

motive
power transmission

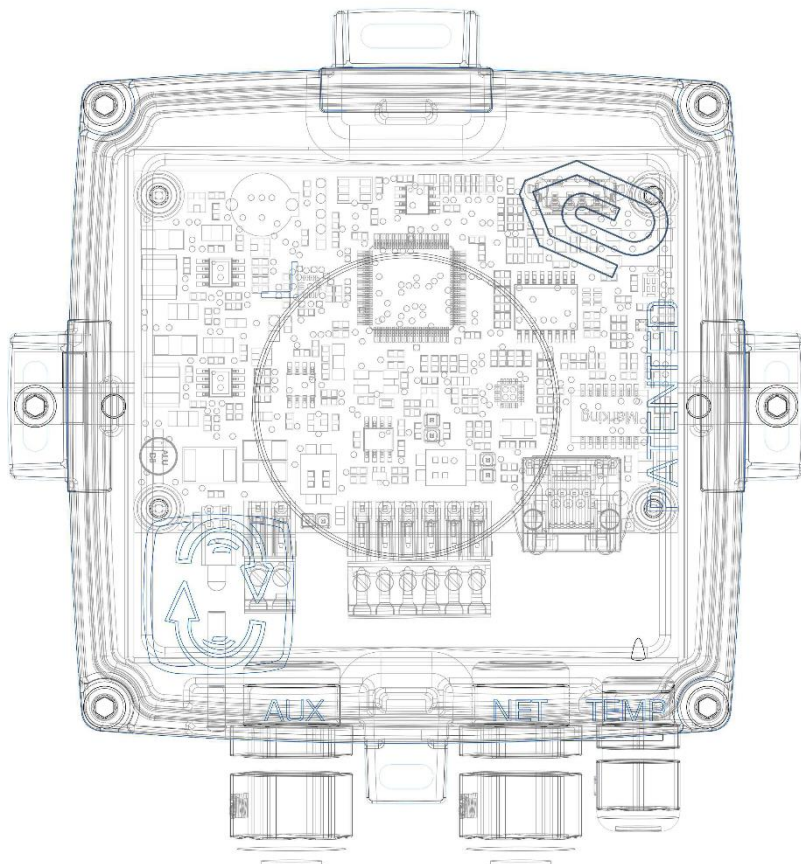


FERMAI
PREDICTIVE MAINTENANCE

DOCTOR 4.0

A UNIVERSAL EXPANDABLE INFORMATION SYSTEM COMPRISING OF
SENSORS + GATEWAY + PLATFORM + PUSHNOTIFIER, OPEN, AUTOTUNING, IIOT, MACHINE LEARNING AND A.I.

technical manual





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1. INTRODUCTION

We have seen

- toy sensors that had to be thrown away when the battery was low,
- disposables that provide a number per day or hour (and how do you know, for example, if the vibrations were an alarm or if someone was using a hammer nearby?),
- mouths filled with the word "artificial intelligence" when there were only 2 neurons (vibration, heating), and it was not even able to understand if a machine was off or on
- experts mentioning "machine-learning" when it had to use the ones to affirm in advance a tolerance for each value taken,

It was nice to see a number in an app and sell it as a solution... But how useful was it really?

But, what if we now had a universal expandable permanent detection system, consisting of gateway + platform + pushnotifier, open, autotuning, IoT, machine learning, all-in-one and not a complicated set of pieces, incorporating the brightest artificial intelligence for anomaly detection? And that it not only receives data, but that it can also send remote commands from an app ("slow down", "stop", etc.)?

We would then find ourselves in front of something that can really do predictive maintenance but, above all, that can do much more than that.

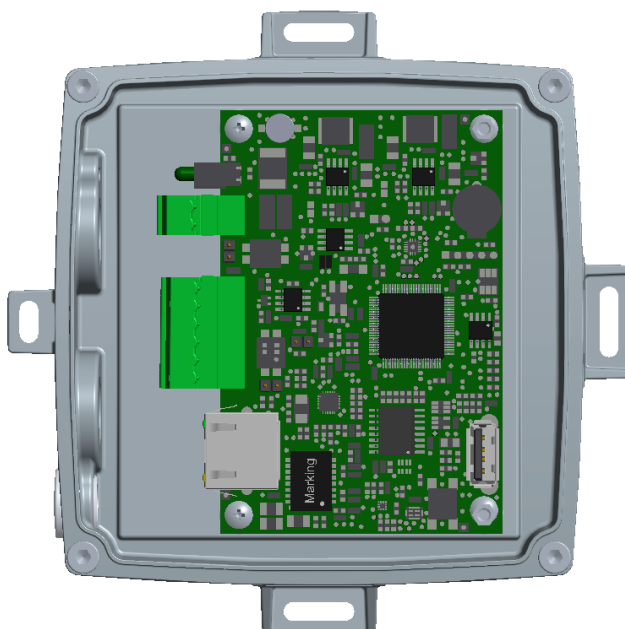
A dream? No, it's already there. We invented and patented it. It's called DOCTOR 4.0

Industrial invention patent No. 102021000024412



Predictive maintenance is just one of its possible uses. The FERMAI IIoT portal is open, application-independent, and simplifies integration

With DOCTOR 4.0 data, you can for example monitor the productivity of a plant or a machine, the flow or pressure of a pump, a fan, or a compressor, the fluid contamination, the energy consumption, you can control the quality, etc. etc.





2. USE

DOCTOR 4.0 is usually used to analyse the operation of a motor, but it can be used universally for different purposes. It can be applied not just on motors, but also on gearboxes, pumps, fans, etc ...

DOCTOR 4.0 can be connected to any motor size, type, power, and speed, because, thanks to the sending of a data packet per second, it learns normal and abnormal operation by itself.

Even if DOCTOR 4.0 detected data can be expanded by connecting further sensors, it all already includes in its hardware sensors of



temperature [°C]



vibrations [mm/sec]



noise [dB],



magnetic flux [Wb]



partial and total working time [h]

By connecting via the portal to its cloud platform <https://doctor.fermai.it/>, you can

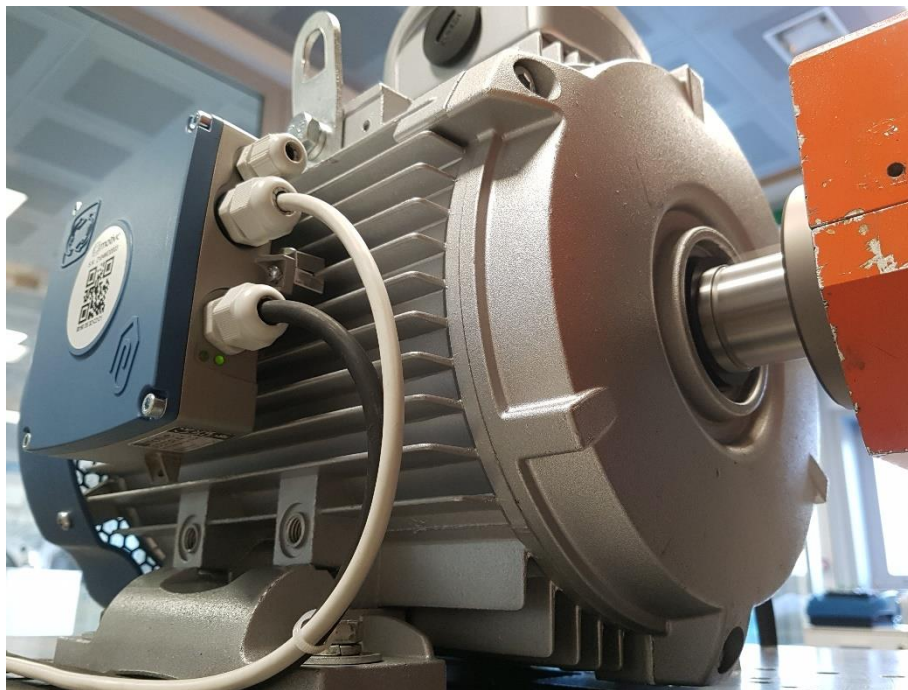
- Geolocalize;
- Understand the normal operation of the machine;
- See and manage temperature, vibration, noise and flow thresholds.
- Receive push notifications of abnormal trends,
- Send commands from your app (power on, off, change of speed, etc).

DOCTOR 4.0 is not a "disposable" whose useful life is that of its batteries and which, in order to save on battery life, must severely limit the data that can be transmitted. DOCTOR 4.0 is supplied directly from the line (12-24Vdc power supply), or via PoE (Power over Ethernet).

In this way the granularity of the data can be one packet sent per second, thus allowing to really understand what is happening on the machine being monitored.



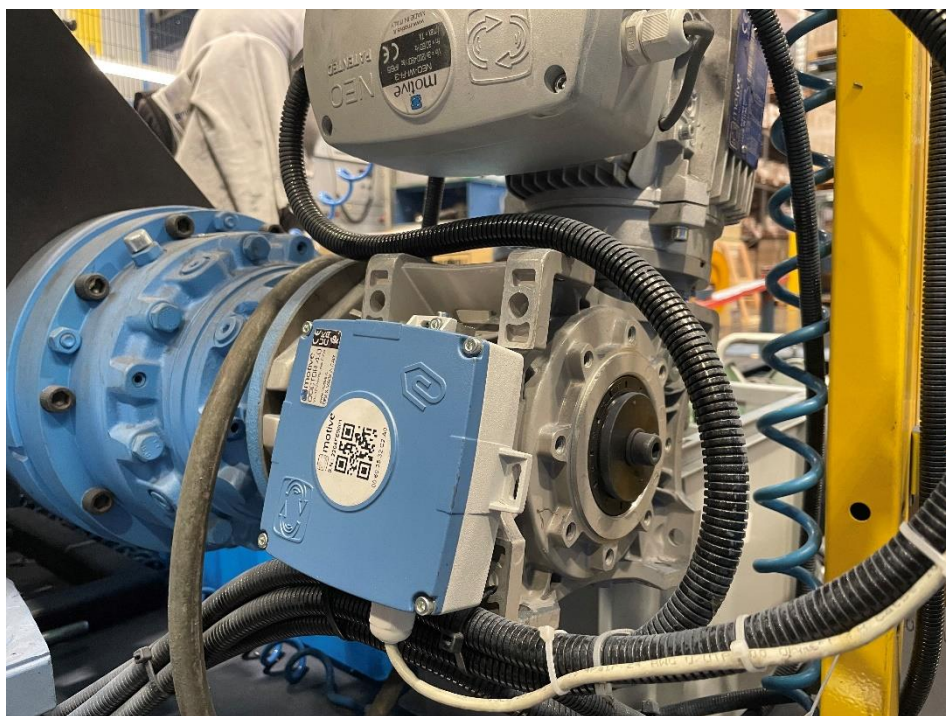
DOCTOR 4.0 does not require additional external devices to operate (plc, data loggers, etc.). It is connected directly to the cloud platform





3. TECHNICAL DATA

	Symbol	U.d.M.	DOCTOR 4.0
Protection index	IP		IP65 (optional IP68)
Power supply	V_{1n}	V	12-24 Vdc
Operating ambient temperature	T_{amb}	°C	-20°C + 80°C
Maximum relative humidity	% (40°C)		5 ... 85 without condensation
Power consumption	W		4
Stand-by losses	W		2






4. DETECTED PARAMETERS

DOCTOR 4.0 is equipped with an MQTT gateway that allows you to read the main values of the machine and send them via internet to FERMAI cloud platform where the data are processed.

There is no need neither of additional edge software connection modules, nor edge software, message brokers, additional data processing modules, data loggers or additional cloud connection modules

DOCTOR 4.0, when mounted on board of any electric motor, detects:

- 1)  Surface **temperature** [°C]. It is the surface temperature of the item (motor, gearbox, machine, etc) that DOCTOR 4.0 is in touch with, and it is measured by means of its NTC thermal probe.

