H4 User's Manual

Contents

Glossary

API	Application Programming Interface
CNC	Computer Numerical Control
COL	Change of Line
DB	Data block
DC	Diagnostic Coverage
DLL	Dynamic-Link Library
DTD	Document Type Definition
EEPROM	Electrically Erasable Programmable Read-Only Memory
ESC	Escape
ESD	Electrostatic Discharge
FB	Function block
HCI	Host Controller Interface
HL	High Level
HMI	Human-Machine Interface
IDE	Integrated Development Environment
IKHC	Interface Keyboard Host Controller
IKWL	Interface Keyboard WireLess
ISO	International Organization for Standardization
JRE	Java Runtime Environment
JVM	Java Virtual Machine
LCD	Liquid Crystal Display
LL	Low Level
MDI	Manual Data Input
$MTTF_d$	Mean Time To dangerous Failure
OS	Operating System
PCB:	Printed Circuit Board
PLC:	Programmable Logic Controller
PL_d:	Performance Level Dangerous
PL_r:	Required Performance Level
SIL:	Safety Integrity Level
POU:	Program Organization Unit
PUR:	Polyurethane
REDIR:	Redirection
RGB:	Red Green Blue
RS:	Recharging Station
R/W:	Read/Write
H4:	Wireless Handheld Terminal
NBTR	Bluetooth Remote Module
NMSPM	Safety System Modules
NSMHC:	Safety Module Host Controller
NSMWL:	Safety Module WireLess
SOP:	Start Of Packet
TFT:	Thin Film Transistor
USB:	Universal Serial Bus
V⎓:	Volts of Direct Current
XML:	eXtensible Markup Language
PN:	Part Number
SN:	Serial Number

History of Revisions

Version	Date	Change
1.0	15/09/2015	First Release
1.1	20/04/2016	First Revision (2014/30/EU Directive)

1 General information

1.1 Manual overview

This user manual is intended to give all kind of information regarding Wireless Handheld Terminal (H4) and its related Host Controller Interface (HCI). Chapter 1 is dedicated to general information: operation and safety main notices and a high level explanation of the device. Chapter 2 gives an overview to each component and then gives the detailed technical data. Chapter 3 details all information concerning the wireless system safety, the coupling procedure between the Wireless terminal and HCI and all possible coupling states. Chapter 4 gives all the necessary information to use the device and represents the software user's guide. Chapter 5 gives useful information in case of application and communication errors. Chapter 6 gives the accessory ordering information.

H4 is available in 3 main configurations:

1) Standard configuration (BT transmission)
2) Wi-Fi Configuration (BT + Wi-Fi transmission)
3) Non safety configuration (Wi-Fi transmission)

Unless communicated the general part of this manual refers to standard configuration. Dedicated appendixes are devoting to give additional info needed to configure and use Wi-Fi configuration and Non safety configuration.

1.2 Safety notices

All safety notices in this manual are specified as follows:

Safety notice	Description
Danger!	Respecting guidelines and regulations avoids life-risks
Caution!	Respecting guidelines and regulations avoids severe injuries or damage to material
Warning!	Respecting guidelines and regulations avoids injuries or damage to material
Information:	Respecting guidelines and regulations avoids errors

H4 is a small, light and comfortable remote system controller which, together with its related HCI appositely configured and connected to machine control logic, guarantees machine control and configuration and the implementation of safety related functions.
All configuration and control commands selected through the keyboard or the touch screen display, the optional handwheel and the potentiometers status are sent through a Bluetooth [R] communication channel to the HCI and then transmitted to the machine control logic through a RS-422 serial communication channel.
The safety related devices status (Stop push-button, Enabling Device and State Selector) is monitored by the H4 and sent through the Bluetooth [R] communication channel to the HCI. HCI provides safety relays (for the Stop push-button and Enabling Device) and Mosfet switches (for the State Selector) which perfectly replicate the safety related devices status.
All HCI outputs: RS-422 signals and the safety relays and Mosfet switch outputs, are cable connected to the machine control logic.

Danger!

- User is responsible for the correct system installation and interfacing to the machine control logic.
- User is responsible for implementing the machine safety related functions. H4 provides the best state of the art technology safety devices and together with HCI allows to fulfil high Performance Level (PL) according to EN ISO 13849-1:2008 and Safety Integrity Level (SIL) according to EN 62061:2005.
- User should implement the safety related functions according to the application safety level determined in a previous risk analysis.
- User, during machine control logic implementation, is responsible for considering all conditions related to the machine motion:
checking the Stop push-button, Enabling Device and State Selector related relays and switches status;
checking all possible further safety devices available on board of the machine: safety fences, optical barriers and so on.
- User is responsible for considering all further safety and accident prevention guidelines related to the particular working environment in addition and independently to this document.
- User is responsible for observing all safety precautions applying to industrial control systems in accordance with national and international regulations.
- User is responsible for observing that all installation, commissioning and maintenance tasks must be carried out only by qualified personnel, so by persons who are familiar with transport, mounting, installation, commissioning and operation of the product and who have the appropriate qualifications. Furthermore is suggested to follow all national accident prevention guidelines.
- All safety guidelines, cabling schemes, mechanical and electrical limit values listed in the technical data must be read before installation and commissioning and strictly respected.
- User is not allowed to take care of the maintenance and repair of the safety devices on board of H4 and HCI. Each maintenance and repair operation must be remanded to 0N3 srl.

Information

- All the instructions contained in this manual ensuring user safety must be taken in consideration. Each non-conformity could cause the safety functions integrated in the handheld terminal not to work properly.
- H4 and HCI have been designed, developed, and manufactured for conventional use in industry. They were not designed, developed, and manufactured for any use involving serious risks or hazards that could lead to death, injury, serious physical damage, or loss of any kind without the implementation of exceptionally stringent safety precautions. Such risks and hazards include the use of H4 in the following applications:
nuclear reactions monitoring in nuclear power plants;
flight control systems;
flight safety;
mass transit control systems;
medical life support systems;
control of weapon systems.
- Electrical components that are vulnerable to electrostatic discharge (ESD) must be handled accordingly.

Danger!

- Do not touch the connector contacts; do not touch the contact tips when removing the protection covers.
- All kind of environmental (temperature, aggressive atmospheres, humidity) and mechanical stresses over the accepted limits explained in 2.6 must be avoided during transport and storage of the devices.
- Two main considerations must be done in order to prevent damages during transport:
always use the original packaging;
always keep the right environmental conditions as explained in the technical data.

- Installation must take place according to the documentation and using suitable equipment and tools.

Warning!

- All devices must be installed by qualified personnel and without voltage supplied
- All national regulations about accident prevention must be taken into account
- Electrical installation must follow the fundamental guidelines (line cross section, protective ground connection, the electrical limits explained in the technical data etc.)

Warning!

- Take care not to squeeze and thus damage the cable with any object.
- Do not lay the cable over sharp edges to avoid damaging the cable sheath.
- Always operate the touch screen with the proper touch-pen. Never use sharp objects that could damage the touch screen.
- H4 and HCI implement the Stop function with:
- the Stop push-button;
- the logic circuits on the wireless handheld terminal that monitor the Stop pushbutton status and transmit it to the HCI;
- the Bluetooth R communication channel between terminal and HCI;
- the logic circuits on the HCI that receive the Stop push-button status and replicate it on the safety relays.

Warning!

- The installation and programming of this equipment must be performed by a skilled installer following the instructions of this manual and the relevant regulatory EN60204-1.

1.2.1 Stop push-button

The Stop push-button provides two redundant switching contacts. The two Safety relays that replicate their status on the HCI have 2 contacts per each and follow the behavior shown in 2.6.2.
User should directly connect the relays outputs to the machine cabinet and monitoring devices. For further information about the HCI cable pin-out please refer to paragraph 2.6.2.1.

The Stop function provided by H4 and HCI allows the user to fulfil high PL (according to EN ISO 13849-1:2008) and SIL (according to EN 62061:2005) for the safety function once it is interfaced with the machine control logic (please refer to paragraph 2.6.4.3).

Warning!

- User is responsible for interfacing the system to the machine control logic and implementing the Stop function according to the safety level determined in a previous risk analysis.
- The “Stop push-button”, as explained in EN 60204-1:2006 (par. 9.2.7.3), cannot be marked or labeled as “Emergency Stop push-button” even if user can implement the Stop function in stop category 0 or 1 of EN 60204-1:2006.
- In case of drop or other possible damages of the device, the stop function operation must always be checked by the operator.
- Releasing the Stop push-button must never cause an uncontrolled restart. User is responsible for implementing these controls on the machine control logic.
- The Stop push-button on the handheld terminal is not a substitute for the permanently-wired Emergency Stop button located on the machine.
- The Stop Push-button on the handheld terminal is disabled if terminal is shut OFF, uncoupled from the related HCI or if HCI is shut OFF.

- In order to avoid confusion between the permanently-wired Emergency Stop Push-button on board of the machine and the disabled Stop Pushbutton on board of the terminal, it is suggested to stock the handheld terminal in a location with protected access when it is shut OFF, uncoupled from the related HCI or if HCI is shut OFF.
- User can always access through the HMI to all diagnostics information about the safety module built up by the H4 and HCI. Please refer to paragraph 4.4. In case of faults or failures user must always refer to 0N3 S.p.A. for maintenance and repair operations.
- For further and more detailed information about the Stop push-button, as the electrical and mechanical life, please refer to paragraph 2.6.4.6 and 2.6.4.3

Information

- The “Stop push-button” functionality is tested mandatorily by the user through a specific coupling procedure each time the H4 is coupled to the related HCI.
- The enabling function is implemented with:
- the Enabling Device;
- the logic circuits on the wireless handheld terminal that monitor the Enabling Device status and transmit it to the HCI;
- the Bluetooth R communication channel between terminal and HCI;
- the logic circuits on the HCI that receive the Enabling Device status and replicate it on the safety relays.

1.2.2 Enabling device

The Enabling Device is a three-position enable switch providing two redundant switching contacts. The two Safety relays that replicate their status on the HCI have 2 contacts per each and follow the behavior shown in 2.6.2
User should directly connect the relays outputs to the machine cabinet and monitoring devices. For further information about the HCI cable pin-out please refer to paragraph
2.6.2.1
Respecting the standard EN60204-1, two positions, “Null" and “Panic", represent off condition while only the “Enable" position allows activation.
The enabling function provided by H4 and HCI allows the user to fulfil high PL (according to EN ISO 13849-1:2008) and SIL (according to EN 62061:2005) for the safety function once it is interfaced with the machine control logic (please refer to paragraph 2.6.4.4).

Warning!

- User is responsible for interfacing the system to the machine control logic and implementing the Enabling function according to the safety level determined in a previous risk analysis.
- The enable switch fulfils its protective function only if the operator can recognize the danger in time.
- In case of dangerous states the logic controller must provide that, additionally to the enable switch, another conscious start command should be required to allow activation.
- The only person permitted in the dangerous area is the person activating the enable switch.
- User can always access through the HMI to all diagnostics information about the safety module built up by the H4 and HCI. Please refer to paragraph 4.4. In case of faults or failures user must always refer to 0N3 S.p.A. for maintenance and repair operations.
- For further and more detailed information about the enable switch, as the electrical and mechanical life, please refer to paragraph 2.6.4.4 and 2.6.4.6.

1.2.2.1 Functionality

The enabling device can have three different positions:

Switch position	Function	Enable switch	Switching contact
1	Zero position	Not pressed	Off (opened)
2	Enable	Pressed	On (engaged)
3	Panic	Pushed all the way in	Off (opened)

The positions null and panic must be cabled and controlled by the machine logic in order to guarantee a stop category 0 or 1 according to EN 60204:2006.

Zero position

When not pressed the enabling device returns to the zero position

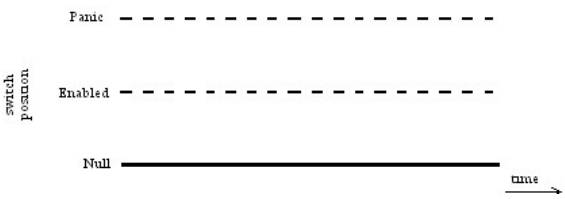


Figure 1.1: Zero position

Enable position

When pressed the enabling device goes into the enabling position. This condition is often associated to machine movement activation. When released it goes back to the null position.

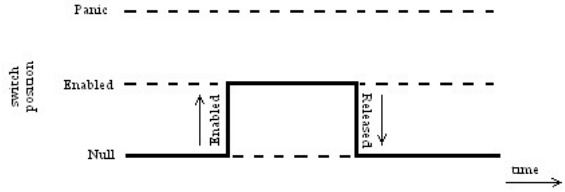


Figure 1.2: Enable position

Panic position

When the enabling device is pushed all the way in it goes to the panic position which corresponds to the same contact condition as the zero state.

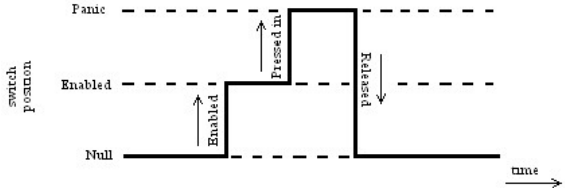


Figure 1.3: Panic position

If the switch is pushed all the way in and then released it goes directly to the null state skipping the enable position.

The state selecting function is implemented with:

- the State Selector;
- the logic circuits on the wireless handheld terminal that monitor the State Selector status and transmit it to the HCI;
- the Bluetooth [R] communication channel between terminal and HCI;
- the logic circuits on the HCI that receive the State Selector status and replicate it on the Mosfet Switches.

1.2.3 State selector

The State Selector is a 16 states BCD coded rotary switch with four non-redundant outputs. Four Mosfet switches replicate the State Selector status on the HCI and follow the behavior shown in 2.6.2. User should directly connect the Mosfet switches outputs to the machine cabinet and monitoring devices. For further information about the HCI cable pin-out please refer to paragraph 2.6.2.1.
The State selecting function provided by H4 and HCI allows the user to fulfil high PL (according to EN ISO 13849-1:2008) and SIL (according to EN 62061:2005) for the safety function once it is interfaced with the machine control logic (please refer to paragraph 2.6.4.5).

Warning!

- User is responsible for interfacing the system to the machine control logic and implementing the State Selecting function according to the safety level determined in a previous risk analysis.
The State Selector function should be only related to the selection of the various working modes available on the machine by the logic controller.
- User can always access through the HMI to all diagnostics information about the safety module built up by the H4 and HCI. Please refer to paragraph 4.4. In case of faults or failures user must always refer to 0N3 S.p.A. for maintenance and repair operations.
- For further and more detailed information about the State Selector, as the electrical life, please refer to paragraph 2.6.4.5 and 2.6.4.6.

1.3 Environmentally-friendly disposal

All components related to the H4 and HCI are designed to respect the environment and reduce as much as possible the impact on pollution.
It is important to specify how to dismiss the different components of the H4 in order to have an environmentally-friendly recycling process.

Component	Disposal
Cables Battery Electronic boards	Electronics recycling
Paper packaging	Paper recycling
Plastic packaging	Plastic recycling

2 Technical data

H4 is a small, light and robust mobile panel featuring a comfortable 5" TFT LCD color touch display

A powerful processor runs Windows CE and, depending on the configuration, a SW application that manages all system settings and control. Stop Push-button, Enabling Device and State Selector are available on board.

All configuration and control commands selected through the keyboard or the touch screen display, the Handwheel and the potentiometers status, the Stop pushbutton, Enabling Device and State Selector status are sent by the Wireless handheld terminal through a Bluetooth® communication channel to the HCI.

