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ABB Automation Technology Products AB
Robotics
SE-721 68 Västerås
Sweden
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1 Welcome to PickMaster 2.0

1.1 Introduction

Thank you for your interest in PickMaster. This document will give you an overview of the product characteristics and how it can be used.

PickMaster - the PC-based control software from ABB - is a plug & produce high-end integration of our high performance S4Cplus robot controller. It uses a reliable powerful vision system from Cognex and specializes on high speed picking of random placed objects from moving conveyors. It is also well suited for generic vision robot guidance applications.

As an Ethernet based network solution PickMaster can control up to 8 robots - simultaneously in the same application or concurrently in independent cells.

By the use of Remote Integration Services (RIS) PickMaster can be operated from any production panels or automation system through an integrated support for field buses, TCP/IP or serial link.

PickMaster gives you the benefit of:

- Fast installation and configuration of one or multiple robots in an Ethernet network. No programming is required.
- Instant product change-over
- Risk reduction offering a product-based repeat solution, configurable for a multitude of operational cases.
- High performance vision recognition and product quality inspection
- Tailored robot controller ProcessWare for best cycle time performance through enhanced built-in high volume flow conveyor tracking and optimal position transfer pipe line
- Self contained robots in a line

PickMaster 2.0 is a modular product, which can be composed to your special needs:

- With integrated vision for full random operation, working with continuously moving conveyors
- Without vision recognition as a tool for efficient production with guided product flows on multiple conveyors
- With integrated vision for random operation and absolute accurate positioning on indexed feeders or trays
- For efficient quality inspection and product categorization alone or together with position recognition.

PickMaster 2.0 runs with the S4Cplus robot controller and RobotWare - at least 4.0.54 or higher. Required RobotWare software option is “Prepared for PickMaster” which includes all necessary software options to interface PickMaster as well as efficient conveyor tracking.

PickMaster runs on Windows 2000 on a regular Pentium III PC with at least 750 MHz clock frequency for efficient production. Recommended is 1.5 GHz or higher for best performance in CPU-demanding applications.

When PickMaster has been installed on your computer an on-line help is available for fast navigation through the use of PickMaster, identical to the paper copy, which can be delivered with the product.

PickMaster is licensed through basic licenses and additional licenses determining the maximum number of robots and cameras attached as well as additional options during design and run time. All PC-software is contained on a CD-ROM.

PickMaster is delivered with different hardware configurations according to the option description chapter.

Below the list of available material (see options and variants for a detailed description):
• PickMaster software box
• Cognex MVS-8120 vision board for max four cameras
• Camera break out box for MVS-8120
• Cognex MVS-8100 vision board for single camera applications
• Trig-Strobe I/O board
• Ribbon cable between vision and I/O boards
• I/O adaptor for MVS-8100
• User’s Guide

1.1.1 List of PickMaster 2.0 features

PickMaster 2.0 is the second generation of PickMaster and the most striking features are:

• Graphical concept
• Eight robots and eight cameras per PickMaster
• Six conveyors per robot
• Fast project start-up
• Fast image updates
• Multiple simultaneous PickMaster projects independently running concurrent picking processes
• Remote operator’s panel interface (RIS)
• Cognex CVL C++ vision software library
• Fast and accurate calibration
• Enhanced PatMax and Blob modelling
• Vision model import/export
• Auto camera trigger
• Quality inspection level I
• Quality inspection level II with inspection area
• Fast pattern programming
• Optimized Prepared for PickMaster process ware
• Standard MS EventViewer logging
• Trigger mode selection
• Enhanced mixing and sorting
• Enhanced runtime tuning
• IRB 340 and IRB 140, other IRB’s on request
• Self contained robot cells
• Prepared for translation to local languages including full Asian language support
• Videos are provided to give a quick introduction about the PickMaster 2.0 software and how it shall be used

Hardware

• MSV-8100 or MVS-8120 frame grabber board alternatives for single and multiple cameras
• Compatible with MVS-8110
• Multiple vision boards in one PC
2 Application description

PickMaster is tailored for advanced high speed picking of random object on moving conveyors, but the flexibility and modularity of the product makes it suitable for a wide range of customer applications, including generic vision recognition integration for robot guidance.

2.1 General description

2.1.1 Scope

Up to eight robots and eight cameras may be connected to a PickMaster PC. They may be running together in one project or in a multitude of independent concurrent projects on the same PC.

2.1.2 Process objects

In a pick and place operations, robots are moving items from pick to place positions.