This NTC probe can be left inside DOCTOR 4.0 or it can be positioned in direct contact with the monitored item, where it is considered more useful, for a more sensitive detection;





parameter	value	unit
Resistance value at 25 °C	4.7K to 100K	Ω
Tolerance on R ₂₅ -value	± 1; ± 2; ± 3	%
B _{25/85} value	3435 to 4190 K	K
Tolerance on B _{25/85} -value	± 0.5; ± 1.0; ± 1.5	%
Operating temperature range at zero power	-55 to +125	°C
Thermal time constant τ	≈ 5	s
Dissipation factor 10	10	mW/K
Thermal gradient*	< 0.05	K/K
Min. dielectric withstanding voltage between terminals and lug	1500	V _{AC}
Min. insulation resistance between terminals and lug at 500 V _{DC}	100	MΩ

If the probe wire supplied is too short, replace the probe with one on the market having the following minimum requirements:

- NTC probe
- Resistance value at 25 °C = 10KΩ
- Range = -55°C + 125°C



2) **magnetic flux** [Wb] of the motor (when connected onto a motor).
Measured by means of an internal magnetometer

parameter	Min.	Typ.	Max.	Unit
Operating temperature range	-40		+85	°C
Linear acceleration sensitivity	-7%		+7%	mg/LSB
linear acceleration sensitivity change vs temperature		0.01		%/°C
Linear acceleration zero-g level offset accuracy	-80	±40	+80	mg



3) **vibrations** [mm/sec]. Measured by means of the built-in accelerometer;



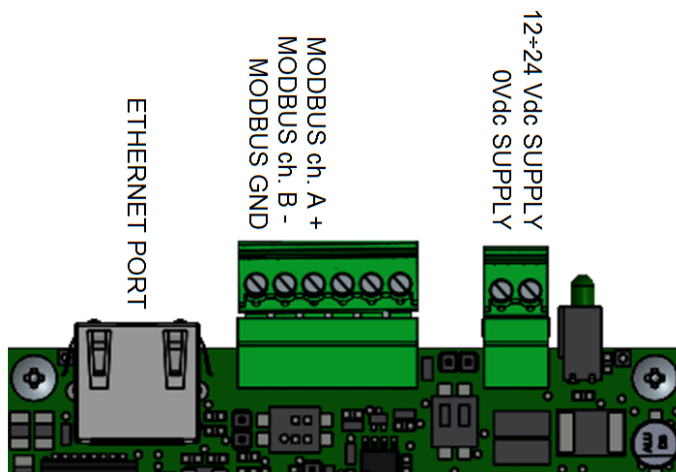
parameter	Min.	Typ.	Max.	Unit
Operating temperature range	-40		+85	°C
Linear acceleration sensitivity	-7%		+7%	mg/LSB
linear acceleration sensitivity change vs temperature		0.01		%/°C
Linear acceleration zero-g level offset accuracy	-80	±40	+80	mg

4) **noise** (dB), measured by means of an internal microphone

parameter	Min.	Typ.	Max.	Unit
Sensitivity	-29	-26	-23	dBFS
Operating temperature range	-40		+85	°C
-26 dBFS sensitivity	±3			dB



CARD PIN OUT:



Terminal pin	Description
12+24Vdc SUPPLY	Power input 12-24V
0Vdc SUPPLY	Power input 0V
CANH	Only for FERMAI use
CANL	Only for FERMAI use
CGND	Only for FERMAI use
MODBUS ch. A+	Input A+ for MODBUS communication
MODBUS ch. B-	Input B- for MODBUS communication
MODBUS GND	Ground for MODBUS communication

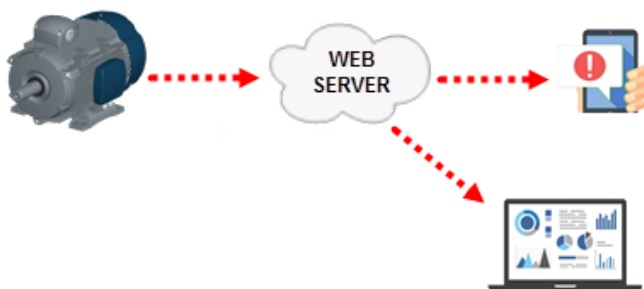


5. OPERATION

The collected data is sent to the FERMAI portal via the company's internet network.

The web server receives the data sent by DOCTOR 4.0, and processes them in an algorithm based on machine learning.

If the value turns out to be out of the ordinary, the portal will automatically notify the user of the anomalous event via email

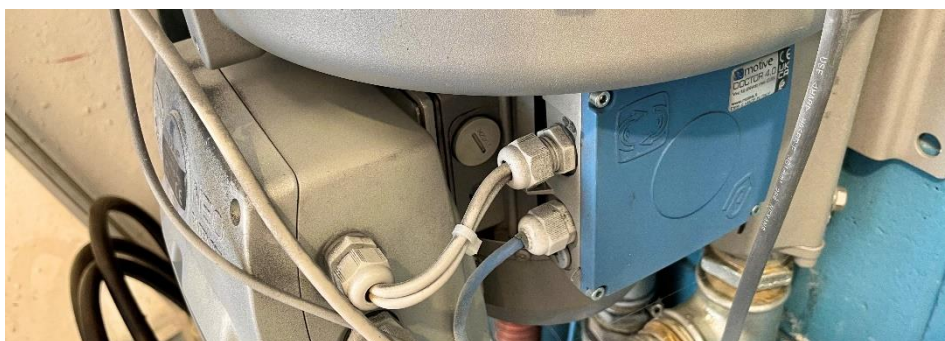
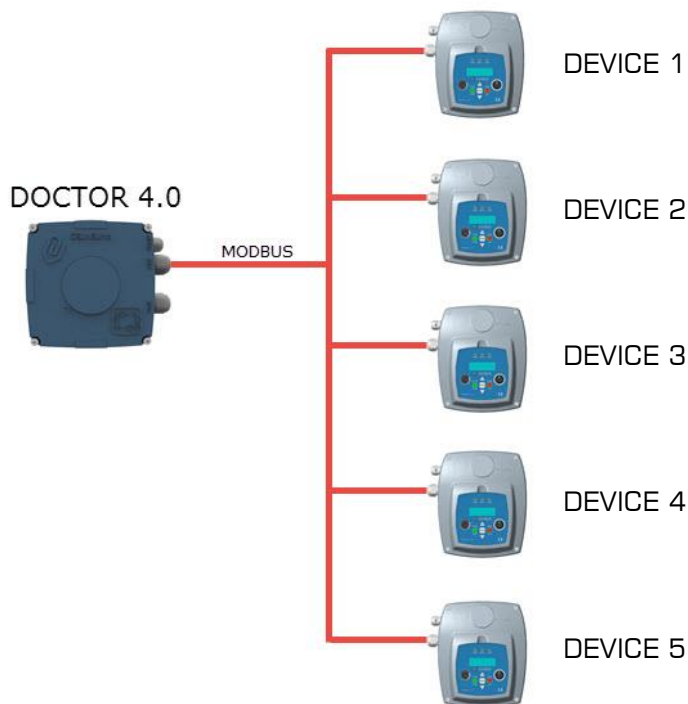


Access to the server is divided into three levels: managers, companies, users (See paragraphs 9.2, 9.3, 9.4)



The Modbus RS-485 connection allows you to connect 5 external devices to the DOCTOR 4.0.

These can also be Variable Frequency Drives with mod-bus port, such as the NEO and NANO series by Motive srl (www.motive.it)

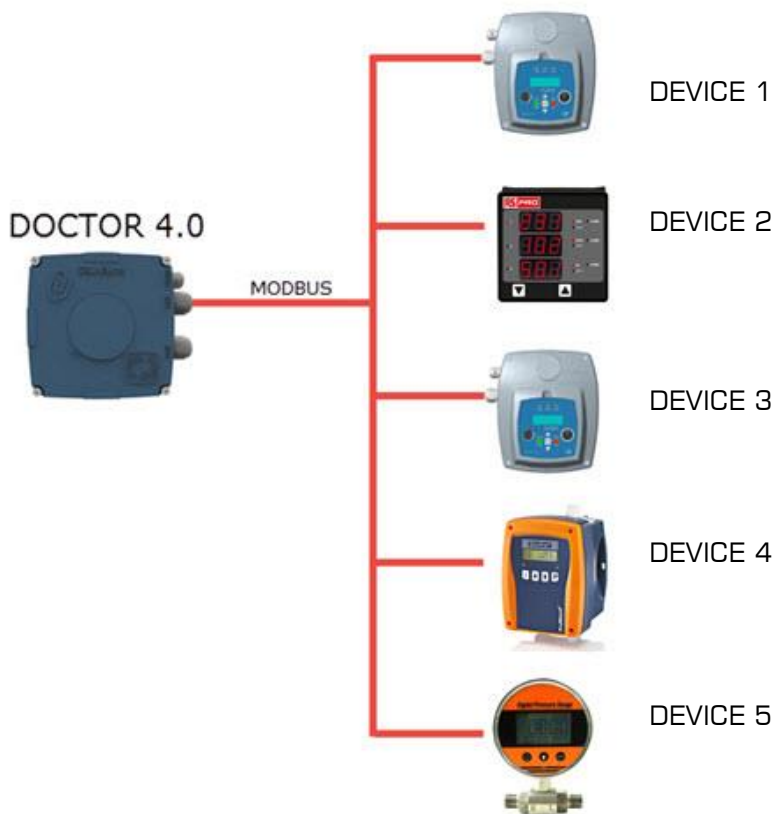


Each device can be connected to one or more modbus nodes of DOCTOR 4.0. For each modbus node it is possible to read and or write a maximum of 5 parameters. The parameters can be selected by the user, for



example voltage, current, revolutions, power, frequency (see par. 10.1.7 Configuration-Modbus)

DOCTOR 4.0 allows you to connect not only inverters, but also other devices (pressure meters, flow meters, piece counters...) via MODBUS.



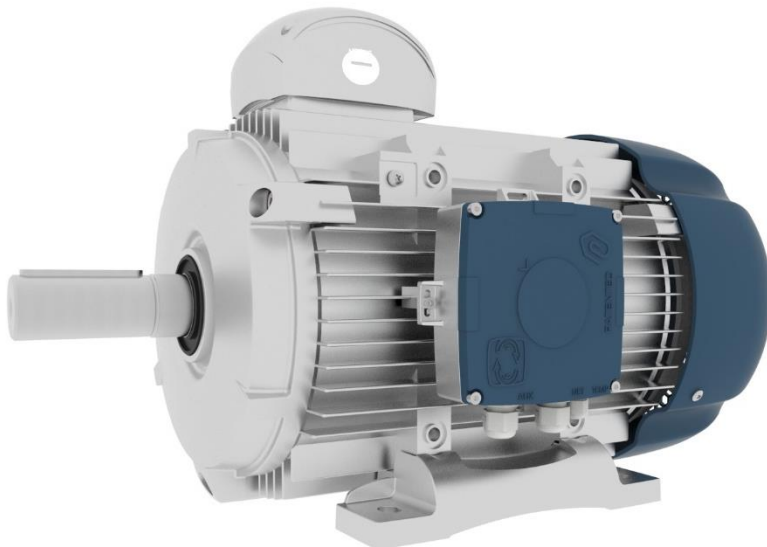
6. MECHANICAL FIXING

Preferably, but not necessarily, DOCTOR 4.0 is mounted directly on the electric motor body (we recommend the motors of MOTIVE www.motive.it, but it can be connected thanks to its terminals to any other motor brand whose body is provided with cooling fins). The fixing kit make it connectable to any motor size.

Mounting onto the motor is preferred because DOCTOR 4.0 is also able to detect the magnetic flux of the same.