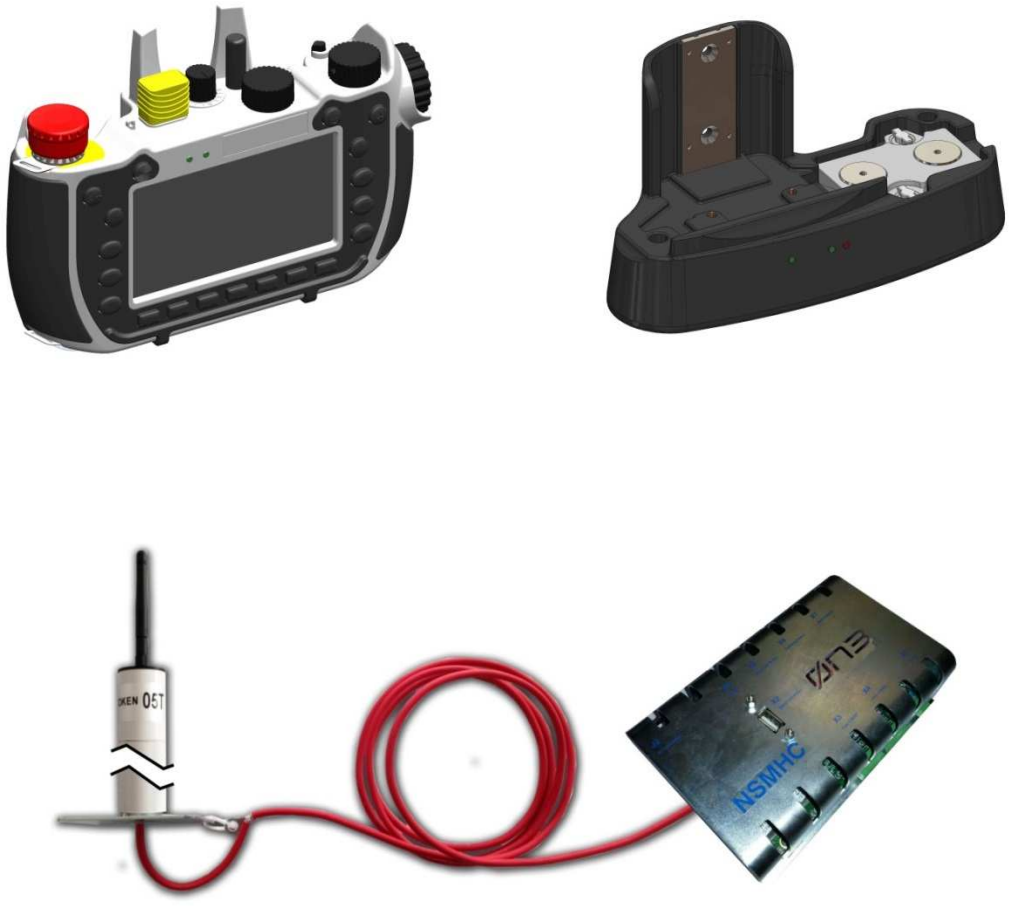


Figure 2.1: H4, Recharging Station and HCI

The uniqueness of the wireless communication is guaranteed by the use of TOKEN. TOKEN is a device containing a unique ID. Depending on the configuration, there can be one or two token to guarantee the safety and uniqueness of the wireless communication. For details on the TOKEN functionality please refer to paragraph 2.1.2.1 HCI replicates the safety devices status on safety relays

and Mosfet switches and transmits all configuration and control commands selected on the mobile panel to the machine control logic through a RS-422 serial communication channel.

All HCI outputs: RS-422 signals and the safety relays and Mosfet switch outputs, are cable connected to the machine control logic.

A Recharging Station (RS) completes the system. It is a storing and battery recharging station for the Wireless handheld terminal. The Recharging Station can charge one spare battery in addition the wireless handheld.

The handheld terminal offers a Windows CE platform on which applications for different purposes can be set up. All of the components related to the H4 and the interface to the machine control logic are hereunder schematically presented:

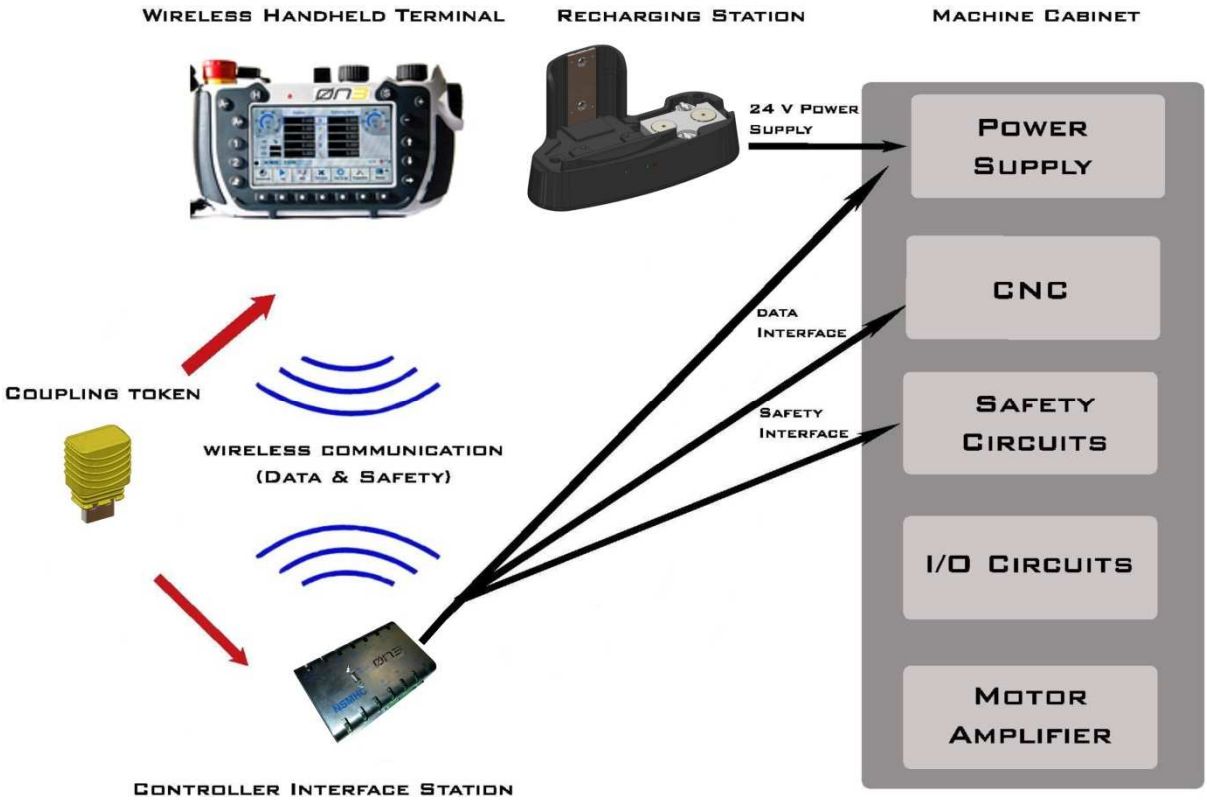


Figure 2.2: H4 Wireless system overview

2.1 H4 overview

H4 is hereunder in detail presented:

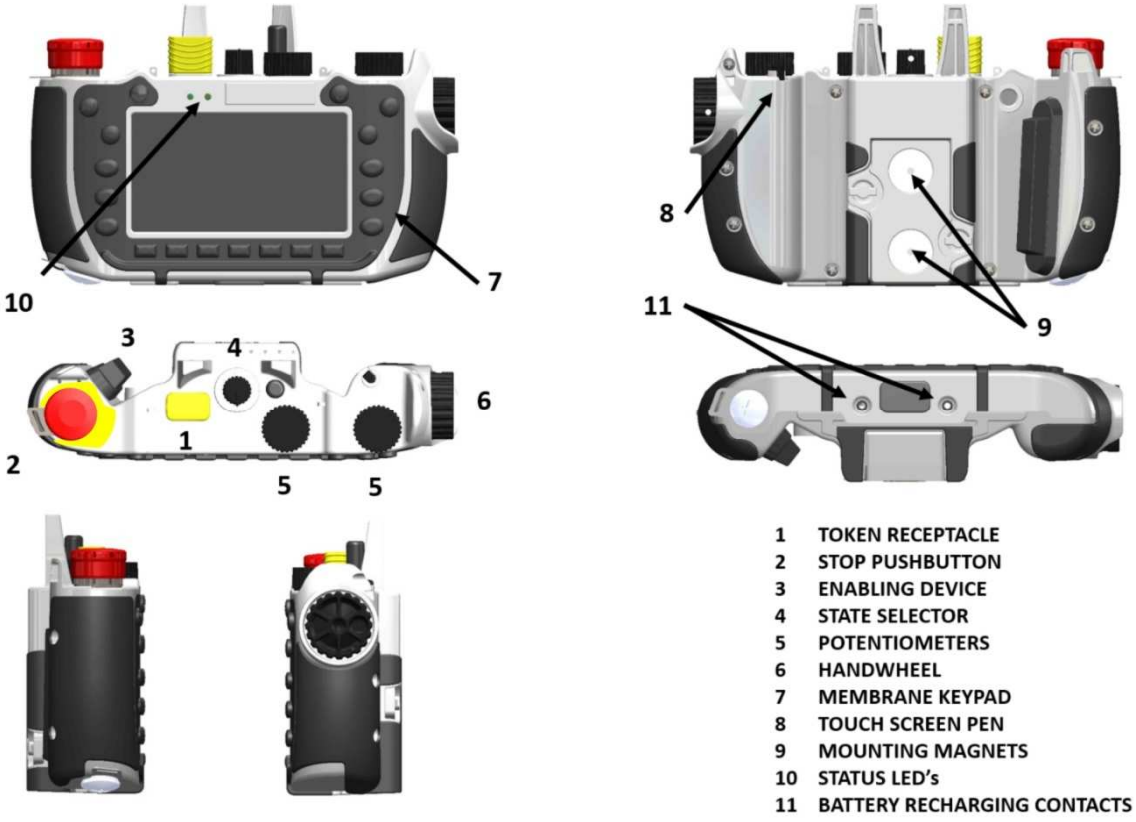


Figure 2.3: H4 overview

- Functional hand grip, user configurable;
- Comfortable and safe access to safety related devices;
- Comfortable and secure handling using rubber membrane keyboard and covering surface;
- Comfortable handling, also using gloves, thanks to well-designed command key spacing;
- Clear display, user configurable brightness.
- Vibration and shock resistant according to EN 61131-2:2007, EN 61131-2 cl. 6.3.1, EN 60068-2-6, EN 61131-2 cl. 6.3.2, EN 60068-2-27
- Non-flammable material (fulfils UL 94-5VA) housing, impact-resistant, water-resistant IP 64, cleaning agents (alcohol and fabric conditioner), oils, cutting oils (drilling oils), fat and lubricants resistant.
- Extremely robust housing. Drop-tested according to EN 61131-2:2007 random drops 1mt.
- Rubber covered keys with mechanical pressure point.
- 2 status LED.

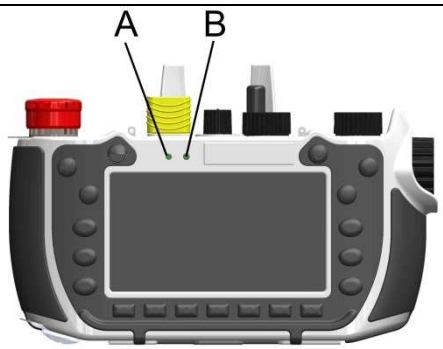


Figure 2.4: H4 LED's

LED	Color	Status	Meaning
A	Red	ON	Coupled to HCI (Host Controller Interface)
		BLINK	Waiting for coupling to HCI
	Green	ON	Battery charging
		BLINK	Charging error

LED	Color	Status	Meaning
B	Red	ON	Hardware fault – RTC Battery low
	Green	ON	Normal operation
		BLINK	Communication error

- TFT LCD Display with resistive touchscreen
- ARM Cortex A8 600 MHz CPU
- Memory size:
    - RAM: 256 MB
    - Flash: 128 MB

2.1.1 Input devices

2.1.1.1 Potentiometers

- The two over-ride potentiometers can be used for different purposes, for instance setting the spindle speed or the machine movement speed along a certain axis.
- Resolution: 0-255 linear

2.1.1.2 Handwheel

- The handwheel can be used for the machine movement fine tuning in the “handwheel incremental JOG” working mode.
- The handwheel counts 40 detents per each 360° turn. Handwheel is internally managed and its counter goes from +32767 to -32767. Handwheel turns are counted as soon as the mobile panel is shut on. Clockwise turns decrement while counter-clockwise turns increment the counter.

2.1.1.3 Membrane keypad

The mobile panel has a rubber covered membrane keypad containing 19 keys. 6 keys are command keys, useful to be implemented for a direct machine control. The remaining 13 keys are function keys, useful to be implemented for navigating and operating through the panels of the software application. The letter or the symbol printed on the keys reminds the suggested function. The USER can freely assign the single keys to different functions.

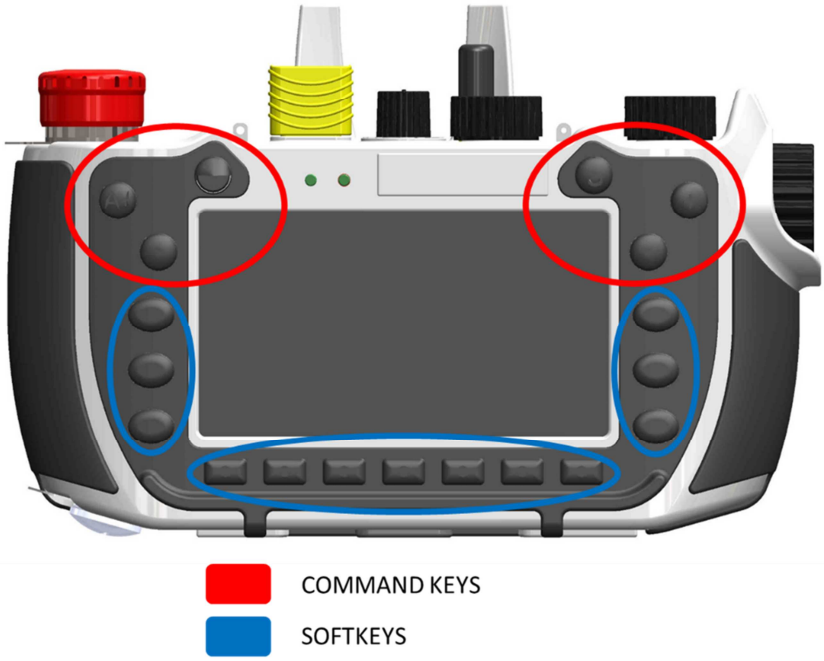


Figure 2.5: Keypad

Key	Suggested Function
H	Hold (Machine stop)
S	Start (Machine start)
A+	Scroll axis down
A-	Scroll axis up
+	JOG+
-	JOG-
⇨	Next
⇧	Level Up
⇧	Up (Softkey)
⇩	Down (Softkey)
1	Custom Button 1 (Softkey)
2	Custom Button 2 (Softkey)
◦	Function softkey (function explained in chapter 3)

Switching ON/OFF the terminal

Pushing simultaneously 2 and ⇩ button will switch ON/OFF of the terminal.

2.1.1.4 Touchscreen pen

The touch screen pen is easily accessible in the back, on the right side of the terminal.

