ZAPI® S.p.A.

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EN

User Manual

CAN TILLER

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	FG	
TECHNICAL ELECTRONIC MANAGER VISA	PP	
SALES MANAGER VISA	MC	

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1 MAIN FEATURES

The function of the Can Tiller board is acquiring analog and digital inputs and sending them to other Can network's nodes via Can Bus.

Twelve digital inputs at 24 V/12 V
Four analog inputs with potentiometer's output in the 0-5 V range or 0-12 V range
Two inputs which can be used as analog or digital inputs (CNC#7 and CNC#8)
Supply Voltage:... 24 V/ 12 V
External temperature working range:...-30 °C ÷ 80 °C
CAN interface [n°] 1

2 TECHNICAL SPECIFICATION

2.1 Digital inputs

All the digital inputs have the positive input at Key voltage (+12 V or +24 V). Proper microswitches must be connected between the digital input and the positive supply output CMM (CNA#15); each input has a pull-down resistor.
The FW, REV, RAISE, LOS, HORN, ETC microswitches are typically open, so the functions related to them become active when the microswitch is closed.
The safety microswitches, as SR, are typically closed, so the functions related to them become active when the microswitch is open.

2.1.1 Digital inputs technical details

DI1 ÷ DI2

- Commutation threshold ON to OFF: 7 V [±0,5 V].
- Commutation threshold OFF to ON: 9 V [±0,5 V].
- Input impedance: 4,3 kohm [±0,5 kohm].

DI3 ÷ DI11 and DI14

- Commutation threshold: 6 V [±0,5 V].
- Input impedance: 4,25 kohm [±0,3 kohm].
- Input impedance: 7,4 kohm [±0,4 kohm] only for DI4 and DI5.

DI12/AI5

- Commutation threshold: 5 V [±0,5 V].
- Input impedance: 47,3 kohm [±2,4 kohm].

DI13/AI6

- Commutation threshold ON to OFF: 3,2 V [±0,3 V].
- Commutation threshold OFF to ON: 7,5 V [±0,5 V].
- Input impedance: 47,3 kohm [±2,4 kohm].

NOTE: DI12 AND DI13 can be used as Analog Input, as well see 2.2.

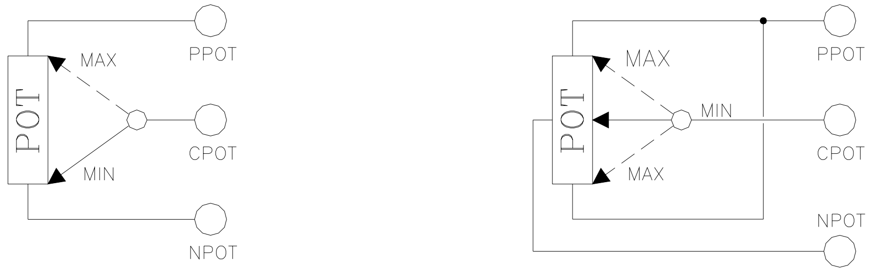
2.1.2 Microswitches

- The recommended microswitches must have a contact resistance lower than 0.1 Ω and a leakage current lower than 100 µA.
- When full load connected, the voltage between the key switch contacts must be lower than 0.1 V.
- If the used microswitches have different features, it is recommended to talk about their utilization with Zapi's technicians.

2.2 Analog inputs

The analog inputs are used to read the output of a potentiometer or an Hall effect device, both with output continuously variable in the 0-5 V range or in the 0-12 V range.
The potentiometer can be in a 3-wire configuration. The potentiometers related to

the AI1 and AI2 analog inputs take the power supply between PPOT (CNA#9) and NPOT (CNC#3). The potentiometers related to the AI3 and AI4 analog inputs take the power supply between PPOT (CNA#9) and NPOT (CNA#12).
The analog devices converted to AI5 and AI6 take the power supply between PPOT (CAN#9) and NPOT (CAN#12).
The potentiometer supply available are +12 V or +5 V; the maximum load current provided by the internal voltage regulator is 100 mA so the minimum load is 47 Ω (PPOT=+5 V), 120 Ω (PPOT=+12 V).
The standard connection of a potentiometer is represented on the left of the picture below (the potentiometer is at rest in an extreme), together a pair of switches for the running request. It is possible to use the configuration on the right (the potentiometer is at rest in the centre), together a pair of switches for the running request too.