The fixing kit is composed as follows:

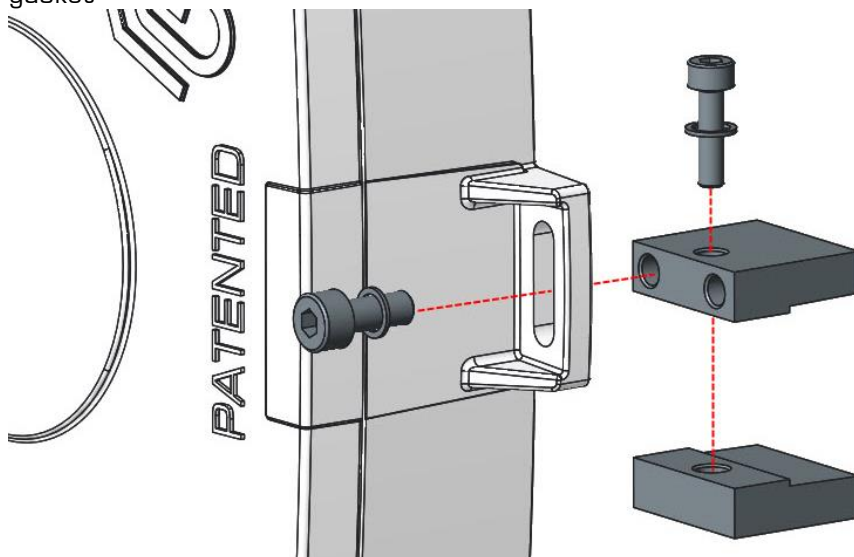
- 2 upper fixing, code *DOCFIXSUP*,
- 2 lower fixing, code *DOCFIXINF*,
- 2 gaskets to be inserted between the fixings, code *DOCFIXGSK*,
- 2 allen screws M4x10 + 2 growers M4,
- 2 allen screws M4x14 + 2 growers M4



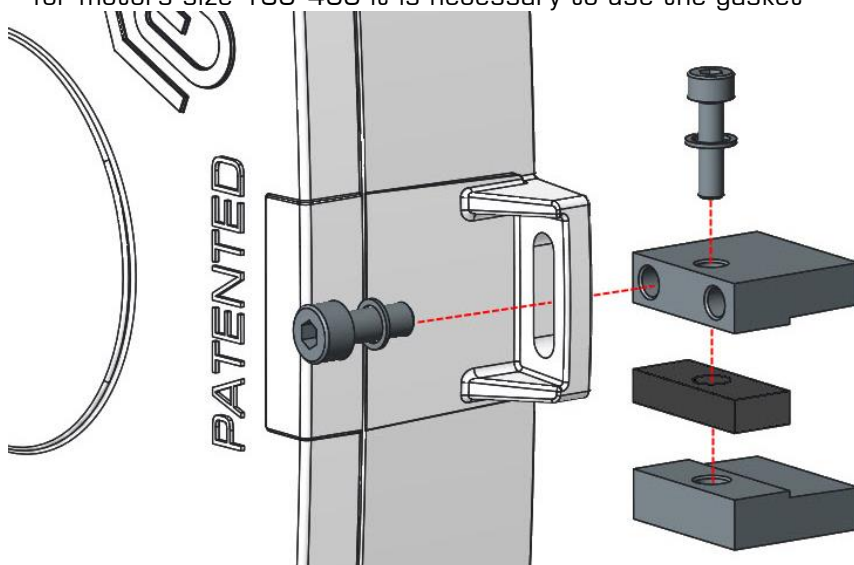


Taking the DELPHI series Motive www.motive.it electric motors as an example, the first distinction is between aluminum motors and cast iron motors:

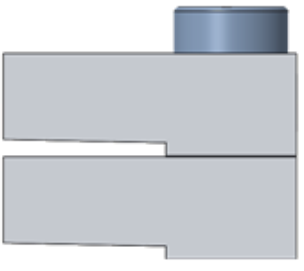

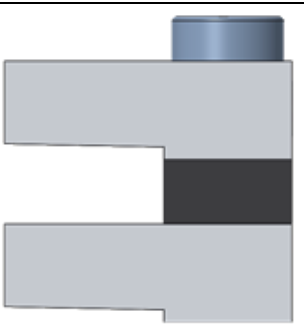
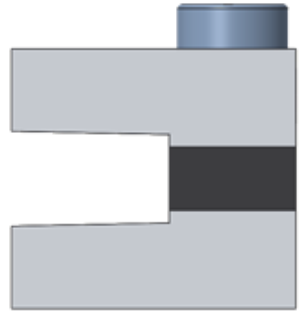
- for aluminum motors it is not necessary to use the intermediate gasket



- for motors size 160-400 it is necessary to use the gasket



In detail, (with Motive electric motors DELPHI series):

motors IEC size 56 ÷ 71	
motors IEC size 80 ÷ 132	
motors IEC size 160 ÷ 315	
motors IEC size 355 ÷ 400	



7. CONNECTION

7.1 Cables connection

The only way to have a functioning artificial intelligence is to have frequent data transmission (DOCTOR 4.0 sends one data packet per second). You can do nothing with one data per hour. This implies the need for a direct power supply of the DOCTOR 4.0, since the energy required to power such frequent data transmission would exhaust the batteries in a couple of days.

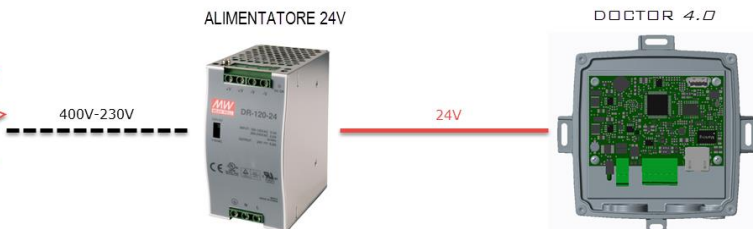
Furthermore, the sending of the data must be secure, free from interference. For this, it was decided to connect to the network using a regular Ethernet cable.

DOCTOR 4.0 can therefore be powered in two alternative ways:

Power supply via
terminals



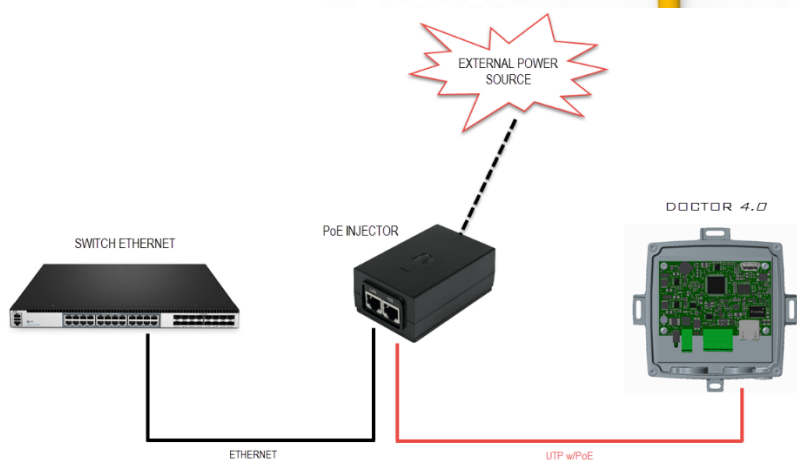
12÷24 Vdc SUPPLY
0Vdc SUPPLY





Of course, first you have to pass the cables through the gland without its connector, and then crimp the connectors

Power supply via ethernet cable with PoE switch



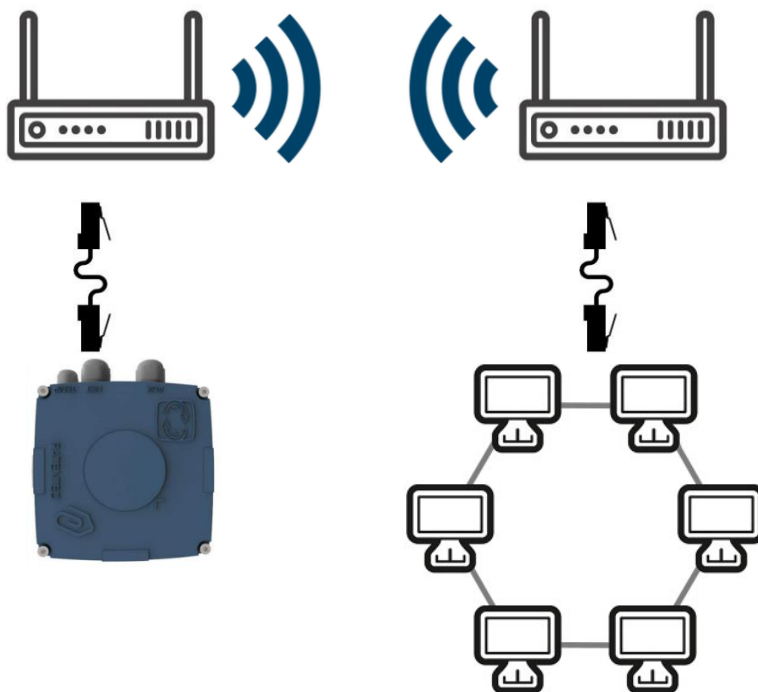


7.2 Wireless Connection

If you need to install DOCTOR 4.0 in a place that cannot be reached by an Ethernet cable from the network, you can do the following:

7.2.1 Connection via Wi-Fi router bridge

Obtain Wi-Fi connectivity via router (bridge) in order to enable DOCTOR 4.0 integration to the company network.



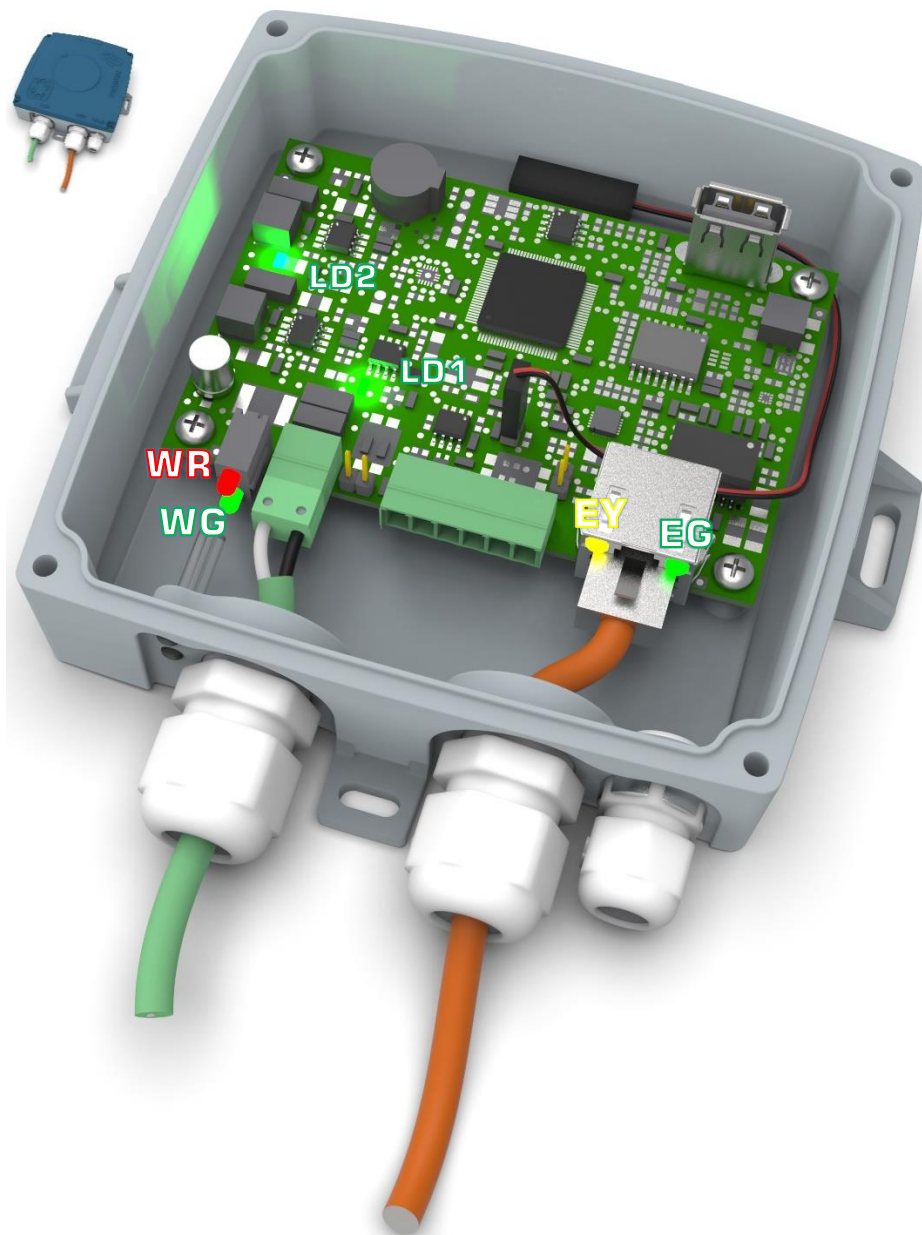


7.2.2 Connection via portable Wi-Fi router with SIM

It is possible to connect DOCTOR 4.0 to a mobile network via a portable Wi-Fi router equipped with a SIM having an internet subscription.



