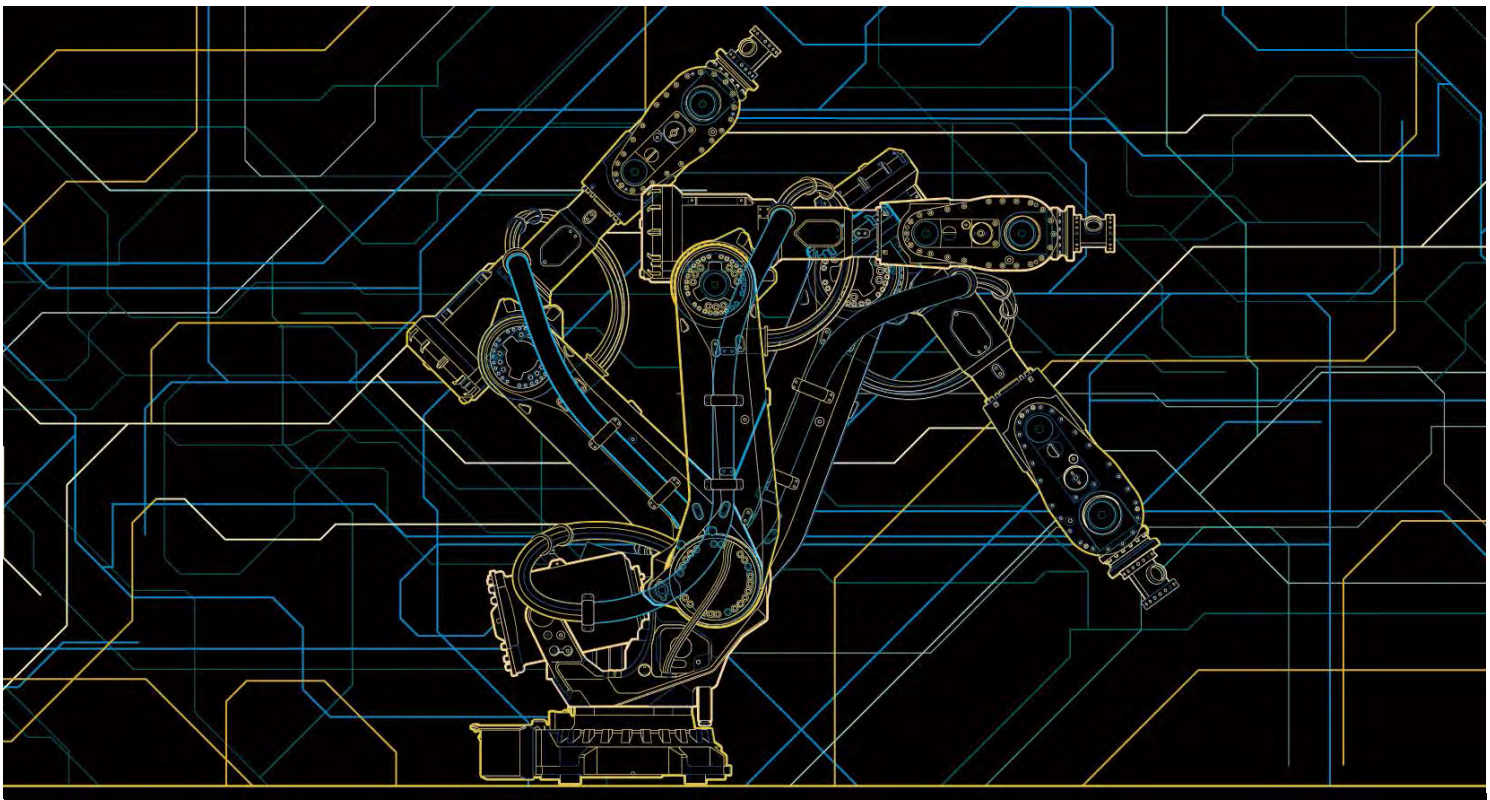


Product manual
FlexMT

Power and productivity
for a better world™

Trace back information:
Workspace Main version a80
Checked in 2014-10-08
Skribenta version 4.1.210

Product manual
FlexMT

Document ID: 3HAC051768-001
Revision: -

The information in this manual is subject to change without notice and should not be construed as a commitment by ABB. ABB assumes no responsibility for any errors that may appear in this manual.

Except as may be expressly stated anywhere in this manual, nothing herein shall be construed as any kind of guarantee or warranty by ABB for losses, damages to persons or property, fitness for a specific purpose or the like.

In no event shall ABB be liable for incidental or consequential damages arising from use of this manual and products described herein.

Additional copies of this manual may be obtained from ABB.

The original language for this publication is Swedish. Any other languages that are supplied have been translated from English.

ABB AB
Robotics Products
Se-721 68 Västerås
Sweden

Table of contents

This page is intentionally left blank

Overview of this manual

About this manual

This manual describes the option FlexMT.

Usage

User manuals are used to understand how to use the product, for example to install, configure, or operate.

Users

This manual is intended for:

- Personnel that are responsible for installation and configuration of robot systems
- Programmers
- Service engineers

Trademarks

FlexMT is a trademark of ABB.

PickMT is a trademark of SVIA, Svensk Industriautomation AB.

References

Reference	Document ID
Product specification - FlexMT	*3HAC049820-001*
Product manual - IRB 2600	*3HAC035504-001*
Product manual - IRB 4600	*3HAC033453-001*
Application manual - PickMT	*3HAC051771-001*
Product manual - Safety center for FlexMT	*3HAC051769-001*
Application manual - PickMT with ABB robot	*3HAC051770-001*
Application manual - FeedLine Light	*3HAC052311-001*

Revisions

Revision	Description
-	First edition.

This page is intentionally left blank

1 Safety

1.1 Safety signals in the manual

Introduction to safety signals

This section specifies all dangers that can arise when doing the work described in this manual. Each danger consists of:

- A caption specifying the danger level (DANGER, WARNING, or CAUTION) and the type of danger.
- A brief description of what will happen if the operator/service personnel **do not** eliminate the danger.
- Instruction about how to eliminate danger to simplify doing the work.

Danger levels

The table below defines the captions specifying the danger levels used throughout this manual.

Symbol	Designation	Significance
 xx0200000022	DANGER	Warns that an accident *will* occur if the instructions are not followed, resulting in a serious or fatal injury and/or severe damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, and so on.
 xx0100000002	WARNING	Warns that an accident *may* occur if the instructions are not followed that can lead to serious injury, possibly fatal, and/or great damage to the product. It applies to warnings that apply to danger with, for example, contact with high voltage electrical units, explosion or fire risk, risk of poisonous gases, risk of crushing, impact, fall from height, etc.
 xx0200000024	ELECTRICAL SHOCK	Warns for electrical hazards which could result in severe personal injury or death.
 xx0100000003	CAUTION	Warns that an accident may occur if the instructions are not followed that can result in injury and/or damage to the product. It also applies to warnings of risks that include burns, eye injury, skin injury, hearing damage, crushing or slipping, tripping, impact, fall from height, etc. Furthermore, it applies to warnings that include function requirements when fitting and removing equipment where there is a risk of damaging the product or causing a breakdown.
 xx0200000023	ELECTROSTATIC DISCHARGE (ESD)	Warns for electrostatic hazards which could result in severe damage to the product.

Continues on next page

1.1 Safety signals in the manual
Continued

Symbol	Designation	Significance
 xx0100000004	NOTE	Describes important facts and conditions.
 xx0100000098	TIP	Describes where to find additional information or how to do an operation in an easier way.

1.2 General

This sections covers safety precautions regarding the standard equipment as well as options that are not included in all installations. If the installation contains further parts, safety instruction may also be found in other documentation.

General safety precautions for all procedures where there is a risk of personal injury or damage to property can be found in this chapter. Additional instructions can also be found close to the instructions for each procedure.

Equipment that is part of a fully- or semi-automatic system must always be treated with care regarding safety during the installation phase, during operation as well as during maintenance and repair.

Installation/commissioning personnel must be trained and thoroughly understand the principles of the FlexMT, to prevent risks to the operator and service personnel.

Users of the FlexMT system must ensure that the safety laws and regulations that apply to their respective country are followed and that all safety devices that are required to guarantee the safety of those who work with the robot are installed correctly.

Only personnel with required training is authorized to use the system.

Trainee operators may only use the system under the supervision of a qualified, experienced operator as follows:

Activity	Trained operator	Trained service and maintenance technicians	Qualified electrician
Installation/commissioning		×	x
Operation	×	×	
Fault tracing		×	×
Correction of mechanical fault		×	
Correction of electrical fault			×
Service		×	×
Maintenance		×	×

x = Authorized to perform the activity

Received training must be documented in writing.

Always check that the installation and maintenance instructions are supplied.

DANGER

Be aware of inherent risks of robot systems ! Safety information for the robot system is supplied in the robots product manual. Ensure that you have read these instructions and follow them.

1.3 Safety during installation, commissioning and decommissioning

Carefully read the safety precautions, before unpacking and installing the equipment.

Personnel who are involved in the installation and commissioning must have relevant training for the respective robot and corresponding safety issues.

WARNING

It is forbidden to step on the part of the conveyors that is outside of the machineEnsure that nobody is on the conveyor, especially when the belt is in motion.

WARNING

It is forbidden to step on the illumination roof, the outer walls of the FlexMT and on any FlexMT option.

DANGER

Ensure that nobody is within the machine enclosure during operation.

If the FlexMT is equipped with the turn station option, an additional safety precaution might be necessary. Depending on the length of parts to be turned, an additional protective shield might become necessary.

DANGER

When using the turn station option, perform a complementary risk analysis with respect to the length of the part and height of the risk zone. See section on mechanical installation.

DANGER

The SafeMove configuration shall not be disabled for any reason.

1.4 Safety during setup, maintenance and repair

Work on mechanical systems must only be carried out by qualified personal or by an instructed person under guidance and supervision of a qualified person according to the applicable technical regulations

Work on electrical systems or operating material must only be carried out by a qualified electrician or by an instructed person under guidance and supervision of a qualified electrician according to the applicable electrical technical regulations.

The equipment can start without prior warning thus causing a crushing risk. Installed protection that belongs to the equipment must always be installed during semi-automatic and fully automatic operation.

DANGER

The following must be ensured before commencing work on the FlexMT:

- Emergency stop must be activated (machine stationary)
- Machine voltage must be disconnected
- Action must be taken so that machine voltage cannot be connected when work is carried out.
- The air supply must be disconnected.
- Action must be taken so that air supply cannot be connected when work is carried out.
- The key for resetting the safety stop must be carried when working within the FlexMT housing.

Mechanical, pneumatic or electrical energy may be stored in the machine, which may cause a risk when carrying out work inside the FlexMT.

The function of safety devices must be checked after all work that might have an impact on the safety arrangements.

1.5 Safety during operation and teachin

WARNING

Ear protection shall be used when working with the air cleaning box/deburring unit for certain details. The need will depend on the application and shall be risk assessed.

WARNING

Eye protection shall be used when working with the air cleaning box/deburring unit for certain details. The need will depend on the application and shall be risk assessed.

DANGER

Pneumatic power to the grippers is not switched off neither during autostop nor in emergency state. Be aware of crushing risk.

Normal precaution should be taken when working with the FlexMT.

1.6 SafeMove

The robot working space in the FlexMT is restricted by the use of SafeMove. Due to space requirements, the SafeMove outer boundaries of restricted space are close to the FlexMT enclosure.

In case of robot malfunction or erroneous programming leading to a movement out of the restricted space, the robot will begin to stop its movement. Minor collisions with the outer FlexMT housing can occur, but will not lead a personal hazard.

DANGER

The SafeMove configuration shall not be disabled for any reason. Modifications of the SafeMove configuration shall not be done without appropriate risk assessment and validation.

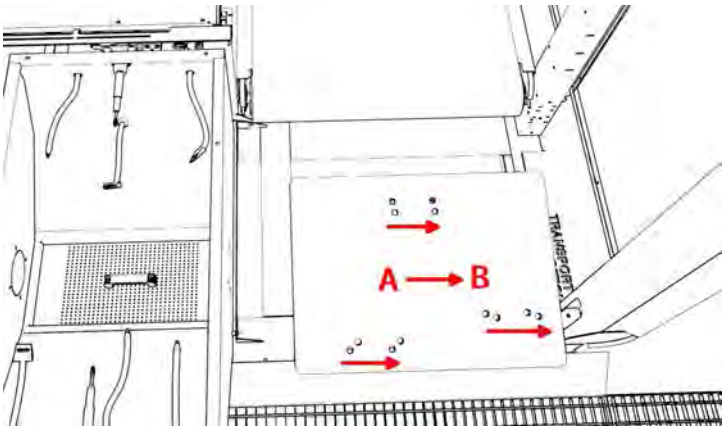
DANGER

The SafeMove configuration inside the machine tool must be adopted to the actual circumstances. Risk assessment must be performed, and the new SafeMove configuration must be validated.

Alternate mounting position.

The FlexMT mechanical configuration does allow an alternate mounting position of the robot. This possibility is given for the integrators convenience and shall not be considered to be a standard option.

If the wall towards the machine tool is (partly) removed, the alternate mounting position of the robot will move the robot ~100mm closer to the machine tool.



Standard mounting position A, alternate mounting position B

Continues on next page

The SafeMove configuration must be changed accordingly to the new work space. The standard ABB guidelines for configuration and validation of SafeMove configurations shall be followed.

DANGER

It is the integrators responsibility to modify and validate the SafeMove configuration for the alternate mounting position in a suitable way.

1.7 Limited liability

Information in this document regarding safety must not be considered to be a guarantee from the manufacturer that the installation cannot cause personal injury or material damage even if all safety precautions are observed.

In particular, liability cannot be accepted if injury/damage has been caused for any of the following reasons, for example (but not limited to):

- Use of the FlexMT in another way than intended.
- Operation of the machine when the safety devices are defective, not in their intended location or in any other way not working.
- When instructions for installation, commissioning, operation, maintenance or repair are not followed.
- Non-authorised design modifications made in the FlexMT.
- Maintenance or repair is carried out by inexperienced or non-qualified personnel.
- The machine must not be used as a container, path, workbench or other storage place.
- Foreign objects.
- Force majeure.

1.8 Regulatory compliance

Supplied equipment must NOT be operated until the machine/system in which the equipment is included, has been determined to be in accordance with national and local laws and regulation.

Namely, within the EU, this refers to the machine directive 2006/42/EG with addition.

2 Installation

Note

Read the safety precautions and other instructions carefully before unpacking and installing the equipment.

Continues on next page

2.1 General

This section describes the installation of the equipment, including unloading and placing the FlexMT in relation to the machine tool. If the installation contains further parts, safety instructions may also be found in other documentation.

2.2 Mechanical installation

When the FlexMT arrives, it is bolted onto a wooden pallet with the vision tower dismantled from the chassis. This section describes how to unpack the FlexMT step-by-step with text and pictures.

Always check the FlexMT for visible or suspected damages prior to unpacking.

Continues on next page

2.2.1 Floor requirements

The floor where the FlexMT becomes installed has to fulfill certain requirements:

- Standard concrete industry floor is typically sufficient to install the FlexMT.
- The surface of the floor shall be flat to within the equivalent of 1mm in 600mm (1 inch in 50 ft).
- The floor and fastening elements shall withstand the forces originating from the robot according to the robot product manual. Use at least bolts with minimum dimensions M20 / 3/4”.

2.2.2 Unloading

DANGER

All lifting devices must be properly dimensioned.FlexMT weight is 2500kg

CAUTION

When transporting using a forklift truck, moving parts on or in the FlexMT must not be touched or damaged. The equipment must be lowered slowly. Knocks, shaking and drops can cause deformations

DANGER

Never go beneath a suspended load.

The FlexMT weight is 2500kg and shall be lifted off the transporter with a forklift from the side. On the wooden pallet there are signs where to lift. The FlexMT can be transported on the workshop floor with a forklift from the side, with 3 handheld lifts as the pictures show, or on appropriate skates.

Initial transport of the unit using handheld lifts (1). Look for fork lift signs

Continues on next page

2.2.2 Unloading
Continued

Initial transport of the unit using handheld lifts (2)

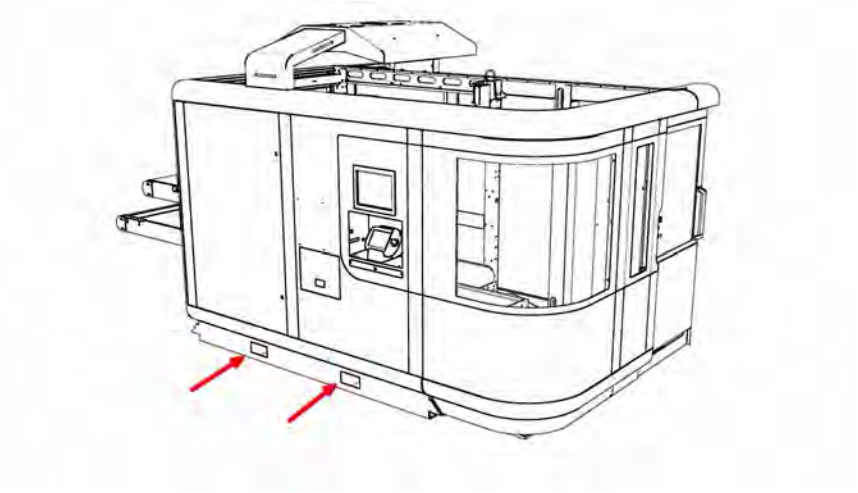
2.2.3 Unpacking and positioning

Start unpacking by removing all the stretch film. Remove all the transport safety and all the bolts from the pallet.

Note

Check all delivered parts for unexpected damage. If necessary, take appropriate actions.

The FlexMT can be lifted using a fork lift with the provided fork lift slots, placed on the bottom of the machine.

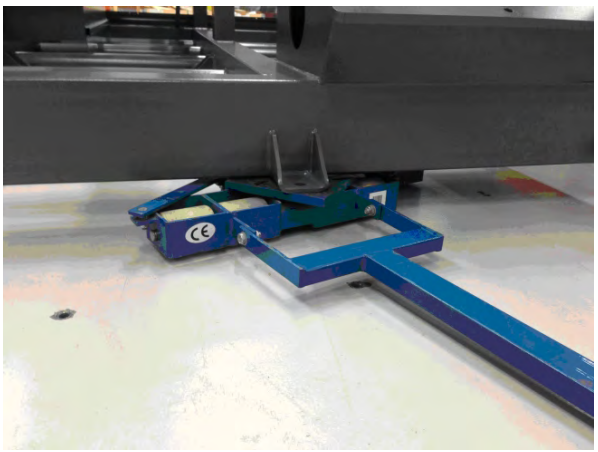


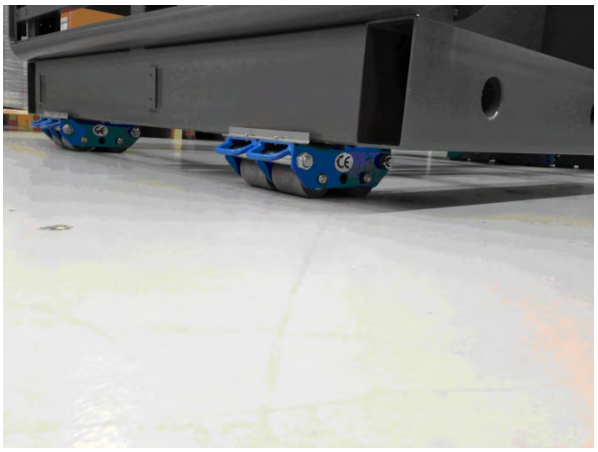
Lift of the FlexMT using fork lift

Continues on next page

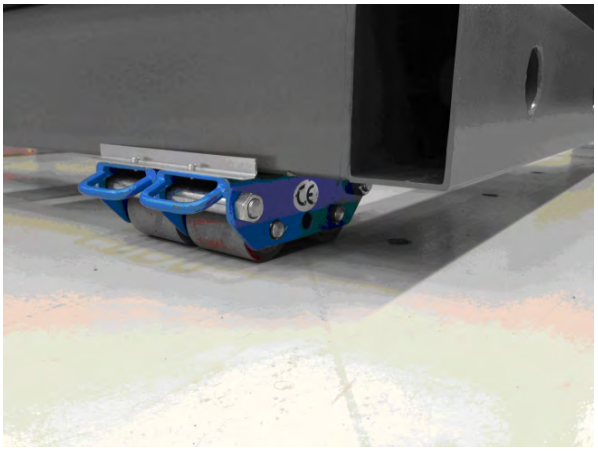
2.2.3 Unpacking and positioning
Continued

The FlexMT can also be positioned by using skates.





Transport of the FlexMT using skates (1)

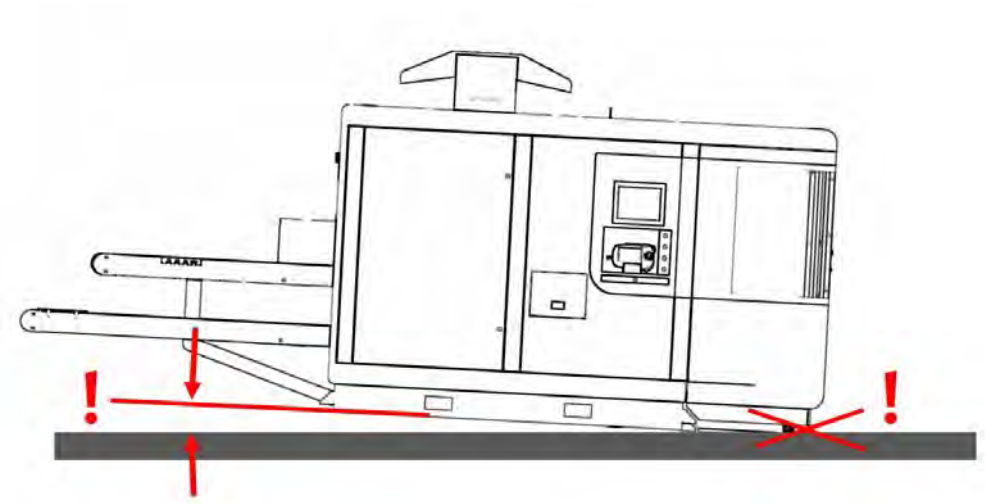


Transport of the FlexMT using skates (2)

CAUTION

Do not lift the FlexMT to high in the back only. It will damage the plates on the front door.

Continues on next page

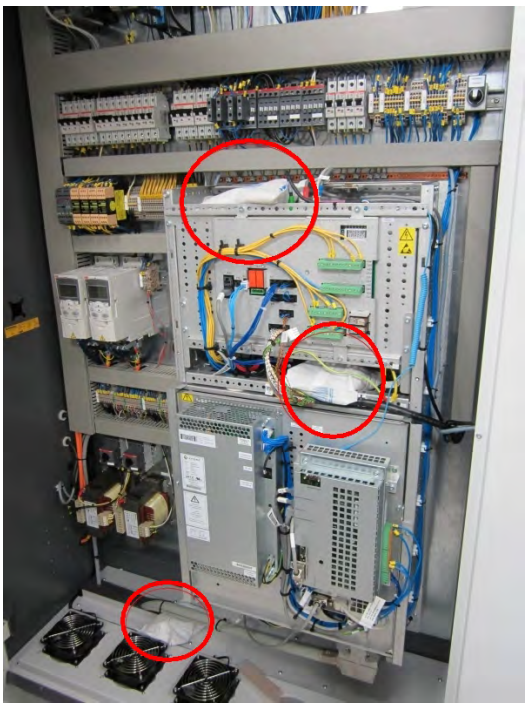


Pay attention on inclination in order to avoid damages to front plates.

Place the FlexMT at a suitable position relative to the machine tool. Take especially the corridor between the FlexMT and the machine tool into account.

Remove all the absorb bags from the electrical cabinet and the rest of the machine.

Prior to transportation untreated surfaces may have been rust proofed with a layer of oil or grease which was applied before packing. Wipe off any excess oil/grease before installation using a lint free cloth.

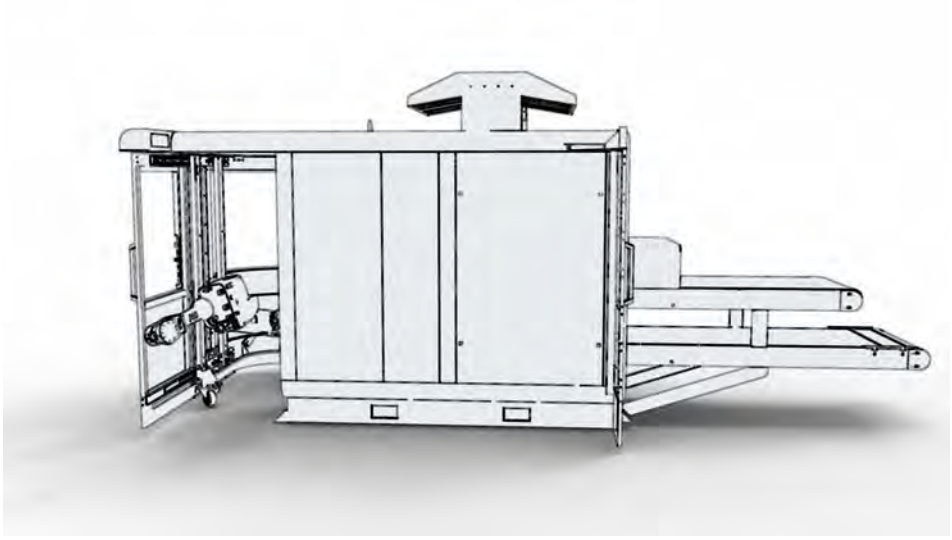


Example of absorbtion bags - in the control cabinet - that must be removed.