2.1.2 Safety-related functions

Hereunder is shown the detail for the safety related devices position:

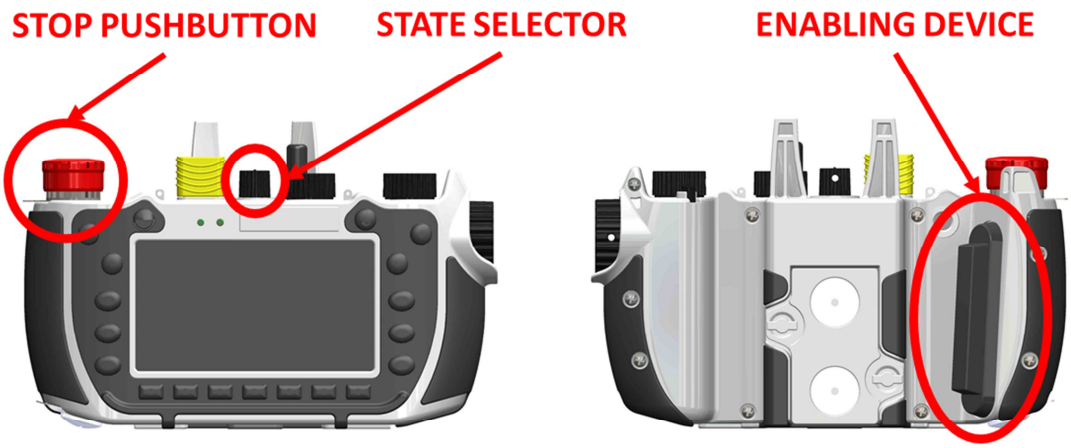


Figure 2.6: Safety related devices position

For all the information about the safety related devices and functions please refer to paragraphs 1.2.1, 1.2.2, 1.2.3 and 2.6.4.

2.1.2.1 Token

Token is a Unique ID key easily pluggable on the top of the Wireless terminal and in the front part of the HCI thanks to a USB type A receptacle. Unique ID is factory-written into an internal EEPROM and guarantees wireless communication safety and uniqueness.

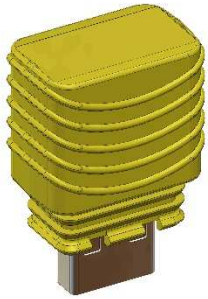


Figure 2.7: Token

2.2 Recharging station

Recharging station is a storing and battery recharging device for the H4 handheld device. It can charge at the same time the H4 handheld plus one spare battery. The status LED indicates the charging status:

A: GREEN, indicates presence of power to handheld, to charge the battery on the handheld.

B: GREEN indicates the end of charging the auxiliary battery

C: RED indicates the current charge of the auxiliary battery

Check the correct charging of the auxiliary battery:

- while charging the red LED (LED C) is on; green LED (LED B) off;
- at the end of charging the green LED (LED B) is on.

Recharging station has a back side supply cable. The skilled installer can disconnect the power cable from the side and connect it to bottom side maintaining the same cap where the cable is already inserted. The recharging station is designed to be wall mounted or desktop mounted. Please refer to the mounting tips at chapter 2.8.

Warning!

- Disconnection and connection cable must be performed by a skilled installer.

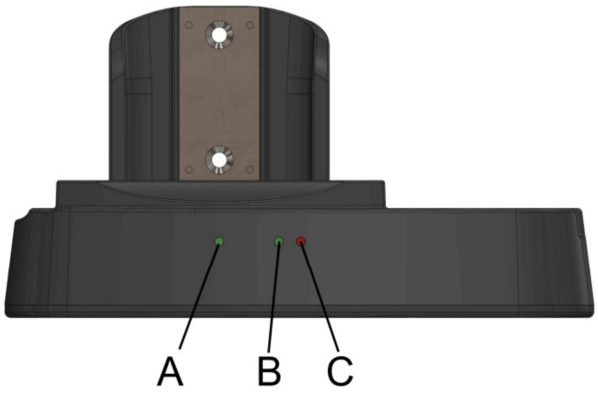


Figure 2.8: Recharging Station LED's

Information

- When not in use, it is always suggested to place the H4 handheld device on the Recharging Station;
- When shut off and not recharged, the handheld terminal battery discharges after seven days. In this case you must execute a complete charging cycle before using the handheld device.

Warning!

- SELV Extra low voltage power supply / Limited power source according to EN 60950-1.
- On the recharging station power supply must be a suitable isolating device and a 2A delayed fuse.

2.3 Battery replacement

Replace the battery if you need to have a fully charged battery in the handheld device.

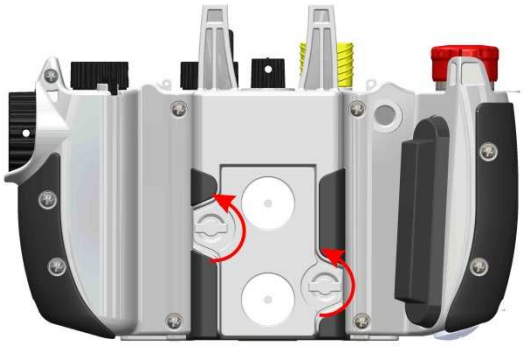


Figure 2.9: Battery replacement

The procedure for battery replacement is the following:

- Unscrew the locks
- replace the battery
- screw the locks

2.4 Receiving station overview

The HCI receiving station is composed of two parts: the NSMHC module and the NBTR module (antenna).
The NSMHC module is enclosed in a metal housing and is normally placed inside the control systems cabinet; the NBTR module is enclosed in a plastic pipe and should be placed in a well exposed position to allow for the best radio communication with the H4 handheld device. The connection between the NSMHC module and the NBTR module is achieved with an Ethernet patch (not crossed) cable up to 20m long. The cable shall be a CAT5 shielded Ethernet cable.

HCI receiving station is hereunder in detail presented:

Figure 2.10: NSMHC receiving station

Figure 2.11: NBTR module (antenna)

Information

- It is suggested to install the NSMHC module in order that the TOKEN input connector is always easily accessible by the user. This is especially true for the double TOKEN configuration
- It is suggested to install the NBTR in order that the antenna has the best transmitting/receiving performances. Do not install the antenna inside metal cabinets. Install the antenna in order that the signal coverage guarantees comfortable operation in the whole machine working area.

2.4.1 Housing

Steel with DIN clamp. IP20 protection for NSMHC

Danger!

- It is mandatory to install the NSMHC module in a cabinet which is certified with a protection degree of IP54 (or more).

Plastic pipe, IP40 protection for NBTR

2.4.2 LED indicators

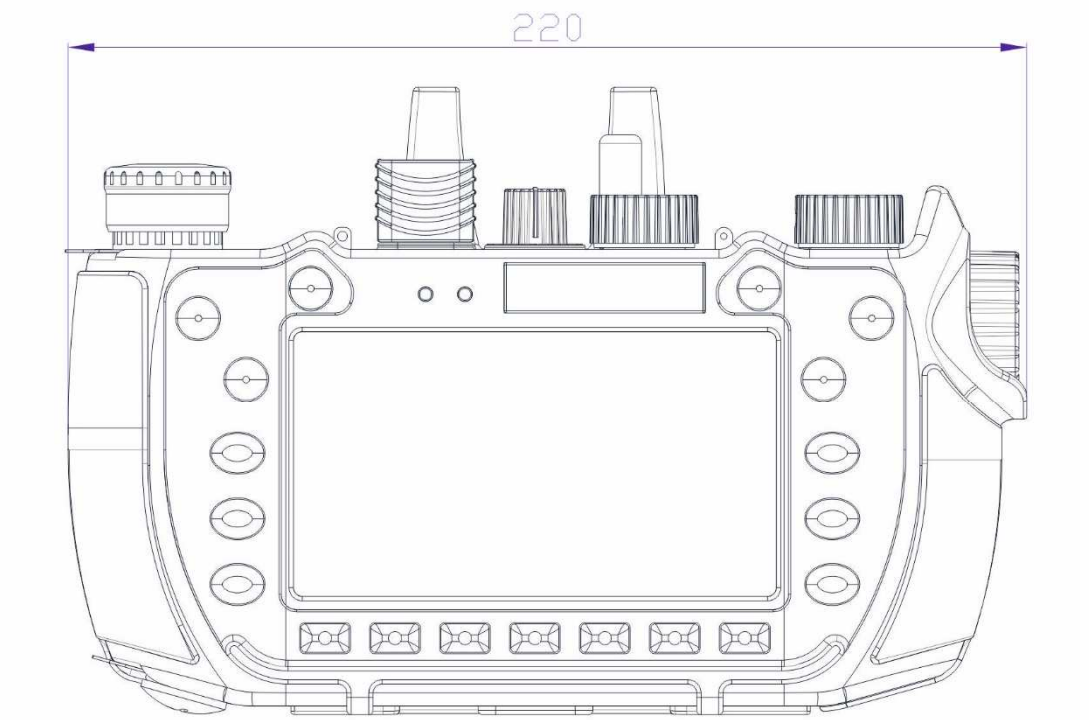
One status LED. LED indicates coupling status between H4 and HCI. For further information about coupling status please refer to paragraph 3.2.6

2.4.3 Interfaces

- RS-422 full-duplex serial interface for communication to machine control logic;
- Bluetooth® communication interface for communication to Wireless handheld terminal.

