ROBOTICS

Product specification

Controller software IRC5



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Overview of this specification

About this product specification

It describes all RobotWare (that is controller software) options for the IRC5 controller

Usage

Product specifications are used to find data and performance about the product, for example to decide which product to buy. How to handle the product is described in the product manual.

Users

It is intended for:

- Personnel dealing with ordering of ABB robots
- Personnel seeking to obtain an overview of RobotWare functionality
- Sales and marketing personnel

References

Reference	Document ID
Product specification - Controller IRC5	*3HAC047400-001*
Application manual - Additional axes and standalone controller	*3HAC051016-001*
Application manual - Controller software IRC5	*3HAC050798-001*
Application manual - Continuous Application Platform	*3HAC050990-001*
Application manual - Discrete Application Protocol RW 6	*3HAC050994-001*
Product specification - Integrated Vision	*3HAC044266-001*
Application manual - PROFIenergy Device	*3HAC050967-001*
Application manual - RobotWare Add-Ins	*3HAC051193-001*
Product specification - Robot user documentation, IRC5 with RobotWare 6	*3HAC052355-001*

Revisions

Revision	Description
-	First revision
A	Released with RobotWare 6.01. • Added the option *RobotWare Add-In prepared [988-1] on page 37*. • The functionality of RAPID Message Queue is corrected, see *RAPID Message Queue on page 101*. • The option Miller AutoAxcess [650-4] is removed. • The previous option Servo Tool Control is now included in the option Spot 6, see *Tool Control [1180-1] on page 105*, • Minor corrections/update
B	Released with RobotWare 6.02. • Added the option *963-1 PROFIenergy*.

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Revision	Description
C	Released with RobotWare 6.03. • Updated the option *Motion Process Mode on page 46*. • Updated the spot features, see *Spot 6 [635-6] on page 157*. • Limitation for option Machine Tending [1167-1] is changed. This option is now available for 4-axis robots. • The option Production Manager [812-1] is removed.
D	Released with RobotWare 6.04. • Updated the option *Motion Process Mode on page 46*. • Limitations for option Force Control Base [661-2] is updated. • Information and links to ARCITEC is removed. • Options *Advanced Rapid [626-1]* and *Fixed Position Events [609-1]* are removed from the list of included options in PickMaster. • Phrase *RobotWare DVD* in section *Communication/PC Interface*, is changed to *RobotWare Download package*. • Robot Web Services added to section RobotWare-OS. • Phrase *Support for MultiMove* in section *Externally Guided Motion/Features* is deleted. • Function SKS Synchroweld added to *Included Power Source functions*. • Function *Production manager for Arc* is renamed to *Production manager* and moved from *Arc options* to *Application options*. • Function *BullsEye* is moved from *Arc options* to *Application options*. • Option *Arc 6* is updated. • Option numbers for *Advanced Rapid* and *Fixed Position Events* are deleted in section *Prepared for PickMaster 3*.
E	• Minor corrections.
F	Released with RobotWare 6.05. • Minor corrections.
G	• Released with RobotWare 6.06. • Added Absolute Accuracy parameters for IRB 1200 • The limitations on Servo Tool Change [630-1] is updated • Changed the description of option 642-2 to Palletizing PowerPac • Option Bosch Interface [832-1] is updated • Option Externally Guided Motion [689-1] is updated • Option Arc 6 [633-4] is updated. • Minor correction
H	Released with RobotWare 6.07. • Minor correction • Added *Fronius TPSi* • Option *Tracking unit interface* [1552-1] is added • Option *Tracking Interface* [1553-1] is added • Option *Externally Guided Motion* [689-1] is updated • Option *Conveyor Tracking* [606-1] is updated • Option *MultiProcess* [634-1] is updated • Option *Sensor Synchronization* [607-1] is updated and the requirement is removed • Option *FTP Client* [614-1] is updated and the description is changed • *NFS Client* is updated