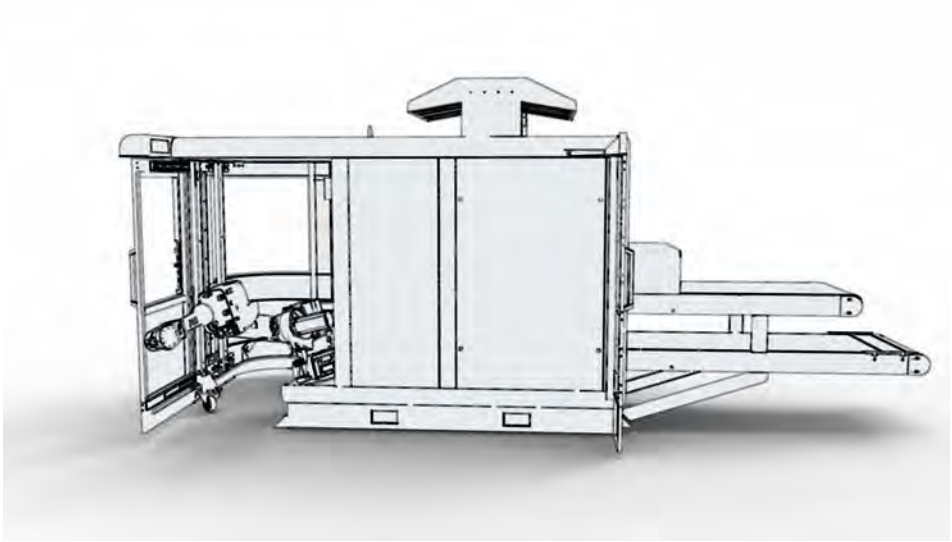
2.2.4 Assemble corridor parts

Adjust width of opening towards machine tool

The width of the opening towards the machine tool can be adjusted according to the actual needs. By selecting a suitable amount of the flexible panels on the back side of the FlexMT, various opening widths can be achieved (850mm, 1300mm, 1500mm):

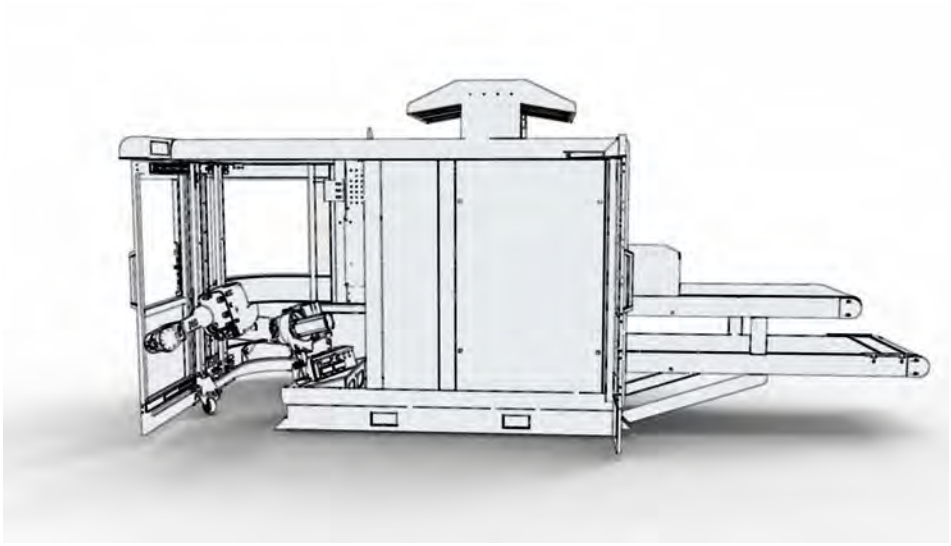


Variable opening towards machine tool: 850 mm



Variable opening towards machine tool: 1300 mm

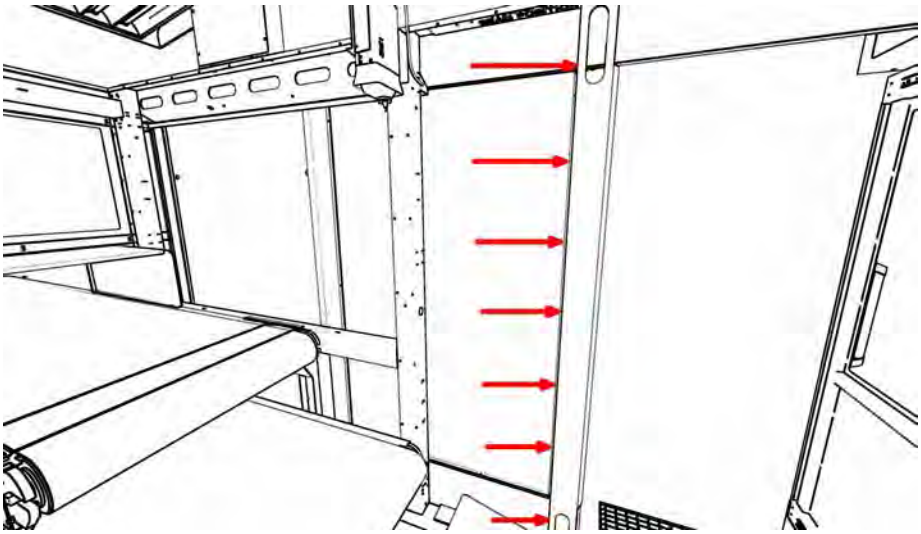
Continues on next page



Variable opening towards machine tool: 1500 mm

Tip

The stabilization stag (se image below) is needed for mechanical stability during transport. Save the stabilization stag when disassembling it !



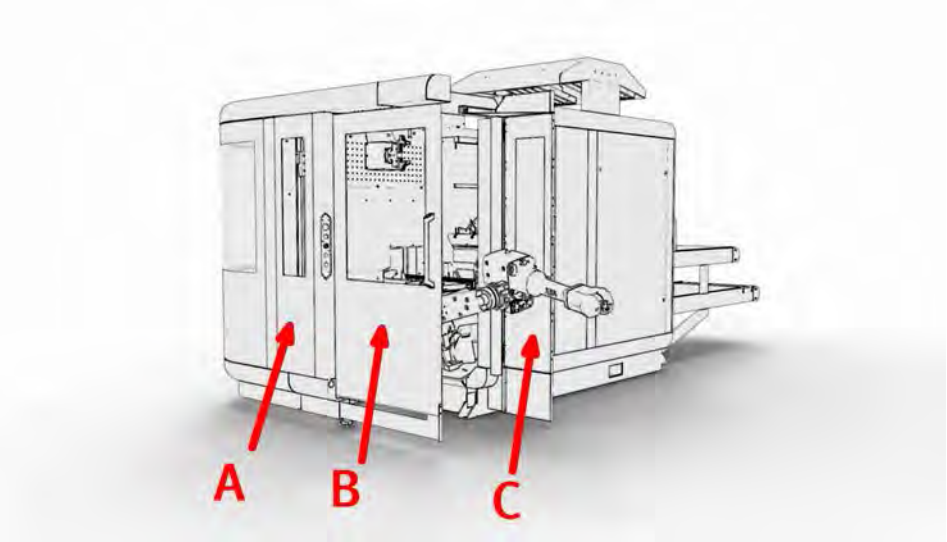
Transportation stability ensured by stag.

Continues on next page

2.2.4 Assemble corridor parts
Continued

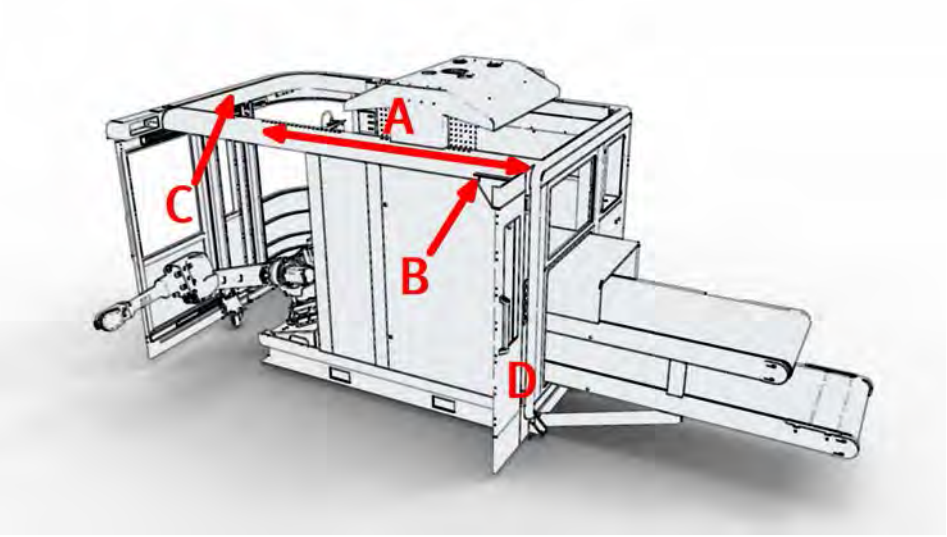
Mount extension panels

The passage towards the machine tool must be protected to prevent operators from entering the robot working space. A ready made corridor part can be mounted on the side of the FlexMT, according to the image below. The extension panels consist of two parts, the extension panel door, and the extension panel back.



Extension panel components

A: Extension panel door, B: Sliding door, C: Extension panel back



Variable positioning of corridor part.

If ordered with the extension panel door, the FlexMT is delivered with the extension panel mounted in place.

The extension panel back has to be mounted on the FlexMT: Select a suitable position along A, and secure the extension panel back D by mounting it to the FlexMT outer shell (screws on upper and lower rim of the FlexMT).

If the corridor part is a door that can be opened, the safety switch B has to be connected to the safety connection point hidden in the FlexMT upper rim at C.

Continues on next page

Most probably, you will have to remove a plate to be able to reach the safety connection point.

2.2.5 Assemble the vision tower

Use straps to lift the vision tower. The straps shall be fastened around the beams inside the tower. See image below.

Lifting of the vision tower

The tower shall be placed on top of the chassis and the camera shall be centered over the inconveyor.

The cables that need to be connected are put inside the tower (see picture below). The cables that they shall be connected to can be found in the vision tower. The

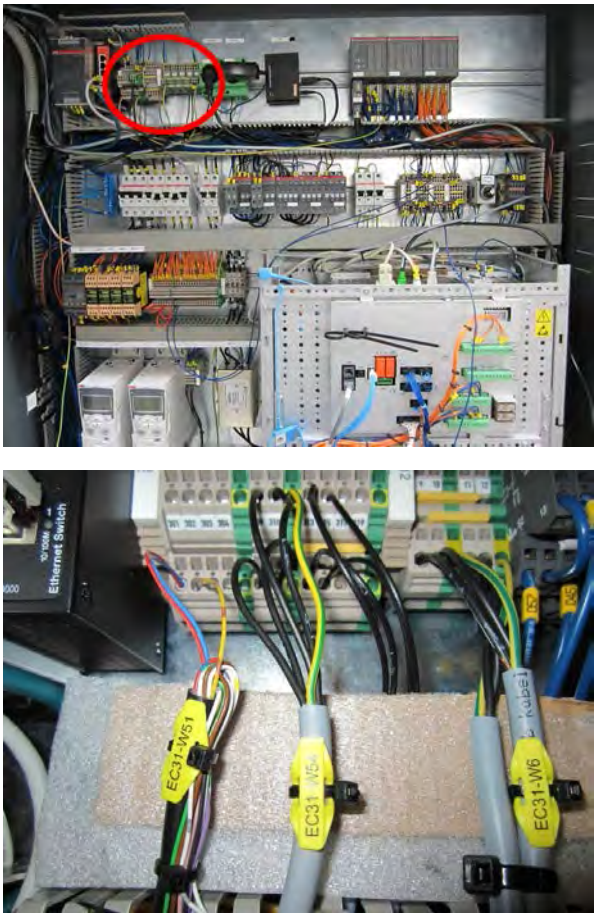
Continues on next page

rest of the cables need to be connected to the terminal inside the electrical cabinet according to the circuit diagram.

Cable path from vision tower to FlexMT chassis.

Continues on next page

2.2.5 Assemble the vision tower
Continued



Internal connection of vision tower cables in control cabinet.

2.2.6 Install the FlexMT to the machine

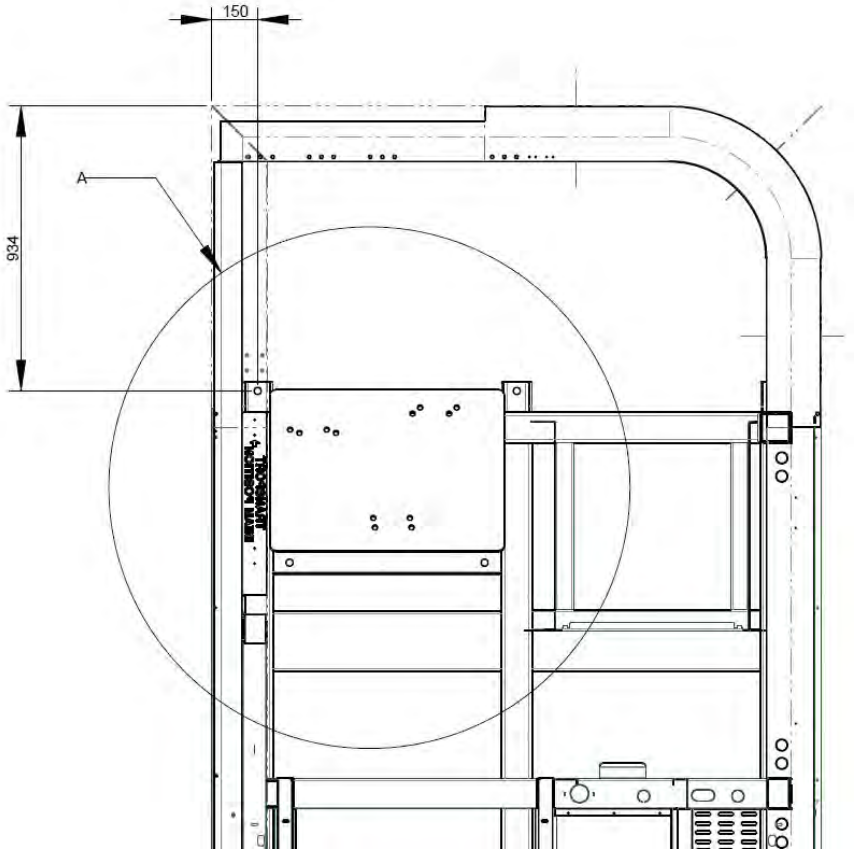
Note

The fastenening elements are not part of the delivery as they must be selected with reference to the floor material. Use only suitable fastening elements. Pay attention to the expected loads.

CAUTION

The conveyor must be levelled both in the direction of movement and across it within < 5 mm/m (< 1 mm/m for rolling parts). Each deviation must be corrected.

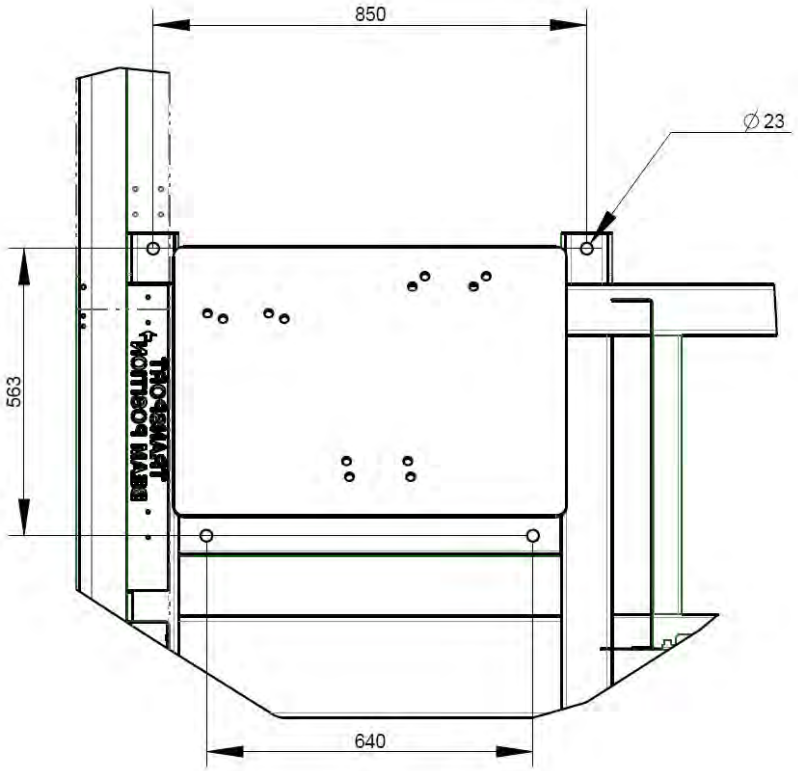
If the wholes are drilled prior to putting the FlexMT into position use the following drilling plan. Pay attention to distances implied by extension panel options.:



FlexMT drilling template (in mm), seen from above (1)

Continues on next page

2.2.6 Install the FlexMT to the machine
Continued



Detail A from previous drawing, seen from above (2)

Put the FlexMT at the intended position.

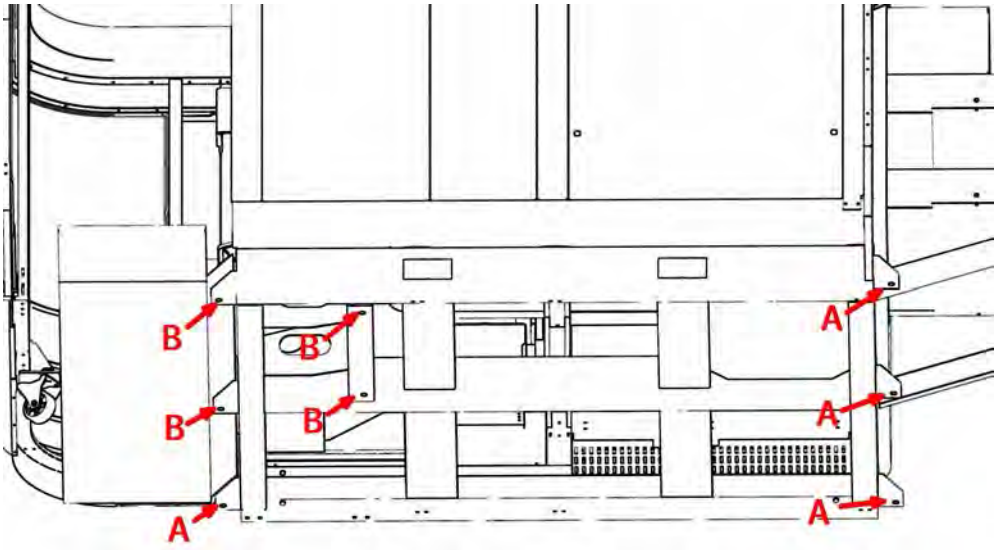
Level the FlexMT with regard to the inconveyor, by using the adjustable machine feet (see picture below). The conveyor must be levelled both in the direction of movement and across it, within < 1 mm/m (< 0.5mm/m for rolling parts). Each deviation must be corrected.

Drill holes and bolt the machine into the floor. There are four brackets with holes where the machine shall be bolted, around the robot.

The FlexMT shall be bolted with minimum bolt diameter M20 / 3/4”. Use metal plates below the brackets to avoid air gaps between floor and FlexMT feet, if necessary.

Continues on next page

The image below shows the FlexMT from below, pointing out the 4 machine foot positions (A) and the 4 bolting positions (B).



FlexMT from below. A: Adjustable machine foot, B: Bolted to the floor.

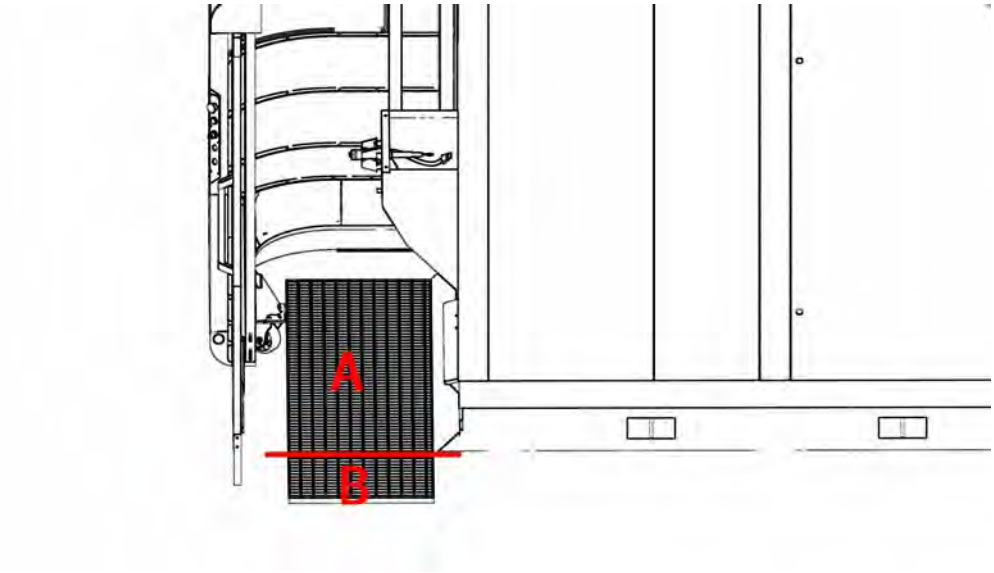
Note

Note that a tightening torque of ~300 Nm / 220 lb ft is required to ensure that the equipment is well secured.

2.2.7 Install FlexMT drop protection

After putting the FlexMT in position and securing it in place, the drop protection plates shall be put into position. Start with putting the main part A into position and secure it to the FlexMT frame.

Thereafter, hook the corridor part (B) into the main part and secure it.



FlexMT drop protection with main part (A) and corridor part (B)

2.2.8 Safety precautions for long parts in turn station

DANGER

A risk assessment has to be performed when using the turn station. It has to consider if the rotated parts constitute a risk to the operator.

If risk assessment indicates a risk, an extra vertical plate needs to be mounted close to the turn station on the FlexMT upper rim to avoid that the the risk area can be reached.

2.3 Electrical installation

Connect the incoming power supply according to specification. Ensure that local rules and legislation is followed, e.g. by setting a lockable main switch if needed.

Continues on next page

2.3.1 Power supply

Power supply conductors shall be connected directly on the supply disconnecting device, QL1. No cable lugs or compression sleeves are required for Cu cables. The supply disconnecting device is located inside the control panel on the left hand side.

The disconnecting device is only suitable for Cu cable. If Al-cable is used, an Al/Cu adaptor terminal must be used (e.g. Elpress type AKP).

If a screened or armored cable is used it shall be symmetrically designed. Chose conductor area depending on your environment and cable routing.

Power supply cable is routed through a cable flange situated in the roof of the control cabinet.

POWER SUPPLY 3x 380...400V 50Hz

Maximum short-circuit current 10kA. Required line fusing: Circuit breaker with minimum characteristic C or better. Max. fuse 40A

POWER SUPPLY 3x 440...480V 60Hz

Maximum short-circuit current 10kA. Required line fusing: Circuit breaker with trip characteristic K. Max. fuse 35A (40A if power limiting switch is used).

2.3.2 Earthing system

The protective earthing system shall be performed according to EN-60204-1, the PE conductor shall be dimensioned according to section 5.2, Table 1.

2.3.3 Potential equalization

FlexMT is equipped with a earthing boss, the earthing boss is fitted on the base frame to the left of the control panel, this shall be connected to a separate functional earthing bonding circuit conductor.

NOTE: Do not connect this to the PE system!

2.4 Pneumatic installation

Connect the incoming air connection. Requirements are 6 bar / 87 psi. Dry air, no oil.

2.5 Machine tool connections

FlexMT connects to the machine tool by means of a safety interface and a functional interface.

Continues on next page

2.5.1 Machine tool safety interface

The equipment has a safety interface that makes connection of the FlexMT to the machine tool safety circuits possible. The safety interface handles the following aspects:

- Bidirectional exchange of emergency stop between FlexMT and machine tool.
- One-directional exchange of autostop from FlexMT to machine tool.
- Machine tool is expected to behave as emergency stop slave in standard configuration.
- Overall safety functions in FlexMT fulfill requirements for PLd according to EN ISO 13849-1.
- Two-channel potential-free connections.
- Optional external autostop interface.
- The physical interface is constituted by terminal blocks in the control cabinet.

Please refer to the SafetyCenter manual for details on the safety interface.

Alternate autostop configuration.

The standard autostop safety interface connection puts the machine tool in autostop as soon as any FlexMT door is opened.

The FlexMT electrical cabinet does allow an alternate autostop configuration towards the machine tool (autostop with override-function). This possibility is given for the integrators convenience and shall not be considered to be a standard option.

In this configuration, the autostop sent to the machine tool can be overridden by first holding the 3-position switch on the FlexPendant and shortly switching the door reset switch. The autostop sent to the machine tool will now be overridden as long as the 3-position switch on the FlexPendant is safely activated.

DANGER

It is the integrators responsibility to perform an suitable risk assessment for this mode of operation.

2.5.2 Machine tool functional interface

The functional interface can communicate by means of any available physical interface. The FlexMT standard configuration includes:

- Digital 24V I/O interface with 16 IN and 16 OUT signals to be connected to the machine tool.
- Digital I/O is working with the machine tools 24V.
- Other physical interfaces are available by using optional IRC5 field bus or interface options (to be ordered with robot).

The functional interface must be configured and commissioned prior to use of the FlexMT. Please refer to the section Commissioning for details on functional interface setup.

2.6 Network connections

2.6.1 Service port

Network connections to the robot controller can be established by means of the robots built-in service port according to the robots manual.

2.6.2 WAN port

The WAN port of the robot controller is exclusively used for communication with the vision system. For security reasons, it is strongly advised not to connect this network to any other network.

Under no circumstances shall ABB or ABB:s suppliers be liable for incidental or consequential damages arising from connecting the vision system / WAN port to any other network.

2.7 Licensing information

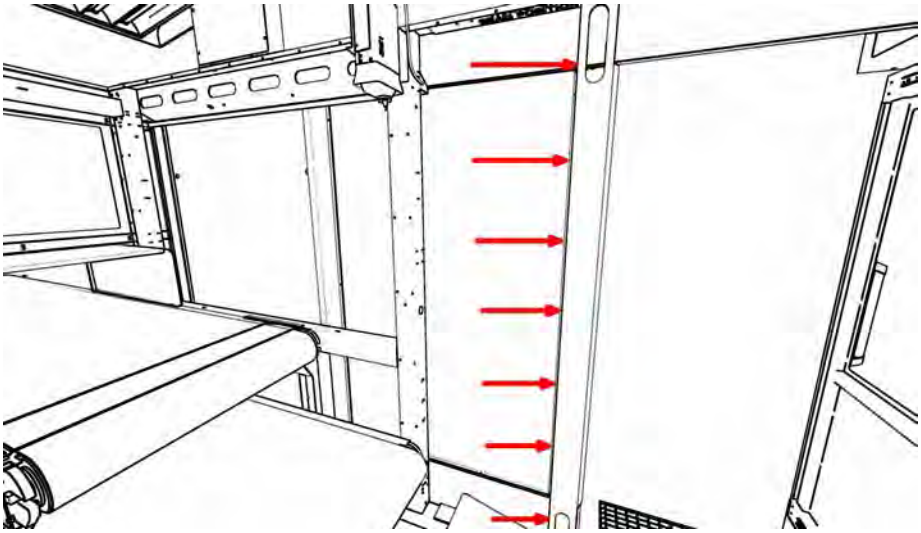
By installing and using the FlexMT and its PickMT SmartCamera you agree to Microsoft and Matrox licensing agreements. These can be found on the PickMT SmartCamera.

2.8 Moving the FlexMT

CAUTION

Mechanically stabilize the FlexMT prior to transporting it again.

The stabilizing stag close to the FlexMT:s machine opening has to be fitted to the FlexMT prior to any transport. This stag was delivered and fitted to the FlexMT for original delivery.



Transportation stability ensured by stag.

This page is intentionally left blank

3 Commissioning

3.1 Safety

Carefully read the section on safety in this manual prior to commissioning.

3.2 User accounts

CAUTION

The FlexMT uses several standard user accounts.The user is strongly advised to change the standard passwords in order to reduce the risk of non-authorized access to important system parameters.

