## DAIMLER

# Project Book for Robot Technology ABB



Version 2020 "Interface MRA II"

Daimler

Powertrain Robotics ABB

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#### 1 General Information

#### 1.1 Preface

This project book defines the robotics specifications for all production locations and production centers within the Passenger Car/Powertrain (GFP/P) divisions of Daimler AG.

This project book regulates the specific section on robotics for **ABB**. Additional project books on robot manufacturers or specific technologies are also dependent on the technologies used and implemented.

All information in this project book has been compiled based on the current state of knowledge and the current state of technology. Technical modifications in the software and hardware areas, as part of ongoing developments and/or project-specific requirements, remain reserved.

The information makes no claim to completeness and the technical boundary conditions shall be coordinated with Daimler AG in the corresponding project phase in individual cases, if necessary.

#### 1.2 Record of Revisions

Version:	Last revised:		Changed by:
2020	24.02.2020	Adaptation for LH2020	ABB



#### 1.3 Contacts at Daimler AG

Contact persons are always the particular representatives in the plants/sub-plants/Powertrain center locations.

#### 1.4 Contacts at ABB

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#### 1.5 Qualification Requirements for the System Supplier

Robotic applications are subject to special technical safety requirements and are very complex in terms of design and programming in combination with the entire system.

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These special requirements can only be met with qualified applicators. In order to maintain robotic applications at a high level in the production plants, we, Daimler AG Powertrain, have certain requirements.

The following qualifications are expected from system suppliers for programming robot systems.

- As a minimum standard, the robot programmer(s) will have qualifications for "advanced programming, expert programming, or the like".
- For programming an application with the option "SafeOperation (safe robot)", the qualification **"Safety Commissioner"** or another comparable qualification shall be verified and is mandatory. Without this verification, signing off on the Safe Acceptance Test Report will not possible and will not be recognized. Verification does not have to be provided for each robot manufacturer; the qualification for one of the robot manufacturers used (Powertrain manufacturer's approval) is sufficient: **ABB**, KUKA).

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## 2 General Points (Industrial Robots)

#### 2.1 Release Listing Industrial Robots

The following release listing for industrial robots from ABB applies for Daimler Powertrain. Use of robot models deviating from this is possible only after consultation between the project partners and the representative.

The ABB product range of articulated robots covers handling capacities from 6 kg to 800 kg.

Robot model	Range [m]	Load capacity [kg]	Primary field of application
IRB 2600 ID	1.85 (2.00)	15 (8)	Process arm IR arc welding, handling
IRB 2600	1.65 (1.85)	20 (12)	Arc welding, seam sealing
IRB 4600	2.05-2.55	20-60	Arc welding, handling
IRB 6620	2.20	150	Handling, spot welding
IRB 6700	3.20-2.60	150-300	Handling, spot welding
IRB 7600	3.50-2.55	150-500	Handling, spot welding
IRB 8700	4.20-3.50	550-800	Handling, spot welding

Data sheets, drawings, CAD files, etc. are available for all robot models on the ABB website. Entry via <a href="http://www.abb.de">http://www.abb.de</a> -> Products and Systems -> Robotics (<a href="https://new.abb.com/products/robotics/de/industrieroboter/irb-6700">https://new.abb.com/products/robotics/de/industrieroboter/irb-6700</a>)

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#### 2.2 Protection Class

Increased protection measures are available as an option for the robots so that they are able to cope with the environmental conditions found within the different fields of application.

The standard versions have the following protection classes:

IRB 2600, 4600, 7600 IP 67, Foundry Plus 2 optional IRB 6620 IP 54, Foundry Plus 2 optional

IRB 6700 IP67 Standard, Foundry Plus 2 optional

IRB 2600ID IP 67 for base, forearm and wrist, IP 54 for upper arm

IRB 8700 Foundry Plus 2

#### Foundry Plus 2

The Foundry Plus 2 option offers increased protection for the manipulator for use in foundries and other harsh environments. Thanks to extensive protective measures, it is suitable for robots to be cleaned with a high-pressure cleaner.

The Foundry Plus 2 option is available for all standard articulated devices except the ID devices.

Foundry Plus 2 robots are only available in the standard orange color.

Since the protective measures indicated above refer exclusively to the manipulator, a sufficiently protected installation location shall be ensured when laying out the control system. For information about the protection class for the control system, see Chapter 3.2.

