4.0 Readiness Level

Technical report

Bergamo, 12-05-2021

Index

1. The industry 4.0 scenario 3
2. Description of the asset 5
3. Requirements analysis 6
4. CONCLUSIONS 14

1. The technological context: the Industry 4.0 scenario

The term Industry 4.0, also known as the fourth industrial revolution, represents the current technological and industrial scenario.
It is characterised by the use and application of sensors and computational technologies for data analysis, the aim of which is to improve the efficiency of production processes and increase their added value on the market.
The Industry 4.0 model revolutionises the entire value chain through the increasing integration of the company with upstream supply networks and downstream customers: business models, approaches to the market and the production process are thus revisited in order to achieve results in efficiency and productivity.
Thanks to the Industry 4.0 paradigm, it is possible to interconnect and make all production resources cooperate by collecting and analysing data and information generated by factory systems.
The enabling technologies of Industry 4.0 can be summarised in the following three areas:

1. Availability of digital data and Big Data analytics
2. Robotics and advanced automation
3. Advanced connectivity

In a limited, sporadic and poorly integrated way, the above technologies are sometimes already available in some companies, mainly in industrial process control for the mass production of components.

The Industry 4.0 revolution aims to create and manage real integrated and interconnected networks of machinery, plants and production facilities, optimising transformation processes, reducing errors and defects, improving time to market and ensuring flexibility and speed to the production process.

The objective of this analysis is to verify that the characteristics of the asset correspond to the "Industry 4.0" concept and to certify consequently the suitability of the asset to be included in the list of goods and services necessary for the modernisation of the industrial organisation in view of Industry 4.0. This certificate is useful for companies wishing to take advantage of the tax benefits for the transition to Industry 4.0 if and when the law provides for it.

Almost all countries that provide tax benefits for the purchase of goods useful for the transition to Industry 4.0 **require that the goods are not only Industry 4.0 compliant, but also interconnected to factory information systems.** In order for an asset to be defined as "interconnected" for the purposes of obtaining the benefit, it is necessary and sufficient that:

a) The ability of the asset to exchange information with internal systems (e.g.: management system, planning systems, product design and development systems, monitoring, even remotely, and control other machines in the plant, etc.) and/or external systems (e.g.: customers, suppliers, partners in collaborative design and development, other production sites, supply chain, etc.) by means of a connection based on documented, publicly available and internationally recognised specifications (examples: TCP-IP, HTTP, MQTT, etc.).

b) In addition, the asset must be uniquely identified, in order to recognise the origin of the information, through the use of internationally recognised addressing standards (e.g. IP address);

Therefore, the responsibility for the interconnection of the asset is on the buyer of the asset itself and not on the supplier, since the interconnection according to the definition given above depends on the former.

This study therefore does not replace the certification and/or expert's report on the asset, which are necessary declarations in order to benefit from the tax relief, if provided for by law. “Consorzio Intellimech” declines all responsibility for the fulfilment of the asset's interconnection requirement, which remains the responsibility of the end user.

2 Description of the asset

The machine under study is an automatic guided vehicle (AGV) whose commercial name is AGV INDEVA®, which allows the transport of material from one part of a warehouse or industrial plant to another with the aid of a magnetic strip placed on the floor and which determines the route.
The main features of the machine are as follows
- Laser-scan based anti-collision safety system that can be parameterised
- Electric traction
- Wi-Fi communication system
- Colour touchscreen programming console
- Integrated diagnostics system
- Remote monitoring and control system
- Automatic remote mission management system.

Given the type of system, AGVs INDEVA are included in the list of assets defined as "Capital goods whose operation is controlled by computerised systems or managed through appropriate sensors and drives"

The AGVs INDEVA® meet the requirements for being “Industry 4.0 compliant”, mainly for the following features.

