



SWD[®] Starter Kit

For AGV & AMR

Instruction manual
V3 - 10/01/2023

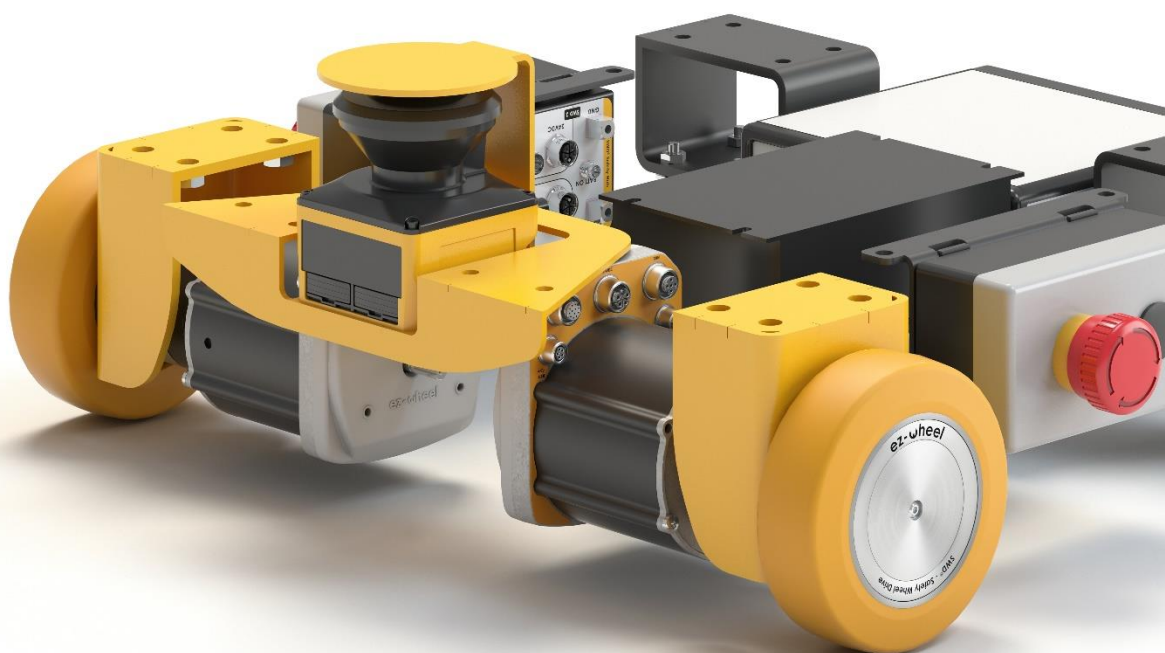


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 **This document should be read carefully before the first use of the product.**

1. Preamble

1.1. Who is this manual for?

This manual is intended for skilled robotics integrators.

The **SWD® Starter Kit** saves a lot of development time, but needs some core competencies in:

- Automation, functional safety, and robotics
- Embedded Linux, Python and C++
- ROS development environment

1.2. Terminology

The terms used in this manual are related to the technical field of industrial machinery and more particularly to driverless industrial trucks and drive systems controlled by fieldbus.

For a precise reading of the manual, a good knowledge of the following standards is recommended:

- Machinery Directive (2006/42/EC)
- Safety requirements for driverless industrial trucks and their systems (ISO 3691-4)
- Variable speed power electric drives (EN 61800-5)
- CANopen Application Profile for Motor Drives (CiA 402)

Dictionary of acronyms:

AGV:	Automatic Guided Vehicle
AGC:	Automatic Guided Cart
AMR:	Autonomous Mobile Robot
CAN:	Controller Area Network
LiDAR:	Light Detection And Ranging
OSSD:	Output Signal Switching Device
SBC:	Safe Brake Control
SDI[p/n]:	Safe Direction Indication [positive/negative]
SLAM:	Simultaneous Localization And Mapping
SLS:	Safety Limited Speed
SRDO:	Safety-Relevant Data Objects
STO:	Safe Torque Off

1.3. Additional resources




The **SWD® Starter Kit** uses **SWD® Core** safety drives, the following **SWD® Core** documents are available from ez-Wheel:

- **SWD® Core** datasheet
- **SWD® Full Range Brochure** Safety Wheel Drive Series Overview
- 2D and 3D mechanical plans of the **SWD® Core**

1.4. Declarations of conformity

The **SWD® Core** product is developed in accordance with legal requirements applicable in the European Union. The **SWD® Core** declarations of conformity (DoC) are being established by ez-Wheel.

1.5. Important information about the manual

	Important information – Read carefully
	Parameterizable value
	Additional information

1.6. Disclaimer

The technical information included in this manual is subject to change without prior notice. No responsibility is assumed for the completeness, up-to-date or accuracy of the data and illustrations provided.


The textual and visual data included in this manual are the property of ez-Wheel SAS. The trademarks ez-Wheel and SWD Safety Wheel Drive are registered.

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16400 LA COURONNE - FRANCE

2. Safety Instructions – SWD® Starter Kit Precautions

	<p>Do not open. Do not expose to a heat source. Do not expose to fire. Do not insert metal parts into the connectors. Under no circumstances should the product receive any modifications not authorized by ez-Wheel. Do not attempt to modify the technical performance of the product. The product must not be used for use beyond the technical performance specified by ez-Wheel. Inappropriate use results in the cancellation of the warranty. Opening the product results in the cancellation of the warranty.</p>
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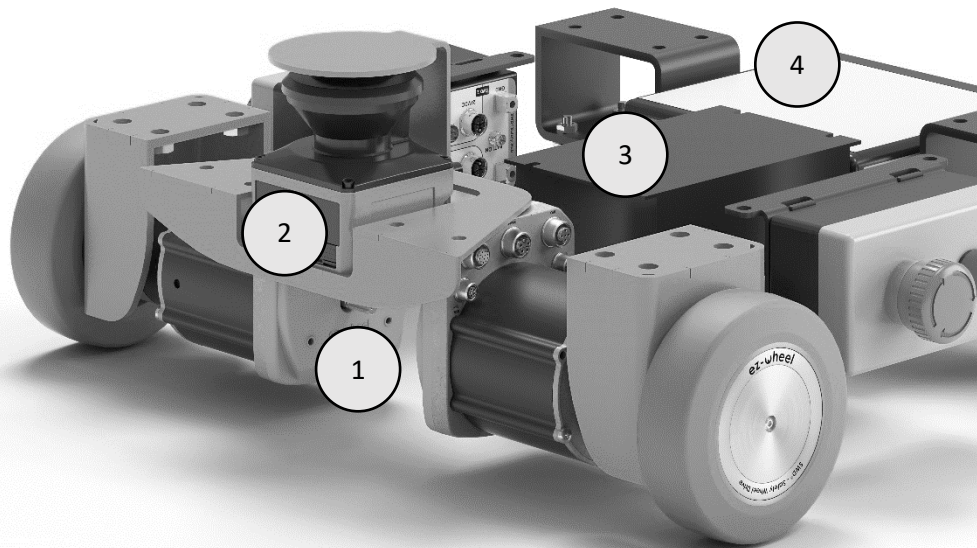
3. Description

3.1. A toolkit for robot developers

The **SWD® Starter Kit** is made of combinable, modular devices for mobile robotics.