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Revision	Description
J	Released with RobotWare 6.08. • Up to seven motion tasks can now be used for options *MultiMove Coordinated* [604-1] and *MultiMove Independent* [604-2]. • Option *Prepared for FlexLoader Vision* [1554-1] is added • Option *Production Framework* [1243-1] is added • Added *Fronius TPSi Seam tracking* • Added *Collision Avoidance*
K	Released with RobotWare 6.09. • Added limitation on *Externally Guided Motion* [689-1] • Updated the *Externally Guided Motion* [689-1] Position Guidance, added support for IRB 14000 • Updated the limitations of *Independent Axis* [610-1] • Removed *Absolute Accuracy, inverted* [603-2] • Updated information about *Absolute Accuracy* • Moved *Production Manager* to Other functions
L	Released with RobotWare 6.09. • Option *Tracking unit interface* [1552-1] is updated
M	Released with RobotWare 6.10. • List of limitations of supported robots updated in section *Collision Avoidance on page 72*. • Updated the Requirements for option *PickMaster 3* [642-1] • Updated option *Arc 6* [633-4] with included options
N	Released with RobotWare 6.10.01 • Updated the limitations for option *Bosch Interface* [832-1] • Updated Weaving feature for option *Arc 6* [633-4] • Updated the requirement for option *Tracking unit interface* [1552-1]
P	Released with RobotWare 6.10.02 • Removed *Production Screen* [637-1] from Fronius TPSi requirements. *Production Screen* [637-1] is included in option *RobotWare Arc* [633-4] • Minor changes
Q	Released with RobotWare 6.11 • Added new options related to PickMaster Twin, *PickMaster Cell Ready* [1580-1], *PickMaster Robot Ready* [1580-2], *PickMaster Vision Ready* [1581-1] • Updated *Collision Avoidance* limitation and added Rapid instruktion • Remove IRB 6620LX as it is phased out • Added *OPC UA Server* [1582-1] • Minor changes
R	Released with RobotWare 6.11.01 • Updated the requirement for option *RobotWare Machine Tending* [1167-1] • Updated general information and the features for option *Tool Control* [1180-1]
S	Released with RobotWare 6.11.02 • Updated the limitations of option *Independent Axis* [610-1] • Updated the limitations of option *SoftMove* [885-1] • Updated the limitations of option *Externally Guided Motion* [689-1]

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Revision	Description
T	Released with RobotWare 6.12 • Changed the name *Local IO* to *Scalable I/O* • Added *OPCUA* [1582-1] • Added *Movable gun arm search* [1583-1] • Updated the requirements of option *MultiMove Coordinated* [604-1] • Updated the limitations of option *MultiMove Independent* [604-2]
U	• Performance description for option *MultiMove Coordinated* [604-1] and *MultiMove Independent* [604-2] had been updated.
V	Released with RobotWare 6.12.03 • Limitations updated for the options *Independent Axis* and *Path Offset*. • Change the name and description for option [1582-1].
W	Released with RobotWare 6.13.02. • Added the option *Process Data Access [1585-1]*. • Added the option *Prep. Visual Servoing [1586-1]*.
X	Released with RobotWare 6.13.03. • Description update to RW Machining options.
Y	Released with RobotWare 6.14. • Updated the limitation for option *Collision Detection [613-1]*. • Updated the limitation for option *PickMaster 3* [642-1].
Z	Released with RobotWare 6.15. • Added information about deactivation/deactivation and trigger signals, see *Collision Avoidance on page 72*.
AA	Released with RobotWare 6.15.03. • Minor corrections.
AB	Released with RobotWare 6.15.08. • Updated the list of supported servers, see *FTP & SFTP Client [614-1] on page 75*.
AC	Released with RobotWare 6.16. • Updated the section *IoT Data Gateway [1582-1] on page 78* • Added the option *Prepared for PaintWare*. • Added the section *RAPID language and programming environment on page 15*. • Minor corrections.
AD	Released with RobotWare 6.16. • The option *Prep. Visual Servoing* [1586-1] has changed name to *High Speed Alignment* [1586-1].
AE	Released with RobotWare 6.16.02. • Company name updated to reflect current legal entities. • Updated portal name from myABB to ABB Robotics One.

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1 Introduction to RobotWare

1.1 Products, classes, and options

Software products

RobotWare is a family of software products from ABB Robotics. The products are designed to make you more productive and lower your cost of owning and operating a robot. ABB Robotics has invested many years into the development of these products and they represent knowledge and experience based on several thousands of robot installations.