Robot

A robot is executing the pick and place operation or any other operation based on positions generated by PickMaster. PickMaster tightly integrates the ABB robot controller and the PC.
Standard robot types for use are:
- IRB 340
- IRB 140 / IRB 140T
- All other IRB’s may be connected to PickMaster. Order on request.

**Item**

An item is an object, which can be identified by type and position.

**Container**

A container is a compound item, which contains a pattern with predefined positions. For six axes control, three-dimensional pattern positions can be defined.

**Conveyor**

Conveyors are tracked by the robot controller measuring position and speed. The conveyor tracking functions are enhanced for high volume product flows. It contains:

**Work area**

A work area may either be part of a continuously running conveyor, or a separate fixed, indexed work area.

**Camera**

Cameras are used to pinpoint randomly placed items and to generate position and orientation. The cameras are connected to frame grabber vision boards mounted on the PCI-bus of the PickMaster PC.

**Triggers**

The trigger mode defines the way the positions are generated from fixed positions or camera recognition. The trigger may either be based on a regular distance on a conveyor or a sensor, which may be a regular I/O signal or an event, generated from a RAPID program, when new positions are requested. Typically a sensor would recognize a box, which is in position and ready to operate on.

2.1.3 **Application types**

PickMaster can handle a wide variety of applications in packaging as it has integrated support for mixing, sorting, collating, etc.

The way the robot shall pick and place from different work areas is easily enhanced by the PickMaster RAPID instructions. The order and priority including exception handling is possible to program with the RAPID instruction set provided with PickMaster.

In most standard cases, no programming adoptions are needed at all. The PickMaster software package contain predefined RAPID modules.

**Random flow**

This is the most flexible way of feeding products. There is no need for fixtures and many different products or packages can be transported on the same feeders without mechanical adoptions.
Predefined flow

The products and place trays are placed in predefined positions. With PickMaster many robots and products are easily configured and the process is executed with highest performance and efficiency with included work area limit supervision.

Indexing conveyors and fixed work areas

In many cases the products are presented to the robots on indexed tables or indexing conveyors. In this case conveyor tracking is not used, but the products may be random placed and vision recognition is then needed.

Double/multiple pick, single place

If higher performance is required, double picking is easily configured. However, special grippers and a less flexible configuration are the disadvantages of this solution.

Pick and place order

The items are normally picked and placed in direction of the conveyor, i.e. first in, first out. It is also sort the items in y-direction orthogonal to the conveyor direction.

Inspection

Quality inspection at the same time as the pinpointing of the positions or as pure inspection even if the products and trays are not random placed.

2.1.4 Use cases

Below a sample of possible layout cases. There are many more variations and they can be combined in joint layouts with different robot types.

Single conveyor

Picking and placing on the same conveyor, assembling, sorting, etc.

Multiple parallel conveyors

The pick and place positions are on parallel conveyors.
Perpendicular layout

Typical use cases is product feeding of packaging machines, i.e. flow wrappers, etc.

Running the perpendicular in direction towards the robot, this layout is well suited for mixing of different product types into well defined positions in a package, i.e. assortment, etc.
**Non conveyor application**

Indexing feeders. The cameras may be placed outside the working area (fixed number of indices) or inside the working area.

**Generic vision guidance**

PickMaster is well suited for any robot application with needs vision to identify positions and then to run any robot application program. The vision integration is not limited to packaging operations with conveyors.
3 Structure and concept

A PickMaster process execution is defined in two files:

- The line definition (*.pml)-file
- The project definition (*.pmp)-file

The processes are defined in a studio environment.

3.1 Line and project

The line definition contains all fixed installation information, which can be shared by many process runs. Examples are robots, conveyors and cameras. The cameras and conveyors are calibrated once and saved with the line definition file. The content is only changed if the physical components have been changed or moved.

The project definition contains all process specific information, i.e. product definition, RAPID-program, which cameras and robots are used, etc. Many projects can be defined on the same line. They can run in independent concurrent execution. The down-time when introducing new products in a line is very short as new projects can be defined and edited while others are still running in production.

Line and projects can be created, opened, copied, deleted and printed. A project is started on a single start button.

3.2 Studio environment

The PickMaster processes are defined and executed in a studio interface environment. The studio is divided in three parts:

- Workspace
- Layout view
- Shared log and camera view

The workspace can switch between project, line and production view. The production view shows current pick rate and total numbers of pick and place operations. In the production view each individual robot in a line can be paused and restarted and the emergency stop can be reset.
Graphical components are easily introduced and edited by right mouse click.

Lower window shows runtime and live images.
3.3 Calibration

The calibration of PickMaster consists of two parts:

- Camera calibration
- Base frame or object frame calibration

The Base frame calibration is made in relation to a conveyor or a user frame for fixed positions. Since the calibration is located in the line, several projects can share the same calibration. The camera calibration and the base frame calibration can be performed independent of each other.