3 INSTALLATION HINTS

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

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

These are Warning boxes, 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

3.1 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.

3.1.1 Connection cables

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

3.1.2 Fuses

- Use a 10 A Fuse for protection of the card.
- For Safety reasons, we recommend the use of protected fuses in order to prevent the spread of fused particles should the fuse blow.

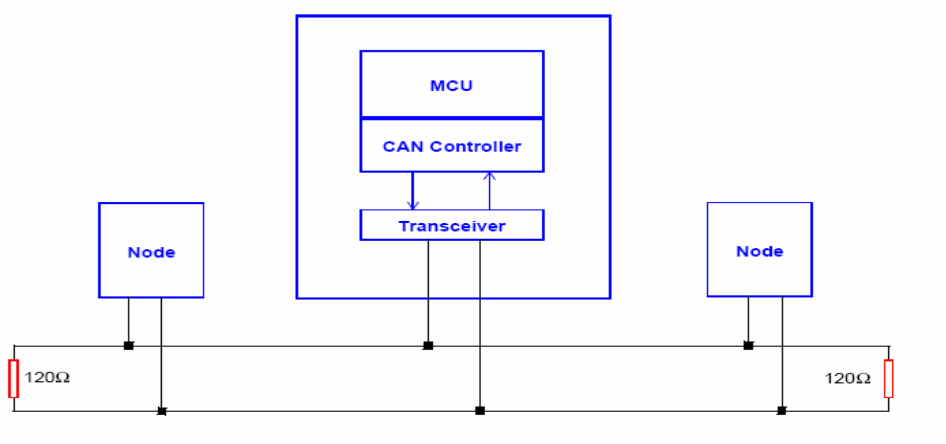
3.2 Installation of the hardware

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 card to a battery with a nominal voltage different than the value indicated on the label. A higher battery voltage may cause a logic failure. A lower voltage may prevent the logic operating.

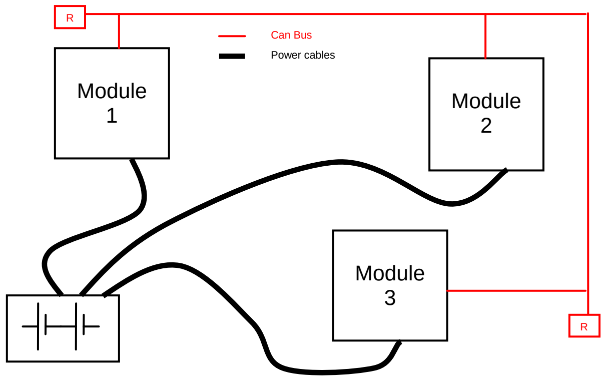
3.2.1 Wirings: CAN connections and possible interferences

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 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.

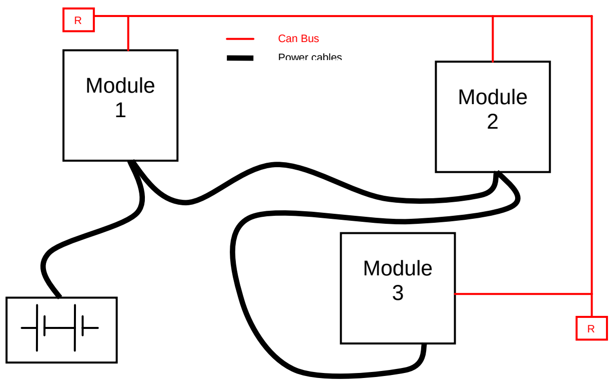
Wrong Layout:



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.

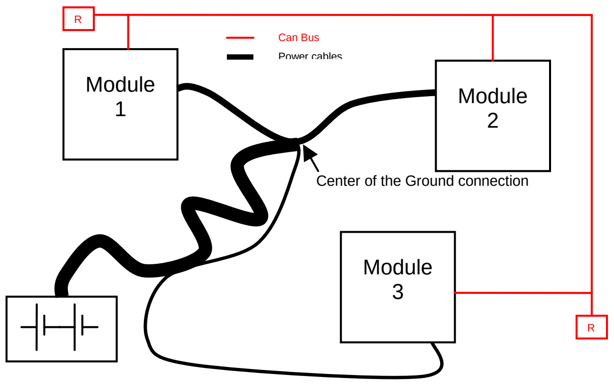
Correct Layout:



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.