Product classes

Within the RobotWare family, there are different classes of products:

Product classes	Description
RobotWare-OS	This is the operating system of the robot. RobotWare-OS provides all the necessary features for fundamental robot programming and operation. It is an inherent part of the robot, but can be provided separately for upgrading purposes. For a description of RobotWare-OS, see *Product specification - Controller IRC5*.
RobotWare options	These products are options that run on top of RobotWare-OS. They are intended for robot users that need additional functionality for motion control, communication, system engineering, or applications.
Process application options	These are extensive packages for specific process application like spot welding, arc welding, and dispensing. They are primarily designed to improve the process result and to simplify installation and programming of the application.
RobotWare Add-ins	A RobotWare Add-in is a self-contained package that extends the functionality of the robot system. Some software products from ABB Robotics are delivered as Add-ins. For example track motion IRBT, positioner IRBP, and stand alone controller. The purpose of RobotWare Add-ins is also that a robot program developer outside of ABB can create options for the ABB robot systems, and sell the options to their customers. For more information on creating RobotWare Add-ins, contact your local ABB Robotics representative at *www.abb.com/contacts*.

Process application options

For IRC5, the former *ProcessWare* options are included in the RobotWare options. These are extensive packages for specific process application like welding, dispensing and painting. They are primarily designed to improve the process result and to simplify installation and programming of application.

Option groups

For IRC5, the RobotWare options have been gathered in groups, depending on the customer benefit. The goal is to make it easier to understand the customer

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value of the options. However, all options are purchased individually. The groups are as follows:

Option groups	Description
Motion performance	Options that optimize the performance of your robot.
Motion coordination	Options that make your robot coordinated with external equipment or other robots.
Motion Events	Options that supervise the position of the robot.
Motion functions	Options that control the path of the robot.
Motion Supervision	Options that supervise the movement of the robot.
Communication	Options that make the robot communicate with other equipment. (External PCs etc.)
Engineering tools	Options for the advanced robot integrator.
Servo motor control	Options that make the robot controller operate external motors, independent of the robot.

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1.2 RAPID language and programming environment

General

RAPID is the primary programming language used for ABB Robotics, designed to facilitate the control and automation of industrial robots. It is a high-level language that is both powerful and user-friendly, making it accessible for both novice and experienced programmers. Its syntax and structure are designed to be intuitive, reducing the learning curve for new users.

RAPID is suitable for a wide range of applications, from simple pick-and-place tasks to complex assembly operations. The language is designed to be reliable and robust, ensuring consistent performance in industrial environments.

Key features of RAPID

RAPID uses a structured text format similar to other programming languages like Python or C, which includes loops, conditionals, and variable handling. It excels in handling complex motion commands, allowing precise control over robot movements.

RAPID supports various data types and operations, enabling efficient data handling and processing. Users can create custom functions and procedures, enhancing the flexibility and adaptability of the programming environment.

It allows seamless communication with external devices and systems, making it ideal for integrated automation solutions.

Overall, RAPID is a versatile and powerful tool that enhances the capabilities of ABB robots, making automation more efficient and accessible.

Summary of the RAPID concept

- Hierarchical and modular program structure to support structured programming and reuse
- Routines can be *Functions* or *Procedures*
- Local or global data and routines
- Data typing, including structured and array data types
- User defined names on variables, routines, and I/O
- Extensive program flow control
- Arithmetic and logical expressions
- Interrupt handling
- Error handling
- User defined instructions (appear as an inherent part of the system)
- Backward handler (user definition of how a procedure should behave when stepping backwards)
- Many powerful built-in functions, for example mathematics and robot specific
- Unlimited language (no maximum number of variables etc., only memory limited). Built-in RAPID support in user interfaces, for example user defined pick lists, facilitate working with RAPID.
- Support for Unicode symbols in strings and comments

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Ease of use

Creating and editing RAPID programs is done using the integrated code editors in RobotStudio or on the FlexPendant. Additionally, there is an app for the FlexPendant called Wizard, where RAPID programming is further simplified to block programming.

RAPID programs can range from simple movement procedures to complex structures including sending and receiving data from sensors, cameras, I/O devices, other machines, and more. This to enable a highly flexible automation, utilizing the robot's capability.

Simple RAPID program examples

Hello world

```
MODULE HelloWorld
PROC main()
TPWrite "Hello, World!";
ENDPROC
ENDMODULE
```

In this example:

The module `HelloWorld` defines a module named HelloWorld.