7.3 Leds:



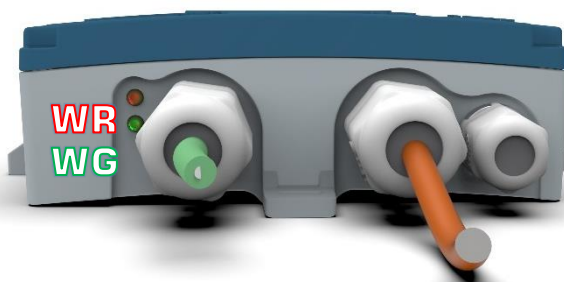


EG: it is the ethernet Activity LED, and it is solid green when the Ethernet Link has been established. It flashes when there is network traffic and it is off when DOCTOR 4.0 is not attached. If off, check the cable connection.

If it shows a slow blink, you have a configuration error: the default configuration is with DHCP client on. Check your DHCP server configuration (Chap.: 10.1.7 Configuration).

EY: It blinks when there is data traffic between DOCTOR 4.0 and the network. It can also be solid on, when there is a high sampling rate

LD1 and **LD2** are on when DOCTOR 4.0 is correctly power supplied



WR: when this red light is on, we have an anomaly (for example, the ethernet cable is disconnected or the network is absent)

If **WR** is on, that means that you can't reach FERMAI portal: check DNS and firewall configuration and allow full access to [*doctor.fermai.it*](http://doctor.fermai.it)

WG: It blinks when DOCTOR 4.0 is sending data, therefore each second. If it is off, check the power supply and the firewall of the network

EG	EY	WR	=
off	off	on	wiring error or network switch port error
on	Not blinking	on	wiring error or network switch port configuration error
on	blinking	on	network configuration error (switch, firewall, DNS, etc)
on	blinking	off	with WG blinking too, communication with portal is OK



7.4 Connections problems?

First check the leds. If all leds are saying that anything is OK, but still there are connection problems, the problem is in your network configuration.

Now, to fix the problem proceed with these checks:

1. Find the right IP: if you have a DHCP network you can find it, or you can make a Network Scan (like Advanced IP Scan)

	Stato	Nome	IP
>		MIB-Win10.lan	192.168.123.102
>		WebServerMotiveDoc.lan	192.168.123.116
>		console.gl-inet.com	192.168.123.254

2. If you can find it, configure the write ip address of your DOCTOR 4.0 (par. 10.1.7 Configuration-Net)

Still connection problems? Well, like when you connect also a printer to your network, there could still be some hidden obstacles (firewall, DNS filtering, Content filtering, etc.)

The easy way to check it is: take a laptop, connect it to the same Ethernet cable of your DOCTOR 4.0 and try to browse www.fermai.it

If needed, check deeply in your lan/firewall connection.

In general, we suggest that any IIoT device, like DOCTOR 4.0, should have separated LAN zone without any kind of restriction, first of all for security reason.



8. REGISTRATION

Before you can activate a DOCTOR 4.0 you must have entered your company data and created your login profile. With the browser, from the site <https://fermai.it/>, first click on "Customer area"



Home DOCTOR 4.0 Prices Contact us



Customer area



Then click on "don't have an account yet??".

Sign in

Email
Your email

Password
***** Show

Sign in

[Don't have an account yet??](#)

It will take you to <https://fermai.it/registrazione>

Sign up

Company data

Company name VAT number

PEC address SDI code

Billing address

Address City POSTCODE

Province Region Paese

Brescia Lombardia Italy

User details

First name Surname Email Phone

Password Repeat password

Sign up



Enter your company data here. Choose a password. Your account name will be the email you enter here.

After registering, you will receive an email confirming the creation of your account

Only with an account will you be able to purchase or activate a DOCTOR 4.0. DOCTOR 4.0 purchases and the portal subscription will be linked to your account. The more DOCTOR 4.0 you will buy over time, the less their purchase will cost you and the less the subsequent activation will cost you

NOTE: If you are a system configurator qualified by FERMAI and you have received from FERMAI a special "manager" enabling profile (see chapter 10.3),

log in with the given "manager" profile and input the company data in the "companies" section (see chapter 10.4) via "add". Then impersonate the client company to continue the DOCTOR 4.0 activation with the company account.



9. ACTIVATION

Each DOCTOR 4.0 is activated via the FERMAI app (available for Android


and IOS  ).



To download the FERMAI app, just connect to the site:
<https://doctor.fermai.it/login>

After connecting to the site, a login screen is shown; to access the portal you need to enter your credentials.



 **FERMAI**
PREDICTIVE MAINTENANCE

Email

Password [SHOW](#)

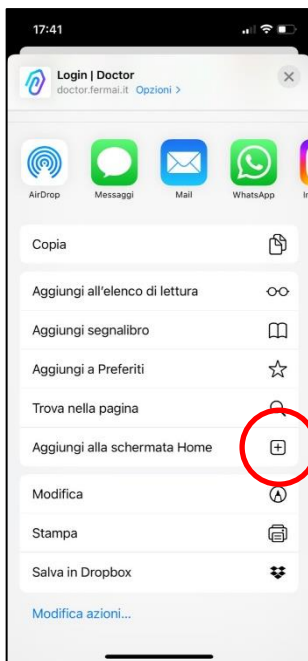
Forgot your password? [Request it](#)

Sign in

After entering the website, you can download the app, as follows



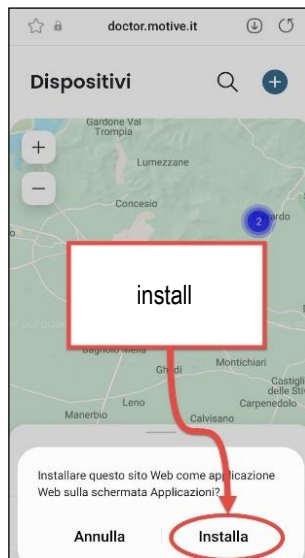
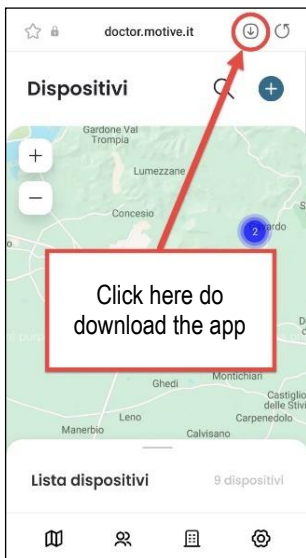
After connecting to the site <https://doctor.fermai.it/> a login screen is shown, in order to access the portal it is necessary to enter the login credentials.
This is how to add the app into your smartphone or tablet:



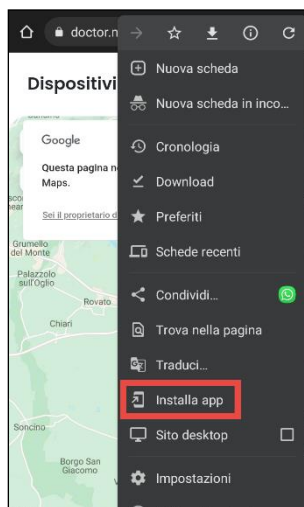


ANDROID

After connecting to the site <https://doctor.fermai.it/> , simply go to the web page settings and click on the "install app" item and it will be downloaded automatically.



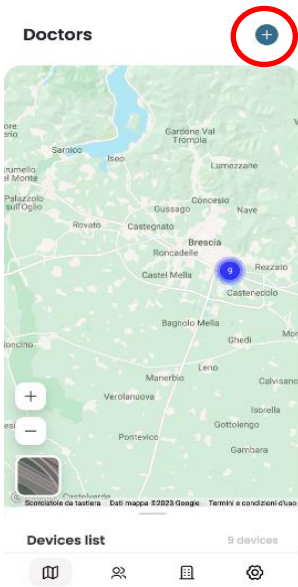
Or:



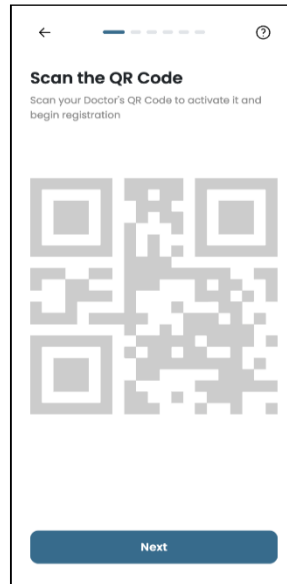


Note: During the association operations, it is necessary to ensure that the motors or gear reducers where the Doctor is applied are turned off and not in motion.

Press the  button to add a new DOCTOR 4.0.



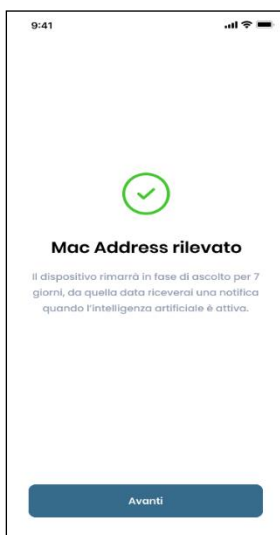
Once selected, you will be asked to scan a QR code.



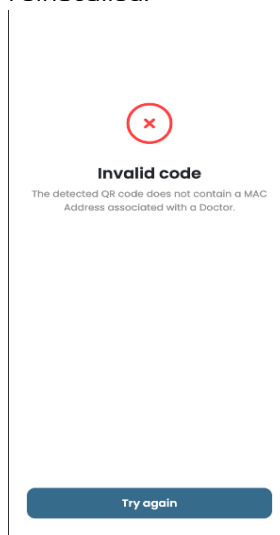
The QR Code can be found on the lid of the DOCTOR 4.0.



If detected correctly, the following message is displayed:



If the message “Invalid code” appears, the device has already been installed and cannot be reinstalled.





After configuring the new DOCTOR 4.0, the app shows the installation steps



1. For the communication with the app and with FERMAI portal, DOCTOR 4.0 must be connected to the company network (in case of communication problems, see also Par. 10.1.7 Configuration-network), and this network to internet,

If the connection has been established, it begins to record and memorize the detected data, showing them on a screen



Collega doctor alla rete

Il dispositivo rimarrà in fase di ascolto per 7 giorni, da quella data riceverai una notifica quando l'intelligenza artificiale è attiva.

Avanti



Dati ricevuti

Il dispositivo rimarrà in fase di ascolto per 7 giorni, da quella data riceverai una notifica quando l'intelligenza artificiale è attiva.