Table 1 Mandatory requirements

1	Control by means of CNC and/or PLC;	✓
2	Interconnection to factory computer systems with remote loading of instructions and/or part programs.	✓
3	Integration with the factory logistics system or with the supply network and/or other machines in the production cycle.	✓
4	Simple and intuitive man-machine interface	✓
5	Compliance with the most stringent occupational health, safety and hygiene parameters	✓

Table 1 Requisiti Variabili

a	Remote maintenance and/or remote diagnostics and/or remote control systems	✓
b	Continuous monitoring of working conditions and process parameters by means of appropriate sets of sensors and adaptability to process drifts	✓
C	Features of integration between physical machine and/or plant with modelling and/or simulation of its behaviour in the process (cyber-physical system)	✗

3 Requirements analysis

3.2.2. 3.1 Compulsory conditions

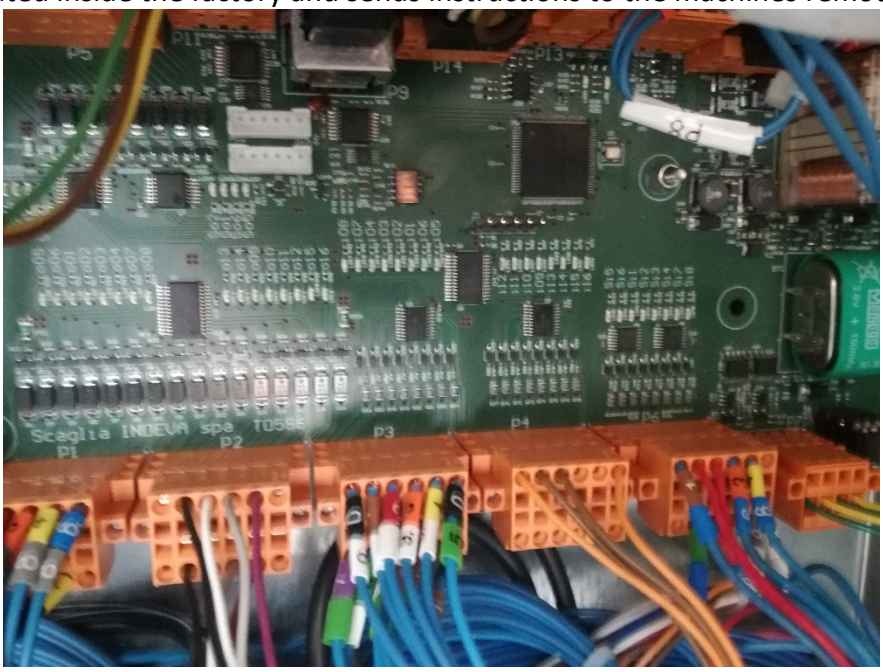
Following is an analysis and verification of the mandatory conditions for considering the machine "4.0".

3.1.1 Control by CNC (Computer Numerical Control) and/or PLC (Programmable Logic Controller)

The machine is equipped with a custom control board developed internally by Scaglia Indeva based on a Microchip dsPIC33 microcontroller. The microcontroller in question has the task of managing the mission program and the inputs derived from the anti-collision system, from instructions received from the plant supervisor via Wi-Fi and the current position on the route.

The microcontroller control is considered a control system equivalent to a PLC.

The plants in question are also equipped with a PLC that governs the entire work cycle of the AGVs located inside the factory and sends instructions to the machines remotely.



