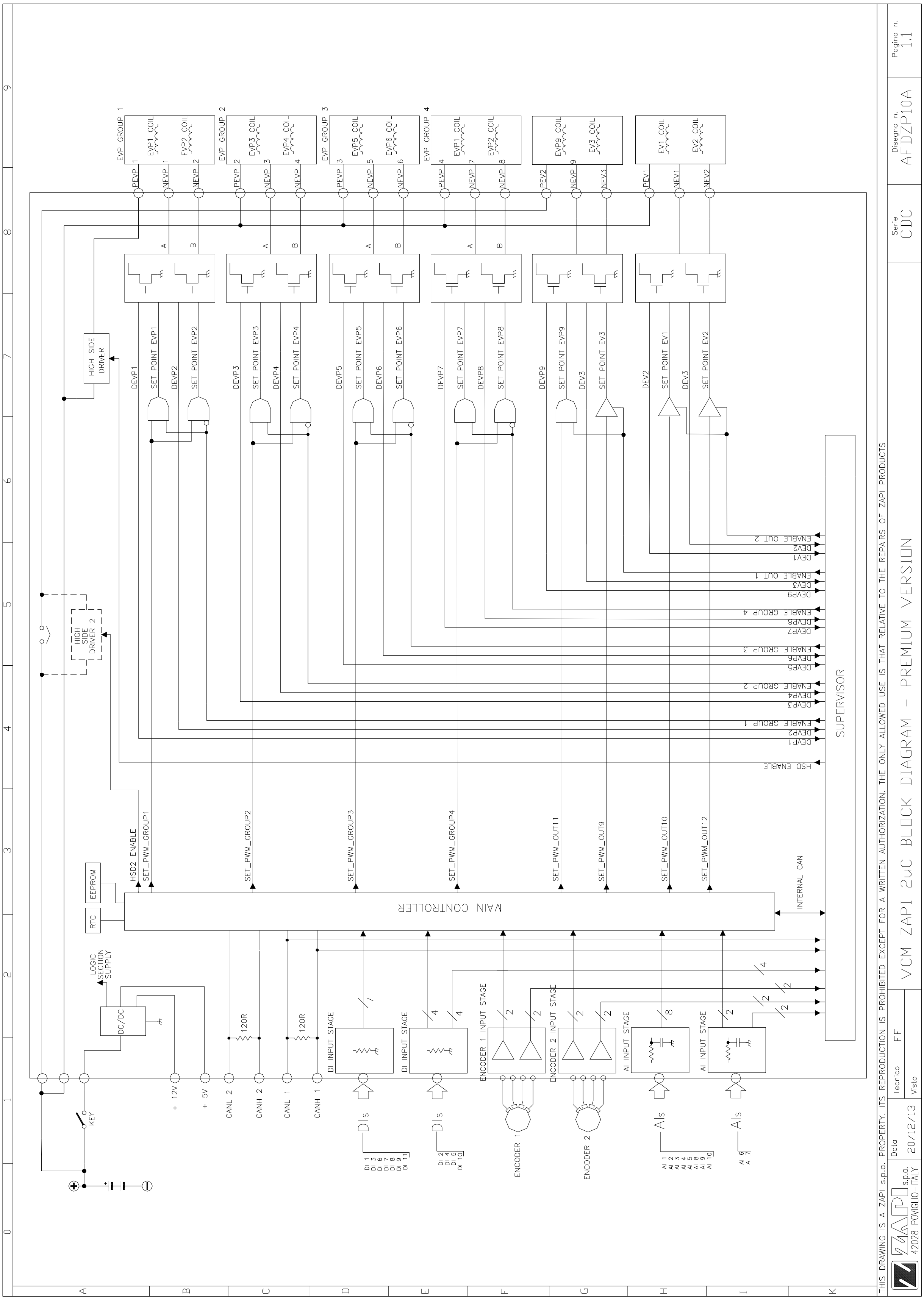
VCM can be operated with 36V or 48V battery without any hardware modification.

2.2 Technical specifications VCM Premium

Voltage [V]... 36, 48, 80V
Digital inputs [n°]..11
Analog inputs [n°]...10
Proportional Output for external loads [n°]...9
PWM Voltage Controlled Output for external loads [n°]..3
+12V output supply [n°]..1
+5V output supply [n°]...2
CAN Interface[n°]...2
IP Protection...IP65
External Operating temperature range.. -40°C;+50°C

VCM can be operated with 36V or 48V battery without any hardware modification.

3 BLOCK DIAGRAM



4 SPECIFICATION FOR THE I/O INTERACES

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

4.1 Digital inputs

Related command devices (microswitches) must be connected to positive (typically to key voltage).
Functional devices are Normally Open; so related function becomes active when the microswitch closes.
Safety devices (like CUTBACK switches) are Normally Closed; so related function becomes active when the microswitch opens.
Pull-down resistances are built-in.
Some inputs are read by both master microcontroller and the slave microcontroller:
The safety level related to these input signal is higher since both microcontrollers check the status of the input pins.

4.1.1 DI1 ÷ DI11 technical details

Nominal Voltage [V]	**36-48V**	**80V**
Input resistance [Ω]	11,2k [±0,5kOhm]	3,2k [±0,1kOhm]
Maximum Input Voltage [V]	60V	24V
Logic level	High	High
High-level [V] min.	13	9
Low-level [V] max.	12	8

4.1.2 Microswitches

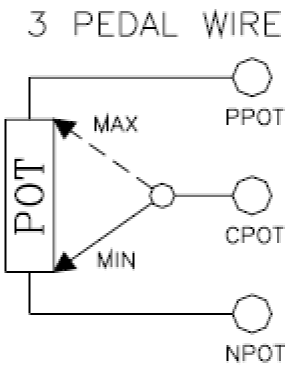
- It is suggested that microswitches have a contact resistance lower than 0,1Ohm and a leakage current lower than 100µA.
- When full load connected, the voltage between the key switch contacts must be lower than 0.1V.
- If the microswitch to be used has different characteristic, it is suggested to discuss them and their application with Zapi technicians.

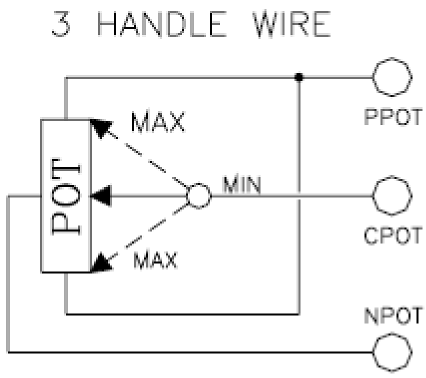
4.2 Analog inputs

The analog units can consist of potentiometers or Hall effect devices.
They could be in a 3-wire configuration. The potentiometers can be supplied through PPOT1, PPOT2 or PPOT3 (CNA#33, CNA#34 or CNB16) and the output signals must be input to CPOT pins.

Potentiometer value should be in the 0.5 – 10 kΩ range; generally, the load should be in the 1.5 mA to 30 mA range. Faults can occur if it is outside this range.

The standard connection for the potentiometer is the one in the Left side of next figure (potentiometer on one end at rest) in combination with a couple of demand switches . On request it is also possible the handling in the Right side of next figure (potentiometer in the middle at rest) still in combination with a couple of demand switches.





Some inputs are read by both master microcontroller and the slave microcontroller:
The safety level related to these input signal is higher since both microcontrollers check the status of the input pins.

Some analog inputs are designed to be properly hardware configured in order to interface with digital devices or special device that supply a current signal (typically 4-20mA).

It is suggested to discuss about analog inputs and their application with Zapi technicians to properly configure each input signal range according to the analog device connected .

The Procedure for automatic potentiometer signal acquisition is carried out using the Zapi CAN PC Console. This enables adjustment of the minimum and maximum useful signal level, in either direction.

4.3 Outputs

The VCM module has several controlled outputs for driving external loads: 8 current controlled outputs and 2 pwm voltage controlled outputs.
They share the following characteristics:

1. they drive the pin to ground (low-side outputs)
2. they can drive loads supplied from Battery Voltage
3. built-in freewheeling diode
4. maximum dc current 2.0A
5. the control of each output depends on both microcontrollers
6. Different built-in programmable levels for dither amount & frequency
7. Overload protection, short circuit protection and open load protection

In the VCM Premiun version 1 additional pwm voltage controlled output is available.
Further an additional special pwm current controlled output is available.
It has the following characteristics:

1. It drives the pin to ground (low-side outputs)
2. It can drive loads supplied from Battery Voltage

3. built-in free-wheel diode
4. maximum dc current 4.0A
5. the control of the output depends on both microcontrollers
6. Different built-in programmable levels for dither amount & frequency
7. Overload protection, short circuit protection and open load protection

Please refers to chapter 7 or contact Zapi for further information about outputs.

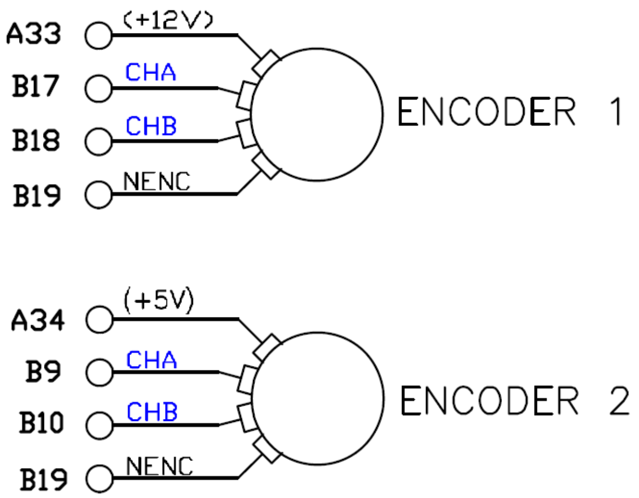
All the output pins can be converted to input pins if necessary. Please contact Zapi for further information

4.4 Incremental encoder

The VCM is fit for two incremental encoder interfaces (PREMIUM version).
These interfaces have the following characteristics

1. It can read signal from encoders with push-pull output or with open-collector output.
2. Input voltage range [0; 12]V
3. Input impedance >3 kΩ