`PROC main()` defines a procedure named main.

`TPWrite "Hello, World!";` is the command that outputs "Hello, World!" to the FlexPendant.

Displaying messages on the FlexPendant

```
MODULE MainModule
  VAR num length;
  VAR num width;
  VAR num area;

  PROC main()
    length := 10;
    width := 5;
    area := length * width;
    TPWrite "The area of the rectangle is " \Num:=area;
  ENDPROC
ENDMODULE
```

This program will calculate the area of a rectangle and show the answer on the FlexPendant.

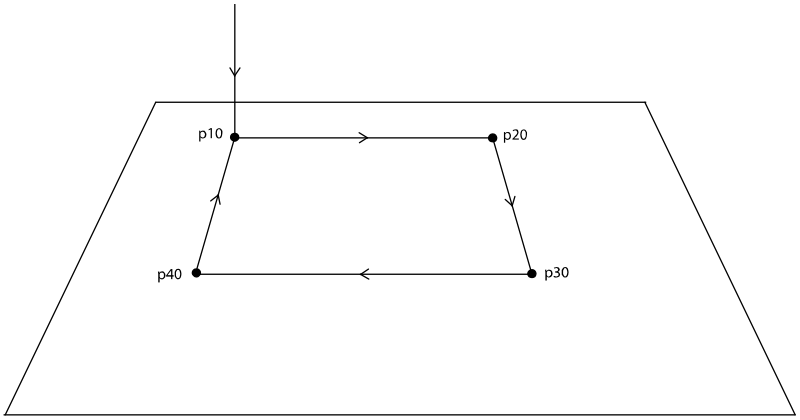
```
The area of the rectangle is 50
```

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Draw a square

The robot is holding a pen above a piece of paper on a table. This program will make the robot move the tip of the pen down to the paper and then draw a square.



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```
PERS tooldata tPen := [ TRUE, [[200, 0, 30], [1, 0, 0 ,0]], [0.8,
     [62, 0, 17], [1, 0, 0, 0], 0, 0, 0]];
CONST robtarget p10 := [ [600, -100, 800], [0.707170, 0, 0.707170,
     0], [0, 0, 0, 0], [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];
CONST robtarget p20 := [ [600, 100, 800], [0.707170, 0, 0.707170,
     0], [0, 0, 0, 0], [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];
CONST robtarget p30 := [ [800, 100, 800], [0.707170, 0, 0.707170,
     0], [0, 0, 0, 0], [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];
CONST robtarget p40 := [ [800, -100, 800], [0.707170, 0, 0.707170,
     0], [0, 0, 0, 0], [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];

PROC main()
  MoveL p10, v200, fine, tPen;
  MoveL p20, v200, fine, tPen;
  MoveL p30, v200, fine, tPen;
  MoveL p40, v200, fine, tPen;
  MoveL p10, v200, fine, tPen;
ENDPROC
```

Draw an arc

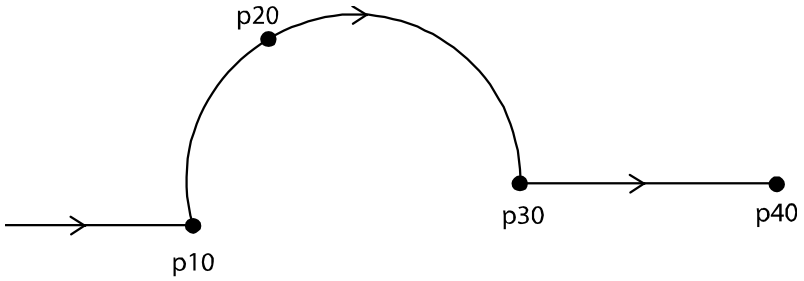
To add a curve or arc to the previous program, the instruction `MoveC` is added.