Temperatura
10°

Vibrazione
XXX

Suono
XXX

Suono
XXX

Avanti

2. Chose the use;

-On a **motor**;



-Select **gearbox** for any only-mechanical machine to exclude the magnetic flux data from the A.I.



Seleziona tipologia

Seleziona il tipo di macchinario su cui vuoi montare il tuo Doctor.



Motore

Se installato su motori, compressori, ventilatori.



Riduttore

Se installato su riduttori meccanici.

Avanti



3. Chose the name of this
DOCTOR 4.0

Nome del dispositivo
Inserisci l'indirizzo del tuo dispositivo

Nome

Luca

Avanti

4. The app automatically identifies the DOCTOR 4.0 position via Google Maps, otherwise it is possible to enter the position manually.

Posizione del dispositivo
Inserisci l'indirizzo del tuo dispositivo

Inserisci manualmente

Avanti

Posizione del dispositivo
Inserisci l'indirizzo del tuo dispositivo

Indirizzo del dispositivo

Via marcello lippi 140, Roma 00175

Città

Roma

CAP

00175

Avanti

Q W E R T Y U I O P
A S D F G H J K L
↑ Z X C V B N M ↵
123 space Go


5. Insert the photo. You can insert the photo of DOCTOR 4.0 or of the machine to which it is applied. It is used to facilitate visual recognition on the list of DOCTOR 4.0 installed



←

.....

Foto del dispositivo
Passa il doctor sotto al telefono per attivarlo e continuare la registrazione.

 Carica file

Avanti

←

.....

Foto del dispositivo
Passa il doctor sotto al telefono per attivarlo e continuare la registrazione.



Avanti

Once all steps are completed, the message “Doctor activated” is displayed. DOCTOR 4.0 is therefore ready, but in “machine learning” mode for a month.

After a month, it will be notified the activation of the artificial intelligence and of the calculated “AI” alarm thresholds.



Doctor attivato
Il Doctor è stato attivato con successo.
Il dispositivo rimarrà in ascolto per 30 giorni al termine dei quali riceverai una notifica di attivazione.

Torna alla home

NOTE: DOCTOR 4.0s can only be added and activated from the app. It is not possible to do it from the web.



10. FUNCTIONS

After configuring the DOCTOR 4.0, access the portal from the site <https://doctor.fermai.it/>.

Alternatively, you can also get there from the Fermai website <https://fermai.it/login>, first clicking on "Customer Area",



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Customer area

Buy

make the login, and then click on "Go to the portal"



Home DOCTOR 4.0 Prices Contact us



Go to the portal

GC

The functions on the left of the FERMAI portal and app are:

Doctors

1. View and locate on a map and view all activated DOCTORs 4.0;
2. View the daily working time and total machine time;
3. View the parameters of the connected Modbus connected devices (eg: VFDs, or pressure transducers, etc.) and of the built-in ones (flux, temperature, vibration, sound);
4. Display of the status of each DOCTOR 4.0 (online with machine working, online with machine not working, offline, in alarm);
5. Alarms communication management
6. Maintenance Management: Plan and record maintenance based on real working time;
7. Chose up to 5 parameters of each Modbus connected devices
8. View the automatic alarm thresholds of the A.I.
9. Establish alarm thresholds manually
10. Telecontrol
11. Integration

Users

Users management

Profile

Profile management



10.1

Doctors

10.1.1 View and locate DOCTORS

By clicking on "Doctors" it is possible to view a map, which shows the points where the DOCTORS 4.0 are located, facilitating their recognition.

Nome	MAC Address	Status
Himik test2	00:60:35:32:C3BF	●
Prova Vedrai	00:60:35:32:C3BF	●
TEST NLMK	00:60:35:32:C732	●
9 novembre	00:60:35:32:C732	●
Test AGS	00:60:35:32:C2C4	●
Test modbus	00:60:35:32:C2C4	●
Pressa incarcassatrice	00:60:35:32:C2AB	●
Zato compressore	00:60:35:32:D432	●
Nastro verniciatura	00:60:35:32:B9A8	●
Finelinea box	00:60:35:32:C741	●
Zato riserva	00:60:35:32:C2B0	●
Aspiratore verniciatura	00:60:35:32:B9A0	●
Sala prove	00:60:35:32:C2C1	●
Aspiratore marcatrice	00:60:35:32:C2CA	●

By zooming in, you can always see all the installed DOCTORS 4.0 in greater detail. It is also possible to specify a geographical location to search for all the DOCTORS in a certain place.

Nome	MAC Address	Status
Prova Vedrai	00:60:35:32:C3BF	●
9 novembre	00:60:35:32:C732	●
Test modbus	00:60:35:32:C2C4	●
Pressa incarcassatrice	00:60:35:32:C2AB	●
Nastro verniciatura	00:60:35:32:B9A8	●
Finelinea box	00:60:35:32:C741	●
Aspiratore verniciatura	00:60:35:32:B9A0	●
Sala prove	00:60:35:32:C2C1	●
Aspiratore marcatrice	00:60:35:32:C2CA	●



Alongside (for the desktop version) or below (for the mobile version) is the list of DOCTOR 4.0 devices that are shown on the map. By zooming forward/backward in the map, the list of devices is also modified, showing only those that are identified within the map.

The list of devices shows the DOCTOR 4.0 names (previously chosen during the configuration phase), their MAC addresses (those printed on the DOCTOR 4.0 cover, but viewable only in the desktop version) and their

Search for a device or location





Name	MAC Address	Status
Prova Vedrai	00:60:35:32:C3:BF	
9 novembre	00:60:35:32:C7:32	
Test modbus	00:60:35:32:C2:C4	
Pressa carcassatrice	00:60:35:32:C2:AB	
Nastro verniciatura	00:60:35:32:B9:A8	
Finelinea box	00:60:35:32:C7:41	
Aspiratore verniciatura	00:60:35:32:B9:A0	
Sala prove	00:60:35:32:C2:C1	
Aspiratore marcatrice	00:60:35:32:C2:CA	

current status.

The status is indicated with 4 different colors:

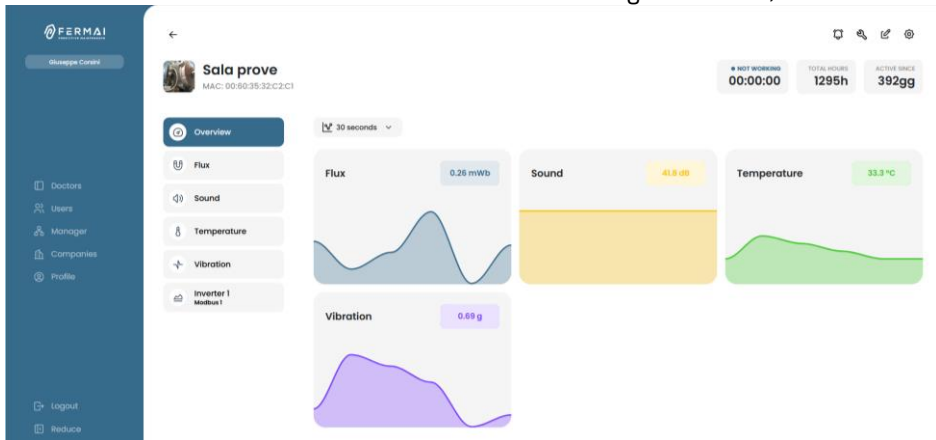
- **Green:** The machine is on
- **Red:** The machine is in an alarm state
- **Blue:** The machine is off, but DOCTOR 4.0 is connected
- **Gray:** DOCTOR 4.0 is offline



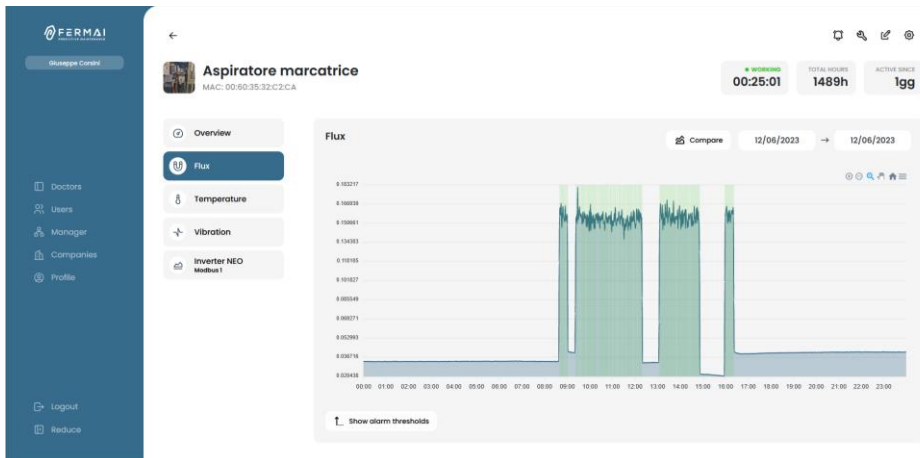
It is possible to manually modify the position in the settings of each DOCTOR 4.0 (see modification paragraph    )



From the list of DOCTORs 4.0 it is possible to choose the one whose data you want to see,
You can either see an overview of the data being collected, or







a detail of the data collected over time for each parameter





10.1.2. Work time and total time

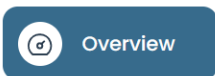
Although not directly connected to the machine power supply, DOCTOR 4.0, thanks to an algorithm linked to flux and vibration data, is able to recognize when the machine is on or off, and therefore count the operating hours. This will be very useful for maintenance planning (see maintenance paragraph 10.1.5    )

This is an example of what you find displayed on the top of the screen of the portal, after that you select a DOCTOR 4.0:

<div>● WORKING</div> <div>00:19:14</div>	<div>MACHINE TOTAL HOURS</div> <div>1497h</div>	<div>DOCTOR ACTIVE SINCE</div> <div>2gg</div>
<div>● WORKING</div> <div>00:19:14</div>	it is the time in which the machine has been switched on during the day from 00:00 o'clock, in hh:mm:ss When the machine is off, it shows:	
		<div>● NOT WORKING</div> <div>00:00:00</div>
<div>MACHINE TOTAL HOURS</div> <div>1497h</div>	It is the total operating time of the machine since its installation (=hours counted since DOCTOR 4.0 was activated on the machine + the initial working hours that can be entered manually)	
<div>DOCTOR ACTIVE SINCE</div> <div>2gg</div>	is the number of days since DOCTOR 4.0 was activated	



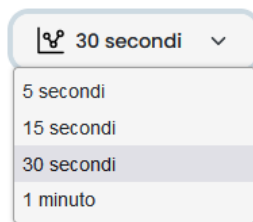
10.1.3. Viewing detected parameters



: it shows an overview of the data acquired in real time, in a range of 30






seconds.

The display frequency can be freely changed with a range between 5 seconds and one minute*



*NOTE: DOCTOR 4.0's "log rate" (frequency of sending data to the portal) remains anyway still set to one sending per second (this is also why it can be "intelligent"), and it cannot be changed.



Parameters: they are flux , temperature , vibrations ,
sound  and Modbus .

For each of them, the graphs of the acquired data are shown. They are displayed over a period of time that goes from 00:00 of the current day up to that precise moment.



By clicking on one of the parameters, a graph is displayed showing the data recorded during the day.

Each alarm is displayed on the graph





By clicking on "show alarm thresholds"


↑... **Mostra soglie allarme**

, the AI alarm thresholds are displayed. They represent the limits of normality, as calculated by AI machine learning

"Manual" alarm thresholds can also be entered, and then you can choose which thresholds to use, whether those "AI" set by artificial intelligence or the "Manual" ones set by the user.