The encoder power supply can be +5V or +12 V

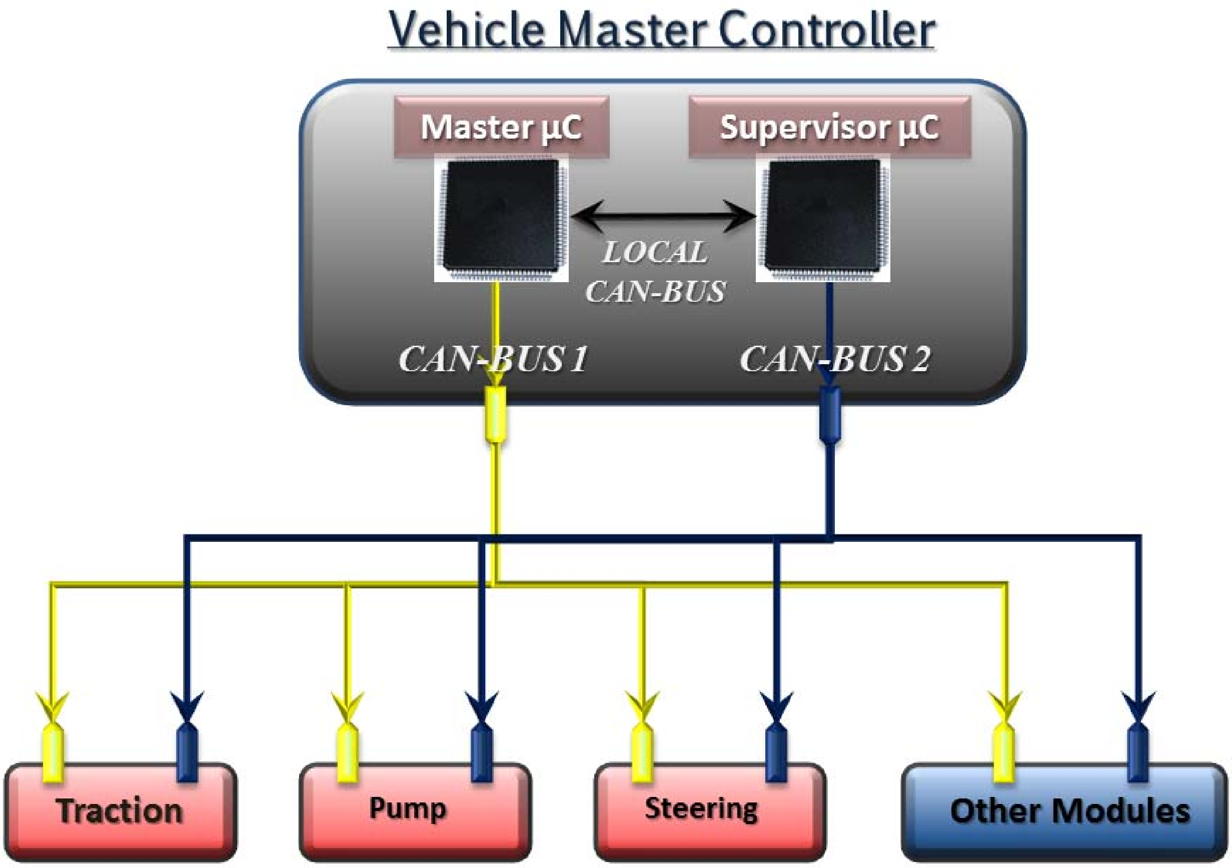


VERY IMPORTANT
It is necessary to specify in the order the type of encoder used, in terms of power supply, electronic output and n° of pulses for revolution, because the logic unit must be set in the correct way by Zapi.

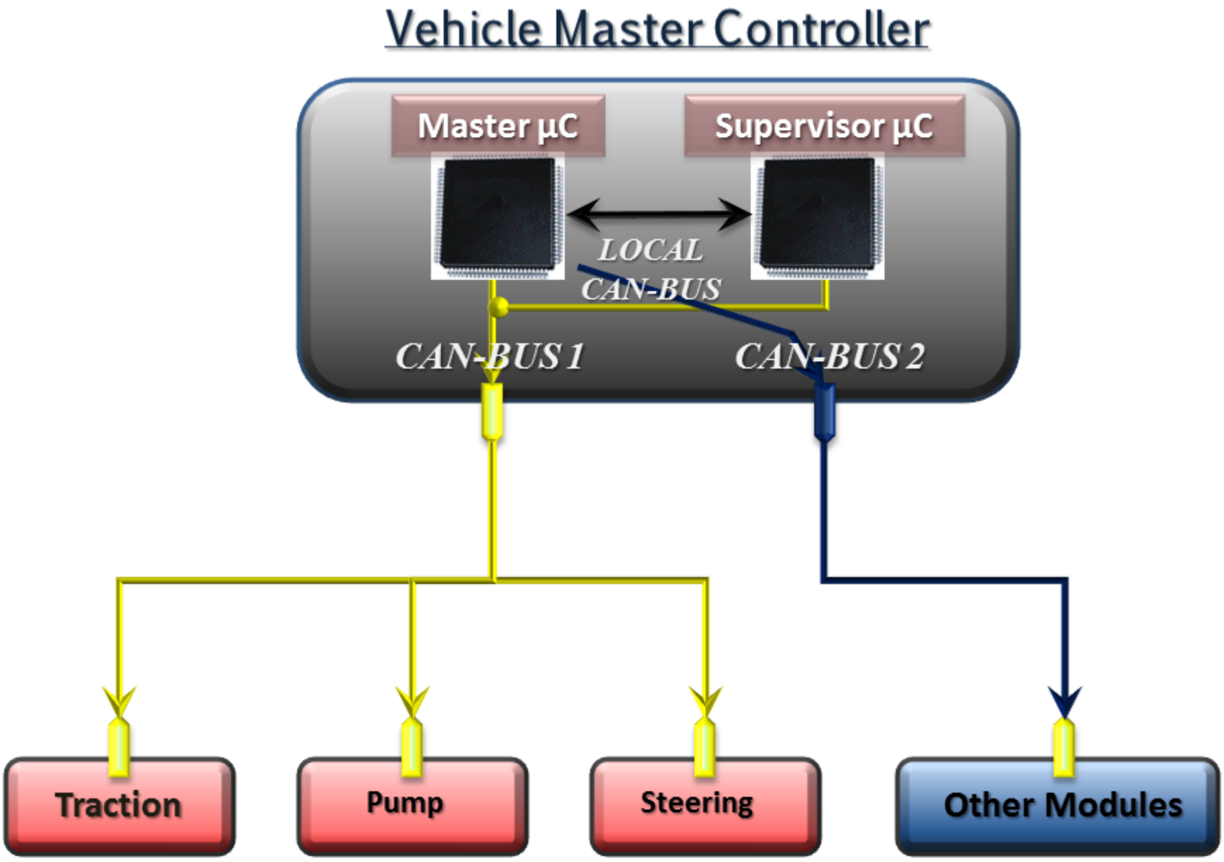
4.5 CAN BUS

The VCM is fit for two CAN bus interfaces. Built in termination 120R is present on both the interfaces.
It is possible configure them via hardware in order to obtain one of these two possible configurations:

1) Two independent lines, each one managed by only one uC.
   Master and Supervisor uC are able to communicate each other by local Can Bus.



2) Two independent lines, one managed by both the uC, the other one managed only by Master uC.
   Master and Supervisor uC are able to communicate each other by local Can Bus.



VERY IMPORTANT
It is necessary to specify in the order the type of configuration used because the logic unit must be set in the correct way by Zapi.

5 ADDITIONAL FEATURES

5.1 Real Time Clock

Real-time clock function is available.
It is possible to modify the calendar using the Zapi Console and adjusting properly the related parameters in the menu “ADJUSTMENT” (See Chapter 9).
Built in 3V battery is present.

5.2 High Side Driver

Two additional high side drivers is available.
The first one is available for both versions, STANDARD and PREMIUM; it can be properly configured to cut only one or all positive supply pins for the outputs (A13, A14, A15, A16).
The maximum carrying current for this driver is 6A.

The second one is available only for VCM PREMIUM. It cuts the positive supply pin of the additional outputs (B8)
The maximum carrying current for this driver is 6A.

6 INSTALLATION HINTS

In the description of these installation suggestions you will find some boxes of different colours, they mean:

*These are **<u>information</u>** useful for anyone is working on the installation, or a deeper examination of the content*

These are <u>Warning boxes</u>, they describe:
- operations that can lead to a failure of the electronic device or can be dangerous or harmful for the operator;
- items which are important to guarantee system performance and safety

6.1 Material overview

Before to start it is necessary to have the required material for a correct installation. Otherwise a wrong choice of cables or other parts could lead to failures/ misbehaviour/ bad performances.

6.1.1 Connection cables

For the auxiliary connections, use cables of 0.5 mm² section.
For the valves connections, use cables of 0.75 mm² section.

6.1.2 Fuses

- Use a proper fuse for protection of the auxiliary circuits.
- For Safety reasons, we recommend the use of protected fuses in order to prevent the spread of fused particles should the fuse blow.

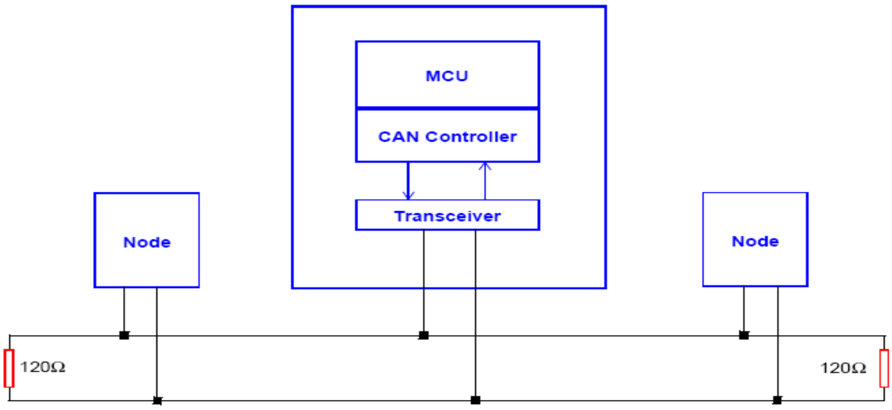
6.2 Installation of the hardware

Before doing any operation, ensure that the battery is disconnected and when all the installation is completed start the machine with the drive wheels raised from the floor to ensure that any installation error do not compromise safety.

Do not connect the controller to a battery with a nominal voltage different than the value indicated on the controller label. A higher battery voltage may cause valves driver section failure. A lower voltage may prevent the logic operating.

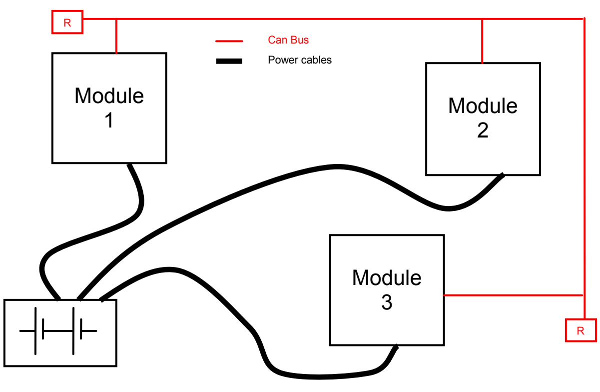
6.2.1 Wirings: CAN connections and possible interferences

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



- The correct operation of the CANbus is of critical importance for the CAN I/O because all functional messages and safety-related messages pass through CAN wires. Moreover the CAN is used to interface master and slave microcontrollers: an incorrect CAN communication will create mismatches between the two microcontrollers and will lead to a stop of all functions.
- The best cable for can connections is the twisted pair; if it is necessary to increase the immunity of the system to disturbances, a good choice would be to use a cable with a shield connected to the frame of the truck. Sometimes it is sufficient a simple double wire cable or a duplex cable not shielded.
- In a system like an industrial truck, where power cables carry hundreds of Ampere, there are voltage drops due to the impedance of the cables, and that could cause errors on the data transmitted through the can wires. In the following figures there is an overview of wrong and right layouts of the cables routing.