Picture 1 main control board

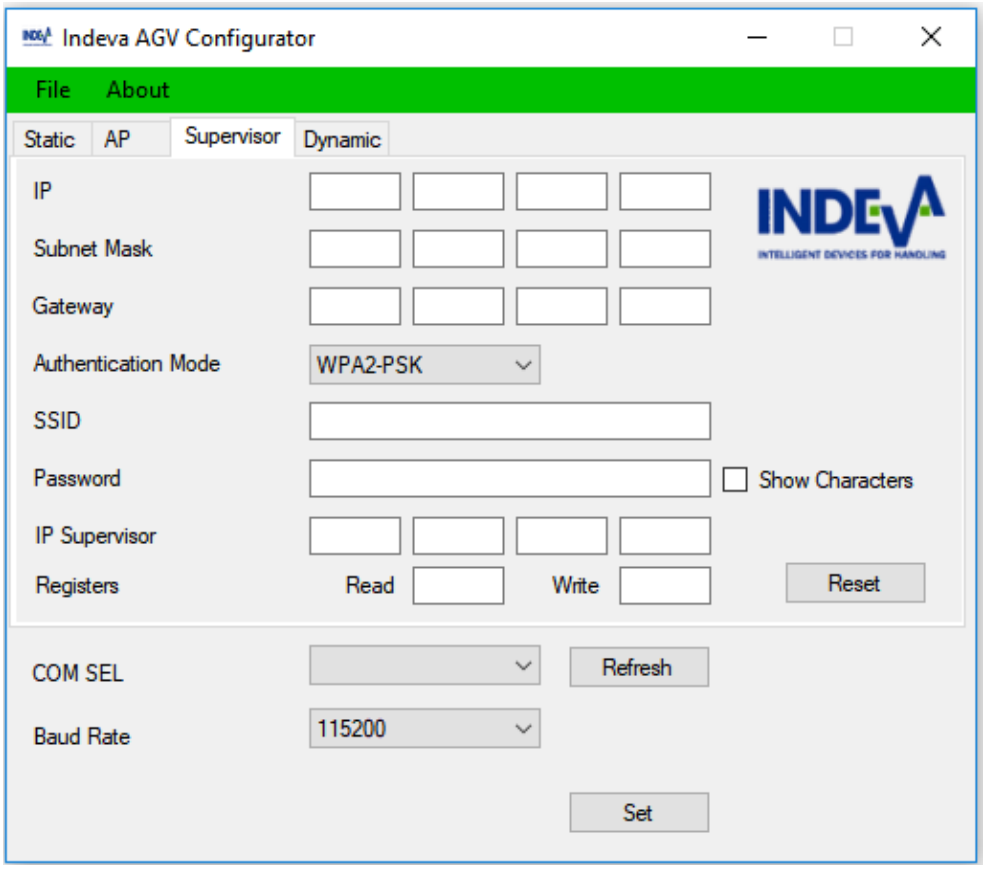
3.1.2 Interconnection to factory computer systems with remote loading of instructions and/or part program

The machine is able to communicate and exchange information with internal systems via a link based on documented, publicly available and internationally recognised specifications.

In fact, the machine is equipped with a radio module with Wi-Fi technology, IEEE 802.11 standard, and communicates via the MODBUS TCP protocol based on a TCP/IP communication channel. Figure 2 shows the Wi-Fi communication control board; the radio module is shown at the top, a molex connector for the power supply and CAN bus interface is at the bottom left, and the RJ45 connector for configuring parameters via serial cable is at the right.

Picture2 - Gateway with radio module and CAN transceiver

The configuration of the network connection is carried out with a special configuration software by connecting to the gateway via a serial connection.



Picture 3 AGV network configurator

The gateway itself provides a CAN interface for data exchange with the main control board.