Choose alarm thresholds

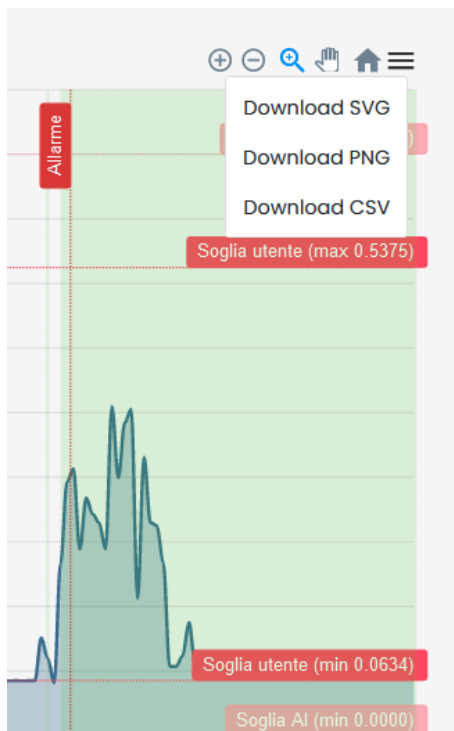
AI ☐ Manuals

 Reset thresholds

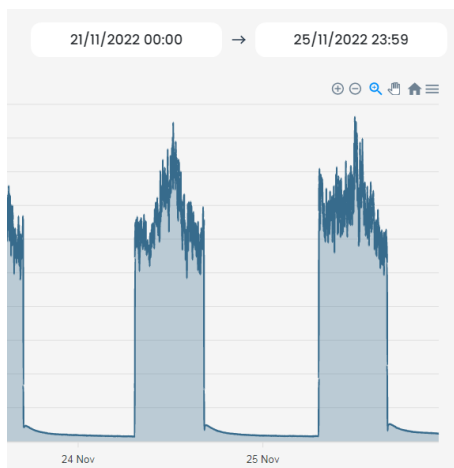
At the first modification of the thresholds, which can be done by dragging the AI threshold pre-set by the artificial intelligence (raising it or lowering it), both thresholds will be shown.

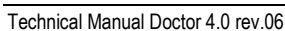
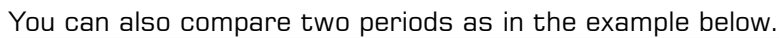


The data of the graphs shown can be downloaded through the small menu  at the top right of the graph, allowing downloads in several formats (SVG, PNG, CSV).



It is also possible to choose the time period for the data to be shown







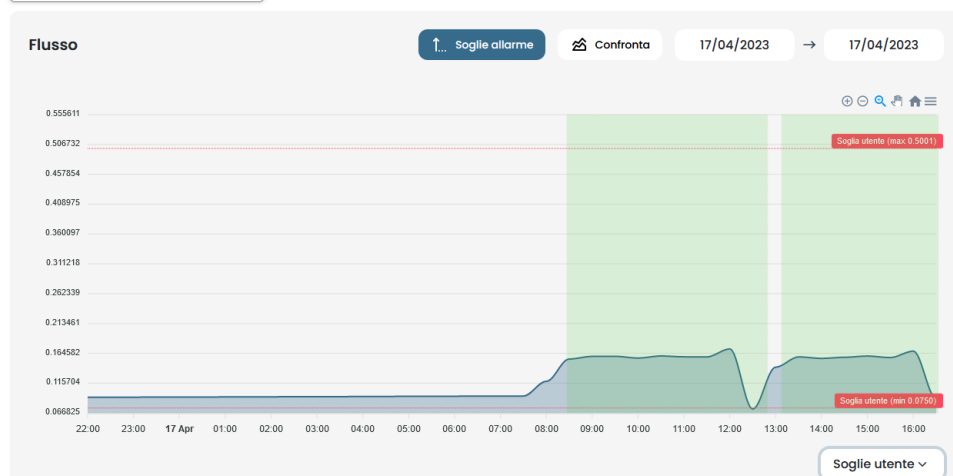
10.1.4 Alarms

Soglie utente ▾

Soglie AI

Soglie utente

It is possible to manually set the alarm thresholds (user thresholds) and to send the alarms from these instead of those calculated by the A.I.



Make the manual thresholds prevail over those of the A.I. it may be desirable when the platform has collected anomalous operating data, or in the initial self-learning phase (about a month), or when it is believed to know the correct functioning of a machine more than the numbers detected by each sensor can make an algorithm understand.

It is also possible to inhibit the minimum alarm thresholds (minimum temperature, minimum vibrations, etc.)




By clicking on the bell icon at the top , you can view both current and past alarms

The alarm state occurs when an alarm threshold is exceeded.

The presence of an alarm in progress in a DOCTOR 4.0 is indicated by the red color,

both in the view of the single device,



Nastro verniciatura
MAC: A00:60:35:32:B9:A8

● ALLARME


00:00:00


ORE TOTALI


1746h

ATTIVO DA

4gg

 Panoramica

 Flusso

 Temperatura

30 secondi

Flusso0.1 mWb

Temperatura27.9 °C


Dispositivi

in the map,



Dispositivi

and in the list of DOCTORs



Cerca un dispositivo o un luogo

Nome	MAC Address	Stato
Prova Vedrai	00:60:35:32:C3:BF	●
9 novembre	00:60:35:32:C7:32	●
Pressa incarcassatrice	00:60:35:32:C2:A8	●
Nastro verniciatura	00:60:35:32:B9:A8	●
Finelinea box	00:60:35:32:C7:41	●
Aspiratore verniciatura	00:60:35:32:B9:A0	●
Aspiratore marcitrice	00:60:35:32:C2:CA	●



The alarm log displays :

- Machine given name;
- Type of alarm;
- Recorded value;
- Date and time of the event;
- State of the alarm;

Finelinea box
MAC: 00:60:35:32:C7:41

● NOT WORKING
00:00:00

MACHINE TOTAL HOURS
298h

DOCTOR ACTIVE SINCE
422gg

Overview

Flux

Temperature

Vibration

Past alarms

Sensor	Value	Date and time	Status	Actions
Temperature	36.6026 °C	7/7/2023, 09:00:06	To be verified	
Temperature	35.5342 °C	7/7/2023, 08:24:25	To be verified	
Flux	0.0583 mWb	7/7/2023, 07:54:25	Verified	
Temperature	38.7868 °C	6/7/2023, 15:50:06	To be verified	
Temperature	31.4057 °C	6/7/2023, 01:55:11	Verified	
Temperature	31.4371 °C	6/7/2023, 01:25:11	Verified	
Temperature	31.5086 °C	6/7/2023, 00:55:11	Verified	


Notification settings

When the status is set as "To be verified" it is possible, thanks to the two side keys, to confirm the occurred verification of the alarm or not to verify it at the moment.

When an alarm occurs, the portal sends a message to the email address that was entered during registration.








Within the alarm log page, it is possible to manage who to notify or not to notify each type of alarm. For this, click first on

 **Notification settings**

Then, make your selections as in the example below

←





Aspiratore verniciatura
MAC: 00:60:35:32:B9:A0

● NOT WORKING
00:00:00

MACHINE TOTAL HOURS
1015h

DOCTOR ACTIVE SINCE
414gg

Overview

Flux

Sound

Temperature

Vibration

Modbus 1
Node 1
Modbus 1

← Notification settings

✓ Save

Enable alarm notifications

	Area Manager areamanager@motive.it	Tester tester@motive.it	Giuseppe Corsini gcorsini@motive.it	Giorgio Bosio gbosio@motive.it	Demo Fermal demo@fermai.it
Temperature	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Vibration	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>
Flux	<input checked="" type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
Sound	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>



10.1.5 Maintenance



Sala prove
MAC: 00:60:39:32:C2:C1

NOT WORKING
00:00:00

MACHINE TOTAL HOURS
1304h

DOCTOR ACTIVE ENDS
394gg

Overview

Flux

Sound

Temperature

Vibration

Inverter 1
Method 1

Maintenance

Planned
No planned maintenance for this device

Performed

January
No maintenance performed

February
No maintenance performed

March
No maintenance performed

April
Ingressaggio cuscinetto
12/4/2023, 06:53:43
1088.28h

May
No maintenance performed

June
No maintenance performed

July
No maintenance performed

August
No maintenance performed

September
No maintenance performed

October
No maintenance performed

November
No maintenance performed


December
No maintenance performed

Schedule

+ Record

Predictive maintenance is evolution, but preventive maintenance should not be neglected. The more the A.I. will have data, the more it will detect operating anomalies but, in the meantime, it is always better to also follow the machine manufacturer's manual. DOCTOR 4.0 counts the operating hours and, better than any agenda, its portal can tell you when it's time to do the required preventive maintenance

DOCTOR 4.0 allows you to manage a maintenance register. For example, an oil change can be planned for a mechanical gearbox. The main advantage of using DOCTOR 4.0 for this option is that the working hours of the machine are automatically counted. DOCTOR 4.0 is in fact able to understand from its flow and vibration measurements when the machine is working or not, and count the working time.

By pressing the button  located at the top of the screen, the page dedicated to maintenance opens.

It is then possible to plan a maintenance, or record a carried one



Schedule



Record



By selecting “Schedule”, it is possible to choose after how many hours, of the machine working, maintenance is to be repeated.

←

Sala prove
MAC: 00:60:35:32:C2:C1

● NOT WORKING 00:00:00

MACHINE TOTAL HOURS 1304h

DOCTOR ACTIVE SINCE 394gg

Overview

Flux

Sound

Temperature

Vibration

Inverter 1
Modbus 1

← Registra manutenzione

Intervention

Schedule between (work hours)

Total working hours 1304.52

Instructions

☐ Schedule repetition
If selected, upon completion of this maintenance a new one will be created after the specified number of hours.

Save

To record a maintenance intervention, click on

+ Record

1. Give a title to the intervention (like “bearings regrease”)
2. Date and hour of the intervention
3. How many hours the machine had been working before the intervention (it's automatic)
4. Description of the intervention;
5. Save the data

Titolo intervento 1

Data e ora intervento 01/12/2022 12:29 2

Ore di lavoro 622.80 3

Descrizione intervento 4

Salva 5




10.1.6 Edit



: within this section it is possible to make changes to DOCTOR 4.0, including:

- machine name,
- typology,
- initial work time, corresponding to that already worked by the machine before the activation of DOCTOR 4.0. It will be added to the working time counted by DOCTOR 4.0 from its activation onwards.

A map is also shown which allows you to view the position of each DOCTOR 4.0, providing its coordinates. In this section, by dragging the DOCTOR 4.0 icon, it is possible to reposition it on the map



Aspiratore verniciatura

MAC: A00:60:35:32:B9:A0

● **ACCESSO**


00:09:06


ORE TOTALI


1016h


ATTIVO DA


4gg


 **Panoramica**


 **Flusso**


 **Suono**

 **Temperatura**



 **Vibrazione**

 **Modbus 1**

 **Node 1**

 **Modbus 1**

Modifica dispositivo



Nome

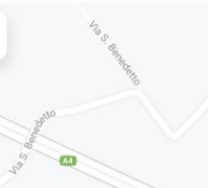
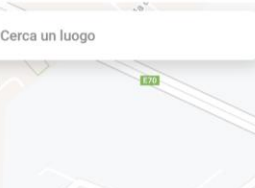
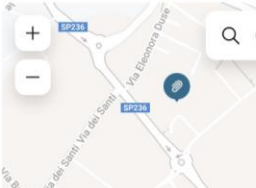
Aspiratore verniciatura


Tipologia

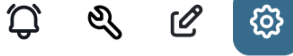
Motore

Tempo di lavoro iniziale (...)

0



 Cerca un luogo



10.1.7 Configuration

Of each DOCTOR 4.0, you can configure: **Modbus, MQTT, Net, Serial**

- **Modbus.** This function makes each DOCTOR 4.0 expandable to external sensors and variable frequency drives

In the left menu, click on Modbus.

We can not only read the parameters of the connected device but, if the device permits it, also "write" (see TELECONTROL paragraph)

If for example a variable frequency drive is connected, it is possible to view and modify (if write-enabled by the VFD software) values such as direction of rotation, speed, on, off, etc.

Reading and/or writing values are allowed up to a maximum of five parameters in total.