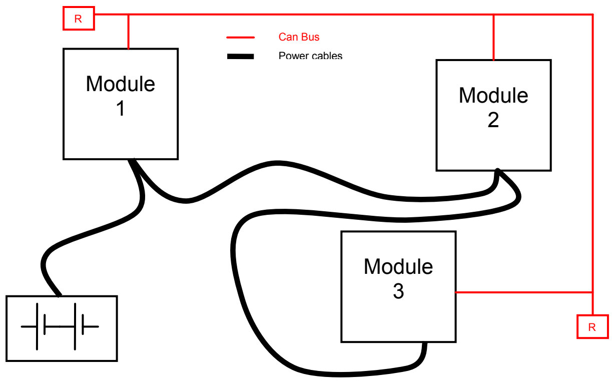
Wrong Layout:



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

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

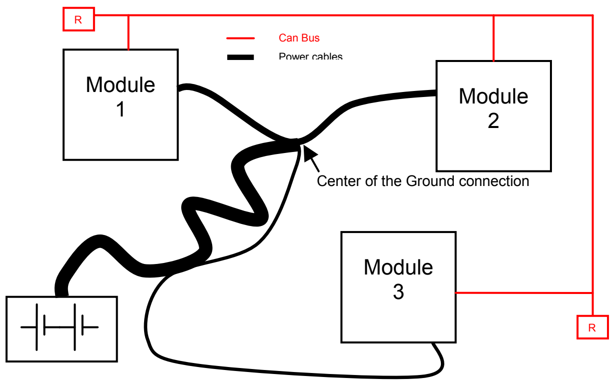
Correct Layout:



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

The chain starts from the –BATT post of the controller that works with the highest current, and the others are connected in a decreasing order of power.
Otherwise, if two controllers are similar in power (for example a traction and a pump motor controller) and a third module works with less current, the best way to deal this configuration is to create a common ground point (star configuration).

Correct Layout:



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

In this case the power cables starting from the two similar controllers must be as short as possible. Of course also the diameter of the cable concurs in the voltage drops described before (higher diameter means lower impedance), so in this last example the cable between the minus of the Battery and the common ground point (pointed by the arrow in the image) must be dimensioned taking into account thermal and voltage drop problems.

6.2.2 Wirings: I/O connections

- After crimping the cable, verify that all strands are entrapped in the wire barrel.
- Verify that all the crimped contacts are completely inserted on the connector cavities.

⚠ ***A cable connected to the wrong pin can lead to short circuits and failure; so, before turning on the truck for the first time, verify with a multimeter the continuity between the starting point and the end of a signal wire.***

- For information about the mating connector pin assignment see the paragraph "description of the connectors".

6.2.3 Insulation of truck frame

⚠ ***As stated by EN-1175 "Safety of machinery – Industrial truck", chapter 5.7, "there shall be no electrical connection to the truck frame". So the truck frame has to be isolated from any electrical potential of the truck power line.***

6.3 Protection features

6.3.1 Hardware Protection

- **Battery polarity inversion**
  The board is protected against reverse battery polarity
- **Overvoltage**
  All input/output pins can withstand, for a short time, an applied voltage up to +B.
- **Undervoltage**
  The VCM is fully operative for key voltages down to 11V
- **Connection Errors**
  All input/output pins are protected against:
  - short circuit to positive battery voltage
  - short circuit to negative battery voltage.
  - Open-circuit and cable disconnection
- **External agents:**
  The controller is protected against dust and the spray of liquid to a degree of protection meeting IP65.

6.3.2 Safety Features

⚠ ***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.
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.
<u>Machine manufacturer holds the responsibility for the truck safety features and related approval.</u>

6.3.3 Double microcontroller architecture

The VCM module has two separated microcontrollers in a master/slave architecture. The communication between them is realized by the local CANbus line.
Many input and output pins are connected to both master and slave microcontroller (see chapter 7) . These pins can be used as part of safety functions whose requested Performance Level is high. The double-microcontroller architecture operates as follows:

- For inputs: both master and slave read the status of the input pin, through two independent circuits. Then the two microcontrollers use the local CANbus line to check if the two read status are equal. Any mismatch during the read process is detected and it can be used to enter an alarm condition or to start other actions.
- For outputs: the master transmits the control command to the output driver (which can be a current command or a PWM command) while the slave gives an enable signal which can block the master command. No output can be turned on unless both microcontrollers has agreed on the activation.

6.4 EMC

EMC and ESD performances of an electronic system 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. Zapi can offer assistance and suggestions, based on its years experience, on EMC related items. However, <u>ZAPI declines any responsibility for non-compliance, malfunctions and failures, if correct testing is not made. The machine manufacturer holds the responsibility to carry out machine validation, based on existing norms (EN12895 for industrial truck; EN50081-2 for other applications).</u>

EMC stands for Electromagnetic Compatibility, and it represents the studies and the tests on the electromagnetic energy generated or received by an electrical device. So the analysis works in multiple directions:

2) **Emission** problems, the disturbances generated by the device and the possible countermeasure to prevent the propagation of that disturbances. It is used to talk about “conduction” issues when guiding structures such as wires and cables are involved, “radiated emissions” when the propagation of electromagnetic energy happens through the open space. In the CAN I/O case there is no power bridge commutating large current at high frequency thus the problems related to emission should be less relevant than in other Zapi product. The main source of emission may be the CANbus because its wire is often very long and it can be a quite good antenna. As usual, <u>a good layout of the cables and their shielding can solve the majority of the emission problems</u>.

3) The **electromagnetic immunity** concerns the susceptibility of the controller with regard to external electromagnetic fields and their influence on the function of the electronic device.
There are well defined tests which the machine has to be exposed to. These tests are carried out at determined levels of electromagnetic fields, to simulate external undesired disturbances and verify the electronic devices response. Normally the same prescriptions (cable layout, shielding..) used to solve emission problems can be applied to solve immunity problems too.

4) The **ESD**, concerns the prevention of the effects of electric current due to excessive electric charge stored in an object. In fact, when a charge is created on a material and it remains there, it becomes an "electrostatic charge"; ESD happens when there is a rapid transfer from a charged object to another. This rapid transfer has, in turn, two important effects:
A) this rapid charge transfer can determine, by induction, disturbs on the signal wiring and thus create malfunctions; **this effect is particularly critical in modern machines, where CANbus lines are spread everywhere on the truck and which carry critical information.**
B) in the worst case and when the amount of charge is very high, the discharge process can determine failures in the electronic devices; the type of failure can vary from an intermittently malfunction to a completely failure of the electronic device.

It is always much easier and cheaper to avoid ESD from being generated, than to increase the level of immunity of the electronic devices.

The VCM can be prone to electrostatic discharge because it is normally connected to many command devices. These devices, which are touched by the operator, are common sources of generation and propagation of ESD.
The best way to avoid ESD is through isolation and grounding of the propagating devices. **It is strongly suggested to connect to truck frame all the parts of the truck which can be touched by the operator**.

7 DESCRIPTION OF THE CONNECTORS

7.1 CNA Ampseal 35 poles

A1	POWER IN 1	Power input 1. The power supply for loads must be connected here with a fuse in series.
A2	NEVP3	Output of the current controlled electrovalve EVP3; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A14.
A3	NEVP4	Output of the current controlled electrovalve EVP4; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A14.
A4	NEVP7	Output of the current controlled electrovalve EVP7; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A16.
A5	NEVP8	Output of the current controlled electrovalve EVP8; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A16.
A6	NEV1	Output of the PWM voltage controlled electrovalve EV1; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A17.
A7	NEV2	Output of the PWM voltage controlled electrovalve EV2; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A17.
A8	DI1	Input of the switch DI1. The input is active high.
A9	DI2	Input of the switch DI2. The input is active high.
A10	DI3	Input of the switch DI3. The input is active high.
A11	CANL 1	CAN 1 Low signal.
A12	CANH 1	CAN 1 High signal. A 120R termination resistance is present between CAN L1 and CAN H1.
A13	PEVP 1/2	Common positive supply for EVP1 and EVP2 .This signal is the voltage redirected from CNA-1 through a Smart Driver **(not present for 80V version)** and a diode.
A14	PEVP 3/4	Common positive supply for EVP3 and EVP4 .This signal is the voltage redirected from CNA-1 through a diode.
A15	PEVP 5/6	Common positive supply for EVP5 and EVP6 .This signal is the voltage redirected from CNA-1 through a diode.
A16	PEVP 7/8	Common positive supply for EVP7 and EVP8 .This signal is the voltage redirected from CNA-1 through a diode.
A17	PEV1	Common positive supply for EV1 and EV2 .This signal is the voltage redirected from CNA-1 through a diode.
A18	DI4	Input of the switch DI4. The input is active high. Read by both microcontrollers.

A19	DI5	Input of the switch DI5. The input is active high. Read by both microcontrollers.
A20	DI6	Input of the switch DI6. The input is active high.
A21	DI7	Input of the switch DI7. The input is active high.
A22	NPOT	This is a ground reference to be used for the analog inputs
A23	AI1	Analog input 1.
A24	NEVP1	Output of the current controlled electrovalve EVP1 driver; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A13.
A25	NEVP2	Output of the current controlled electrovalve EVP2 driver; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A13.
A26	NEVP5	Output of the current controlled electrovalve EVP5 driver; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A15.
A27	NEVP6	Output of the current controlled electrovalve EVP6 driver; 2 A maximum continuous current (driving to –Batt); built-in freewheeling diode to A15.
A28	KEY	Connected to the power supply through a microswitch (CH) with a 10 A fuse in series.
A29	-BATT	Ground. Connect to ground reference.
A30	CANL 2	CAN 2 Low signal.
A31	CANH 2	CAN 2 High signal. A 120R termination resistance is present between CAN L 2 and CAN H 2.
A32	-BATT	Ground. Connect to ground reference.
A33	PPOT1	Low power regulated output (+12V). Maximum current 550mA.
A34	PPOT2	Low power regulated output (+5V). Maximum current 100mA.
A35	AI2	Analog input 2.