#### Foundry Prime

The Foundry Prime option includes a number of safety precautions that make the robot suitable for high-pressure cleaning applications, such as mold cleaning. The relative humidity can be up to 100%. The manipulator is suitable for handling solvent-based cleaning products; however, these shall first be approved by ABB. Foundry Prime is only available for certain robot models and excludes some other options.

Foundry Prime robots are only available in the standard orange color. The same restrictions apply to the control system as with the Foundry option.

Foundry Prime robots can only be ordered via the system supplier.

#### 2.3 Coloring

The robot and control cabinet are supplied in the standard color for ABB.

Manipulator: Orange (also Foundry Plus 2), light gray

Control system: (Door: Pale gray; Base and control panel: Dark gray; Sidewall, upper, lower, and back sides:

Aluminum / Zinc, bright).

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#### 2.4 Robot Calibration with "Axis Calibration"

ABB industrial robots are aligned using calibration pins in the individual robot axes. Details about this can be found in the ABB standard documentation.





Calibration of the robots with "Calpendulum" (likewise available from ABB) is no longer planned.

#### 2.4.1 Specifications and Methodology for the System Supplier:

- The robot system is initially commissioned by the robot manufacturer as a provision through Daimler AG with the system supplier. The initial commissioning by ABB is only the function test, which consists of:
  - Testing the wiring
  - Visual check: manipulator and controller
  - Updating the revolution counter
  - Testing the Syncpos
  - Testing the emergency off
  - Testing the robot motion
  - Testing the calibration data
- For initial commissioning, it is important to ensure that the robot is available without loads (no process application mounting and no additional load mounting), that it is firmly bolted in place, connected to the power supply (no extension cables permitted) and that the connecting line between the robot mechanism and the robot controller is connected.
- After the initial commissioning has been completed successfully, loads can be adapted onto the robot system.

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- After mounting all loads (without component part), the system manufacturer carries out a reference calibration on the robot system and documents this in the robot documentation.
- The reference calibration shall be carried out according to the robot manufacturer's specifications.

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## 3 Control System Profinet M/S with PROFIsafe (MRA II Interface)

#### 3.1 PROFIsafe Interface

The robot control system is connected in a technologically safe manner to the cell control via Profinet/PROFIsafe.

The robot controller system fulfills the safety categories Cat. 3, performance level D (refer to Chapter 1.2.3 in the product specifications IRC5), or SIL2 (Safety Integrity Level).

In the IRC5 controller, DSQC 1018 is installed in the main computer (newly ordered robots are delivered (starting in January 2020) with the new main computer DSQC 1024, executable with RobWare 6.08 and later). This contains a safety module in which a PROFIsafe F-Device is integrated. This can communicate with an external PROFIsafe F-Host.

The SafeMove Pro function is also implemented via the safety module in the host computer.

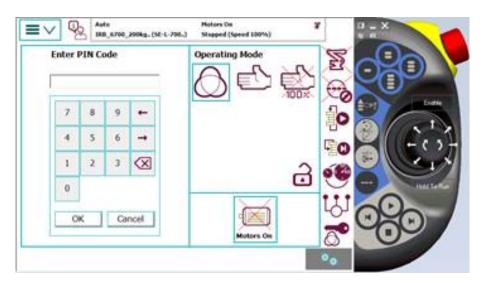
#### Restriction:

These functionalities are only available for the Main MultiMove robot and the first additional MultiMove robot. If only the stop circuit in the main cabinet is affected when one IRB goes into emergency stop, all others also go into e-stop. But Safe Move and ProfiSafe are available for all IRB.

Additionally, the Keyless System function is used. This eliminates the operation mode selector switch and the motor on button from the control panel.

These functions are now available on the FlexPendant.

Locking via the PIN code shall not be used.



Additional information about configuring the PROFIsafe interface and SafeMove Pro can be found in the Functional Safety and SafeMove manual.

#### 3.2 General Information

Control cabinet closures as per the PPA requirement specifications. These are included in the delivery in the accessories pack and are assembled by the customer.

The power switch is supplied by default as a range switch. This shall be explicitly stated when ordering when it is designed as a main switch.

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The robot control system is designed in protection class IP54.

#### 3.3 **World Zones**

The control system offers "world zones" for monitoring working areas. Outputs are used to indicate whether the TCP is inside or outside the predefined working area.

After powering on the control system, the world zones are only active after "Motors On".