PickMT

Administrator account, which is used for all administrative purpose.
User: Administrator, Password: Administrator

Operation account, which is used for daily operation. Restricted access.
User: PickMT, password: PickMT

Robot

Standard access is performed by the DefaultUser. Please follow ABB:s advice on user rights administration.

Safety related work (i.e. SafeMove) is performed with the SafetyUser account.
User: SafetyUser, password: SafetyUser

Pluto

Normally, the Pluto program must not be accessed nor the program changed. However, if re-configuration or downloading of programs is necessary, the passwords can be found in the SafetyCenter manual, together with in-depth configuration and downloading information.

3.3 Basic steps

- Switch on power.
- Perform the power-on safety check according to the SafetyCenter manual (press emergency stop, open door, reset emergency stop, close door, reset door safety, reset emergency stop).
- Check the function of the external emergency stop.

DANGER

Do not continue commissioning until the safety circuits are functioning.

3.4 Vision system PickMT

FlexMT is delivered with PickMT pre-installed and pre-configured on the PickMT SmartCamera.

Tip

Do not install any updates or patches if not advised from ABB or ABB:s subsupplier.

- Visually check that the all parts of the illumination system are working. If not, replace illumination according to the maintenance section.
- Visually check the camera image for any signs of artefacts (misalignment, blurring, dirt). If necessary, take appropriate actions, e.g. realignment, adjusting focus, lens cleaning, ... according to the maintenance section.
- Keep in mind that the smart camera has limited system resources for non-vision related tasks. Do not strain neither memory nor hard disk space.

Tip

Immediately after initial commissioning, start maintaining your own system backups.

- Now you can start teaching your first details.
- Refer to the PickMT manual for detailed information on teachin, configuration and problem solving.

Tip

If pre-installation and pre-configuration data of the PickMT system should get lost for any reason, you can find a primary backup on the robot harddisk. Refer to the repair section for detailed information.

3.5 Robot system

FlexMT is delivered with a pre-installed and pre-configured robot gripper system and robot program. For details on the structure of the FlexMT robot software refer to section on robot programming.

Commissioning includes the following main steps:

- Adjusting robot coordinate systems,
- establishing the FlexMT - machine tool communication interface and
- adopting the robot program to the individual automation needs.

Note

FlexMT commissioning uses standard robot functionality for maintaining work objects, tool data and other settings. Please refer to the robot product manual for this standard functionality.

Continues on next page

3.5.1 Robot base coordinate system

The robot is mounted on an inclined pedestal for better reach and accessibility to the machine tool. In order to simplify handling and jogging of the robot, the robot base coordinate system shall be parallel to the floor (not angled), preferably with either the X or Y axis parallel with the front of the machine tool.

The following values were changed in the robot configuration (cf. MOC.CFG) in order to take inclination into account.

- gravity_alpha, gravity_beta
- base_frame_orient_u0, base_frame_orient_u1, base_frame_orient_u2, base_frame_orient_u3
- base_frame_x, base_frame_y, base_frame_z

DANGER

Do not change position or orientation of robot base coordinate system, as this will affect the SafeMove configuration.

3.5.2 Calibration of coordinate systems

All robot coordinate systems that are used in the FlexMT are pre-defined from factory. However, they should be redefined to compensate for possible changes due to transportation and setup.

Calibration point markers

Most calibration points are represented by circles with a pointing mark. The tip of the calibration tool should be as close as possible to the center of the circle, as pointed out by the pointing mark.

Appearance of a typical calibration mark

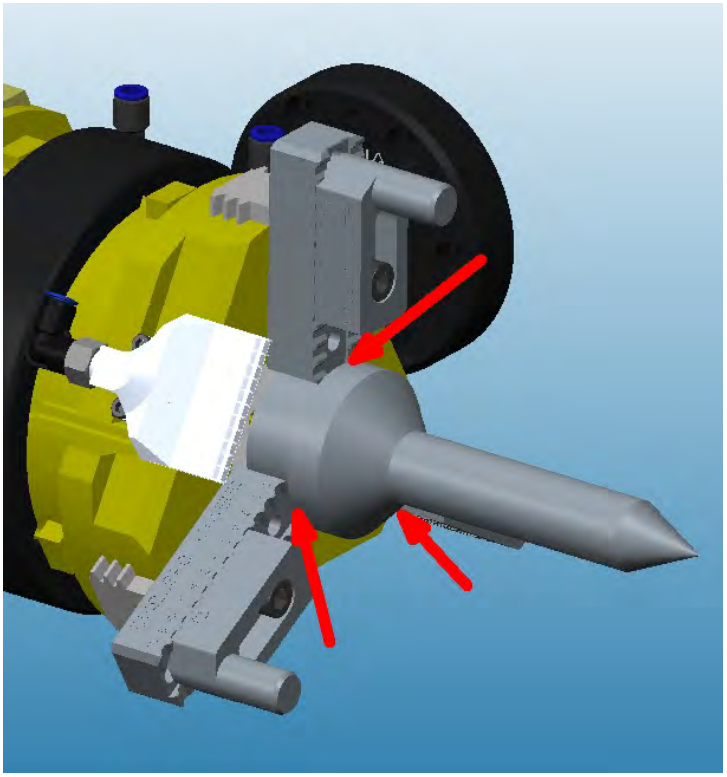
Continues on next page

3.5.2 Calibration of coordinate systems
Continued

Calibration tool fitting

The calibration tool shall be placed and gripped in the gripper. The flat surface must be firmly pressed on the contact points on the adjustable finger base, as pointed out in the illustration below.

The calibration tool is predefined with name tCalibTool1 (if calibration tool is gripped in Gripper1), or tCalibTool2 (if calibration tool is gripped in Gripper2). For gripper notation check marking on the gripper unit.



Calibration tool mounted to the gripper.

Prior to the actual calibration, please check the accuracy of the calibration tool by appropriate means, e.g. reorientating with respect to a well defined position. Suitably, this can be done by reorienting the robot around a sharp tip. If necessary, redefine the tool definition for the calibration tool.

Tip

Follow well established guidelines for calibration tools and work objects as described in the robot manuals.

Calibration aiding procedures

All of the work objects below shall be calibrated by standard 3-point work object calibration. Some of them will need a point-of-interest, where parametrized movement routines will perform their work. In most cases, the tool orientation in the point-of-interest will be used during later movements. Refer to each work object for more detailed information.

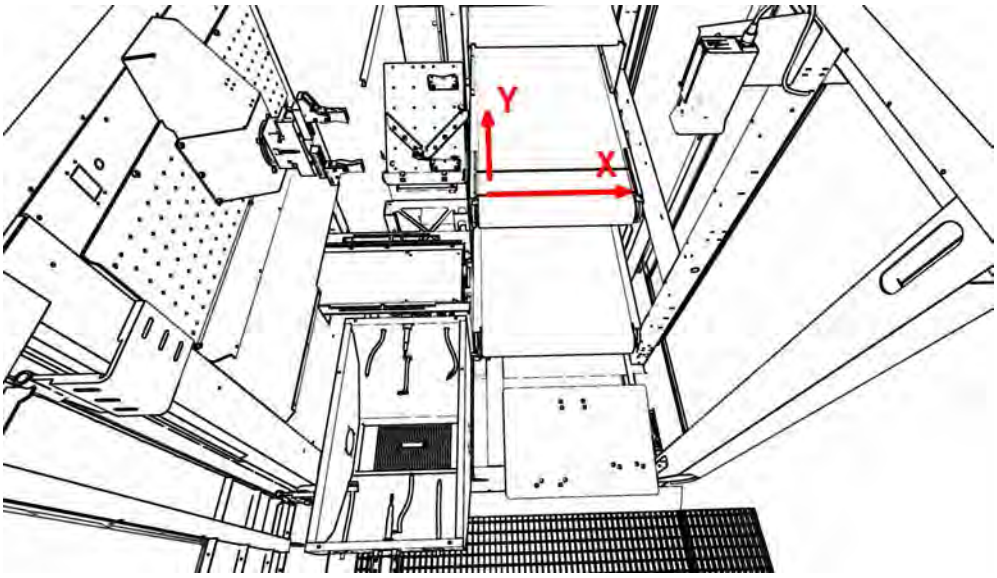
Continues on next page

If a point-of-interest is defined, FlexMT supplies a calibration routine that assists the operator in doing the calibration. All calibration aiding procedures have the same appearance. The operator confirms calibration of the selected point-of-interest, selects which calibration tool is used, follows the instruction on where and how to point the calibration tool, and confirms the current position.

The following coordinate systems shall be redefined (if the corresponding option is present on the FlexMT). The position of the calibration points can be found in the images below.

Camera coordinate system wCamera

Coordinate system for picking from inconveyor. Follow the calibration instructions in the PickMT manual. Standard 3-point calibration.



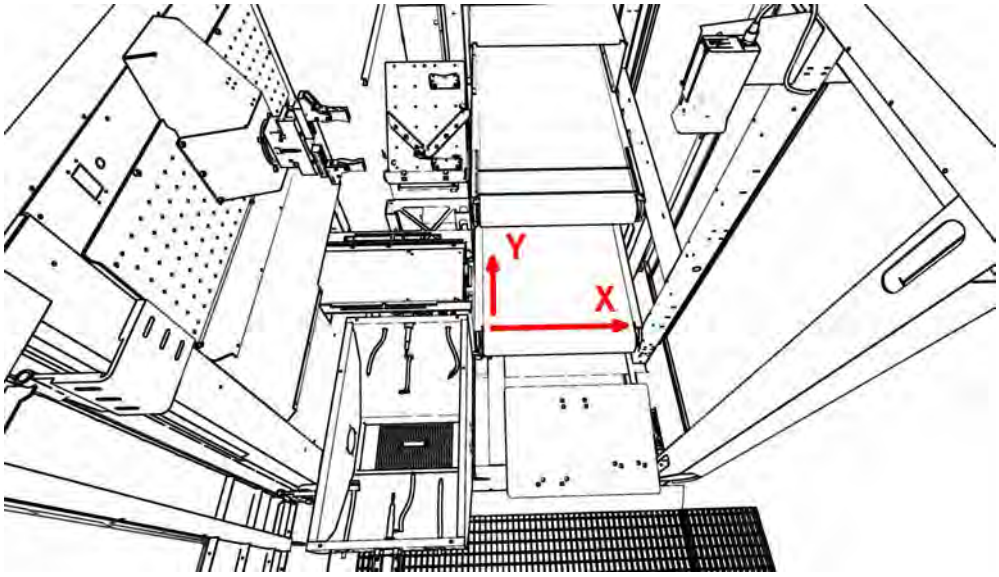
Approximate positioning of wCamera in the FlexMT

Continues on next page

3.5.2 Calibration of coordinate systems
Continued

Outbelt coordinate system wFeederOut

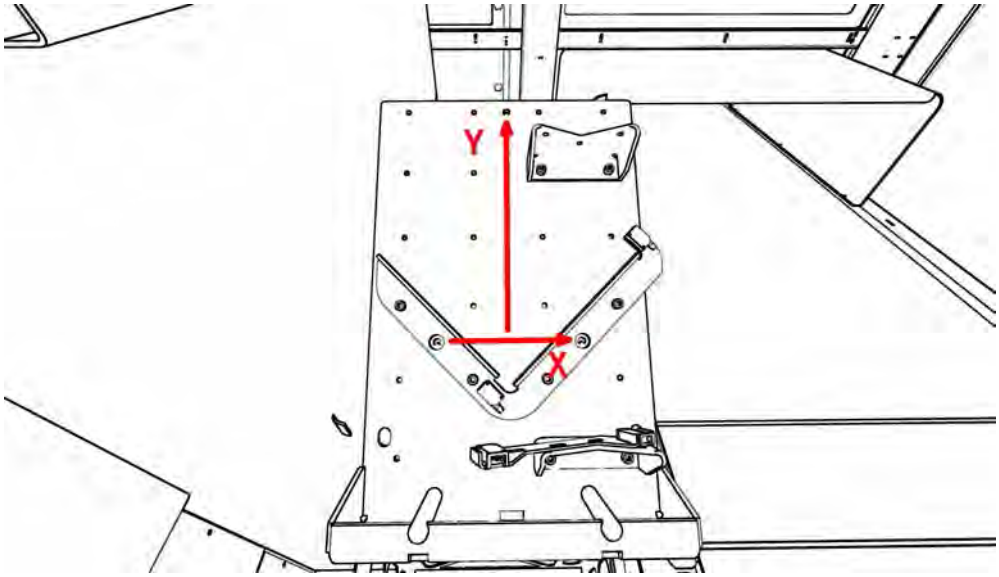
Coordinate system for leaving on outconveyor. The X-axis is above the rotation roller's shaft, the Y-axis is at the left belt edge and in the belt's direction of movement, the Z-axis points upwards. Follow the calibration instructions in the PickMT manual, section FeedLine Light. Standard 3-point calibration.



Approximate positioning of wOutBelt in the FlexMT

Re-grip table wRegrip

The re-grip table coordinate system wRegrip is oriented as follows. Standard 3-point calibration.

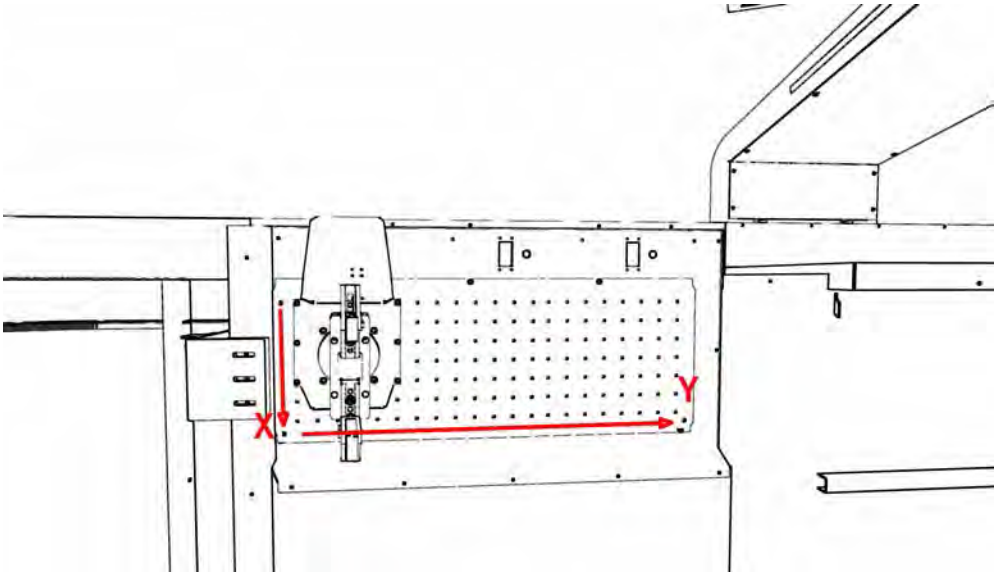


Approximate positioning of wRegrip in the FlexMT

Continues on next page

Turning station wTurnStation

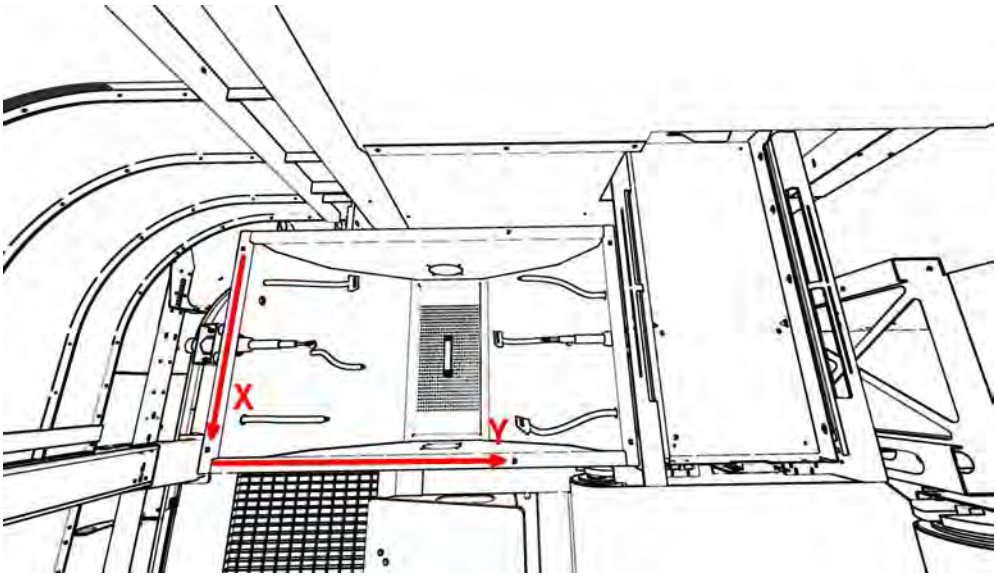
The turning station coordinate system wTurnStation is oriented as follows. Standard 3-point calibration.



Approximate positioning of wTurnStation in the FlexMT

Air cleaning box wAirClean

The air cleaning box coordinate system wAirClean is oriented as follows. Standard 3-point calibration. Afterwards, call the calibration routine CalibAirClean. The point of interest should be in the middle of the air cleaning box, at the height where the air cleaning starts. Note that orientation of the tool is used in pre-configured movements.



Approximate positioning of wAirClean in the FlexMT

Deburring tools wDeburr

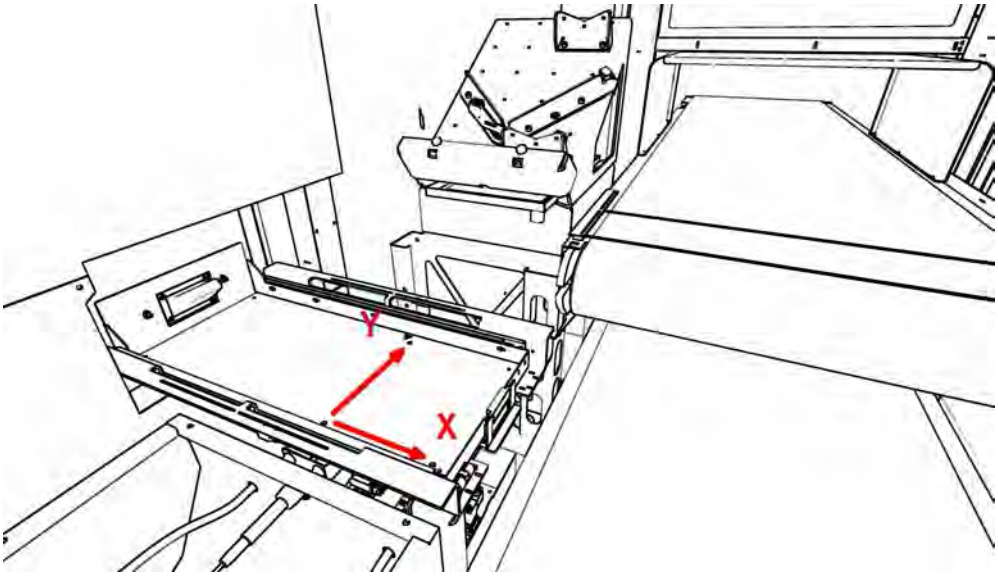
Continues on next page

3.5.2 Calibration of coordinate systems
Continued

The grinding and deburring tools are accessed from their own coordinate system wDeburr. In the pre-configured setup, wDeburr is identical to wAirClean. Standard 3-point calibration.

Statistical outlet wSample

The statistical outlet coordinate system wSample is oriented as follows. Standard 3-point calibration. Afterwards, call the calibration routine CalibSampleOutlet. The point of interest should be in the center of the sample outlet surface, where the sensor will detect parts. Note that orientation of the tool is used in pre-configured movements.



Approximate positioning of wSample in the FlexMT

Continues on next page

Marking unit wMarker

The marking unit coordinate system wMarker is oriented as follows. Standard 3-point calibration. Use the three mounting holes on the marking unit as calibration points (X1, X2, Y1) and lower the calibration tool into the holes. No exact positioning of this coordinate system is necessary due to the nature of the marking process.

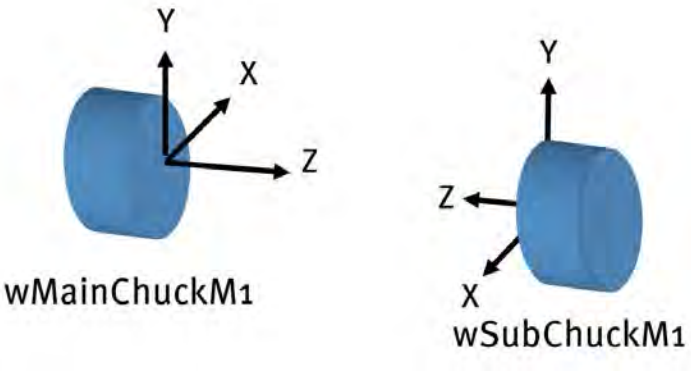
Approximate positioning of wMarker in the FlexMT

Afterwards, call the calibration routine CalibMarker. The point of interest is where the calibration tool touches the marking needle. Note that orientation of the tool is used in pre-configured movements.

Machine tool main and sub chuck wMainChuckM1, wSubChuckM1

Coordinate system for the machine tools main chuck and sub chuck.

The coordinate systems X-Y plane for a chuck must be at the front plane of the main and sub chuck, with x=0,y=0 at the chuck's rotation shaft. The typical machine tool for this application is a lathe.



Perform a standard 3-point calibration of wMainChuckM1 and wSubChuckM1 according to the coordinate directions above.

Continues on next page

3.5.2 Calibration of coordinate systems
Continued

Call the routine CalibMainChuck and follow instructions. On request, a cylindrical part must be gripped with the main chuck. Position the robot so that this part can be gripped by the machine tool chuck gripper, precisely centered. Confirm to the calibration routine. From the current robot position, the object frame of wMainChuckM1 is now moved to be located exactly in the main chucks center.

Call the routine CalibSubChuck and follow instructions. On request, a cylindrical part must be gripped with the sub chuck. Position the robot so that this part can be gripped by the machine tool chuck gripper, precisely centered. Confirm to the calibration routine. From the current robot position, the object frame of wSubChuckM1 is now moved to be located exactly in the main chucks center.

If the chucks are movable, the calibration must be checked, so that the z-axis in wMainChuckM1 and wSubChuckM1 is in line with actual chuck movement (even for long movements).

3.5.3 Further integration steps

The pre-configured robot software for FlexMT contains suggestions for a working application skeleton.

Note

Please follow suggestions in the section about robot program for building your own applications. Further in-depth reading of the PickMT manual with its section on robot integration and FeedLine Light is strongly recommended.

- Immediately after initial commissioning, start maintaining your own system backups.

If pre-installation and pre-configuration data of the robot system should get lost for any reason, you can find a primary backup on the PickMT system harddisk. Refer to the repair section for detailed information.

3.6 Machine tool

The FlexMT system provides a framework for handling the most common machine tool interface types.

Interaction with the machine tool is handled by a machine tool specific module (Machine.sys). This module translates actual machine tool communication signals into a standardized set of commands to be understood by FlexMT.

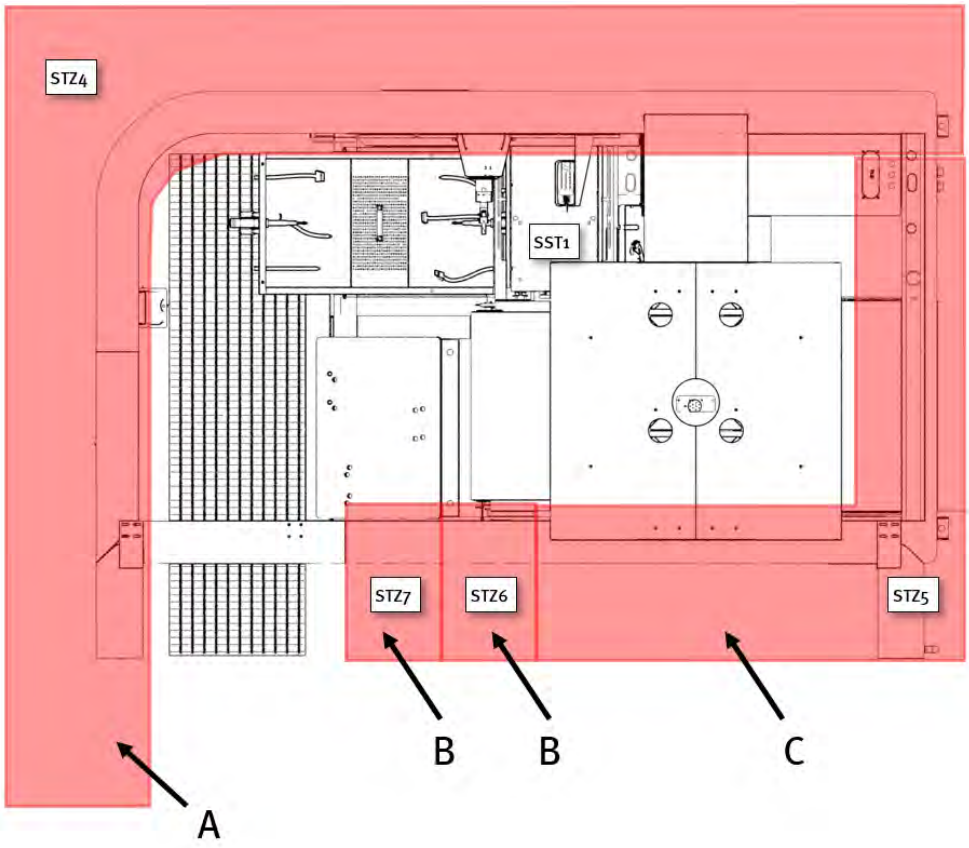
This standardized set of commands can be expanded and adopted. Due to the large variety of machine tool interfaces and integrator needs, it is the integrators responsibility to implement this interface module.

Refer to section on machine tool connection for hardware information and section on robot program for further implementation suggestions.

3.7 SafeMove

The FlexMT comes with a standardized setup for the SafeMove system. The delivery setup is as follows:

- STZ4, ST5, ST6, and ST7 define forbidden areas based on the contours of the FlexMT shell. At the same time, they limit the maximum robot speed to 1200 mm/s (-> use max v1000 in robot).
- SST1 ensures that the robot is kept at standstill when the statistical outlet is opened. Opening the statistical outlet while the robot is moving leads to an immediate SaveMove safety violation. SST1 is activated by an external sensor supervising the statistical outlet.
- SafeMove manual override is placed out of reach for the operator (i.e. inside the control cabinet), i order to minimize abuse and to protect the equipment.



Schematic positions of SafeMove zones within the FlexMT. The marked areas are forbidden zones.

When delivered, all SafeToolZones are activated. If the opening towards the machine tool is enlarged by removing one of the flexible panels, the corresponding SafeToolZone should be deactivated. Standard opening (850mm): STZ6 and STZ7 must be activated. Medium opening (1300mm): STZ7 can be deactivated. Wide opening (1500mm): STZ6 and STZ7 can be deactivated.

The areas close to the machine tool (A, B, C) must in same cases be adopted to the actual machine tool layout.

Continues on next page

Follow standard SafeMove configuration routines as described in the robot manual.

DANGER

If the intended use of the FlexMT is changed, a new risk assessment with regard to SafeMove configuration must be done.

