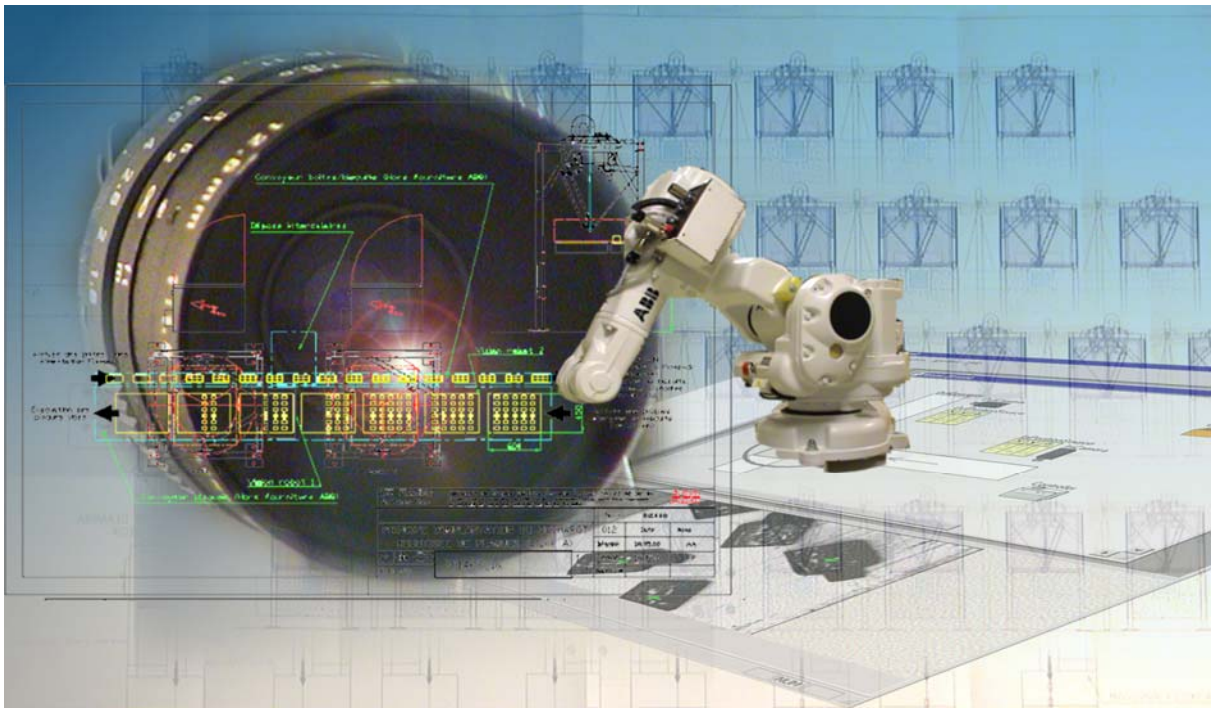
Product Specification
PickMaster

3HAC 5842-10
Version 3.20



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Article number: 3HAC 5842-10
Version 3.20

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1 Welcome to PickMaster™ 3.20

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 IRC5 or S4Cplus robot controller and of all IRB types. PickMaster™ is a configurator and cell controller of flexible packaging lines with moving conveyors.

For position recognition of random production flows as well as powerful quality inspection PickMaster™ uses a reliable powerful vision system from Cognex. It enables recognition of a wide variety of both regular and irregular shaped objects, which makes PickMaster™ the ideal tool for controlling packaging robots in the Consumer Industry, but it also makes it well suited for generic vision robot guidance applications.

PickMaster™ can control up to 8 robots[1] and 8 cameras - simultaneously in the same application or concurrently in independent cells. Each robot can track 6 conveyors simultaneously.

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, serial link or digital I/O.

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
- Cell controller capability for extensive operational control of process and connected robot controllers
- Risk reduction offering a product-based repeat solution, configurable for a multitude of operational cases.
- High performance vision recognition and product quality inspection including Gigabit Ethernet cameras with high resolution for the highest demands.
- Advanced information sharing between cameras and robots
- Powerful sorting functions
- 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
- Customization tools for user defined software enhancements and extensions.

PickMaster™ 3.20 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.
- Integration of customized external vision algorithms
- Integration of external sensor systems (on request) other than the included standard vision system

[1] With IRC5, PickMaster™ can operate MultiMove robotcontrollers with multiple robots connected to one cabinet

- Dynamic position alteration through user hook software additions.

PickMaster™ 3.20 runs with the IRC5 robot controller and RobotWare 5.05.03 or higher and it also runs with the S4Cplus robot controller and RobotWare 4.0.113 or higher. Required RobotWare software option in both cases is “Prepared for PickMaster - PickMaster 3” which includes all necessary software options to interface PickMaster™ as well as efficient conveyor tracking.

2 PickMaster Features

PickMaster is tailored for advanced high speed picking of random object on moving conveyors. 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. PickMaster is available for all robot types.

2.1 Scope

- Eight robots and eight cameras per PickMaster running together in one process or in a multitude of independent concurrent processes on the same PC.
- 25 work areas per robot whereof six conveyors

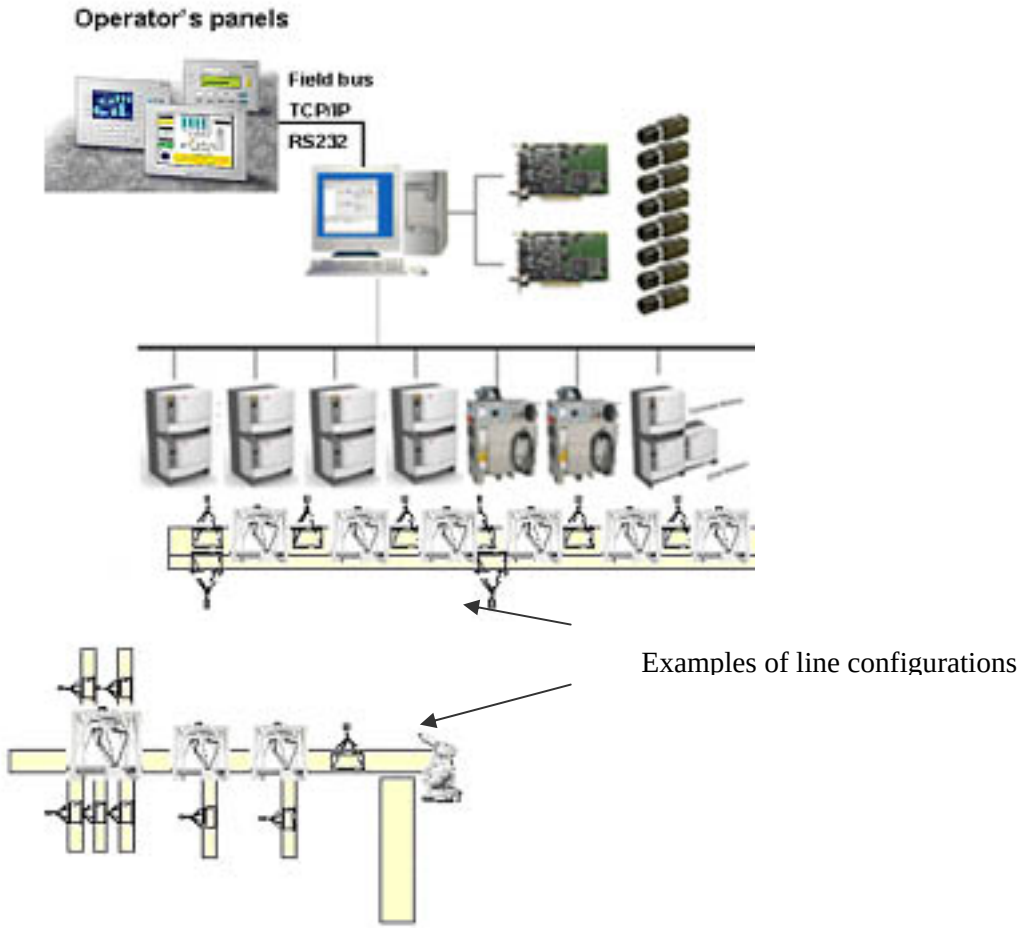


Figure 1: PickMaster scope and configuration examples

- Project execution is easily started and stopped from a single button in the PickMaster studio interface. Individual robots can be controlled separately at any time and status changes are reported back to PickMaster.