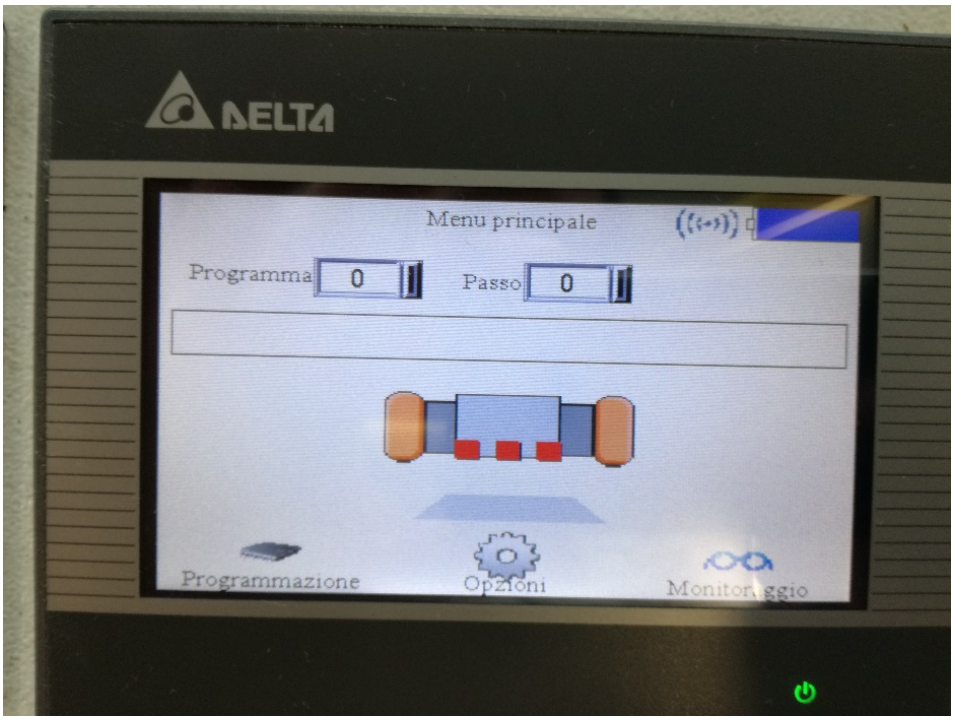
The supervisor consists of a PC and a PLC dedicated to controlling the vehicles and other devices on the installation based on the data collected from them. The supervisor also monitors the position of the AGVs along all possible routes on which they may be found.

3.1.3 Automated integration with the factory's logistics system or supply network and/or other machines in the production cycle

Using the MODBUS TCP protocol, it is also possible, even from third-party systems, to acquire position and status information on the AGVs and integrate them into a transport network with other machines in the production cycle to automate the flow of materials from the warehouse to the delivery area throughout the internal production process.

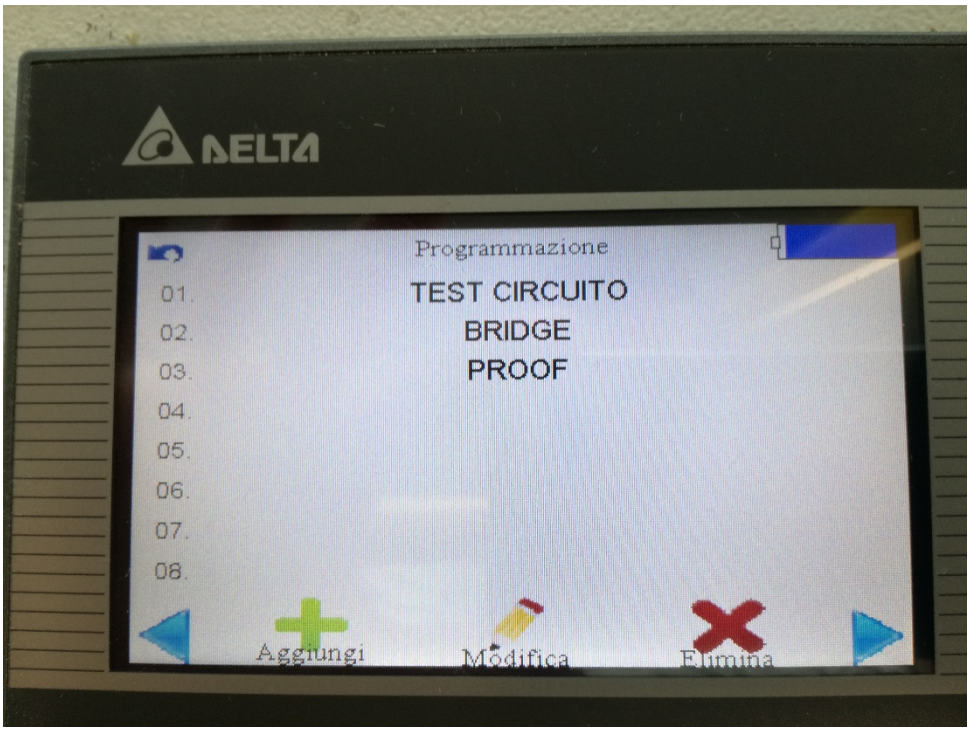
3.1.4 Simple and intuitive interface between man and machine

The machine in question is equipped with a touchscreen operator interface system for setting route parameters and checking machine status.