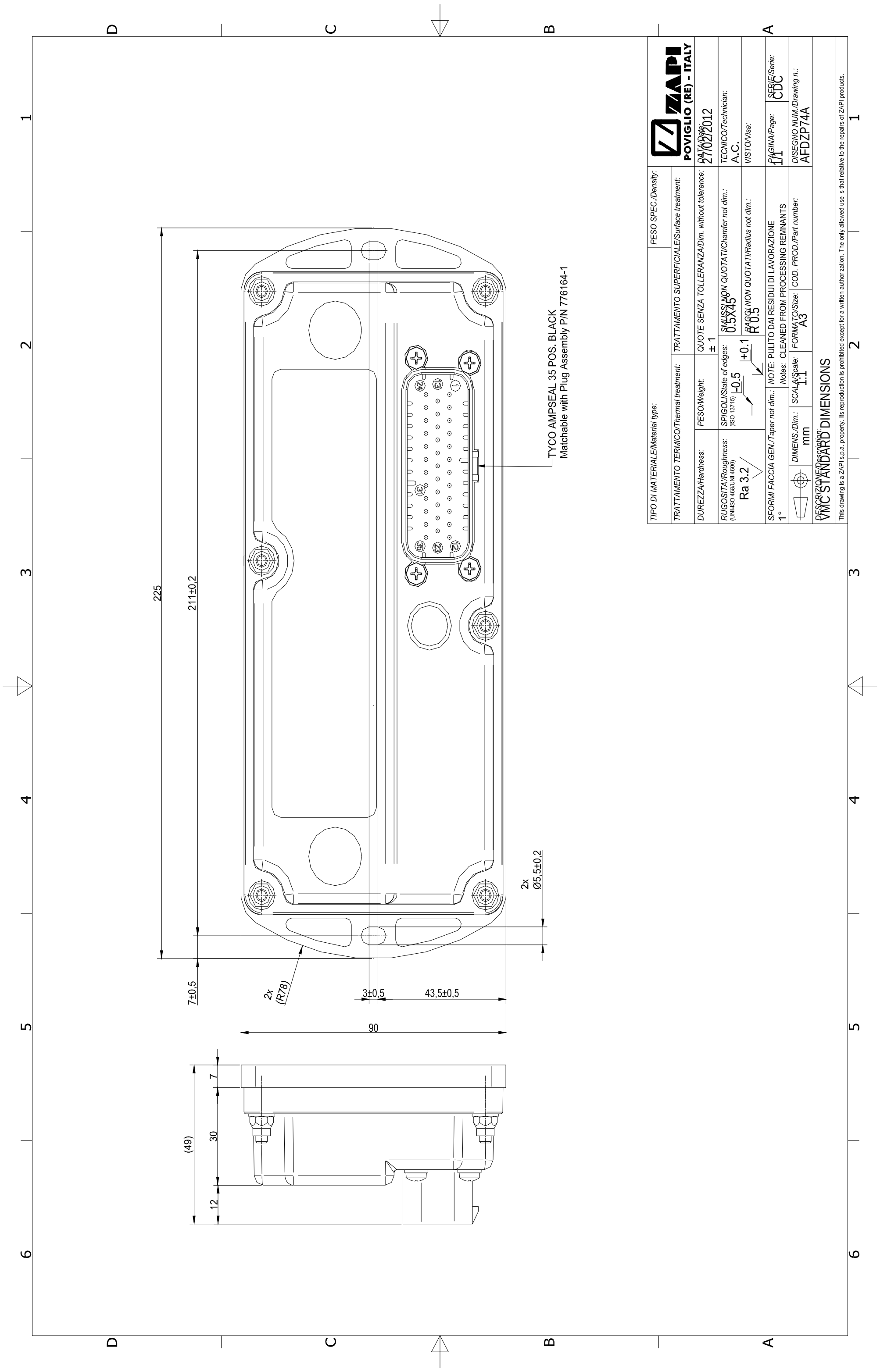
7.2 CNB Ampseal 23 poles (only for VCM PREMIUM)

B1	AI3	Analog input 3.
B2	AI4	Analog input 4.
B3	AI5	Analog input 5.
B4	AI6	Analog input 6. Read by both microcontrollers.
B5	AI7	Analog input 7. Read by both microcontrollers.
B6	AI8	Analog input 8.
B7	POWER IN 2	Power input 2. The power supply for loads must be connected here with a fuse in series.
B8	PEV2	Common positive supply for EVP9. Optionally, in the 36-48V version, it is possible to install a Smart driver on this output.
B9	CHA 2	Phase A of incremental encoder 2. Read by both microcontrollers.
B10	CHB 2	Phase B of incremental encoder 2. Read by both microcontrollers.
B11	AI9	Analog input 9.
B12	AI10	Analog input 10.
B13	DI8	Input of the switch DI8. The input is active high.
B14	DI9	Input of the switch DI9. The input is active high.
B15	NEV3	Output of the PWM voltage controlled electrovalve EV3 driver; 2 A maximum continuous current (driving to –Batt).
B16	PPOT3	Low power regulated output (+5V). Maximum current 75mA.
B17	CHA 1	Phase A of incremental encoder 1. Read by both microcontrollers.
B18	CHB 1	Phase B of incremental encoder 1. Read by both microcontrollers.
B19	NPOT	This is a ground reference to be used for encoders
B20	-BATT	Ground. Connect to ground reference.
B21	DI10	Input of the switch DI10. The input is active high. .
B22	DI11	Input of the switch DI11. The input is active high.
B23	NEVP9	Output of the current controlled electrovalve EVP9 driver; 4A maximum continuous current (driving to –Batt); built-in freewheeling diode to B7.