PickMaster contains methods for calibrating the cameras and the base frame of the robot—either with conveyors or fixed object frames.

3.3.1 Camera Calibration

The camera calibration is done in one step using a two-dimensional blob grid pattern with regular pitch. The accuracy is dependent on the quality of the grid, the camera resolution, lens, etc. An accuracy of 1/40 pixel is achievable.

Methods and design papers are included to easily verify the calibration result. For minor inaccuracies separate camera and base frame calibration tuning can be applied.

3.3.2 Base Frame / work object calibration

The base frame calibration is done with the teach pendant and the robot and it contains position calibration settings as well as conveyor pulse ratio settings in case a conveyor is used.
3.4 Runtime operation

Project execution is easily started and stopped from a single button in the PickMaster studio interface. In the production view individual robots can be controlled.

3.4.1 Remote Integration Services (RIS)

There is a programmable interface for tailored run time operation interfacing called Remote Integration Services. With this option, PickMaster can be operated from a remote place like an operator’s panel, thus making it possible to integrate PickMaster in the overall line control. RIS provides the runtime interface as well as the configuration menus to set up the command codes.

The available interfaces in RIS are:

- COM, accessible from any programming language from the PickMaster computer or any other computer in the Ethernet network
- Serial interface
- Field bus interface. Provides access to Hilscher field bus cards, which supports most of the field bus standards. See www.hilscher.de for available cards and specifications.

Project commands:
- Start
- Stop
- Status: Project running/Stopped/Configuration Error/No License/Error

Robot commands for selected robot
- Start
- Stop
- Reset E-stop
- Pick rate
- Status: Running/Stopped/Paused/Shutdown/E-stopped/Error/Controller in Man mode

The command codes are unique per project and per robot.

3.4.2 Runtime tune

Many process parameters can be tuned in runtime.

- Positions and orientations: individuals positions and complete patterns in containers
- Pick and place time
- Pick and place tool activation

3.4.3 Logging

Extensive logging is provided by PickMaster. The logging has the following features:

- All log messages are showing in the log view in the PickMaster studio interface
- Categorization of error, warning and status messages
- Local language support
- All robot controller messages included
• Storage in the application log of the Microsoft EventViewer database. Right clicking on a message lets the user directly open the EventViewer.

• Extensive support for saving logs, filtering, scripting, etc are provided with the MS EventViewer.
4 Vision integration

4.1 General
The integrated vision system enables accurate pinpointing of geometrically accurate items as well as less structured items using blob search.

The vision capability is optional in PickMaster 2.0. Efficient object search and inspection is provided by Cognex MVS-8120 and MVS-8100 frame grabber boards, which plug into the PCI-bus of the PC. The powerful vision search algorithms are executed on the MMX accelerated PC. They provide fast and reliable robot guidance as well as concurrent inspection capability. A maximum of eight cameras can be connected on one PC (2 MVS-8120 boards).

4.2 Hardware
The vision boards are mounted on the PCI-bus of the PickMaster PC. Available are the single camera board MVS-8100 and the multiple camera board MVS-8120. The MVS-8120 can control up to four CCD cameras simultaneously. Maximum two boards may be mounted in one PC.

There is always one trig/strobe I/O board needed for each vision board. The trig/strobe I/O is also mounted on the PCI-backplane.

4.3 Vision models
It is possible to define search models with a multitude of criteria to either accept or reject items in a project based on visual recognition and to use the results to guide the robots.
With the basic vision option search and feature specific basic inspection is possible (Inspection I). With inspection II, enhanced vision area inspection is possible.

All vision functions use a window, where the camera view is used for modelling and testing. General functions are Zoom In, Zoom Out, Pan, switching between live and acquired image, light and contrast, etc.

There are two choices of vision models available: Blob and Geometric model. The Geometric model uses the highly efficient PatMax-algorithms from Cognex.

- A vision model is attached to an item in a PickMaster project
- There may be several vision models connected, which are examined simultaneously in the same image
- When multiple models are found in the same position, the position with the best score is selected.
- A model may be exported to a paint program, modified and then imported back again. This is done in order to get perfect models without irrelevant information like reflections.