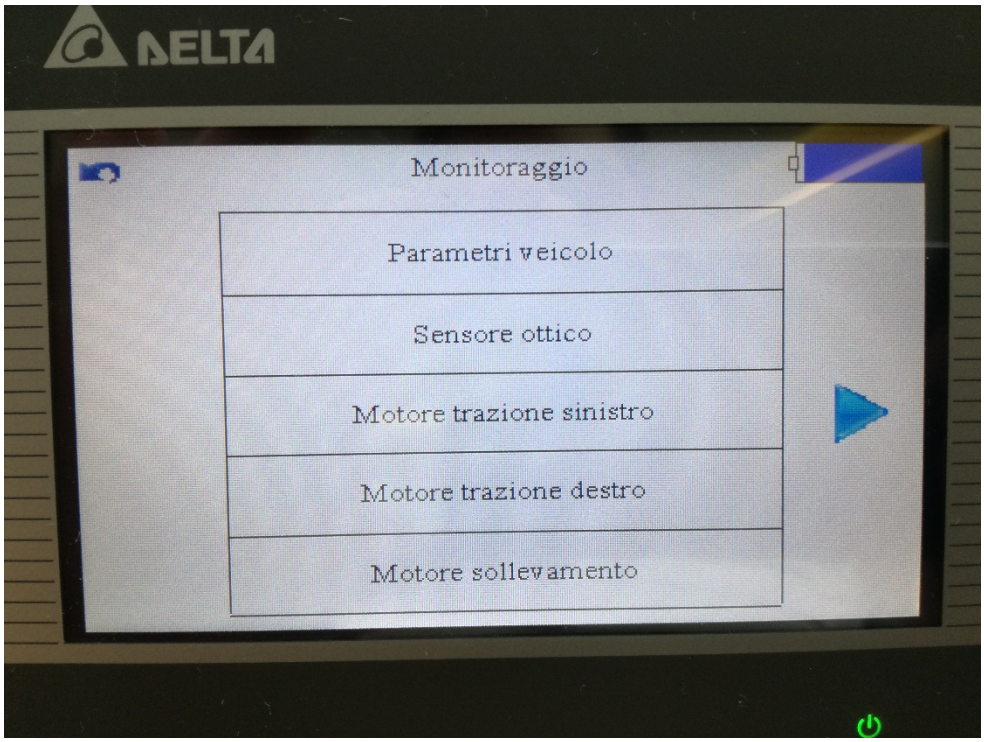


Picture 4 main visualization HMI

The programming and monitoring menus are easy to navigate and allow you to find the required information in a few simple steps.



Picture 5 programming menu



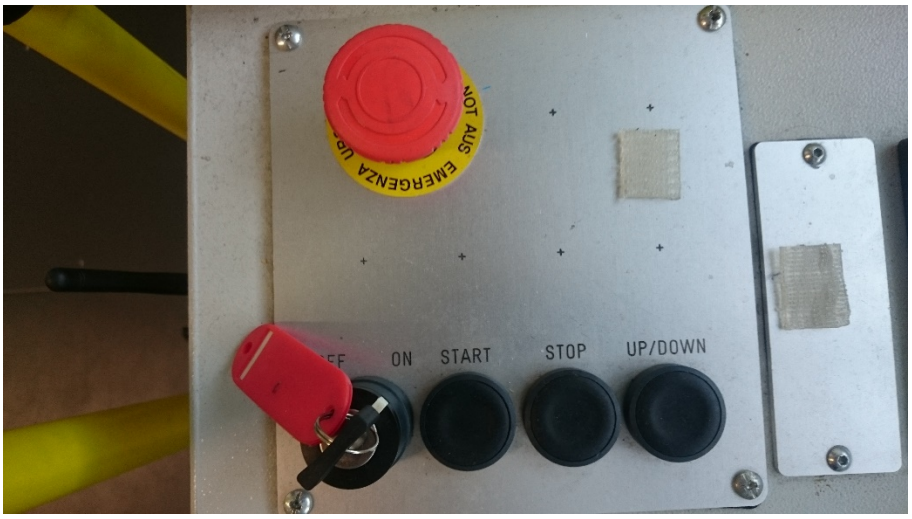
Picture 6 monitoring menu

The same settings can also be checked and set by the remote monitoring software.

