Omni Drive Module

Neobotix GmbH

Nov 21, 2023

Assembly Instructions

OmniDriveModule

↓ Download as PDF[1]

The Neobotix OmniDriveModules have been designed to allow engineers and designers to easily create their own, customised mobile robot platform. Different from other solutions, the kinematics of the ODM enables the mobile robot to move omnidirectionally even on a floor that is not perfectly flat.

These modules are intended for research and experiments and need to be modified and completed by the customer. Several important issues must be considered when working with them:

- The OmniDriveModule is a partly completed machine and not ready for immediate operation.

- The drive amplifiers have been configured with general purpose settings. Some of these settings might need to be adjusted according to the individual application in order to achieve the best performance.

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[1] https://neobotix-docs.de/hardware/en/OmniDriveModule.pdf

- Being only partly completed machines, the OmniDriveModules are not conform with all EC Directives applicable for turnkey machinery.

- To achieve the level of safety required by the applicable directives the customer must integrate the ODM into another machine. Additional measures might be necessary to ensure the safe operation of the completed machine.

- An independent assessment of risks has to be performed by the customer to verify conformity with all applicable directives.

- Only the customer can be held responsible for the safe operation of the OmniDriveModule.

1.1 Product Description

The Neobotix OmniDriveModule is a two-axes drive unit for use in a mobile robot or a similar application.

The module contains two high-performance servomotors with an industrial grade servo amplifier each ("Whistle 10/60" from Elmo Motion Control), mounted to a common printed circuit board. One of the motors drives the module's driving wheel while the other motor rotates the wheel around its vertical axis. Both motors can rotate infinitely without mechanical boundaries, thus allowing an omnidirectional robot to move continuously and without the need to re-align the wheels due to any limits. The orientation drive features an inductive position switch which can be used for homing.

Due to the high transmission ratio of both worm gearings, no brake is required. This significantly reduces the module's power consumption and heating. Fail-safe brakes can be integrated for additional safety.

1.1.1 Components

The OmniDriveModule is made up from the following components:
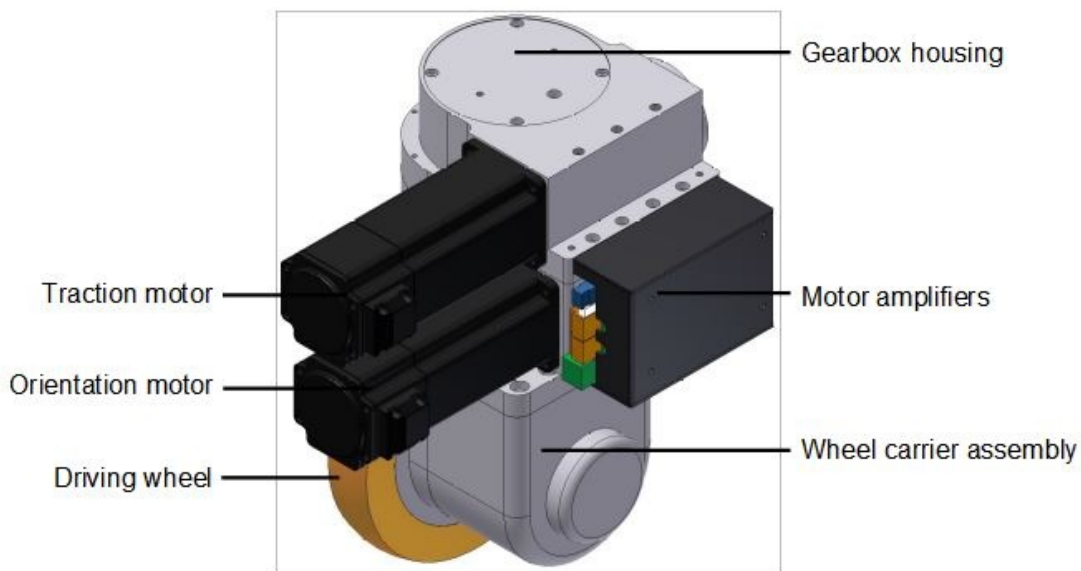
1.1.2 Possible Drive Kinematics

The OmniDriveModules can be used to build several different drive kinematics according to the application's requirements. Each configuration has its own advantages and disadvantages. The most commonly used configurations are the

following:

1.1.2.1 1 OmniDriveModule with 2 fixed rollers
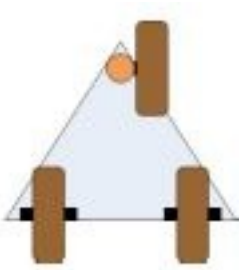
This configuration is the cheapest and easiest to control. Although possible, it is very rare that the OmniDriveModule is moved in a way that will make the fixed wheels jam.

In this configuration, true omnidirectional motion is not possible since the vehicle will always follow the drive unit.

1.1.2.2 3 OmniDriveModules
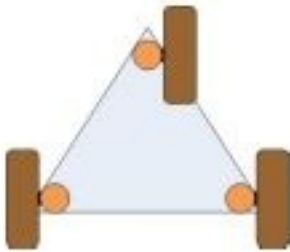
This configuration ensures high stability for smaller robots, avoids static indeterminacy and allows fully omnidirectional movement.

All three wheels must be aligned correctly at all times to avoid jamming or slippage. Please mind that the angle between the wheels must change according to the movement's centre of rotation.

1.1.2.3 4 OmniDriveModules
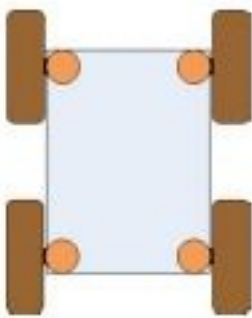
This configuration is most commonly used for service robots. It guarantees highest stability even for big and heavy robots. Although it is statically indeterminate this will not cause problems in most applications because all wheels are aligned actively.

All four wheels must be aligned correctly at all times to avoid jamming or slippage. Please mind that the angle between the wheels must change according to the movement's centre of rotation.

1.1.3 Special Features

1.1.3.1 Logic Power Supply

The drive amplifiers of the OmniDriveModule feature a separate power supply pin for the internal logic unit. In case of an emergency stop the main power line can be cut without affecting the internal microcontroller or the motors' feedback devices.

This means that during emergency stop all important functions of the drives (CAN-communication, position detection, etc.) are maintained even if the possibly dangerous power is switched off and motions are stopped.

1.1.3.2 Position Switch

An internal inductive position sensor is connected to the amplifier of the orientation drive and can be used for homing.

Due to variances in the assembly process the homing position may slightly differ from module to module. Therefore the control software must implement an adjustable offset for each orientation drive.