3.8 Marking unit

3.8.1 General

The marking unit is a standard FlexMT option. The hardware consists of a SIC marking equipment, i.e. an i52 marking head with an E10 controller unit.

During operation, the robot communicates by means of serial communication with the controller unit. The robot must thus be equipped with the serial communication option.

For in-depth information refer to the section on pre-configuration data.

3.8.2 Configuration changes

The controller unit is pre-configured for use with the FlexMT. Configuration changes can be done by using the SIC controller configuration software (delivered on the SmartCamera storage, to be installed on a separate PC, communication with standard USB cable).

Typical changes might be modifications of the marking setup files. FlexMT is using three different marking files for different sizes: SMALL, MEDIUM, LARGE.

For in-depth information refer to the section on pre-configuration data, especially if you intend to modify the marking units configuration.

3.9 Deburring/grinding unit

The deburring/grinding unit is a standard FlexMT option. The hardware consists of an Atlas Copco pneumatic die grinder LSF28 ST030E and a Nitto pneumatic filer ASH-900.

These units can be equipped by any suitable tools according to the customer needs.

This page is intentionally left blank

4 Function description

4.1 General

WARNING

Appropriate training is required in order to use FlexMT. Incorrect use of the product can lead to personal injury and material damage.Before commissioning the product, it is your responsibility to carefully read the chapter, ”Safety precautions”, and to be familiar with the safety devices.

FlexMT is a module based automation cell for handling parts in machine tending applications. The system can easily be adapted to the requirements of the customer.

In a typical application FlexMT is integrated with a machine tool. The operator places parts on a conveyor belt that acts as a buffer. The robot picks the parts from the conveyor belt. A vision system with camera that is located above the conveyor belt guides the robot to the correct grip position. After that all parts under the camera have been picked, the conveyor belt feeds new parts forward.

FlexMT can be configured with a variety of useful options. Please refer to the product specification for further details.

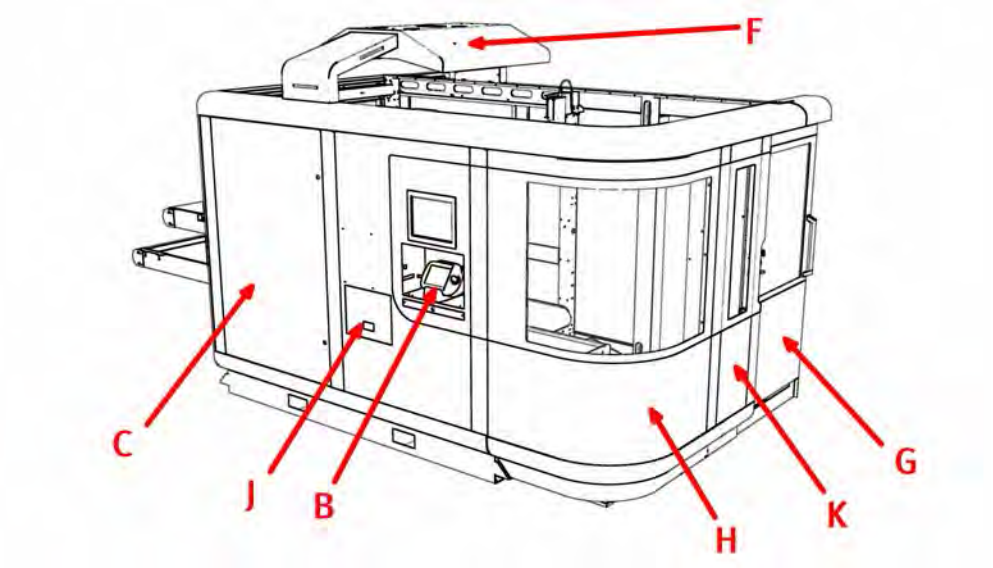
4.2 Overview

FlexMT contains numerous mechanical devices and sensors that are important to know about in order to understand the function.

Continues on next page

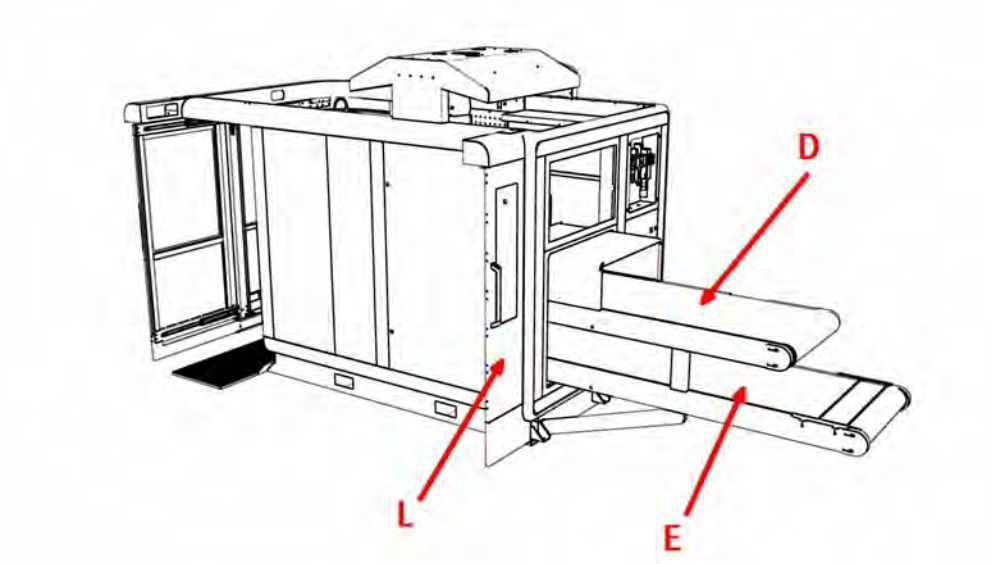
4.2.1 Functional units

The FlexMT consists of the following main parts:



Schematic overview with FlexMT functional units (1)

B Operators panel, C Electrical cabinet with IRC5 panel mounted controller, F Vision system and illumination, G Retractable sliding door with entry control, H Swing door, J Statistical outlet, K Extension panel door.



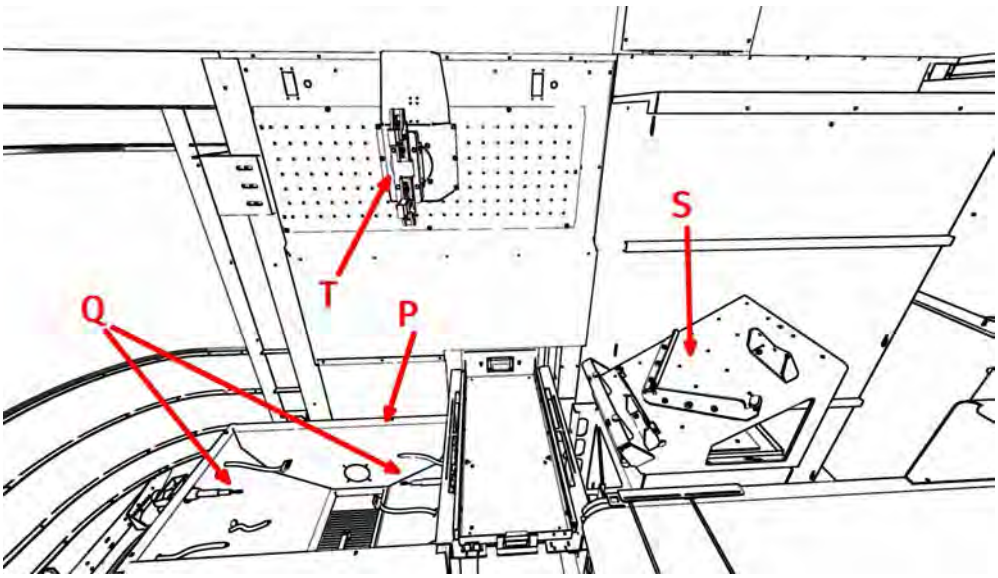
Schematic overview with FlexMT functional units (2)

D Inconveyor, E Outconveyor, L Extension panel back

Continues on next page

4.2.1 Functional units
Continued

The main options the FlexMT can be equipped with are:

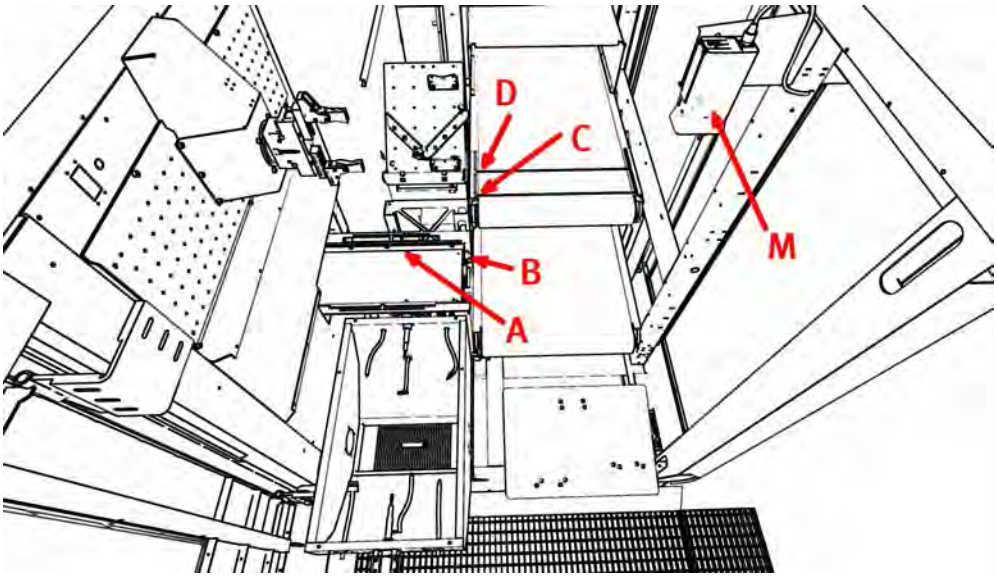


Schematic overview with FlexMT functional options

M Marking unit, P air cleaning box, T Turn unit, S re-grip table, Q Deburring Tools

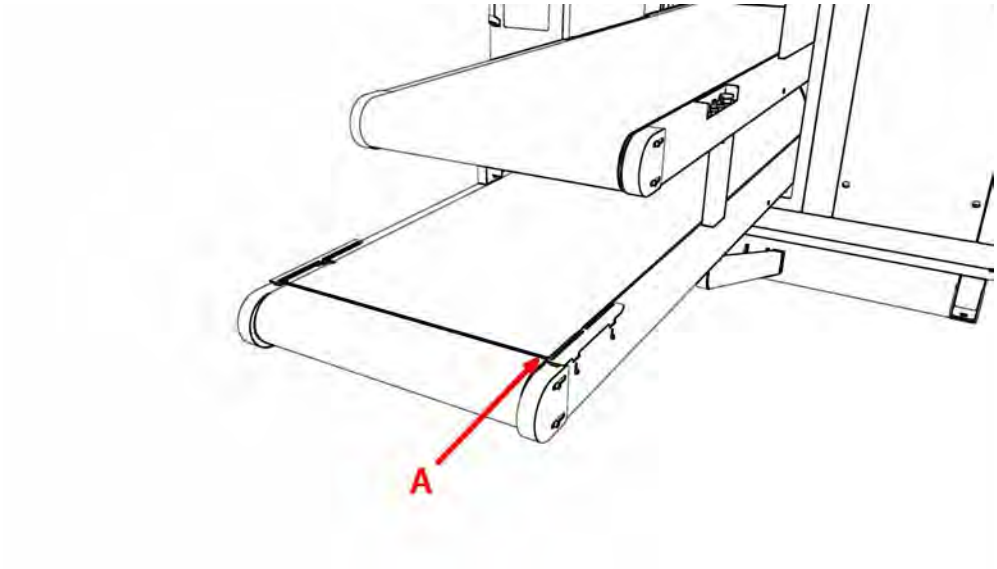
4.2.2 Sensors

The main sensors the FlexMT can be equipped with are:



Schematic overview with sensors (1)

- A Sensor that detects if a part has been placed on the statistical outlet.
- B Safety sensor that ensures that statistical outlet is closed when the robot moves inside this area.
- C Inconveyor TooFar-sensor, detects if parts on the inconveyor have been transported to far. This is usually due to unidentified parts.
- D Inconveyor InPosition-sensor, detects that a part has been transported into the cameras field of view.



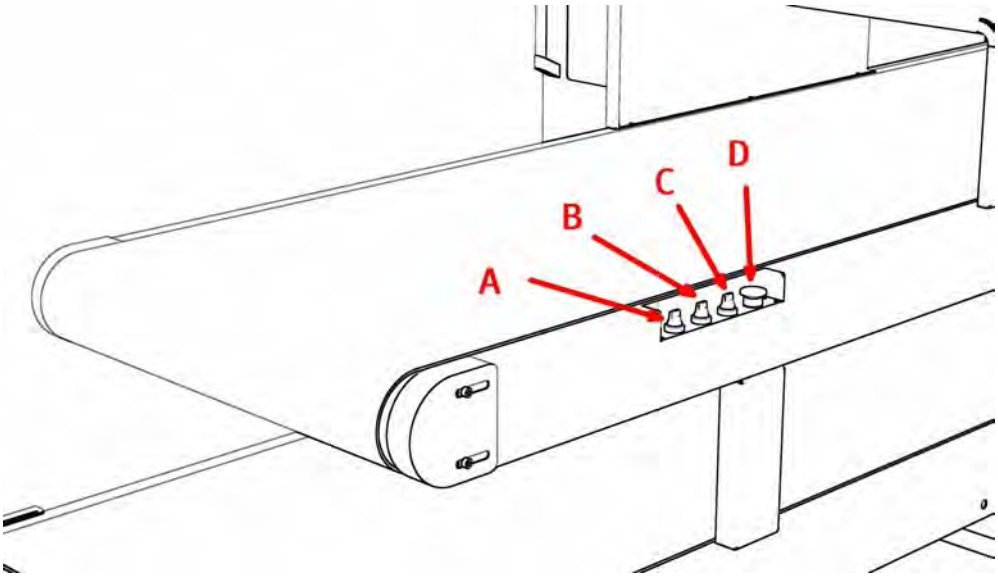
Schematic overview with sensors (2)

- A Outconveyor ToFarOutbelt-sensor, detects when a part arrives at the end of the outconveyor.

4.2.3 Operator panels

The main operator panels of FlexMT are situated at the start of the inconveyor, below the vision system screen, and at the sliding door towards the machine tool.

The operating panel at the start of the inconveyor controls basic conveyor operation.



Operator panel at start of inconveyor

- A Move inconveyor forward and backward, reset errors by shortly switching the knob to ”Move Forward”.
- B Function selector inconveyor: Manual or Automatic, with visual indicator.
- C Function selector for OutConveyor: Automatic mode or emptying mode.
- D Emergency stop button.

Continues on next page

The operator panel below the vision system screen contains the robot operator panel, i.e. FlexPendant, safety and motor controls, and a USB connection for data transfer to and from the vision system.

FlexMT main operator panel

- A Robot operator panel (Emergency stop, Motors On, Operating mode witch Auto/Manual with reduced speed)
- B Illumination switch, turns illumination on or off.
- C USB connector, located below the vision system screen.

Continues on next page

4.2.3 Operator panels
Continued

The operator panel at the sliding door combines the following elements:

FlexMT operator panel at sliding door

- A Emergency stop
- B Start robot (if in home position)
- C Request cell entry and request confirmation lamp
- D Door reset (after cell entry)
- E Reset of emergency stop.

4.3 General function description

The purpose of FlexMT is to feed parts to the cameras field of view where they are to be identified by a camera and picked by a robot. The inconveyor is filled with parts manually. Finished parts are left on the outconveyor. These are then picked manually by the operator.

The belt system of the FlexMT is controlled by a number of background tasks (FlexMT core functions).

Continues on next page

4.3.1 Functions for inconveyor

- Two operation modes, either manual or automatic operation. Changing operation mode by operator and after confirmation from robot.
- Forward and backward operation using a switch.
- Sensor to stop the belt when the part reaches the cameras field of view.
- Sensor to stop the belt when the part reaches the end of the belt.
- Adjustable belt speed, changed at frequency inverter.
- Time monitored belt stop with manual reset.
- After powering FlexMT and after emergency stop, the inconveyor is stationary.

4.3.2 Functions for outconveyor

- Two operation positions, either automatic operation or emptying. Changing operation mode via operator.
- Sensor to stop the belt when the part reaches the end of the belt.
- Time monitored belt stop with manual reset.
- In order for outconveyor in emptying mode to start running after powering up or emergency stop, a brief switch to automatic operation and back to emptying mode is required.

4.4 Functions for marking unit

This manual describes the basic operations controlled during automatic operation, control operation, and basic setup operation. In-depth information is given in the manual of the marking unit. This manual can be found in the documentation folder on the SmartCamera.

During automatic operation, the robot controls the start and stop of marking. Communication is performed by means of standard serial channel communication.

4.5 Functions for other options

Functions for other options, e.g. air cleaning box, deburring, turn station and re-grip table, are controlled by various output signals directly from the robot.

This page is intentionally left blank

5 Robot program

5.1 Safety

WARNING

Applicable training is required in order to use the product. Incorrect use of the product can lead to personal injury and material damage.Before programming the FlexMT, it is your responsibility to carefully read the chapter on safety, to become familiar with the FlexMT and its options, and to become familiar with the safety devices.

5.2 Overview

The FlexMT RAPID code consists of three main blocks, all of which are necessary to run the FlexMT:

- PickMT core code.
  This code handles the interface and the communication to and from PickMT. No changes should be made to this code.
- FlexMT core code.
  This code handles feeder subsystem, operator interaction, and some assistant functions for the FlexMT. No significant changes should be made to this code, especially not the feeder subsystem.
- FlexMT application code.
  This code handles the complete workflow of parts in the cell (e.g. unloading and loading of parts, option handling, picking from inconveyor, leaving on outconveyor, …).
  This code consists of a basic executable skeleton, which can be modified by the integrator in order to match the actual application.
  However, the basic structure should be followed to ensure smooth operation.

The FlexMT application code contains also a template for a machine tool interface, which must be modified and adopted to the actual machine tool by the integrator.

The provided application code offers two possibilities:

- Application code for parameter based simplified TeachIn for upright standing cylindrical parts, the so called FeedLine Light
- Application code for a general teachin. No general robot program can be provided for unknown parts, so that the skeleton has to be adapted to each new part.

The following sections describe parts that are relevant for commissioning and adopting the code skeleton to the actual application. Further information on the three main parts can be found in the technical appendix.

5.3 Machine interface module (TemplateMachine.sys)

5.3.1 Overview

The FlexMT standard modules communicate with the machine tool by means of the interface module TemplateMachine.sys. Read this module and the comments to each function, in order to add machine tool specific code where needed.

5.3.2 States and actions

This module contains a number of predefined states and actions that are consistently used throughout the FlexMT. If needed, new values can be added. However, do not remove existing values, as they are used in the FlexMT core functionality.

Examples for predefined values are:

- Predefined machine checks/waits:
  DOOR_OPENED, PREPICK_OK, LOAD_SUB_OK, LOAD_MAIN_OK, UNLOAD_SUB_OK, UNLOAD_MAIN_OK, HOME_POSITION_OK
- Predefined machine actions:
  CLOSE_CHUCK_MAIN, CLOSE_CHUCK_SUB, CLOSE_DOOR, OPEN_CHUCK_MAIN, OPEN_CHUCK_SUB, PREPARE_LOAD_MAIN, PREPARE_LOAD_SUB, PREPARE_UNLOAD_MAIN, PREPARE_UNLOAD_SUB, OPEN_DOOR, CYCLE_START, INIT_MACHINE, STOP_MACHINE

5.3.3 Procedures, functions and traps

The module contains a number of predefined traps for information transfer with machine tool:

Name	Description
TRAP PrePickTrap	Receives information from machine tool that a part soon needs to be loaded. If needed, add code to confirm to machine tool that signal has been received.
TRAP DoorClosedTrap	Used on machine tools with slow doors. Signal is caught by trap instead of foreground program so that robot can continue work. Confirms to machine tool that door closed signal has been received and whole loading sequence is finished.

The module contains a number of predefined procedures/functions for communication with machine tool:

Name	Description
PROC InitMachine	Initiate whats neccessary for machine handling. Sets up traps. NEEDED: Set up correct signals for interrupt handling.
PROC MachineAction (string sAction)	Performs desired machine tool action. NEEDED: Define signals and communicate with machine tool.
FUNC bool MachineCheck (string sCheck)	Checks machine tool and conditions and returns correct state for use in main flow of program. NEEDED: Define signals and communicate with machine tool.
FUNC bool MachineWait (string sWait,num nMaxTime)	Waits for machine condition to be ok within nMaxTime. Returns false if nMaxTime elapses. NEEDED: Define signals and communicate with machine tool.

5.3.4 Communication flow

Depending on the type of the machine tool and the type of application a variety of communication flows are possible.

A typical machine tool communication flow for a load-unload sequence as realized in the standard setup could be (Pseudo-RAPID) as follows. Note that no movement is included in this schematic code.

```
MachineAction INIT_MACHINE;
Await MachineCheck(LOAD_MAIN_OK)=TRUE;
MachineAction PREPARE_LOAD_MAIN;
MachineAction OPEN_DOOR;
Await MachineWait(DOOR_OPENED,10);
! Enter machine tool and load part
MachineAction CLOSE_CHUCK_MAIN;
MachineAction PREPARE_UNLOAD_SUB;
! grip detail
MachineAction OPEN_CHUCK_SUB;
! leave machine
MachineAction CLOSE_DOOR;
MachineAction CYCLE_START;
```

Different machine tools have different behavior. As described in the previous section, FlexMT supplies a comprehensive set of tools and adoption possibilities to handle these behaviors.

5.4 Main module (MainModule.mod)

The main module contains the overall logic within the FlexMT. It contains the following procedures and functions:

Name	Description
FUNC bool CheckInPosition()	This routine checks if the feeder subsystem is in position for taking a new image.
FUNC num CheckPos()	This procedure checks where the robot is positioned. Returns correct number for the zone the robot currently is positioned in.
PROC CheckSystem()	This procedure checks if end-of-cycle or entry has been requested, checks what to do next, and enters the actual state.
PROC GoHome()	Not to be used from any position. Make sure robot can move to closest via position before calling this. Robot must be jogged in manual to a position where it is possible to go straight to closest via-position.
PROC InitGrippers()	Initiate tGripper1 and tGripper2. These are used in the program to get information about the used grippers. If your cell has switchable grippers add or replace conditions in this procedure for nLoadGripperNumber. nLoadGripperNumber is changed from PickMT in case of FeedLine Light detail.
PROC InitializeMain()	This procedure holds all initialization made when starting the robot program from the beginning. Add all initialization for the current application here.
PROC LoadCameraModules()	Loads camera modules as specified by PickMT. Check comments in RAPID code for details.
PROC PickCamera()	Grabs new image from camera, waits for new coordinates and picks part from the conveyor. If an image problem occurs, there will be a couple of retries before stopping.
PROC ResetMessages()	This procedure resets error, warning and information flags. Make sure to check conditions for still active error/warning/information before reset. The resets in this routine is mainly for reset of machine roof light indications.
PROC SyncRoutine()	This procedure is executed to check synchronization needed. Brake check is performed automatically.

5.5 Part specific modules (ModCam1.mod)

The provided part specific application code offers two possibilities:

- Application code for a general teachin.
  No general robot program can be provided for unknown parts, so the skeleton has to be adopted to each new part. Positions, movements and option handling have to be modified or generated for each new part.
  This is the most general and open approach to machine tending.
- Application code for parameter-based simplified TeachIn for upright standing cylindrical parts (so called FeedLine Light).
  A generic robot program based on geometrical part data is executed. No robot programming is necessary for different parts, and teachin is reduced to entering a few geometrical parameters.
- Application code for parameter-based simplified TeachIn, but with modified robot program. Both approaches can be combined, where picking parts and tending the machine is handled as in Standard FeedLine Light, but the option handling can be programmed part specific.

DANGER

These routines are provided as example code. You have to ensure that they are working with the actual parts and process.

Continues on next page

5.5.1 FeedLine Light operation

The ModCam1.mod module for FeedLine Light operation contains part specific movement, option handling and machine tool handling.

DANGER

The handling routines are called for each part. Make sure your code is good for all parts, else activate the option “special robot program” from PickMT.

It contains the following base procedures and functions:

Name	Description
PROC InitializeCam()	Initializes camera and part specific data.
PROC MainRoutine()	This is the main routine for FeedLine Light It checks for entry request, maintenance request and other production breaking conditions. Then it calls the state logic to decide what to do next.
PROC MoveRobotTo(num nTargetZone)	This routine moves the robot to a selected zone. Argument: nTargetZone, to where the robot should move.
PROC Pick()	This routine performs the actual picking of a detail from belt at camera position.
PROC RefPosIn()	This routine is called to approach camera belt before picking.
PROC RefPosOut()	This is an intermediate position used when leaving the picking area. Update this position to suite the current application.
PROC GripDetail(\switch Left_over_part)	This procedure close the gripper on the active tool.
PROC ReleaseDetail()	This procedure releases the gripper on the active tool. It will also set correct information for gripper, what is carried, mass and center of gravity. Also it will call load compensation calculation.
FUNC string StateLogic()	Checks setup and machine condition and selects correct state in main program flow. I.e. this function handles the main program flow.
PROC StopRoutine()	This procedure is executed when PickMT is stopped
PROC LeaveFeederOut()	Leave detail on out belt. This routine uses help functions in FeederOut.sys, to make those work the SetUpFeederOut must be called during initialization. Note! Position that is sent as argument to CalcFeederOut-LeaveTarget is overwritten with next leave position.

It contains the following option handling procedures and functions.

Name	Description
PROC AirCleanDetail()	Example code to air clean solid cylindrical parts.
PROC DeburrDetail()	Example code for deburring.
PROC LeaveSampleOut-let()	Example code for leaving the finished detail in the statistical outlet.
PROC MarkDetail()	Example code for marking detail.
PROC TurnDetail()	Example code for turning detail before loading machine.

Continues on next page

5.5.1 FeedLine Light operation
Continued

Name	Description
PROC WashDetail()	Example code for washing detail.
PROC RegripDetail()	Example code for regripping detail.

It contains the following general machine tool handling procedures and functions. Note that the GLOBAL procedures (like LoadMachine_MAIN) are called from MainRoutine and perform logical work, whereas the LOCAL routines (like LoadMAIN) perform the actual movement work.