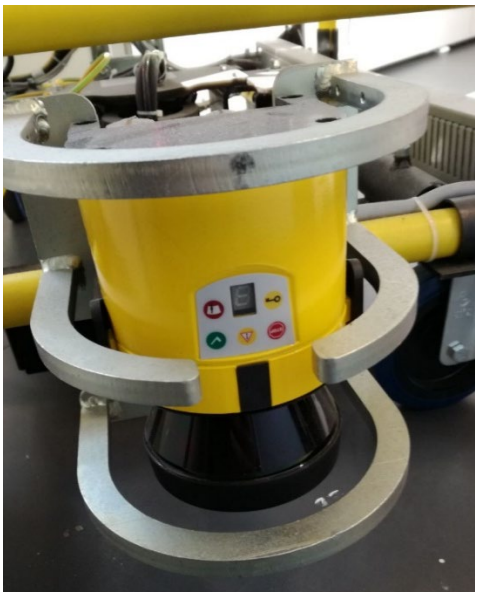
3.1.5 Compliance with the latest occupational safety, health and hygiene standards

Analysis of the machine's EC declaration of conformity does not reveal any formal defects, in fact all the harmonised standards indicated in the declaration are in the version currently in force.

The inspection of the machine does not show any evident criticalities from a safety point of view, as evidenced by the presence on board the machine of emergency mushrooms and photocells designed to interrupt the operation of the machine in the event of the operator being detected in the work area.



Picture7 Safety devices on the machine



Picture8 safety laser range finder

3.2 Variable requirements

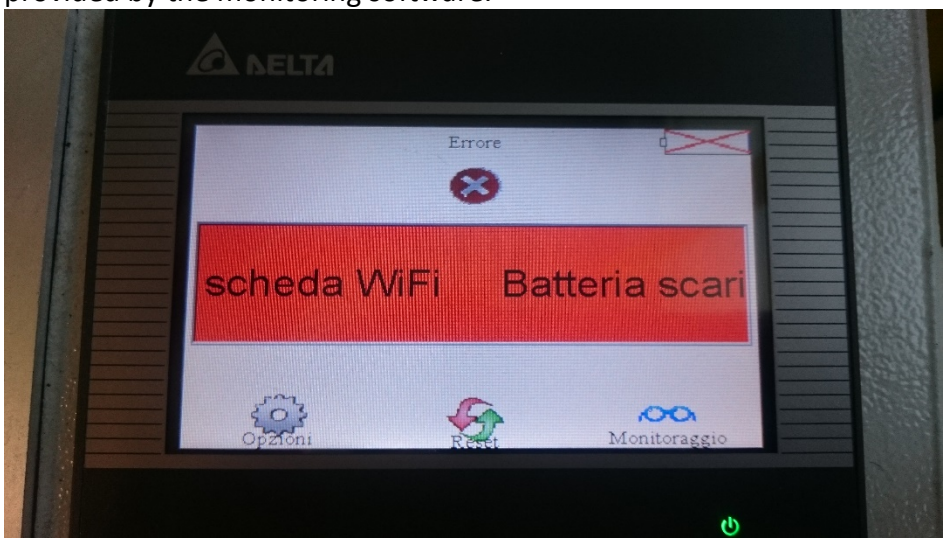
Following are a series of features which are complimentary for industry 4.0

3.2.1 .Remote maintenance and/or remote diagnostics and/or remote control systems;

The machine is able to provide both local, through detailed communication of the fault on the user interface, and remote, information on the operating status and any stoppages with indications of the type of fault that has occurred.