### 4.3.1 Geometric Model (PatMax)

PatMax is a pattern-location search technology. The PatMax dialogue box gives the user possibility to graphically display differences between trained pattern and found when it comes to angle, score, match info. This tool measures:

- Position of the pattern
- Size relative to the originally trained pattern
- Angle relative to the originally trained pattern
To create a good geometric model the following parameters can be set in the dialogue box:

- Items to Find
- Score Limit
- Contrast Limit
- Area Overlap
- Score Using Clutter
- Uniform Scale
- Limit Angle
- Granularity

### 4.3.2 Blob

A blob analysis finds objects by identifying groups of pixels that fall into a predefined grey-scale range. Blob analysis is well suited for applications where:

- Objects vary greatly in size, shape, and/or orientation
- Objects are of a distinct shade of grey not found in the background
The following features may be tuned, recognized and inspected:

- Segmentation method (Static/relative)
- Type of Blobs (White/Black)
- Morphology (Erode/Dilate/Close/Opening)
- Clean Up operation (Fill/Prune)
- Connectivity
- Minimum size a blob can have to be considered
5 Inspection

Visual inspection capability is used to verify the quality and categorization of the products for picking or placing. It is also used for enhanced feature recognition and accurate identification of similar looking objects (level II).

Both inspection levels I and II can be used for quality inspection even if the positions are pre-defined. The inspection results are sent with the positions to the robot controller, where the decision may be done to pick and place accepted or rejected items.

PickMaster can pick only the accepted items or it can also be configured to pick out only the rejected items.

5.1 Level I

This inspection type is included in the basic vision server option. Inspection level I allows enables type categorization related to the vision model parameters. For each parameter an acceptance range can be defined with a lower and an upper limit. Hits with values inside the acceptance band are marked as accepted, else not accepted.

Acceptance profiles can be defined and used as type categorization for a vision model as a combination of the parameters.

Categorization is based on the geometric or blob model parameters, depending on the type of model used.
5.2 Level II (Inspection Server or Inspection upgrade option)

Level II inspection is integrated when the inspection server option or the inspection upgrade option is included.

The level II inspection is used to detect if additional features exist inside a given area and if needed with a given position and orientation. With this option burn marks on cookies or other defects can be detected. It can also be used to verify that a label or other feature exists in a given position.

This is enhanced vision inspection capability enables the definition of inspection areas inside or outside a base alignment model. For each inspection area a new model is defined. It then combines the search results of each model to a final result categorization.

Areas are defined in relation to the origin model, which can be a geometric model or a blob model. For each inspection area the model can be a blob or geometric model. The models are tuned in the same way and with the same search criteria as described above and the relations is set to the alignment model.
6 RAPID instructions and definitions

With Prepared for PickMaster the robot is configured to work together with a PickMaster PC. Prepared for PickMaster contains a set of RAPID instructions, functions, variables and data types. There are also predefined system and program modules as well as RAPID routines included in Prepared for PickMaster. The RAPID modules are part of the project definition and downloaded to the robot controller at project start-up.

Prepared for PickMaster takes care of the communication, initialisation enhanced conveyor tracking and makes it possible to perform advanced mixing, sorting and collating as well as exception handling as timeout or error handling.

See User’s Guide for the full set of instructions.
7 Technical Specification

7.1 Hardware

7.1.1 PC

At least one PC Pentium III 750 MHz or higher is required to run PickMaster. Two free PCI-slots per vision server and an Ethernet network board are required. It should be equipped with a monitor of at least 17 inches with resolution 1024 x 768 pixels or higher.

PickMaster was tested on IBM.

7.1.2 Network

Communication

The PickMaster PC communicates with the robot controllers through EtherNet and TCP/IP. Ordinary Ethernet interface boards can be used for the PC. The EtherNet interface is standard for the robot controller.

PickMaster and Prepared for PickMaster include all the necessary communication software.

RIS (optional)

PickMaster can be operated remotely by use of the option RIS (remote integration services). The RIS option makes it possible to operate PickMaster from other interfaces than the PickMaster studio design interface and thereby protecting the once designed and fine-tuned projects from being changed by normal day to day operation. There are three ways of connecting external customized operators panels to PickMaster.

- Field bus connection. PickMaster includes a generic driver interfacing the Hilscher field bus card series. Hilscher field bus cards, which plug into the PCI-bus of the PickMaster PC, support all major field bus standards. See hilscher.com for the field bus card product range.
- TCP/IP: Design custom made operator’s panels and connect a client through the TCP/IP interface – on the PickMaster PC or on any other computer on the Ethernet.
- Serial RS232 interface. PickMaster is accessible through commands over a RS232 serial connection to PickMaster.