Name	Description
LOCAL PROC EnterMachine(\switch Gripper1FaceMAIN|switch Gripper1FaceSUB)	This procedure is for moving robot into machine. Add positions here if necessary. pViaMachine1/pViaMachine2 is in this example code a position inside the machine where both chucks are reachable and the gripper could turn around without crashing. pViaMachine1 is placed with gripper 1 facing main chuck. pViaMachine2 is placed with gripper 1 facing sub chuck.
LOCAL PROC ExitMachine(\switch Gripper1FaceMAIN|switch Gripper1FaceSUB)	This procedure is for moving robot out of machine. Add positions here if necessary. pViaMachine1 / pViaMachine1 see above. pViaMachine is in this example code a position just outside the machine tool where the robot can request the machine to close its door.
PROC LoadMachine_MAIN()	This procedure is for loading the main chuck in machine tool.
PROC LoadMachine_MAIN_UnLoad_SUB()	This procedure is for loading the main chuck and unloading the sub chuck.
LOCAL PROC LoadMAIN()	This procedure loads detail in main chuck. Make sure to use EnterMachine before all loading/unloading and ExitMachine after all loading/unloading The load position is always calculated. X and Y is set to 0 and Z is calculated with help from PickMT values. To change the leave position, adjust “wMainChuckM1” by running the procedure “CalibMainChuck”
PROC SynchroneousMode()	This procedure unloads sub chuck and then waits for machine to be ready before loading main chuck and leaving on out belt
LOCAL PROC UnloadLeftOverPart()	This procedure unloads left over part in main chuck. Make sure to use EnterMachine before all loading/unloading and ExitMachine after all loading/unloading. The unload position is always calculated. X and Y is set to 0 and Z is calculated with help from PickMT values. To change the unload position, the work object has to be adjusted until the position is correct. In this case adjust “wMainChuckM1” by running the procedure “CalibMainChuck”
PROC UnloadMachine_LeftOverPart()	This procedure is for unloading the LeftOverPart from the machine tool.
PROC UnLoadMachine_MAIN()	This procedure is for unloading the main chuck in machine tool.
PROC UnloadMachine_MAIN_Load_MAIN()	This procedure is for first unloading and then loading the main chuck in machine tool.
PROC UnLoadMachine_SUB()	This procedure is for unloading the sub chuck in machine tool.

Continues on next page

Name	Description
LOCAL PROC Unload-MAIN()	This procedure unloads detail in main chuck. Make sure to use EnterMachine before all loading/unloading and ExitMachine after all loading/unloading. The unload position is always calculated. X and Y is set to 0 and Z is calculated with help from PickMT values. To change the unload position, the work object has to be adjusted until the position is correct. In this case adjust “wMainChuckM1” by running the procedure “CalibMainChuck”
LOCAL PROC Unload-SUB()	This procedure unloads detail in sub chuck. Make sure to use EnterMachine before all loading/unloading and ExitMachine after all loading/unloading. The unload position is always calculated. X and Y is set to 0 and Z is calculated with help from PickMT values. To change the unload position, the work object has to be adjusted until the position is correct. In this case adjust “wSubChuckM1” by running the procedure “CalibSubChuck”

5.5.2 Standard teachin operation

The ModCam1.mod module for standard teachin operation contains a subset of the FeedLine Light solution. For reference, check with section above.

However, the user has to program it's own StateLogic, movements, and option handling. We recommend to use the FeedLine Light code as template and modify it to your needs. For programming of standard teachin robot code, refer also to the PickMT ABB integration manual.

All assistant code from the FlexMT system can of course be used, e.g. the LeaveFeederOut routine for leaving parts ordered on the outconveyor.

5.6 Option control

The module Options.sys contains useful code to control the options within the FlexMT. Examples are:

- Marking Unit: InitMarker, LoadMarkerFile, ChangeMarkerString, StartMarker
- AirCleanBox: StartAirClean, StopAirClean

Check Options.sys for more usable functions.

5.7 User messaging

The FlexMT standard modules integrates a localizable user communication interface.

The module UserComunication.sys contains the following elements:

- A number of predefined values for different messages, questions and help texts, each defined by a numerical constant, e.g. CONST num LOW_AIR_PRESSURE:=3;
  If needed, new values can be added.
  However, do not remove or change values, as they are used in the FlexMT core functionality.
- A number of predefined procedures/functions for interacting with the operator:

Name	Description
PROC CheckLanguage()	Checks used language in FlexPendant. If language used for user text is not the same as FlexPendant language the user texts are updated.
PROC InitMessages()	Initiate all messages to default text.
FUNC bool isUserInput(num TextNumber,num nTRUEButton\num nFALSEButton\icondata icdIcon\num nMaxTime\string diBreakSignal\string doBreakSignal\bool ShowInPickMT)	Show User Message box on FlexPendant and waits for operator input. Returns TRUE if button “nTRUEButton” is pressed or FALSE if “nFALSEButton” is pressed. If nMaxTime, diBreakSignal or doBreakSignal is used and the input messages box breaks on any of them this function throws an error to the user program to be handled by user. Returned errors: ERR_TP_MAXTIME : When max time is reached ERR_TP_DIBREAK : If Di break signal occurred ERR_TP_DOBREAK : If Do break signal occurred NOTE! If ShowInPickMT=TRUE all other arguments except TextNumber will NOT have any effect
PROC WriteError(num TextNumber,bool ShowInPickMT\switch NoStop\switch GoHomeAndStop)	Write error message to FlexPendant event log and PickMT if wanted. Also set error flag for correct indication at light tower. Program execution then stops directly, after home run or continue in user program depending on switch settings. Arguments: TextNumber = Number of text to be shown. ShowInPickMT = shows error in PickMT too. NoStop = Robot continue in user program afterwards. GoHome = Calls user routine “GoHome” to move robot home before EXIT program.
PROC WriteWarning(num TextNumber,bool ShowInPickMT\switch NoStop\switch GoHomeAndStop)	Write warning message to FlexPendant event log and PickMT if wanted. Also set warning flag for correct indication at light tower. Program execution then stops directly, after home run or continue in user program depending on switch settings. Arguments as in WriteError.
PROC WriteInformation(num TextNumber,bool ShowInPickMT\switch NoStop\switch GoHomeAndStop)	Write information message to FlexPendant event log and PickMT if wanted. Also set information flag for correct indication at light tower. Program execution then stops directly, after home run or continue in user program depending on switch settings. Arguments as in WriteError.

Continues on next page

Name	Description
PROC UpdateUser-Texts()	Read user texts from file and updates all user texts in program. NOTE! The correct user text file must be placed in robot HOME directory. Name of file should be FILE_PREFIX+sUsedLan-guage+FILE_SUFFIX, this is for example “UserTexts_en.txt” for english. File structure like this: 1;MessageRow1/Header;MessageRow2; .... MessageRow11 2;MessageRow1/Header;MessageRow2; .... MessageRow11 ... ... MAX_MESSAGES;MessageRow1/Header;MessageRow2; .... MessageRow11 NOTE! The number first in every row points to which message, also look at to CONSTANT declarations in this file. It’s not neces-sary to write all lines for every message, one row could be good enough: 1;Message1Row1 2;Message2Row1; Message2Row2 6;Message6Row1

Certain ranges are reserved for specific purposes:

1-99: FlexMT core messages. These are defined in FeedLineAlarmsToPV.sys, too, in order to enable inter-task data exchange.

100-299: Application messages

300-499: User dialog messages

5.8 Alarms and light tower

The light tower contains a RGB LED light, that is controlled by the background task RGBLightTower. Its main loop collects information from both the feeder subsystem and from user decisions.

If the user wants to light a certain color, the variables bUserDefinedRedLight, bUserDefinedYellowLight, bUserDefinedBlueLight or bUserDefinedWhiteLight can be set to TRUE in the users code.

Light indications should always be accompanied with user messages for explanation.

5.9 WorldZones

Some users prefer the use of WorldZones to verify the robots presence in certain areas/volumes, and/or to block certain movements. FlexMT offers predefined WorldZone handling in the module Common.sys.

The FlexMT defined WorldZones are active in jogging mode and automatic mode.

The following zone is predefined and must be configured during commissioning.

- ForbiddenZone: A zone that e.g. lies above the area that the robot needs to move. Prevents the robot moving through this zone.

The following zones are predefined for the user convenience and can be configured during commissioning.

- SafeZone: The robot could be started from here directly. Connected to DOF_SafeZone.
- HomeZone: Indicates robot home position. Connected to DOF_HomeZone.
- MachineZone: Robot is outside of machine tool. Connected to DOF_LoaderOut.

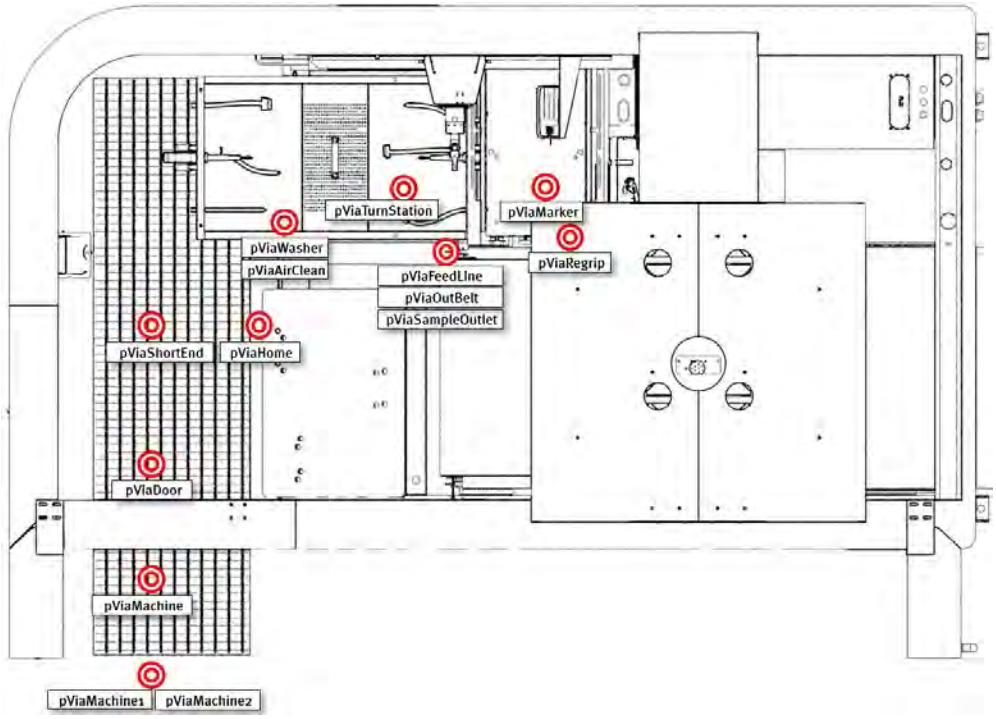
The geometrical definition of these WorldZones can be changed by geometrical data defined in Common.sys. After changing these values, the robot controller must be restarted in order to activate the new definitions.

5.10 Motion and zone overview

The principal motion in the FlexMT is controlled by the MoveTo-routine, which moves the robot from known zone positions to a target zone position. From these zone positions (viaPositions), movement within certain areas of the FlexMT can be initiated.

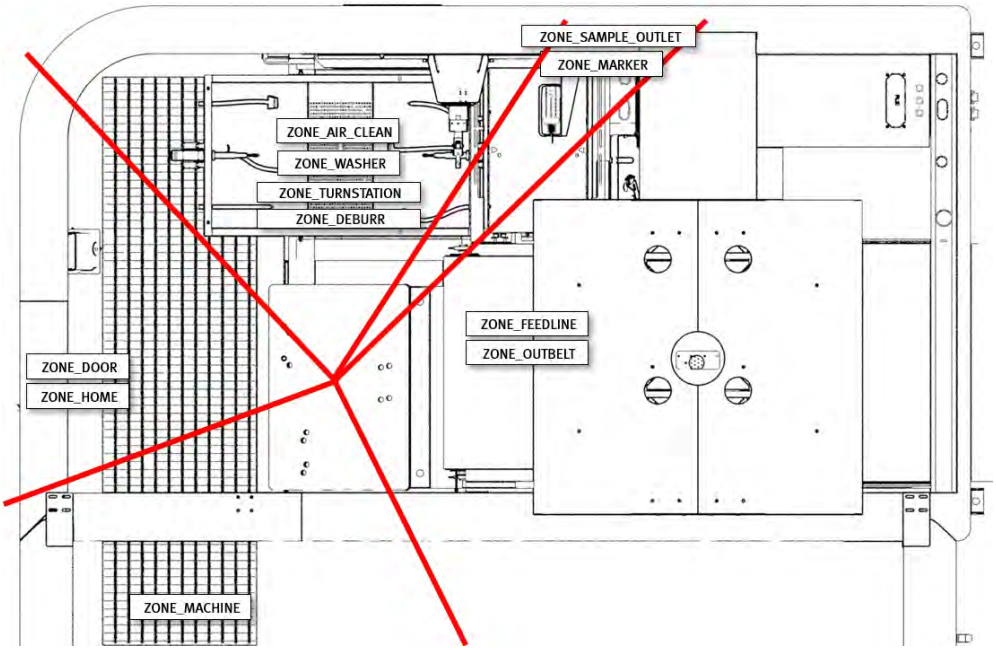
A schematic view of the principle motion within the FlexMT is shown and main positions is shown in the next figure.

The pre-configured setup of FlexMT zones is shown in the figure thereafter.



Schematic motion overview

Continues on next page



Schematic zone overview

This page is intentionally left blank

6 Operation

WARNING

The machine may only be operated by trained operators with the required knowledge of the FlexMT:s functions and risks.

The FlexMT:s work place during operation is at the beginning of the inconveyor, where the operator adds new material and unloads the outconveyor. For ”Teachin” there is a work place in front of FlexMT, at the vision system screen location.

The inconveyor has two operation modes.

In manual operation mode, the inconveyor can be run forward and backward manually. In the automatic operation position the inconveyor is run forward automatically when there are no more parts in the picking area. If the inconveyor is not refilled in time, the conveyor stops after a set monitoring period.

The outconveyor has two operation modes.

In automatic operation mode, the conveyor is controlled by the robot. The outconveyor is moved forward at need, until details arrive at the end of the belt.

In manual (emptying) mode, the outconveyor moves forward until parts are detected at the end of the conveyor.

Continues on next page

6.1 Safety

DANGER

Before the machine is started or restarted, always check that all safety devices are fault free and that no damage can be caused when the machine is started.

DANGER

When the operator replaces or repositions the gripping fingers, the air pressure to the gripper must be safely shut down.

6.2 Powering up / shutting down

6.2.1 Powering up the FlexMT

- Turn on the main power supply. Wait until all devices started up regularly.
- Perform the forced safety check: Press and restore at least one emergency stop button, open and close at least one door, reset door status by shortly activating the reset key, and finally reset emergency stop condition.
- Refer to the safety manual for more detailed information.

6.2.2 Shutting down the FlexMT

- Stop the FlexMT as described below and await complete cycle stop.
- Exit the PickMT application.
- Turn off the main switch.

6.3 Starting and stopping

6.3.1 Standard start/stop operation

6.3.1.1 Cycle start

- Ensure that machine tool is ready for automatic operation and that correct program is loaded.
- Ensure that correct parts are loaded onto the inconveyor.
- Ensure that the doors for the outer protection are properly closed and that the emergency stop is not deployed.
- If necessary, acknowledge any remaining error messages on the robots FlexPendant.
- If necessary, turn the robots operating mode selector to automatic. Confirm mode change with OK.
- Select correct part in the PickMT user interface by choosing correct group and detail.
- Click ”Start” in the PickMT user interface.
- The selected robot program for the part will now be loaded in the robot and the FlexMT will start.

6.3.1.2 Cycle stop

To stop the system, click on ‘Stop’ in the PickMT user interface.

Please note: Pressing Stop will not make the robot stop immediately; It will only stop at the end of the cycle or after a certain maximum time. If an emergency situation has arisen, use the emergency stop.

6.3.1.3 Quick stop

In the event of a quick stop, the robot will stop immediately in the position it is in whilst the external equipment completes its started work cycle.

Perform a quick stop by pressing ”Stop” on the robots FlexPendant.

6.3.1.4 Restart after quick stop

Press ”Start” on the robots FlexPendant.

6.4 Emergency and SafeMove stop

6.4.1 Emergency stop

Press any emergency stop button to stop the entire robot cell.

Emergency stop must only be used in emergency situations and not to stop the machine normally. The robot cell stops as quickly as possible and unwanted/unexpected situations can occur where there may be a risk when restarting the robot cell without manual intervention.

Please note: Grippers will remain pressurized.

6.4.2 Restart after emergency stop

Ensure that the restarting of the installation does not cause any risks of damage to equipment or personal injury.

- Restore all emergency stop buttons.
- Acknowledge the message on the robots FlexPendant.
- Ensure that the external equipment is ready for automatic operation.
- If the robot cannot be automatically run back to a safe position (e.g. while loading/unloading the machine tool): Switch the robot operating mode switch to manual. Jog the robot close to its safe position. Switch back to automatic mode.
- Press ”Motors on” on the operator panel.
- Perform a standard cycle start.

6.4.3 SafeMove stop

A SafeMove stop occurs when the robot or its predefined gripper safety volume is moved out of the allowed SafeMove areas. The SafeMove supervision is active in both automatic mode and in manual operation.

The two main reasons for SafeMove stop are:

- Jogging the robot manually out of the safe areas.
- Pulling out the statistical outlet while robot is accessing this area.

6.4.4 Restart after SafeMove stop

SafeMove stop occurred due to that statistical outlet was pulled out while robot was moving:

- Push the statistical outlet back in place.
- Acknowledge error message on FlexPendant and press “Motors On”,
- Press “Motors On” once more.
- Press ”Start” on FlexPendant.

SafeMove stop occurred due to jogging out of the safe areas:

- Acknowledge error message on FlexPendant.
- Jog robot back into safe area.

If the SafeMove override switch is needed, it can be found inside the FlexMT electrical cabinet.

6.5 Entry control

Entry control to the cell during automatic operation occurs as follows:

Operator panel at sliding door

The operator stops the system in a controlled way by pressing the button for the entry request (C) at the door. The green lamp (C) starts to flash. The system stops in a suitable moment at its predefined home position, so that restart can occur without problem. As soon as entry is permitted, the door is unlocked and the green lamp (C) illuminates continuously.

The operators take the key (D) with them and carries out work in the cell.

DANGER

When the operator enters the machines work area, the operator must, under all circumstances, take the key that is used for the confirmation of the protection door with them. This is to prevent unintentional confirmation and restart of the machine. There must only be one key for the entire cell.

After work has been carried out in the cell, the operator closes the door and confirms using the key switch (D). The system can then be restarted with the start button (B), or from the robots FlexPendant. Upon restart, the door is locked again.

DANGER

Before making an acknowledgment with the key and restarting the system, the operator must be sure that nobody is in the cell and that restart can occur without the risk of injury.

The lock opens even in the event of manual operation when the robot program has stopped. As soon as the door is unlocked, the green lamp illuminates continuously.

Continues on next page

6.5.1 Manual operation of dangerous equipment

Some dangerous equipment in the cell is deactivated at autostop, i.e. the deburring devices and the rotation of the turn unit. If this equipment must be activated for test operation this is possible using a special procedure:

The operator presses the enabling device on the robots FlexPendant. The robot can now be started. The key to reset door safety is used to enable/start special dangerous equipment. As soon as the reset key was activated for a short period, special dangerous equipment can be started.

When the operator releases the enabling device on the robots control panel the special dangerous equipment also stops.

6.6 Conveyor operations

6.6.1 Operator panel inconveyor

Operator panel at inconveyor

On the operator panel for the conveyors, there is a knob for running the inconveyor forward/backward (A), a knob for switching inconveyor operation mode (B), a knob for switching outconveyor operation mode (C) and an emergency stop (D).

Forward / backward inconveyor

When the button for running the inconveyor is turned in one direction during manual operation, the belt starts to run in that direction. The belt stops when either the sensor at the cameras field of view or the sensor at the end of the inconveyor is affected or when the button is quickly turned in another direction.

Backward operation is, however, only possible as long as the knob is held in position for backward operation.

Function selection inconveyor

For being able to run the inconveyor manually, the knob for selecting operating mode must be turned to manual operation. This requests permission for manual operation from the robot, and the lamp in the knob starts to flash. The lamp lights continuously as soon as FlexMT can be run in manual mode.

WARNING

If you have stopped the robot in the middle of a started gripping manoeuvre, then run the belt manually, and then allow the robot to continue the grip manoeuvre, there is a risk of a collision.

Function selection outconveyor

When the knob is in position for emptying, the belt is run until the sensor at the end of the outconveyor is affected, otherwise the outconveyor is controlled by the robot.

If the parts have reached the end of the outconveyor, the belt stops and the yellow lamp (warning) is switched on. The operator must then pick off the parts. The belt either starts automatically when the parts are picked off, or the operating mode knob must be turned briefly (1s) to automatic mode and back.

6.6.2 Loading inconveyor

The conveyor can be loaded during manual or automatic operation.

Parts are placed on the conveyors loading area for processing with a distance that allows sufficient clearance for the grippers claw.

If the machine is in manual mode and the desired number of parts is loaded, the operator can run the belt forward using the manual mode button until the belt can be filled with further parts. Otherwise, the belt runs automatically until the first parts reach the cameras field of view.

During manual operation the conveyor can be run forward until the sensor at the cameras field of view is affected.

WARNING

If you have stopped the robot in the middle of a started gripping manoeuvre, then run the belt manually, and then allowed the robot to continue the grip manoeuvre, there is a large risk of a collision.

6.6.3 Emptying in- or outconveyor

The inconveyor can be emptied in manual operation mode. If the operator does not reach all parts on the conveyor, the belt can be run backwards using the backward operation button.

The outconveyor must be emptied in emptying operation mode. This is selected via the associated operation mode knob.

WARNING

If you have stopped the robot, and then run the outconveyor manually, and then let the robot continue, this may cause a collision risk, depending on which position pattern is used on the outconveyor.

6.6.4 Automatic operation

6.6.4.1 Inconveyor

During automatic operation, the inconveyor is controlled based on the robots requirement. Parts can be place on the outconveyor during operation.

6.6.4.2 Outconveyor

During automatic operation, the outconveyor is controlled based on the robot being able to leave parts. Parts can be picked at the outconveyor end during operation.

If the parts have reached the end of the outconveyor, the belt stops and the yellow lamp (warning) is switched on. The operator must then pick off the parts. The belt either starts automatically when the parts are picked off, or the operating mode knob must be turned briefly (1s) to emptying and back.

6.7 Other operations

6.7.1 Operation with robot in manual mode

6.7.1.1 Start in manual operating mode (Programming mode)

DANGER

Running the machine in manual mode with an operator close to robot, machine tool and FlexMT options leads to increased risks for the operator.Be carefull and observant to potential risks.

The equipment can be run with open doors in manual operating mode. The robot operation mode must be Manual with reduced speed.

It is also possible to run the vision system with robot in manual mode. PickMT notifies the operator about the manual mode. However, the following restrictions do apply:

- No automatic robot program loading will take place when PickMT is started with robot in manual mode.
- Do not forget to save the robot program after making changes! If the machine starts in automatic mode, the robot program is reloaded and any changes made are lost (MainModule.com and part specific modules).

Note

A convenient way to automatically load the right modules is to start PickMT with robot in automatic mode. As soon as the program start is completed, all modules are loaded corectly, The robot can then be put into manual mode for further work.

6.7.1.2 Continuing work in automatic mode after manual mode operation

- Save the robot program if changes have been made.
- Close fences and reset safety circuits.
- Set the robot operating mode to automatic.
- Acknowledge the message on the FlexPendant.
- Press ”Motors on” on the robot operation panel
- Press Start on the FlexPendant.

6.7.2 Manually setting the belt speed (option)

Using the potentiometer mounted on the side of the controller cabinet the belts speed can be manually set to a speed appropriate to the product.

6.7.3 Manual cyclic brake check

The FlexMT is programmed to automatically perform the cyclic brake check that is needed for the secure operation with SafeMove.

Sometimes, it can become necessary to perform this procedure manually. Please adhere to the robots guidelines in how to perform a cyclic break check.

In short, move the robot to a suitable position. Then, call the service routine CyclicBrakeCheck.

6.7.4 Statistical outlet

If configured so, the robot will leave sample parts in the statistical outlet with a specified frequency. The robot will wait for a previous sample part still in place to be removed.

Due to the size of the statistical outlet opening (which accommodates quite large details) and current safety regulations, the robot must be in a safe standstill while the outlet is opened.

In order to take out a sample part that is already in place, press function key  on the FlexPendant. The robot will come to a safe standstill, and the sample outlet can be opened. When the sample outlet is closed again, the operator can confirm, and the robot will continue.

If the robot is waiting to be able to place the next sample part, it already is at standstill, thus the sample outlet can be opened directly.

In order to take a sample part directly, i.e. prior to the specified sampling frequency, press function key  on the FlexPendant. The robot will place the next part in the statistical outlet and come to standstill, and the sample outlet can be opened. As soon as the sample outlet is closed again, the operator can confirm, and the robot will continue.

7 Maintenance

7.1 Safety

DANGER

Always adhere to the general safety instructions as described in chapter ”Safety”.

7.2 General

This section covers maintenance procedures for the FlexMT.

> **Note**
>
> Maintenance procedures for the robot are described in the robots product manual.

Most maintenance of the FlexMT is obvious to perform, even if not listed in this section.

This sections covers both maintenance of equipment and options that are not included in all installations. If the installation contains further parts, maintenance instruction may also be found in other documentation.

The machine is made of components that have a minimal maintenance requirement. However, there are some components that require scheduled maintenance.

Only perform maintenance when the machine is off.

Below is a summary of maintenance intervals and corresponding corrective actions.

Maintenance intervals	Corrective action
Daily	Conveyor belt cleaning
Every week	Conveyor belt check FlexMT overall cleaning Air cleaning box cleaning Compressed air lubricator
Every month	Electrical function check Gripper system check
Every 3 months	Checking cables and cable racks Checking contacts
Every 6 months	Filter cartridge replacement
If necessary	Conveyor belt adjustment Replacing illumination Replacing reflectors/sensors Cleaning camera optic Cleaning TFT screen
In the event of changes to the system	Backup robot Backup Vision system
Various	Robot according to robot manual Air preparation condensate drain Gripper system lubrication (10 Mio cycles)

7.3 Mechanical maintenance

7.3.1 FlexMT overall cleaning

What: Overall cleaning of the FlexMT.

When: Once / week. More often if needed.

How: Let the robot move to its home position (-> entry request). Clean all surfaces from chips, oil and other material that might disturb correct function. Vacuum clean with industrial grade vacuum cleaner. Be careful when cleaning inside.

7.3.2 Air cleaning box cleaning

What: Cleaning of the Air cleaning box.

When: Once / week. More often if needed, e.g. when performing intense deburring.

How: Remove all chips and material from deburring units. Vacuum clean with industrial grade vacuum cleaner. Remove oil and dirt from deburring tools and their holders.

7.3.3 Conveyor belt cleaning

What: Cleaning the conveyor belt.

Type: If a felt conveyor belt is installed, vacuum contaminants from the belt. Use Induren A or soap solution and cloth for PVC belts.

When: Once / day. Vacuum the felt belt at least once /week.

How: Clean/vacuum surface of the belt. Run the belt to be able to clean the entire belt.

7.3.4 Conveyor belt check

What: Checking the conveyor belt

When: Once / week.

How: Run the conveyor belt and check that the belt does not slip at the motor drum nor move sideways.