- Line PLC and custom operator's panel connectivity through TCP/IP, field buses, serial port and discrete I/O. This function, called RIS (Remote Integration Services), gives full control over the PickMaster packaging process and the individual robots.
- Runtime process tuning of positions, motion path, dwell times, tool activation, etc.
- Camera distribution and position information sharing as well as capability to control the work capacity distribution of the robots.
- Wide range of enhancements in the RAPID program through dedicated RAPID instructions.
- Advanced sorting functions
- User hooks for changing/removing or adding positions or position types enabled by the Microsoft® .NET platform interface.
- When operating with IRC5, PickMaster™ 3.20 supports MultiMove. It is possible to configure the controllers with more than one robot.

2.2 Applications and processes

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

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

However, in most cases, no programming adoptions are needed at all. The PickMaster software package contains predefined RAPID modules.

2.2.1 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.

2.2.2 Predefined flow

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

2.2.3 Dynamic positioning

All positions Generated in PickMaster may be tracked or changed through the User Hooks concept based on the Microsoft® .NET platform. By the use of external software in the preferred choice of programming language (i.e. VisualBasic .NET, C#, e.a.), the vision or trigger information can be extended by information coming from external devices like sensor devices or production/batch information systems. It may as well just be used as to extract hit-data to a production logging system. The User hooks also allow enhancements as to connect information form multiple position source locations to conclude to a result.

2.2.4 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.

2.2.5 Double/multiple pick, single/double/multiple place

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

2.2.6 Configurable Pick and place sorting order

The items are normally picked and placed in direction of the production flow on the conveyors, i.e. first in, first out. It is also possible to extract the items from the flow in any three dimensional direction.

2.2.7 Mixing and sorting

Single product types, generated by PickMaster can be selected and extracted from the inflow and diverted to different positions.

Alternative operations can be executed if products or specific product types are missing from the inflow. A so called queue level signal can be used for evaluating if a position queue is empty and thus requires new input.

Sorting directions makes it possible to optimize the capacity of the robot, i.e. to make sure the robot runs the shortest distance, etc.

Clearance areas can be declared to reject touching objects.

2.2.8 Camera Distribution (optional)

Multiple robots can be connected to the same camera. This is useful to save hardware and installation costs. It is essential that the objects are well separated and that neighbor objects are not touched by the ones being picked or placed. Also the elasticity of the conveyors may lower the accuracy the further away the robots are from the trigger point.

2.2.9 Load Balancing and bypassing

With simple drag and drop the load of a production flow can be balanced among multiple robots. The position information is acquired at one initial point on the line either through a position trigger of predefined positions or through a camera using the camera distribution option. The production can easily be balanced with equal or biased loads on all robots involved. The function can be used to avoid upstream robots to consume most of the products on the conveyors and thereby leaving too little to the other robots.

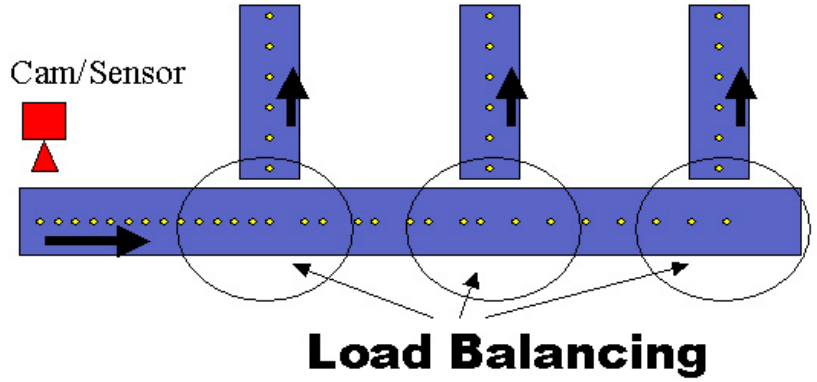


Figure 2: Distribution of the work-load to multiple robots

The Load Balancing function can also be applied on robots with individual trigger points (separate camera or sensor per robot). Simply decide, how much of the passing production shall be used and bypass the rest.

2.2.10 Adaptive Task Completion (optional)

PickMaster™ can be configured to ensure that every object is picked and every position is filled as a joint operation of multiple robots. Without the need to assign objects to specific robots, the ATC-function makes sure one but only one robot consumes the position. This option can be used for progressively filling cases, which pass multiple robots.

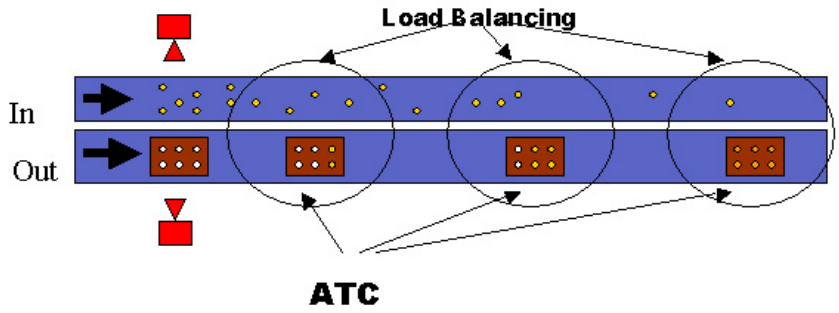


Figure 3: ATC: Dynamic sharing of common tasks

2.2.11 Robot stops and exceptions

A single robot can be paused, stopped or even powered down during production. The way the remaining robots are reacting is configurable. If load balancing is used, the workload designated to a paused robot can be redistributed automatically among the running robots. If ATC is used, the specific positions are redistributed to the next robot.

2.3 PC-interface

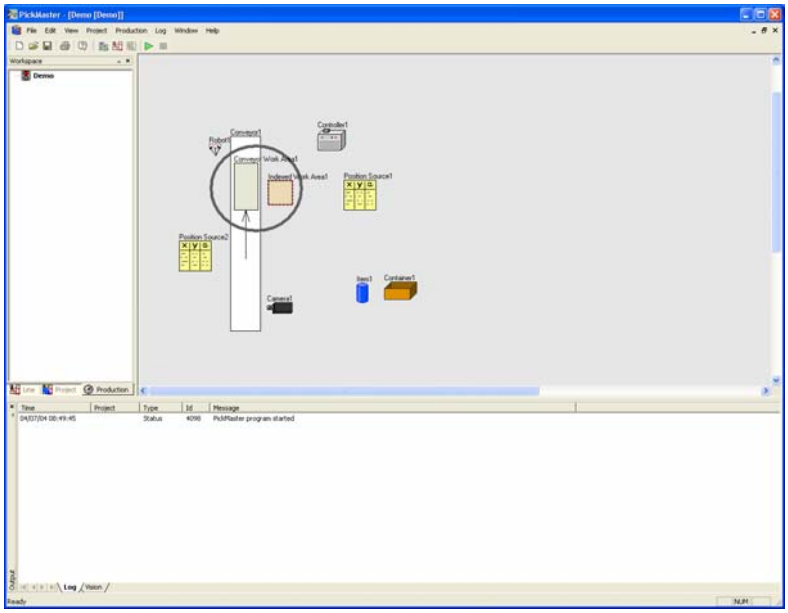


Figure 4: PickMaster main screen

Graphical components are easily introduced and edited by right mouse click

- Plug-and-Produce installation and configuration limits on-site software and hardware engineering to a few hours.
- Graphical concept with line and project configurator. Studio application with workspace area, symbolic line/project view, log and runtime vision display.
- On-line context-sensitive help for fast navigation through the use of PickMaster, identical to the User's Guide paper copy
- Fast project start-up (2-3s for the complete line)
- Line and project information are stored in XML-format (*.pmline) and (*.pmproject)-files
- Immediate task change-over and fully automatic one button production start

- Status control of process as well as individual robots
- Definitions of single objects as well as single/multi-layer pattern and container
- Pre-programmed RAPID-code down-loaded at process start
- Several processes can be handled in concurrent and self-contained operations from one PickMaster
- Event logging to Microsoft Event Viewer database
- Available in six languages: English, German, French, Italian, Spanish, Japanese[2].

2.4 Integrated vision (optional)

Leading Cognex vision technology using standard cameras with high speed communication over Gigabit Ethernet and built-in algorithms, provides the integrated vision. Backward compatibility is maintained, including support for Cognex framegrabber solutions.