RIS include interfaces to configure the commands to run PickMaster. RIS is configured per PickMaster project and the following interfaces are exposed:

- Project start/stop
- Project and robot status: status codes are described in the PickMaster documentation
- Robot start/stop
- E-stop reset
- Pick rate

1 Currently supported field buses: ProfiBus/InterBus;CanBus;DeviceNet;SDSM (Smart Distributed System);ASIM/Universal Protocol (RS232/422/485)
7.1.3 Vision

The Cognex vision system is available in two different vision hardware configurations, the MVS-8100 and the MVS-8120.

MVS-8100 is used for single camera applications, whereas four simultaneous cameras can be connected to MVS-8120.

Vision boards MVS-8110 already installed with PickMaster 1.x are compatible to run on Win 2000 and PickMaster 2.0.

Additional equipment not supplied with PickMaster: cameras, camera cables

Maximum two vision boards can be plugged into the PC. MVS-8100 and MVS-8120 can be used together.

Performance

The image recognition time and transfer time for one type of objects in a scene is typically about 50-250 ms. Variations occur depending on the complexity and geometric accuracy of the models as well as if inspection is included.

The vision recognition and inspection perform the most CPU consuming calculations on the PC. Recommended is to use state of the art powerful PC’s to avoid restrictions in speed or performance loss.

Accuracy

The vision absolute accuracy is 1/40 pixel. This makes it possible to obtain accuracy levels of a few 1/100 mm. To obtain the total positioning accuracy and repeatability, the following parts are contributing to the total result:

- Camera resolution and field of view
- Accuracy of the calibration sheet. This is very much dependent on the type of the reproduction technologies (printing) to obtain the calibration blob pattern
- Lens distortions affect the peripheral positions. Non-linear calibration calculation give the best result
- The robot repeatability
- Conveyor accuracy. Highest accuracy is achieved when indexed feeders are used and the camera is mounted inside the working area.

Camera

Recommended camera is Sony XC-55 with full frame shutter and rapid reset. The cables can be ordered directly from Cognex. Cameras and cables are not supplied with this product.

Trig-Strobe Board

For each vision board one trig/strobe I/O board is required for connecting the camera trigger and strobe signals to the S4Cplus system. The vision board and the I/O board are connected through a ribbon cable.

The DSQC 524 Trig-Strobe board adapts the vision system I/O (5 VDC) with the I/O of the robot controller (24 VDC). The board supports four trig-strobe pairs, which matches the maximum number of cameras an MVS 8120 interface board can support. Each trig-strobe pair is separately powered
with 24 VDC and connected to ground, which makes it possible to connect to more than one robot controller in parallel. The same board is used to interface the MVS-8100 board.

**Trig/strobe ribbon cable**

Ribbon cable connection between vision board and trig/strobe board.

**Trig/strobe adaptor**

When using MVS-8100 single camera vision board an additional I/O converter is required for the ribbon cable connection.

### 7.1.4 Robot Controller and I/O signals

The robot controller must be equipped with at least one Digital I/O-board, e.g. DSQC 328 or similar. As an example, one DSQC 328 with 16 in and 16 out signals can handle one robot with four cameras and four conveyors if no other signals are occupied.

The detailed use of I/O signals is as follows:

- Gripper vacuum and blow: two signals per vacuum tool
- Conveyor synchronization (during calibration): one signal per conveyor
- Position generator trigger, e.g. camera: one signal per work area, e.g. pick and place area
- Conveyor start and stop order: one signal per conveyor if this function is used

Detailed hardware connection diagrams are shown in the User’s Guide.

### 7.1.5 Robots

IRB 340 (See 3HAC 5054-1/Rev. 2 Product Specification IRB 340)

IRB 140 (See 3HAC 9041-1 Product Specification IRB 140)

Other IRB’s are available for integration on request.

### 7.1.6 Conveyor

Continuously moving conveyor belts are the preferred way to feed items and packages. It gives a high flexibility since the robot can operate on the items on the fly for the full time they are within the working area of the robot.

**Speed**

The system has been tested with a maximum conveyor speed at 1400 mm/s with an IRB 340 without vision recognition. The capability to follow conveyors at high speeds is dependent on the acceleration and speed limitations of the actual robot.

On conveyors with vision recognition the speed is limited by the following factors:

- Camera trigger frequency. The vision model search time and position transfer time limits the trigger frequency. For an average time of 250 ms the maximum frequency is 4 Hz.
- Motion blur. On high speed conveyors the camera shutter time needs to be very short which again requires very good light.
Drive Unit

The conveyors are operated by external drive units connected to I/O controls. Drive units like the ABB AC300 has a 24V I/O interface allowing forward, backwards, and stop operations, speed preset, and increment and decrement.

Encoder

The position of a conveyor is measured by one or more encoders. Usually an encoder is placed close to an identification and operation area in order to minimize errors caused by the elasticity and inaccurate guidance. The encoder measurement sample rate is configured in the robot controller and by default set to 20 ms.