2.5 Dimensions

2.5.1.1 Hand-held device



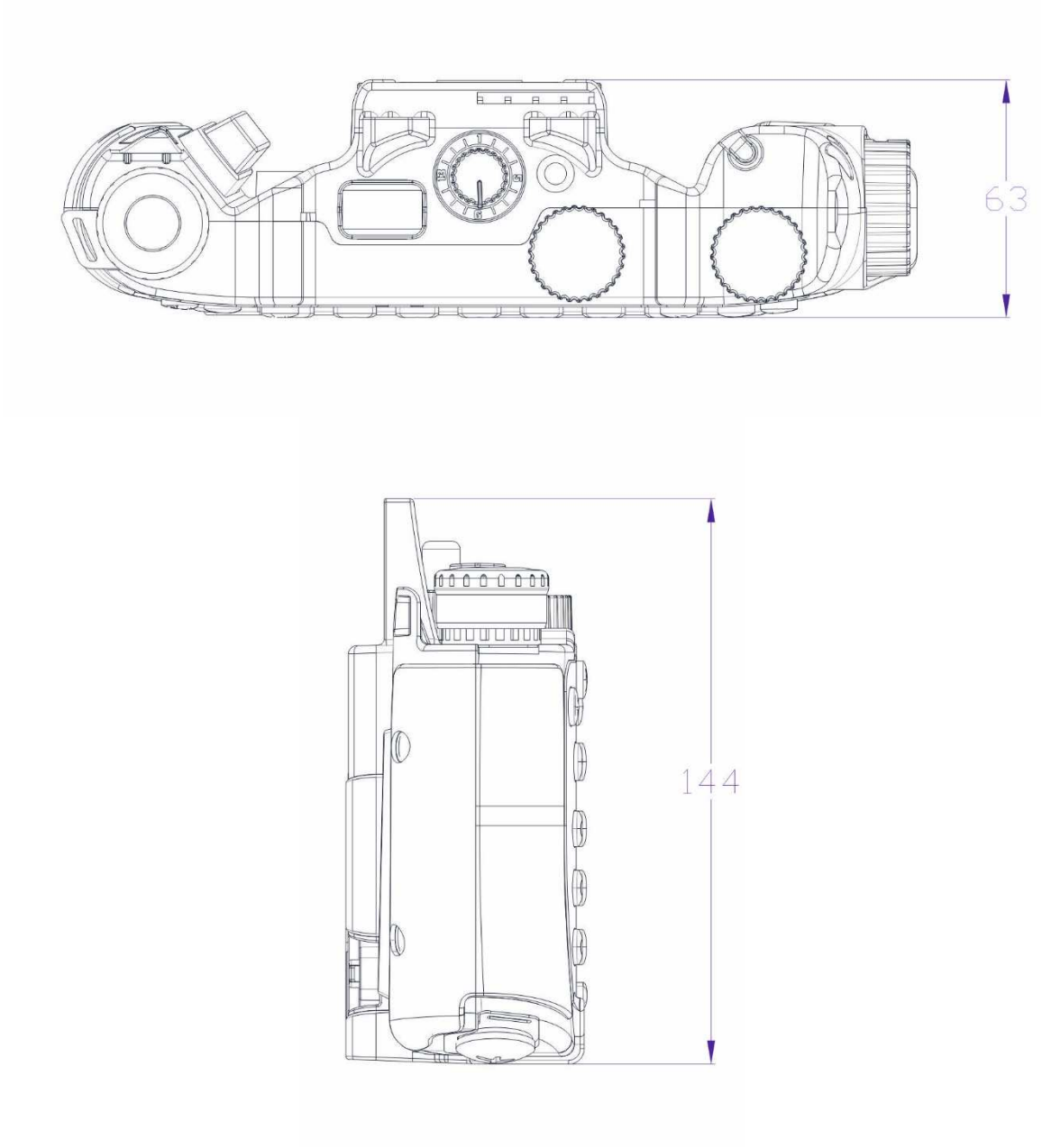


Figure 2.12: Handheld Terminal dimensions in millimeters

2.5.1.2 Charging station

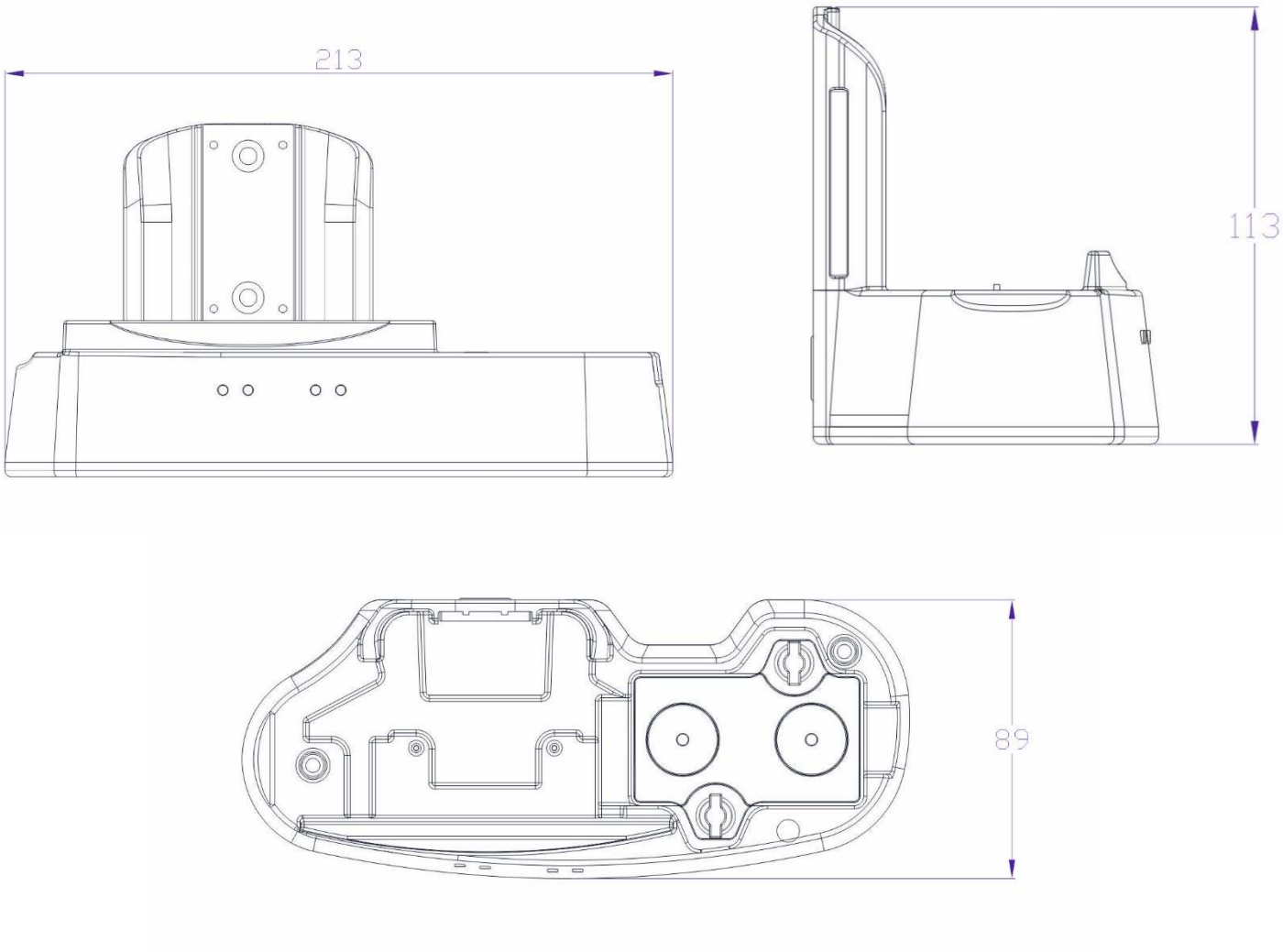


Figure 2.13: Recharging station dimensions in millimeters

2.5.1.3 Host controller interface

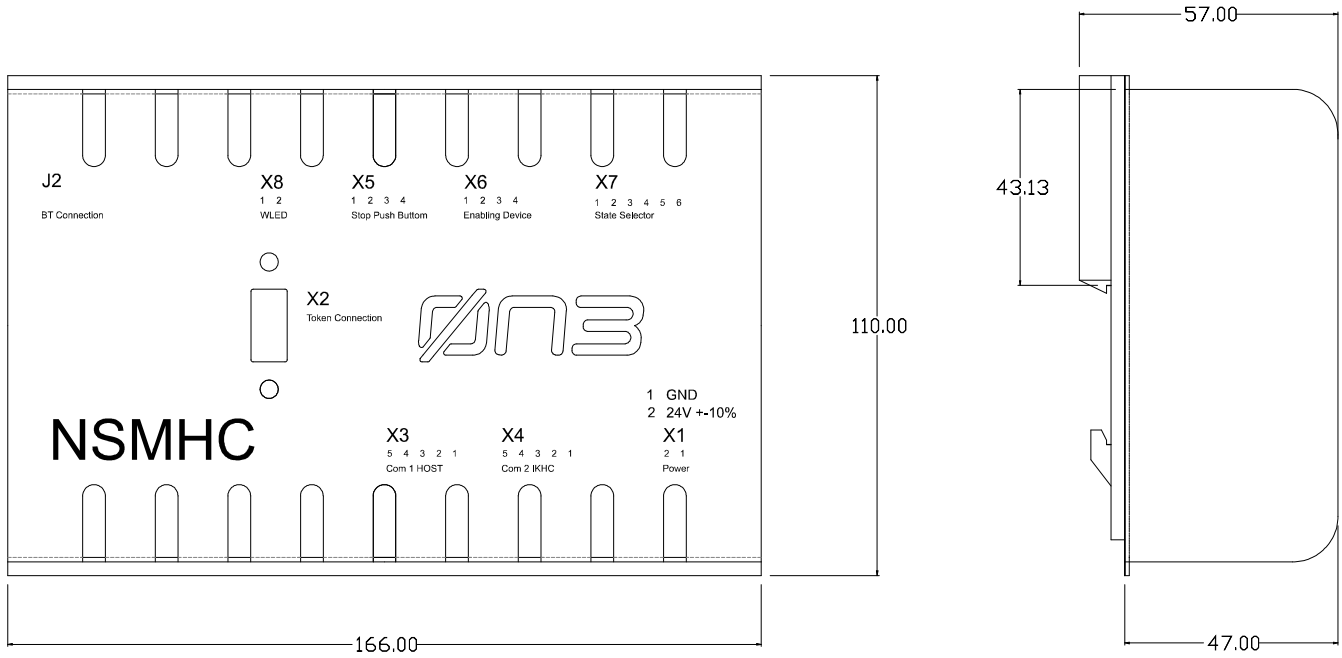


Figure 2.14: NSMHC dimensions in millimeters

2.5.1.4 Token

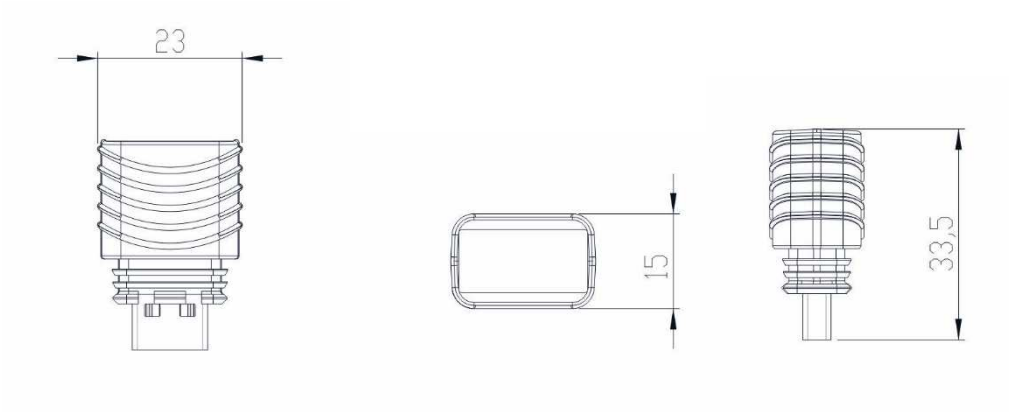


Figure 2.15: Token dimensions in millimeters

2.6 Technical data details

2.6.1 Handheld device specifications

Features	
Operating System	Windows CE 6.0
Processor Type Cooling	 ARM Cortex A8 600 MHz Passive Cooling
Flash Memory	128 MB Flash
RAM Memory	 256 MB SDRAM
Bluetooth® Wireless Interface Transceiver Transfer Rate Max working distance	 BLUEGIGA WT11 (Class 1) up to 3Mbps 50m
Coupling Interface TOKEN Connection	 USB A receptacle (no physical interface, connector only)
Keyboard Suggested command keys Suggested softkeys	 6 13
Status LED	2 (RED/GREEN)
Display Type Diagonal Colors Resolution Contrast ratio	 TFT LCD 5" (12,7 cm) 64K RGB 480 x 272 500:1

Viewing angle: • Horizontal • Vertical Background lighting: • Brightness • Half-brightness time Touch screen technology	 Direction Right / Direction Left = 70° Direction Up = 50° / Direction Down = 70° 300 cd/m^2 at least 20000 hours Resistive sensor technology
Power Supply Battery Type Battery Output voltage Battery Capacity Electrical life Full recharging time	Internal battery (removable) Li-ion Polymer battery 3.7V 4000mAh 500 full charge cycles minimum (Battery capacity ≥ 70% of the initial value) ≤ 4.5 hours

Mechanic	
Handheld terminal color	Body structure: RAL 7035; Rubber part: RAL7016
Stop push-button	2 contacts
Enabling Device	3 positions switches, 2 contacts
State Selector	16 state BCD coded
Handwheel	40 detents per turn
Override potentiometer	2 linear potentiometers
Outer dimensions Length Height Width	 220 mm 144 mm 63 mm
Weight	About 900g
Environment	
Temperature Operating temperature Transport and storage temperature	 +5˚ to +45˚C −20˚ to +70˚C
Relative humidity Operating Transport and storage	 Max 95%; non-condensing Max 95%; non-condensing
Protection Type	IP 64 (The partial or total removal of each cap will not guarantee the IP64 degree of the equipment).
Altitude	Max 2000m

2.6.1.1 Handheld device chemical resistance

Test 1 (Less strict)

The units under test (UUT) are placed in a closable plastic box (120 x 85 x 65 mm).

A ball of absorbent cotton appositely tinctured with solvent will be placed above the UUT; to avoid early evaporation, a generic solid body will be put over the ball or, in a more simply way, the closable plastic box will be closed.

After a 10 minutes wait, the eventually body and the ball of absorbent cotton will be removed; the solvent that remains on the UUT will not be wiped off and the box will be closed immediately afterwards for 24 hours.

The test will be performed at environmental temperature (about 20 ˚C).

Test 2 (Very strict)

The units under test (UUT) are fully and thoroughly wet by solvent, then will be closed into a closable box (120 x 85 x 65 mm) for 24 h.

Approximately 5 ml solvent will be sprayed over the UUT. The box will be closed and the UUT will remain in the closed box for at least 24 hours.

The test will be performed at environmental temperature (about 20 ˚C).

Touchscreen test procedure

The Touchscreen is placed into a closable plastic box (120 x 85 x 65 mm) and a ball of absorbent cotton appositely tinctured with solvent will be placed above it, then the box will be closed for 1 h.

The test will be performed at environmental temperature (about 20 ˚C).

2.6.1.2 Test results

Chemical solvent	Test 1 passed	Test 2 passed	Notes
Denatured Ethyl Alcohol	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	
Diesel	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	 Handles Terminal housing Rubber cap Rubber (lateral cover)	Test 2: Rubber (Keyboard): heavy deformation; reduced hardness
Unleaded Gasoline	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	Rubber (Keyboard) Handles Rubber cap Rubber (lateral cover)	 Test 2: Terminal housing: housing gets doughy
Blu Diesel	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	 Handles Terminal housing Rubber cap Rubber (lateral cover)	Test 2: Rubber (Keyboard): rubber gets doughy
Silicone Spray	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	Rubber (Keyboard) Terminal housing Rubber cap Rubber (lateral cover)	 Test 2: Handles: loss of color
Kluber	Rubber (Keyboard) Handles	Rubber (keyboard) Handles	

KONSTANT OY 32	Terminal housing Rubber cap Rubber (lateral cover)	Terminal housing Rubber cap Rubber (lateral cover)	
Acetone	Rubber (Keyboard) Rubber (lateral cover)	Rubber (Keyboard) Rubber (lateral cover)	Test 1 and 2: Handles: loss of color Terminal housing: clouding Rubber cap: swelling
Shell Garia 9603 M15	Rubber (Keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	Rubber (keyboard) Handles Terminal housing Rubber cap Rubber (lateral cover)	

Touchscreen test results

Test passed with the following solvents:

- Unleaded Gasoline;
- Denatured Ethyl Alcohol;
- Diesel
- Kluber KONSTANT OY 32;
- Acetone.

2.6.2 HCI specifications

• **Features**	
Status LED	1
Coupling Interface TOKEN Connection	USB A receptacle (no physical interface, connector only)
Bluetooth® Wireless Interface Transceiver Transfer Rate Max working distance	 BLUEGIGA WT11a (Class 1) up to 3Mbps 50m
RS-422 Serial Interface Transceiver	ISO35 RS-422 Transceiver

Transfer Rate Connection	57600 bps 2 twisted pairs (TX+/TX-,RX+/RX-) plus reference ground
Power Supply Rated voltage Max interruption of the supply Starting current Power consumption	24V⎓ ± 25 % Supplied by a SELV or PELV power supply 5 ms 2A 240mA @ 24V (idle) 2.4A @24V (max)
Mechanic	
Stop push-button related relays	2 contacts. 8A max
Enabling Device related relays	2 contacts. 8A max
State Selector related Mosfet switches	4 Mosfet switches. 500mA each max
Outer dimensions Length Height Width	166 mm 110 mm 57 mm
Weight (without cable)	760g
Environment	
Temperature Operating temperature Transport and storage temperature	 0° to +55°C −20° to +70°C

Relative humidity Operating Transport and storage	 Max 95%; non-condensing Max 95%; non-condensing
Vibration and shock during operation	fulfils EN 60204/A1:2009 (par 4.4.8), EN 61131-2:2007 (par. 4.2.2), EN 60068-2-6:2008
Altitude	2000m

Protection Type	IP 20 **(IP54 must be achieved by installing HCI in a IP54 cabinet)**
Flame resistant	fulfils UL 94: HB 1/16"

2.6.2.1 NSMHC connectors

Ref.	Name	Function	
X1	Power	Power supply	
X2	Token Connection	Token receptacle	
X3	Com1 HOST	Serial interface to NC host (RS-422)	
X4	Com2 IKHC	Auxiliary serial interface (RS-422)	
X5	Stop Pushbutton	Stop pushbutton output contacts	
X6	Enabling Device	Enabling device output contacts	
X7	State Selector	State selector repeater	
X8	WLED	Safety LED output	
J2	BT Connection	Connection to NBTR module (RJ45)	

2.6.2.1.1 X1 Power

Pin #	Signal Name	Signal description
1	GND	Ground reference
2	P24Vin	Positive power supply 24V⎓ (+/- 10%)

2.6.2.1.2 X2 TOKEN Connection

Token receptacle.
It is a USB type A receptacle.
WARNING: This USB type A receptacle is not designed to accept standard USB devices. Only the proprietary token can be inserted on it. Any USB device insertion could result in damage for both devices.

2.6.2.1.3 X3 COM1 Host

RS-422 interface connector to connect to a CN host system. The interface pins are optically coupled; therefore it is important to connect the ground reference also.

Pin #	Signal Name	Signal description
1	GNDISO-M	Reference voltage RS-485 data signal
2	HcRxP	RS-422 positive data from MPU
3	HcRxM	RS-422 negative data from MPU
4	HcTxM	RS-422 negative data to MPU
5	HcTxP	RS-422 positive data to MPU

2.6.2.1.4 X4 COM2 IKHC

RS-422 interface connector to connect to an auxiliary device. The interface pins are optically coupled; therefore it is important to connect the ground reference also.

Pin #	Signal Name	Signal description
1	GNDISO-S	Reference voltage RS-485 data signal
2	IkRxP	RS-422 positive data from Cabinet IntKey
3	IkRxM	RS-422 negative data from Cabinet IntKey
4	IkTxM	RS-422 negative data to Cabinet IntKey
5	IkTxP	RS-422 positive data to Cabinet IntKey

2.6.2.1.5 X5 STOP push-button

Safe output contacts from a safety relay that replicate the Spot pushbutton contacts of the input device.

Pin #	Signal Name	Signal description
1	STPB2A	Side A of STPB2 relay contact (connected to STP2B when closed)
2	STPB1B	Side B of STPB1 relay contact (connected to STP1A when closed)
3	STPB2B	Side B of STPB2 relay contact (connected to STP2A when closed)
4	STPB1A	Side A of STPB1 relay contact (connected to STP1B when closed)

2.6.2.1.6 X6 Enabling Device

Safe output contacts from a safety relay that replicate the Enabling device contacts of the input device.

Pin #	Signal Name	Signal description
1	ENDV2A	Side A of ENDV2 relay contact (connected to ENDV2B when closed)
2	ENDV1B	Side B of ENDV1 relay contact (connected to ENDV1A when closed)
3	ENDV2B	Side B of ENDV2 relay contact (connected to ENDV2A when closed)
4	ENDV1A	Side A of ENDV1relay contact (connected to ENDV1B when closed)

2.6.2.1.7 X7 State Selector

State selector repetition. These are not clean contacts, but digital output (0- 24V⎓) that replicate the status of the state selector of the input device

Pin #	Signal Name	Signal description
1	GND	Reference voltage for output SSEL level
2	SSEL1	SSEL1 output 24V⎓ level
3	SSEL2	SSEL2 output 24V⎓ level
4	SSEL3	SSEL3 output 24V⎓ level
5	SSEL4	SSEL4 output 24V⎓ level
6	GND	Reference voltage for output SSEL level

2.6.2.1.8 X8 WLED

Safety LED output. At this output can be connected a LED for safety information. It can drive a LED with 6mA current.

Pin #	Signal Name	Signal description
1	WLEDP	Positive signal to drive an external activity led (anode)
2	GND	Return path for WLEDP signal (cathode)

2.6.2.1.9 J2 BT Connection

At this RJ45 connector is inserted an Ethernet patch (not crossed) cable to connect with the NBTR (antenna).
Cable length can be up to 20m to allow for the best antenna position in the plant.