<u>Can advantages</u>

The complexity of today systems needs more and more data, signal and information must flow from a node to another. CAN is the solution to different problems that arise from this complexity
- simplified design (readily available, multi sourced components and tools)
- lower costs (less and smaller cables)
- improved reliability (fewer connections)
- analysis of problems improved (easy connection with a pc to read the data flowing through the cable).

3.2.2 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".

3.2.3 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.

3.3 Protection and safety features

3.3.1 Protection features

- **Connection Errors:**
  All inputs are protected against connection errors.
- **External agents:**
  The controller is protected against dust and the spray of liquid to a degree of protection meeting IP54.

3.3.2 Safety Features

ZAPI devices 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>.

3.4 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 responsability 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 two directions:

1) The study of the **emission** problems, the disturbances generated by the device and the possible countermeasure to prevent the propagation of that energy; we talk about “conduction” issues when guiding structures such as wires and cables are involved, “radiated emissions” issues when it is studied the propagation of electromagnetic energy through the open space. In our case the origin of the disturbances can be found inside the controller with the switching of the mosfets which are working at high frequency and generate RF energy, **but wires and cables have the key role to propagate the disturbs because they works as antennas**, so a good layout of the cables and their shielding can solve the majority of the emission problems.

2) The study of the **immunity** can be divided in two main branches: protection from electromagnetic fields and from electrostatic discharge.
The **electromagnetic immunity** concern the susceptibility of the controller with regard to electromagnetic fields and their influence on the correct work made by 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.

3) The second type of immunity, **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, with serial communications (canbus) which 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.

⚠ ***IMPORTANT NOTE: it is always much easier and cheaper to avoid ESD from being generated, than to increase the level of immunity of the electronic devices.***

There are different solutions for EMC issues, depending on level of emissions/ immunity required, the type of controller, materials and position of the wires and electronic components.

1) **EMISSIONS**. Three ways can be followed to reduce the emissions:

   A) SOURCE OF EMISSIONS: finding the main source of disturb and work on it.
   B) SHIELDING: enclosing contactor and controller in a shielded box; using shielded cables;
   C) LAYOUT: a good layout of the cables can minimize the antenna effect; cables running nearby the truck frame or in iron channels connected to truck frames is generally a suggested not expensive solution to reduce the emission level.

2) **ELECTROMAGNETIC IMMUNITY**. The considerations made for emissions are valid also for immunity. Additionally, further protection can be achieved with ferrite beads and bypass capacitors.

3) **ELECTROSTATIC IMMUNITY**. Three ways can be followed to prevent damages from ESD:

   A) PREVENTION: when handling ESD-sensitive electronic parts, ensure the operator is grounded; test grounding devices on a daily basis for correct functioning; this precaution is particularly important during controller handling in the storing and installation phase.
   B) ISOLATION: use anti-static containers when transferring ESD-sensitive material.
   C) GROUNDING: when a complete isolation cannot be achieved, a good grounding can divert the discharge current trough a “safe” path; the frame of a truck can works like a “local earth ground”, absorbing excess charge. **So it is strongly suggested to connect to truck frame all the parts of the truck which can be touched by the operator, who is most of the time the source of ESD.**

4 DESCRIPTION OF THE CONNECTORS

4.1 A connector: Molex Minifit, 16 pins

A1	DI1	First digital input.
A2	DI2	Second digital input.
A3	DI3	Third digital input.
A4	DI4	Fourth digital input.
A5	DI5	Fifth digital input.
A6	DI6	Sixth digital input.
A7	DI7	Seventh digital input.
A8	DI8	Eighth digital input.
A9	PPOT	Positive of AI1, AI2, AI3, AI4, AI5, AI6.
A10	AI2	Second analog input.
A11	AI3	Third analog input.
A12	NPOT	Negative of analog inputs.
A13	AI4	Fourth analog input.
A14	+BATT	+Batt, short circuit to CNB#5.
A15	COMMON	Positive of all the digital inputs.
A16	-BATT	-Batt.