The vision system is capable of recognizing regular as well as irregular forms. This includes unwrapped food like chicken, meat, etc or more geometrical accurate products or wrapped and packaged forms.

The vision capability is optional. Efficient object search and inspection is provided by the Gigabit Ethernet Vision system, which plugs in through an ordinary network card 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 (through 1 dual port Gigabit Ethernet network adapter and 2 five port industrial switches). Optionally, two frame grabber boards may be installed in one PC, or a combination of one frame grabber and up to four Gigabit Ethernet cameras (summing up to no more than 8 cameras in total).

With PatMax™, many vision recognition tasks are easily solved, which normally require extensive custom image processing or which may be impossible to solve. PatMax™ is a patented method by Cognex, which is top of the line in vision technology. PatMax™ returns reliable, accurate and repeatable 2-dimensional positions and orientations.

List of vision features:

- Concurrent camera acquisitions and vision processing on multiple cameras.
- Fast image updates
- Fast and accurate calibration, linear or higher order algorithms for short focal lenses

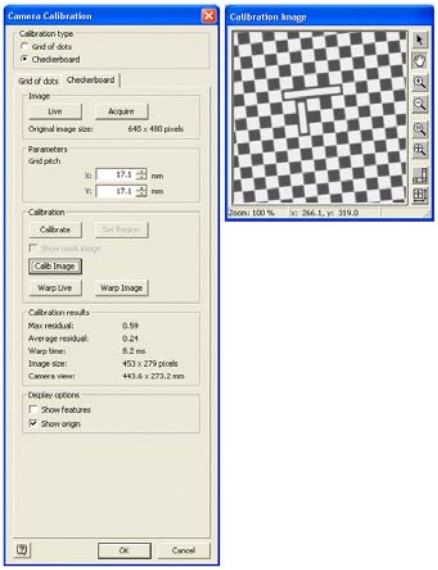


Figure 5: Checker board calibration

[2] English is the standard language. See “Delivery Situation” and “Solution Bank” for the release of the translated versions, which will always be released after the English version for each new main release.

- For geometric model search, enhanced use of PatMax^{TM} solves many difficult search tasks. Well suited for geometric search of both regular and irregular shapes.

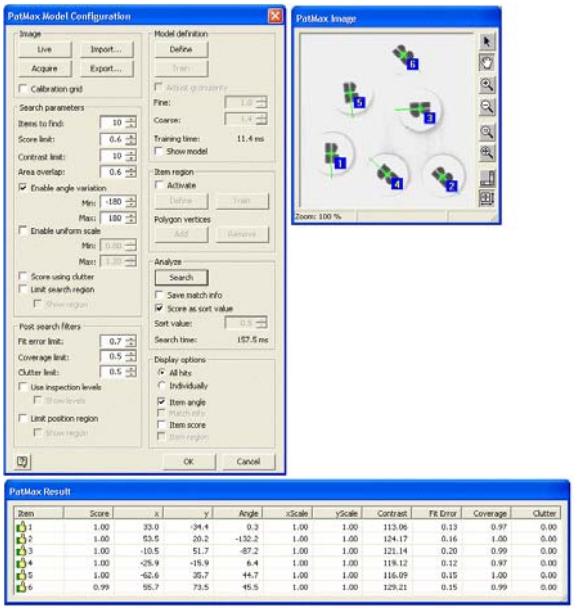


Figure 6: Geometric search method with rich parameter control

- Sub score parameters for adequate fine tuning, e.g. items to find, score limit, contrast limit, area overlap, clutter, scale, angle, granularity
- Enhanced Blob modeling for fast and simple search operations without the need for taught models can find many different types of objects based on pixel features like area, perimeter, etc.

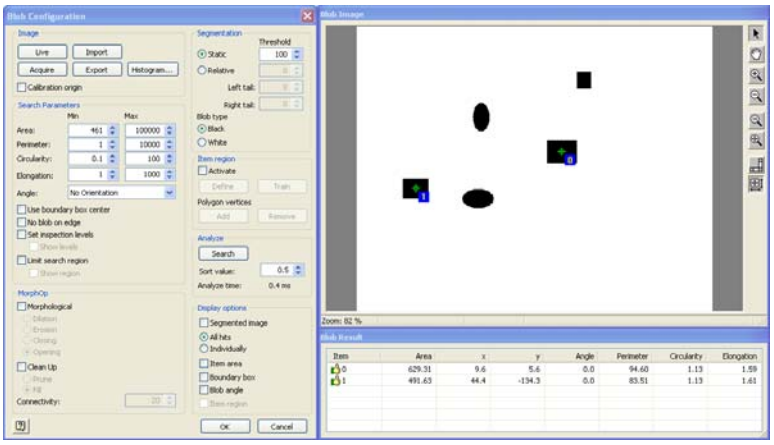


Figure 7: Enhanced blob search

- Multiple models per object possible
- Vision model import/export for bitmap editing of camera images. Allows corrective changes the image by any paint or draw program in order to optimize the modeling.
- Zoom, pan, etc of the camera view simplifies accurate modeling
- Auto camera trigger
- Quality inspection with reject and type categorization: level I
- Quality inspection through multiple inspection areas: level II

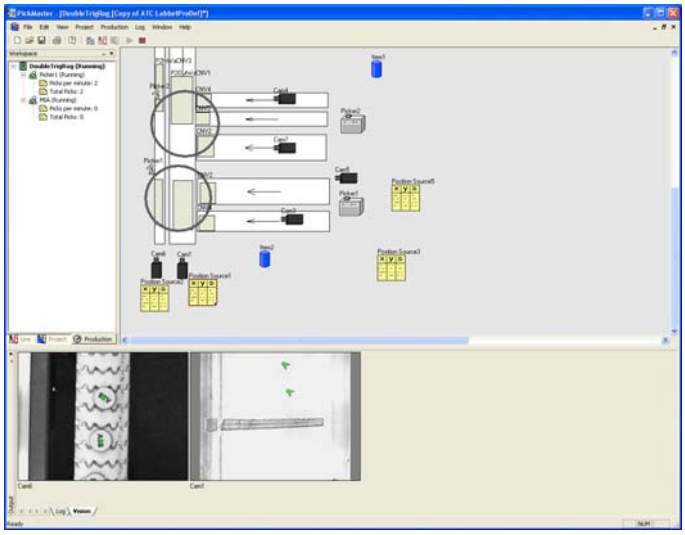


Figure 8: Runtime and live images in the lower window

- Runtime vision analyzer

2.4.1 External Vision Model SDK

In addition to the built-in vision technology, PickMaster can be enhanced by any type of image algorithms, which is called through an “External Vision Model Interface SDK”. The external functions can execute on the same PC as PickMaster or on another computer. They can be used both as separate self-contained models and as inspection models in Inspection II. See the separate interface specification document for advanced integration “External Vision Model SDK”, provided with the PickMaster software.

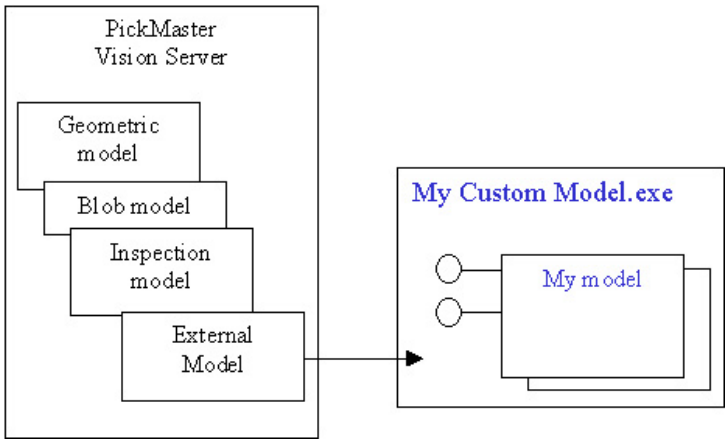


Figure 9: Enhancement capability through user defined algorithms for co-exixstence with standard models

2.4.2 Post inspection

PickMaster can be configured for object recognition and inspection and connect an I/O signal in the robot controller instead of a complete robot operation coordinated to a conveyor. The function can be used to inspect objects after they have passed the robot zone or before they enter and to take appropriate action by the use of simple pushers.