Tip: Proper functioning of the overall drive system can only be achieved by aligning all wheels correctly at all times.

1.1.3.3 Digital and Analogue I/Os

Each drive amplifier provides six digital inputs, two digital outputs and one analogue input. Three digital inputs and one digital output can be accessed via the PCB's connectors. Please refer to *Digital-I/Os* (page 12) for details. One of the inputs is used for the position switch of the orientation drive. Further information about the I/Os can be found on the Elmo Motion Control homepage[2].

1.1.3.4 Programming

Each drive amplifier contains an integrated logic capable of running simple user programs. This feature can be used to shift some basic functions from the main control software to the drive amplifiers. Possible functions are:

- Automatic homing after power on
- Automatic realignment of the drives after emergency stop
- Automatic motor off after a predefined time of inactivity

Details on the programming feature can be found on the Elmo Motion Control homepage[3].

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[2] https://www.elmomc.com/
[3] https://www.elmomc.com/

1.2 Safety

1.2.1 Intended Usage

1.2.1.1 Fields of Application

The OmniDriveModule is intended to be used as part of the drive system of a mobile robot. It has been designed for use in fields like robotics, autonomous vehicles and intralogistics. Vehicles based on the Neobotix OmniDriveModule may be used in laboratories and similar controlled indoor environments without public access.

1.2.1.2 Environmental Conditions

The OmniDriveModule must only be used indoors. Outdoor use may significantly reduce the system's life expectancy and may result in damages to the module.

Due to the unsealed drive amplifiers at the side of the OmniDriveModule it has to be protected against collisions, dirt, metal objects (e.g. screws or washers) and moisture.

Under normal operating conditions the massive aluminium body of the drive module serves as a sufficient heat sink for the amplifiers, the motors and the gears. In case the module is to be covered completely, appropriate ventilation or other means of cooling might become necessary.

The drive module must be kept clean at all times. Exposure to excessive dirt or moisture may lead to damage of the ball bearings or other moving parts. Neobotix cannot be held responsible for damages caused by dirt or moisture.

1.2.2 Improper Usage

Warning:

- Using a vehicle based on the OmniDriveModules for any kind of passenger transportation is strictly prohibited. Climbing onto any vehicle that is based on the Neobotix OmniDriveModules is also prohibited.

- It is prohibited to operate a vehicle based on the OmniDriveModule in public areas without supervision by a qualified trained person.

- The Neobotix OmniDriveModules must be kept dry at all times. Exposing the modules to rain, mist or splash-water may cause severe damage to the electronic components.

Tip: The control software for aligning and moving two or more ODMs must be tested with special care. Using an untested or faulty control software may damage the modules or even the complete vehicle.

1.2.3 Qualified Personnel

This product must only be modified, commissioned, operated and serviced by qualified personnel. More information can be found at *Qualified Personnel* (page 22).

1.2.4 Safety Measures and Precautions

In order to ensure a safe and successful operation of the OmniDriveModule, please mind the following:

- Always take care to protect the drive amplifiers at the side of the module against collisions and moisture.

- Always lift the wheels off the ground while working on the control software.

- Always test any new or changed control software thoroughly with the wheels lifted off the ground. Make sure that the alignment of all wheels is correct at all times and under all conditions.

- The wire diameter of the power supply to the OmniDriveModules as well as any relays must be chosen according to the maximum expected current.

Warning: If three or more modules are used, very high sum currents might occur.

1.3 Mounting

1.3.1 Integrating the Module into a Platform

Six threaded holes in the bottom side of the OmniDriveModule can be used to mount the module onto a carrier plate.

The OmniDriveModule is not designed to be mounted under a vehicle but into it. The base plate of your vehicle must be in between the wheel carrier assembly and the gearbox housing.

A U-shaped cut-out of 60 mm to 70 mm width is recommended for the vertical axle of the wheel carrier assembly.

1.3.2 Mounting Components onto the Module

If all OmniDriveModules are mounted to a common base plate, additional components may be placed on top of the modules. The step above the drive amplifiers can be used for mounting an auxiliary plate. This might be used to carry smaller components, for example electronic devices.

Using a single plate on top of and screwed to all modules will significantly improve the structure of the overall drive system. It will also optimise the distribution of forces thus allowing a high payload.

1.4 Electrical Installation

1.4.1 Power Supply

1.4.1.1 Main Power

Both drive amplifiers are connected to common supply lines. Use the following components for the power supply:

- Plug: Würth Elektronik, Series 351 WR-TBL, 691 351 500 003

- Plug (alternative): Phoenix Contact, MSTB 2,5 HC/ 3-ST, 1911868

- Power cable: H07V-K or better, 2,5 mm^2 or bigger

- Logic supply cable: H05V-K or better, 0,5 mm^2 or bigger
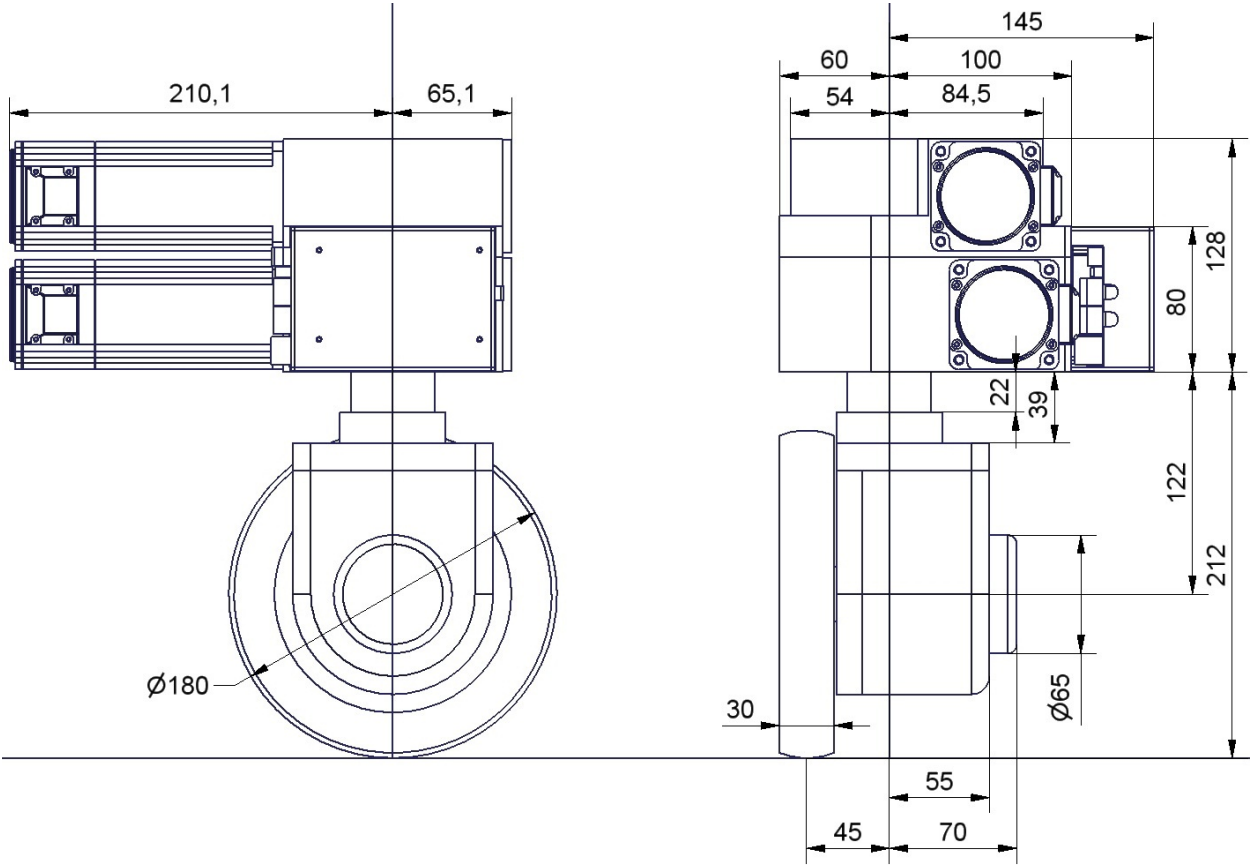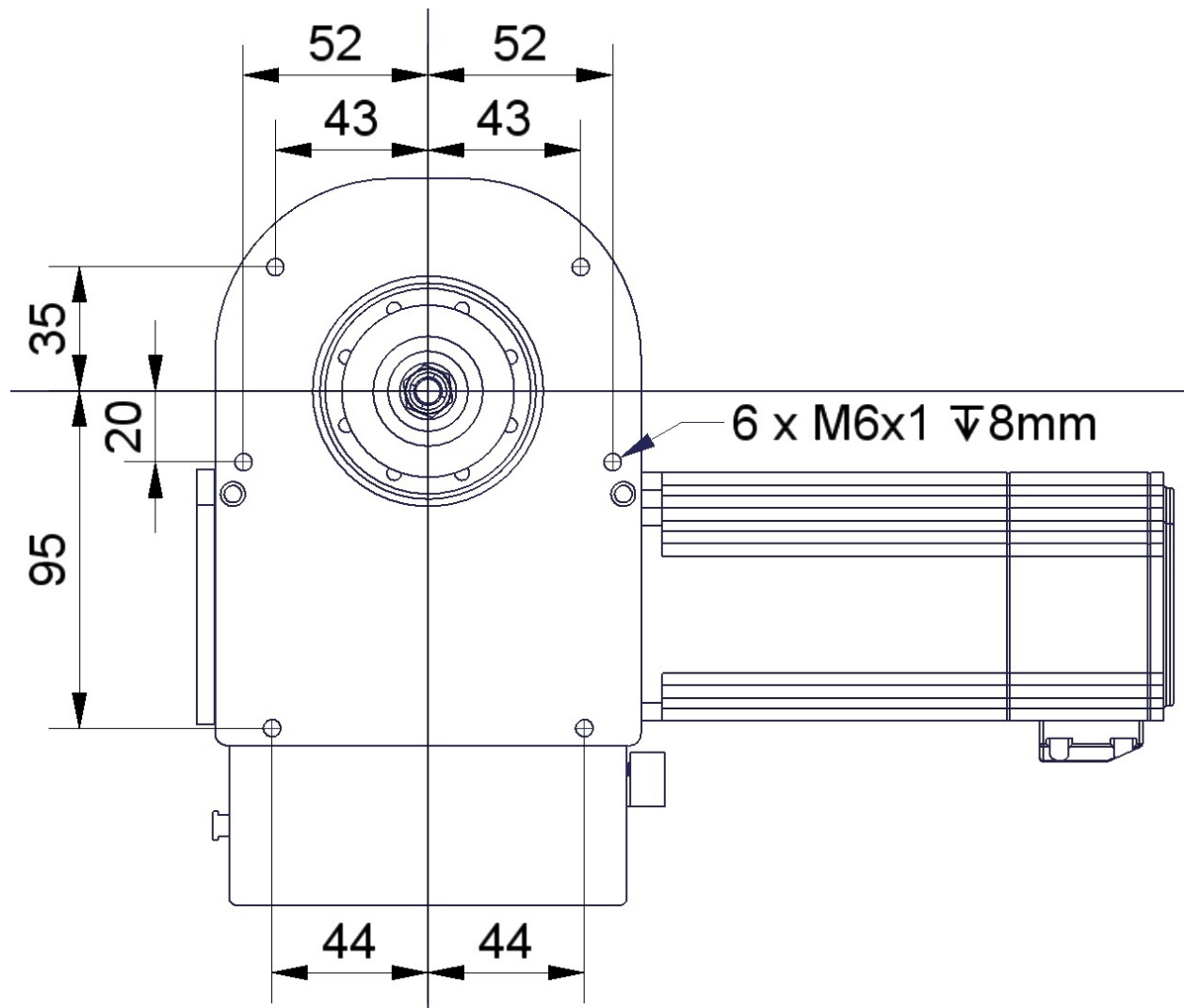
Fig. 1: Dimensions of the OmniDriveModule
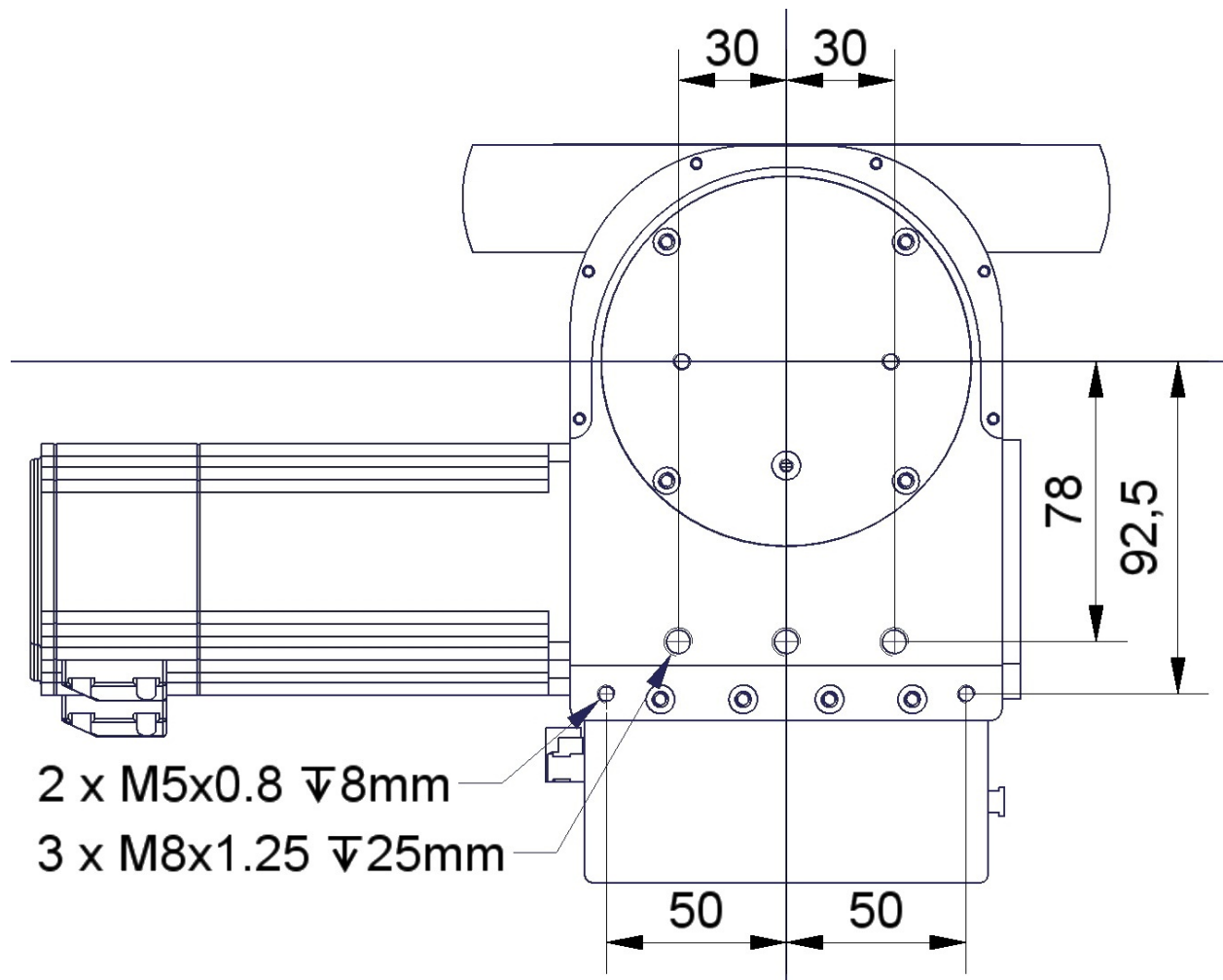
Fig. 2: Bottom view of the OmniDriveModule