4.2 B connector: Molex Minifit, 6 pins

B1	CAN LOW	Low level CAN-BUS voltage I/O.
B2	-BATT	-Batt.
B3	+KEY	Key input.
B4	CAN HIGH	High level CAN-BUS voltage I/O.
B5	+BATT	+Batt, short circuit to CNA#14.
B6	SAS	Internal connected to DI1 with a 100 Ω resistance.

4.3 C connector: Molex Minifit, 8 pins

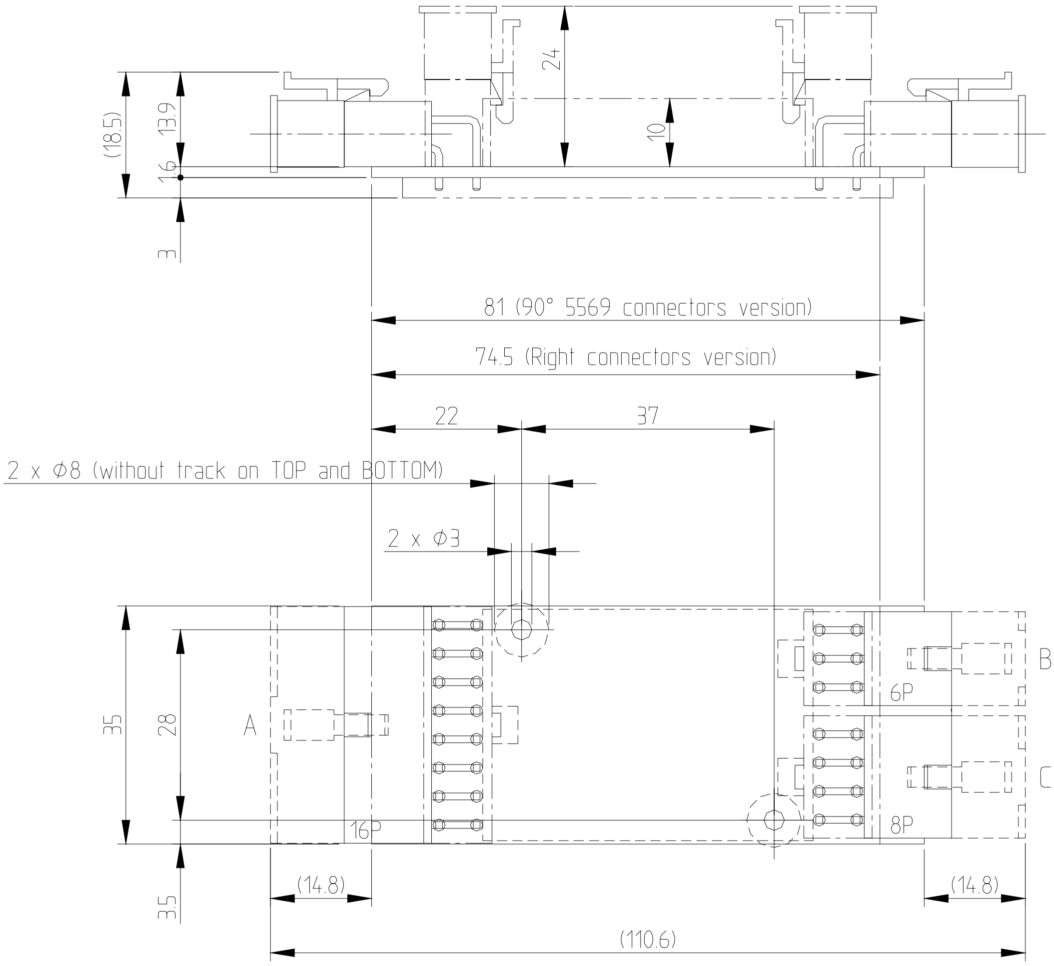
C1	DI9	Ninth digital input.
C2	AI1	First analog input.
C3	NPOT	Negative of analog inputs.
C4	DI10	Tenth digital input.
C5	DI14	Fourteenth digital input.
C6	DI11	Eleventh digital input.
C7	DI12/AI5	Twelfth digital input/fifth analog input.
C8	DI13/AI6	Thirteenth digital input/sixth analog input.