The interface board DSQC 377 handles one encoder. It is possible to connect an encoder to two interface boards thereby making it possible for two robots to track frames on the same conveyor.

The encoder should be of type two phase with 90 degrees phase shift, voltage 24 VDC and current 50 - 100 mA. The pulse ratio from the encoder should be in the range of 5000 - 20000 pulses per meter of conveyor motion (See 3HAC 0966-48 Conveyor Tracking Manual chapter 7 Hardware Configuration and Connections). The maximum frequency is 50 kHz (may occur with high conveyor speed and many pulses per meter).

The number and speed of the conveyors are CPU-consuming factors on the S4Cplus controller. Maximum six conveyors may be attached. Maximum four encoder boards may be connected inside the cabinet.

7.1.7 Dial-up connection

It is recommended to order the PickMaster PC with a dial-up connection possibility (modem) to make the application easily accessible for remote support. The dial-up connection may also be established on another PC in the PickMaster network. It does not necessarily need to be the same PC as where PickMaster is installed. See also Remote support services under software.

7.2 Software

7.2.1 PickMaster Software 3HAC 15490-1

The PickMaster Software resides on one CD and installs according to standard Windows procedures. PickMaster 2.0 is designed to run on Windows 2000, SP2. The PickMaster software package contains the following parts:

- Acrobat Reader
- Vision software CVL from Cognex
- PickMaster 2.0 program
- License Manager
- Instructive Videos about calibration, line setup and project setup

7.2.2 Compatibility

Projects made in PickMaster 2.0 are not compatible with PickMaster 1.x versions and vice versa.
7.2.3 Remote support services
In order to facilitate the access to an installed PickMaster line for support reasons, a remote access software is delivered with the product. With this software it is possible to take control of the PickMaster PC from anywhere in the world in order to do efficient support without the need of going into the line.

7.2.4 RobotWare
RobotWare 4.0.54 or later is necessary to run in the robot controller S4Cplus, with the option Prepared for PickMaster included.

Prepared for PickMaster
Prepared for PickMaster is the name of the RobotWare option installed in the robot controller. Each robot controller in a PickMaster line needs the Prepared for PickMaster option, which includes all necessary functions for conveyor tracking, communication with PickMaster and running stereotype pick-and-place movements. The enhanced conveyor tracking included in Prepared for PickMaster can track six conveyors simultaneously.

RAPID-instructions make it possible to do advanced mixing of different products.
The option Prepared for PickMaster is exclusively offered together with PickMaster.

7.3 Pick and Place process performance
The performance is here described on an IRB 340 as a realistic process case for complete cycles with varying distances and real gripping and dropping time. The performance can both be higher and lower depending on the products and grippers.

In the diagram below the grip and drop time is 35 ms each.
When the z-offset is varied the performance is influenced as described in the diagram above.

**Repeatability**

The tracking error for an IRB340 described as conveyor repeatability is valid for each pick and place position separately and under the assumption that the speed is kept constant.

<table>
<thead>
<tr>
<th>Conveyor speed [mm/s]</th>
<th>Repeatability [mm]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>250-500</td>
<td>2</td>
</tr>
<tr>
<td>500-800</td>
<td>5</td>
</tr>
<tr>
<td>800-1400</td>
<td>15</td>
</tr>
</tbody>
</table>

Table 1  Conveyor repeatability for IRB 340

The above figures are considering a belt with small speed deviations.
8  Specification of Variants and Options

8.1  PickMaster Options

PickMaster can be composed from a set of options in order to tailor the product scope to the production line and the processes, which shall run on them. PickMaster can run with or without vision recognition and also with or without conveyor tracking.

The PickMaster options are differentiated as basic and additional licenses. For each order for the product PickMaster, one, but only one basic license is required.

The basic PickMaster option does not contain support for vision nor conveyor tracking. It is limited to connecting one none tracking robot.

The vision equipment is delivered only with four vision/inspection server alternatives. Up to two vision server options may be defined with one PickMaster.

The inspection level II can be ordered as alternative to a vision server. The inspection server option contains the basic vision server features plus the inspection II capability. Inspection II can also be added as an extension to a basic vision server (for upgrading).

PickMaster 2.0 is hardware compatible with PickMaster 1.x. Upgrade licenses from PickMaster 1.x to PickMaster 2.0 can be ordered as well as additional options as an extension to an existing PickMaster 2.0.

8.1.1  Basic Licenses

731

Basic PickMaster server licensed to run one non-tracking robot. In order to use conveyor tracking, option 743 is also required.