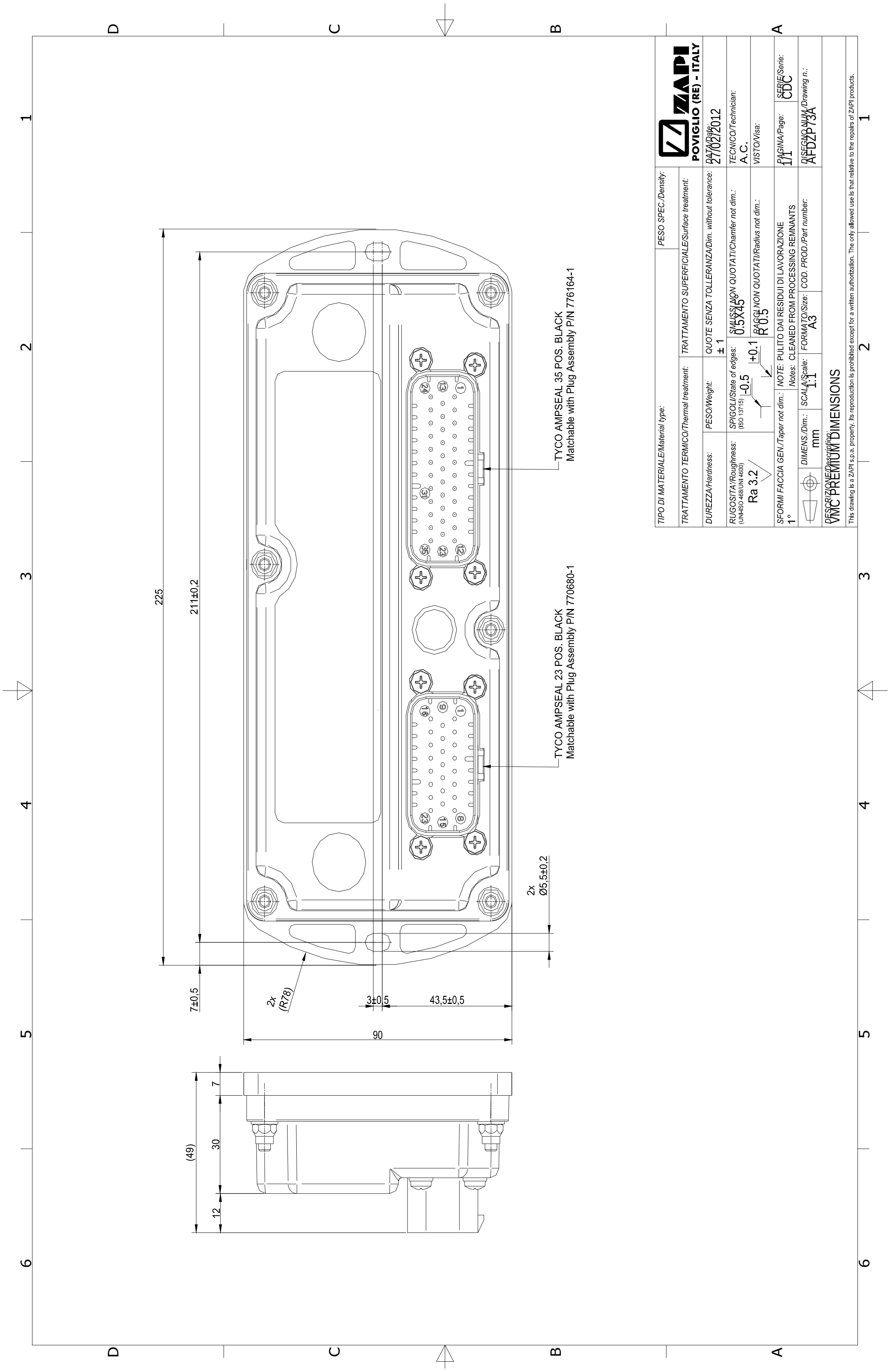
8 DRAWINGS

8.1 Mechanical drawing

8.1.1 VCM STANDARD

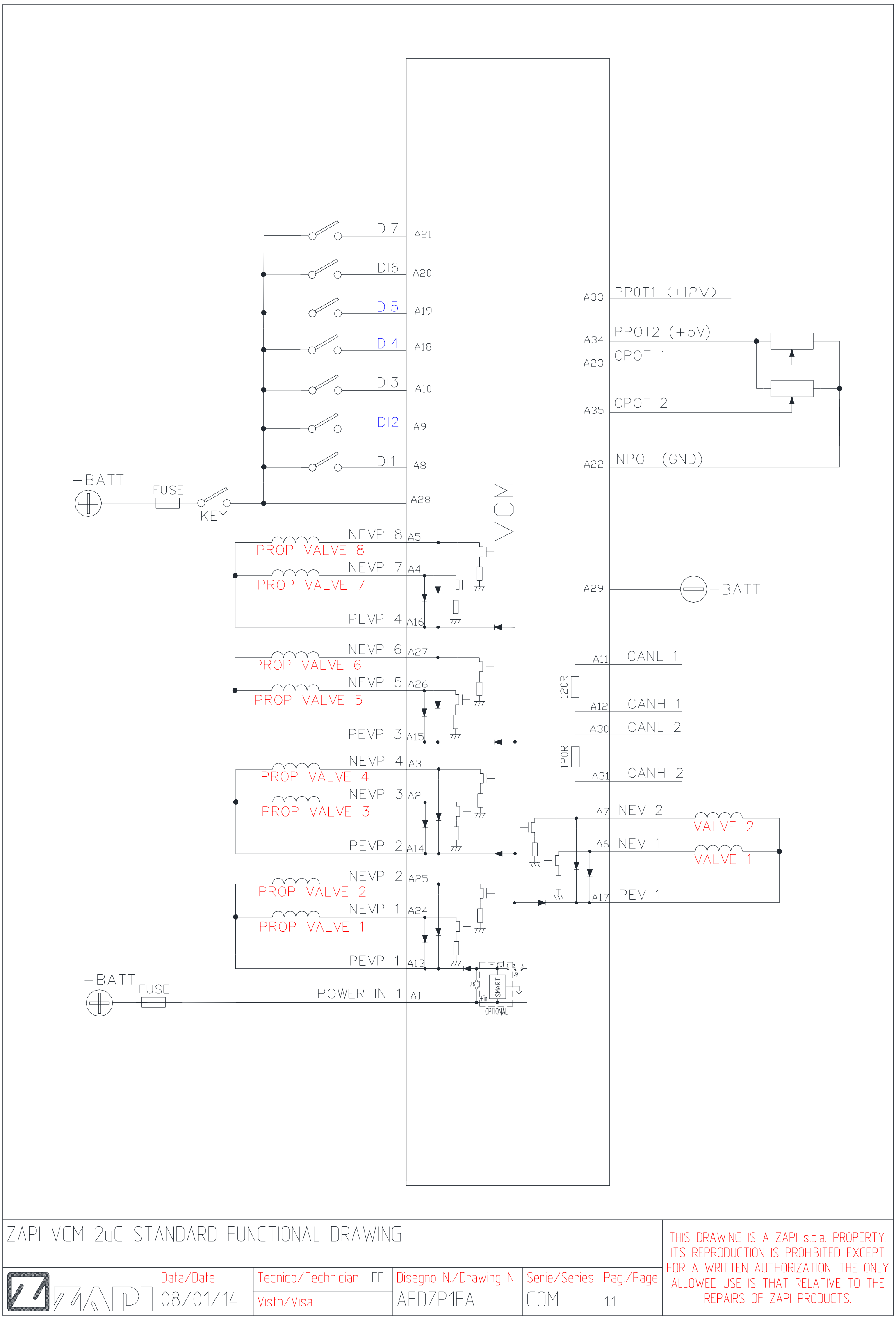


8.1.2 VCM PREMIUM

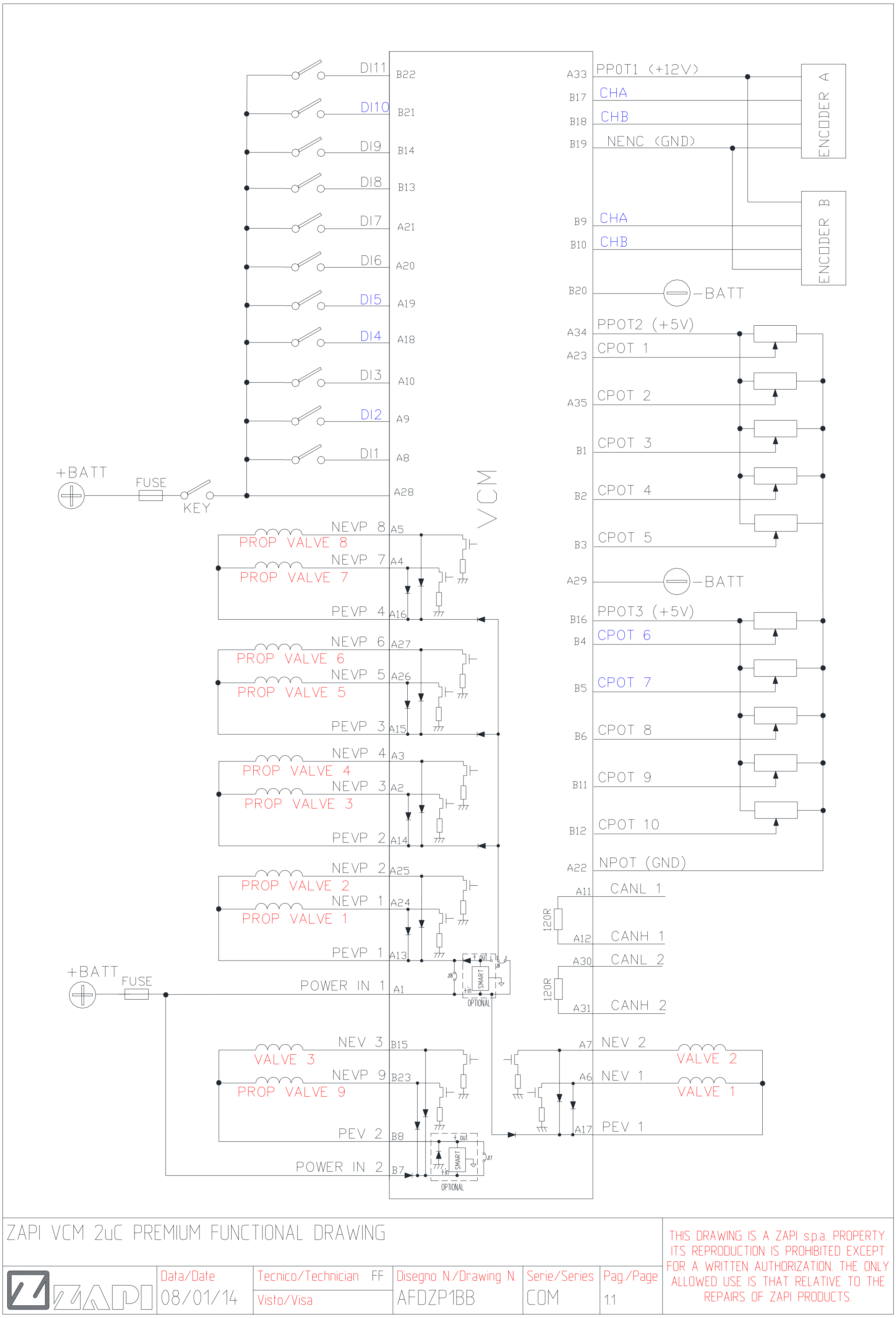


8.2 Functional drawing

8.2.1 VCM STANDARD



8.2.2 VCM PREMIUM



9 PROGRAMMING & ADJUSTMENTS

To access and adjust all parameters it is necessary to use the Zapi PC CAN console. Since the VCM has no external serial connector, the Zapi handset console can be used only if it is connected in remote through a different module, like Traction controller, Pump controller or other. This module has to be connected to the same CAN Bus line of the VCM.

9.1 Description of programmable functions

Here it is shown a list of all programmable functions of the VCM. The list refers to VCM Premium.
For Standard version it is possible to refer to this list but considering that some functions or parameters are not available.

Each menu and submenu can be different from what shown below according to the software customization of VCM.

Menu "Set Model"

1) **CONNECTED TO**
This parameter is used in systems where multiple modules are connected through CANbus: when the parameter value is set to a number corresponding to a node of the CAN line, the console connects to that node as if it was directly connected. In this way the console operates as a remote console. The node number corresponding to the VMC is "1".

2) **MODEL TYPE**
This parameter defines if the console must connect to the master microcontroller or to the supervisor microcontroller. Set the parameter to "0" to connect the master and to "1" to connect to the slave.
It is possible to choose only if both the uC, master and supervisor, are connected to the same line (see paragraph 4.5).

Menu "Set Options"

1) **HOUR COUNTER**
   - RUNNING: the counter registers travel time only.
   - KEY ON: the counter registers when the "key" switch is closed.

2) **EVP1**
PRESENT/ABSENT
It enables the EVP1.

3) **EVP2**
PRESENT/ABSENT
It enables the EVP2.

4) **EVP3**
PRESENT/ABSENT
It enables the EVP3.

5) **EVP4**
PRESENT/ABSENT
It enables the EVP4.

6) **EVP5**
PRESENT/ABSENT
It enables the EVP5.

7) **EVP6**
PRESENT/ABSENT
It enables the EVP6.

8) **EVP7**
PRESENT/ABSENT
It enables the EVP7.

9) **EVP8**
PRESENT/ABSENT
It enables the EVP8.

10) **EV1**
PRESENT/ABSENT
It enables the EV1.

11) **EV2**
PRESENT/ABSENT
It enables the EV2.

12) **EV3**
PRESENT/ABSENT
It enables the EV3.

13) **EVP9**
PRESENT/ABSENT
It enables the EVP9.

14) **EPS**
PRESENT/ABSENT
This parameter enables the electric steering controller presence.

15) **DEBUG CAN MESSAGE**
Reserved

16) **BATTERY CHECK**
PRESENT/ABSENT
ON: the battery discharge level check is carried out; when the battery level reaches 10%, an alarm is signaled 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 signaled.

17) TRANSFER HOURS
Three levels are available:

LEVEL 0= if there is a mismatch between Hour meter of traction and VCM, an alarm is signalled and the higher value is store on both after 2 min.

LEVEL 1= if there is a mismatch between Hour meter of traction and VCM, an alarm is signalled and the value present on the traction is stored in the VCM

LEVEL 2= if there is a mismatch between Hour meter of traction and VCM, an alarm is signalled and the value present in the VCM is stored in the traction

18) ENC. LOCK TEST
It enables the diagnoses of “encoder locked” for the encoder 1 and the encoder 2. In case of encoder locked an alarm is signaled and the pump is stopped.

Menu “Adjustments”

3) SET BATTERY TYPE
It selects the nominal battery voltage.

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

5) BAT. MIN ADJ.
It adjusts the lower level of the battery discharge table. It is used to calibrate the discharge algorithm with the battery of the application. See chapter 9.6 for more information.

6) BAT MAX ADJ.
It adjusts the upper level of the battery discharge table. It is used to calibrate the discharge algorithm with the battery of the application. See chapter 9.6 for more information.

7) ENC1 SENS 100MM
It defines the sensibility of encoder 1 expressed in number of pulses/100mm.

8) ENC2 SENS 100MM
It defines the sensibility of encoder 2 expressed in number of pulses/100mm.

9) WATCH YEAR
It permits to set the year of the Real Time Clock.

10) WATCH MONTH
It permits to set the month of the Real Time Clock.

11) WATCH DATE
It permits to set the date of the Real Time Clock.

12) WATCH HOURS

It permits to set the hour of the Real Time Clock.

13) WATCH MINUTES
It permits to set the minutes of the Real Time Clock.

Menu “Parameter Change”

1) I MIN EVP1
0 to 100. This parameter determines the minimum current applied on the EVP1 when the position of the command is at the minimum.

2) I MIN EVP1 OFF
0 to 100. This parameter determines the minimum current applied on the EVP1 when it is turning off and the position of the command is at the minimum.

3) I MIDDLE EVP1
0 to 100. This parameter determines the minimum current applied on the EVP1 when the position of the command is in the middle.

4) I MAX EVP1
From 0 to 100. This parameter determines the maximum current applied to the EVP1 when the position of the command is at the maximum.

5) I MIN EVP2
0 to 100. This parameter determines the minimum current applied on the EVP2 when the position of the command is at the minimum.

6) I MAX EVP2
From 0 to 100. This parameter determines the maximum current applied to the EVP2 when the position of the command is at the maximum.

7) I MIN EVP3
0 to 100. This parameter determines the minimum current applied on the EVP3 when the position of the command is at the minimum.

8) I MAX EVP3
From 0 to 100. This parameter determines the maximum current applied to the EVP3 when the position of the command is at the maximum.

9) I MIN EVP4
0 to 100. This parameter determines the minimum current applied on the EVP4 when the position of the command is at the minimum.

10) I MAX EVP4
From 0 to 100. This parameter determines the maximum current applied to the EVP4 when the position of the command is at the maximum.

11) I MIN EVP5
0 to 100. This parameter determines the minimum current applied on the EVP5 when the position of the command is at the minimum.

12) I MAX EVP5
From 0 to 100. This parameter determines the maximum current applied to the EVP5 when the position of the command is at the maximum.

13) **I MIN EVP6**
0 to 100. This parameter determines the minimum current applied on the EVP6 when the position of the command is at the minimum.

14) **I MAX EVP6**
From 0 to 100. This parameter determines the maximum current applied to the EVP6 when the position of the command is at the maximum.

15) **I MIN EVP7**
0 to 100. This parameter determines the minimum current applied on the EVP7 when the position of the command is at the minimum.

16) **I MAX EVP7**
From 0 to 100. This parameter determines the maximum current applied to the EVP7 when the position of the command is at the maximum.

17) **I MIN EVP8**
0 to 100. This parameter determines the minimum current applied on the EVP8 when the position of the command is at the minimum.

18) **I MAX EVP8**
From 0 to 100. This parameter determines the maximum current applied to the EVP8 when the position of the command is at the maximum.

19) **I MIN BRAKING**
From 0 to 100. This parameter determines the maximum current applied to the EVP9 (load wheels brakes) when the position of the command is at the maximum.

20) **I MAX BRAKING**
From 0 to 100. This parameter determines the maximum current applied to the EVP9 (load wheels brakes) when the position of the command is at the maximum.

21) **EVP1 OPN DELAY 1**
Seconds. It determines the acceleration ramp on EVP1.
The parameter sets the time needed to increase the current from MIN EVP1 to the MIDDLE EVP1.

22) **EVP1 OPN DELAY 2**
Seconds. It determines the acceleration ramp on EVP1.
The parameter sets the time needed to increase the current from MIDDLE EVP1 to the MAX EVP1.