How to do:

We can connect up to 5 Modbus devices (or "nodes") and, for each one, we can choose to read 5 Modbus data ("registers").

Example of a device connected to DOCTOR 4.0 (in this case a variable frequency drive):






The steps to follow are shown below:



Click on the configuration icon

In this section it is possible to intervene on the nodes (connected devices) and the parameters of each device that you want to control

All devices are shown in the **Modbus** pane. Active ones are indicated by a green light labelled **Active**. To activate a new one, simply open a

"inactive" node by a click on  .




● NOT WORKING
00:00:00

MACHINE TOTAL HOURS
1501h

DOCTOR ACTIVE SINCE
2gg

1. Select the device to be connected by

clicking on  button at its right

Modbus

● Active Inverter NEO	Update	● Inactive Modbus 2 Node 1	Update
● Inactive Modbus 3 Node 1	Update	● Inactive Modbus 4 Node 1	Update
● Inactive Modbus 5 Node 1	Update		

← ● Inactive
Modbus 3 Node 1
Device 1



2. Click again on



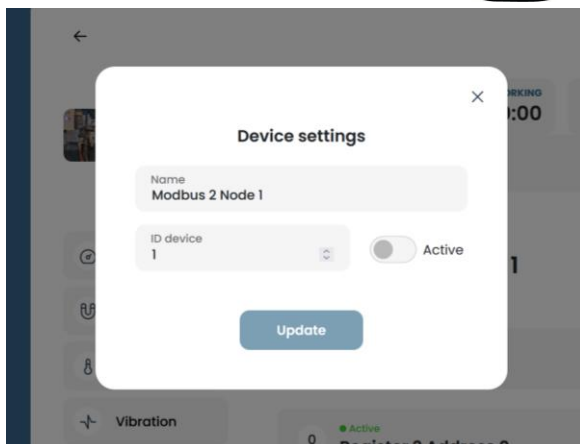
0 ● Active Register 1 Address 0	Update	0 ● Active Register 2 Address 0	Update
0 ● Active Register 3 Address 0	Update	0 ● Active Register 4 Address 0	Update
0 ● Active Register 5 Address 0	Update		



3. Give the device a name (example: inverter NANO fan)

4. Activate

5. Click on 

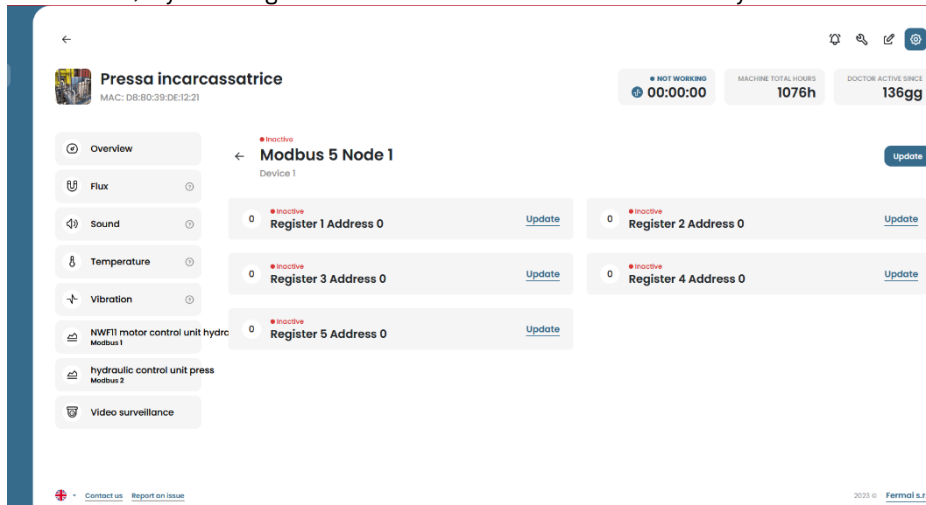


The 'Device ID' is a number to be assigned to the Modbus channel of the external device (such as an external sensor or inverter) connected to the DOCTOR 4.0, in order to pair it.

For example, if you want to connect a new external device, you need to access the configurations by clicking on the icon of configurations

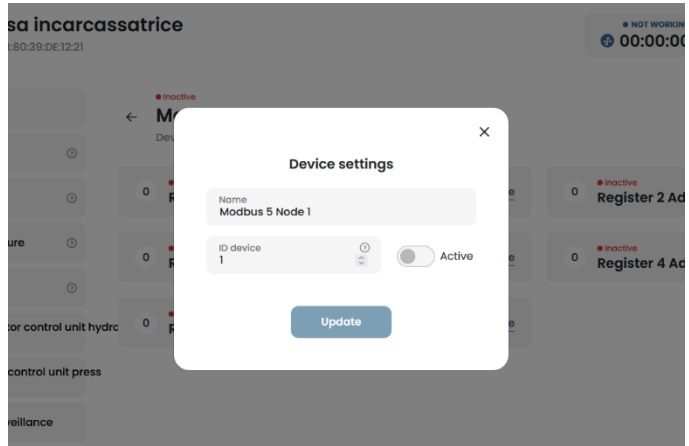


, and choose a Modbus channel (in this example, number 5, by clicking on Modbus5 Node 1). You will find yourself here:

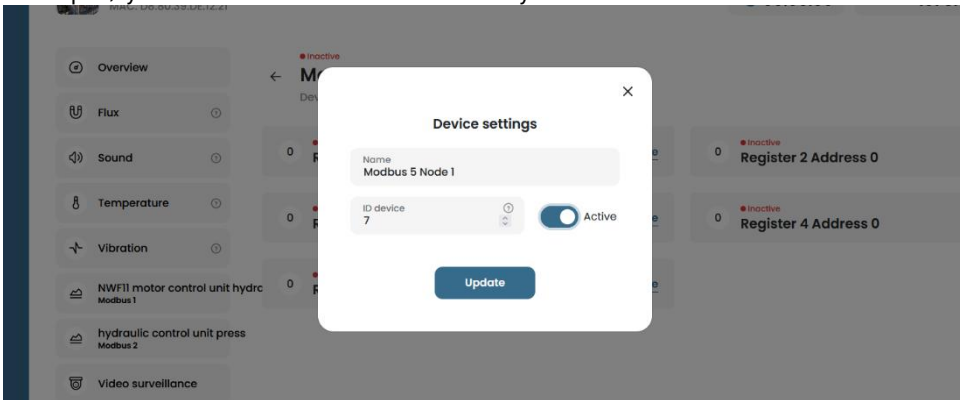




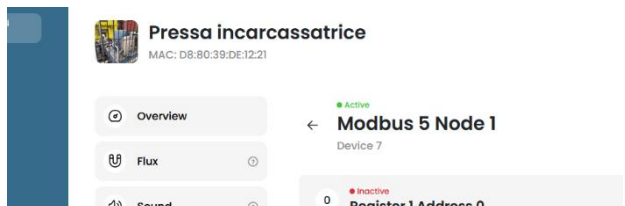
Click on Update,
and it will appear
this window



Here you can choose any number in the ID Device field, not necessarily sequential, which should correspond to the Modbus address you will also need to input into the external device modbus code to pair them. So, for example, you choose the number 7 and you activate it.



Now, click on Update
e vedrai che è
diventato **Active**





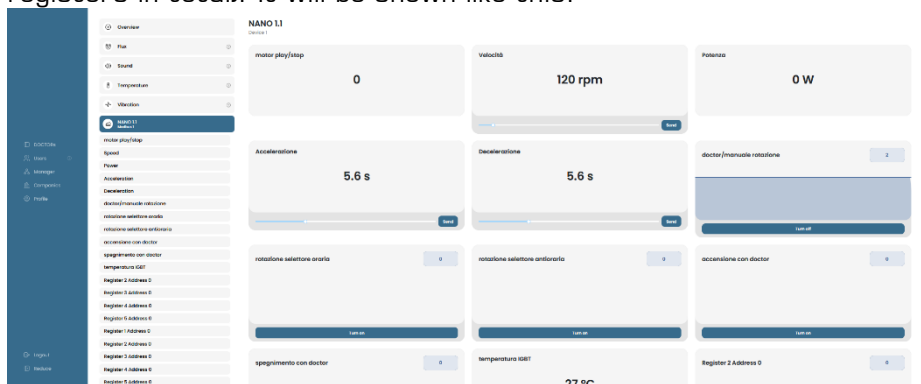
At this point, you need to go to the external device to be connected and assign the same number (in the example, number 7) to the Modbus address code.

In this photo example, we show how to do this on the WiFi keypad of a NEO Variable Frequency Drive by Motive.



If you assign the same ID code number to multiple devices, the reading will not be correct due to conflicts.

Viceversa, if you assign in the portal the same ID code number to multiple channel codes of the same device, you can achieve a register count greater than 5 (if there is for example a VFD, you can have up to $5 \times 5 = 25$ registers in total). It will be shown like this:





Once the device (node) is activated, 5 free MODBUS addresses are shown (example: Register 1 Address 0).

Clicking on [Update](#) you can open the “Change registry setting” page.

- **Name** is a free field (you can write for example on-off, speed, power, current, flow, pressure, etc...)
- **Unit of measurement** (for example W, A, V, RPM...)
- **Active**, to activate or disactivate this registry



- **Reading** typology, can be set to
 - **Continuous reading** (for example if I want to view parameters such as voltage, current...),
 - **Counter** (a progressive number, that you can use if I want, for example, show the pieces counted via a sensor connected to the digital input), or
 - **On/off**. The use of this typology of register allows to detect immediately, avoiding the algorithmic calculation time of the A.I., if the machine is on or off)

The image shows a dropdown menu titled 'Reading'. The selected option is 'Continuous Reading'. Other visible options are 'Counter' and 'ON/OFF'.

When on/off is selected, the "value on" box appears which must be set to the value assumed by the register when the machine is on.

The image shows a configuration panel for the 'Reading' typology. It includes a dropdown menu for 'Typology' (set to 'ON/OFF'), an 'Address' field (set to '0'), a 'Data Rate' field (set to '0'), and a 'Value on' field.

- **Reading** Address, is the device registry MODBUS address (it can be found in the MODBUS variables table of the device manufacturer's manual)
- **Multiplier** (by default=1). If the value of this register within the modbus matrix of the connected device includes a multiplier (e.g.: *10), you can anyway view the data correctly on the portal by entering a demultiplier here (=0,1, in this example).
- **Alarms**. You might wish to connect modbus and control, for example, a pressure sensor, a flow sensor, or another sensor, or you might wish to use the current A or the absorbed power kW values detected by an variable frequency drive to receive further useful alarm alerts, in addition to vibration, noise, flux and temperature of DOCTOR 4.0.
For this reason, the graphs of the modbus detected values can show and manage the alarm thresholds
This can be activated by clicking the "alarms" switch
- **Writing***. It permits the telecontrol of the registry from the app of DOCTOR 4.0, when such registry of the device is writable



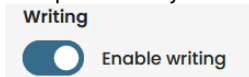
- **Update** , to save all

If the data has been updated correctly, the updated configuration message is shown at the top:

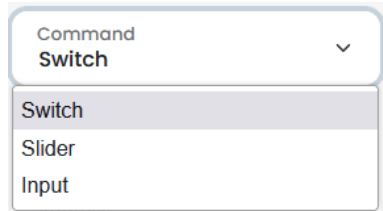


* If it is necessary to set a read+write command (telecontrol), after having set the values previously indicated it is necessary to:

1. Enable writing



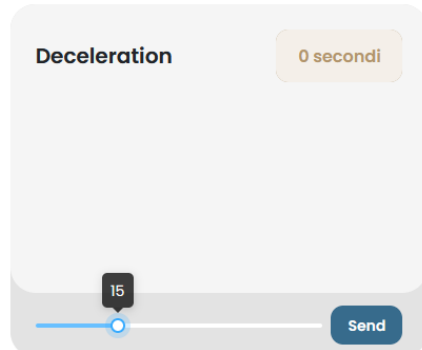
2. **Command**, you can set 3 types of command: switch, slider, input



If the command is set to Switch, the command functions as an on-off button.