```
MoveL p10, v500, fine, tPen;
MoveC p20, p30, v500, fine, tPen;
MoveL p40, v500, fine, tPen;
```

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1.2 RAPID language and programming environment
Continued



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References

The RAPID programming language is described in detail in the following documents.

What do you want to know	Where to read about it
• More detailed information about the functionality • What instructions are there for a specific category, for example, move instructions • Descriptions of specific functionality, for example, interrupts or error handling	*Technical reference manual - RAPID Overview*
• Information about a specific instruction, function, or data type	*Technical reference manual - RAPID Instructions, Functions and Data types*
• Details about how the robot controller handles different parts of RAPID	*Technical reference manual - RAPID kernel*

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2 Option restructuring

General

A change in the option structure has been implemented, in order to achieve a simplified product offer. This means that a number of options have been removed from the specification form. The corresponding functionality has been either included in the basic robot product or merged with other options.

In this product specification, all options are still described as before. A comment has been added in the beginning of each chapter affected by the change, to indicate that options have been included in the base product or merged with another option.

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3 RobotWare-OS

3.1 Multiple Axis Positioner

General

Note

This functionality is included in RobotWare - OS.

The option *Multiple Axis Positioner* enables coordination of robot motion with multiple axis manipulators or robot carriers (gantries).

Note

Note that simultaneous coordination with several single axis manipulators, for example track motion and work piece manipulators, does not require the option *Multiple Axis Positioner*.

Features

- Coordinated movement of robot and multiple axis manipulator

Application

This option shall be used for all types of multiple axis manipulators for example positioners for arc welding.

The kinematic model of the positioner enables the coordinated movement of robot and manipulator together, meaning correct TCP movement relative to the work piece, also when the work piece or the robot (for robot carrier Application) is moved around, during program execution or jogging.

Performance

The performance of the coordinated robot movement with a moving work object on a multiple axis manipulator is the same as for a fix work object, if the manipulator is correctly calibrated.

Requirements

Note

A configuration file describing the kinematics of the manipulator is necessary and is normally supplied by the manipulator supplier.

RAPID instructions

There are no RAPID instructions included in this option.

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3.2 Fixed Position Events

General

Note

This functionality is included in RobotWare - OS.

The option *Fixed Position Events* is used to issue certain events depending on the current robot position. The events can be used to control or check the status of surrounding equipment.

Features

- Change the value of an I/O signal, when the TCP is at a certain time and/or distance before or after a programmed position.
- Generate an interrupt, when the TCP is at a certain time and/or distance before or after a programmed position.
- Check the value of an I/O signal, when the TCP is at a certain time and/or distance before or after a programmed position.
- Make a procedure call, when the TCP is at a certain position on the path or in the middle of a corner zone.

Application

Application	Description
Handling press work	To provide a safe communication system between the robot and the press and to reduce cycle time. At the instant when the robot leaves a press, an output is set and restarts the press action. This function is also useful for other process equipment. The start/stop will always occur when the robot is at the exact position, irrespective of the robot speed.
Check status of process equipment	For example a robot which is used for extracting parts from a die casting machine. Before entering, the robot can check if the gate is open (check an I/O signal) or check a number of logical conditions and take care of the complete press start (make procedure call).

Performance

The event issued with *Fixed Position Event* will always occur when the robot is at the exact position, irrespective of the robot speed.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Instruction
TriggIO	Definition of trigg conditions for an output
TriggEquip	Definition of trigg conditions for process equipment with compensation for equipment delay

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Instruction	Instruction
TriggCheckIO	Definition of trigg conditions for check of signal value
TriggInt	Definition of trigg conditions for an interrupt
TriggL	Position fix output/interrupt during linear movement
TriggC	Position fix output/interrupt during circular movement
TriggJ	Position fix output/interrupt during joint movement
MoveLSync	Procedure call in the middle of the path or in corner zone, during linear movement
MoveCSync	Procedure call in the middle of the path or in corner zone, during circular movement
MoveJSync	Procedure call in the middle of the path or in corner zone, during joint movement

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3.3 File and Serial Channel Handling

General

Note

This functionality is included in RobotWare - OS.