7.3.5 Belt tension

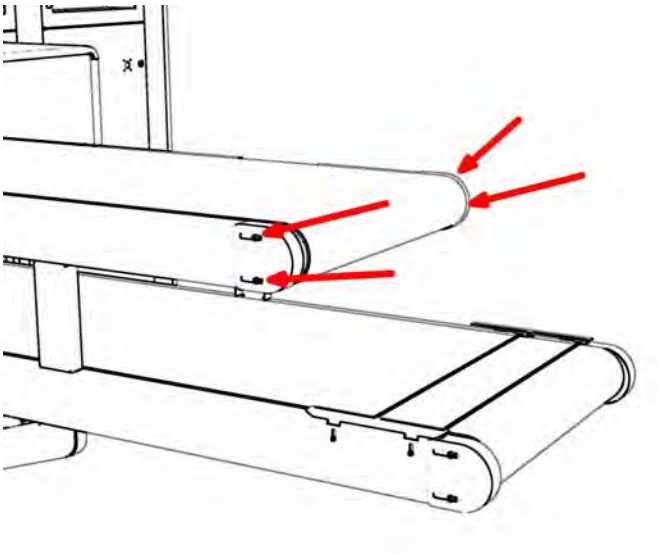
Note

Before setting the belt tension, the belt must not have been tensioned.

Normal tension for the conveyor belt is 0.5 %. If a PVC conveyor belt is used the normal tension is 0.3%.

How to adjust the belt tension:

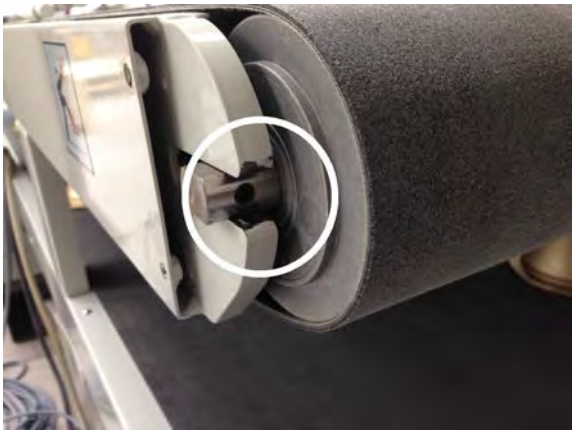
- Unscrew the 4 screws holding the protection cover and remove it. See figure below.
- Check that the rollers are installed at exactly 90˚ in relation to the frame.
- Make sure that the belt has never been tensioned before and is now installed without tension.
- Measure a distance of 1000mm in the middle of the belt and make a mark at 0 and 1000mm.
- Using both adjustment screws (see figure 15), tension the belt until the distance between the marks is 1005mm.
- If a PVC belt is used the distance between the marks should be 1003mm after tensioning the upper conveyor belt and 1004mm after tensioning the lower conveyor belt.
- Clean off the marks.
- Mount the protection cover.



Screws holding protection cover.

Continues on next page

7.3.5 Belt tension
Continued



Adjustment screws

7.3.6 Conveyor belt adjustment

What: Adjust the conveyor belt

When: When it starts to move sideways or slackens.

How:

- Check that the rollers are installed at exactly 90˚ in relation to the frame.
- Tighten the adjustment screw that is located on the side that the belt oscillates on (maximum ¼ turn at a time) until the belt no longer moves sideways. Wait until the belt has gone around 10 times before the next adjustment.

Note

After each adjustment the belt must be run for approximately 30 minutes at the same time while being monitored, as it takes some time for the belt to react to the new settings.

The belt is adjusted when test operation is performed at the manufacturer, however, it may need to be readjusted after transportation or after repair.

7.3.7 Gripper system check

What: Check gripper system

When: Once / month

How: Visually check the gripper system, including gripper holder, gripper finger holders and gripper fingers, for signs of mechanical wear. Replace damaged or worn parts.

7.3.8 Gripper system lubrication

What: Schunk lubrication intervals

When: After 10 Mio. cycles. At ambient temperature above 60°C the lubricants can harden faster. Decrease interval accordingly.

How: During maintenance, treat all greased areas with lubricant. Thinly apply lubricant with a lint-free cloth. Recommended lubricants: Metallic sliding surfaces (Schunk LINOMAX or Schunk microGLEIT GP 360 or equivalent), All seals (Schunk Renolit HLT 2 or equivalent), bores on the piston (Schunk Renolit HLT 2 or equivalent)

In addition to the described maintenance, the guides of the gripper can be re-lubricated as needed by means of lubricating nipples. The lubricating nipples can be used instead of the air purge connection. Remove the two set screws for the air purge connection and replace them with two conical grease nipples.

For in-depth information, follow original Schunk manuals.

7.4 Electrical maintenance

7.4.1 Robot, control cabinet

What: See ABB robot product manual.

7.4.2 Illumination

What: Fluorescent lamp

When: When the fluorescent lamps are coming towards the end of their service life, and when the first fluorescent lamp stops working, all the remaining ones must be replaced at the same time.

How: Turn the fluorescent lamp a ¼ turn until the contact grooves are free.

If only one lamp stops working after a maximum of six months, it is enough to only replace that particular lamp.

7.4.3 Reflectors/sensors

What: Always check that all reflectors and sensors are intact and clean and are secured properly.

When: As necessary. Depends on surroundings and amount of dirt from parts handled in the FlexMT and surroundings.

7.4.4 Electrical function check

What: Check all electrical functions, breakers and limit position functions

When: Once / month

7.4.5 Checking cables and cable racks

What: Checking cables and cable racks

When: Every 3 months

How: Inspect the entire cable rack (mounting points, dirt deposits, wear) and remedy any breaks. Check all cables. Replace damaged cables. Extend cables that rub against sharp edges.

7.4.6 Checking electrical connections

What: Checking electrical connections

When: Every 3 months

How: Inspect all electrical contacts and make sure that they are secured properly.

7.5 Pneumatic maintenance

7.5.1 Air preparation condensate drain

What: Condensate drain.

When: When condensate level is approx. 10 mm below the filter element.

How: Turn the drainage screw at the bottom of the bowl in an anticlockwise direction as seen from below. The condensate will then flow out.

When: Depending on quality of the compressed air, generally 1-2 times/year.

How: For further cleaning pull the blue button downwards and turn the bowl clockwise until it is loose. See figures below. Replace the filter and clean the bowl. Assemble in reverse order.

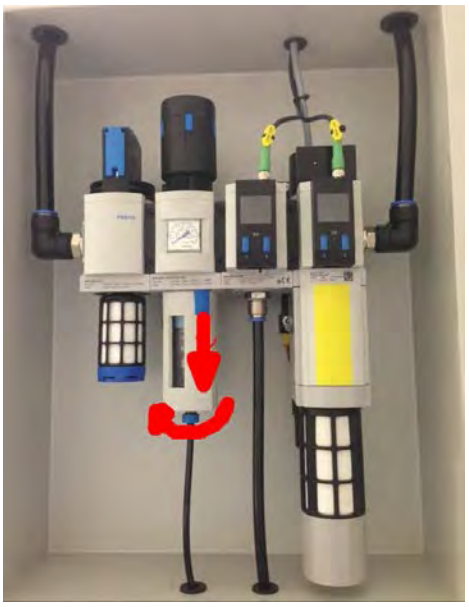
7.5.2 Filter cartridge replacement

What: Replace filter cartridge MS6-LFP-E

When: Depending on quality of the compressed air, generally 1-2 times/year, or when air flow becomes to low.

How: Exhaust the unit. Push the unlocking slide in the direction of the arrow. Turn the filter bowl in an anti-clockwise direction as seen from below. Pull the filter bowl away from the unit. Turn the filter plate in an anti-clockwise direction. Replace the filter cartridge if the pores are dirty. Grasp the filter cartridge only at the lower end when it is new. Fit the individual parts again in the reverse sequence. The following checks must then be made: The locking pinof the filter bowl must face the large recess in the housing. The unlocking slide must be heard to clip into place when the end stop is reached.

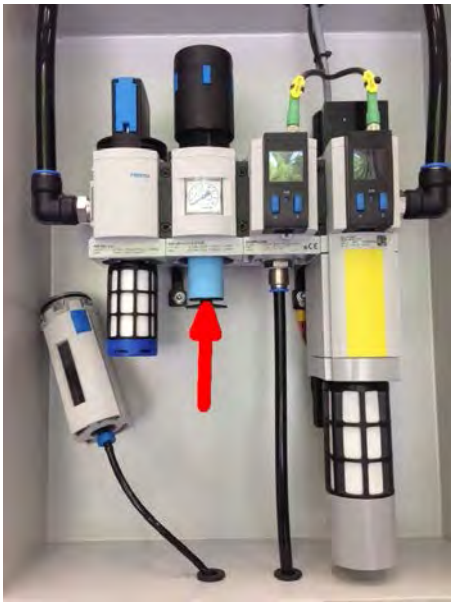
Cleaning; Use only the following cleaning agents: Water or soap suds (max. +60 °C), or petroleum ether (free of aromatic compounds).



Service unit - Open filter housing

Continues on next page

7.5.2 Filter cartridge replacement
Continued



Service unit - Filter replacement

7.5.3 Compressed air lubricator

What: If a deburring/grinding unit is used the FlexMT is equipped with a lubricator placed in front of the air cleaning unit.

When: Depending on usage of the deburring/grinding unit. Typical 1 time/week.

How: The lubricator is placed in front of the air cleaning box. It has an inspection window where the oil level is visible. If oil level is below the minimum level mark refill it by pulling the blue button down and turn the bowl clockwise until it is loose. Refill with a suitable oil so the oil level is above minimum level. Recommended oil is Festo special oil as per ISO VG 32 (type Festo OFSW-32)

7.6 Backup

7.6.1 Backup of vision system

What: Backup of details stored in the vision system.

When: When you have made a change or as necessary.

How: Create a backup under the tab settings/service and save it onto a secure media (i.e. not the PickMT SmartCamera itself).

7.6.2 Backup of robot program

What: Make a backup of the robot program

When: When you have made a program change

How: Follow the robot manual and save the copy onto a secure media (i.e. not the robot itself).

7.7 Other maintenance

7.7.1 Marking unit

What: Clean the stylus pin guide and the stylus assembly regularly.

When: Depends on amount of dust and dirt in the cell. Every month.

How: Unplug the marking machine. Unscrew the stylus pin guide (see marking unit manual). Remove the stylus, the spring and the core. Clean all parts and remove the grease. Lubricate the stylus and the stylus pin guide using the oil supplied with the marking unit. Reassemble the machine and manually fasten the stylus pin guide. Note : please pay attention to the direction when reassembling the core (see marking unit manual). Avoid dust and abrasive particles on the guiding and driving elements.

7.7.2 Camera

What: Optic

When: When the image quality is affected by dirt.

How: Wipe the front of the object clean using a clean cloth. If this is not sufficient, use pure alcohol or similar. Ensure not to leave a film on the lens.

If the cameras position is changed, perform a new calibration according to the PickMT manual.

7.7.3 PickMT Screen

What: Carefully wipe off using a damp cloth.

When: As necessary

8 Repair

This section covers repair procedures for the FlexMT.

Note

Repair procedures for the robot are described in the robots product manual.

Most repairs of the FlexMT are relatively obvious to perform. The most important procedures are listed in this section. Minor repairs that can be performed with standard industry procedures are not listed here.

Continues on next page

8.1 Safety

DANGER

Always adhere to the general safety instructions as described in chapter ”Safety”.

8.2 Conveyors

DANGER

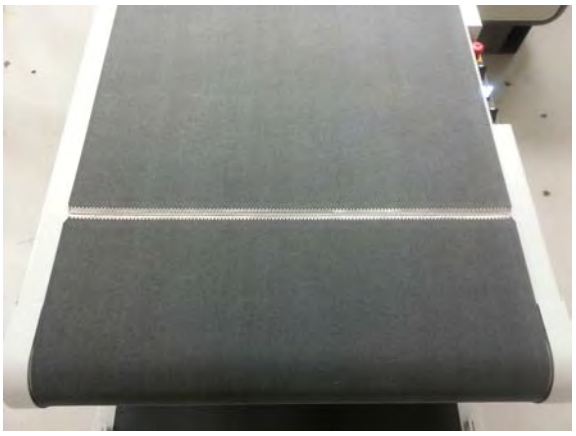
Prior to all work with the conveyors: After positioning the belts in suitable positions, safely shut the power to the FlexMT down and lock against accidential turn-on.

Continues on next page

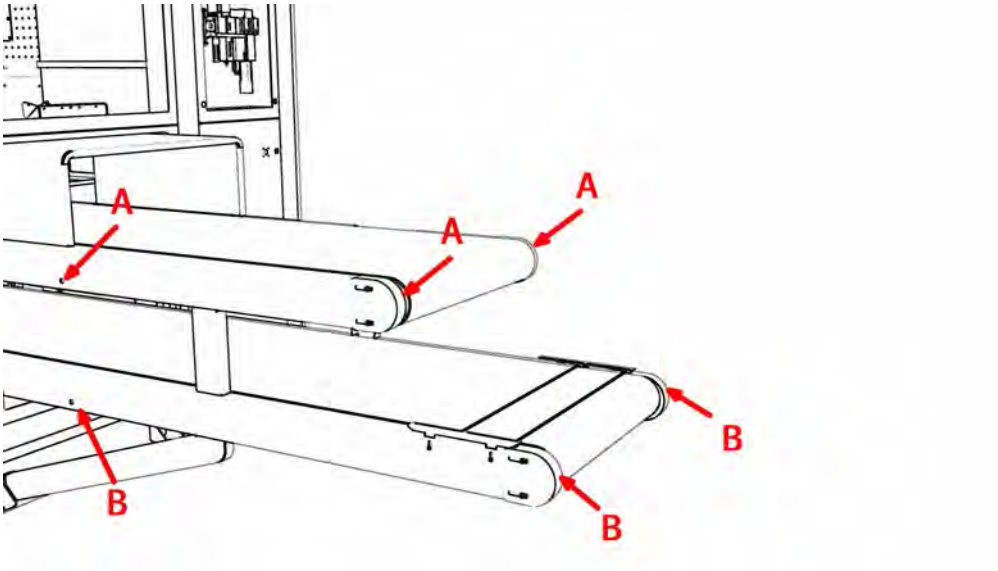
8.2.1 Exchange of conveyor belt

Exchange a conveyor belt by the following procedure

- Run the belt to a suitable exchange position. The belt splice should be close to the end of the conveyor.



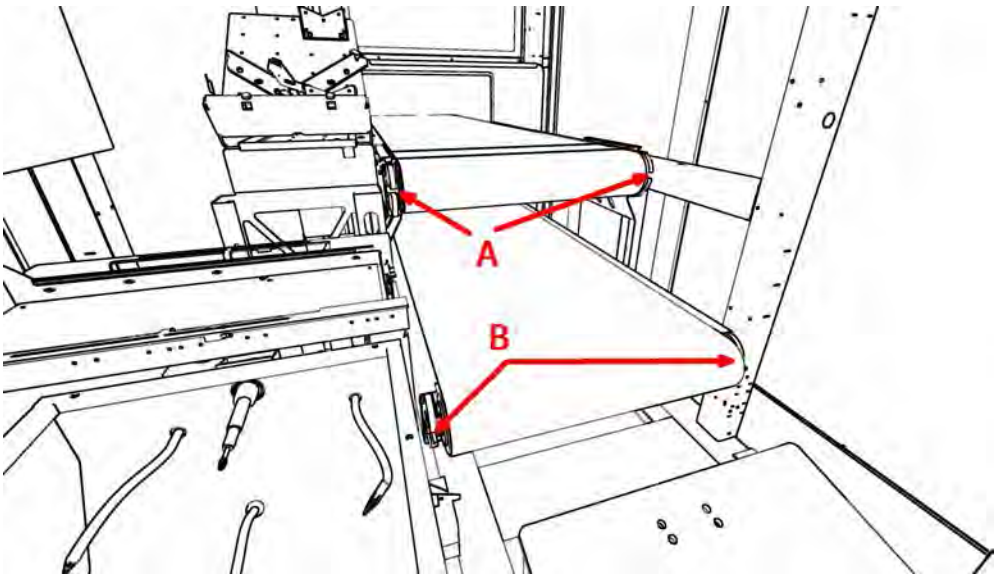
- Remove the relevant protection cover at the end of the belt (see illustrations below).
- Reduce belt tension by releasing the tensioning screws (see illustrations below).
- Remove the idler drum below the middle of the conveyor (see illustrations below).



Protective caps and release points idler drum in middle of conveyor

Continues on next page

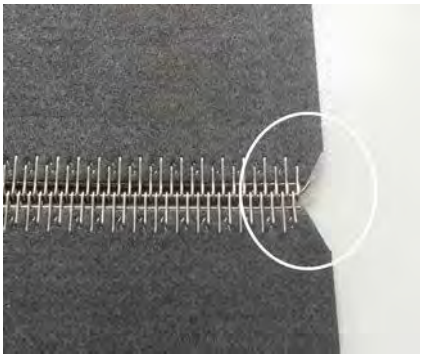
A: In-conveyor points of interest, B: Out-conveyor points of interest, B



Location of belt tensioning screws

A: In-conveyor points of interest, B: Out-conveyor points of interest, B

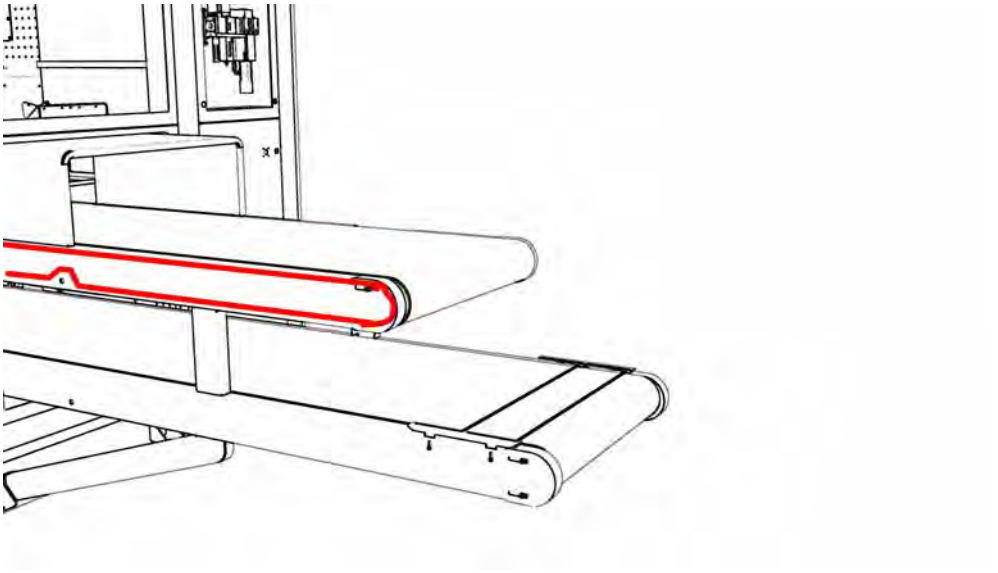
- Open the belt splice by straightening the lock wire.



- Connect the new belt to the old belt splice.
- Drag the new belt with the help of the old belt through the FlexMT.
- Remove old belt, then connect and lock the new belt splice.
- Refit the idler drum below the middle of the conveyor.
- Take special care to the belt path below the conveyor.

Continues on next page

8.2.1 Exchange of conveyor belt
Continued



The belt path should be as indicated in picture.

- Adjust belt tension according to instructions in the maintenance section.

DANGER

Power to the FlexMT has to be restored prior to mounting the protection caps, in order to perform the belt adjustment. Be careful when adjusting the belt. Risk for finger squeeze.

- Adjust belt side position and stability according to instructions in the maintenance section.
- Mount the protection cover.

8.2.2 Exchange of conveyor motor

- Disconnect the motor cable in the electrical cabinet.
- Follow the instructions for belt exchange.
- When the belt is opened, replace the conveyor motor.
- Refit the belt and check belt adjustment and stability according to instructions in the maintenance section.

8.3 Illumination

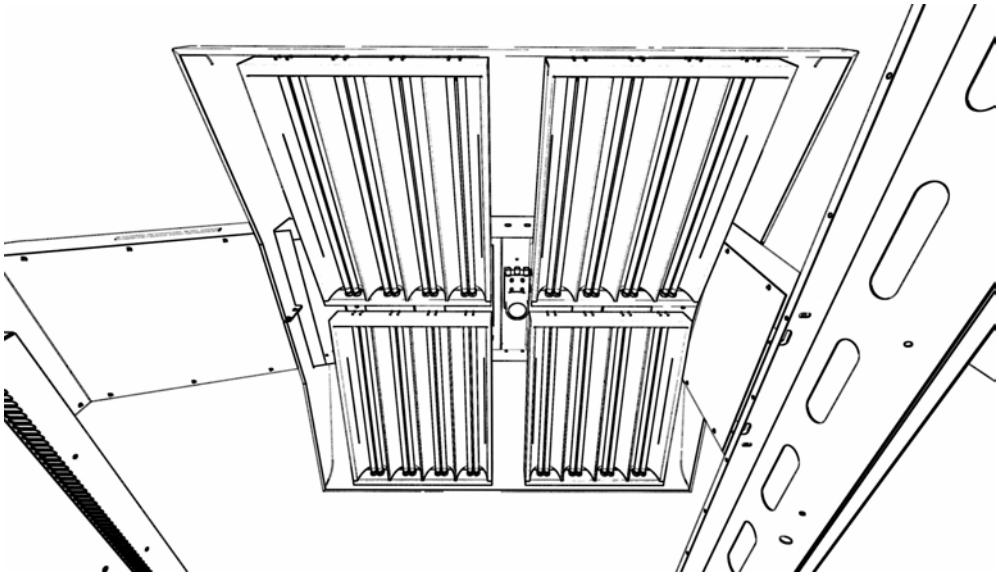
DANGER

Prior to work with the illumination: Safely shut the power to the FlexMT down and lock against accidental turn-on.

Exchange of fluorescent tubes is described in the maintenance section.

In rare cases, the complete luminaires have to be exchanged. Use the following procedure:

- Identify the defect luminaires.
- Remove the fluorescent tube and the reflector.
- Remove the inner protection housing.
- Loosen the power cables.
- Remove the luminaires.
- Replace by the new luminaires and assemble in reverse order.



Layout of luminaires and smart camera

8.4 PickMT SmartCamera

8.4.1 Exchange of camera lens

Change of camera lens shall be performed with as little impact as possible on existing teach-In. Use the following procedure:

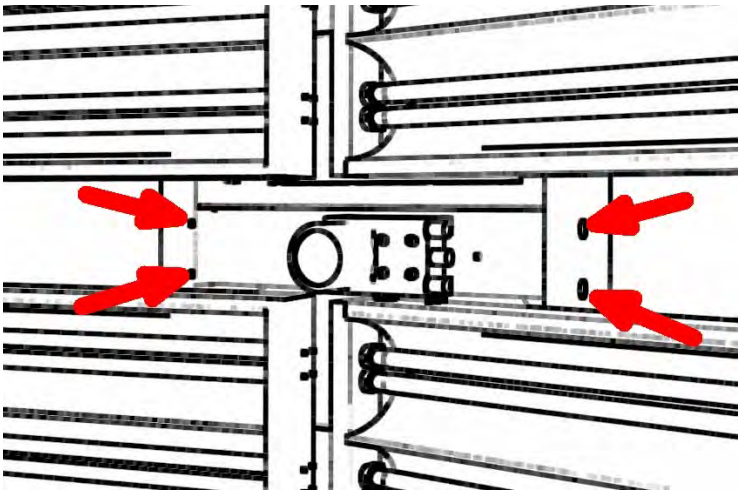
- Remove the protective cover
- Unscrew the old lens.
- Mount the new lens on the smart camera.
- Adjust focus of the new lens.
- Observe an existing image, e.g. one of the existing teach-in, and compare image brightness. Try to adjust aperture to match the previous appearance with the old lens.
- Mount the protection cover.
- Calibrate vision system with robot according to PickMT manual.
- Run system at slow speed for the first few picks.

8.4.2 Exchange of smart camera

Change of camera shall be performed with as little impact as possible on existing teach-In. Use the following procedure:

CAUTION: Safely shut the power to the FlexMT down and lock against accidental turn-on.

- Loosen the three cables connecting the smart camera
- Loosen the four screws holding the camera mounting plate. Preferably use a magnetic tool. See sketch below for identifying the location.



Location of smart camera mounting plate screws (view from below)

Location of smart camera mounting plate screws (view from side)

- Remove camera from camera mounting plate and replace by new camera.
- Move lens from the old smart camera to the new smart camera. Follow the procedure for exchange of the camera lens.
- Assemble camera mounting plate into FlexMT frame. Do not tighten screws firmly yet.
- Attach the three cables connecting the smart camera
- Turn power to the FlexMT on.
- Restore PickMT backup to the new smart camera

Continues on next page

- Use an existing teach-in as reference when adjusting the camera mounting plate. The camera image (field of view) should look the same as in an existing teachin.
- Calibrate vision system with robot according to PickMT manual.
- Run system at slow speed for the first few picks.

8.5 Gripper

DANGER

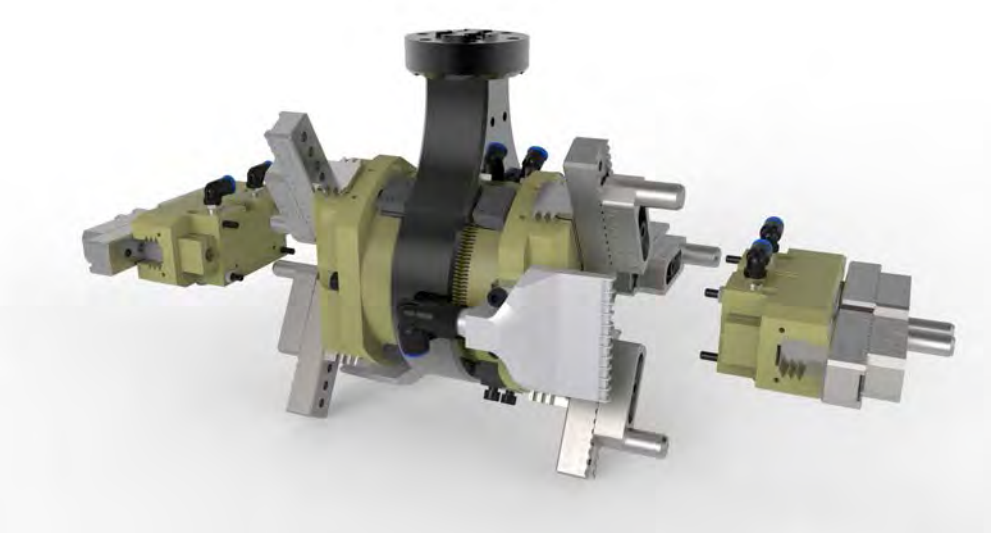
Prior to work with the gripper: Safely shut the pneumatic supply to the FlexMT down and lock against accidental turn-on.