On the connected robot, the RobotWare option “Prepared for PickMaster” is required.

Physical items delivered with this option:

•  PickMaster software box

729

Upgrade license from PickMaster 1.1 to PickMaster 2.0

This option requires a valid PickMaster 1.1 license and must be installed on the same PC as the former PickMaster 1.x, from which it will inherit the same functional options, extended by the conveyor tracking option 743 times the number of robots in the upgraded PickMaster 1.1 installation. The product reference for the existing PickMaster 2.0 will be asked for when ordering this option.

A license to use one non-tracking robot is included in this option.
Physical items delivered with this option:

- PickMaster software box

730

Extension license for additional licenses on PickMaster 2.0

This option requires a valid PickMaster 2.0 license and must be installed on the same PC as the former PickMaster 2.0 and the new additional options will be accumulated to the existing options. The product reference of the existing PickMaster 2.0 will be asked for when ordering this option.

No licenses are included in this option.

No physical items are delivered with this option.

8.1.2 Additional Licenses

734

Additional robot

License to use one non-tracking robot. Maximum number of robots is eight. In order to use conveyor tracking, option 743 is required for each robot.

On each connected robot, the RobotWare option “Prepared for PickMaster” is required.

No physical items are delivered with this option.

735

Additional camera

License to use one camera with inspection level I. Maximum number of cameras is eight.

No physical items are delivered with this option.

738

Six axes control

License to use a six axes robot, i.e. IRB 140. Other robots are available on request.

No physical items are delivered with this option.

736

Remote Integration Services (RIS)

This option is used to run PickMaster from a remote operator’s interface. Software for field-bus connectivity is included in this option.

No physical items are delivered with this option.

741

Vision Server 8100

34
Single camera vision integration with inspection level I included. A license to use one camera is included in this option.

Physical items delivered with this option:
- Cognex MVS-8100 single camera frame grabber board
- Trig-strobe I/O board with ribbon cable
- Trig-strobe I/O converter

Two free PCI-slots are required on the PC. Maximum number of vision / inspection servers is two.

740

Vision Server 8120
Vision integration for multiple cameras with inspection level I included. A license to use two cameras is included in this option.

Physical items delivered with this option:
- Cognex MVS-8120 four-camera frame grabber board
- Camera break-out box
- Trig-strobe I/O board with ribbon cable

Two free PCI-slots are required on the PC. Maximum number of vision / inspection servers is two.

745

Inspection Server 8100
Single camera vision integration with inspection level I and II included. A license to use one camera is included in this option.

Physical items delivered with this option:
- Cognex MVS-8100 single camera frame grabber board
- Trig-strobe I/O board with ribbon cable
- Trig-strobe I/O converter

Two free PCI-slots are required on the PC. Maximum number of vision / inspection servers is two.

742

Inspection Server 8120
Vision integration for multiple cameras with inspection level I and II included. A license to use two cameras is included in this option.

Physical items delivered with this option:
- Cognex MVS-8120 four-camera frame grabber board
- Camera break-out box
- Trig-strobe I/O board with ribbon cable

Two free PCI-slots are required on the PC. Maximum number of vision / inspection servers is two.
743
Conveyor Tracking
By default each PickMaster license to run a robot means by default a non-tracking robot. To be able to use conveyor tracking, option 743 is required once per robot.
On each connected robot, the RobotWare option “Prepared for PickMaster” is required.
No physical items are delivered with this option.

744
Inspection upgrade
Vision inspection level II add-on license. This option extends the vision capability of vision server 8100 or 8120. Required is an existing vision server 8100 or 8120.
No physical items are delivered with this option.

747
User’s guide English
Physical items delivered with this option:
- One printed User’s Guide copy in english

8.2 PickMaster related Controller Options
The following options need to be ordered for the robot controller operating with PickMaster.

8.2.1 RobotWare Option

567
Prepared for PickMaster
Each robot operating with PickMaster requires Prepared for PickMaster. The option contains all necessary functions to interface PickMaster and to run enhanced conveyor tracking on up to six conveyors.

8.2.2 Hardware options

249/245
Encoder Interface Unit for PickMaster (internal/external)
For each conveyor connected to the robot controller, one encoder board for PickMaster is required. This option is only software supported together with PickMaster.
At least one digital I/O board or similar is required for exchanging signals between PickMaster and the robot controller. See hardware description for the number of signals required.

8.3 Examples of PickMaster configurations

Below a description of some installation cases and their related PickMaster options.