Fig. 3: Top view of the OmniDriveModule

The internal logic unit of the drive amplifiers can be powered independently from the main power supply. In case of an emergency stop the amplifiers will still be running, keeping track of the motor position and communicating on the CAN-bus.

Tip: By default the OmniDriveModule is configured for 24 V logic supply voltage. Please contact Neobotix if you want to use other supply voltages.

The pin assignment is as follows:

Pin	Function	Voltage / VDC	Description
1	Common ground	0	Common return line
2	Motor power supply	20 – 59	Main power supply, may be switched off
3	24V logic supply	11 – 30	Auxiliary supply, not to be switched at stop

1.4.1.2 Position Switch

If 24 V are used as logic supply voltage, the inductive position switch of the orientation drive is powered directly from the amplifiers' PCB. If different voltages are used, they must be connected to a common ground.

Attention: The ground line of the digital input is by default connected to the common ground of the amplifier power supply. In case independent supply voltages are required, please contact Neobotix.

Use the following components for the power supply of the switch in case you are not supplying 24 V for the amplifiers' logic:

- Housing: Würth Elektronik, MPC4, receptacle, dual row, 2 circuits, 649002113322

- Contacts: Würth Elektronik, MPC4, crimp terminal female, 18-24 AWG, 64900613722DEC

The pin assignment is as follows:

Pin	Function	Voltage / VDC	Description
1	Supply	24	Position switch power supply
2	Ground	0	Return line

1.4.1.3 Brakes

The servomotors can optionally be equipped with fail-safe brakes that need to be released while the motor rotates. A 24 V supply capable of providing 0.75 A is required for the brake.

Use the following components for the power supply of the brakes:

- Housing: Molex, series KK receptacle 2 circuits, 22-01-2021

- Contacts: Molex, series KK crimp terminal 22-30 AWG, 08-50-0032

The pin assignment is as follows:

Pin	Function	Voltage / VDC	Description
•	Ground	0	Return line
•	Supply	24	Brake power supply

1.4.2 Communication Interfaces

1.4.2.1 CAN

Both drive amplifiers are connected to the PCB's CAN-bus connector. Please use the following components for the CAN-bus connection:

- Housing: TE Connectivity, HE14 receptacle double row 8 circuits, 281839-4

- Contacts: TE Connectivity, HE14 crimp terminal female 28-24 AWG, 182734-2

The pin assignment is as follows:
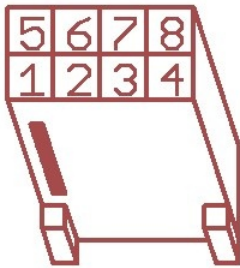
Pin	Function
1,5	GND
2,6	CANL
3,7	CANH
4,8	Shield

If the CAN bus ends at one of the OmniDriveModules a terminating resistor of 120 Ω has to be activated. Please move switch S1 beside the LEDs to position ON.

1.4.2.2 RS-232

Each drive amplifier has a separate RS-232-interface which can be used for configuration and for communication with the control software.

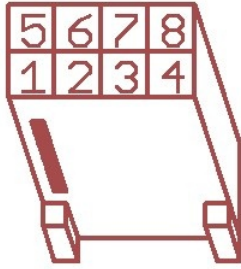| Pin	Function	Description
1	GND (Orientation)	Reference ground line (orientation drive)
2	TxD (Orientation)	Transmit line (orientation drive)
3	RxD (Orientation)	Receive line (orientation drive)
4	GND (Traction)	Reference ground line (traction drive)
5	TxD (Traction)	Transmit line (traction drive)
6	RxD (Traction)	Receive line (traction drive)

1.4.3 Digital-I/Os

The drive amplifiers each feature 6 digital inputs, 2 digital outputs and 1 analogue input which may be used for special functions if required. They can be assigned to predefined functions (torque off, hard stop, etc.) or be accessed by the user program running on the amplifier. Their current state can also be read by the control software via the CAN-bus or the serial interface.