File and Serial Channel Handling is an option, which allows the robot system to communicate with external units.

Features

- Transferring information via serial channels.
- Read part numbers from a bar code reader
- Print out production statistics on a printer during production
- Transfer data between the robot and a PC
- Data transfer via files
- Write/read production data on a USB memory stick or other mass storage memory from RAPID program

Application

Application	Description
Transferring information via serial channels	Bar code readers can be used to trace a product with its corresponding production information, for every work object throughout a production line. Bar code readers can also be used to make the robot perform the proper actions, corresponding to the work object, in lines which handle different types of products, for example in packing and pelletizing Application. This is the same as controlling the robot production from a file. This file may have been created in a PC, stored on a USB memory stick, and read by the robot at a later time.
Data transfer via files	Storing production statistics on a USB memory stick or other mass storage memory. This information can then be processed by an ordinary PC.

Performance

Data/Information	Description
Transferring information via serial channels	The transfer is controlled entirely from the robot's work program. To control the transfer from a PC, use the option *PC Interface*.
Data transfer via files	Data in the form of text strings (characters), numerical values or binary information can be read/written.

Requirements

This option includes software functionality only. Serial channels (RS232 or RS 485 serial channel), bar code readers etc. need to be purchased separately, from ABB or external provider.

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RAPID instructions

RAPID instructions included in this option:

Instruction	Description
Open/Close	Open/Close a file/serial channel
Write	(Write/WriteBin/WriteStrBin/WriteAnyBin)Write to a character- or string-based/binary serial channel or file.
Read	(Read/ReadNumReadStr/ReadBin/Read-StrBin/ReadAnyBin)Read a string/number/binary value from a serial channel or file.
FSSize	Get the size of a file system
MakeDir	Create a new directory
RemoveDir	Delete a directory
OpenDir	Open a directory to read the underlying files or subordinates
CloseDir	Close a directory
ReadDir	Read next object in a directory, file or subdirectory
IsFile	Check the type of a file
FileSize	Get the size of a file
CopyFile	Copy a file, from RAPID
RenameFile	Rename a file from RAPID
RemoveFile	Delete a file
Rewind	Start reading from the beginning of a file
ClearIOBuff	Clear the input buffer of a serial channel
ReadRawBytes	Read data from raw byte
WriteRawBytes	Write data raw byte to a device
ClearRawBytes	Clear all contents of a rawbytes variable
CopyRawBytes	Copy raw byte data
PackRawBytes	Pack data from variables into rawbytes
UnpackRawBytes	Unpack data from rawbytes into variables
RawBytesLen	Returns the amount of data in a ‘container’ of type raw byte (bytes)

Data types

Datatype	Description
rawbytes	A general data ‘container’, for communication with I/O devices

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3.4 Advanced RAPID

General

> **Note**
>
> This functionality is included in RobotWare-OS.

The option *Advanced RAPID* is directed towards advanced RAPID programmers. The package includes a detailed reference manual on the RAPID language kernel and a number of instruction and function groups useful for application development, as listed below.

The groups are:

- Bit Functions
- Data Search Functions
- RAPID Support Functions
- Power Failure Functions
- Advanced Trigg Functions

Technical reference manual - RAPID kernel

The manual describes the RAPID language syntax and semantics in detail concerning the kernel, that is all general language elements which are not used to control robot or other equipment. In addition to this the manual includes descriptions on:

- Built-in Routines
- Built-in Data Objects
- Built-in Objects
- Intertask Objects
- Text Files
- Storage allocation for RAPID objects

Bit Functions

Bit functions is a package for handling, that is setting, reading and clearing, individual bits in a byte. The instructions/functions are:

Instructions/Functions	Description
byte	Data type for a byte data
BitSet	Set a specified bit in a byte
BitClear	Clear a specified bit in a byte
BitCheck	Check if a specified bit in a byte is set
BitAnd	Logical bitwise AND operation on byte
BitOr	Logical bitwise OR operation on byte
BitXOr	Logical bitwise XOR operation on byte
BitNeg	Logical bitwise NEGATION operation on byte

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Instructions/Functions	Description
BitLSh	Logical bitwise LEFT SHIFT operation on byte
BitRSh	Logical bitwise RIGHT SHIFT operation on byte

Data Search Functions

With these functions it is possible to search all data in a RAPID program, where the name or the data type is given as a text string. This might be useful for instance in the following examples:

- A common need is to check if a data with a certain name is declared in the system, and in such case what is its value, for example a robtarget.
- Another need is to list all variables of a certain datatype, which are declared in the system, and write their values on the screen, for example all weld data.

The following instructions/functions are included in the data search functions:

Instructions/Functions	Description
SetDataSearch	Define the search criteria
GetNextSym	Search next data and get its name as a string
GetDataVal	Get the value of a data, specified with a string for the name
SetDataVal	Set the value of a data, specified with a string for the name