#### 3.4 **Dust Filter (Standard Version)**

Synthetic filter, prevents the fans from clogging and prevents heat sink caused by dust. Not allowed to be used if there is a risk that weld splatter will hit the rear of the cabinet.

#### 3.5 Safety Signals

The safety signals are applied to the Profinet F-Device interface via the new safety module (PROFIsafe).

#### 3.6 **External Status LEDs (Option)**

External status indication of the safety signals, in addition to the internal LEDs on the safety card. The LEDs are located on the control panel for the control cabinet.

#### 3.7 Activation of Application-Specific Functions (PLC)

For Powertrain, there is a fixed definition for the signal arrangement between the system and the robot control systems, which shall be mandatory to implement. Special arrangements can be made after coordination.

#### 3.8 **Cabinet Casters**

The control cabinets are provided to the system supplier with casters. In the case of stacked cabinets, only the bottom cabinet receives casters. For the stacked cabinets, the supplier of the installations must remove the castors.

#### 3.9 Ambient Temperature (Standard)

The control cabinets are designed for an ambient temperature of +5°C to +52°C without additional cooling. At Daimler Powertrain, the control cabinets are provided with increased fan power for optimal cooling.

#### 3.10 Air-Water Heat Exchanger (Option)

In principle, the use of an air-water heat exchanger as per MDM shall be coordinated with the representative subject to the application location.

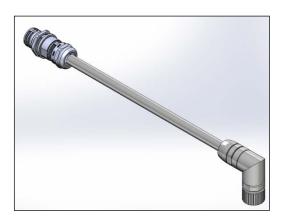
If the IRC5 cabinet door is open, the air-water heat exchanger shall be switched off via a door switch for the IRC5 as per Requirement Specifications for Electrical Components 1.3.

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#### 3.11 FlexPendant Cable Extension

The new Keyless System function eliminates the need for an external control panel. Instead, you now have the option of installing a FlexPendant cable extension. This is intended for permanent installation. This cable is available in lengths of 15, 22, and 30 m.



## 3.12 Cable Reel (Option)

A cable reel with different cable lengths can be ordered from ABB or SUMCAB. If the cable reel is procured at a later point in time, the existing cable can be used.



#### 3.13 HotPlug (Option)

The FlexPendant can be disconnected and reconnected without interrupting the safety circuit and stopping the program execution.

Important: The operator shall ensure that unconnected FlexPendants are removed from around the robot, as the emergency stop located on them will not be effective in this case.

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#### 3.14 Tool Changer Interface (Option)

With the Tool Changer Interface, the 24 V supply to the brakes of the external axes can be interrupted. The objective is to prevent arcing across the tool changer contacts when an external axis is docked/undocked. It is possible to interrupt the brakes individually.

If you want to dock between two tools with servomotors, the Servo Tool Change option is also required. However, if only the tool with its servomotor is to be exchanged for a gripper, this option is not required.

#### 3.15 Voltage Supply

Power supply voltage: 200-600 V, 3 phases

Power line voltage tolerance: +10%, -15% Power line frequency: 48.5 to 61.8 Hz

Rated power output:

IRB 140, 1600, 2600, 4 kVA (transformer size)
IRB 4600, 66x0, 6700, 7600, 8700 13 kVA (transformer size)

Additional drive module (Multi Move) 4 or 13 kVA

Recommended Protection:

IRB 140, 1600, 2600	for 400-600 V	3x16 A inert
	for 200-220 V	3x16 A inert
IRB 4600, 66x0, 6700, 7600,	for 400-600 V	3x25 A inert
8700	for 200-220 V	3x35 A inert

#### 3.15.1 Design Variants for the Control System

At Daimler, the compact control system shown nearby is the one used as standard. For MultiMove applications, the control system can be expanded on with additional drive modules.



The units (control module, drive modules) come separate from ABB and shall be assembled by the system engineer as required.

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## 3.15.2 Bus System

The Profinet master/slave software stack is used.

A maximum of 50 I/O devices can be operated on the control system.

There are a maximum of 2048 digital inputs or outputs per I/O device.

#### The maximum number of internal control I/O signals is 12000 I/O signals

To configure the PROFINET network in the IRC5 control system, a PROFINET configuration file shall be created and downloaded to the IRC5 control system. This PROFINET configuration file shall be created using third-party configuration software.