The connectors X2 and X5 of the PCB provide easy access to three of the digital inputs and one digital output. These inputs can be equipped with a limiting resistor if the signal voltage is higher than 5 V. The positions for these are marked "Rin1", "Rin2" and "Rin3" and are located right beside the connectors.

Please keep in mind that the limiting resistor has to be bridged if the default signal level of 5 V is used.

The digital input 1 of the orientation drive amplifier is connected to the output of the position switch and cannot be used for customised functions.

Tip: The ground line of the digital inputs of the orientation drive amplifier is by default tied to the common ground of the amplifier power supply. In case independent voltage levels are required, please contact Neobotix.

The return line of the digital inputs of the traction drive amplifier can also be tied to the common ground by bridging the solder jumper marked "G←I-".

The motors' encoder signals are also available at the IO connectors. They can for example be used for motion monitoring by an external safety device.

Furthermore the IO connectors provide power supply for additional low power sensors. The module's logic supply voltage is available at pins "VL" (supply) and "G" (ground).

Further information can be found in the documentation of the drive amplifier "Whistle" on the homepage of Elmo Motion Control[4].

Use the following components for the I/O connection:

- Housing: TE Connectivity, HE14 receptacle double row 12 circuits, 281839-6

- Contacts: TE Connectivity, HE14 crimp terminal female 28-24 AWG, 182734-2

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[4] https://www.elmomc.com/
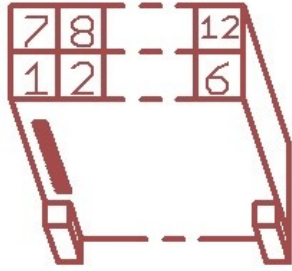
Pin	Function	Description
1	A+	Channel A of the TTL motor encoder, for motion monitoring
2	B+	Channel A of the TTL motor encoder, for motion monitoring
3	O-	Emitter contact of the optocoupler of digital output 1
4	G	Main ground
5	I-	Common ground of the digital inputs
6	I2	Digital input 2 (mind the limiting resistor)
7	A-	Channel A (inverted) of the TTL motor encoder, for motion monitoring
8	B-	Channel B (inverted) of the TTL motor encoder, for motion monitoring
9	O1	Collector contact of the optocoupler of digital output 1
10	VL	Logic supply (output)
11	I1	Digital input 1 (mind the limiting resistor)
12	I3	Digital input 3 (mind the limiting resistor)

1.4.3.1 Motion Monitoring

On request the connectors can be prepared to provide direct access to the encoder signals of the traction and / or orientation motor from outside.

This option will change the pin assignment as follows.

Pin	Function	Description
1	O-	Emitter contact of the optocoupler of digital output 1
2	B+	Channel A of the TTL motor encoder, for motion monitoring
3	A+	Channel A of the TTL motor encoder, for motion monitoring
4	O1	Collector contact of the optocoupler of digital output 1
5	B-	Channel B (inverted) of the TTL motor encoder, for motion monitoring
6	A-	Channel A (inverted) of the TTL motor encoder, for motion monitoring

This option requires different connector housings:

TE Connectivity, HE14 receptacle double row 6 circuits, 281839-3

1.4.3.2 Enable Lines

On request the drive amplifiers can be configured to have two 24 V enable lines. The signals can be integrated into the CAN bus cable and then be conveniently patched through to all OmniDriveModules.

This option uses digital inputs 2 and 3 which then are no longer available for other functions.

Attention: Please note that this feature is not safety approved.

The pin assignment of the CAN bus connector changes as follows:
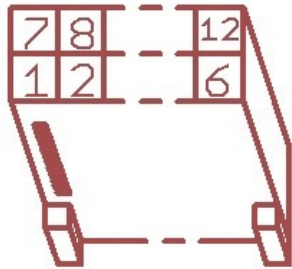
Pin	Function
1,7	GND
2,8	CANL
3,9	CANH
4,10	Shield
5,11	Enable1
6,12	Enable 2

This option requires the same connector housings as the digital I/Os.

1.5 Configuration

The best way to configure and optimise the drive amplifiers is by using the interface software Composer which is provided for free download from the homepage of the manufacturer Elmo Motion Control. The latest version can be found at:

https://www.elmomc.com/product/composer/

It is recommended to connect the computer that runs the Composer to the amplifier by a standard RS-232 serial connection (COM port). The appropriate configuration cable can be supplied on request.

The drive amplifiers are configured with general purpose settings and ready for operation. Before the OmniDriveModule can be used in a mobile robot, the communication parameters have to be adjusted according to the features of the control system.

If extraordinary kinematics are to be realised or if the modules are to be used under extreme conditions (very heavy vehicle or payload, uneven or soft floor, asymmetric centre of gravity, . . .) it might be necessary to adjust the control loop parameters of some or all amplifiers. Please contact Neobotix in such cases.

1.5.1 Connecting to the Amplifiers

After installing and starting the Composer the start dialogue will appear. Connect the computer to the amplifier by using the configuration cable and turn on the power supply of the amplifier.

Note: Please be careful to actually connect to the amplifier which you currently want to access.