This solution requires the following additional options
-PickMaster: One extra camera option

-Robot controller: One extra encoder board

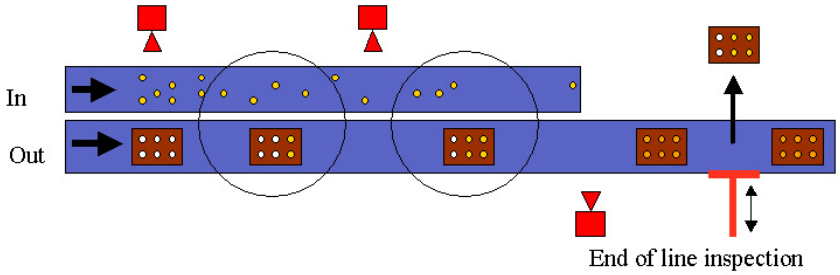


Figure 10: Post inspection and conveyor synchronized I/O control

2.4.3 Detailed vision information and run time Vision Analyzer

The vision and inspection results can be checked in detail in runtime for each individual camera. The images and results are saved in a buffer. The results can be saved to a file (.pmv) and analyzed online or offline in a separate executable Vision Analyzer, which is also provided with the PickMaster software. Camera information and time stamps for each camera acquisition are also saved with this file.

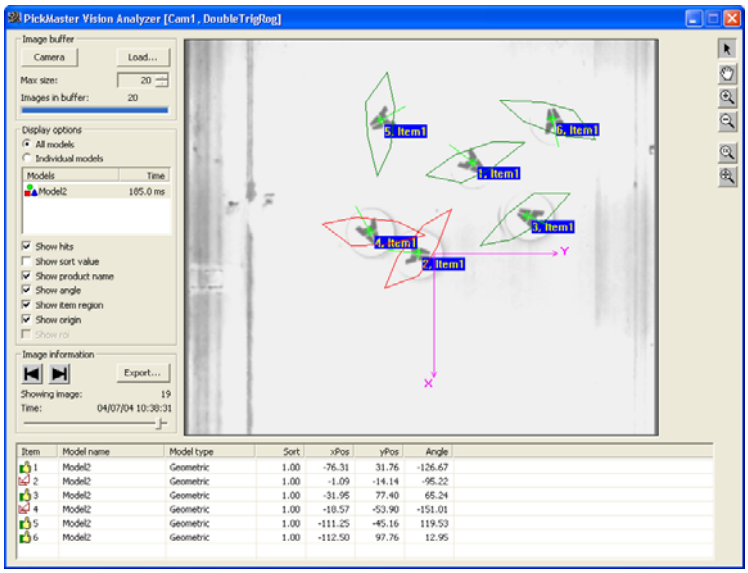


Figure 11: Multiple camera acquisitions and results stored by detailed Vision Analyzer

2.5 Inspection

Visual inspection capability is an enhanced use of the vision integration, 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).

It is possible to identify untaught defects like scratches or burn marks.

Both inspection levels II and I 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.

2.5.1 Level I: Type categorization and reject by parameter variance profiles

This inspection type is included in the camera option.

With Inspection Level I 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.

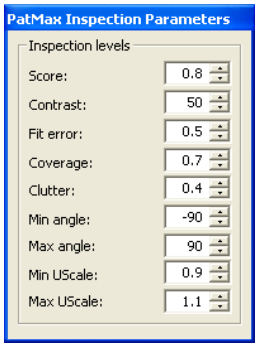


Figure 12: Tayloring and typing of the search result precisely through parameter boundaries

On blob models, histogram analysis can be applied.

For PatMax models, a boundary check and filtering is possible. A protected multi-edge area can be defined around an item. This function will reject any objects of which the boundary area is touching or overlapping another.

2.5.2 Level II (optional): Inspection area selection through combinations of models and criteria

Level II inspection is accessible when the inspection option is included. The inspection models can be of type geometric, blob, histogram, and length measurement or external models.

The level II inspection is used to inspect additional features inside a given area in relation to a base search model. Multiple inspection areas can be evaluated at the same time and with different types of models.

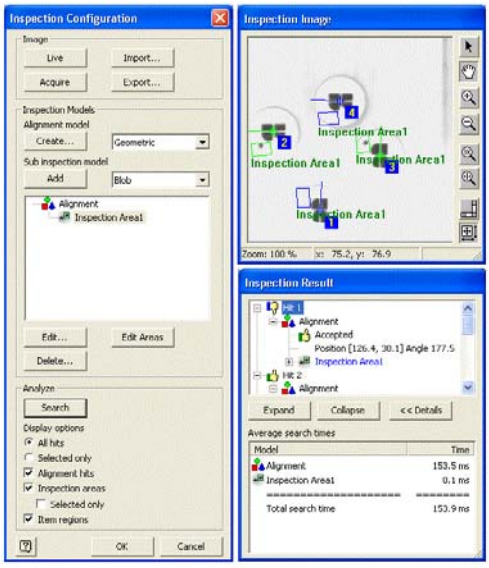


Figure 13: Comprehensive and endless inspection capability through logical binding of search results

The following types of inspection are available inside an inspection area:

- Geometric: presence of taught features. Evaluates numbers of hits, positions and orientations in relation to the base model. Inspection of labels, right side up, distinction of minor features for type selection, etc are common use cases.
- Blob: presence of untaught features by blob analysis. Evaluation of pixel size, numbers, etc is possible. Untaught defects like burn marks on baked products, scratches other defects can be detected after the object was found.

- Histogram: inspection of the grey scale characteristics in the inspection area by tolerances in mean value, standard deviation, etc of the pixel values.

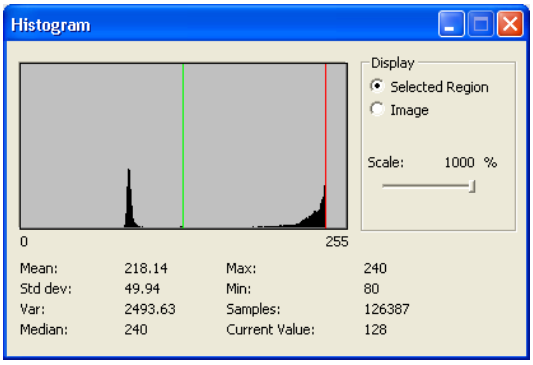


Figure 14: Histogram fine-tuning to differentiate gray scale values

- Size: definition of size measurement lines and configuration of acceptance levels in mm.

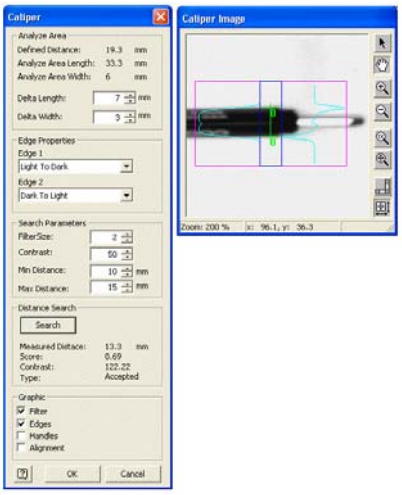


Figure 15: Size tolerance inspection

2.6 External Sensor SDK (On request)

With the ESS any type of external external sensor systems can be integrated in PickMaster – both through access in design time and by providing position information in run-time. The interfaces are based on the Microsoft ATL COM concept and they are available on request.

The external sensor can be a 3D vision system or a bar code reader, e.a and it can reside on another computer system.

ABB does not take any responsibility for the proper functioning of an external software and hardware. The support is limited to the interface specification.

2.7 Controller side process flexibility

Optimized real-time control of positions and conveyors are provided by the RobotWare option “Prepared for PickMaster” in the S4Cplus controller.

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. The RAPID modules may be adapted to fit specific application needs, but in most cases, very little or nothing needs to be changed.

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

Functions for executing service routines directly from PickMaster are also included.

See PickMaster User’s Guide for the full set of instructions.