The **SWD® Starter Kit** introduces key technologies for mobile robots' development

- **SWD® Safety Wheel Drive**: the world's first drive with embedded safe motion control
- Safety Laser Scanner: the smallest laser scanner for safety critical applications
- ROS Robot Operating System: the reference middleware for robotics

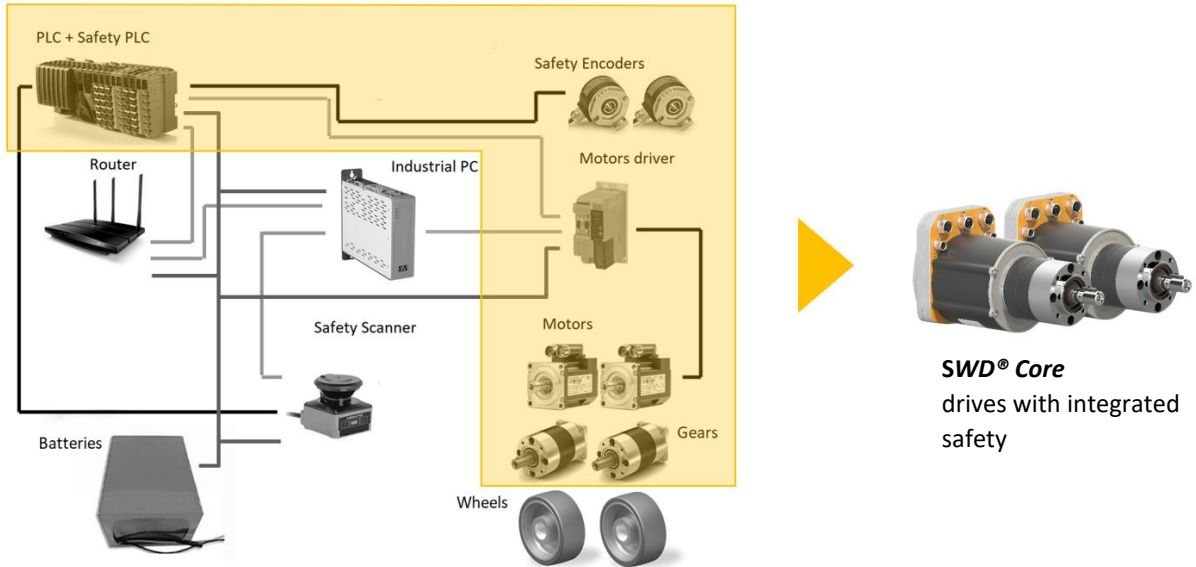


1	SWD® Core safety drives
2	Safety laser scanner
3	Embedded PC with ROS
4	Battery

3.2. Integrated Safety

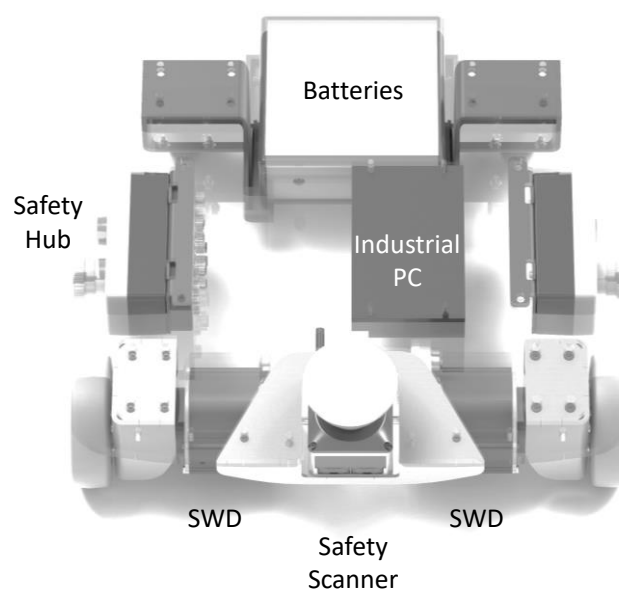
The **SWD® Starter Kit** provides the simplest AGV/AMR safety architecture ever:

- SWD integrates motor drivers
- Unique, fully certified safe motion features
- Safety encoder integrated into SWD



The robot architecture is therefore extremely simplified compared to conventional AGVs or AMRs:

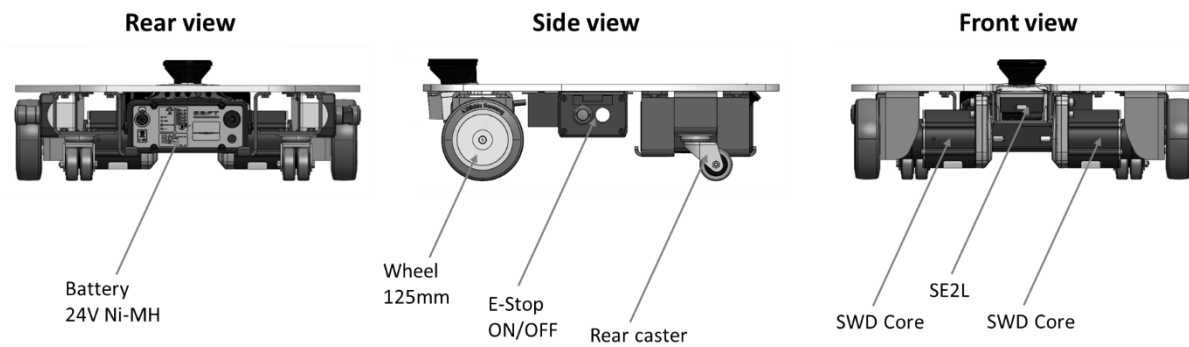
- ✓ Drives interfaced directly with safety laser scanners
- ✓ Replaces safety encoders, PLCs, and motor drivers



3.3. Specificities of the SWD® Starter Kit

The **SWD® Starter Kit** is a demonstration platform based on AMR use case, including:

- One safety laser scanner in front/center position
- Two **SWD® Core** safety drives with 125mm wheels
- An ARM iMX6 PC controller with Linux Ubuntu 20.04 OS and ROS Noetic metasytem
- A 24 VDC 9 Ah Ni-MH rechargeable battery
- A chassis and complete wiring with two E-Stops



The **SWD® Starter Kit** is not a complete, functional AMR:



- Navigation has to be done
- No fleet management software

3.4. Safety features

Motor disconnection	STO SIL2/PLd with E-Stops buttons
Motion control	SLS, SDI SIL2/PLd with safety laser scanner detection zones
Braking	SBC SIL2/PLd, configurable with STO

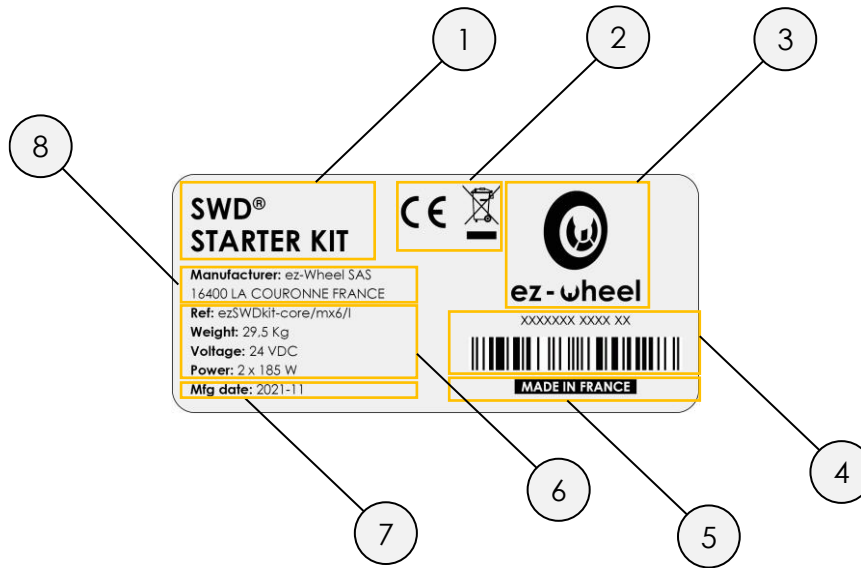
3.5. Conditions of Use

Temperatures	0 to +40°C
IP index	IP66 for SWD® Core , IP65 for safety laser scanner, IP54 for battery, NC for others
Maintenance period	5 years

3.6. Weight

Total weight	29,5 Kg
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3.7. Product Label

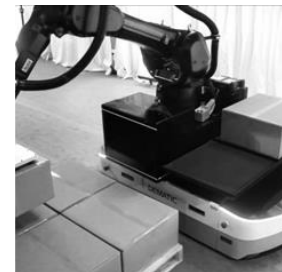


1	Commercial identification of the product
2	Legal pictograms
3	Identification of the manufacturer
4	Serial Number
5	Geographical origin of the product
6	Product information Product performance
7	Manufacturing date
8	Address of manufacturer

3.8. Applications

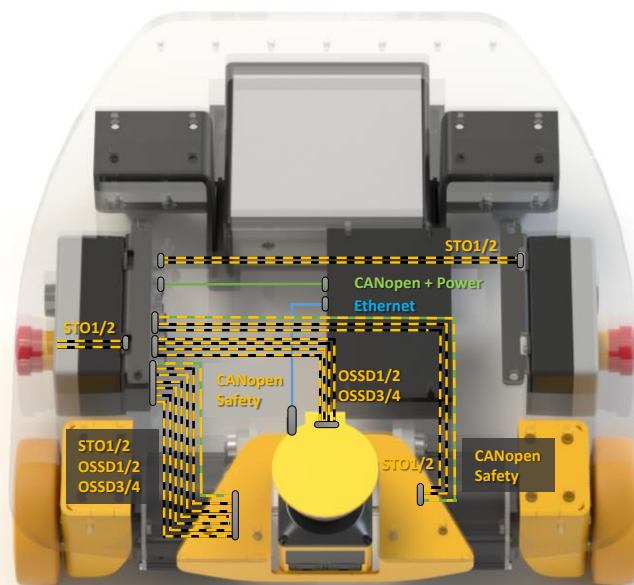
The **SWD® Starter Kit** is intended for development of mobile robotics applications such as:

- Industrial AGVs, AGCs and AMRs
- Logistics AGVs, AGCs and AMRs
- Cobots and mobile robot arms
- Mobile platforms

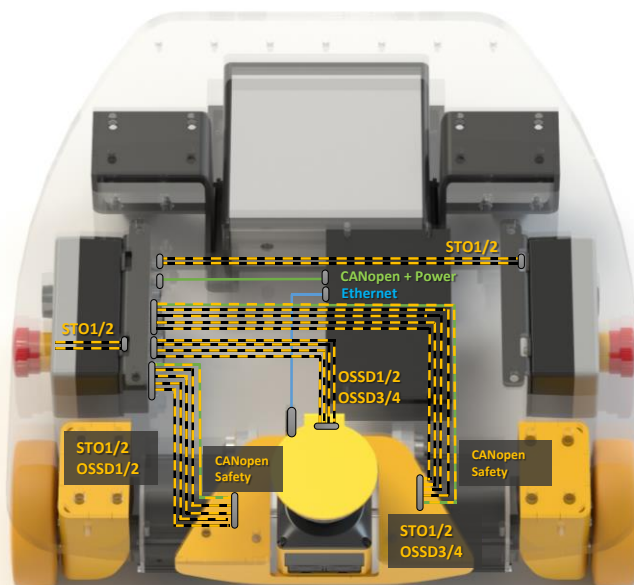


4. Synoptic

Safety and Control synoptic of the product



*Figure 1 - Commissioning 12 pts: OSTDs from the laser scanner are connected to one **SWD® Core***



*Figure 2 - Commissioning 17 pts: OSTDs from the laser scanner are connected to both **SWD® Core** (by pairs)*

- i** The commissioning 17 points is used when the safety laser scanner is mounted with no adapter to the 17-pin connector of the SafetyHub.
- i** The pinout of the adapter for 12/17 points wiring is available on the appendix

Safety

Direct connection of safety sensors and switches to SWD safe inputs:

- Emergency Stop L → SWD L - STO inputs
 - Emergency Stop R → SWD R - STO inputs
 - Safety laser scanner OSSD outputs → SWD programmable inputs
- i** CANopen Safety between SWD L and R is used to replicate the safety inputs from one drive to the other one

Control

- i** CANopen from iMX6 to SWD L and R, uses CiA 402 velocity control mode for speed and direction control. Ethernet from safety laser scanner to iMX6, is used to get data for SLAM and ROS-based algorithms
- i** CANopen and CANopen Safety frames are transmitted on the same physical CAN bus

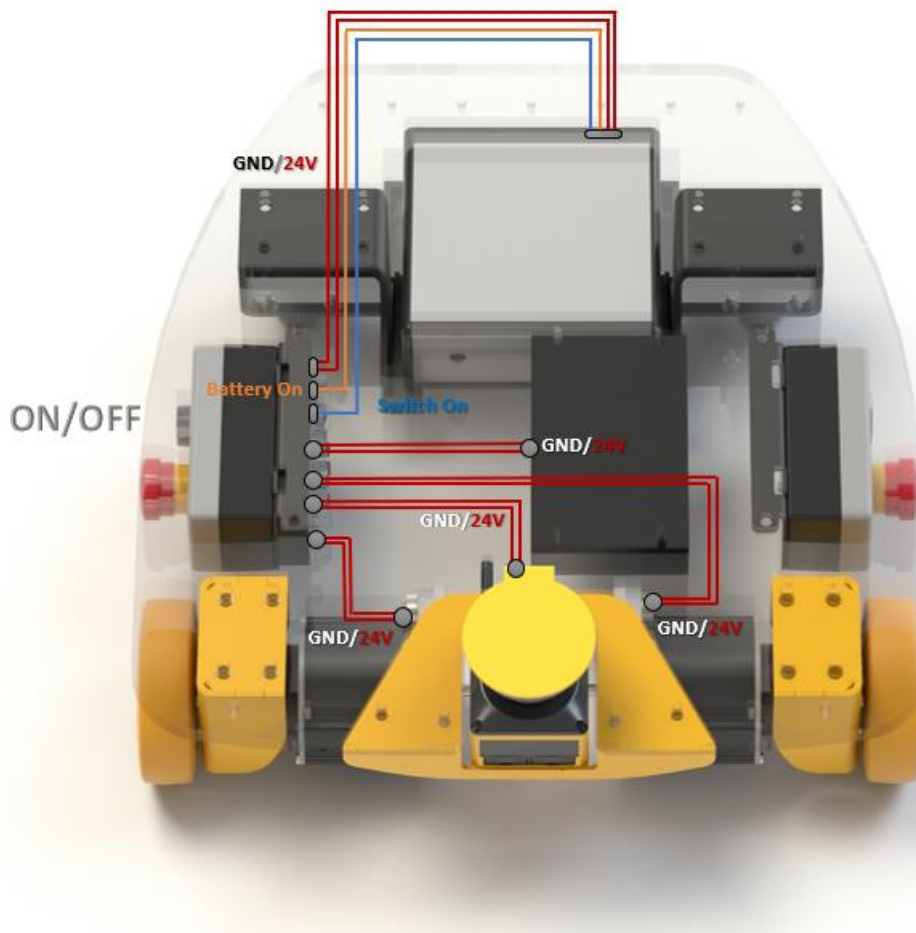


Figure 3 - Power Supply synoptic of the product

Power supply

- All devices powered by Ni-MH 24V / 9Ah battery
- Battery to junction box
- Junction box to SWD L, SWD R, safety laser scanner and iMX6
- Activation signal, from the ON/OFF button to the activation input of the battery

Charging

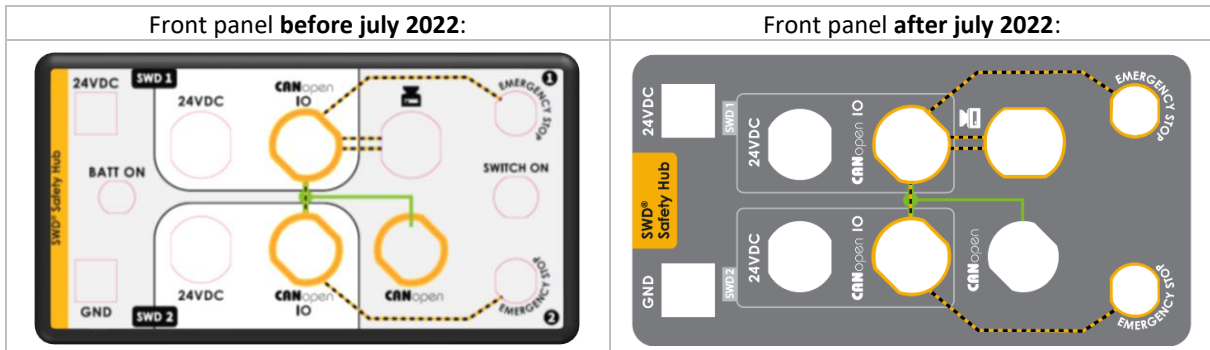
The external charger can be directly connected on the battery panel connector:



5. Interfaces

5.1. Overview

The **SWD® Starter Kit** is using the **SWD® Safety Hub** interface to centralize the connections of all devices and facilitate the overall wiring.