The PROFINET-IO Configurator Express software is free to use along with NetNames+ and must be downloaded from the Phoenix website.

Other recommended software tools include PROFINET-IO Configurator Professional and PCWORX from Phoenix Contact

#### Restrictions:

PROFINET-IO Configurator Express and the PROFINET-IO Configurator Professional only support GSDML files up to version 2.35. For devices with higher versions, the IO Configurator in RobotStudio must be used.

If the robot is used as F-Host, the configuration of the safety devices must also be effected via the IOC in RobotStudio. Only non-safe devices can still be configured via the Phoenix Configurator (up to GSDML version 2.35).

Configuration via RobotStudio I/O Configurator (IOC)

From RobotStudio V2019.4 on, configuration is done completely in the IOC - both the unsafe, internal slave part, and the safe part (safety slots, watchdog time and F-addresses). To do this, the user needs appropriate user rights – which includes configuration of the safety controller (write/lock), write access to I/O, change configurations

When using the IOC, devices that were previously displayed unslotted are now displayed slotted with a header module.

Example: If a device has 2x8 bit I/Os, a total of 4 slots plus head module are created. The numbering in each slot goes from 0-7 bits.

In RobotStudio versions up to 2019.3, the internal slave part is displayed unslotted, as before. Configuration of the safe signals can be carried out as before using "Visual SafeMove".

In addition, there is the restriction that a configuration created with the Phoenix configurator for a device will have to be recreated completely as soon as the hardware configuration changes. However, header parameters such as Fast Startup can still be changed.

In future, IPPNIO will be stored in the "Home" directory in the back-up by default. However, if the storage location is changed manually to a directory outside the "Home" directory, this is no longer the case and the IPPNIO will not be automatically saved with the back-up.

The configuration for the first 8 bytes of the inputs and outputs is defined by Daimler Powertrain and is located in the system. A configuration example for a single system is available there as an XML file. This interface is installed when the Powertrain sample program is imported.

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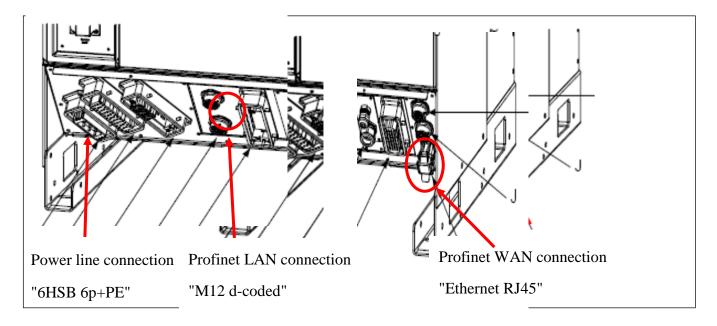
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## 3.15.3 Connector Plug

Compact control system

The plugs for the Profinet bus are located in the plug field on the front of the control panel along with the power supply plug.

The mating plug for the power supply cable and the mating plug for the Profinet bus are included.



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#### 3.16 MultiMove

MultiMove enables the operation of several robots via one controller. The system shall be understood as one machine with several manipulators and potentially additional axes. All mechanical units operate with one control system, i.e. an operating mode, a programming unit, a common dual-channel safety circuit.



This results in extended coordination possibilities between different robots and other mechanical units in addition to saving on hardware and the simplified communication with a superordinate control system.

MultiMove enables coordinated operation of up to four robots with up to three external axes each (max. 36 axes) in one production line. The unrestricted flexibility of MultiMove allows changes between independent and coordinated operation of the robots to be made as desired. The robots can also work in groups of two or three in a coordinated manner, while other robots within the system execute their program independently and at the same time.

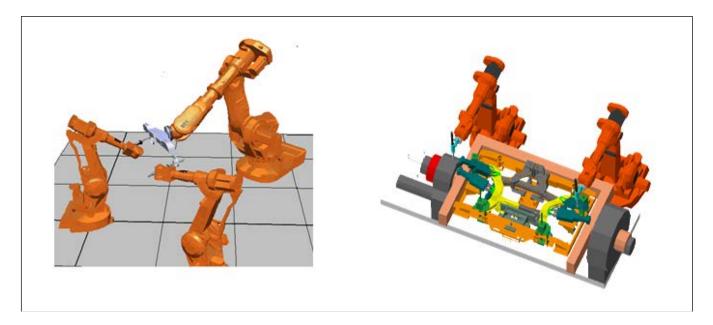
When designing a system, it shall be ensured that the number of movement tasks is limited to a maximum of 6.