3 Technical Specification

3.1 Product content

PickMaster™ 3.20 Software package

PickMaster™ 3.20 Hardware

PickMaster™ 3.20 User's Guide

3.2 Software Package

PickMaster™ 3.20 includes

- PickMaster™ 3.20 software with line and project configurator, vision modeler, inspection modeler (optional), event logging, production panel, Remote Integration Services (RIS)
- PickMaster™ Vision Analyzer
- Cognex Vision Software CVL 6.5, including configuration tool for Gigabit Ethernet Cameras
- PickMaster SDK
  -External Model
  -External Sensor[3]
- License manager

3.2.1 Compatibility

Projects made in PickMaster™ 3.20 are not compatible with PickMaster™ 1.x versions and vice versa. PickMaster™ 3.20 is compatible with Cognex Gigabit Ethernet vision, MVS-8100, MVS-8100d, MVS-8120 and MVS-8504, but not with the MVS-8110.

3.3 Hardware

3.3.1 Vision equipment options

- Gigabit Ethernet vision system, including 1 to 8 cameras (1390x1080, monochrome), cables, network interface card, switches (if required) and a Cognex license provided on a USB stick.
- Vision PCI board Cognex MVS-8504 (four cameras)
- Camera breakout cable for MVS-8504
- I/O card for MVS-8504

3.3.2 Required equipment

Robot Controller

- M2002 S4Cplus
- At least one 24 V Digital I/O board
- 0..6 Encoder Interface board for 'Prepared for PickMaster'
- IRC5 BaseWare 5.06.01 or S4Cplus BaseWare 4.0.113 or later
- Option 'Prepared for PickMaster'

[3] On request

PC

PickMaster runs on Windows 2000 Professional or Windows XP on a regular Pentium III PC. The Gigabit Ethernet vision system is not compatible with Windows 2000.

Recommended is Pentium 4 2 GHz or higher for best performance in CPU-demanding applications (many cameras, inspection, etc).

The Gigabit Ethernet vision system requires one PCI Express slot. Single Vision System requires two free PCI-slots per vision system. Analogue multi vision system and Digital Vision system requires one PCI-slot per card. Ethernet network board are required for all vision cards. Optionally one additional free slot is needed if a RIS field bus cards is used.

The PC should be equipped with a monitor of at least 17 inches with minimum resolution 1024x768 pixels. Recommended is a resolution with 1280x1024 pixels.

PickMaster was tested on IBM.

Cameras and cables

See chapter on vision below

3.4 Specifications

3.4.1 Maximum configuration

- One PickMaster/PC
- Eight robots/PickMaster
- Two framegrabber cards/PickMaster
- Eight cameras/PickMaster
- 25 work areas/robot
- Six conveyors/robot

3.4.2 Vision

- Search tools PatMax™ /Blob
- Vision quality inspection tools Level I and Level II (optional)
- Linear and non-linear calibration
- Camera acquisition time and transfer rates: typically 50-200 ms on a high performance PC. Complex models can affect performance.
- Up to eight simultaneous camera acquisitions

Hardware

PickMaster™ is available with Gigabit Ethernet and analogue framegrabber vision systems (Cognex MVS-8504). With the the Gigabit Ethernet system, the PC communicates with the camera using a standard Gigabit Ethernet network interface card, instead of using a framegrabber. Both network cards and framegrabbers are mounted on the PCI-bus of the PickMaster PC. Maximum two framegrabber boards can be plugged into the PC. Different variants of the MVS-8100D or MVS-8504 can be used together.

Gigabit Ethernet Vision

The PickMaster Gigabit Ethernet vision system supports 1-8 cameras. It is delivered with a dual port network interface card through which the PC communicates with the cameras. If 3-5 cameras are used a five port switch is required. If 6-8 cameras are used, two switches are required. Switches are included in the delivery.

The camera has a built in I/O system, which enables triggering directly from the robot controller, without the need for additional hardware.

The Cognex framegrabber holds a license key which enables the Cognex software algorithms. For the Gigabit Ethernet system this key is instead supplied on a USB stick, which must be plugged in to the computer during runtime.

The following camera option is delivered as standard:

- Basler Scout scA1390-17gm: High resolution (1390x1080) digital CCD camera



Figure 16: Cognex USB licenses, Gigabit Ethernet camera, Gigabit Ethernet network interface card, industrial Gigabit Ethernet switch.

Analogue vision

MVS-8504 is an analogue vision card[4] used for max four simultaneous cameras. It uses an I/O card for trig/strobe communication, prepared for DIN rail mounting outside the PC.

Additional equipment not supplied with PickMaster and analogue vision are: cameras, camera cables

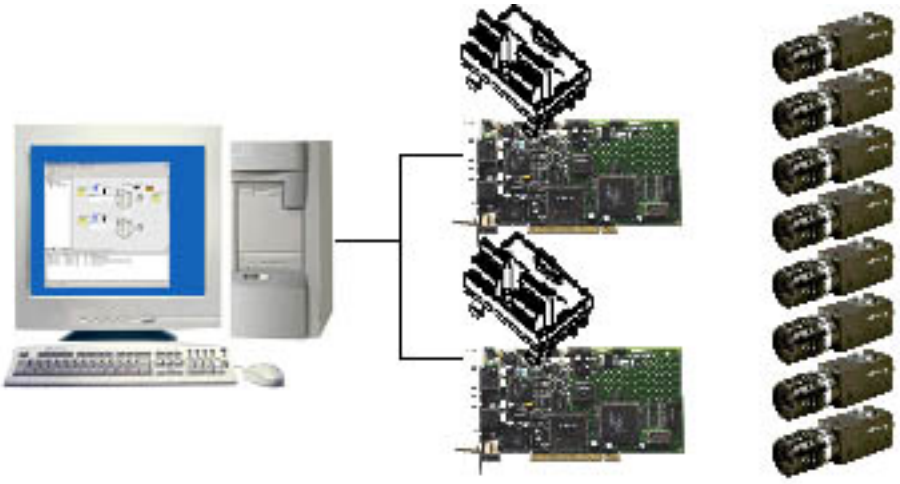


Figure 17: Maximum camera configuration with analogue frame grabber boards

[4] The older vision boards MVS-8100M and the MVS-8120 already installed with PickMaster™ 2.x are compatible to run on Win 2000/XP and PickMaster 3.20.

3.4.2.1.1.1 Recommended analogue cameras and cables (not supplied with PickMaster™

All camera types, which are approved for use with Cognex 8504 boards (as well as MVS-8100 and MVS-8120 sold with earlier PickMaster versions), can be used with PickMaster. For moving object on conveyors, cameras with full frame shutter and progressive scan are recommended. PickMaster has been tested with Sony XC-55, Hitachi and HR-50

A high-resolution analogue camera is possible in conjunction with MVS-8504. A compatible camera, with progressive scan is the JAI CV-A1 high-resolution camera.

The camera cables can be ordered through Cognex with the following specifications (the last figure represents the cable length in ft):

300-0136-30 for MVS-8504 (also compatible with MVS-8120) Sony XC55 and Hitachi

300-0316-30 for HR-50

3.4.2.1.1.2 I/O card

When using MVS-8504 an I/O card for the trig/strobe is required. This component is delivered with PickMaster™.

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 pattern. The checker board calibration form is more accurate than the blob form as it corrects any camera alignement inaccuracy.
- Lens distortions affect the peripheral positions. Non-linear calibration calculation gives 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.

3.4.3 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 required 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.

3.4.4 Robots

Approved for use on all robot types.

3.4.5 Conveyor tracking

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. When changing the speed of the conveyors, i.e. when using them for stop and go, the accuracy is decreased dependent on the acceleration and deceleration slopes. Indexing feeders cannot be used for regular conveyor tracking.

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 blurs. On high-speed conveyors the camera shutter time needs to be very short which again requires very good light.

Drive Unit

External drive units connected to I/O controls operate the conveyors. 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

One or more encoders measure the position of a conveyor. 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 one encoder to two interface boards.

The encoder should be of type Open collector PNP output, two phases with 90 degrees phase shift, voltage 10-30V[5] and current 50 - 100 mA.[6]

The pulse ratio from the encoder should be in the range of 5000 - 10000 pulses per meter of conveyor motion (See wiring diagrams in 3HAC 15497-2 User's Guide). The pulses from channels A and B are used in quadratures to multiply the pulse ratio by four to get the counts. This means that the control software will measure 20000 - 40000 counts per meter for an encoder with the pulse ratio given above. Reducing the number of measured counts below 20000 will reduce the accuracy of the robot tracking.