Details for both versions:

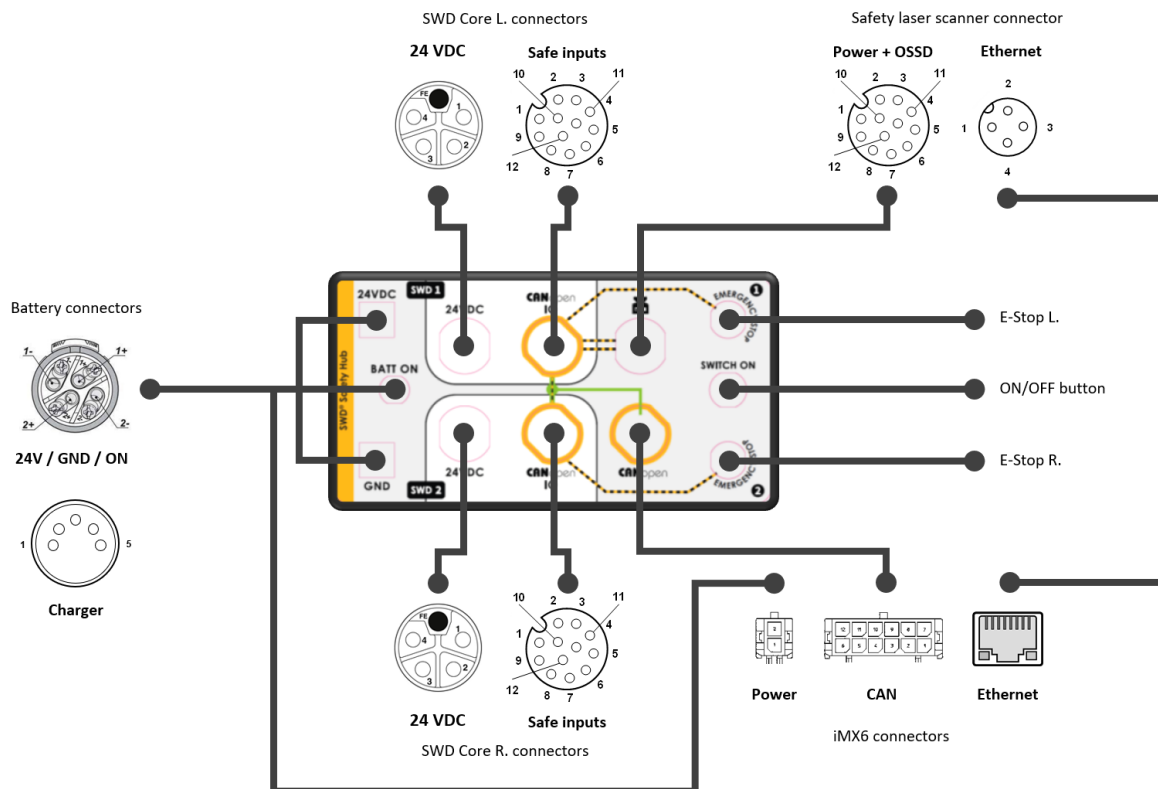


Figure 4 - Wiring synoptic, SWD® Safety Hub before July 2022

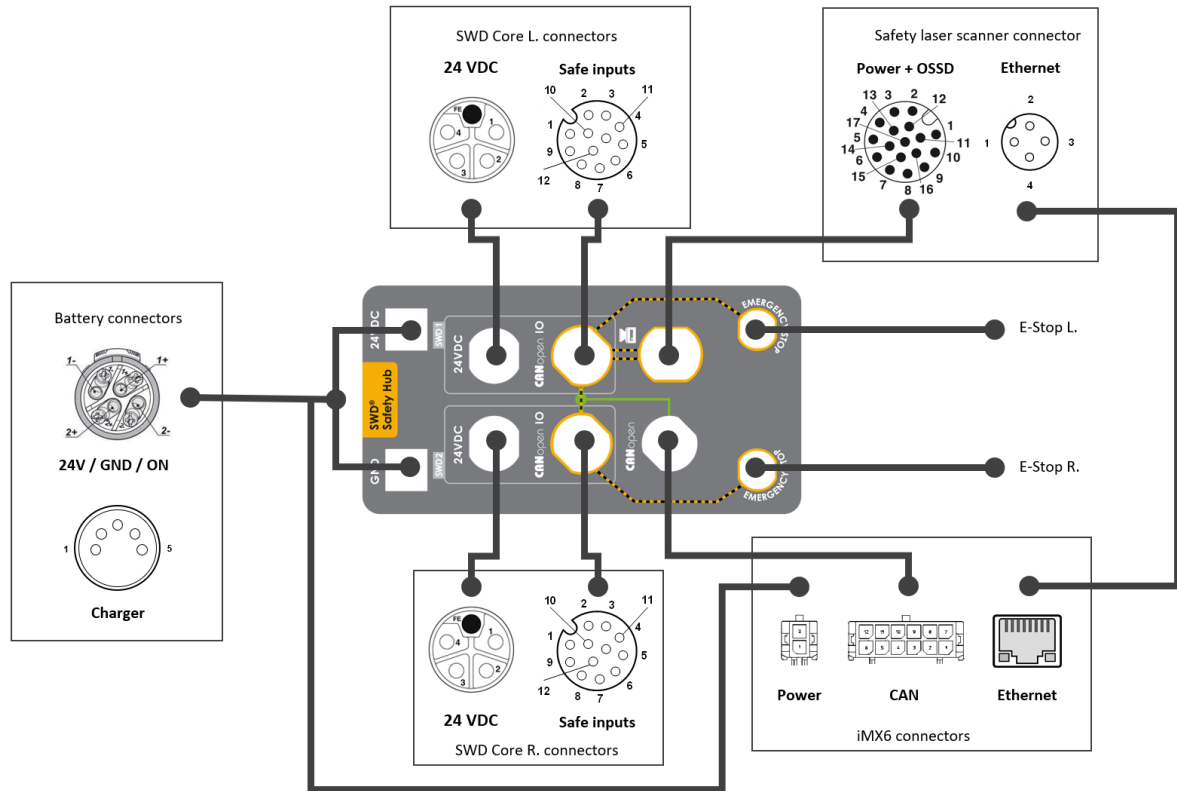


Figure 5 - Wiring synoptic, SWD® Safety Hub after July 2022

5.2. SWD® Core connectors

The I/O connector and 24 VDC connector of the **SWD® Core** are used in the **SWD® Starter Kit**.

The other connectors (CAN, USB, Ethernet, and Brake) are not used, please refer to the Instruction Manual of the **SWD® Core** for details on the complete connections of the product.

- i The same connector types and pin numbers are used in the **SWD® Core**, and the associated connection featured on the **SWD® Safety Hub**. The following pinout description is therefore valid for both.

I/O connector

The I/O connector is type M12 - 12 pin A-coded.

It is used for the CAN interface between the drives and the iMX6, and for the safety loops coming from the safety laser scanner and E-Stops.

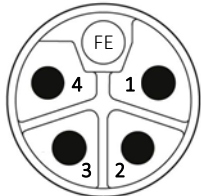
Pin #	Designation
1	CAN H - used for CANopen Safety
2	INSafe_3 - used for OSSD / SafeOUT1
3	CAN L - used for CANopen Safety
4	Power supply 24 VDC (2A) - disabled
5	STO_1 - used for E-Stop
6	GND Power Supply (2A) - unused
7	INSafe_1 - used for OSSD

8	STO_2 - used for E-Stop
9	INSafe_4 - used for OSSD / SafeOUT2
10	INSafe_2 - used for OSSD
11	GND - unused
12	ON - unused

24 VDC connector

The 24 VDC power connector is of type M12 Power - 5-pin L-coded (4 pin + FE). It is used to distribute the battery power on the drives.

Pin #	Designation
1	+ Power supply 24 VDC (16A)
2	+ Power supply 24 VDC (16A)
3	GND Power Supply (16A)
4	GND Power Supply (16A)
FE	Mechanical earth connected to the chassis



5.3. Safety laser scanner connectors

The Power+OSSD connector and Ethernet connector of the safety laser scanner are used in the **SWD® Starter Kit**.

Please refer to the safety laser scanner User Manual for details on the complete connections of the product.

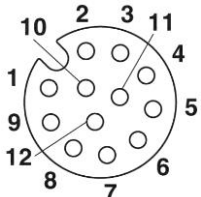
- ⚠ The original connector of the safety laser scanner has been replaced by a M12 Power+OSSD connector to get homogeneous connections with the **SWD® products**.
- i The same connector types and pin numbers are used in the safety laser scanner, and the associated connection featured on the **SWD® Safety Hub**. The following pinout description is therefore valid for both.

Power + OSSD adapter (if any)

After July 2022, an adapter might be used for Power + OSSD of the safety scanner. The connector is of type M12 - 12 pin A-coded.

It is used for the safety loops going to the **SWD® Core** safety drives.