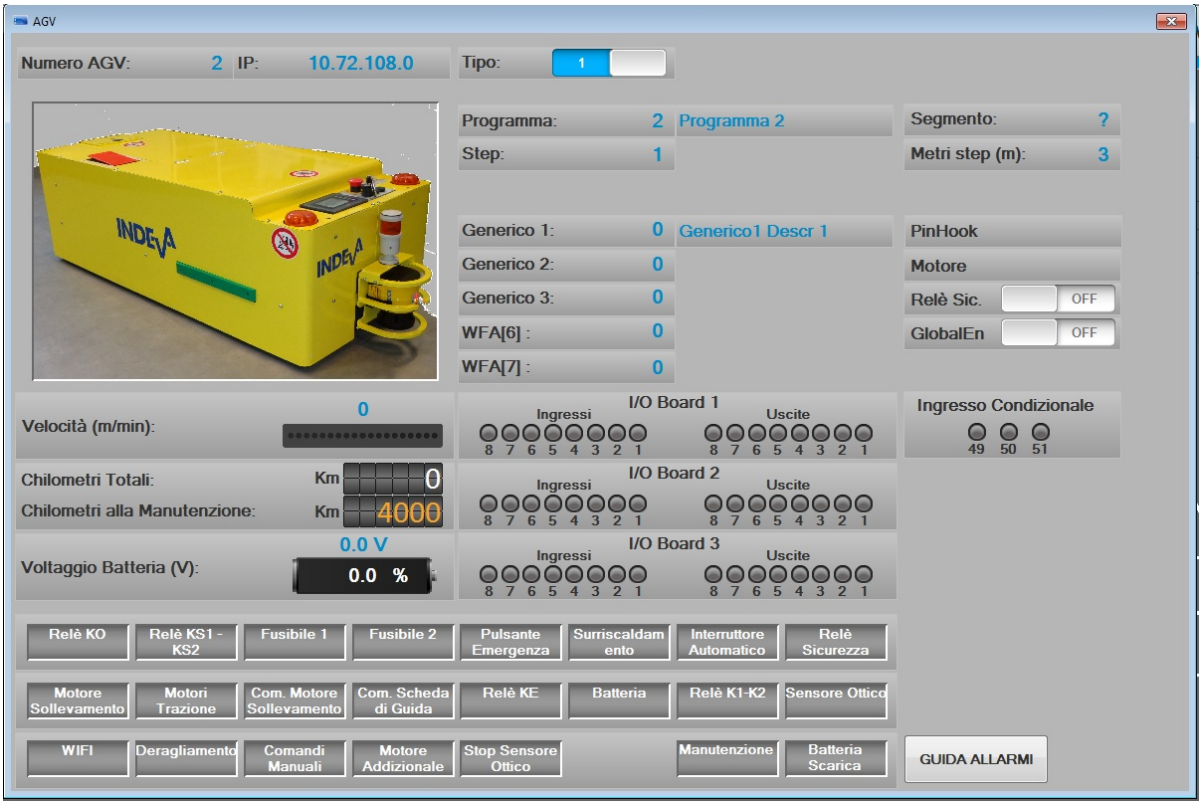
The information provided by the telediagnostic system concerns either operating problems internal to the machine (e.g. a CAN bus communication error) or problems due to the working cycle (e.g. derailment or safety braking).

This information is provided by the machine via the touchscreen panel or via the remote interface provided by the monitoring software.



Picture 9 on-board diagnostics

In addition, from the remote monitoring software it is possible to view the same data from a PC with a broader overview of the AGV operating status.