SetAllDataVal	Set the value of all searched data

RAPID Support Functions

This package includes a number of miscellaneous instructions etc., which are used in application development.

Instruction	Description
AliasIO	Instruction used to define a signal of any type with an alias (alternative) name. The instruction can be used to make generic modules work together with site specific I/O, without changing the program code.
ArgName	Function used inside a routine to get the name of a data object, which is referenced as argument in the call of the routine. The name is given as a string. The function can also be used to convert the identifier of a data into a string.
BookErrNo	Instruction used to book a new RAPID system error number. This should be used to avoid error number conflicts if different generic modules are combined in a system.
ErrLog	Write a system error message.
ErrRaise	Write a system error message and RAISE the error to the calling routine.
TextTabGet	Function used to get the text table number of a user defined text table during runtime.
TextGet	Function used to get a text string from the system text tables (installed at cold start).
TextTabInstall	Instruction used to install a text table in the system.
TextTabFreeToUse	Function to test whether the text table name (text resource string) is free to use.

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Instruction	Description
SetSysData	Instruction which will activates the specified system data (tool or workobject). With this instruction it is possible to change the current active tool or workobject.
IsStopStateEvent	Function which will return information about the movement of the Program Pointer (PP).
ReadCfgData	Read system configuration data.
WriteCfgData	Write system configuration data.
WarmStart	Restart the system.

Power Failure Functions

The package is used to get I/O signal values before power failure and to reset them at power on. The following instructions are included and are normally used in the power on event routine:

Instruction	Description
PFRestart	Check if path has been interrupted

Advanced Trigg Functions

Instruction	Description
TriggSpeed	Instruction to define conditions and actions for control of an analog output signal with an output value proportional to the actual TCP speed.Note that this instruction must be used in combination with a TriggL/C/J instruction.
StepBwdPath	Instruction used to move backward on its path in a RESTART event routine.
TriggStopProc	Generation of restart data at program stop or emergency stop.
IPers	An interrupt when changing a persistent.
IError	An interrupt at event (error) generation.
GetTrapData	Used in a trap routine to obtain all information about the interrupt that caused the trap routine to be executed.
ReadErrData	Used in a trap routine to obtain numeric information (domain, type and number) about an error, a state change, or a warning, that caused the trap routine to be executed.

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3.5 Auto acknowledge input

General

Note

This functionality is included in RobotWare-OS.

Auto Acknowledge Input is a system input which will acknowledge the dialog presented on the FlexPendant when switching from operator mode manual to auto with the key switch on the robot controller.

WARNING

Note that using such an input will be contrary to the regulations in the safety standard ISO 10218-1 chapter 5.3.5 Single point of control with following text:

"The robot control system shall be designed and constructed so that when the robot is placed under local pendant control or other teaching device control, initiation of robot motion or change of local control selection from any other source shall be prevented."

Thus it is absolutely necessary to use other means of safety to maintain the requirements of the standard and the machinery directive and also to make a risk assessment of the completed cell. Such additional arrangements and risk assessment is the responsibility of the system integrator and the system must not be put into service until these actions have been completed

Features

An optional system input can be created, which will acknowledge the dialog presented at the FlexPendant when switching from operator mode manual to auto. The option must be activated in Installation Manager and then the system input defined in the configuration file for I/O.

Limitations

The system parameter cannot be defined using the FlexPendant or RobotStudio, only with a text string in the I/O configuration file.

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3.6 Logical Cross Connections

General

Note

This functionality is included in RobotWare-OS.

The option *Logical Cross Connections* can be used to check or control process equipment, which is external to the robot. The functionality can be compared to the one of a simple PLC.

Features

- Boolean values (true/fault) based on the logical conditions: AND, OR, NOT

Application

Any application where logical conditions are used for digital signals.

Application	Description
Program execution	To be interrupted when both inputs 3 and 4 are ‘high’.
Register is to be incremented	When input 5 is set, but only when output 5=1 and input 3 = 0.

Performance

Maximum of 300 cross connections can be configured.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

There are no RAPID instructions included in this option.

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3.7 Analog Signal Interrupt

General

Note

This functionality is included in RobotWare-OS.

The option *Analog Signal Interrupt* can be used to generate a program interrupt, when a supervised analog signal reaches a predefined limit.