8.3.1 Use case 1

Eight robots along two conveyors with predefined product positions

![Diagram of robots along conveyors]

**Basic license**

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
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</table>

**Additional licences**

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<td>Additional Robot</td>
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<tr>
<td>8</td>
<td>743</td>
<td>Conveyor tracking</td>
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<tr>
<td>(1)</td>
<td>736</td>
<td>RIS if remote operator’s panels are used</td>
</tr>
<tr>
<td>(1)</td>
<td>738</td>
<td>Six axes control if at least one of the robots is a six axes robot</td>
</tr>
<tr>
<td>(x)</td>
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<td>x copies of the printed User’s Guide</td>
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</tbody>
</table>

**Robot options per robot: i.e. the quantity multiplies by 8.**

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<th>Option</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
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<tr>
<td>2</td>
<td>249/245</td>
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8.3.2 Use case 2

One robot along conveyors with one camera
### Basic license

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Basic license including one robot

### Additional licences

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Option</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>743</td>
</tr>
</tbody>
</table>

Conveyor tracking

<table>
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<th>Option</th>
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Vision/Inspection Server 8100

<table>
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<th>Option</th>
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</thead>
<tbody>
<tr>
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<td>736</td>
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</tbody>
</table>

RIS if remote operator’s panels are used

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Option</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>738</td>
</tr>
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</table>

Six axes control if at least one of the robots is a six axes robot

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Option</th>
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</thead>
<tbody>
<tr>
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<td>747</td>
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x copies of the printed User’s Guide

### Robot options per robot

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<tbody>
<tr>
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Prepared for PickMaster

<table>
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<th>Option</th>
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<tbody>
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<td>249/245</td>
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</table>

Encoder Interface Unit for PickMaster (internal/external)

### 8.3.3 Use case 3

Two robots along conveyors with six cameras
### Basic license

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<tbody>
<tr>
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### Additional licences

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<tr>
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### Robot options per robot: i.e. the quantity multiplies by 2

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<th>Option</th>
<th>Description</th>
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<td>567</td>
<td>Prepared for PickMaster</td>
</tr>
<tr>
<td>3</td>
<td>249/245</td>
<td>Encoder Interface Unit for PickMaster (internal/external)</td>
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</table>
8.3.4 Use case 4

One robot along indexing feeders with three cameras

**Basic license**

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<th>Quantity</th>
<th>Option</th>
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</tr>
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<tbody>
<tr>
<td>1</td>
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**Additional licences**

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<tr>
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<th>Option</th>
<th>Description</th>
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<td>Vision/Inspection Server 8120</td>
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<tr>
<td>1</td>
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<td>Additional camera</td>
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<tr>
<td>(1)</td>
<td>736</td>
<td>RIS if remote operator’s panels are used</td>
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<tr>
<td>(1)</td>
<td>738</td>
<td>Six axes control if at least one of the robots is a six axes robot</td>
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<tr>
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<td>747</td>
<td>x copies of the printed User’s Guide</td>
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**Robot options**

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<th>Option</th>
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<tbody>
<tr>
<td>1</td>
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<td>Prepared for PickMaster</td>
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</table>
9  Spare parts

3HAC 15490-1
   PickMaster 2.0 Software

3HAC 15492-1
   Cognex vision board MVS-8100.
   Single camera frame grabber vision board.

3HAC 15494-1
   Cognex vision board MVS-8120
   Vision frame grabber board for maximum for maximum four simultaneous cameras

3HAC 6214-1
   Cognex camera connection brakeout box
   Brake out box used for MVS-8120 to connect up to four camera cables.

3HAC 10846-1
   Trig strobe I/O DSQC 524
   Conversion board for four pairs of trig and strobe signals. Converts 5VDC TTL signals to 24 VDC signals and vice versa. All signals are stabilized and opto-isolated.

3HAC 11530-1
   Ribbon cable for trig/strobe I/O board

3HAC 15493-1
   I/O Adapter
   Trig/strobe I/O signal connection adaptor. Used to connect MVS-8100 to the ribbon cable for the trig/strobe I/O DSQC 524.

3HAC 15497-1
   User’s Guide in English
   Printed user documentation in english.
10 Documentation

The following documents are part of the PickMaster product:

**3HAC 5842-3**
Product Specification PickMaster 2.0 (this document)

**3HAC 15497-1**
User’s Guide English, also available as pdf and HTML on-line help with the product

**Cognex vision system documentation**
Included on the PickMaster CD

**Video documentation**
Instructive videos are also provided to give a quick introduction about the PickMaster software and how it shall be used.
The videos describes the following:

- Line set-up (a PickMaster “Line”)
- Calibration (Camera calibration and Base Frame calibration)
- Project set-up
- Inspection II configuration