Pin #	Designation
1	24 VDC
2	GND
3	OSSD1
4	OSSD2
5	NC
6	NC
7	NC
8	NC
9	OSSD3
10	OSSD4
11	NC
12	NC

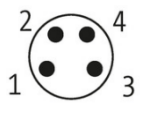


Ethernet connector

The Ethernet connector is a M8 4-pin A-coded.

It is used to exchange non-safe data between the safety laser scanner and the iMX6 PC.

Pin #	Designation
1	TD+
2	RD+
3	RD-
4	TD-



5.4. iMX6 connectors

The Power connector, CAN connector and Ethernet connector of the iMX6 embedded PC are used in the **SWD® Starter Kit**.

Please refer to the TEK3-IMX6 BOX PC Product Manual for details on the complete connections of the product.

Power connector

The Power connector is a Molex 43025-0200 (2-pin Micro-Fit 3.0)

It is used to bring the battery power on the PC.

Pin #	Designation
1	GND
2	DC Voltage input (8-36 VDC)

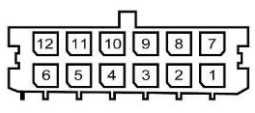


CAN connector

The CAN connector is a Molex 43025-1200 (12-pin Micro-Fit 3.0)

It is used for the CANopen interface between the drives and the iMX6.

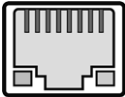
Pin #	Designation
1	Ground for CAN
2	NC
3	CAN Bus 1A high
4	CAN Bus 1A low
5	NC
6	NC
7	NC
8	NC
9	NC
10	NC
11	NC
12	NC



Ethernet connector

The Ethernet connector is a standard RJ45 for 10/100 Mbps transmission. It is used to exchange non-safe data between the safety laser scanner and the iMX6 PC.

Pin #	Designation
1	TD+
2	TD-
3	RD+
4	NC
5	NC
6	RD-
7	NC
8	NC



5.5. Battery connectors

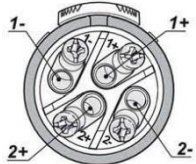
The Power connector and Charger connector of the Mobility Module battery are used in the **SWD® Starter Kit**.

⚠ Please refer to the Mobility Module User Manual for details on the complete connections of the product.

Power connector

The Power connector is a Neutrik Speakon 4-pin. It is used to power the kit and to turn ON and OFF the battery.

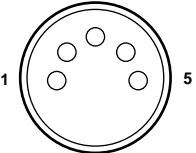
Pin #	Designation
1+	24 VDC
2+	GND
1-	RD+
2-	ON signal



Charger connector

The Charger connector is a Neutrik XLR 5-pin. It is used to connect the charger to the battery.

Pin #	Designation
1	Charger+
2	NC
3	NC
4	NC
5	GND



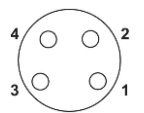
5.6. SWD® Safety Hub connectors

The SWD® and Scanner connectors of the **SWD® Safety Hub** follow the pinouts of the above-described connectors.

Emergency stop connector

The Emergency stop connectors are of type M8 4-pin A coded.
They are used to connect the two normally closed switches of an E-Stop button (2NC type).

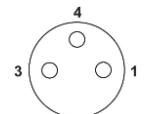
Pin #	Designation
1	SW1 NC1
2	SW1 NC2
3	SW2 NC1
4	SW2 NC2



Switch ON and Batt ON connectors (Only for SWD® Safety Hub before July 2022)

The Switch ON and Batt ON connectors are of type M8 3-pin A coded.
They are used to forward the ON button signal to the activation signal of the battery.

Pin #	Designation
1	SW
3	GND
4	NC



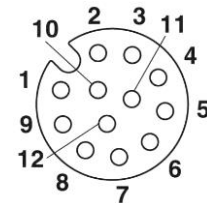
Safety Laser Scanner connector

It is used to connect the Safe Inputs/Outputs between the laser scanner and the SWD®. It is also used to supply the power for the safety laser scanner.

Version before July 2022:

The Safety Laser Scanner connector is a M12 12-pin A coded.

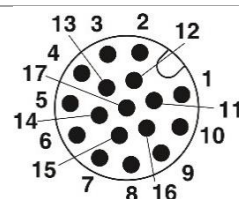
Pin #	Designation
1	24 VDC
2	GND
3	OSSD1
4	OSSD2
5	OSSD3
6	OSSD4
7	NC
8	NC
9	NC
10	NC
11	NC
12	NC



Version after July 2022:

The Safety Laser Scanner connector is a M12 17-pin A coded.


Pin #	Designation
1	24 VDC
2	GND
3	OSSD1
4	OSSD2
5	NC

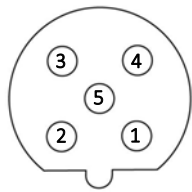


6	NC
7	NC
8	NC
9	OSSD3
10	OSSD4
11	NC
12	NC
13	NC
14	NC
15	NC
16	NC
17	NC

CANopen connector

The CANopen connector is a M12 5-pin A coded. It is used to connect CAN bus to the PC.

Pin #	Désignation
1	Masse mécanique
2	+ Alimentation 24 VDC (4A) - si activée = 
3	GND Alimentation (4A)
4	CAN H
5	CAN L

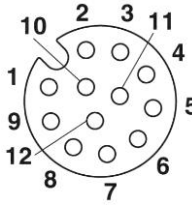


CANopen IO connector

The CANopen IO connector are of type M12 12-pin A coded.

They are used to connect the safe Inputs/Outputs of the safety devices, such as the emergency buttons, the safety laser scanner and the SWD®.

Pin #	Designation
1	CAN H - used for CANopen Safety
2	INSafe_3 - used for OSSD / SafeOUT1
3	CAN L - used for CANopen Safety
4	Power supply 24 VDC (2A) - disabled
5	STO_1 - used for E-Stop
6	GND Power Supply (2A) - unused
7	INSafe_1 - used for OSSD
8	STO_2 - used for E-Stop
9	INSafe_4 - used for OSSD / SafeOUT2
10	INSafe_2 - used for OSSD
11	GND - unused
12	ON - unused

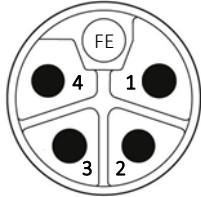


24VDC connector

The 24VDC connector are of type M12 4-pin + FE L coded.

They are used to supply power to the SWD®.

Pin #	Designation
1	+ Power supply 24 VDC (16A)
2	+ Power supply 24 VDC (16A)

3	GND Power Supply (16A)	
4	GND Power Supply (16A)	
FE	Mechanical earth connected to the chassis	

6. Mechanical assembly

6.1. Dimensions of the packaging and contents of the pack

The **SWD® Starter Kit** is packed within its original cardboard box and is protected by a half-pallet size wood box.



cardboard box dimensions	555 (l) x 545 (p) x 220 (h) mm
half-pallet size wood box dimensions	800 (l) x 600 (p) x 380 (h) mm

⚠ For all logistics operations on the gearmotor alone, preferably use the original packaging.