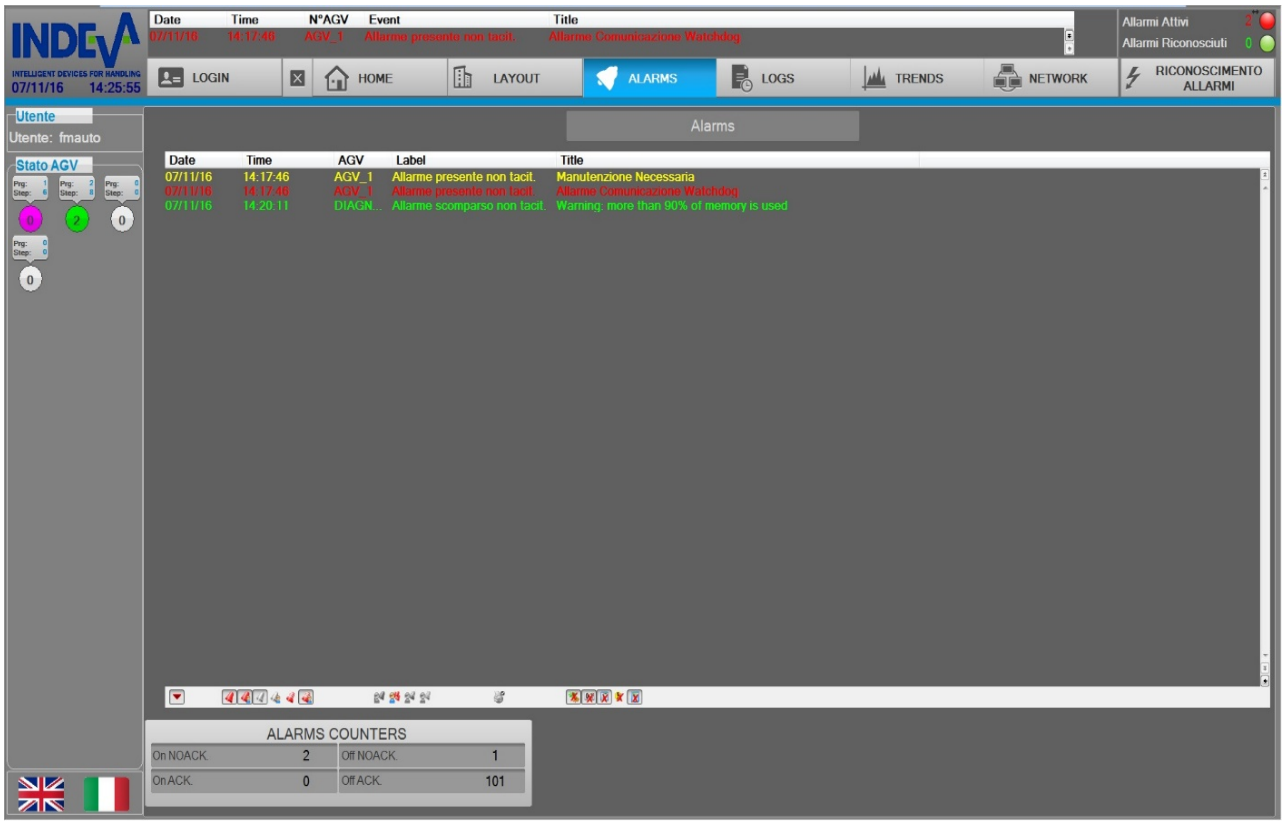
Picture 10 - real-time remote diagnosis and monitoring data

3.2.3. Continuous monitoring of working conditions and process parameters using appropriate sensor sets and adaptability to process drifts

The machine is able to detect and communicate any process anomalies, safely stopping its operation in the event of anomalies such as the appearance of an obstacle in its path.

The machine is then able to resume its work cycle if the obstacle is removed.

Figure 11 shows how, even from the remote monitoring software, all information regarding the working conditions of the machines is available to the user who can check the working status of the plant without being physically present.



Picture 11 communication log of working conditions

3.2.4. Features of integration between physical machine and/or plant with modelling and/or simulation of its behaviour in the process (cyber-physical system).

The machine does not support the creation of a cyber-physical system as it does not implement any kind of simulation mechanism or modelling of its own operating state. Therefore, this requirement is not met.

1. CONCLUSIONS

Based on the analysis previously shown, the machine, equipped with the software systems analysed and mentioned above as well as in the user and maintenance manual, reflects the requirements to be **"4.0 compliant".**

This applies to **all types of AGVs produced by Scaglia Indeva** that have the same configuration as the one described in the user and maintenance manual referred to in this technical report with the software equipment analysed in the previous points.