Continues on next page

8.5.1 Exchange of gripping module on gripper

One or more gripping modules (Schunk) can be exchanged by the following procedure

- Move the robot to a suitable service position.
- Unscrew gripper fingers
- Loosen pneumatic tubes
- Remove pneumatic connections
- Unscrew gripper module
- Mount new gripper, pneumatic connections and pneumatic tubing
- Mount gripper fingers
- Restore pneumatic supply to FlexMT
- Test the new gripper.

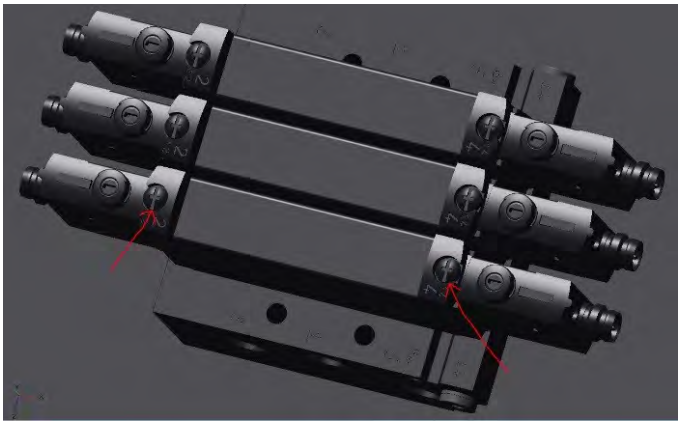


FlexMT standard gripper

8.5.2 Exchange of valves

One or more valve modules (Festo) can be exchanged by the following procedure

- Unscrew the 2 screws holding the control valve. See figure below.
- Pull the control valve straight up.
- Assemble in reverse order.



Demount control valves

DANGER

Safely shut the pneumatic supply to the FlexMT down and lock against accidental turn-on.

8.6 Re-grip table

Mechanical parts on the re-grip table can - if worn out - be replaced by spare parts. No special procedure has to be followed.

However, check if the robots work object has to be redefined or if picking positions have to be adjusted.

FlexMT re-grip table in two different configurations

8.7 Turn station

DANGER

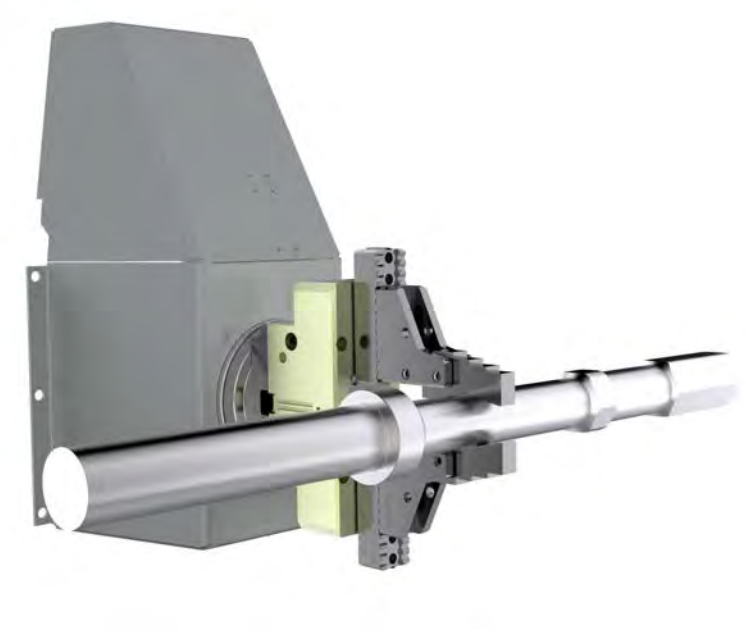
Prior to work with the turn station: Safely shut the pneumatic supply to the FlexMT down and lock against accidental turn-on.

Continues on next page

8.7.1 Exchange of gripping module on turn station

The gripping module (Schunk) can be exchanged by the following procedure

- Move the robot to a suitable service position.
- Unscrew gripper fingers.
- Remove pneumatic connections.
- Unscrew gripper module.
- Mount new gripper.
- Mount gripper fingers.
- Restore pneumatic supply to FlexMT.
- Test the new gripper.



FlexMT turn station with axis in gripper

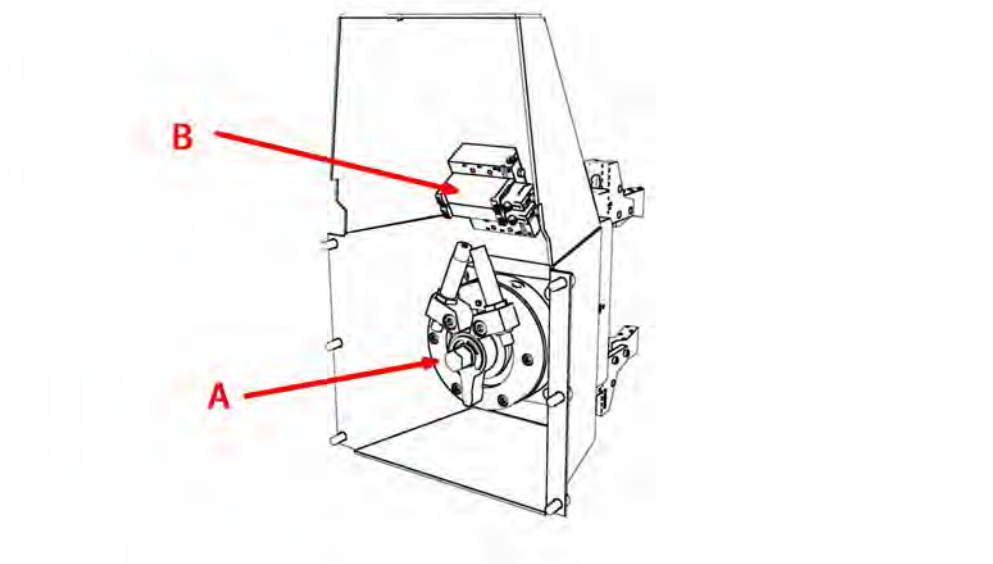
8.7.2 Exchange of rotation module

The rotation module can be exchanged by the following procedure

- Remove electrical and pneumatic connections to the turn station. Remove turn station from holding panel by unscrewing the six holding screws.
- Follow the instructions above form removal of gripping module.
- Remove internal pneumatic connections to the rotation module.
- Dismount and exchange the rotation module.
- Assemble in reverse order. Be sure to adjust the angular stop positions to the desired range.
- Test the turn station gripper.

CAUTION

If there are any changes in position/design between the new and old unit the robot positions need to be updated.



FlexMT turn station from behind, showing the rotation module and the valve positioning

8.7.3 Exchange of valves

For exchange of valve modules in the turn station follow the first steps of instructons above (exchange of rotation module) in order to obtain access to the valve package.

Then follow the procedure for changing valves on the gripper.

The valves are positioned in the turn station housing, as seen in the figure above.

DANGER

Safely shut the pneumatic supply to the FlexMT down and lock against accidential turn-on.

8.8 Air cleaning box

DANGER

Prior to work with the air cleaning box: Safely shut the pneumatic supply to the FlexMT down and lock against accidental turn-on.

Continues on next page

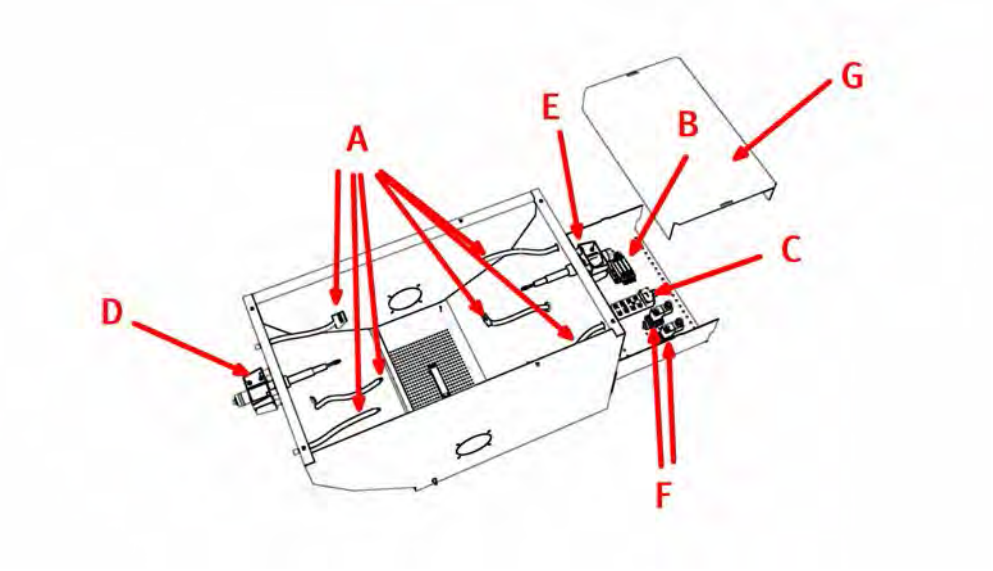
8.8.1 Exchange of flexblow hoses

If a flexblow hose holding a blowing nozzle gets unstable it is replaced by the following procedures:

- Use a wrench to hold the pneumatic connection. Turn the flexblow hose counterclockwise until it is loose.
- Turn the blowing nozzle counterclockwise to release it from the hose.
- Replace the flexblow hose and assemble in reverse order.

CAUTION

If there are any changes in position/design between the new and old unit the robots position need to be updated.



Components of the air cleaning box and deburring tools

A: Flexblow hoses, B: Valves controlling air cleaning, C: Signal splitter box, D: Deburring tool 1, E: Deburring tool 2, F: Valves controlling deburring tools, G: Protective cover.

8.8.2 Exchange of valves

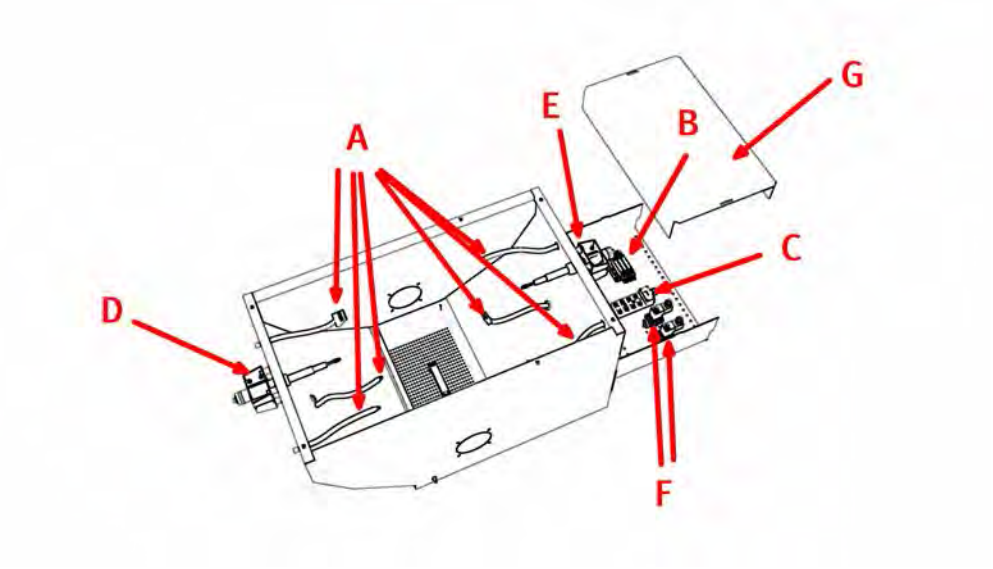
The valves controlling the blowing nozzles are located below the statistic outlet, see figure above. One or more valve modules (Festo) can be exchanged by the following procedure:

- Pull the statistic outlet to its outer position.
- Remove the cover hiding the valves.
- For exchange of valve modules follow the procedure as for changing valves on the gripper.

8.9 Grinding/Deburring units

DANGER

Prior to work with the grinding deburring units: Safely shut the pneumatic supply to the FlexMT down and lock against accidential turn-on.



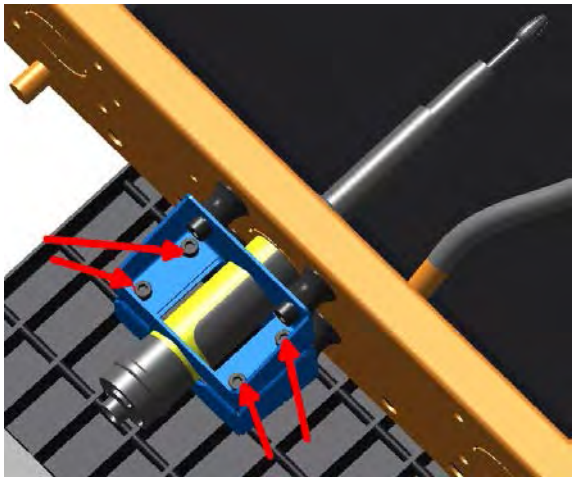
Components of the air cleaning box and deburring tools

Continues on next page

8.9.1 Exchange of grinding/deburring unit

The grinding/deburring unit can be exchanged by the following procedure:

- Disconnect the pneumatic connection to the grinding/deburring unit.
- Demount the 4 bolts and nuts holding the bracket. See figure below.



Grinding/deburring unit fastening system.

- Pull the unit backwards.
- Mount the new unit.
- Connect the pneumatic connection to the grinding/deburring unit.
- Restore pneumatic supply to FlexMT.

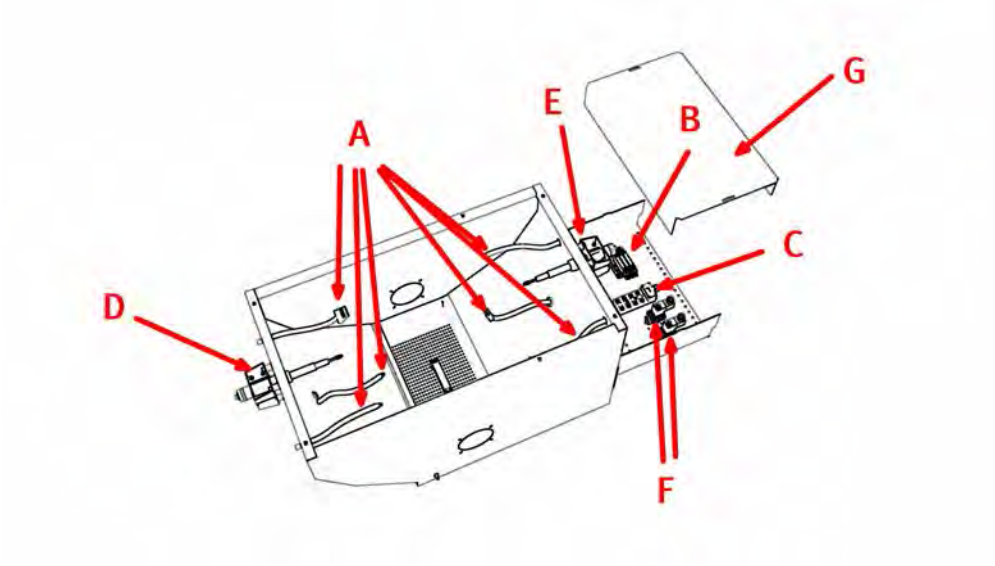
CAUTION

If there are any changes in position/design between the new and old unit the robot positions need to be updated.

8.9.2 Exchange of valves

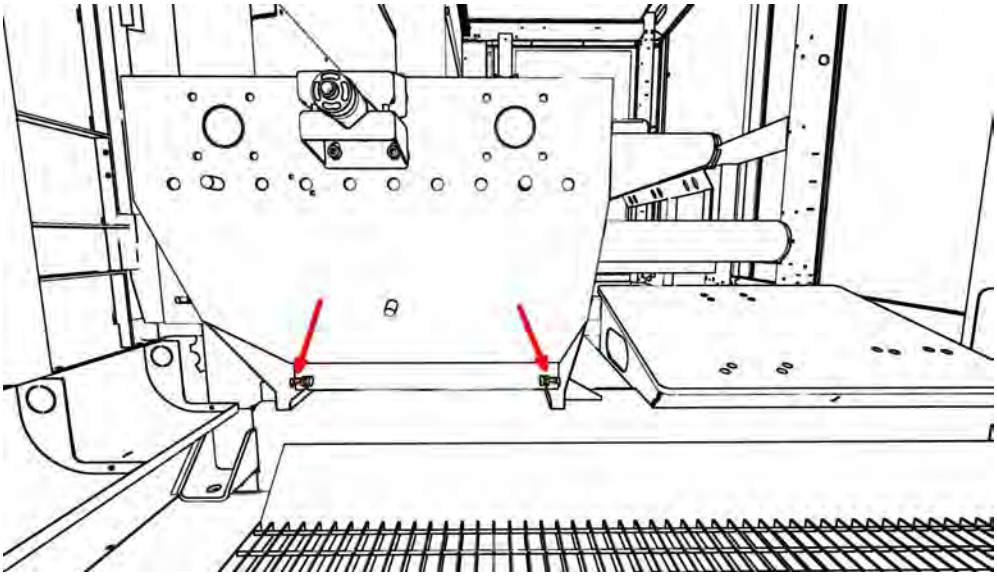
The valves controlling the deburring/grinding units are located below the statistic outlet, next to the valves controlling the air cleaning nozzles. One or more valve modules (Festo) can be exchanged by the following procedure:

- Pull the statistic outlet to outer position.
- Remove the protective cover over the valves (G).



Air cleaning box valve section cover

- Disconnect the pneumatic connections that connects the valves to FlexMT.
- Disconnect the electrical connection to the distributor box.
- Pull the two bayonet fastenings, placed in front of the air cleaning box, and twist them 90°.

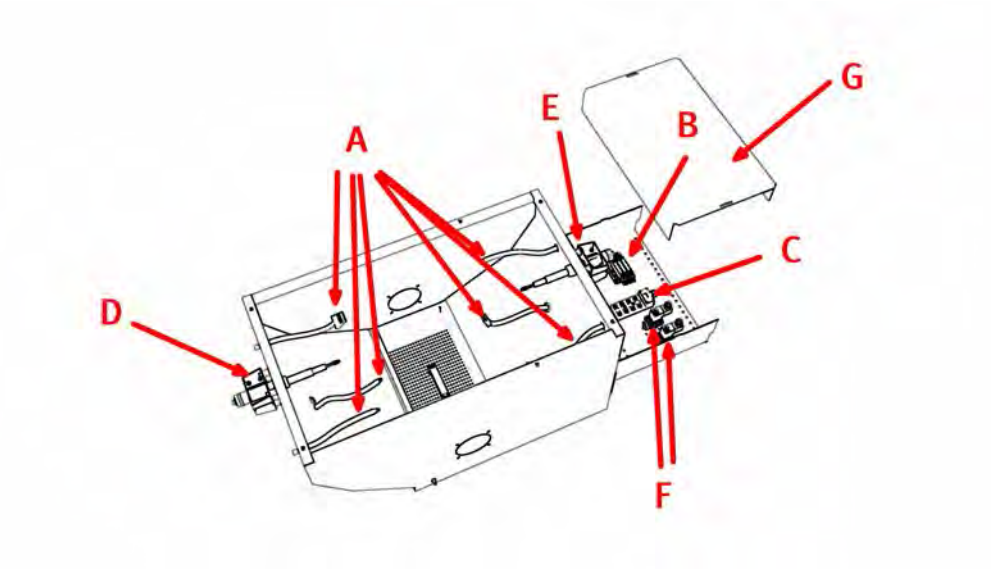


Bayonet fastenings holding the air cleaning box in place.

- Drag the air cleaning box out of FlexMT.

Continues on next page

- Identify the valves (F) according to figure below.



Valve location for deburring units

- Disconnect the pneumatic connections and the two M4 screws, placed underneath, holding the valve.
- Replace the valve with a new one.
- Mount the air cleaning box in reverse order, make sure the air cleaning box connects correct to the pins placed in the FlexMT frame.

CAUTION

If there are any changes in position/design between the new and old unit the robot positions need to be updated.

CAUTION

Run system at slow speed for the first cycles to ensure the air cleaning box is in correct position.

8.10 Marking unit

8.10.1 Exchange of marking unit

The marking unit can can be exchanged by the following procedure:

- Disconnect the electrical contact by turning it anticlockwise
- Unscrew the four M6 screws holding the marking unit
- Replace with a new marking unit in reverse order.

CAUTION

If there are any changes in position/design between the new and old unit the robot positions need to be updated.

CAUTION

Run system at slow speed for the first cycles to ensure the air cleaning box is in correct position.

8.11 Robot mounting/dismounting

Robot weight

- 4600, 60kg, 2.05m: 425kg
- 2600, 20kg, 1.65m: 272kg

Specification of bolts and washers

Below specifies required bolts and washers for securing the robot at Flex MT.

- ABB 4600: 6 bolts M16 x 60, 6 washers 17 x 30 x 3, quality 8.8
- ABB 2600: 3 bolts M16 x 60, 3 washers 17 x 30 x 3, quality 8.8

Tightening torque 200 Nm

How to mount or dismount a robot to FlexMT

DANGER

Avoid dangerous robot swing movements by carefully taking into account the center of mass of the hanging robot.

Mount the robot to FlexMT by the following procedure

- Use a fork lift and place the pallet with the robot as close as possible to the FlexMT robot pedestal.
- Attach straps to robot.
- Attach the straps to a forklift with enough handling weight to handle the robots weight.
- Place the robot at the FlexMT robot pedestal.
- Secure the robot by mounting the M16 bolts, tightening torque 200Nm.
- Mount electric and pneumatic connections to the robot.

For dismounting the robot, follow the steps above in reverse order.

8.12 Robot fine calibration

When fine-calibrating the robot, it must be on flat level surface. Thus it must be dismounted from the FlexMT.

8.13 Software repair

When delivered, a backup of the robot and the PickMT is included. The robot backup is saved on the PickMT SmartCamera, and a backup of the PickMT SmartCamera is saved on the robot.

Continues on next page

8.13.1 Robot repair

A robot backup that restores the robot system to its factory settings is saved on the smart camera harddisk, location “D:\SystemRepair\RobotBackup\.

Copy this backup to a USB memory stick and restore it with standard robot backup restore procedures (refer to robot manual).

8.13.2 PickMT SmartCamera repair

A smart camera backup that restores the smart camera to its factory settings is saved on the robot hard disk, location “BACKUP\SystemRepair\SmartCameraBackup\”.

Copy this backup to a USB memory stick and restore it with standard smart camera restore procedures (refer to PickMT manual).

9 Troubleshooting

9.1 Alarms, warnings and informations

9.1.1 FlexMT

A number of alarms, warnings and informations are generated from the system.
All messages are accompanied by corresponding light tower signalling.

Colors are blue (B) for information, yellow (Y) for warning, and red (R) for alarms.

Alarms from conveyor subsystem

Number	Symbol	Comment	Color
91 001	TIMEOUT_IN_POSITION	Timeout inconveyor. Place parts on belt and reset inconveyor.	R
91 003	ALARM_TOO_FAR_BELT1	Part went to far on inconveyor. Remove part and reset inconveyor.	R
91 004	ALARM_EMERGENCY_STOP_BELT1	Emergency stop. Reset cell to normal operation state.	R
91 005	ALARM_FC_BELT1	Alarm frequency inverter inconveyor. Check frequency inverter and inconveyor.	R
91 006	ALARM_FC_OUTBELT1	Alarm frequency inverter outconveyor. Check frequency inverter and outconveyor.	R
91 007	TIMEOUT_MANUAL_FORWARD_BELT1	Timeout manual run forward inconveyor. Restart belt with run forward knob.	R
91 008	TIMEOUT_MANUAL_BACKWARD_BELT1	Timeout manual run backward inconveyor. Restart belt with run backward knob.	R
91 009	TIMEOUT_EMPTYING_OUTBELT1	Timeout emptying outconveyor. Restart outconveyor with outconveyor auto/manual switch.	R
91 010	ALARM_TOO_FAR_OUTBELT1	Part reached end of outconveyor. Remove part. Restart outconveyor with outconveyor auto/manual switch.	R
91 011	ALARM_TOO_FAR_FAULTY_OUTBELT1	Faulty signal from TooFar sensor outconveyor. Check sensor function.	R

Alarms from FlexMT system

Number	Symbol	Comment	Color
91 100	NOT_VALID_ROBOT_ZONE	No valid zone detected in CheckPos. Jog robot to known zone.	R
91 101	SAFEMOVE_OVERRIDE_ACTIVE	SafeMove override active during robot start. Switch to normal mode.	R
91 102	LOW_AIR_PRESSURE	Low air pressure detected in CheckSystem. Check air preparation.	R
91 103	NOT_VALID_GRIPPER	No valid gripper number. Check user RAPID code.	R

Continues on next page

9.1.1 FlexMT
Continued

91 104	IMAGE_GRABBING_PROBLEM	No image coordinate received from PickMT. Check PickMT status.	R
91 105	SOFTWARE_SYNC_NEEDED	Software synchronization needed. Turn robot to manual, move to sync position and call SoftwareSync.	R
91 106	WRONG_GRIPPER_NO	No valid gripper number. Check user RAPID code.	R
91 107	GATE_NOT_LOCKED	Gate not locked detected during system start. Lock gate with reset switch and restart.	R
91 108	MACHINE_NOT_HOME	Machine tool not in home position during system start. Check and restart.	R
91 109	USER_MESSAGE_SHOW_ERROR	Internal error during user message display. Restart system.	R
91 110	SAMPLE_OUTLET_NOT_IN_POSITION	Statistical outlet is not pushed in. Push outlet into position and press Play.	Y
91 112	DETAIL_IN_SAMPLE_OUTLET	Part is still present in statistical outlet. Remove part and press Play..	Y
91 113	WRONG_TARGET_POSITION	Internal error in MoveTo-routine. No valid target zone. Check user RAPID code.	R
91 114	NO_DETAIL_FOUND	No detail found by PickMT. Check teachIn, illumination and part appearance.	B
91 115	NO_DETAIL_IN_POSITION	No parts on inconveyor. Load more parts.	B
91 116	MACHINE_DOOR_NOT_OPENED	Machine door tool was not opened within time limit. Check machine tool.	R
91 117	MARK_TEXT_CHANGE_PROBLEM	Marker unit text could not be changed. Check communication status. Reset marker unit.	B
91 118	MARK_TEXT_TOO_LONG	Marker unit text to long. Shorten text to be written.	R
91 119	MARK_FILE_LOAD_PROBLEM	Marker unit file could not be loaded. Check file integrity and reset marker unit.	B
91 120	MARKER_COM_TIMEOUT	Marker communication timeout. Check communication status and reset marker unit.	B
91 121	MARKER_UNEXPECTED_ANSWER	Marker unit unexpected response. Check communication status and reset marker unit.	R
91 122	MAX_HEIGHT_EXCEEDED_UNLOAD	Maximum part height for unloading exceeded. Reduce height or check value of FEEDER_MAX_HEIGHT.	R
91 123	MAX_HEIGHT_EXCEEDED_LOAD	Maximum part height for loading exceeded. Reduce height or check value of FEEDER_MAX_HEIGHT.	R
91 124	TOO_SMALL_DETAIL_DIAMETER	Minimum part diameter reached. Increase diameter or check value of MIN_RAW_DETAIL_DIAMETER.	R

9.1.2 PickMT

Alarms for the PickMT system are described in the PickMT manual.