If the command is set to Slider, the command will be variable. In the settings during configuration, the minimum value and maximum value are set.



If the command is set to "Input", we have a free field in which to enter a value

- **Value on**, visible when command set on "switch", to set the ref value for on status
- **Value off**, visible when command set on "switch", to set the ref



value for off status

- **Minimum**, visible when command set on “slider”, set the ref value for the minimum
- **Maximum**, visible when command set on “slider”, set the ref value for the maximum

3. **Update** , to save all



Within the CONFIGURATION section there are additional configurable items in each DOCTOR 4.0

Configuration

Modbus

● Active Inverter NANO	Update	● Inactive Prova 3	Update
● Active Inverter NANO	Update	● Inactive nodo 3	Update
● Inactive	Update		

Network ⓘ

[Update](#)

Mode: ⓘ

DHCP

IP address:
192.168.97.100Subnet Mask:
255.255.255.0Gateway:
192.168.97.254Server DNS:
192.168.97.254

Serial

[Update](#)Baud Rate:
9600Parity:
NullBits of data:
8 bitBits of stop:
1 bit

Video surveillance

Stream URL:
rtmp://cam.doctor.fermai.it/doctor/14Stream Key:
[Show](#)

MQTT: it's the information about the host, its port, the client ID and the username with password for access.

In other words, here are the data of the connection between a DOCTOR 4.0 and the FERMAI portal. By changing it, a DOCTOR 4.0 can be connected to another non-FERMAI platform



if you want to modify the MQTT, you have to contact FERMAI

Network: DOCTOR 4.0 is connected by the ethernet cable to your company IT network, and this to the FERMAI portal by internet. This field displays your company's network connection, like for any connected PC. In the editing section you can choose whether you want to move from the dynamic address in DHCP (default) to a static one, then going to modify (in the case of static), the IP address, the subnet mask, the gateway and the DNS.

Rete

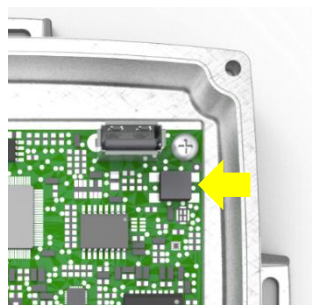
[Modifica](#)Modalità:
DHCPIndirizzo IP:
192.168.123.100Subnet Mask:
255.255.0.0Server DNS:
Non impostato



A wrong modification may make DOCTOR 4.0 unreachable. Evaluate carefully the modifications before saving them and save the previous data. If you lose the network connection for a wrong parameterization of the network, contact FERMAI
DOCTOR 4.0 is configured by default in DHCP

Rete		Modifica
Modalità:	Indirizzo IP:	
DHCP	192.168.123.100	
Subnet Mask:	Server DNS:	
255.255.0.0	Non impostato	

If you lose the network connection due to incorrect network settings, you can restore the factory network settings by holding down the small button near the USB socket on the board.



Serial: It provides details on baud rate, data and stop bits, and parity.
It is the configuration of the ModBus signal.
It is preset for the ModBus signal of Motive VFDs "NEO" and "NANO" which have BaudRate: 9600, Data Length: 8Bit, Parity: Null, Parity Bit: 1.
It can be modified to be able to connect to devices with a different ModBus signal

Seriale	
Baud Rate:	Parità:
9600	none
Bit di dati:	Bit di stop:
8 bit	1 bit



Video surveillance

To access the "video surveillance" section you must have a camera equipped with RTMP (Real Time Messaging Protocol).



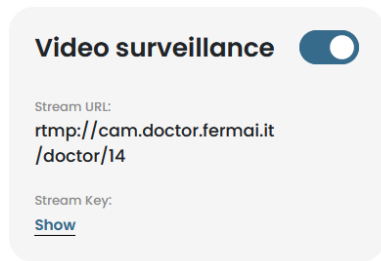
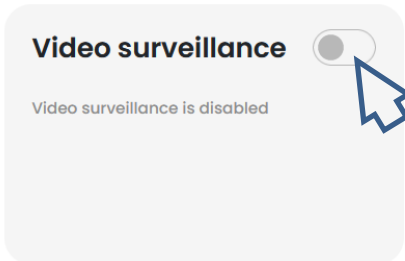
FERMAI separately supplies proprietary cameras already configured for operation.

If using a camera supplied by FERMAI, as it is already configured, it will be sufficient to connect it to the internet and follow the following steps on the portal.

1. Click on the configuration icon

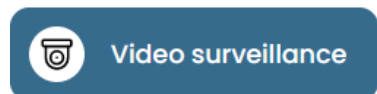
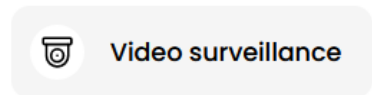


2. Put ON the "Video surveillance" switch.



By doing so, it will appear the Video surveillance entry on the left, inside the navigation list.

3. Click on it to access the camera video

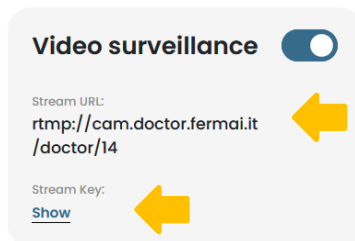




Alternatively, it is possible to use a camera not supplied by FERMAI as long as it is equipped with the RTMP protocol. In that case, add the following step:

4. Change the URL of your camera using the streaming URL present in the FERMAI portal in order to allow your camera to communicate with the portal.

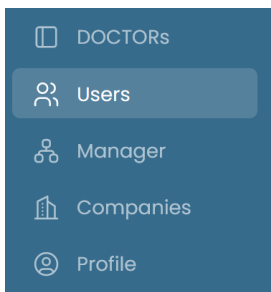
By clicking on “Show Stream Key”, the password that must be entered to configure the camera URL will appear





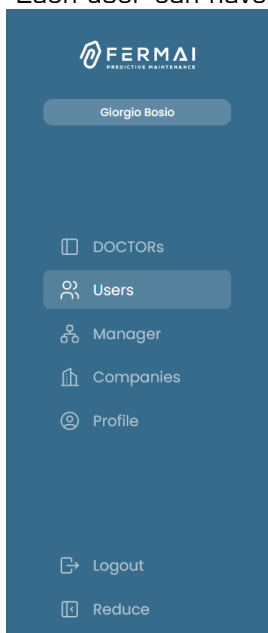
10.2

Users



This section lists all users in the company who have access.
You can add or delete them

Each user can have two types of access: read-only or read-and-write.



Update user

USER DATA

Name

Surname

Email

tester@motive.it

Telephone

SECURITY

Password

SHOW

The password must have a minimum length of 8 characters

PERMISSIONS



Read only

If selected, the user will not be able to make changes to device settings

Delete

Save

In case you decide that a user shall not be allowed to make changes to DOCTORs settings, you must select the "Read only" option, in the user's editing section. The "read only" option will not permit the telecontrol



10.3 Manager

A "Manager" is a qualified installer that has been enabled by FERMAI to manage several companies.

A manager can then register and impersonate various companies and provide external support to the monitoring and maintenance service.

10.4 Companies

Both a "manager" and a company can register a company.

Only a manager can see "Companies" written in the plural. This section contains general information about the companies that are using the DOCTOR 4.0 managed by the manager, also showing their location on the map.

In this section the manager can add all the companies he manages

The company sees it instead as "Company" written in the singular in the menu. Entering, it finds only its data

Each company will only see its DOCTORS and users

The company can add or delete users in the users section

10.5 Profile

In the profile section there is the data of the account with which you are logged in

11. TELECONTROL

If you get an alarm, what do you do? With DOCTOR 4.0 you could for example stop or slow down the machine.



See paragraph 10.1.7 CONFIGURATION – Modbus

A "manager" is not enabled to such telecontrol possibility. Only the company users can be enabled.

You can enable or disable the telecontrol to each user singularly



WARNING: Write commands (telecontrol) cannot be used to remotely start a machine. Fermai relieves itself of any responsibility for the improper use of DOCTOR 4.0.

12. INTEGRATION

The FERMAI portal is open and simplifies integration with data acquisition from other devices, not only DOCTOR 4.0



At this link

https://drive.google.com/file/d/1nZkSsabM9Knn2G2mA6sE7Ipl4mK4dMot/view?usp=share_link

you can view the technical documentation about the APIs used.

Conversely, if you want to connect a DOCTOR 4.0 to another platform other than the FERMAI one, you can change its MQTT address (See par. 10.1.7 Configuration – MQTT)



13. BUY

From the website <https://fermai.it>, price section, it is possible to purchase the DOCTOR 4.0.

On the price configurator page, you can select the required number of DOCTORS.

After selecting the number of DOCTORS, the unit and total prices are shown, both regarding the hardware and the platform fee.

Actually, logged in with your profile, the site calculates how many DOCTORS you have already bought. The more you have already bought, the less the next one will cost.

The subscription to the portal is also cumulative. The more DOCTOR 4.0 you activate, the less the subscription of the next one will cost you



14. WHY “FERMAI”?

With the hardware, the firmware, and the knowledge of the industrial world, Motive srl (www.motive.it), which has been designing and manufacturing electric motors, mechanical speed reducers and electronic frequency converters since 2000, would have made it without FERMAI. But from the possibility of having "granular" data, of a packet per second, also arose the possibility of using it to go beyond the state of the art, and thus create real artificial intelligence software that exploited "machine learning" to detect anomalous behavior of any data.

Therefore, a team of algorithm developers was also needed. In 2021, it was thus decided to create an "ad hoc" container for the new team: FERMAI.

FERMAI means "ferma mai" (never stops), or "fermai in passato" (had to stop in the past), because one of the main functions that was initially thought of was that of predictive maintenance, aimed, as we know, at avoiding machine stops. But, in our province dialect, it also means "clip", the IT icon of knowledge which is our logo. We also didn't forget to include the letters "AI", the initials of Artificial Intelligence.

In 2022, one year after the start of research and development activities, with the product still in preparation, ENEA "National Agency for New Technologies, Energy and Sustainable Economic Development", appointed by the Italian Ministry for Economic development, fully promotes DOCTOR 4.0 as an absolute innovation for the circular economy (the reconversion of production activities towards an economy model that maintains the value of products, materials and resources for as long as possible and which minimizes the production of waste).



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CONFORMITY DECLARATION

FERMAI s.r.l. whose Head Office is situated in Castenedolo (BS) - Italy
declares, under its own exclusive responsibility,
that its product

DOCTOR 4.0

is designed, produced and tested according to the following international norms
(last issue):

EN 55014-2	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus - Part 2: Immunity - Product family standard
EN 61000-3-2	Electromagnetic compatibility (EMC) Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase)
EN 61000-3-3	Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection
EN 61000-6-4	Electromagnetic compatibility (EMC) Part 6-4: Generic standards - Emission standard for industrial environments
EN 61000-6-2	Electromagnetic compatibility (EMC): Part 6-2: Generic standards - Immunity standard for industrial environments
EN 61000-4-2	Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3	Electromagnetic compatibility (EMC) Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-4	Electromagnetic compatibility (EMC) Part 4-4: Testing and measurement techniques - Electrical fast transient/burst immunity test
EN 61000-4-5	Electromagnetic compatibility (EMC) Part 4-5: Testing and measurement techniques - Impulse immunity test
EN 61000-4-6	Electromagnetic compatibility (EMC) Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances induced by radiofrequency fields
EN 61000-4-11	Electromagnetic compatibility (EMC) Part 4-11: Testing and measurement techniques - Tests for voltage-induced immunity, short interruptions and voltage variations

following the provisions of the Directives

EMC Electromagnetic Compatibility (EMC) 2014/30/EU

The Legal Representative: Giorgio Bosio