23) **EVP1 CLS DELAY 1**
Seconds. It determines the deceleration ramp on EVP1.
The parameter sets the time needed to decrease the current from the MIDDLE EVP1 to MIN EVP1 OFF.

24) **EVP1 CLS DELAY 2**
Seconds. It determines the deceleration ramp on EVP1.
The parameter sets the time needed to decrease the current from the MAX EVP1 to MIDDLE EVP1.

25) **EVP2 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP2.
The parameter sets the time needed to increase the current from MIN EVP2 to the MAX EVP2.

26) **EVP2 CLS DELAY**
Seconds. It determines the deceleration ramp on EVP2.
The parameter sets the time needed to decrease the current from the MAX EVP2 to MIDDLE EVP2.

27) **EVP3 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP3.
The parameter sets the time needed to increase the current from MIN EVP3 to the MAX EVP3.

28) **EVP3 CLS DELAY**
Seconds. It determines the deceleration ramp on EVP3.
The parameter sets the time needed to decrease the current from the MAX EVP3 to MIDDLE EVP3.

29) **EVP4 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP4.
The parameter sets the time needed to increase the current from MIN EVP4 to the MAX EVP4.

30) **EVP4 CLS DELAY**
Seconds. It determines the deceleration ramp on EVP4.
The parameter sets the time needed to decrease the current from the MAX EVP4 to MIDDLE EVP4.

31) **EVP5 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP5.
The parameter sets the time needed to increase the current from MIN EVP5 to the MAX EVP5.

32) **EVP5 CLS DELAY**
Seconds. It determines the deceleration ramp on EVP5.
The parameter sets the time needed to decrease the current from the MAX EVP5 to MIDDLE EVP5.

33) **EVP6 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP6.
The parameter sets the time needed to increase the current from MIN EVP6 to the MAX EVP6.

34) **EVP6 CLS DELAY**
Seconds. It determines the deceleration ramp on EVP6.
The parameter sets the time needed to decrease the current from the MAX EVP6 to MIDDLE EVP6.

35) **EVP7 OPN DELAY**
Seconds. It determines the acceleration ramp on EVP7.
The parameter sets the time needed to increase the current from MIN EVP7 to the MAX EVP7.

36) EVP7 CLS DELAY
Seconds. It determines the deceleration ramp on EVP7.
The parameter sets the time needed to decrease the current from the MAX EVP7 to MIDDLE EVP7.

37) EVP8 OPN DELAY
Seconds. It determines the acceleration ramp on EVP8.
The parameter sets the time needed to increase the current from MIN EVP8 to the MAX EVP8.

38) EVP8 CLS DELAY
Seconds. It determines the deceleration ramp on EVP8.
The parameter sets the time needed to decrease the current from the MAX EVP8 to MIDDLE EVP8.

39) BRAK OPEN DELAY
Seconds. It determines the acceleration ramp on EVP9.
The parameter sets the time needed to increase the current from MIN EVP9 to the MAX EVP9.

40) BRAK CLOSE DELAY
Seconds. It determines the deceleration ramp on EVP9.
The parameter sets the time needed to decrease the current from the MAX EVP9 to MIDDLE EVP9.

Menu “Special Adjustment”

To reach this menu, using the handset console, enter into the “Alarms” menu and then push the two right buttons at the same time.

---

1) SYNC FREQ
It is the carrier frequency of the proportional valve coils drivers. The default value is 1000 Hz. It can be adjusted in the 100Hz up to 15000 Hz. The resolution is 100Hz(it can be adjusted in steps of 100 Hz).

2) DITHER AMPLITUDE
It is the dither signal amplitude. The dither signal is a square wave which is overlapped to the proportional valves set point. In this way the proportional valves response to set point variations is optimized. This parameter has 9 levels. It is expressed as 2000mA/255

3) DITHER FREQUENCY
It is the dither signal frequency. 4 levels are available.
L0=50Hz, L1=62,5Hz, L2=83Hz, L3=125Hz, L4=250Hz

4) ADDRESS
Reserved.

5) RS232 CONSOLE
Reserved

9.2 Description of the TESTER function

The most important input or output signals can be measured in real time using the TESTER function of the console. The following listing shows the available measurements :

1) **WORKING HOURS**
   It shows the working hours of the truck according to the setting of the HOUR COUNTER option.

2) **BATTERY VOLTAGE**
   Voltage value with 1 decimal digit. Battery voltage value measured at the key on.

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

4) **STEER ANGLE**
   Degree value. It shows the current steering angle.

5) **RTC YEAR**
   Year of the Real Time Clock.

6) **RTC MONTH**
   Month of the Real Time Clock.

7) **RTC DATE**
   Date of the Real Time Clock.

8) **RTC HOUR**
   Hour of the Real Time Clock.

9) **RTC MINUTES**
   Minutes of the Real Time Clock.

10) **OUTPUT GROUP #1**
    % value. Percentage of the maximum current applied on the output group #1 (EVP1 and EVP2).

11) **OUTPUT GROUP #2**
    % value. Percentage of the maximum current applied on the output group #2 (EVP3 and EVP4).

12) **OUTPUT GROUP #3**
    % value. Percentage of the maximum current applied on the output group #3 (EVP5 and EVP6).

13) **OUTPUT GROUP #4**
    % value. Percentage of the maximum current applied on the output group #4 (EVP7 and EVP8).

14) **NEVP9 OUTPUT**
    % value. Percentage of the maximum current applied on the EVP9 (Load wheels brakes).

15) **NEV3 OUTPUT**
% value. Percentage of the battery voltage applied on the EV3 (Laser).

16) **NEV2 OUTPUT**
% value. Percentage of the battery voltage applied on the EV2 (Back up alarm).

17) **NEV1 OUTPUT**
% value. Percentage of the battery voltage applied on the EV1 (battery unlock).

18) **ENCODER #1**
Number of pulsed read by the encoder 1.

19) **ENCODER #2**
Number of pulsed read by the encoder 2.

20) **DIGITAL INPUT**
It is a decimal value that represent the status of all the digital inputs.

21) **DIGITAL INPUT #1**
ON/OFF. This is the level of the digital input A8 .
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

22) **DIGITAL INPUT #2**
ON/OFF. This is the level of the digital input A9 .
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

23) **DIGITAL INPUT #3**
ON/OFF. This is the level of the digital input A10 .
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

24) **DIGITAL INPUT #4**
ON/OFF. This is the level of the digital input A18.
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

25) **DIGITAL INPUT #5**
ON/OFF. This is the level of the digital input A19 .
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

26) **DIGITAL INPUT #6**
ON/OFF. This is the level of the digital input A20 .
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

27) **DIGITAL INPUT #7**
ON/OFF. This is the level of the digital input A21.
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

28) DIGITAL INPUT #8
ON/OFF. This is the level of the digital input B13.
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

29) DIGITAL INPUT #9
ON/OFF. This is the level of the digital input B14.
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

30) DIG. INPUT #10
ON/OFF. This is the level of the digital input B21.
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

31) DIG. INPUT #11
ON/OFF. This is the level of the digital input B22
ON +VB = When it is closed to positive voltage the input is active.
OFF GND = When it is open the input is not active.

32) ANALOG INPUT #1
Volt value. This is the level of the analog input A23.

33) ANALOG INPUT #2
Volt value. This is the level of the analog input A35.

34) ANALOG INPUT #3
Volt value. This is the level of the analog input B1.

35) ANALOG INPUT #4
Volt value. This is the level of the analog input B2.

36) ANALOG INPUT #5
Volt value. This is the level of the analog input B3.

37) ANALOG INPUT #6
Volt value. This is the level of the analog input B4.

38) ANALOG INPUT #7
Volt value. This is the level of the analog input B5.

39) ANALOG INPUT #8
Volt value. This is the level of the analog input B6.

40) ANALOG INPUT #9
Volt value. This is the level of the analog input B11.

41) ANALOG INPUT #10
Volt value. This is the level of the analog input B12.

9.3 Description of the console SAVE function

The SAVE function allows the operator to save the values of **all parameters** of

the controller into a file.
The information saved in the file can then be reloaded into another VCM using the RESTORE function.

There is no difference in using the SAVE function while connected to the Master or to the Slave. The parameter values are the same in both EEPROM.

9.4 Description of the console RESTORE function

The RESTORE PARAM function allows transfer stored data into the memory of the VCM. This is achieved in a fast and easy way using the method previously used with the SAVE PARAM. Function.

There is no difference in using the RESTORE function while connected to the Master or to the Slave. Anyway it is suggested to connect to the Master in order to restore the parameters.

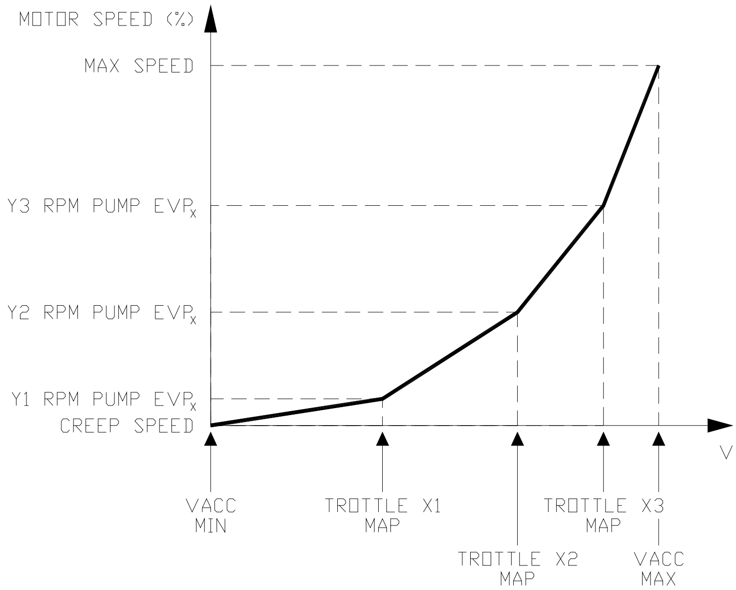
9.5 Description of the throttle regulation

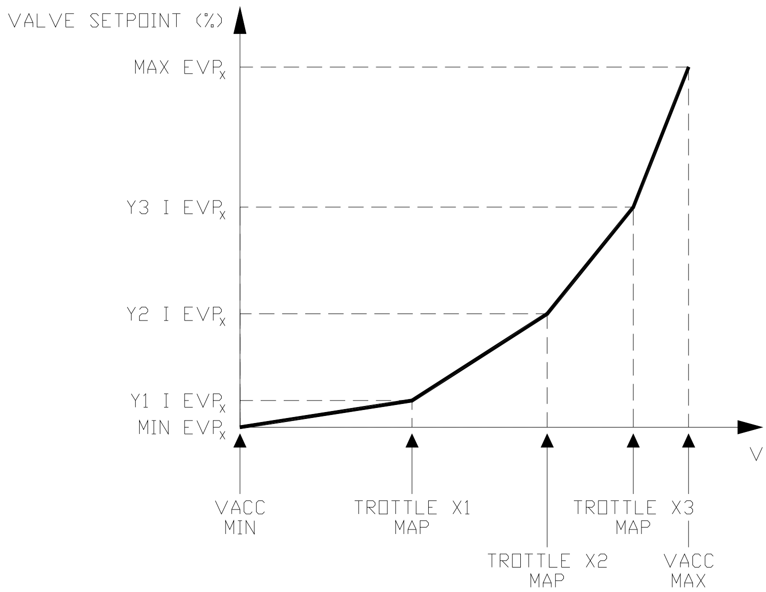
This example is referred to an hydraulic functions management. A similar structure can be implemented also for other type of functionalities.