Choose *Open Communication Directly* to open the communication settings dialogue. After selecting RS 232 as interface and clicking Properties you can select the COM port that you are using. Please select a baud rate of 57600 Bit Per Second and click Connect. The dialogue should close and the configuration toolbox, called Smart Terminal, should appear.
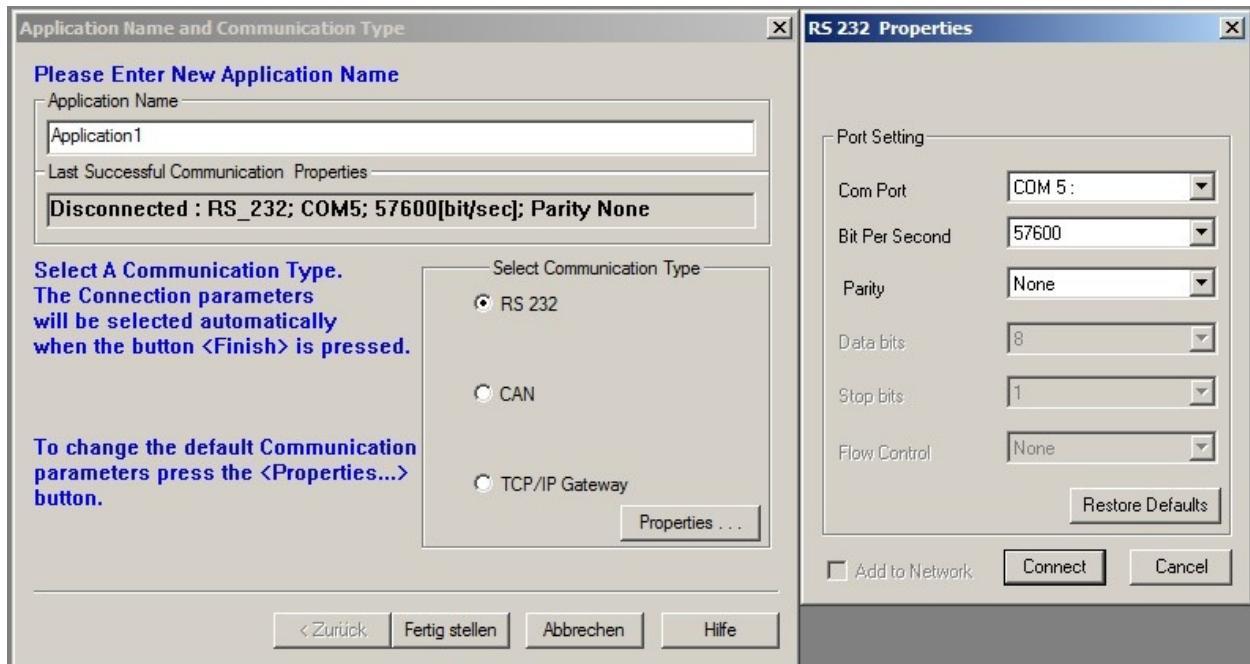
In case you cannot connect to the amplifier, please check the following:

- Amplifier power: Is the amplifier connected to a sufficient power supply and is the power supply turned on? In case the module is connected to a laboratory power supply: Is the current limit high enough to provide the inrush current and a sufficiently fast rise of the logic supply voltage?

- Cable: Is the computer actually connected to the correct amplifier? When handling several drives in a row it sometimes happens that only the power supply is connected to the next module while the configuration cable is still plugged to the previous module.

- Baud rate: The baud rate of the serial connections has been changed to 57.6 kBaud to make working with the modules more convenient. The default baud rate of the *Composer* is only 19.2 kBaud.

- COM port: Try other COM port numbers. If a USB-to-serial converter or a similar device is used, please check which number has currently been assigned to the interface. Close the *Composer*, re-connect the converter and restart the *Composer*.
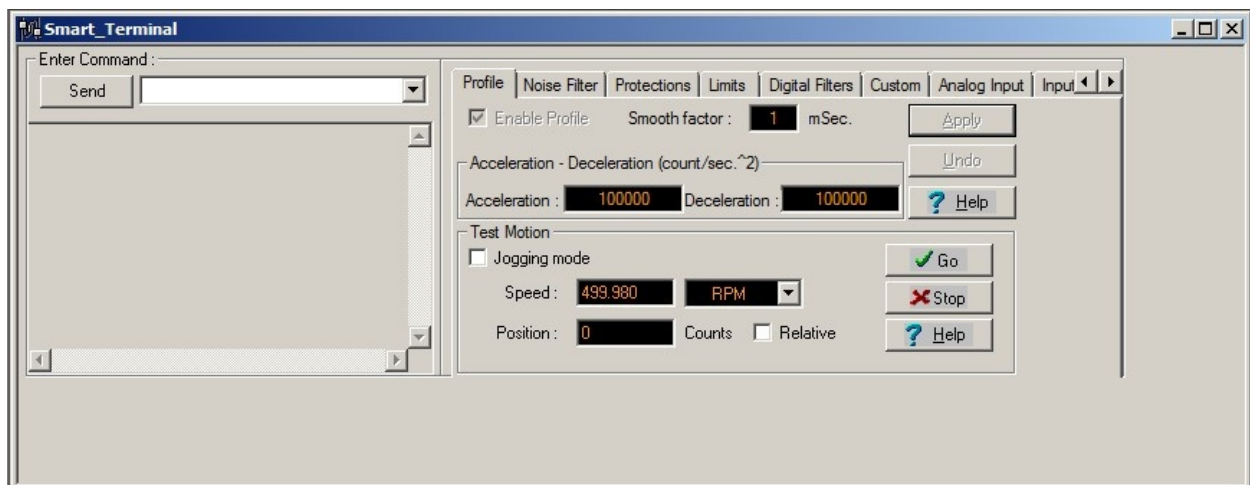
Use the button *Disconnect* on the right end of the main toolbar to close the connection to the amplifier. Disconnect button is shown below:

1.5.2 Handling Different Configurations

There are basically three ways of handling different configurations.

Main buttons: Create New Application, Open Existing Application, Save Application (f.l.t.r.)

1.5.2.1 Saving the Current Configuration

After connecting to an amplifier the current configuration is automatically uploaded to the *Composer* and can be saved in a file by clicking the button *Save Application* in the top left corner of the main window. The *Composer* will always ask whether the current configuration should also be written to the amplifier's non-volatile memory or if it should only be written to a file on the computer.

A Save-As-dialogue will always appear. If the configuration has been saved before (in the current session), the last used file name will be selected automatically but will also automatically have an extension indicating the currently used interface. To avoid having duplicate files please select the appropriate file manually before clicking Save.

Any changes to the configuration on the amplifier can also be written to the non-volatile memory without creating a file on the computer. Simply type "sv" into the command line of the Smart Terminal and hit Enter or click on Send.

1.5.2.2 Using an Existing File

To use a backup file simply click the button Open Existing Application, select the file and click Download in the open dialogue. In case the current interface differs from the settings stored in the file, you will need to open the properties dialogue by clicking Change in the Communication Info area of the file open dialogue.

After the connection has been established successfully, the configuration is downloaded to the volatile memory of the amplifier. To save the configuration permanently, please refer to the previous section.

The motor specific commutation parameters are also stored in the configuration file. This means that any known motor can be run by any amplifier after downloading the correct file to the amplifier. It also means that after connecting a new motor to any amplifier, the unique commutation parameters of the new motor have to be determined even if all other settings that are already saved in the amplifier may remain unchanged. Please contact Neobotix if you intend to replace the motor.

1.5.2.3 Creating a New Configuration

All motor parameters can be defined anew by using an integrated wizard. Since the OmniDriveModules are not meant to be run with different motors, it is not recommended to modify any settings with this feature.

In case you intend to modify the drives or need any further assistance please contact Neobotix.