6.2. Overall dimensions

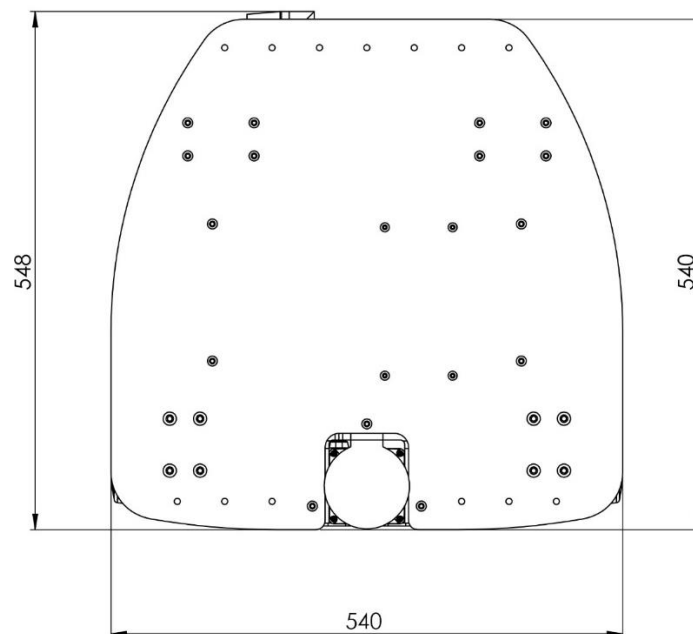


Figure 6 - Overall dimensions, top view

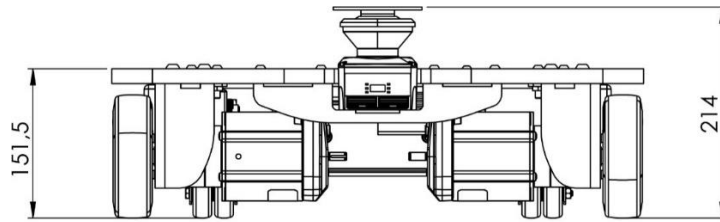
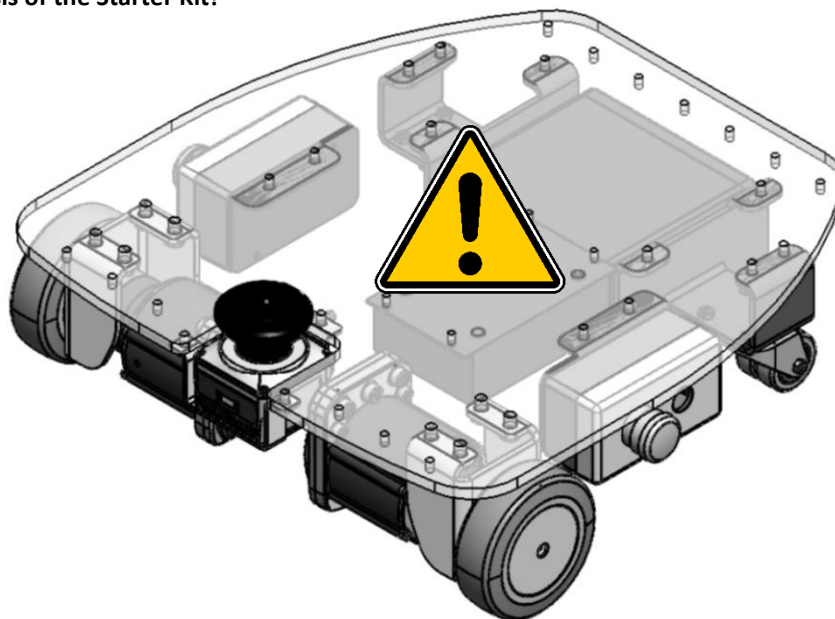


Figure 7 - Overall dimensions, front view

6.3. Mechanical specifications

The casters are designed to support a maximum load of 40 kg per caster, but the plastic chassis, for demonstration purpose only, is not designed to carry load.

 **Do not step or put loads on the chassis of the Starter Kit!**



7. Safety features

7.1. Overview of safety features

Safety features available from the SWD® Core safety drives

The **SWD® Core** includes safe engine shutdown features, as well as advanced safe speed monitoring features. This exclusive integrated solution developed by ez-Wheel simplifies the machine architecture by avoiding the need for external supervisory system and safety logics.

The engine shutdown functions include:

- STO (Safe Torque Off): safe disconnection of motor torque
- SBC (Safe Brake Control): safe braking engagement








Speed monitoring functions are based on a safety encoder integrated into the product and include:

- SDI (Safe Direction): safe control of the direction of rotation
- SLS (Safely Limited Speed): safe rotational speed limitation



These safety functions are implemented in accordance with IEC 61800-5-2 (functional safety requirements for the development of safety drives) and according to the CiA/DS 402-4 profile for the safety functions of motor controllers.

	Safety features	Possible settings
	Safe disconnection of engine torque	Rearmament: <ul style="list-style-type: none"> ▪ automatic ▪ by request for acquittal Braking configuration associated with the STO (Cf. SBC)
	Safe braking engagement	Joint activation of the STO: <ul style="list-style-type: none"> ▪ from internal braking to SWD® Core ▪ an external electromechanical brake ▪ of both brakes simultaneously
	Safe control of the direction of rotation	Prohibition of the direction of rotation: <ul style="list-style-type: none"> ▪ positive or negative ▪ with two tolerance thresholds levels
	Safe rotational speed limitation	Prohibition of speeding: <ul style="list-style-type: none"> ▪ eight switchable throttling thresholds ▪ an adjustable trigger time

-  Refer to the Instruction Manual of the **SWD® Core** to get all details on the operation and configuration of available safety features.

7.2. Use of safety features in the SWD® Starter Kit

Emergency Stops

E-Stops on each side of the kit, stopping the motors (STO safe torque off function)



When one SWD® reads the STO signal from an E-Stop button, it sends the STO message to the other drive through the CANopen Safety

Safety fields and Safe Motion

Close obstacle: when the safety laser scanner detects an obstacle in the close range (<1m forward), the speed limit (SLS safely limited speed function) is engaged on the SWD® motors, set at 0.3 m/s



Collision risk: when the safety laser scanner detects an immediate risk of collision (<50cm forward), the forward direction (SDI safe direction function) is engaged on the SWD® motors

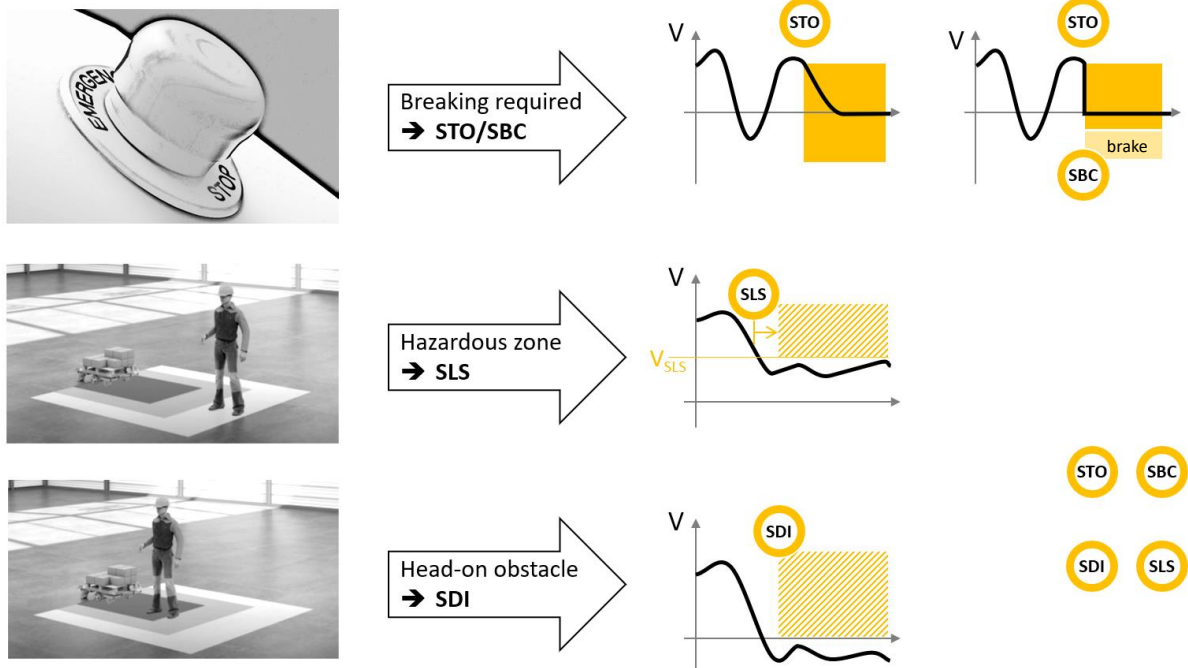


Figure 8 - Use of Safety Features

7.3. Safety fields configuration

The default configuration of safety fields in the safety laser scanner is set as follows:

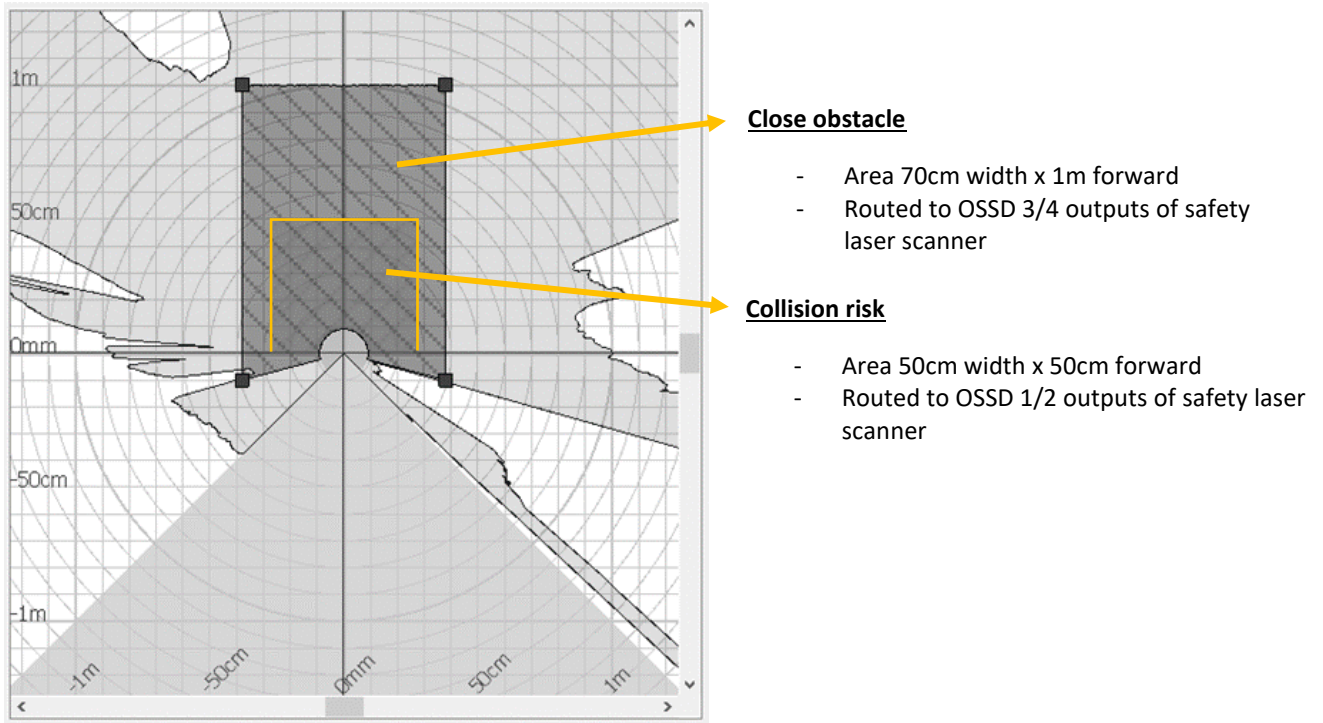


Figure 9 - Safety fields of the safety laser scanner

- i** To edit and customize the safety fields, use the software provided by the laser scanner provider

 - For IDEC SE2L:
 - [SLS Project Designer](#) software available from their [website](#) .
 - [Video tutorial available online](#)
 - For SICK NanoScan3:
 - [Safety Designer](#) available from their website
 - [Video tutorial available online](#)

- i** Any safety laser scanner is compliant with **SWD® StarterKit** if it has OSSDs outputs.

7.4. Safety loops configuration

The safety loops of the **SWD® Starter Kit** are set up as follows:

- Emergency Stop L → SWD L - STO inputs
- Emergency Stop R → SWD R - STO inputs
- Safety laser scanner OSSD outputs → SWD L - programmable inputs
- CANopen Safety between SWD L and R, to replicate the safety inputs from one drive to the other one

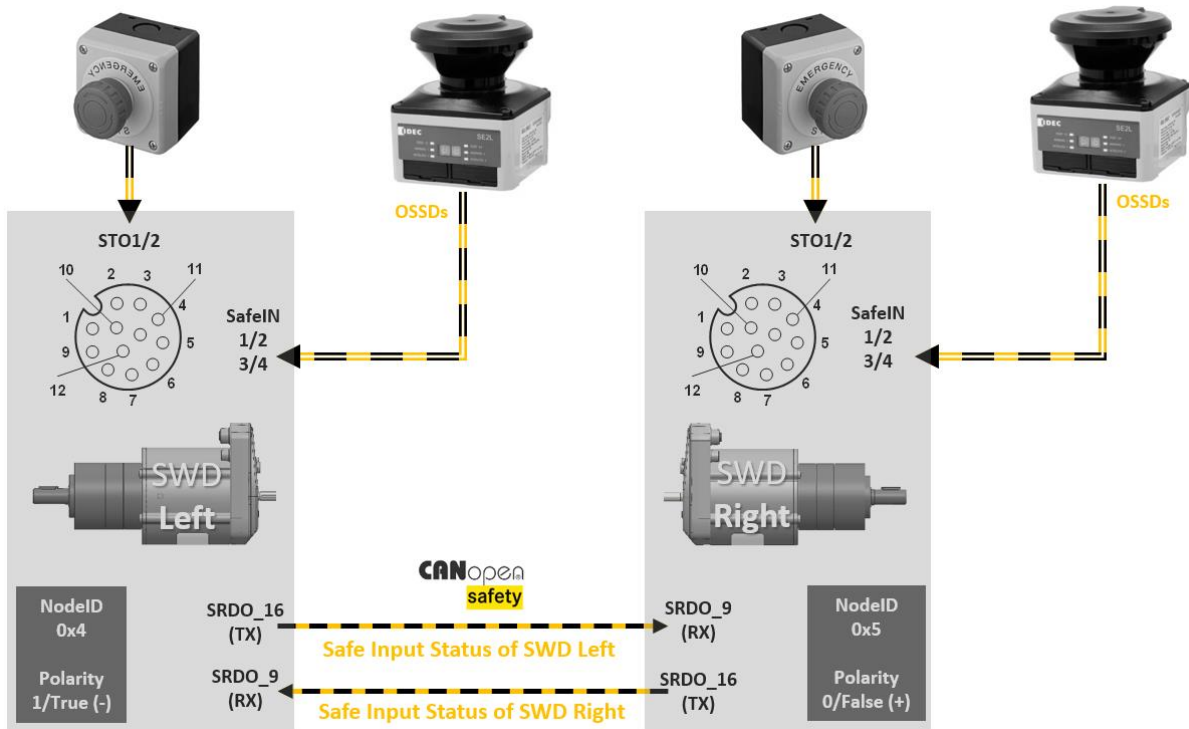


Figure 10 - Synoptic of safety with SWD® Core

- i** The drives configuration is done by CANopen messages. Scripts are available to commission the drives on ez-Wheel GitHub: <https://github.com/ezWheelSAS>.

8. Starting the SWD® Starter Kit

8.1. Power on

Setting up the kit

Put the kit on the floor on a stable and flat surface.

Battery

Install and plug the battery power connector on the rear side of the robot.

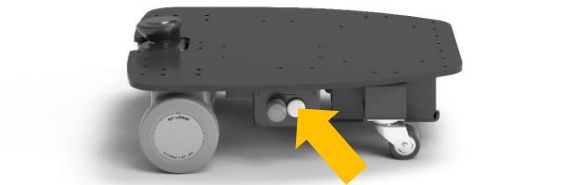
Start button

Press the white ON/OFF button on the side of the robot, nearby the Emergency Stop.

The iMX6 PC and safety laser scanner lights turn on, and the kit starts booting for a few tens of seconds.

Emergency Stops

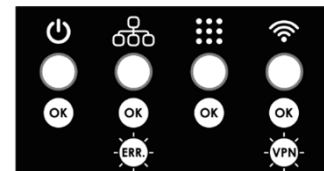
To start safely, you can engage one of the Emergency Stops while the robot is powering on.



8.2. Display and status

When powered, the embedded PC shows the status of each service started on the side 4-LED display.

- Power LED: green when the battery power is available.
- Devices LED: green when the connection to the **SWD® Core** and to the safety laser scanner is active, flashing if the connection cannot be established.
- ROS LED: green when the ROS environment is active.
- Wi-Fi LED: green when the internet connection is established, flashing when the VPN connection is activated (only for support).



8.3. Connection to Control Page

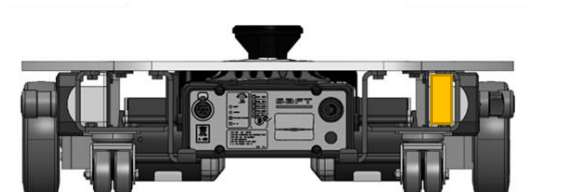
Once started, the **SWD® Starter Kit** generates its own Wi-Fi access point to connect third-party devices. Any device with a navigator can connect to the **SWD® Starter Kit**, to access the web Control Page, hosted on the embedded iMX6 PC.