This regulation applies a not linear relationship between the position of the hydraulic command, the speed of the pump motor and the valve set point. The main goal is to increase the resolution for the speed modulation during slowly moving.
Three adjustments are used for the throttle regulation:
1) THROTTLE X1 MAP
2) Y1 RPM PUMP EVPx
3) Y1 I EVPx
4) THROTTLE X2 MAP
5) Y2 RPM PUMP EVPx
6) Y2 I EVPx
7) THROTTLE X3 MAP
8) Y3 RPM PUMP EVPx
9) Y3 I EVPx

THROTTLE X1 POINT & THROTTLE Y1 POINT: the speed (or set point) grows up with a fixed slope (linear relationship) from the THROTTLE 1 POINT up to THROTTLE X2 POINT. This slope is defined by the matching between the X1 point percentage of the maximum value setting with the Y1 point percentage of the full value.
Same as for the pairs (X2;Y2) and (X3;Y3)
From the X3 point up to the maximum, the slope of the relationship between the speed (or set point) and the throttle position is different to match to match the full

speed in with the maximum voltage in the potentiometer position.

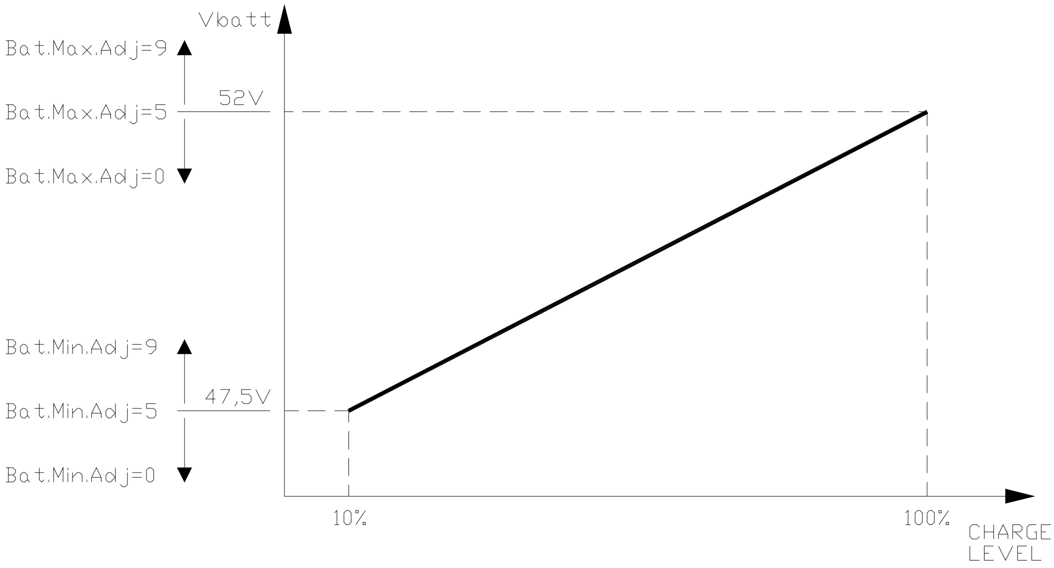




9.6 Description of the battery charge detection setting

The Battery Charge detection uses two setting that specify the Full Charge Voltage Level (100%) and the Discharge Voltage Level (10%). These two settings are the Bat.Max.Adj and the Bat.Min.Adj. It is possible to adapt the Battery Charge Detection to your specific battery, by changing the above two settings (e.g. if the Battery Discharged Detection occurs when the battery is not totally discharged, it is necessary to reduce the Bat.Min.Adj setting as indicated in the figure below).

48V NOMINAL BATTERY VOLTAGE



9.7 Description of ALARMS menu

Both master and slave microcontrollers remember the last five Alarms that have occurred. Items remembered relative to each Alarm are:

1) the code of the alarm
2) the number of times the particular Alarm occurred
3) the Hour Meter count when the first alarm event has occurred
4) the controller temperature of the first alarm event.

This function permits a deeper diagnosis of problems as the recent history can now be accessed.
If an alarm is continuously happening, the controller does not use new memory of the logbook but it just updates the memory cell about that particular alarm.

10 CONTROLLER DIAGNOSTIC

10.1 Diagnostic features

The VCM has two microcontrollers which carry out many diagnostic analysis to check all the internal functions. Each microcontroller carry out its own analysis independently of the other one and it is capable of raise an alarm code in the CANbus line.
Moreover many internal functions are stopped if at least one of the two microcontrollers detects a fault.
The complete list of the Master and Slave alarms is shown in the following table.
The list also shows the corresponding alarm codes in the Zapi format (the same shown from an MDI or an Eco Smart Display) and in the CANopen format.

MASTER

ZAPI CODE	CANopen Code	Alarm name
8	8200	WATCHDOG
19	8211	LOGIC FAILURE #1
200	8392	WRONG PARAMETER
201	8393	WRONG SLAVE VER.
202	8394	HM MISMATCH
204	8396	BATTERY LOW
208	8400	EEPROM KO
209	8401	PARAM RESTORE
210	8402	WRONG RAM MEM.
211	8403	PUMP INC. START
213	8405	ENCODER LOCKED 1
214	8406	ENCODER LOCKED 2
215	8407	OUT PORT PULL-UP
217	8409	ANALOG INPUT
219	8411	VALVE ENABLE
223	8415	NO CAN MSG. 5
224	8416	WAITING FOR NODE
225	8417	CONTROLLER MISM.
226	8418	PUMP IN ALARM
227	8419	NO CAN MSG. 14
228	8420	NO CAN MSG. A
229	8421	SDO TRAC.
241	8433	M/S PAR CHK MISM
242	8434	PARAM TRANSFER
244	8436	CHECK UP
246	8438	NO CAN MSG C
247	8439	NO CAN MSG 6
248	8440	NO CAN MSG 10
249	8441	CAN BUS DISPLAY

SLAVE

ZAPI CODE	CANopen Code	Alarm name

8	8200	WATCHDOG
19	8211	LOGIC FAILURE #1
199	8391	OUT1/2 COIL SH.
200	8392	OUT3/4 COIL SH.
201	8393	OUT5/6 COIL SH.
202	8394	OUT7/8 COIL SH.
203	8395	EV3 COIL SH.
204	8396	EV1 COIL SH.
205	8397	EVP9 COIL SH
206	8398	EV2 COIL SH.
207	8399	WATCH DOG MASTER
208	8400	EEPROM KO
209	8401	PARAMETER RESTORE
210	8402	WRONG RAM MEM.
211	8403	PEV DRV. OPEN
212	8404	PEV DRV. SHORT.
213	8405	VALVE MISM. OUT
215	8407	OUT PORT PULL-UP
217	8409	ANALOG INPUT
218	8410	IN. MISM. D
219	8411	IN. MISM. A/E
223	8415	NO CAN MSG. C
224	8416	NO CAN MSG. 4
225	8417	CONTROLLER MISM
227	8419	NO CAN MSG. 14
228	8420	NO CAN MSG. A
231	8423	DRV. SHRT A
232	8424	DRV. OPEN A
233	8425	DRV. SHRT B
234	8426	DRV. OPEN B
243	8435	COIL OPEN A
244	8436	COIL OPEN B
245	8437	COIL OPEN EVP9
246	8438	DRV. SHRT EVP9
247	8439	DRV. OPEN EVP9

10.2 Description of alarms displayed on the console

MASTER

1) WATCHDOG

Cause:
A software watchdog is programmed inside each microcontroller. Its role is to check the correct operation of the software. All functions are blocked.
Troubleshooting:
it is an internal error, the module must be replaced.

2) LOGIC FAILURE #1

This alarm signals that an undervoltage at the key input has been detected. All functions are blocked.
Troubleshooting depends on which is the reason of the alarm:

A) A real undervoltage situation happened. The alarm should disappear by simply switching off and on again the key. The cause of the undervoltage event has to be found on the application. For example: a truck function requesting a very large battery current may decrease too much the battery voltage.
B) Fault in the circuit which detects the undervoltage condition. The board must be replaced.

3) **WRONG PARAMETER**
Cause:
This is an alarm related to the throttle configuration.
Troubleshooting:
Check the parameters.

4) **WRONG SLAVE VER**
Cause:
Wrong software version on supervisor uC.
Troubleshooting:
Install the correct software version in the supervisor uC.

5) **HM MISMATCH**
Cause:
Mismatch between VCM and traction regarding the Hour Meter .
Troubleshooting:
Check the parameter setting concerning the HM.

6) **BATTERY LOW**
Cause:
It occurs when the battery charge is calculated being less than or equal to 10% of the full charge and the BATTERY CHECK setting is other than 0 (refer to SET OPTION menu).
Troubleshooting:
Get the battery charged. If it doesn't work, measure with a voltmeter the battery voltage and compare it with the value in the BATTERY VOLTAGE parameter. If they are different adjust the value of the ADJUST BATTERY function.

7) **EEPROM KO**
Cause:
Fault in the area of memory where the parameters are stored or problems during the read/write operations of this memory. This alarm does not inhibit machine operation but default parameters are used.
Troubleshooting:
If the fault continues when the key switch is re-cycled, replace the board. If the fault disappears, the previously stored parameters will have been replaced by the default parameters.

8) **PARAM RESTORE**
Cause:
This warning appears when the controller restored the default values.
Troubleshooting:
If a CLEAR EEPROM was mode before the last keyon-recycle, this warning just means that the EEPROM was correctly cleared. A travel demand or a pump request cancel the alarm. If this alarm appears at keyon without any CLEAR EEPROM request by the operator, there could be a problem inside

the controller.

9) **WRONG RAM MEM**

Cause:

The algorithm implemented to check the main RAM registers finds a wrong contents: the register is “dirty”. This alarm inhibit the machine operations.

Troubleshooting:

Try to switch the key off and then on, if the alarm is still present replace the logic board.

10) **PUMP INC. START**

Cause:

This is a warning for an incorrect starting sequence.

Troubleshooting:

The possible reasons for this alarm is (use the readings in the TESTER to facilitate the troubleshooting) pump demand active at key on or a pump demand is present without the seat input active.

Check the wirings. Check the micro-switches. It could be also an error sequence made by the operator. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller.

11) **ENCODER LOCKED #1**

Cause:

The encode1 is stuck or the encoder signals are not correctly received by the controller.

Troubleshooting:

Please check if the ENCODER1 on the tester menu is different than zero during a lifting request.

Check the wirings and check that the sensor works correctly. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller.

12) **ENCODER LOCKED #2**

Cause:

The encode1 is stuck or the encoder signals are not correctly received by the controller.

Troubleshooting:

Please check if the ENCODER 2 on the tester menu is different than zero during a lifting request.

Check the wirings and check that the sensor works correctly. A failure in the logic is possible too; so when all of the above conditions were checked and nothing was found, replace the controller.

13) **OUT PORT PULL-UP**

Cause:

This is an alarm related to the hardware configuration.

Troubleshooting:

The problem is on the logic board, which must be replaced.

14) **ANALOG INPUT**

Cause:

There is a problem in the analog-to-digital module of the microcontroller. All functions are stopped.