9.2 PickMT troubleshooting

Troubleshooting information concerning PickMT, e.g. teachin or accuracy problems, can be found in the PickMT manual.

Other PickMT related problems can often be solved by checking the PickMT generated log-file. Refer to the PickMT manual for information on extended logging.

9.3 Robot troubleshooting

Troubleshooting information concerning the robot can be found in the robot manuals.

9.4 Marking unit

The marking unit can - if in rare cases necessary - be resetted by shortly pressing the red button in the control cabinet. It is located directly on the side of the marking unit control unit.

10 Decommissioning

When decommissioning the FlexMT, start with decommissioning of the robot according to the robot product manual.

Allways follow the relevant countries regulations for removing and recycling mechanical, electrical and electronic material. Take into account oil and grease that can be found inside the equipment.

Continues on next page

10.1 Environmental information

10.1.1 Hazardous material

The table specifies some of the materials in the product and their respective use throughout the product.

Material	Example application
Batteries, NiCad or Lithium	Serial measurement board
Copper Cables,	Motors
Cast iron/nodular iron	
Steel	
Neodymium Brakes	Motors
Plastic/rubber	
Oil, grease	Gearboxes
Aluminium	

Dispose components properly to prevent health or environmental hazards.

10.1.2 Oil and grease

Where possible, arrange for oil and grease to be recycled. Dispose of via an authorized person/contractor in accordance with local regulations. Do not dispose of oil and grease near lakes, ponds, ditches, down drains, or onto soil. Incineration must be carried out under controlled conditions in accordance with local regulations.

Also note that:

- Spills can form a film on water surfaces causing damage to organisms. Oxygen transfer could also be impaired.
- Spillage can penetrate the soil causing ground water contamination.

10.2 Scrapping of FlexMT

When a FlexMT is disassembled while being scrapped, it is very important to remember the following before disassembling starts, in order to prevent injuries:

- Start with scrapping/disassembling the robot according to the robots product manual.

11 Spare parts

Spare part list is not included in the manual but are delivered as a separate documents.

This page is intentionally left blank

12 Diagrams

12.1 Circuit diagram

The circuit diagram is not included in this manual, but delivered as separate document.

12.2 Pneumatic diagram

The pneumatic diagram is not included in this manual, but delivered as separate document.

13 Appendix A: Configuration

13.1 Conveyor system parameters that can be set by PickMT

Some parameters controlling the flow of parts and behaviour of in- and outconveyor can be adjusted part specific in the PickMT Teachin.

Parameters	Description
Inconveyor	
nTimeDelayGrabBelt1	Delay between belt stop and the signal InPositionBelt1
nTimePartAtStartRunBelt1	The maximum time the belt may run when the sensor Belt1InPosition is affected at belt start
nTimePartsLowBelt1	The time within which the sensor Belt1PartLow must be affected again so that the alarm for filling requirement is not triggered.
nTimeoutBelt1	Timeout time so that the alarm for lack of parts is not triggered for conveyor 1
nTimeDelayStopBelt1	Delay between sensor Belt1InPosition and belt stop
nDisableTooFarFeeder1	DisableTooFarBelt1. If this flag is set to 1, sensor Betl1TooFar is ignored.
Outconveyor	
nTimeoutEmptyingOutbelt1	Maximum running time for outconveyor1 during emptying.
nDisableTooFarOutbelt1	DisableTooFarOutbelt1. If this flag is set to 1, sensor Outbelt1TooFar is ignored.
nRunTimeFeederOut	The time which the outconveyor must run in order to allow new details to be put on the outconveyor.
General	
nTimeDelayAllowRobotOutbelt1	Delay time for signal AllowRobotLeaveOutbelt1 which takes into account ramp-down time of the belt. Must be lower than ramp-down time.
nTimeDelayMode	Delay time for switch between automatic and manual operation (inconveyor)
nTimeMaxManualForwardBelt1	Longest forward belt running time during manual operation of inconveyor.
nTimeMaxManualBackwardBelt1	Longest backward belt running time during manual operation of inconveyor.

These parameters are defined as a user defined PLC in PickMT. Parameters can be changed, renamed, added. Refer to PickMT manual for in-depth information on user defined PLC.

13.2 Setting the frequency inverter

13.2.1 General

This document describes parameter settings of the frequency inverter ABB ACS355-01E-04A7-2 (CE) and ACS355-03U-04A7-2+E200(UL) which is used in FlexMT.

The document reports settings of the essential parameters that are required for tuning the FlexMT. Further optimization and settings can be done, for this refer to ABB ACS355 documentation.

13.2.2 Operation ABB ACS355

13.2.2.1 Key functions

ABB Inverter display

1. LCD display – Divided into five areas:
   - a. Upper left – Control location:
     - LOC: drive control is local, that is, from the control panel
     - REM: drive control is remote, such as the drive I/O or fieldbus.
   - b. Upper right – Unit of the displayed value.
   - c. Center – Variable; in general, shows parameter and signal values, menus or lists. Shows also fault and alarm codes.
   - d. Lower left and center – Panel operation state:
     - OUTPUT: Output mode
     - PAR: Parameter mode
     - MENU: Main menu.
     - FAULT: Fault mode.
   - e. Lower right – Indicators:
     - FWD (forward) / REV (reverse): direction of the motor rotation
     - Flashing slowly: stopped
     - Flashing rapidly: running, not at setpoint
     - Steady: running, at setpoint
     - SET: Displayed value can be modified (in the Parameter and Reference modes).

2. RESET/EXIT – Exits to the next higher menu level without saving changed values. Resets faults in the Output and Fault modes.

3. MENU/ENTER – Enters deeper into menu level. In the Parameter mode, saves the displayed value as the new setting.

Continues on next page

13.2.2.1 Key functions
Continued

4. Up
   - Scrolls up through a menu or list.
   - Increases a value if a parameter is selected.
   - Increases the reference value in the Reference mode.
   - Holding the key down changes the value faster.
5. Down
   - Scrolls down through a menu or list.
   - Decreases a value if a parameter is selected.
   - Decreases the reference value in the Reference mode.
   - Holding the key down changes the value faster.
6. LOC/REM – Changes between local and remote control of the drive.
7. DIR – Changes the direction of the motor rotation.
8. STOP – Stops the drive in local control.
9. START – Starts the drive in local control.

13.2.2.2 Operation

You operate the control panel with the help of menus and keys. You select an option, eg operation mode or parameter, by scrolling the  or  keys until the desired option is visible in the display and then pressing the  key. With the  key, you return to the previous operation level without saving the made changes. The basic control panel has five panel modes: Output mode, Reference mode, Parameter mode, Copy mode and Fault mode.

When a fault or alarm occurs, the panel goes automatically to the Fault mode showing the fault or alarm code. You can reset the fault or alarm in the Output or Fault mode. After the power is switched on, the panel is in the Output mode, where you can start, stop, change the direction, switch between local and remote control and monitor up to three actual values (one at a time). To do other tasks, go first to the Main menu and select the appropriate mode.

13.2.3 Parameters

Factory parameters settings are found in the electrical documentation.

13.2.4 View and change parameters

Step	Action	Display
1	Go to the Main menu by pressing if you are in the output mode, otherwise by pressing repeatedly until you see MENU at the bottom.	
2	If the panel is not in the Parameter mode (“PAr” not visible), press key or until you see “PAr” and then press . The display shows the number of one of the parameter groups.	
3	Use keys and to find the desired parameter group.	
4	Press . The display shows one of the parameters in the selected group.	
5	Use keys and to find the desired parameter.	
6	Press and hold for about two seconds until the display shows the value of the parameter with SET underneath indicating that changing of the value is now possible. Note: When SET is visible, pressing keys and simultaneously changes the displayed value to the default value of the parameter.	
7	Use keys and to modify the parameter value. When you have changed the parameter value, SET starts flashing. • To save the displayed parameter value, press • To cancel the new value and keep the original, press .	 

13.2.5 Alarms

Error codes are shown on the display in event of malfunctions. See the table below for the most common error codes. Complete description of alarm/fault messages are found in the frequency inverter manual.

The drive can be reset either by pressing the keypad key, RESET EXIT, or by switching the supply voltage off for a while. When the fault has been removed, the motor can be restarted.

Alarm messages

2001 Current limit

2002 Overvoltage

2003 Undervoltage

2009 High temp frequency inverter

Fault messages

0001 Current limit exceeded

0002 Over voltage

0003 High temperature frequency inverter

0004 Short-circuit in motorcables or motor

0006 Under voltage

0009 High motor temperature

13.3 Pre-configuration settings

The FlexMT is pre-configured when delivered. This section describes some pre-configuration data that might be needed for in-depth technical use of the FlexMT.

Continues on next page

13.3.1 Robot pre-configuration

Robot related pre-configuration (i.e. SafeMove, I/O, base frame, work objects and robot positions) has been described earlier in this manual.

Serial port setting for communication with the marking unit are as follows:

Name: COM1, Connector: COM1, Baud rate 9600, Parity: None, Number of bits: 8, Number of stop bits: 1, Flow control: None, Duplex: Full

13.3.2 PickMT pre-configuration

PickMT has been pre-configured with the options that are present in the delivered FlexMT. If needed, this pre-configuration can be changed. Please consult the PickMT manual for detailed information on configuration.

13.3.3 Marking unit pre-configuration

The marking unit has been pre-configured for use with FlexMT.

There are three pre-configured marking files that are used with PickMT (SMALL, MEDIUM, LARGE). These files can - if needed - be changed by the use of the marking units configuration software (se reference section on auxiliary software).

When changing marking files, keep the following information in mind: The part specific marking string is written to the text variable PICKMT, with a constant length that is defined in the PickMT setup files.

The serial communication of the SIC controller is set to match the standard setting for COM1 on the robot: Baud rate 9600, Parity: None, Number of bits: 8, Number of stop bits: 1, Only RC: NO, Type: RS232

No further configuration of the SIC controller is necessary. if desired, most advanced options of the marking unit can be used. In certain cases, this would need minor modifications of the RAPID code.

13.3.4 Frequency inverter pre-configuration

The frequency inverter units have been pre-configured for use with FlexMT.
Se section below for parameter handling of these devices.

13.4 Known limitations and issues

13.4.1 RobotWare 5.15.06

- The cyclic break check functionality on a robot as used in the FLexMT is subject to an internal error. Due to not yet known reasons, RW 15.15.06 can therefore not be used.

13.4.2 RobotWare 5.60

A break in communication between PickMT and the robot systems occurs under the following circumstances:

- Robot is in automatic mode and stopped, motors are off
- Operator presses ”Run” button on FlexPendant.
- An error message about safety mechanism intervention is displayed and acknowledged
- From this point onwards, the communication channel to the robot is broken until the robot system is restarted (warm start).

This page is intentionally left blank

14 Appendix B: Communication

14.1 Inputs and outputs

14.1.1 Conveyor system

Name	Description
diFeeder1InPosition	Sensor that indicates that parts are on the cameras field of view
diFeeder1TooFar	Sensor that indicates that parts are at the end of inconveyor
diEmergencyStopOk	Emergency stop is not active
diFeeder1ManualForward	Knob for forward operation of inconveyor
diFeeder1ManualBackward	Knob for backward operation of inconveyor
diFeeder1SelectAutomatic	Knob for selecting method of operation (automatic – manual) of inconveyor
diOutFeeder1TooFar	Sensor that indicates that parts are at the end of outconveyor
diFeeder1SelectEmptying	Knob for selecting method of operation (automatic – emptying) of outconveyor
diAlarmU11FeederIN	Alarm from frequency inverter inconveyor
diAlarmU12FeederOUT	Alarm from frequency inverter outconveyor
doRunForwardBelt1	Runs inconveyor forward
doRunBackwardBelt1	Runs inconveyor backward
doManualLampFeeder1	Indication for operator when running inconveyor manually is permitted
doRunFeederOut1	Run outconveyor

14.1.2 Entry control and safety

Name	Description
diEntryRequest	Entry request signal from door operator panel
diReset_AutoStop	Reset autostop signal from door operator panel
diStartRobot	Start robot signal from door operator panel
doLockGate	Lock door with magnetic holder
doEntryRequestControlLamp	Turn on lamp in entry request button on door operator panel
diAirPressureOK	Signal from air preparation unit that air pressure is ok.
doGreenLamp	Turn on green light in RGB signal lamp
doBlueLamp	Turn on blue light in RGB signal lamp
doRedLamp	Turn on red light in RGB signal lamp

14.1.3 Gripper

Name	Description
diGripperSensor1	Spare signal on robot arm that can be used by integrator
diGripperSensor2	Spare signal on robot arm that can be used by integrator
diGripperSensor3	Spare signal on robot arm that can be used by integrator
diGripperSensor4	Spare signal on robot arm that can be used by integrator
diGripperSensor5	Spare signal on robot arm that can be used by integrator
diGripperSensor6	Spare signal on robot arm that can be used by integrator
doValve1Gripper	Open gripper 1
doValve2Gripper	Open gripper 2
doValve3Gripper	Spare signal on robot arm connected to valve. Can be used by integrator
doValve4Gripper	Spare signal on robot arm connected to valve. Can be used by integrator
doValve5Gripper	Spare signal on robot arm connected to valve. Can be used by integrator
doValve6Gripper	Spare signal on robot arm connected to valve. Can be used by integrator
doValve7Gripper	Spare signal on robot arm connected to valve. Can be used by integrator

14.1.4 Turn station

Name	Description
doTurnStationGripperOpen	Open gripper
doTurnStationRotate	Rotate turn station

14.1.5 Air cleaning box

Name	Description
doValve1BlowBox	Activate valve 1 on air cleaning box
doValve2BlowBox	Activate valve 2 on air cleaning box
doValve3BlowBox	Activate valve 3 on air cleaning box
doValve4BlowBox	Activate valve 4 on air cleaning box
doValve5BlowBox	Activate valve 5 on air cleaning box
doValve6BlowBox	Activate valve 6 on air cleaning box

14.1.6 Deburring

Name	Description
doValve1Deburr	Activate grinding/deburring tool 1
doValve2Deburr	Activate grinding/deburring tool 1

14.1.7 Marking unit

No digital I/O is used for the marking unit.

14.1.8 Statistical outlet

Name	Description
diDetailInBoxSensor	Sensor that indicates that parts are placed in the statistical outlet.
diBoxInPositionSensor	Sensor that indicates that the box is in position and ready to receive parts.

14.2 Internal communication

The FlexMT has a function interface that makes communication of the equipment with corresponding robot and the rest of the robot cell possible. The structure of the robot cells function interface, e.g. to the principal machine, can be found in the robot cells interface description.

Continues on next page

14.2.1 PickMT <> Robot

For details on communication between PickMT and robot refer top the PickMT manual.

14.2.2 Marking unit <> Robot

A number of commands are used to control the SIC controller. Note that the example commands below are not representing complete code, neither do they contain necessary handshaking communication with the controller. Consult RAPID code for in-depth information.

WriteStrBin ioSicMarker,”LOADFILE ” +”MEDIUM” +”\0D\0A”;

WriteStrBin ioSicMarker,”SETVAR PICKMT ” + “example text” +”\0D\0A”;

WriteStrBin ioSicMarker,”RUN\0D\0A”;

A number of advanced commands can be issued to the marking unit controller. Please refer to the marking units manual for in-depth information.

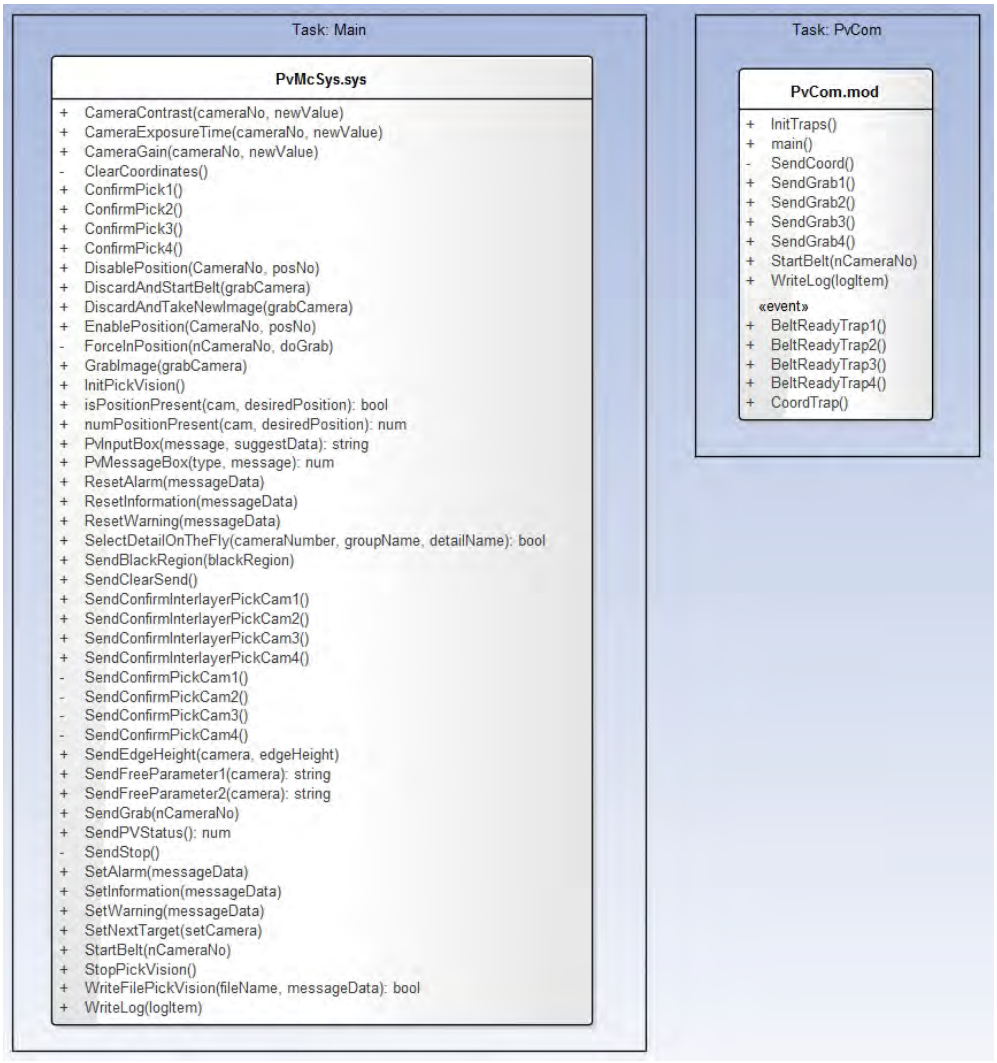
This page is intentionally left blank

15 Apendix C: FlexMT RAPID reference

15.1 PickMT core functionality reference

The PickMT core consists of two modules, PvCom.mod which is running in a background task and PvMcSys.mod which is the interface towards the application RAPID code.

FlexMT core functionality - control tasks (2)



These two modules are documented in more detail in the PickMT manual.

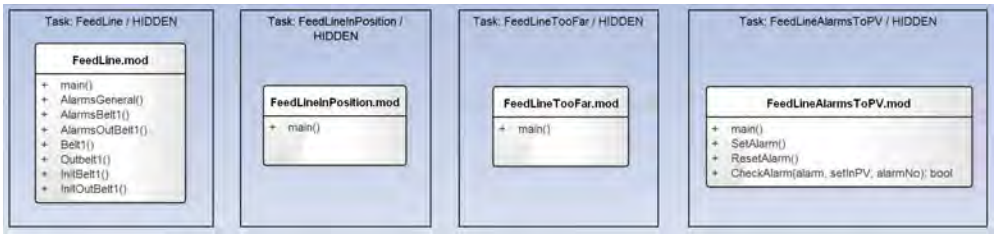
15.2 FlexMT core functionality reference

The FlexMT core functionality is structured according to the following overviews. Some modules relevant for commissioning have been described in the robot program section. All other modules are described below.

Continues on next page

15.2.1 Control subsystem

FlexMT core functionality - control tasks (1)



FlexMT core functionality - control tasks (2)

FeedLine.mod

Overal handling of conveyors and alarms connected to conveyor system.

FeedLineInPosition.mod

Specialized task for handling start and stop of inconveyor with short response time, regular operation with InPosition-sensor.

FeedLineToFar.mod

Specialized task for handling start and stop of inconveyor with short response time, regular operation with ToFar-sensor.

FeedLineAlarmsToPV.mod

Specialized task for checking and communicating alarms to PickMT.

EntryControlLamp.mod

Specialized task responsible for handling entry request confirmation lamp.

EntryControl.mod

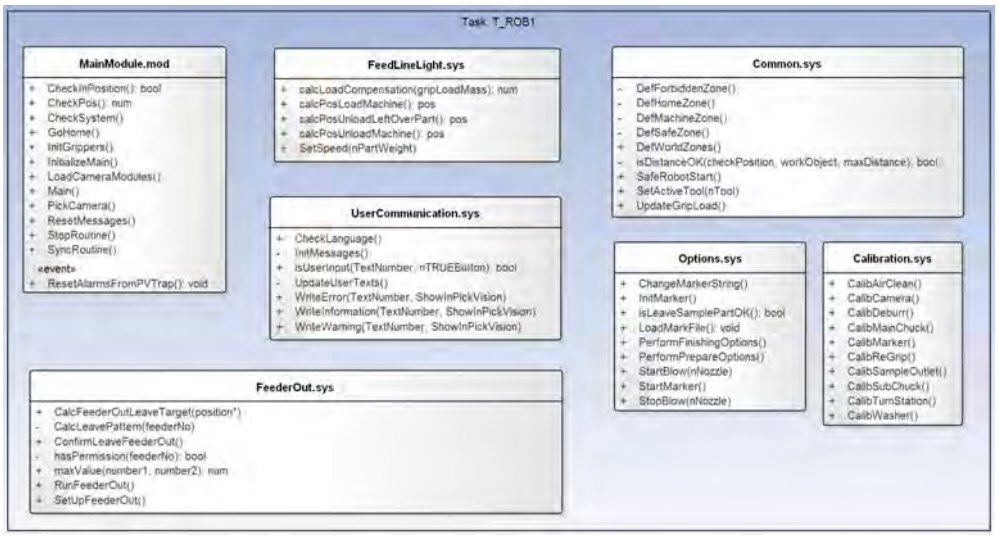
Specialized task responsible for handling entry request, autostop reset and door lock signals.

RGBLightTower.mod

Specialized task responsible for controlling light tower according to various error, warning and information situations

15.2.2 Utility and assistance subsystem

FlexMT core functionality - utility and assistance subsystem



Calibration.sys

Contains helper functions to be called during calibration. These helper functions define the point-of-interest positions in most used work objects. Refer to chapter on commissioning.

Options.sys

Contains helper functions for setting up and controlling optional equipment.

UserCommunication.sys

Contains helper functions for localizable user interaction and information. Refer to chapter on robot program.

MainModule.mod

Main module controlling FlexMT function. Refer to chapter on robot program.

Common.sys

Contains tool data, work object data, and world zone information (refer to chapter on world zones).

FeedLineLight.sys

Refer to PickMT manual.

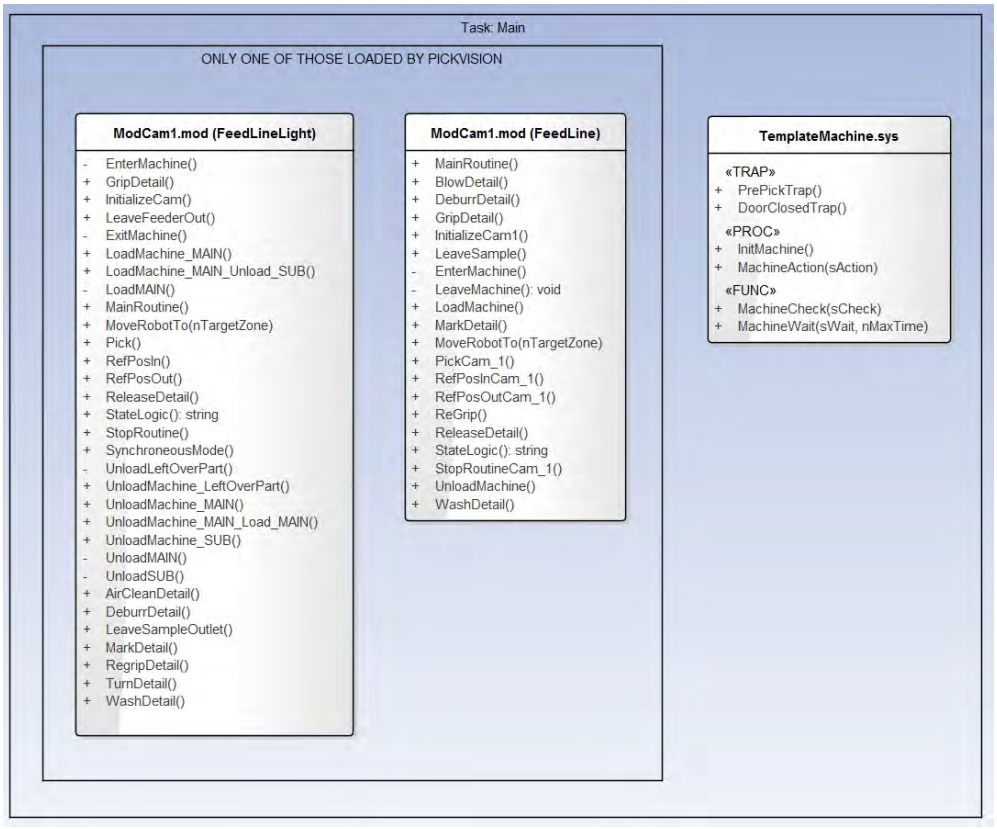
FeederOut.sys

Refer to PickMT manual.

15.3 FlexMT application functionality

The FlexMT application functionality handles machine tool and part specific aspects of the FlexMT. The integrator is fully responsible for adopting this functionality to the actual application.

FlexMT core functionality - main task



TemplateMachine.sys

Provides bridge between logical functions within the FlexMT application and physical interface to the machine tool.

ModCam1.mod

ModCam1.mod handles the part specific programming, e.g. loading, unloading, marking, air cleaning. Two example modules are delivered, one for operation with simplified TeachIn (FeedLine Light), the other for standard operation with standard TeachIn. Refer to chapter on robot program.

This page is intentionally left blank

16 Apendix D: Own notes

Contact us

ABB AB
Discrete Automation and Motion
Robotics
S-721 68 VÄSTERÅS, Sweden
Telephone +46 (0) 21 344 400

ABB AS, Robotics
Discrete Automation and Motion
Nordlysvegen 7, N-4340 BRYNE, Norway
Box 265, N-4349 BRYNE, Norway
Telephone: +47 51489000

ABB Engineering (Shanghai) Ltd.
5 Lane 369, ChuangYe Road
KangQiao Town, PuDong District
SHANGHAI 201319, China
Telephone: +86 21 6105 6666

www.abb.com/robotics

3HAC051768-001, Rev -, en