Increasing the number of measured counts beyond 40000 will have no significant effect as inaccuracies in robot and cell calibration will be the dominating factors for accuracy. The encoder board (DSQC 377) is able to handle min 500 and max 50000 counts per meter.

The maximum frequency is 50 kHz (may occur with high conveyor speed and many pulses per meter).

The encoder should be connected to the robot by a screened cable to reduce noise.[7]

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[5] Normally supplied by 24 VDC from DSQC 377

[6] Lenord-Bauer Gel 260-V-02500A001

[7] If this cable is long, the inductance in the cable will produce spike pulses on the encoder signal, which may, over a period of time, damage the opto-couplers in the encoder board. The spike pulses can be removed by installing a capacitor between the signal wire and ground for each of the 2 phases. The capacitors should be connected to the terminal board where the encoder is connected and not on the DSQC 377.

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 together with one I/O board.

3.4.6 Operator's panel connectivity - RIS

PickMaster can be operated remotely by use of the function called RIS (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 also protecting the once designed and fine-tuned projects from being changed by an operator. RIS provides the runtime interface as well as the configuration menus to set up the command codes.

The available RIS interfaces:

- 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[8]. See www.hilscher.com for the field bus card product range and specifications.
- TCP/IP, accessible from any programming language from the PickMaster PC or any other computer in the Ethernet network
- Serial RS232 interface. PickMaster is accessible through commands over a RS232 serial connection to the PickMaster PC.
- Digital I/O interface. PickMaster supports digtal boards from Advantech, the 16 I/O PCI-1750 and the 32 I/O PCI-1756. See www.advantech.com.

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

Project commands:

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

Robot commands for selected robot

- Start
- Pause
- Stop
- Reset E-stop
- Pick rate

3.4.7 Remote support

PickMaster is delivered with remote support capability. 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.

[8] Currently supported field buses: Profibus; Interbus; Can; DeviceNet; SDSM (Smart Distributed System); ASIM/Universal Protocol (RS232/422/485)

3.4.8 RobotWare

At least RobotWare 5.06.01 on IRC5 or RobotWare 4.0.113 on S4Cplus is necessary to use on the robot controller, with the option Prepared for PickMaster - PickMaster 3 included.

Prepared for PickMaster

Prepared for PickMaster is 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.

The option Prepared for PickMaster is exclusively offered together with PickMaster.

4 Specification of Variants and Options

4.1 PickMaster Options

PickMaster can be composed from a set of options in order to tailor the product scope to the needs of the production line and the processes. PickMaster can run with or without vision.

PickMaster is configured through basic options and additional options separated by either software licenses or hardware parts. For each order of the product PickMaster, one, but only one basic license is required.

The integrated vision system is available with four vision card alternatives. Up to two vision cards options may be defined with one PickMaster.

PickMaster 3.00 is hardware compatible with PickMaster 2.30. Upgrading from PickMaster 2.x to version 3.20 can be done from downloaded files from http://solutionsbank.us.abb.com. Additional options can be ordered as an extension to an existing PickMaster 2.xx.

4.1.1 Basic Options

42-6

Basic PickMaster license

This option does not include any robot or vision options. To be able to run a PickMaster the necessary Additional options have to be selected separately.

Physical items delivered with this option:

- PickMaster software box

42-7

Extension license for additional licenses on PickMaster™

This option requires a valid PickMaster 2.x or 3.x license and must be installed on the same PC as the original product and the new additional options will be accumulated to the existing options. The product reference of the existing PickMaster will be asked for when ordering this option.

No licenses are included in this option.

No physical items are delivered with this option.

4.1.2 Additional Options

Robot Licenses

559-1

Lic. for one robot

License to use one robot. Maximum number of robots is eight

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

No physical items are delivered with this option.

Vision and Sensor Licenses

558-1

Lic. for one camera

License to use one camera with inspection level I. Maximum number of cameras is eight. The license is compatible with all vision hardware choices.

No physical items are delivered with this option.

551-1

Inspection

License to use one camera with inspection level II. Maximum number of cameras is eight. Each of this option requires one 558-1, i.e. this option adds on to the camera license.

No physical items are delivered with this option.

523-1

Camera Distribution

License to distribute the results from cameras to multiple robot work areas.

The number of licenses designates the maximum number of additional work areas, which can share the result from a camera with the first work area. The maximum number of licenses is eight, which also corresponds to unlimited number of distributed work areas.

No physical items are delivered with this option.

553-1

External Sensor

License to use an external sensor through the PickMaster SDK. Maximum number of sensors is eight. The license does not require any vision hardware from ABB.

No physical items are delivered with this option. Note: the option is offered on request.

Vision Hardware

895-1

Gigabit Ethernet Ready

License for Cognex vision tools, and Gigabit network interface card.

Physical items delivered with this option:

- 1 Cognex license for up to eight cameras on USB Stick
- 1 Intel PRO/1000 PT Dual Port Server Adapter

One free PCI Express slot and one USB slot is required on the PC.

896-1

Gigabit Ethernet Camera

Includes cameras, cables, and depending on amount – switches.

Physical items delivered with this option:

- Camera Basler scA1390-17gm (according to amount)
- 20m Ethernet cable with screw lock at camera end (according to amount)
- 10m Power Trigger Strobe cable (according to amount)
- Industrial five port Gigabit Ethernet switch (1 pcs for amount 3-5, 2 pcs for amount 6-8)
- 4m Ethernet cable for connecting PC to Switch (1 pcs for amount 3-5, 2 pcs for amount 6-8)

562-1

Analogue Multi Vision

Vision integration for multiple cameras. Each of this option requires at least one 558-1.

Physical items delivered with this option:

- Cognex MVS-8504 four-camera frame grabber board
- Camera break-out cable
- I/O card

One free PCI-slot is required on the PC. Maximum number of cards is two.

Process Licences

524-1

Adaptive Task Completion

License to distribute positions dynamically between robot work areas. When a robot misses a position, the following robots will handle it. Used to make sure that no position is lost. If the positions are distributed from a camera, at least one option 523-1 is required.

No physical items are delivered with this option.

User’s Guide

260-1

User’s guide English

Physical items delivered with this option:

- One printed User’s Guide copy in English

264-1

User’s guide Italian

Physical items delivered with this option:

- One printed User’s Guide copy in Italian

268-1

User’s guide Spanish

Physical items delivered with this option:

- One printed User’s Guide copy in Spanish

265-1

User’s guide Japanese

Physical items delivered with this option:

- One printed User’s Guide copy in Japanese

262-1

User’s guide French

Physical items delivered with this option:

- One printed User’s Guide copy in French

4.2 PickMaster related Controller Options IRC5

The following options need to be ordered for the IRC5 robot controller operating with PickMaster. See also the related robot controller product specification.

4.2.1 RobotWare Option

642-1

Prepared for PickMaster - PickMaster 3

Each robot operating with PickMaster requires Prepared for PickMaster - PickMaster 3. The option contains all necessary functions to interface PickMaster and to run enhanced conveyor tracking on up to six conveyors.

4.2.2 Hardware options

726-1

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.

716-1 VDC or 717-1 AD Combi

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.

4.3 PickMaster related Controller Options S4Cplus

The following options need to be ordered for the S4Cplus robot controller operating with PickMaster. See also the related robot controller product specification.

4.3.1 RobotWare Option

257-1

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.

4.3.2 Hardware options

80-1/135-1

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.

201-1

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.

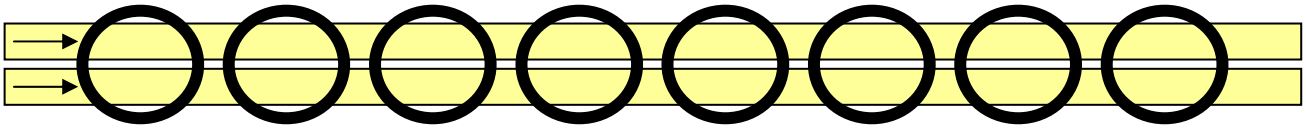
4.4 Examples of PickMaster configurations[9]

This chapter describes some installation cases and their related PickMaster options.