2.6.2.1.10 Connectors and pin ordering

Top view

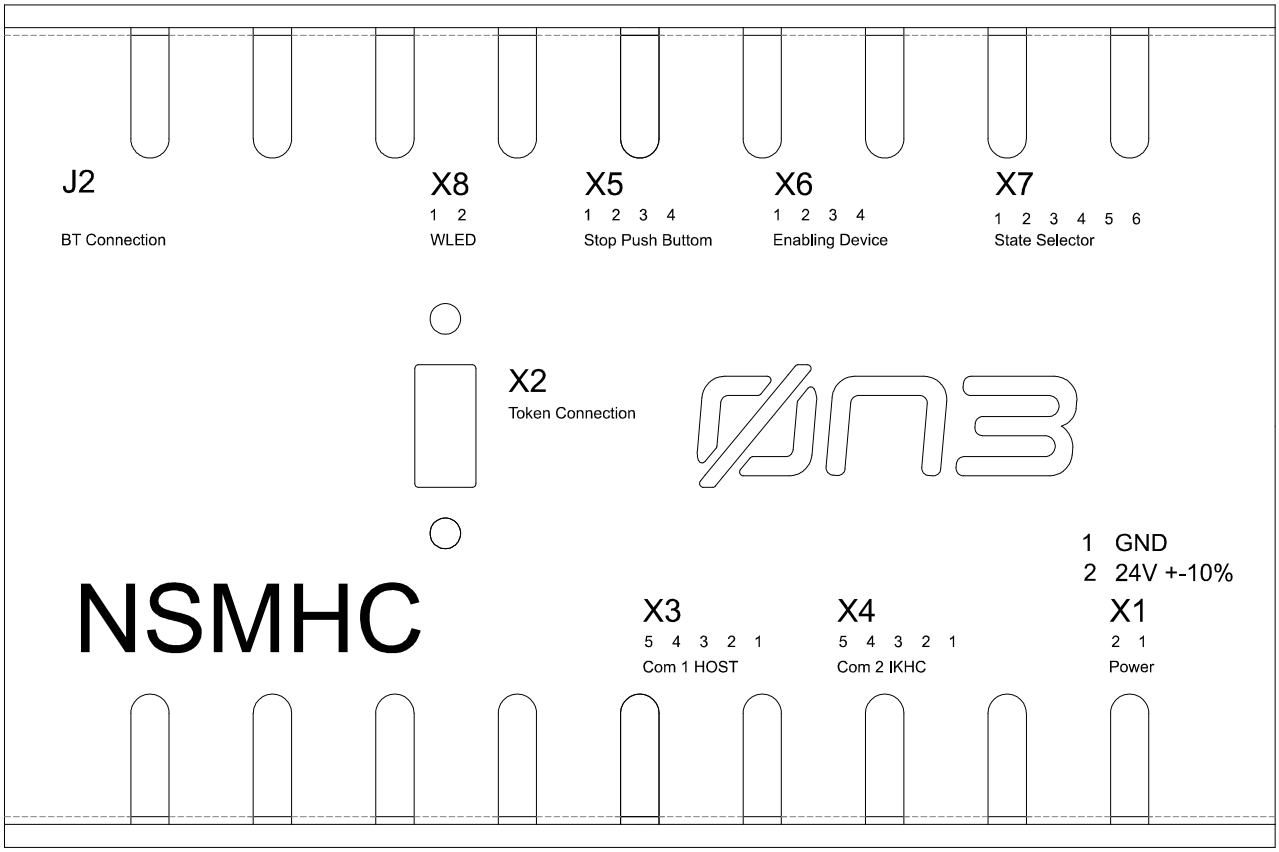


Figure 2.16: NSMHC connectors

2.6.3 Recharging station specifications

Features	
Electrical characteristics Rated voltage Voltage output Power Consumption	24V⎓ ± 25 % Supplied by a SELV or PELV power supply 5V ± 10 % 21.6W (max) = 900mA (max) @ 24V
Protection type Voltage input Current input Voltage output	Protection from polarity inversion, over-voltage and under-voltage Protection from overload current Internally regulated
Mechanics	
Recharging Station color	RAL 7016
Outer dimensions Length Height Width	213mm 113mm 89mm
Weight (without cable)	About 400g
Environment	
Temperature Operating temperature Transport and storage temperature	 +5˚ to +45˚C −20˚ to +70˚C
Relative humidity Operating Transport and storage	 Max 95%; non-condensing Max 95%; non-condensing
Altitude	Max 2000m
Protection Type	IP 64
Flame resistant	fulfils UL 94V-0: HB 1/16"

2.6.4 Safety-related devices

2.6.4.1 Safety relays related to Stop Push-button and Enabling Device

Characteristics	Value
Max switching voltage	24V⎓ Supplied by a SELV or PELV power supply
Max switching current	8A
Minimum switching power	300mW (5V, 5mA)

Danger!
An external fuse rated @ 4A shall be provided in series with the switching contact in order to avoid an overcurrent that could weld the relais contacts

2.6.4.2 MOSFET switches related to State Selector

Even if each mosfet switch is capable of sourcing 500mA, it is recommended to limit the sourcing current at 100mA continuously, in order to limit the power dissipation inside the HCI.

2.6.4.3 STOP function

Characteristics	Value
Performance Level (PL) as defined in EN ISO 13849-1:2008	d
Safety Integrity Level (SIL) as defined in EN 62061:2005	2
Stop push-button: • Mechanical life • Electrical life • Maximum operating frequency	 250000 operations minimum 250000 operations minimum 900 operations/hour

2.6.4.4 Enabling function

Characteristics	Value
Performance Level (PL) as defined in EN ISO 13849-1:2008	d

Safety Integrity Level (SIL) as defined in EN 62061:2005	2
Enabling Device: • Mechanical life • Electrical life • Maximum operating frequency	Position 1→ 2: 1000000 operations minimum Position 1→ 2→ 3→ 1: 100000 operations minimum 100000 operations minimum 1200 operations/hour

2.6.4.5 State Selecting function

Characteristics	Value
Performance Level (PL) as defined in EN ISO 13849-1:2008	c
Safety Integrity Level (SIL) as defined in EN 62061:2005	1
State Selector: • Electrical life	25000 operations minimum

2.6.4.6 Details on the PL and SIL level of the safety related functions

In the following tables we will detail PL and SIL values, the parameters useful for their calculation and the assumptions we made.

2.6.4.6.1 Details on the PL (EN ISO 13849-1:2008)

	PL	$MTTF_d$[years]	DC	Category
Stop Push-button	d	>16837	95,09%	3
Enabling Device	d	16544	95,40%	3
State Selector	c	348	66.5%	1

2.6.4.6.2 Details on the SIL (EN 62061-1:2005)

	SIL	PFH_d[1/hour]	SFF	HFT
Stop Push-button	2	$6.87\ 10^{-9}$	98.85%	1
Enabling Device	2	$6.90\ 10^{-9}$	98.85%	1
State Selector	1	$3{,}28\ 10^{-7}$	90,03%	0

2.6.4.6.3 Parameters useful for the PL (EN ISO 13849-1:2008) and SIL (EN 62061-1:2005) Calculation

Parameter	Description	Stop push-button	Enabling device	State selector
Dop	Average number of annual operating days of the safety function	240	240	240
Hop	Average number of daily hours of operation of the safety function	16	16	16
Tcycle	Average elapse time (seconds) between two uses of the safety function	1152	288	19200
Nop	Average number of annual operations	12000	48000	720
b10	Number of cycles that determine a failure of 10% of the components	250000	1000000	25000
MTTF	Mean Time To Failure (years)	208	208	347
B10d	Number of cycles that determines a dangerous failure of 10% of the components	Note 2	Note 2	25000
MTTFd	Mean Time To Dangerous Failure (years)	Note 2	Note 2	347

Note 1

The numerical values shown in 2.6.4.6.3 consider only the highest safety performances of the Safety Functions of the H4 Wireless system, starting from the Safety Device (Stop Push-button, Enabling Device, State Selector) of the Terminal and ending on the HCI output connector. The numerical values of $MTTF_d$, PFH_d, SFF and DC were obtained using the assumptions shown in 2.6.4.6.3 and are related to each safety function frequency of use. The values for the overall safety functions of the machine depend on how the output safety signals are managed inside the machine controller.

Note 2

The Stop Push-button and Enabling Device on board of H4 are compliant with IEC60947-5-1. Considering that and referring to paragraph D.5.3 (table D.8) of ISO 138492, it is not possible to relate dangerous failures to these components and, so, the values of b_{10d}, $MTTF_d$ and PFH_d for the Stop Push-button and Enabling Device does not have any relevance (from a mathematical point of view: b_{10d}, $MTTF_d$ = infinite and PFH_d = 0).

Note 3

As indicated in EN 60204-1:2006-par.9.2.7.3, in a wireless control terminal the Stop Device shall not be marked or labeled as an Emergency Stop Device. Anyway, from an hardware point of view, the Stop Push-button is exactly the same device used on board of H3 Wired terminal, except for the yellow background color.

2.6.5 Timing specifications

H4 and HCI, as previously explained in detail, interface with the machine control logic. In this section we summarize all timing characteristics relating to the communication between H4 and the machine control logic.

All configuration and control commands selected through the keyboard or the touch screen display, the optional handwheel and the potentiometers status are sent through a Bluetooth communication channel to the HCI and then transmitted to the machine control logic through a RS-422 serial communication channel. The average time that runs from the change of an input on the Wireless terminal to when its transmission from the HCI to the machine control logic is concluded is called $t_{RS-}422$.

The safety related devices status, monitored by the H4, is sent through the Bluetooth communication channel to the HCI. HCI provides safety relays and Mosfet switches which perfectly replicate the safety devices status. The average time that runs from the change of the safety devices status on the Wireless terminal to when their status is perfectly replicated on the HCI on the output contacts of its Safety relays and Mosfet switches is called t_{Safety}.

In case of wireless communication faults, further explained in chapter 4, or problems in the hardware in charge of checking and transmitting the safety devices, a safety time-out ($t_{Safetytime-out}$) forces the safety relays and the Mosfet switches into a “safe" state.

Timing	Value
t*RS−*422	less than 150 ms
t*Safety*	less than 100 ms
t*Safetytime−out*	160 ms

2.7 Stickers

H4 as well as the Recharging Station and HCI and TOKEN, is labeled with a sticker nameplate that allows single component unique identification. Wireless terminal, RS and HCI provide the same kind of sticker showing:

- Model name.
- product part number ;
- product versioning
- production serial number
- production date (mm/yy)
- producer logo ;
- CE mark.

The NSMHC module is identified by the following label:

The label is applied on the back of the case, so it is not visible when the case is clipped on the DIN bar.

Another label is applied on the case that holds the NBTR module:

This second label holds the Token code. The Token Code is important because only the token with that same code can allow an H4 terminal to connect with the NSMHC module.

Figure 2.17: Handheld terminal, HCI, and RS Sticker

TOKEN has a unique ID on its TOP

Figure 2.18: TOKEN Sticker

2.8 Mounting the charging station

Recharging Station is designed to be wall mounted or desktop mounted. Each mounting type is related to different target surfaces, hereunder summarized:

Mounting type	Target surface *
Wall mount	Brick made surface
	Wooden/Plastic surface
	Metal surface
Desktop mount	Wooden/Plastic surface
	Metal surface

* Target surface: through hole and wall thickness more than 5mm

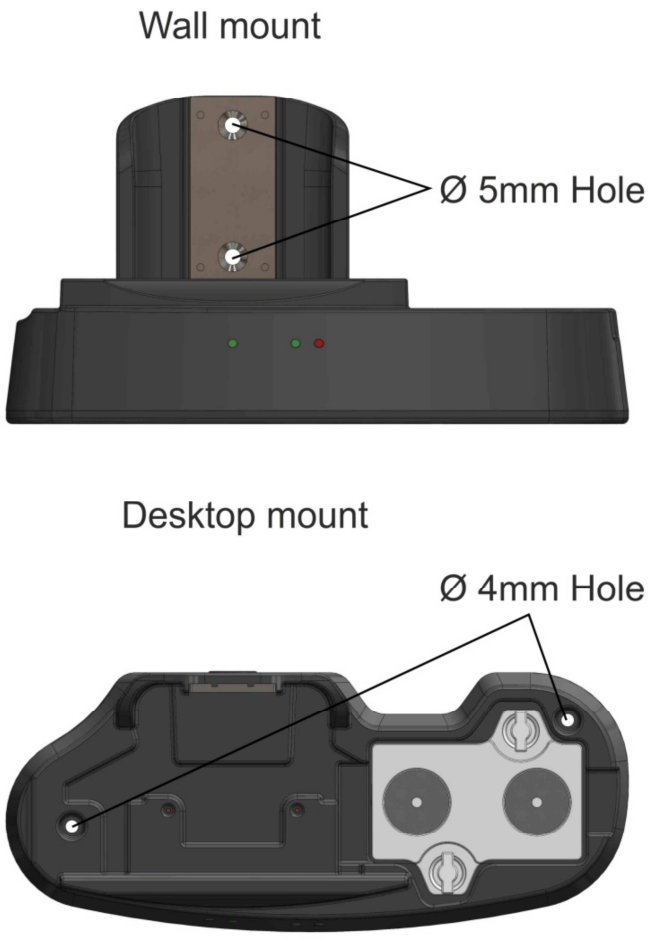


Figure 2.19: Recharging station holes

Warning!

- Installation must be done in such a way that you cannot push the cable into the interior of the device and even damage the cable and its entrance by accident.

2.9 Standards and certifications

2.9.1 EC directives

Directive	Description
2006/42/EC	Machine Directive
2014/30/EU	Electromagnetic Compatibility Directive (EMC)
1999/5/EC	Radio equipment and telecommunications terminal equipment and the mutual recognition of their conformity

2.9.2 International standards

Standard	Description
Safety of Machinery	
EN 60204-1:2006	Safety of machinery - Electrical equipment of machines Part 1: General requirements
EN ISO 13849-1:2008	Safety of Machinery – Safety related parts of control systemsPart 1: General principles for design
EN 62061:2005	Safety of Machinery – Functional safety of safety related electrical, electronic and programmable electronic control systems
EMC	
IEC 61000-(1-2-3)	Electromagnetic Compatibility (EMC)
EN 61000-6-2:2005	Electromagnetic Compatibility (EMC) Part 6-2: Generic Standards – Immunity for Industrial Environments
EN 61000-6-4:2007	Electromagnetic Compatibility (EMC) Part 6-4: Generic Standards – Emission Standard for Industrial Environments
EN 61000-4-2:2010	Electromagnetic compatibility (EMC) Part 4-2: Testing and measurement techniques - Electrostatic discharge immunity test
EN 61000-4-3:2007	Electromagnetic compatibility (EMC) Part 4-3: Testing and measurement techniques - Radiated, radio-frequency, electromagnetic field immunity test
EN 61000-4-5:2007	Electromagnetic compatibility (EMC) Part 4-5: Testing and measurement techniques - Surge immunity test
EN 61000-4-6:2007	Electromagnetic compatibility (EMC) Part 4-6: Testing and measurement techniques - Immunity to conducted disturbances, induced by radio-frequency fields
EN 61000-4-8:1993	Electromagnetic compatibility (EMC) - Part 4-8: Testing and measurement techniques - Power frequency magnetic field immunity test
EN 61326-3-1:2008	Immunity requirements for safety –related systems and for equipment intended to perform safety-related functions (functional safety)- General industrial applications