To connect to the Wi-Fi hotspot, the SSID and initial password are indicated on the front plate beside the safety laser scanner.



SSID: SWD-StarterKit-880756
Password: swd_starterkit

Upon MAC address of each hardware kit



Once a PC or a tablet connects to the **SWD® Starter Kit** Wi-Fi access point, a web page is accessible with any navigator by typing the page's address.



<http://10.10.0.1>

The **SWD® Starter Kit** generates a web Control Page for the user to monitor the real time activity.

The page is used to check the status of the safety features set up with the **SWD® Core** safety drives and the safety laser scanner and shows an example of map built thanks to a ROS open-source SLAM algorithm using the data from the safety laser scanner.



- i** The SLAM algorithm used by default is Hector Slam available under ROS Noetic, but other algorithms such as LaMa or Gmapping could be used.

You can also connect through a ssh connection with the following parameters:

HostName	10.10.0.1
User	swd_sk
Password	swd_sk

8.4. Safety features monitoring



Once the control page of the connected Starter Kit is active and displayed, the status of the safety features can be monitored:

- **STO** status is RED when one of the two Emergency Stops is engaged, the motors are stopped (Safe Torque Off).
- **SDI** status is RED when the safety laser scanner detects an obstacle in the short perimeter (<50cm), the motors cannot go forward (Safe Direction).
- **SLS** status is RED when the safety laser scanner detects an obstacle in the nearby perimeter (<1m), the robot cannot exceed 0,3 m/s (Safely Limited Speed).

8.5. Hand control for teleoperation

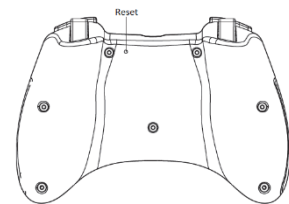
The **SWD® Starter Kit** is delivered with a consumer type console joystick, for demonstration purpose only. The wireless joystick is directly connected to the embedded iMX6 PC and allows a manual teleoperation of the machine.

- i** The **SWD® Starter Kit** uses standard ROS Noetic packages (using *joy* and *teleop_twist_joy*) providing interfaces with a standard console joystick.



- i** To activate the hand controller, ROS packages must be started.
- i** The status of the ROS LED can be checked to confirm that ROS is active.
- ⚠** If the motion control becomes jerky, then the joystick might be discharged. You should see joy's LEDs blinking.

If you unconfigured the original controller settings, you can press the 'Reset' button, on its rear.



Appendices

1. Quick start

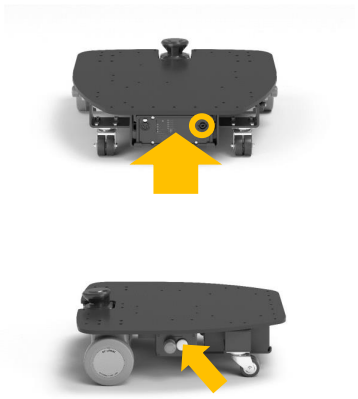


QUICK START

1 Power on

Put the kit on the floor on a stable and flat surface.
Install and plug the battery power connector on the rear side of the robot.
Press the white ON/OFF button on the side of the robot, nearby the Emergency Stop.

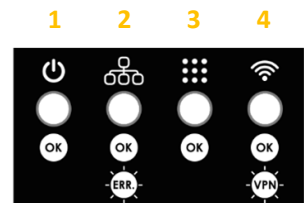
- i** The iMX6 PC and safety laser scanner lights turn on, and the kit starts booting for a few tens of seconds.
- i** To start safely, you can engage one of the Emergency Stops while the robot is powering on



2 Display and status

Display of the 4 LEDs - when the embedded PC is powered:

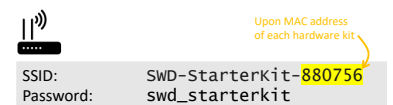
1	Power	●	The battery power is available
2	Devices	●	The connection to the SWD® Core and to the safety laser scanner is active
		✱	The connection cannot be established
3	ROS	●	The ROS environment is active
4	Wi-Fi	●	The Internet connection is established
		✱	The VPN connection is activated (only for support)



3 Connection to the web Control Page hosted on the embedded PC

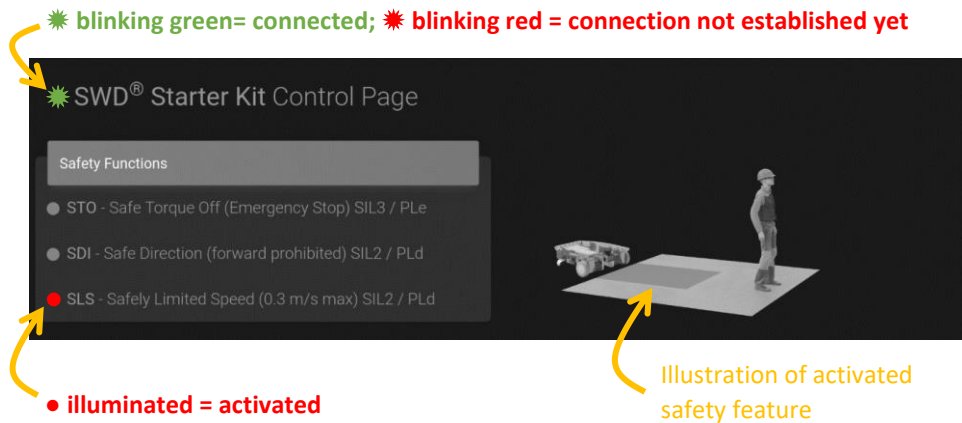
Connect a third-party device to the Starter Kit thanks to its own Wi-Fi access point

- i** SSID and initial password are indicated on the front plate beside the safety laser scanner or on the leaflet.
- i** Once a PC or tablet connected to the **SWD® Starter Kit** Wi-Fi access point, a web page is accessible with any navigator by typing the page's address: **http://10.10.0.1**.
- i** The **SLAM** algorithm used by default is **Hector Slam** available under **ROS Noetic**, but other algorithms such as **LaMa** or **Gmapping** could be used.



4 Safety features monitoring

- The page is used to check the status of the safety features set up with the **SWD® Core** safety drives and the safety laser scanner and shows an example of map built thanks to a ROS open-source SLAM algorithm using the data from the safety laser scanner.



STO	●	when one of the two Emergency Stops is engaged, the motors are stopped (Safe Torque Off)
SDI	●	when the safety laser scanner detects an obstacle in the short perimeter (<50cm), the motors cannot go forward (Safe Direction)
SLS	●	when the safety laser scanner detects an obstacle in the nearby perimeter (<1m), the robot cannot exceed 0,3 m/s (Safely Limited Speed)

5 Hand control for teleoperation (for demonstration)

- The wireless joystick is directly connected to the embedded iMX6 PC and allows a manual teleoperation of the machine.
- The **SWD® Starter Kit** uses standard ROS Noetic packages (using *joy* and *teleop_twist_joy*) providing interfaces with a standard console joystick.

To activate the hand controller, ROS packages must be started.

- The status of the ROS LED can be checked to confirm that ROS is active.
- Make sure you released the emergency buttons.
- If the motion control becomes jerky, then the joystick might be discharged. You should see joy's LEDs blinking.



2. Adapter pinout of the connector between the safety laser scanner and the **Safety Hub**

M_203142 M12A-17BMMM-SL8B01		
1	+24V	Brown
2	GND	Blue
3	SWD1_SAFE_IN_1	White
4	SWD1_SAFE_IN_2	Green
5	X	
6	SWD2_SAFE_IN_1	Yellow
7	SWD2_SAFE_IN_2	Black
8	X	
9	SWD1_SAFE_OUT_1	Red
10	SWD1_SAFE_OUT_2	Violet
11	SWD2_SAFE_OUT_1	Grey_Pink
12	SWD2_SAFE_OUT_2	Red_Blue
13	X	
14	X	
15	X	
16	X	
17	X	

M_203141 M12A-12BFFA-SL7001		
Brown	+24V	1
Blue	GND	2
White	SWD1_SAFE_IN_1	3
Green	SWD1_SAFE_IN_2	4
		5
Yellow	SWD2_SAFE_IN_1	6
Black	SWD2_SAFE_IN_2	7
		8
Red	SWD1_SAFE_OUT_1	9
Violet	SWD1_SAFE_OUT_2	10
Grey_Pink	SWD2_SAFE_OUT_1	11
Red_Blue	SWD2_SAFE_OUT_2	12