For coordinated movements, all units involved will work with the same moving work object being held by one of the robots or positioners. The other mechanical units move in a synchronized manner by simultaneously executing their movement instructions. If the unit (robot or positioner) carrying the workpiece is moved in synchronization mode, all coordinated mechanical units maintain their relative positions to the moving workpiece. This results in great advantages when optimizing MultiMove programs. After the process is executed, the synchronization can be canceled and the robots can, for example, execute independent handling operations.

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#### Examples for MultiMove use:

- Coordinated handling of heavy component parts by multiple robots (load sharing)
- Two or three robots simultaneously execute a process on one workpiece positioner
- Use of one robot for workpiece handling while the other robots simultaneously execute processes



The MultiMove Independent or MultiMove Coordinatet software option is required to synchronize the robot movements. The standard scope of delivery for a MultiMove system includes the MultiMove Coordinated option, which also enables independent operation. Also refer to the MultiMove Application Manual.

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## 4 Software, Technology Packages, and Software Options

The following are technology packages made up of various software options from ABB. They are classified according to application types (arc welding, spot welding, gluing, etc.) and can be combined as desired. In this case, the memory capacity of the control system shall be taken into account. A number of other RobotWare options are available in addition to the technology packages. The detailed descriptions for individual software options can be found in the IRC5 Control Software product specifications.

## 4.1 Standard Package

The standard package includes the basic material handling package as well as the choice of one of the following technology packages:

- Arc welding
- Spot welding
- Adhesive bonding

Refer to the IRC5 Control Software product specifications

Basic Technology Package for Material Handling

Technology package	ABB Number
AbsAcc (only floor-mounted robots)	603-1
World Zones	608-1
Path Recovery	611-1
Collision detection	613-1
FTP and NFS Client	614-1
PC Interface	616-1
Multitasking	623-1
FlexPendant Interface	617-1
Safe Move Pro	1125-2

#### 4.2 Optional Technology Packages

Technology package	Description
RobotWare Arc	Arc welding
RobotWare Spot 6	Spot welding, pneumatic and servo-motor powered
RobotWare Dispense	Adhesive bonding
Robot Reference Interface	Real time sensor communication

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#### 5 Robot Mechanics and Accessories

#### 5.1 Axis Limitation for Basic Axes

The standard scope of delivery includes axis limitation for the first basic axis.

#### 5.2 Base Plates

Steel base plates can be ordered for all robot models to attach the robot to the foundation. The base plates include screws and centering bolts for attaching the robot to the base plate, as well as dowels and anchor rods for attaching the base plate to the foundation.

#### 5.3 Base

Bases in heights from 200 mm to 2000 mm made of steel are available for all robot models. The base includes screws and centering bolts for attaching the robot to the base, as well as dowels and anchor rods for attaching the base to the foundation.

Base height approx. 200 mm (in steps of 100 mm up to 2000 mm overall height)

Also refer to the Base (System) product manual

#### 5.4 Robot Safety

When designing the system, the system engineer shall check whether a safety device (SafeMove Pro) is required. If yes, this shall be used and personnel and machine safety shall be ensured.

All robots are equipped with the SafeMove Pro functionality. If it is not required, a corresponding configuration cannot be created in the Security Wizard in RobotStudio.

#### 5.4.1 Safely Monitored Robot Control System (SafeMovePro)

The functionality is implemented by the security module in the host computer. The following functions, among others, are available through SafeMovePro:

- Safe Cartesian speed (elbow, flange, and TCP)
- Safe axle speed
- Safe standstill
- Cartesian zone with safe orientation
- Brake Test
- Robot is stopped actively
- The hardware has 8 safe outputs, as well as 8 safe inputs for dynamically activating the monitoring functions

#### Notes

- The ADUs in an additional driver stage module cannot be monitored
- If an additional driver stage module is required for a robot to drive additional external axes (up to 9 axes are possible in a control cabinet), the axes driven in the additional driver module are not monitored via Safe Move.
- Standstill monitoring using Safe Move Pro is only possible with single-axis positioners such as the IRBP L or IRBP C.

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• The robot controller with the "Axis Activation Unit" option (1313-1) has performance level D. Further information can be found in the technote document "Positioner safety" Revision B.