Troubleshooting: this a failure internal to the microcontroller, replace the board.

15) VALVE ENABLE

Cause:

It occurs when the uC master try to activate an output but the supervisor uC doesn't activate the enable.

Troubleshooting:

Check if some alarm is present on supervisor uC. Otherwise a fault in the hardware is present, the board must be replaced.

16) NO CAN MSG 5

Cause:

Timeout on the local CAN BUS

Troubleshooting:

Switch OFF and ON. If the alarm is still present replace the board.

17) WAITING FOR NODE

Cause:

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

18) CONTROLLER MISM

Cause:

Wrong customer ID code found in the protected area of memory where this parameter are stored

Troubleshooting:

Replaced the controller.

19) PUMP IN ALARM

Cause:

Alarm on pump controller.

Troubleshooting:

Check the alarm on pump controller.

20) NO CAN MSG 14

Cause:

No CAN message from pump controller

Troubleshooting:

Check the CAN connection on pump controller side. Verify that the pump communicates on CAN bus

21) NO CAN MSG A

Cause:

No CAN message from the Mini Lever or Joystick

Troubleshooting:

Check the CAN connection on Mini Lever or Joystick side. Verify that the Mini Lever or Joystick communicate on CAN bus

22) SDO TRAC

Cause**:**

There is a problem in the communication of HM between VCM and traction

Troubleshooting: Verify the communication between the two controllers. If all is ok try to replace the board.

23) **M/S PAR CHK MISM**

Cause:

Parameters are saved both in the master Eeprom and in the slave Eeprom. The two non-volatile memories must contains the same parameter values and they are compared periodically. If a difference is found, this alarm is raised. This alarm does not inhibit machine operation but default parameters are used.

Troubleshooting:

Try to save again the parameters.

If the fault continues when the key switch is re-cycled, replace the board.

24) **PARAM TRANSFER**

Cause:

Parameters are saved both in the master Eeprom and in the slave Eeprom. The two non-volatile memories must contains the same parameter values and they are compared periodically. If the master is not able to transfer the parameters to the slave, this alarm is raised.

Troubleshooting:

Try to save again the parameters.

If the fault continues when the key switch is re-cycled, replace the board.

25) **CHECK UP**

Cause:

This is just a warning to call for the time programmed maintenance.

Troubleshooting:

It is just enough to turn the CHECK UP DONE option to level ON after the maintenance is executed.

26) **NO CAN MSG. C**

Cause:

No CAN message from traction controller

Troubleshooting:

Check the CAN connection on traction controller side. Verify that the traction communicates on CAN bus

27) **NO CAN MSG. 6**

Cause:

No CAN message from EPS.

Troubleshooting:

Check the CAN connection on steering controller side. Verify that the steering communicates on CAN bus

28) **NO CAN MSG. 10**

Cause:

No CAN message from DISPLAY

Troubleshooting:

Check the CAN connection on display side. Verify that the display communicates on CAN bus

29) **CAN BUS DISPLAY**

Cause:

The key relay driven by display is open

Troubleshooting:

Check the relay.

SLAVE

1) **WATCHDOG**

Cause:

A software watchdog is programmed inside each microcontroller. Its role is to check the correct operation of the software. All functions are blocked.

Troubleshooting:

it is an internal error, the module must be replaced.

2) **LOGIC FAILURE #1**

Cause:

This alarm signals that an undervoltage at the key input has been detected. All functions are blocked.

Troubleshooting depends on which is the reason of the alarm:

A) A real undervoltage situation happened. The alarm should disappear by simply switching off and on again the key. The cause of the undervoltage event has to be found on the application. For example: a truck function requesting a very large battery current may decrease too much the battery voltage.

B) Fault in the circuit which detects the undervoltage condition. The board must be replaced

3) **OUT 1/2 COIL SH**

Cause:

This alarm occurs when there is a short circuit of the EVP1 or EVP2 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.

Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.

B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

4) **OUT 3/4 COIL SH**

Cause:

This alarm occurs when there is a short circuit of the EVP3 or EVP4 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.

Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.

B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

5) **OUT 5/6 COIL SH**

Cause:

This alarm occurs when there is a short circuit of the EVP5 or EVP6 coil. After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.

Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.

B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

6) OUT 7/8 COIL SH

Cause:
This alarm occurs when there is a short circuit of the EVP7 or EVP8 coil.
After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

7) EV3 COIL SH

Cause:
This alarm occurs when there is a short circuit of the EV3 coil.
After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

8) EV1 COIL SH

Cause:
This alarm occurs when there is a short circuit of the EV1 coil.
After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

9) EVP9 COIL SH

Cause:
This alarm occurs when there is a short circuit of the EVP9 coil.
After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
Troubleshooting:

A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

10) EV2 COIL SH

Cause:
This alarm occurs when there is a short circuit of the EV2 coil.

After the overload condition has been removed, the alarm exits automatically by releasing and then enabling a travel demand.
Troubleshooting:
A) The typical root cause for this error code to be displayed is in the harness or in the load coil. So the very first check to carry out concerns connections between controller outputs and loads.
B) In case no failures/problems have been found externally, the problem is in the controller, which has to be replaced.

11) WATCHDOG MASTER
Cause:
An Hardware watchdog is present inside to synchronize the microcontrollers. All functions are blocked.
Troubleshooting:
It is an internal error, the module must be replaced.

12) EEPROM KO
Cause:
Fault in the area of memory where the parameters are stored or problems during the read/write operations of this memory. This alarm does not inhibit machine operation but default parameters are used.
Troubleshooting: if the fault continues when the key switch is re-cycled, replace the board. If the fault disappears, the previously stored parameters will have been replaced by the default parameters.

13) PARAM RESTORE
Cause:
This warning appears when the controller restored the default values.
Troubleshooting:
If a CLEAR EEPROM was mode before the last keyon-recycle, this warning just means that the EEPROM was correctly cleared. A travel demand or a pump request cancel the alarm. If this alarm appears at keyon without any CLEAR EEPROM request by the operator, there could be a problem inside the controller.

14) WRONG RAM MEM
Cause:
The algorithm implemented to check the main RAM registers finds a wrong contents: the register is “dirty”. This alarm inhibit the machine operations.
Troubleshooting:
Try to switch the key off and then on, if the alarm is still present replace the logic board.

15) PEV DRV OPEN
Cause:
VCM is not able to drive the high side driver of output PEVP1.
Troubleshooting:
This type of fault is not related to external components; replace the logic board.

16) PEV DRV SHORT
Cause:
The high side driver of output PEVP1 is shorted.
Troubleshooting:
A) Check if there is a short or a low impedance pull-up between pin A13 and

+BATT.

B) The driver circuit is damaged in the logic board, which has to be replaced.

17) VALVE MISM OUT

Cause:
Mismatch between uC Master and uC slave for output set point calculation.
Troubleshooting:
The logic board has to be replaced.

18) OUT PORT PULL-UP

Cause:
This is an alarm related to the hardware configuration.
Troubleshooting:
The problem is on the logic board, which must be replaced

19) ANALOG INPUT

Cause:
There is a problem in the analog-to-digital module of the microcontroller. All functions are stopped.
Troubleshooting: this a failure internal to the microcontroller, replace the board.

20) IN MISM D

Cause:
Mismatch on digital input between Master and Slave
Troubleshooting:
Compare the values read by Master and Slave by tester menu of console. Ask the assistance of a Zapi technician

21) IN MISM A/E

Cause:
Mismatch on analog inputs or encoder inputs between Master and Slave
Troubleshooting:
Compare the values read by Master and Slave by tester menu of console. Ask the assistance of a Zapi technician

22) NO CAN MSG. C

Cause:
No CAN message from traction controller
Troubleshooting:
Check the CAN connection on traction controller side. Verify that the traction communicates on CAN bus

23) NO CAN MSG 4

Cause:
Timeout on the local CAN BUS
Troubleshooting:
Switch OFF and ON. If the alarm is still present replace the board.

24) CONTROLLER MISM

Cause:
Wrong customer ID code found in the protected area of memory where this parameter are stored
Troubleshooting:

Replaced the controller.

25) NO CAN MSG 14

Cause:
No CAN message from pump controller
Troubleshooting:
Check the CAN connection on pump controller side. Verify that the pump communicates on CAN bus

26) NO CAN MSG A

Cause:
No CAN message from the Mini Lever or Joystick
Troubleshooting:
Check the CAN connection on Mini Lever or Joystick side. Verify that the Mini Lever or Joystick communicate on CAN bus

27) DRV SHRT A

Cause:
The driver of one of the first eight outputs is shorted.
Troubleshooting:

A) Check if there is a short or a low impedance pull-down between one of the output and –BATT.
B) The driver circuit is damaged in the logic board, which has to be replaced.

28) DRV OPEN A

Cause:
VCM is not able to drive of one of the first eight outputs.
Troubleshooting:
This type of fault is not related to external components; replace the logic board.

29) DRV SHRT B

Cause:
The driver of one of the outputs NEV1,..NEV3 is shorted.
Troubleshooting:

A) Check if there is a short or a low impedance pull-down between one of the outputs and –BATT.
B) The driver circuit is damaged in the logic board, which has to be replaced.

30) DRV OPEN B

Cause:
VCM is not able to drive of one of the outputs NEV1,..NEV3 .
Troubleshooting:
This type of fault is not related to external components; replace the logic board.

31) COIL OPEN A

Cause:
This fault appears when the no load is connected between one of the outputs NEVP1, NEVP2….NEVP8 and the positive.
Troubleshooting:

A) It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.

B) If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it.

32) COIL OPEN B

Cause:
This fault appears when the no load is connected between one of the outputs NEV1….NEV3 and the positive.
Troubleshooting:
A) It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.
B) If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it.

33) COIL OPEN EVP9

Cause:
This fault appears when the no load is connected between one of the output NEVP9 and the positive.
Troubleshooting:
A) It is suggested to check the harness, in order to verify if some coil is connected to the right connector pin and if it is not interrupted.
B) If, even connecting the coil to the right pin or replacing it, the alarm is still present than the problem is inside the controller logic board, replace it

34) DRV SHRT EVP9

Cause:
The driver of the output NEVP9 is shorted.
Troubleshooting:
A) Check if there is a short or a low impedance pull-down between one of the outputs and –BATT.
B) The driver circuit is damaged in the logic board, which has to be replaced.

35) DRV OPEN EVP9

Cause:
VCM is not able to drive of the output NEVP9.
Troubleshooting:
This type of fault is not related to external components; replace the logic board.

11 RECOMMENDED SPARE PARTS FOR CONTROLLER

Part Number	Description
C16520	6.3 A 20 mm Control Circuit Fuse
C12796	Female Ampseal pin harness side
C12532	Ampseal Connector 35 pins Female
C12531	Ampseal Connector 23 pins Female

12 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDICATED

Check the all microswitches. 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 cables to the controller. Ensure the insulation is sound and the connections are tight. Cables should be checked every:...................... 3 MONTHS

Check the correct operation of the steering command devices: stepper motor and/or twin potentiometer. 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.

IMPORTANT NOTE ABOUT WASTE MANAGEMENT:
This controller has both mechanical parts and high-density electronic parts (printed circuit boards and integrated circuits). If not properly handled during waste processing, this material may become a relevant source of pollution. The disposal and recycling of this controller has to follow the local laws for these types of waste materials.
Zapi commits itself to update its technology in order to reduce the presence of polluting substances in its product.