ETSI EN301489-1 V1.9.2	Electromagnetic compatibility and Radio spectrum Matters (ERM) – Electromagnetic Compatibility (EMC) standard for radio equipment and services – Part1: Common technical requirements
ETSI EN301489-17 V2.2.1	Electromagnetic compatibility and Radio spectrum Matters (ERM) – Electromagnetic Compatibility (EMC) standard for radio equipment and services – Part17: Specific conditions for broadband data transmission system
EN 55011:2007	Industrial, scientific and medical (ISM) radio-frequency equipment - Electromagnetic disturbance characteristics - Limits and methods of measurement
Degrees of protection and environmental tests	
EN 60529, 1997+A1:2000	Degrees of protection provided by enclosures (IP code)
EN 60068-2-1:2007	Environmental testing Part 2-1:Tests – TestA: Cold
EN 60068-2-2:2007	Environmental testing Part 2-2:Tests – TestB: Dry heat
EN 60068-2-6:2008	Environmental testing Part 2-6:Tests – TestFc: Vibration (sinusoidal)
EN 60068-2-30:2005	Environmental testing Part 2-30:Tests – TestDb: Damp heat, cyclic (12h+ 12 h cycle)
EN 60068-2-31:2008	Environmental testing Part 2-31:Tests – TestEc: Rough handling shocks, primarily for equipment-type specimens
EN 61131-2:2007 § 4.2.1, § 4.2.2	Programmable controllers – Part2: Equipment requirements and tests, § 4.2.2: Shock (according EN 60068-2-27)
Stop Push-button conforming to:	
IEC 60947-5-5, 6.2	Safety Lock Mechanism
IEC 60947-5-5, 5.2	
IEC60947-5-1, Annex K	Direct opening action mechanism
EN 60204-1:2006-9.2.7.3	
Enabling Device conforming to:	
IEC 60947-5-1	
EN 60947-5-1	
JIS C8201-5-1	
UL508	
CSA C22.2 No 14	
IEC 60947-5-8:2006	Low-voltage switchgear and control gear

2.9.3 TUV certificate

ZERTIFIKAT ◆ CERTIFICATE ◆ 認証証書 ◆ СЕРТИФИКАТ ◆ CERTIFICADO ◆ CERTIFICAT

Product Service

CERTIFICATE

No. Z10 15 08 92135 001

Holder of Certificate: **0N3 S.r.l.**
Via Monviso 14
10090 VILLARBASSE
ITALY

Factory(ies): 90067

Certification Mark:

Product: **Remote control, industrial (wireless handheld teminal)**

Model(s): **H4 (with safety modules NSMHC & NSMWL)**

Parameters:

Power supply:		
H4 (Handheld Terminal):		3,7 VDC
HCI (Host Controller Interface):		24 VDC
RS (Recharging Station):		24 VDC
Operating temperature:		+5°C...+45°C
IP class:	H4 and RS:	IP 64
	HCI:	IP 20
Safety Functions:	"Stop"	cat 3, PL d / SIL 2
	"Enabling"	cat 3, PL d / SIL 2
	"State Select"	cat 1, PL c / SIL 1

Tested according to:
2006/42/EC
EN ISO 13849-1:2008
EN 62061:2005/A1:2013
EN 60204-1:2006/A1:2009

The product was tested on a voluntary basis and complies with the essential requirements. The certification mark shown above can be affixed on the product. It is not permitted to alter the certification mark in any way. In addition the certification holder must not transfer the certificate to third parties. See also notes overleaf.

Test report no.: OV87344C

Valid until: 2020-08-16

Date, 2015-08-18 (Peter Weiss)

584116

Page 1 of 1

A1 / 04.11

TÜV SÜD Product Service GmbH · Zertifizierstelle · Ridlerstraße 65 · 80339 München · Germany

TÜV®

Extract from “Report to the Certificate” (Report No.: OV87344C), chapter 5.

Use of the remote control system NMSPM (H4) must comply with the current version of the operator manual of the company 0N3 S.r.l..

In addition, the conditions listed below also apply.

A. When using the safe relay outputs and at least one of the two relays is in open position, appropriate circuitry on the machine shall ensure that the connected machine is in a defined safe condition.
B. 0N3 S.r.l. shall make sure that each system has its own system address called Unique ID, UID (no multiple uses of addresses).
C. Before using the wireless handheld terminal the user has to make sure that the terminal belongs to the machine he likes to control. Because of that a clear identification of the paired wireless handheld terminal and the machine is needed.
D. The proper connection of safe outputs (receiving station) to the external environment shall be checked and documented.
E. It has to be checked by the machine integrator if the stop concept of the receiving station (machine side) fits to the safety concept of the machine. In particular, the maximum reaction times (provided in the user manual) shall be taken into account.

3 Wireless terminal safety system

3.1 Architecture overview

H4 internal boards and HCI connection to the machine cabinet is hereunder presented:

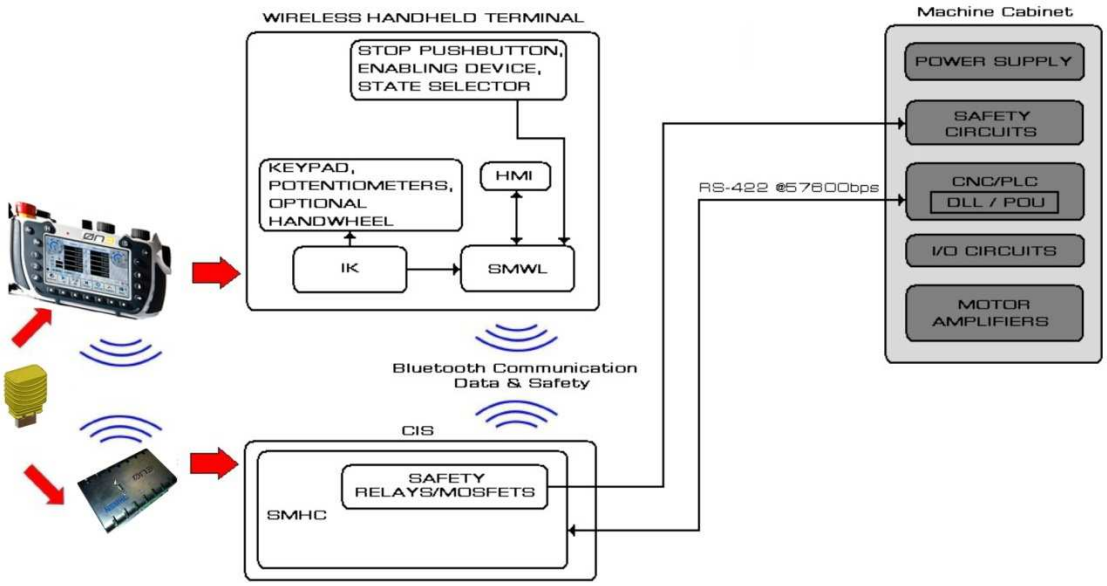


Figure 3.1: Architecture Overview

The NMSPM system is defined as the set of components that build up the safety system part.
It is composed of:
The NSMWL module mounted into the H4 Wireless terminal.
The NSMHC module and the NBTR module on the CNC cabinet, included the cable connecting the 2 modules.
The TOKEN (single or double) that allow the virtual connection between the two parts.
The system is in charge of creating a virtual safe link between the safety related devices on board of the H4 and the related safety relays or mosfet switches on board of HCI, directly connected to the machine safety circuits.
From a safety point of view the H4 will behave exactly as it would have hard-wired safety related devices.
The whole system is designed to allow a point to point coupling between the Wireless terminal and the related HCI in environments where more than one terminal HCI couple can coexist.

3.2 Operation

The aim of the NMSPM system is to establish a safe wireless connection between a control cabinet (CNC) and a handheld terminal (H4).
The safety of the information is assured by the intrinsic safety of the message flowing thru an unsafe communication media (black channel), while the unambiguous connection between the CNC and the H4 is accomplished by the use of unique hardware keys called TOKEN.
Each token holds specific and unique information that are used as part of the message between the CNC and the H4.

The NMSPM system can operate with the token in two different ways: single token operation and double token operation. The operation mode is configured at the factory and cannot be changed on the field.

When the double token configuration is chosen, the NSMHC and NSMWL modules do not hold any coupling related information. The information is hold by the couple of tokens. When the tokens are inserted, one on the cabinet side and the other on the terminal side, the radio connection is established between the two Bluetooth modules that hold the same information read from the token. Both token holds the same information and they can be used equally on the cabinet or terminal side.

In the single token configuration, instead, the only token shall hold information about the NSMHC module to which it will connect when inserted into the terminal. This information is written into the token at the factory with a special procedure called “adoption”. So every token is registered to work with a specific NSMHC module. In fact the information written into the token during the adoption procedure is get from the NBTR part of the NSMHC, so these are the two parts that shall work together (Token and NBTR module).

The handheld terminal instead is never related to a specific token, so it can work with every NC cabinet, with single or double token configuration.

3.2.1 Operating states

At any given moment, the safety system can be in one of the following operating modes:
“**off**” The HCI station is powered off
“**idle**” The HCI station is at rest. No terminal is connected to the NSMHC module. Output contacts are closed, allowing the NC machine to operate.
“**run**” The safety system is working. Communication with a handheld terminal is established by a correct coupling procedure and the safety output contacts replay the state of the input devices on the terminal.
“**safe**” Safety system is in a safe state (safety output contact are open). This state can be entered by several conditions. The most common is when the radio link is lost after a successful coupling (possible reasons: distance between the 2 radio devices exceed the maximum allowed, electromagnetic noise, power off of the terminal before performing the uncoupling procedure).
“**emergency**” This state is reached each time an internal logic failure as POST or RTT failure (concerning the H4 terminal or the HCI) happen. In this case, of course, the Wireless terminal does not control the HCI and the machine to which it is connected. The Stop Push-button contacts on HCI are OPEN. The only way to get o E M G state is shutting OFF the system.

3.2.2 Safety system details

H4 and HCI safety system, as previously said, will behave as if the system would have hard-wired safety related devices.
In order to guarantee PL d, SIL 2 for the Stop and Enabling safety function and PL c, SIL 1 for the State selecting function (according to EN ISO 13849-1:2008 and EN 62061:2005), the safety system must consider all kind of problems related to the use of a Wireless handheld terminal:

- The safety system accounts for problems as ensuring the uniqueness of the control of a certain machine connected to the HCI by a certain handheld terminal. The uniqueness of the control is certified by means of executing specific coupling/uncoupling procedures using a device called TOKEN which holds a unique identifier code (UID)

- The safety system accounts for problems as lack of wireless signal.

- The safety system accounts for problems as insertion of TOKENs with different ID in the H4 terminal and HCI.

• The safety system accounts for problems as internal logic malfunctions executing a POST (Power On Self-Test) at Power ON and RTT (Real Time Test) during the whole system working life.

• The safety system communicates its status by means of LEDs on board of the terminal and HCI.

The safety system manages all possible events that can occur while operating the H4 wireless handheld terminal and HCI, appositely controlling the safety relays and mosfet switches.
We can summarize all of the safety system working conditions in statuses, each one related to a specific configuration of the safety relays and mosfet switches on the HCI.
The safety output contacts status in all possible working system statuses is hereunder summarized:

Status	Condition	WLS Connectio	HCI Output Contacts		
			Stop Push-button	Enabling Device	State Selector
OFF	HCI OFF	DROPPED	OPEN	OPEN	(0) OPEN
IDLE	HCI ON, TOKENs not inserted	DROPPED	CLOSED	OPEN	LAST VALID
RUN	HCI and Terminal coupled	ACTIVE	AS ON TERMINAL	AS ON TERMINAL	AS ON TERMINAL
SAFE(i) SAFE(r)	Lack of WLS signal, coupling/ uncoupling time-out expired	DROPPED	OPEN	OPEN	LAST VALID
EMG	POST or RTT failed	DROPPED	OPEN	OPEN	LAST VALID

Resuming we can say that:

• OFF: this state is reached each time HCI is powered OFF (or, rather, power supply into the machine cabinet, to whom HCI is connected, is OFF). Obviously, in this case, Stop Push-button contacts on HCI are OPEN.

• IDLE: in this state the Wireless terminal does not control the HCI and the machine to which it is connected. Stop Push-button contacts on HCI are CLOSED in order to let the machine work in automatic mode. This state can be mainly reached in two situations:

- each time, starting from OFF state, HCI is powered ON with no TOKEN inserted (double token configuration) or with TOKEN inserted (single token configuration);
- each time, starting from RUN state, a correct uncoupling procedure has been executed.

• RUN: this state can be mainly reached if a correct coupling procedure has been executed. In this case the Wireless terminal controls the safety outputs on HCI and user data are transferred through the wireless channel. The Wireless terminal controls the HCI and the machine to which it is connected.

• SAFE(i)/SAFE(r): these states can be mainly reached in case of lack of wireless signal or coupling/uncoupling procedures failed and the related time-out expired. SAFE(i) state is reached if these problems occurred when state of origin was IDLE state. SAFE(r) state is reached

if these problems occurred when state of origin was RUN state. In this case, of course, the Wireless terminal does not control the HCI and the machine to whom it is connected. The Stop Push-button contacts on HCI are OPEN.

• EMG: this state is reached each time an internal logic failure as POST or RTT failure (concerning the Wireless terminal or the HCI) happen. In this case, of course, the Wireless terminal does not control the HCI and the machine to which it is connected. The Stop Push-button contacts on HCI are OPEN. The only way to get to EMG state is shutting OFF the system.

3.2.3 LED functionality

Safety LED output signals are present both on the NSMHC and the NSMWL.
At any given moment, each LED can be in one of the following state.
The meaning of each state is described inside each procedure.

LED status	Description
OFF	Led is off
BlinkF	Fast blinking (100ms on / 100ms off)
BlinkS	Slow blinking (500ms on / 500ms off)
Blink22	Irregular blinking (200ms on / 200ms off / 200ms on / 400ms off)
ON	Led is steady on

3.2.4 Complete safety system status diagram

We hereunder show a diagram that resumes all possible transitions between system statuses. Dashed lines are related to transition statuses. Each status is represented together with the related LED status.

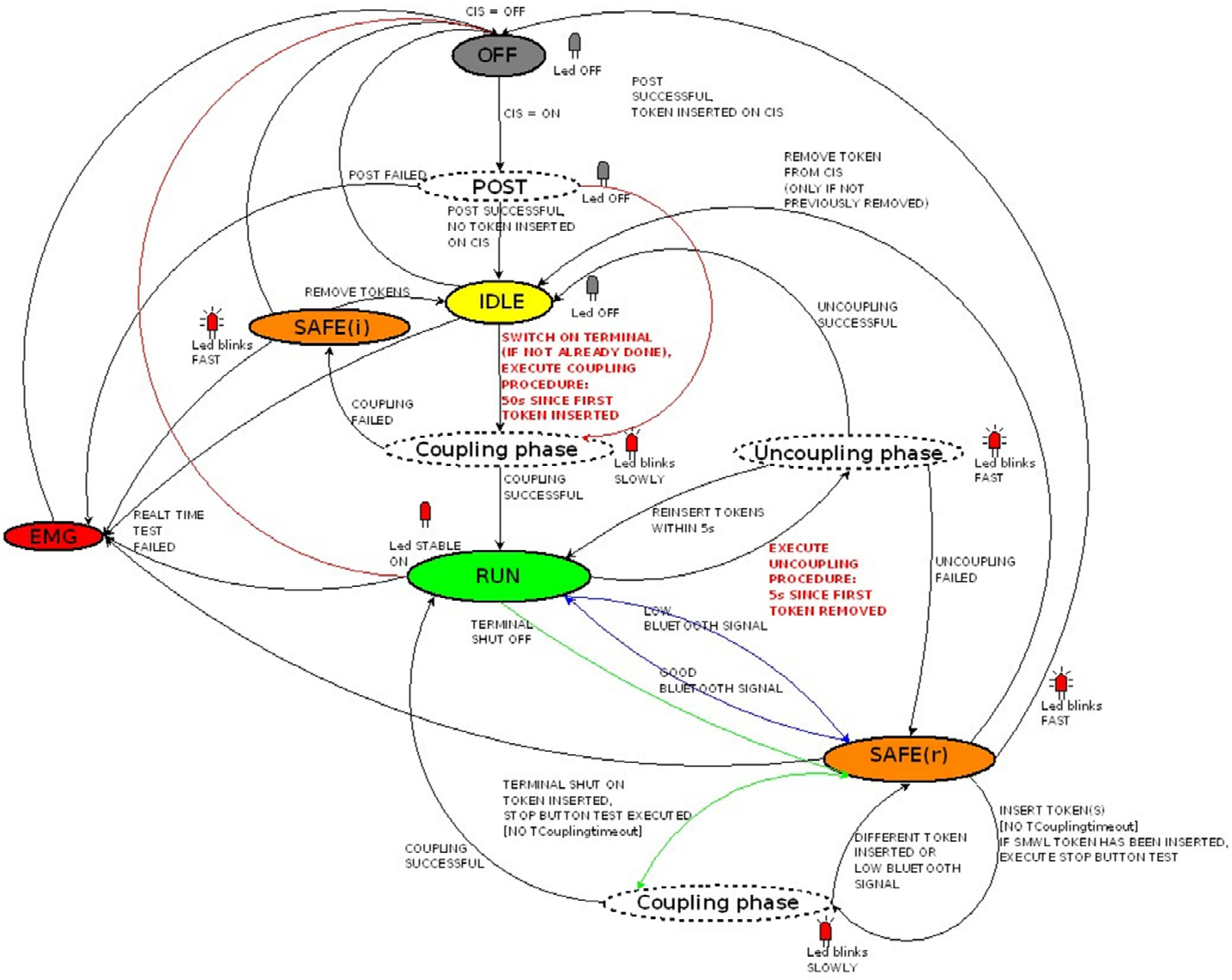


Figure 3.2: Safety system status diagram

In figure 3.2 we evidenced with colored arrows situations that must be satisfied sequentially:
- blue arrows: if we are in SAFE(r) state because of a lack of Bluetooth signal,we can automatically re-enter RUN state once the Bluetooth signal is sufficiently powerful
- green arrows: if we are in SAFE(r) state as a consequence of a shutdown of the Terminal, we can go to coupling phase and then to RUN state simply shutting on the terminal, inserting the TOKEN and executing the Stop Push-button test;
- red arrows: if we are in RUN state and the HCI is switched OFF, as soon as it is switched ON again (there is no $t_{Couplingtime-out}$), if TOKENs are left inserted into the terminal and HCI, after a correct POST the system can go directly to the coupling phase and to RUN state.