1.5.2.4 Basic Settings

The Smart Terminal of the Composer shows all the basic settings that can easily be changed. In case you need to modify any other settings or need in-depths information, please refer to the documentation on the Elmo MC homepage or contact Elmo MC or Neobotix directly.
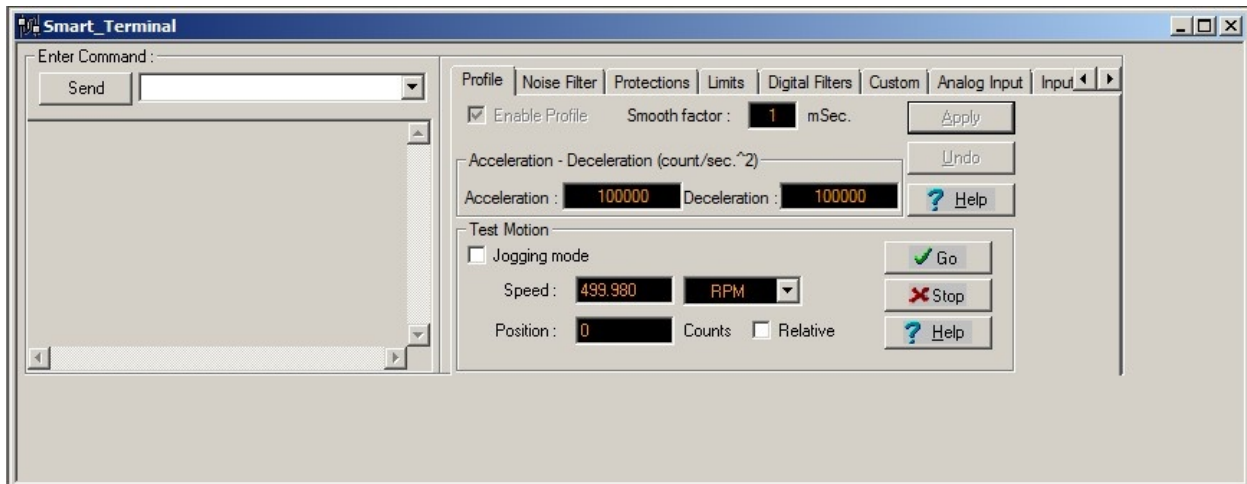
The communication settings can be changed by entering the command "PP" plus an index number in square brackets in the command line at the top left of the *Smart Terminal*. Enter the command and either hit enter or click the *Send* button to read the current value. Add the equals sign and the new value right after the command to change a setting.

The following commands may be necessary:

Command	Description	Common values
PP[2]	RS-232 baud rate	4: 57600 Baud (Default)
		3: 38400 Baud
		2: 19000 Baud
PP[13]	CAN ID	1-8
PP[14]	CAN baud rate	0: 1000 kBaud (Default)
		1: 500 kBaud
		2: 250 kBaud
PP[15]	CAN group ID	1 – 128 (Default: 30)

1.5.3 Advanced Settings

The motor must be deactivated for some settings to be applied. Use the button Stop & Motor Off to deactivate the motor.

1.5.3.1 Acceleration and Deceleration

The maximum permitted acceleration and deceleration can be set by editing the two according fields in the tab *Profile* of the Smart Terminal and clicking *Apply*. These values are the limiting values and will be used by the internal control loop of the amplifier. The actual acceleration and deceleration in normal operation is mainly determined by your motion control software and will be (and should be) significantly lower.

1.5.3.2 Speed Limits and Stop Deceleration

Several speed limits can be set on the tab *Limits*, sub tab *Velocity*. The Command limits define the velocity range that will be accepted by the amplifier. Motion commands with velocities exceeding this range will be rejected.

The *Feedback* velocities define the range in which the motor is allowed to operate without raising an error. Therefore the Feedback limits should be set wider than the command limits.

The *Stop* deceleration is the deceleration that is used when a stop command is sent to the amplifier. This deceleration can be much higher than the values defined as normal acceleration and deceleration. It is meant to provide the fastest yet safest stopping of the axis in case of an emergency.

1.5.3.3 Control Loop Parameters

The internal parameters of the velocity and position control loop can be changed in the Digital Filters tab.

The values of the current control loop should not be changed manually.

In the unlikely case that the behaviour of the OmniDriveModule does not meet the application's requirements the internal parameters may be changed carefully. Please consult your local Elmo Motion Control department before modifying these values.

1.5.4 Testing and Debugging

The *Test Motion area* in the Profile tab can be used to move the motor under manual control for testing purposes. Activate Jogging mode to make the motor rotate continuously with the given Speed, or deactivate the check-box to move the motor to the given Position. Simply click the Go button to start the motion and Stop to set the velocity back to zero.

The Composer also offers a function to record high definition measurements of the motor's movements and to plot these data graphically. Please contact Neobotix or Elmo Motion Control if you need further information on this topic.

1.6 Maintenance

The Neobotix OmniDriveModule does not require excessive maintenance. Please check the following details approximately every month to ensure the best function and a long life expectancy.

1.6.1 Cleaning

The gearbox housing of the OmniDriveModule is completely sealed and will not be affected by dirt. Nevertheless it is recommended to regularly remove dust and dirt in order to optimise heat dissipation, especially if the module is integrated into a closed hull and has only limited convection cooling.

Please keep the PCB and the amplifiers as clean as possible. This will prevent short circuiting and damage to the electronics.