5 DRAWINGS

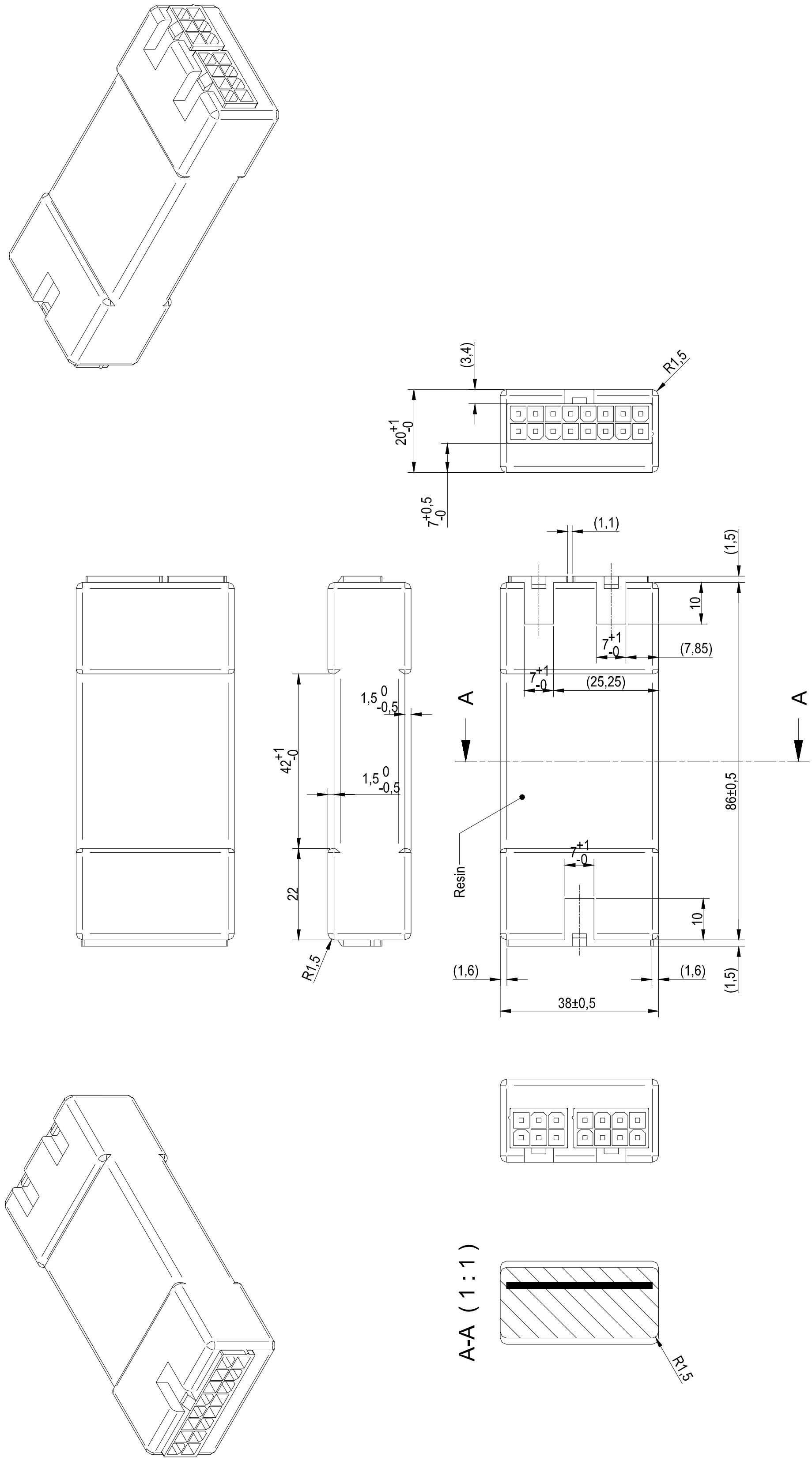
5.1 Mechanical drawing

Controller is available in two versions:

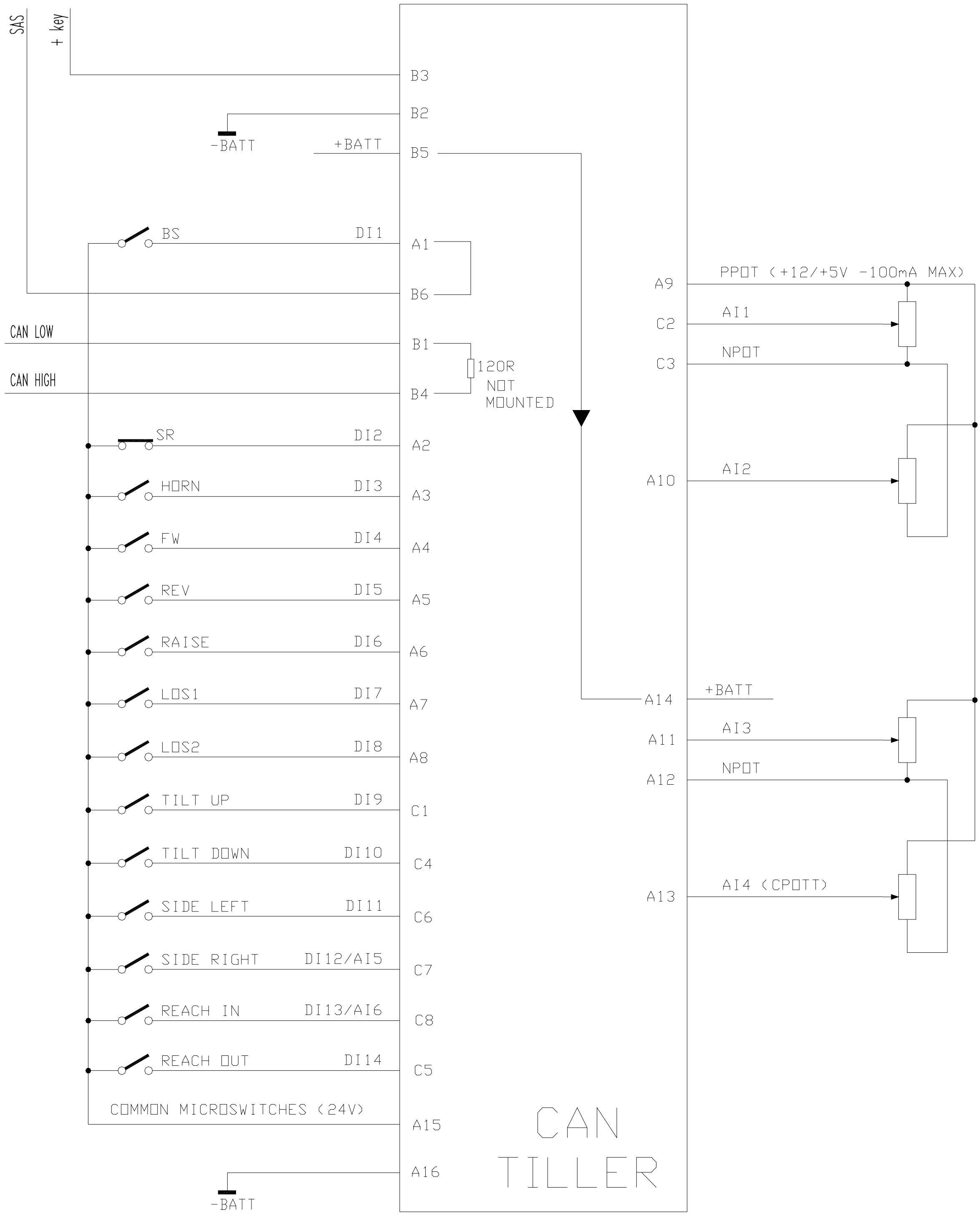
- B, C connector: Molex Minifit Jr. 0° (right) 5566
- B, C connector: Molex Minifit Jr. 90° 5569.



It is also possible to have the card inside an encapsulating resin case.



5.2 Functional drawing



6 RECOMMENDED SPARE PARTS

Part number	Description
C12404	Connector 16 pos., Receptacle Housing, Dual Row: P/N 0039012160
C12359	Connector 6 pos., Receptacle Housing, Dual Row: P/N 0039012060
C12414	Connector 8 pos., Receptacle Housing, Dual Row: P/N 0039012080
C12777	Crimp terminal FE MOLEX Mini-Fit Jr.: serie 5556

7 PERIODIC MAINTENANCE TO BE REPEATED AT TIMES INDICATED

Check the belly 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

Using the console tester menu check the functioning of all the digital and analog inputs. Check every .... 3 MONTHS

Checks should be carried out by qualified personnel only. The installation of this electronic device 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 differs 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.