4.4.1 Use case 1

Eight robots along two conveyors with predefined product positions





Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

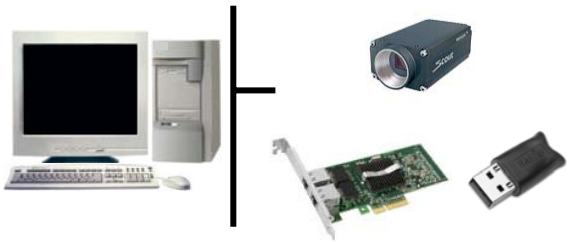
Quantity	Option	
8	559-1	Lic for one robot
(n	260-1	n copies of the printed User's Guide)

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

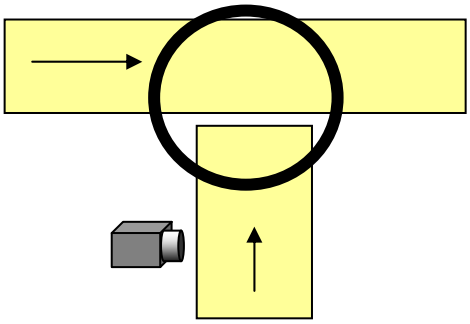
Quantity	Option	
1	642-1	Prepared for PickMaster
2	726-1	Encoder Interface Unit for PickMaster (internal/external)

4.4.2 Use case 2

One robot along conveyors with one camera



[9] Controller related options only described for IRC5



Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

Quantity	Option	
1	895-1	Gigabit Ethernet Ready
1	896-1	Gigabit Ethernet Camera
1	559-1	Lic for one robot
1	558-1	Lic for one camera
(1	551-1	If Inspection is used on the camera)
(n	260-1	n copies of the printed User’s Guide)

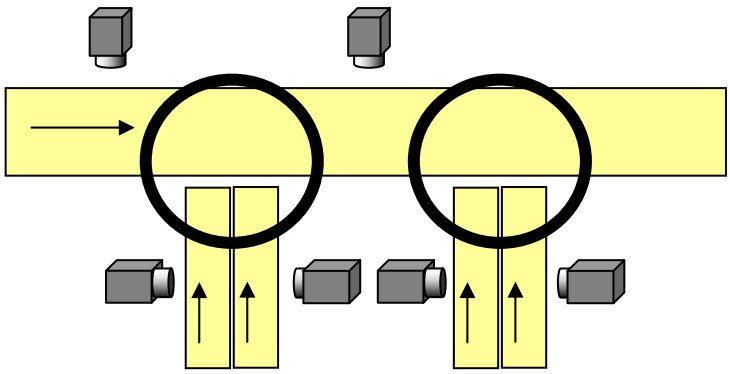
Robot options per robot

Quantity	Option	
1	642-1	Prepared for PickMaster
2	726-1	Encoder Interface Unit for PickMaster (internal/external)

4.4.3 Use case 3

Two robots along conveyors with six cameras





Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

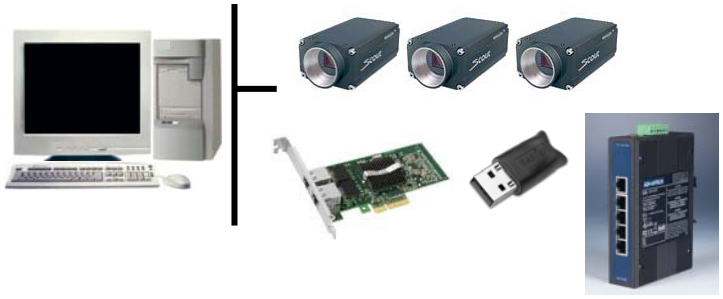
Quantity	Option	
1	895-1	Gigabit Ethernet Ready
6	896-1	Gigabit Ethernet Camera
2	559-1	Lic. for one robot
6	558-1	Lic. for one camera
(n	551-1	Inspection on n cameras)
(n	260-1	n copies of the printed User's Guide)

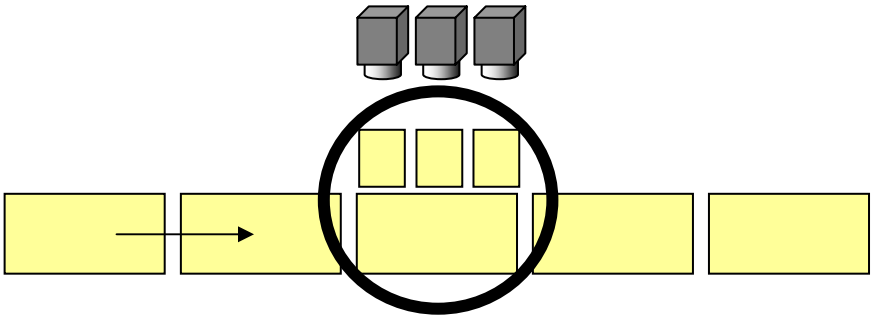
Robot options per robot: i.e. the quantity multiplies by 2

Quantity	Option	
1	642-1	Prepared for PickMaster
3	726-1	Encoder Interface Unit for PickMaster (internal/external)

4.4.4 Use case 4

One robot along indexing feeders with three digital cameras (normal resolution).





Basic license

Quantity	Option	
1	42-6	Basic license including one robot

Additional licenses

Quantity	Option	
1	895-1	Gigabit Ethernet Ready

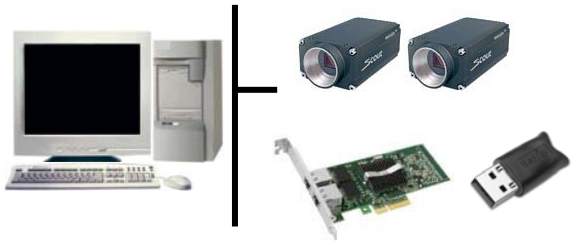
3	896-1	Gigabit Ethernet Camera
1	559-1	Lic. for one robot
3	558-1	Lic. for one camera
(n	551-1	Inspection on n cameras)
(n	260-1	n copies of the printed User's Guide)

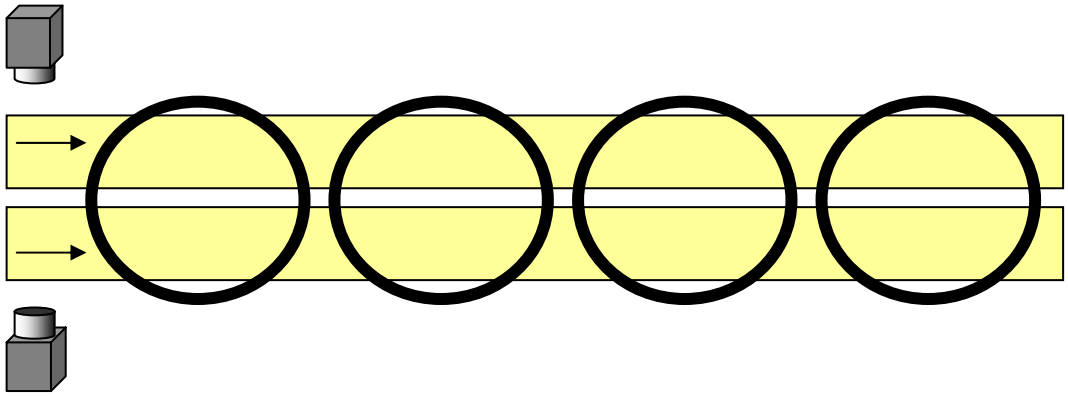
Robot options

Quantity	Option	
1	642-1	Prepared for PickMaster

4.4.5 Use case 5

Four robots along conveyors with two cameras





Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

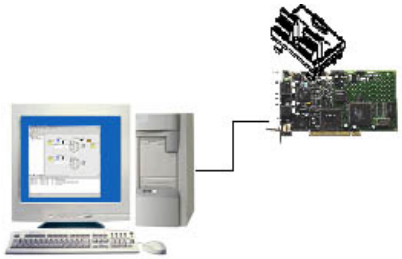
Quantity	Option	
1	895-1	Gigabit Ethernet Ready
2	896-1	Gigabit Ethernet Camera
4	559-1	Lic for one robot
2	558-1	Lic for one camera
6	523-1	Camera Distribution
(n	551-1	Inspection on n cameras)
(n	260-1	n copies of the printed User's Guide)