3.2.5 Safety guidelines

Danger!
The following guidelines shall be strictly complied in order to operate in a safe environment.
User is responsible for the correct system installation and interfacing to the machine control logic.
The operator shall be aware which machinery or group of machinery is controlling.
The operator shall be aware if the handheld terminal is enabled and connected to the machinery that is supposed to control.

Information!
The SMWL module can safely drive an LED that can inform the operator about the status of the safety system. The safety LED is off when the handheld terminal is not powered or when in idle mode (i.e. powered but with the radio communication off). The LED will blink when establishing a connection and finally be steady on when connection is established and the telegram packets are flowing.

Caution!
It is important that the LED shall be clearly visible and the operator instructed that he can rely on the stop pushbutton only when the LED is steady ON

Information!
The handheld terminal is not linked to any specific machinery by default. The link between the handheld terminal and the machinery is accomplished by the token and by the coupling procedure. The token, therefore shall help to clearly identify the machinery under control, for example by putting a well visible label on the token and a similar label on the cabinet of the machinery under control

Warning!
Furthermore, the coupling procedure shall be driven by the application software in such a way that will force the operator to be aware of the machinery is going to take control.
The following condition shall always be analyzed:
The handheld terminal is off.
In such case the stop pushbutton will not be able to perform its duty.
When the safety led is off, the operator shall be aware that the stop pushbutton won't be able to perform its duty. It is under the system integrator to decide if machinery is allowed to operate by other meaning than the handheld terminal, instruct the operator of such possibility and the safety behavior to comply with
The handheld terminal is powered but not connected to any control cabinet. (No token inserted).
Also in this case the stop pushbutton will not be able to perform its duty. The absence of the token, the safety LED off and possibly an evident message by the local software shall inform the operator of such condition.
The handheld terminal is powered and connected but the connection drops due to electromagnetic interference or out of range.
The token is present but the safety LED will be blinking. In such cases the control cabinet shall behave as if it received a stop command and consequentially should be in safe state.
All over this discussion is always mentioned the Stop Pushbutton and never the Enabling device. In fact, both devices work together, i.e. when the Stop Pushbutton is able to perform its duty, the same is for the enabling device. It is up to the application environment to allow the machinery to work or not to work when the enabling device is not held by the operator

Caution!
If the application software allows controlling more than one machinery at the time, then the safety circuits on the plant should be wired in such a way that the Stop Pushbutton will halt all the machinery that could be involved

3.2.6 Coupling procedure details

Depending on the system configuration (single or double token) and on the operator behavior, there are four different approaches to achieve the coupling between a CNC and a H4.
The different operating modes only differ for the initial condition. The final coupling procedure is the same for all the operating modes and is performed as follow:

1) The handheld terminal is powered on and token is inserted into it.
2) The coupling led on the terminal blinks fast
3) Operator performs the stop-button test by pressing and releasing the stop pushbutton (during this operation the enabling device handle shall be released).
4) The coupling led on the terminal blinks slow.
5) Coupling succeeded. Both LEDs on the terminal and HCI are stable ON. System is in RUN state.

3.2.6.1 Single token configuration with token always inserted in the handheld terminal

This could be the default configuration when there is one terminal for every machine and the terminal is the only interface to control the machine.
When the controller cabinet is powered on the safety system enters the safe state and waits indefinitely for a terminal to link to.
The coupling operation shall take place when the handheld terminal is powered on.
Following the indication from the safety LED and/or messages from the local software, the operator shall exercise the stop pushbutton while leaving the enabling device in the rest position.
The handheld terminal starts looking for the assigned cabinet to connect to. While the radio connection is not established, the local software on the handheld terminal shall display a well visible warning message informing the operator its stop pushbutton is not operative. When connection is established, the safety led will be steady on, informing the operator the stop pushbutton is able to perform its task.
The application software should help the operator to identify the machinery under control. The safety system changes from “safe” to “run” state. It could reenter “safe” state if any of the general condition occurs.

3.2.6.2 Single token configuration with token dynamically inserted in the handheld terminal

This could be the default configuration when there is one terminal to control several machines (however one at the time). This implies that the machines not connected to the terminal can operate by their own (i.e. by meaning of a fixed console in the NC cabinet.
Tokens (one for every HCI) are usually inserted into the HCI to allow the safe system enters the “idle” state.
When the operator wants to take control of one machine, he has to remove the token from the HCI controlling that machine, insert it into the handheld terminal and follow the coupling procedure. If the coupling is accomplished before the timeout elapses, the safe system switch from “idle” to “run” state”, without entering the “safe” state. Otherwise, after time out elapses the safe system enters “safe” state and holds it until a successful coupling is accomplished or the token is inserted back into the HCI.
Once in “safe” state, however, coupling can be retried any time later without having to return the token to the HCI.
The coupling operation could take place at any moment after power on.
While the handheld terminal is powered but not connected (because token is not inserted and coupling procedure has not taken place), the safety led is off. Furthermore, the local application software should inform the operator that the Stop Pushbutton is not active.
When connection is established, the safety led will be steady on informing the operator the stop pushbutton is able to perform its task. The application software should help the operator to identify the machinery under control.

3.2.6.3 Double token configuration with tokens always inserted in the handheld terminal

As for the analog single token, this configuration is used when there is one terminal for every machine and the terminal is the only interface to control the machine.
When the controller cabinet is powered on the safety system enters “idle” state and waits for a coupling procedure to occur before timeout elapses (approx. 60 seconds). After that the cabinet enters safe state and will be necessary to extract and re-insert the token to try for a next coupling procedure.

3.2.6.4 Double token configuration with tokens dynamically inserted both in the cabinet and in the handheld terminal

This configuration assumes that there is more than one machinery in a plant which can work without the need of the handheld terminal. When the operator decides to take control of one of the machinery thru the handheld terminal, he performs the coupling procedure with the specific cabinet controlling the machinery. Coupling can be performed without entering the safe state (i.e. the machinery can continue to work while coupling is in progress), the function of the Stop Pushbutton will be active only when the coupling procedure is completed successfully and the safety LED is steady on. Before coupling and while coupling procedure is in progress, the local software on the handheld terminal shall display a well visible warning message informing the operator its stop pushbutton is not yet operative.
When connection is established, the safety led will be steady on informing the operator the stop pushbutton is able to perform its task. The application software should help the operator to identify the machinery under control.

3.2.6.5 Operation without handheld terminal

In case the operation without the handheld terminal is required, the token shall be removed from the terminal and inserted into the NSMHC slot in the CN cabinet. The safety system will then enter the “idle” state.

We assume the token is inserted into the handheld terminal and the terminal has just been powered on. The steps are:

As soon as the initial self-test procedure has finished or the token is sensed (whichever comes last), the safety led start blinking fast.
At this time the operator shall push and release the Stop pushbutton while leaving the Enabling device in its rest position. If the safe system was in the “idle” state (double token configuration only) the pushing of the Stop pushbutton will not affect that state.
When the test on the Stop pushbutton is accomplished, the safety LED will start flashing slowly while the radio system tries to connect.
If the 2 radio’s antennas are in the allowed distance range, after a few seconds (usually from 5 to 25) a valid link is established and the safety LED is lit steady on. From now on the system enters “run” state.
If, for any reason, the radio link is not established after timeout elapses (about 30 seconds), the safety LED start flashing fast again.
To start a new coupling procedure, the token shall be removed from the terminal, the safety led turns off, token is reinserted into the terminal slot and the test over the stop pushbutton can start again.
Alternatively, instead of removing and reinserting the token, the handheld terminal can be powered off and then on again.

In case of double token configuration, also NSMHC module has a timeout that can elapse if coupling is not accomplished. To restart the coupling procedure then, also the token from the NSMHC module shall be removed and then reinserted.

3.2.7 Run state

When the handheld terminal and a HCI are coupled, the safety system is up and active. Wireless connection is also active and user data are transferred from the handheld terminal to the CNC. The output contacts on HCI follow the status of the safety devices on the handheld terminal. Three timings are related to RUN state:

- $t_{Safety:}$ typical average elapsed time measured from the changing of state of an input safety device on terminal to the changing of the related output contact on HCI;
- $t_{Safetytime-out:}$ maximum time-out allowed before setting the output contacts in SAFE state in case of lack of information from the handheld terminal.
- $t_{Couplingtime-out:}$ maximum time-out for correctly concluding coupling procedure. Hereunder we summarize these timing values:

Timing	Value
t_{Safety}	less than 100 ms
$t_{Safetytime-out}$	160 ms
$t_{Couplingtime-out}$	50 s

In conclusion it is important to say that in case $t_{Safetytime-out}$ elapses due to a lack of wireless signal, the safety system goes from RUN state to SAFE(r) state, as it is well described in figure 3.2. As soon as the wireless connection will be restored the safety system will automatically enter RUN state.

3.2.8 Uncoupling procedure

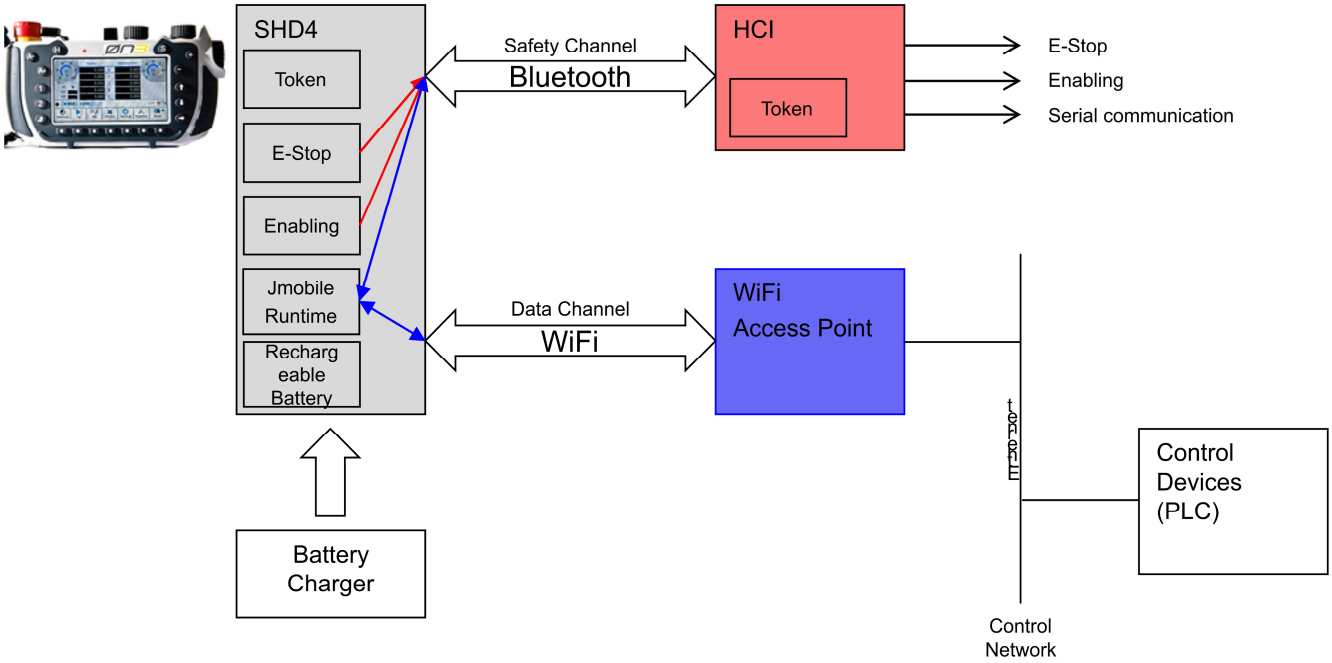
When the handheld terminal is no longer needed to control a HCI and the related machine, the uncoupling procedure shall be performed.
Uncoupling procedure can be executed each time the system is in RUN state
Uncoupling procedure is slightly different depending on system configuration.
In both cases uncoupling procedure starts with step 1.
1) TOKEN is removed from the handheld terminal. Its LED starts blinking fast.
A time-out counter ($t_{Uncouplingtime-out)}$ is started.

2s) In Single token configuration, TOKEN is inserted into HCI station
2d) In double token configuration, the second TOKEN is removed from the HCI station

Two different cases may occur:

a) Uncoupling succeeded. Both LEDs on the terminal and HCI are OFF. System is in IDLE state.
b) The 5s $t_{Uncouplingtime-out}$ elapsed. HCI goes into SAFE(r) state. Both LEDs blink fast.

4 Software wireless features



4.1 Installation Notes

Correct positioning of wireless

It is necessary to make sure that the antenna is located far from metal walls, in the central part of the work area, possibly with the crow flies free between the antenna and the docking station and in general with the work area.

4.1.1 Check Performance Wireless Antenna

Given that the wireless antenna is correctly placed as indicated in the manual and that the work area is defined by the device it is possible to check the status of your wireless connection.

You have to use the system variables indicating the signal strength to have information of the full coverage of the work area.

The procedure must be completed for both the Bluetooth Signal Strength and WIFI Signal Strength.

To verify that the wireless signal coverage is satisfactory in the work area set is necessary to move the device H4 in all positions of use.

During this procedure, verify that the minimum signal recorded never drops below the threshold value of 50.

4.2 Wi-Fi connection using JMobile software

When the Wi-Fi connection is use the following holds:
- the BT channel only transfers safety-related data
- data exchange between the JMobile runtime in the HMI and the control system use the Wi-Fi connection.
- The Wi-Fi connection require a Wi-Fi access point installed in the control system.

This chapter describes how to set-up the Wi-Fi connection.

4.3 Setting-up Wi-Fi connection

The user must select a proper Wi-Fi access point to estabilish communication with H4 handheld.
The access point must be compatible with wireless communication according to IEEE 802.11g.
When installing the access point you will to assign a proper SSID name to the equipment. This name will be used by the H4 handheld to uniquely select the access point for wireless connection.
The access point must be connected to the network where the control systems is included.
Please note that JMobile Studio will use the same network connection to configure the H4 handheld for the application.