Depending on the environment the module is used in, some amount of hairs and dust will accumulate on the wheel's axle near the bearing. Please clean this area regularly to avoid damage to the seals of the ball bearing and to minimise friction.
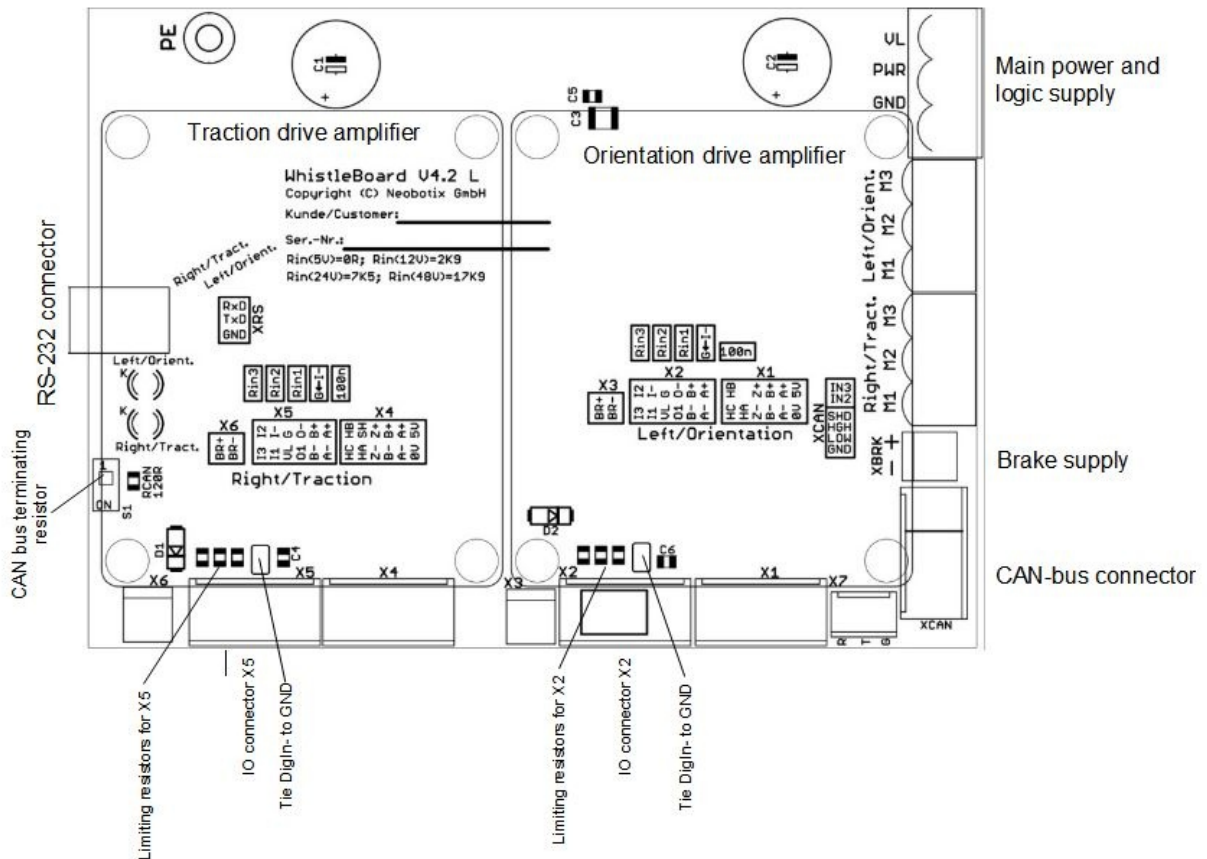
1.6.2 Traction Wheel

The traction wheel is very hard-wearing and not expected to show any signs of damage or wear within the expected lifetime of the module. In case you find any signs of wear, please contact Neobotix.

1.7 Technical Data

1.7.1 Dimensions

Dimensional drawings of the OmniDriveModule can be found in chapter *Mounting* (page 6).

1.7.2 Board-Layout

1.7.3 Properties

Description	Unit	Value
Weight	kg	18
Traction drive gear ratio (second stage)	1	2:1
Traction drive gear ratio (first stage)	1	15:1
Rated wheel torque @ 48V	Nm	34
Rated wheel torque @ 48V	rpm	100
Position sensor supply voltage	VDC	24
Orientation drive gear ratio	1	19:1
Motor encoder resolution	Inc. / Rev.	10.000
Maximum payload per module	kg	150
Expected working time	a	10
Amplifier supply voltage (minimum / recommended)	VDC	24 / 48

1.8 Taking out of Service

You can find information about taking out of service and about recycling *here* (page 23).

1.9 Legal Notes

The general legal notes can be found at *Legal Notes* (page 25).

1.9.1 Declaration of Incorporation

This product is a partly completed machinery and sold without CE marking.

This partly completed machinery must not be put into service until the final machinery into which it is to be incorporated has been declared in conformity with the provisions of Directive 2006/42/EC and all other applicable EU directives.

1.9.2 RoHS Information

This product complies to the RoHS directives 2011/65/EU (RoHS 2) and 2015/863/EU of the European Parliament and the Council on the restriction of the use of hazardous substances in electrical and electronic equipment.

Qualified Personnel

This product must only be modified, commissioned, operated and serviced by qualified personnel. Qualified personnel are defined as persons who

- due to their specialist training and experience have adequate knowledge for the work at hand,

- have been instructed by the responsible robot operator in the operation of the robot or its parts and the currently valid safety guidelines,

- are sufficiently familiar with the applicable official health and safety regulations, directives and generally recognised engineering practice (e.g. DIN standards, VDE stipulations, engineering regulations from other EC member states) that they can assess the work safety aspects of the product and

- have access to this manual and who have read it.

The following groups of persons are generally not considered qualified:

- Employees, interns or other academic staff not familiar with the product,

- visitors and quests,

- all members of other departments of the company or institution in which the product is operated.

This list is not intended to be exhaustive.

Taking out of Service

3.1 Disassembly

Once the mobile robot has reached the end of its lifetime it should be disassembled and its components should be recycled.

Tip: Before the robot can be disassembled the battery charger, any other external power supply and the batteries must be disconnected from the robot. It is strongly recommended to wait for at least 30 minutes after disconnecting all power sources before starting the disassembly. This will help to discharge any electrical energy that might be left in the system.

Disassembly of the robot should be done by qualified personnel only, preferably someone who has already worked on the robot in the past and knows its technical details. This will ensure

- fast and trouble-free disassembly,
- reduced risk of injuries or damages to components that are to be reused and
- proper sorting of parts according to materials and way of recycling.

More information on qualified personnel can be found at *Qualified Personnel* (page 22).

3.2 Recycling

3.2.1 Reusable components

Many components of the mobile robot (e. g. the servo motors and the amplifiers) have a very long life expectancy and will most probably still be usable when the overall system has reached the end of its lifetime.

Please check carefully which components can be reused immediately or in later projects and make sure that they are removed with care.

Tip: Reusing components does not only help the environment by reducing resource consumption but will also safe a significant amount of money.

3.3 Mechanical parts

The frame and the other mechanical parts of the robot are mostly made from aluminium or steel. Both materials should be separated completely and can then be sold to certified recycling companies.

3.4 Electrical components

Electronic scrap and electrical wires are both a source of valuable resources as well as a threat to the environment and must not be treated like consumer waste.

Attention: All electrical wires and components must therefore be collected and sold to or deposited at the appropriate recycling facilities.

3.5 Batteries

Note: You can find information about the batteries and the recycling process at batteries.

Legal Notes

4.1 Version Information

The English part of this online documentation has been translated and is not the original. Please refer to the German version in case of uncertainties or questions.

4.2 Liability

Every care has been taken in the preparation of this manual which represents the state of technology at the time of its composing. However, inaccuracies or omissions might occur. Please inform Neobotix in case you notice any.

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4.3 Downloads and Further Information

Additional information, data sheets and documentations, also for other products of Neobotix, can be found in the download section on our homepage: https://www.neobotix-robots.com/service/downloads.