#### Application Examples:

- Manual loading of a gripper (human / robot interaction)
- Manual checking inside the robot cell during operation
- · Optimizing the cell size
- Protecting sensitive equipment
- Ensuring safe alignment of robotic tools (e.g. lasers)

Synchronization by means of a reference switch is required. The dual-channel non-contact switch is connected via the equipment control system.

#### Specifications for the Reference Switch and Actuator

To use the SafeMovePro option, a dual-channel, non-contact reference switch and a suitable actuator are specified for referencing.

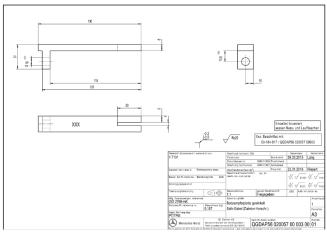
The non-contact reference switch is connected via the equipment control system. The IRC5 robot control system from ABB does not permit direct connection via the robot control system plug field. The cable and the connection shall be made by the system manufacturer on site.

Additional information can be found in the Appendix to the Project Book.

#### Switch model (Euchner)



#### Actuator



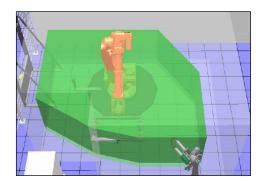
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## Application Examples for SafeMove

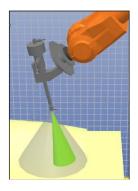
Robot-guided device for manual loading. Use of the "Safe Standstill Monitoring" function



Monitoring of Cartesian zones



Orientation monitoring



Using the SafeMovePro option requires the safety functions to be examined and approved. Information about this can be found in the "General Part" of the Robotics Requirement Specifications from Daimler Powertrain.

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#### 5.5 Absolute Accuracy

All floor-mounted robots are aligned before delivery and provided with a compensation set of parameters. This enables absolute accuracy of the TCP over the entire working area of at least +/-1 mm. For robots with rollover capability, accuracy is limited to the frontward working area.

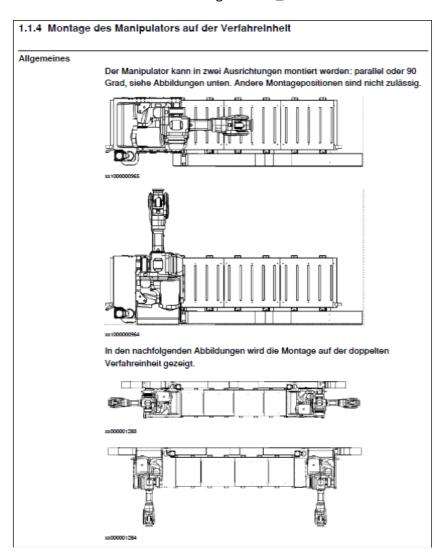
#### 5.6 Collision Protection

Configurable collision detection (collision detection, standard option) is available as a software solution for all robots and **shall be parameterized and used**.

#### 5.7 Traveling Axes / Linear Units

The traveling axes are available as per ABB product specifications.

- The selection is effected in accordance with the robot order list.
- The max. cable length between the control system and IR (incl. traveling axis) shall not exceed 50 m
- Central lubrication unit (Lincoln) with associated control system and signal output (initiator signal
  on M12 plug-in connector) when the min. value of residual lubrication quantity is reached. For this,
  also refer to the circuit diagram IRBT\_Central Lubrication in the Annex.



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#### 6 Documentation

Further information on our robots can be downloaded free of charge and effective immediately via our MyABB portal at https://myportal.abb.com. An account must first be created for you.

We need the following data to create your personal account:

E-mail:

First name:

Last name:

User's country:

Phone:

Additional phone:

Preferred language:

Customer no. at ABB:

Please send the required data to de-myabbaccess@abb.com. Once your account has been created, you'll receive your access data by email. For the introduction to and training in MyABB each user will receive a video explaining use of the portal.

With a myABB account, it is possible to access the online document database.

It is also possible to use the documentation offline using the "User documentation package" tool. That tool can be downloaded.

Further information on the documentation portal can be found in the document "myABB Online Documentation".

The Annex contains additional documents, some of which are specific to Daimler.

Data sheets, drawings, CAD files, etc. are available for all robot models on the ABB website. Accessible via http://www.abb.de -> Products and Systems -> Robotics (https://new.abb.com/products/robotics/de/industrieroboter/)

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