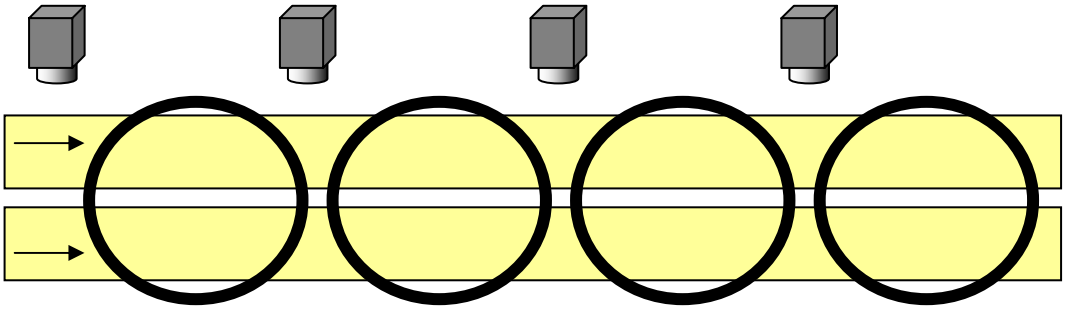
Robot options per robot: i.e. the quantity multiplies by 4

Quantity	Option	
1	642-1	Prepared for PickMaster
2	726-1	Encoder Interface Unit for PickMaster (internal/external)

4.4.6 Use case 6: Alternative 1

Four robots along conveyors with four cameras and ATC





Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

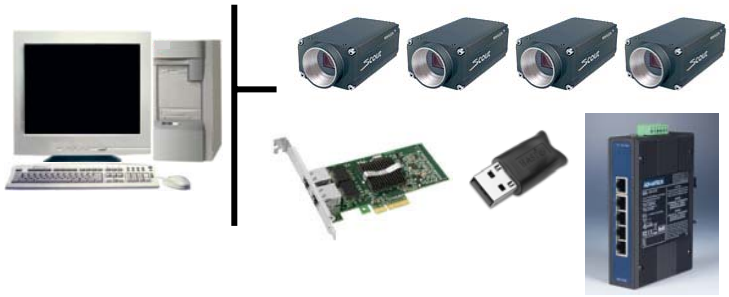
Quantity	Option	
1	562-1	Analogue Multi Vision
4	559-1	Lic for one robot
4	558-1	Lic for one camera
x	524-1	Adaptive Task Completion
(n	551-1	Inspection on n cameras)
(n	260-1	n copies of the printed User's Guide)

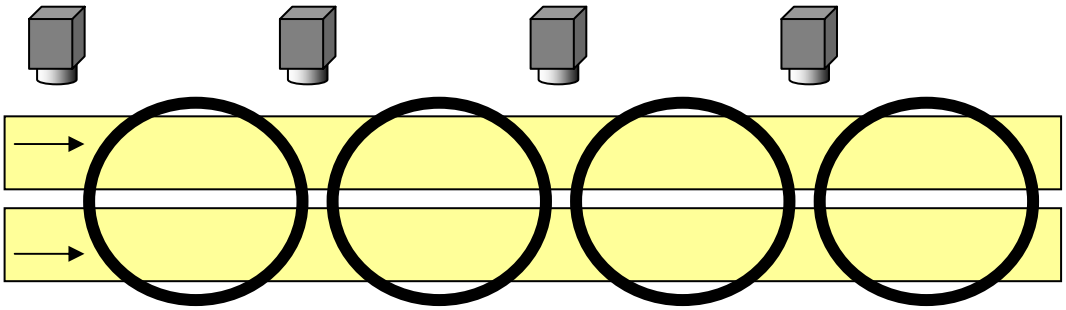
Robot options per robot: i.e. the quantity multiplies by 4

Quantity	Option	
1	642-1	Prepared for PickMaster
2	726-1	Encoder Interface Unit for PickMaster (internal/external)

4.4.7 Use case 6: Alternative 2

Four robots along conveyors with four cameras and ATC





Basic license

Quantity	Option	
1	42-6	Basic license

Additional licenses

Quantity	Option	
1	895-1	Gigabit Ethernet Ready
4	896-1	Gigabit Ethernet Camera
4	559-1	Lic for one robot
4	558-1	Lic for one camera
x	524-1	Adaptive Task Completion
(n	551-1	Inspection on n cameras)
(n	260-1	n copies of the printed User's Guide)

Robot options per robot: i.e. the quantity multiplies by 4

Quantity	Option	
1	642-1	Prepared for PickMaster
2	726-1	Encoder Interface Unit for PickMaster (internal/external)

5 Spare parts

3HAC 023774-001

PickMaster™ 3.20 Software

3HAC 15492-1

Cognex vision board MVS-8100M type A.

Single camera frame grabber vision board.

3HAC 021513-001

Cognex vision board MVS-8504

Vision frame grabber board for maximum four simultaneous cameras

3HAC 021515-001

Cognex camera connection breakout cable

Brake out box used for MVS-8504 to connect up to four camera cables.

3HAC 021514-001

Cognex I/O card for MVS-8504 card

3HAC 10846-1

Trig strobe I/O DSQC 524

I/O conversion board for four pairs of trig and strobe signals used for MVS-8100M. Converts 5VDC TTL signals to 24 VDC signals and vice versa. All signals are stabilized and opto-isolated.

3HAC 11530-1

Ribbon cable with 40-pin connector used for trig/strobe I/O DSQC 524.

3HAC 15493-1

I/O Adapter

Trig/strobe I/O signal connection adaptor including ribbon cable with 10-pin connector. Used to connect MVS-8100M to the ribbon cable for the trig/strobe I/O DSQC 524.

3HAC021474-001

Camera cdc 50

Normal resolution camera for Cognex Digital Vision system

3HAC021475-001

Camera cdc 200

High resolution camera (1280x1024) for Cognex Digital Vision system

3HAC021517-001

Vision 8100D1

Cognex Digital frame grabber for one CDC camera

3HAC021518-001

Vision 8100D2

Cognex Digital frame grabber for two CDC cameras

3HAC021519-001

Vision 8100D3

Cognex Digital frame grabber for three CDC cameras

3HAC021520-001

Vision cable outlet 1

Cable outlet (40ft / 12m) for Vision 8100D1

3HAC024256-001

Vision cable outlet 2

Cable outlet (40ft / 12m) for Vision 8100D2

3HAC024257-001

Vision cable outlet 3

Cable outlet (40ft / 12m) for Vision 8100D3

3HAC 023776-001

Digital Repeater Kit

CDC repeater box and 40tf (12m) cable

3HAC 031723-001

Dual Port Network Interface Card

IntelPro/1000PT Dual Port

3HAC 031782-001

USB License

Cognex USB Vision License

3HAC 031718-001

Gigabit Ethernet Camera

Gigabit Ethernet Camera Res. 1390x1080 Monochrome

3HAC 031721-001

Power/Trig/Strobe Cable

Power/Trig/Strobe cable for Gigabit Ethernet Camera

3HAC 031806-001

Camera Ethernet Cable

20m CAT6 Ethernet cable with fastening screws for connecting camera to PC or switch

3HAC 031743-001

Switch Ethernet Cable

4m CAT6 Ethernet cable for connecting switch to PC

3HAC 031722-001

Gigabit Ethernet Switch

5 port switch for connecting multiple Gigabit Ethernet cameras

6 Documentation

The following documents are part of the PickMaster™ product:

3HAC 5842-10

Product Specification PickMaster™ 3.20 (this document)

Getting Started

PickMaster™ 3.20 Getting Started, English/Italian/Spanish/Japanese/French, included in 3HAC 031979-001 PickMaster Software 3.20.

3HAC031978-001

PickMaster™ 3.20 User's Guide English, also available as PDF and HTML online help with the product

3HAC031978-002

PickMaster™ 3.20 User's Guide French, also available as PDF and HTML online help with the product

3HAC031978-003

PickMaster™ 3.20 User's Guide German, also available as PDF and HTML online help with the product

3HAC031978-004

PickMasterTM 3.20 User's Guide Italian, also available as PDF and HTML online help with the product

3HAC031978-005

PickMaster™ 3.20 User's Guide Spanish, also available as PDF and HTML online help with the product

3HAC031978-006

PickMaster™ 3.20 User's Guide Japanese, also available as PDF and HTML online help with the product

Cognex vision system documentation

Included on the PickMaster™ CD

User Hooks documentation

Description of the .NET user hook interface. Included on the PickMaster™ CD. Only available as HTML online documentation.

PickMaster™ SDK

Software interface description for the integration of external models and external sensors.

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