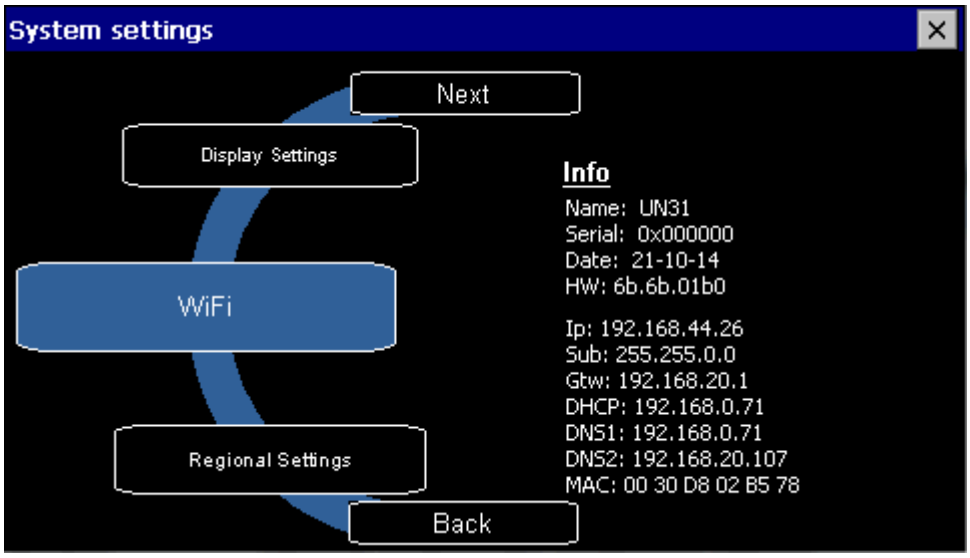
4.4 Setting-up Wi-Fi connection in H4

4.4.1 Connecting H4 to the Wi-Fi network

The H4 handheld includes a tool dedicated to setting-up the Wi-Fi connection. Use connection tool to choose the Wi-Fi network for the connection.
Please note the following:

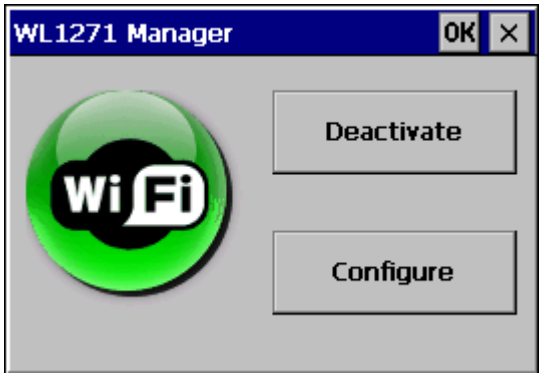
- association in the Wi-Fi network between H4 handheld and the available access point is manual
- association must be performed using the System Settings menu in the H4 handheld
- association to multiple Wi-Fi access points is possible
- H4 handheld will connect to only one access point at the time
- if more than one access point has been configured in the list, the H4 handheld may connect to any of the points in the configuration
- diagnostic information on wireless connection is available to JMobile runtime. Presentation to user can be designed at application level
- connection to configured access point, when available, is automatic
- Wi-Fi connection may be active also in the case the BT Safety Channel is not connected

Use System Settings to access the Wi-Fi configuration tool as shown in figure.

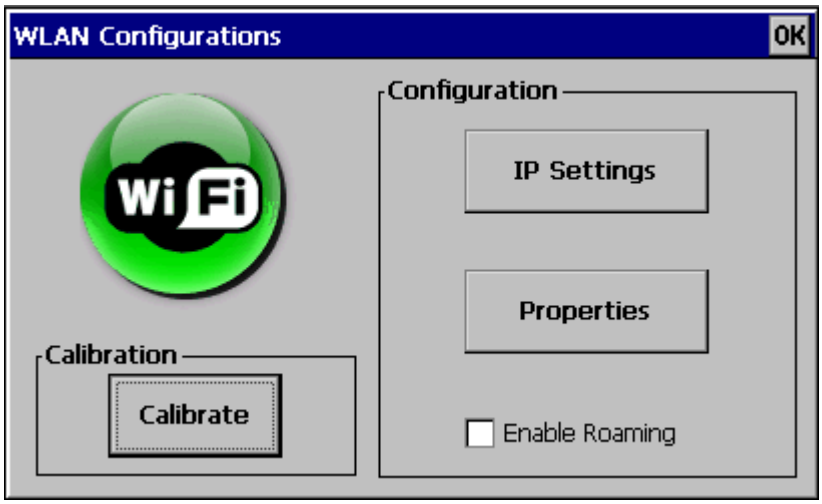


Note: In the System Settings menu, the "Network" item will appear as "Not available" when operating an H4 handheld device because no wired network interface exists.

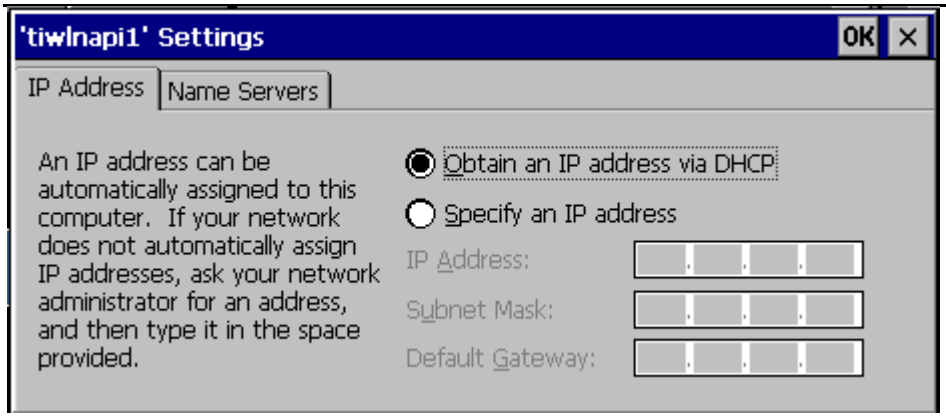
Use the Wi-Fi configuration tool to Activate/Deactivate and Configure the wireless network in the H4 handheld.

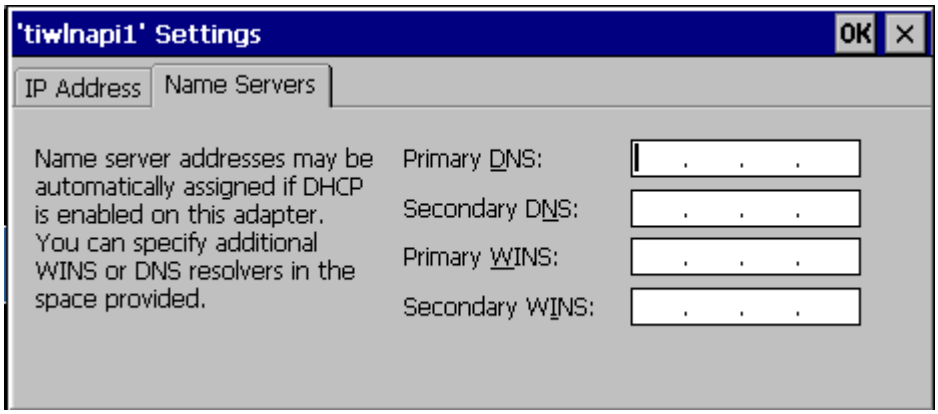


Use WLAN Configurations page to enter Wi-Fi communication properties.

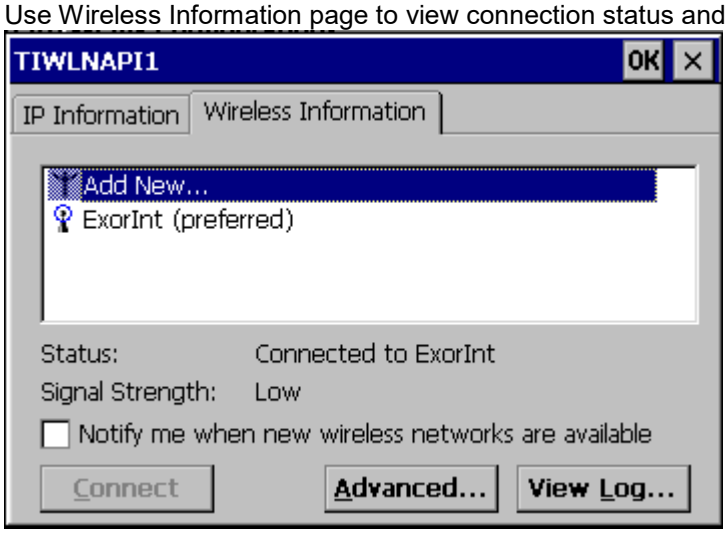


Use Settings page to enter network properties.

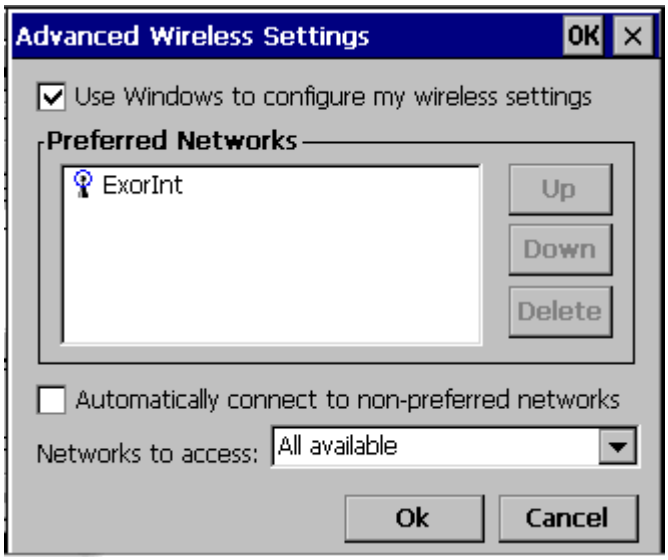


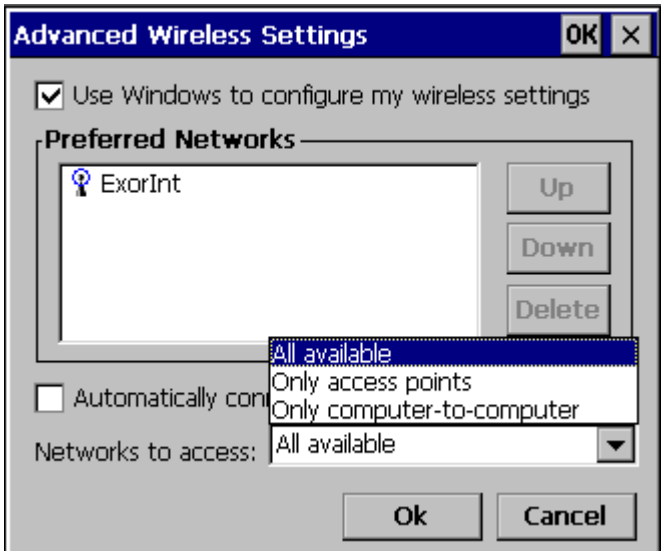


Use Wireless Information page to view connection status and to select the access point for connection.

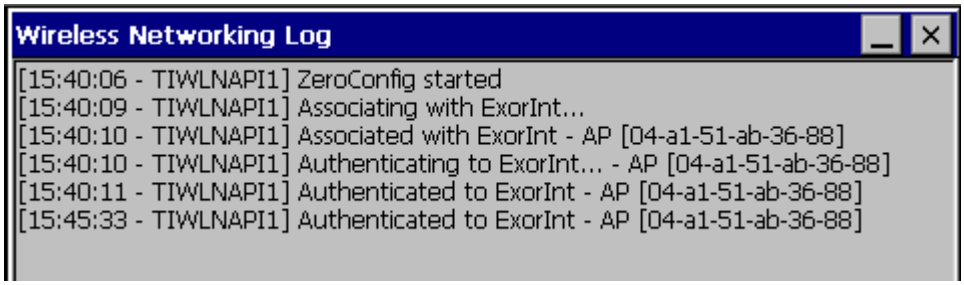


Use Advanced Wireless Settings page to select the Preferred Networks. In case more networks are available, the H4 handheld will attempt connection based on the priority specificed by the list Preferred Networks.





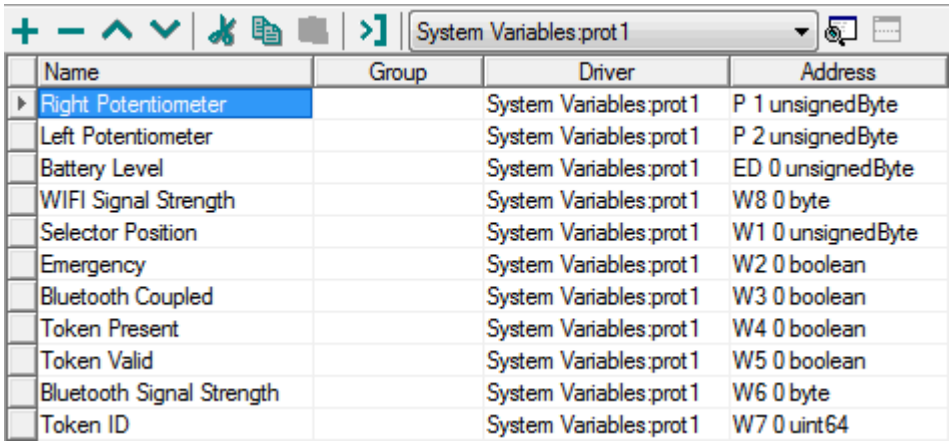
Use Wireless Networking Log to review information on status of Wi-Fi connection.



4.5 Operation status information

H4 handheld devices running the JMobile HMI runtime include a set of System Variables dedicated to information on BT and Wi-Fi networks.

These system variables are added automatically to the HMI project when it is created for H4 handheld devices.
Note: All system variables for wireless operation are read-only.



Name	Group	Driver	Address
Right Potentiometer		System Variables:prot1	P 1 unsignedByte
Left Potentiometer		System Variables:prot1	P 2 unsignedByte
Battery Level		System Variables:prot1	ED 0 unsignedByte
WIFI Signal Strength		System Variables:prot1	W8 0 byte
Selector Position		System Variables:prot1	W1 0 unsignedByte
Emergency		System Variables:prot1	W2 0 boolean
Bluetooth Coupled		System Variables:prot1	W3 0 boolean
Token Present		System Variables:prot1	W4 0 boolean
Token Valid		System Variables:prot1	W5 0 boolean
Bluetooth Signal Strength		System Variables:prot1	W6 0 byte
Token ID		System Variables:prot1	W7 0 uint64

The value of a system variable can be copied to other protocols/devices using Data Transfer or using Javascript.

Note: It is strongly suggested to use relaxed polling periods (Tag Refresh Rate >= 1s) in order not to waste CPU resources.

Battery Level Integer value in the range [0..100] indicating the battery charge percentage (0=battery low, 100=battery fully charged).

Wi-Fi Signal Strength An integer value in the range [0,100] indicating the level of the current Wi-Fi network (0=no signal, 100=max signal level).

Selector Position Position of the selector switch (0..15) in the device.

Emergency Status of the Emergency Stop button (1 = button pressed).

Bluetooth Coupled Coupling status between the wireless handheld and remote safety module (TRUE = coupled).

Token Present Presence of the Token (TRUE = token inserted).

Token Valid Status of the Token (TRUE = token inserted and VALID).

Bluetooth Signal Strength Bluetooth RSSI level in range [0, 100 = Max quality]

Token ID TOKEN ID value if token is present/connected, otherwise 0.
0 is returned also in case of error.

The content of these system variables is available to the JMobile programmer. The presentation of information to the user is under the programmer's responsibility.

5 Accessory ordering information

Type:	Spare battery H4
Part Number:	R-BATT3V74A401
Description:	Rechargeable battery replacement for H4