The interrupt can be used to give an error message for example ‘temperature above limit’, or make the robot wait for a door to be opened.

Features

- Supervision of analog signals

Application

Supervision of external equipment, such as temperature sensors and equipment doors. In the later case, the Analog Signal Function can be used to minimize cycle time of the cell, since the robot can enter an area, which is enclosed by a door, at an optimal moment.

Performance

Analog Signal Interrupt requires less computer capacity than handshaking methods.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
ISignalAI	Interrupt from analog input signal
ISignalAO	Interrupt from analog output signal

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3.8 Electronically Linked Motors

General

Note

This functionality is included in RobotWare-OS.

Electronically Linked Motors is used to make master/slave configurations of motors, which are defined as external axes. The main application is to replace mechanical driving shafts of gantry machines, but the option can be used to control any other set of motors as well. In addition to plain position following, also a torque/slave function is available, where the combined torque will be distributed between master and slaves.

Features

- Up to 4 master motors
- Up to 11 motors total (masters and followers)
- Jogging and calibration routines
- Replacement of mechanical driving shafts
- Arm/Motor position available on the TPU
- Possibility to activate/deactivate link during process
- Automatic calibration at startup

Application

Gantry machines: to replace mechanical driving shafts.

Performance

Performance	Description
When jogging	the electronically linked motors will follow the master motor
Calibration	running follower motors independent of the master - is performed through a RAPID calibration program, to ensure high personnel safety
At startup	a routine will automatically set the master- and follower motors at the start position, through a safe maneuver

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

There are no RAPID instructions included in this option.

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3.9 Service Information System

General

> **Note**
>
> This functionality is included in RobotWare-OS.

Service Information System is a service routine, which gives an alarm on the FlexPendant when the robot needs service.

Service alarms intervals exist for gearbox supervision as default. There is also a possibility to set user specific service intervals for calendar and operational time as well as for gearbox supervision.

The status of the service values can be checked on the FlexPendant when the robot is in manual mode.

Service information system furthermore includes a duty time counter function. This function is available for all robot types.

> **Note**
>
> There is also a hardware duty time counter available as option.

Service Information System is a free option and comes with all robots (does not have to be ordered).

Features

- Duty time. Sum of time, when the controller has been in the state ‘Motors on’.
- Calendar time. Elapsed time from latest service.
- Gearbox supervision. Calculated from advanced algorithms.
- Service interval alarms (Default and User set). The default alarms indicates when service should be performed. The user can also make alarms appear at a given interval before the default alarms.
- WebWare Support.

Application

All robot installations, with high quality demands. The *Service Information System* function gives possibility to predict the maintenance production stops.

Performance

- FlexPendant. Alarms are given when a service interval is passed. (Both when robot in production and manual mode.) Possibility to check the status of the service values. (Manual mode, only).
- WebWare. The option provides support for building WebWare interfaces, with possibility to check Service Information status via a computer network (LAN).

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3.9 Service Information System
Continued

Requirements

Service Information System does not require any additional software or hardware.

RAPID instructions

There are no RAPID instructions included in this option.

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3.10 Robot Web Services

General

Robot Web Services provides a Web interface for external clients to interact with the robot controller. Allows system integrators and end-users to program their own operator interfaces and client applications for the robot controller.

Robot Web Services can be used for any kind of software running on external devices. It will facilitate platform independent communication with the robot controller.

The online manual and more information can be found in Developer Center on the *RobotStudio Online Community*.

Features

Enables the possibility to interact with the robot controller using PC clients , web clients and mobile clients. The messages are composed of XHTML or JSON and the protocol is based on the HTTP.

Application

Robot Web Services is designed after the architectural style "Representational State Transfer" (REST). REST consists of a coordinated set of components, connectors, and data elements within a distributed hypermedia system, where the focus is on component roles and a specific set of interactions between data elements rather than implementation details. Its purpose is to induce performance, scalability, simplicity, modifiability, visibility, portability, and reliability.

Performance

There is no specific performance data available for this option.

Requirements

- Knowledge of Hypertext Transfer Protocol (HTTP)
- Knowledge of XML or JSON
- Programming library which can initiate HTTP requests and parse the response.
- A client such as a standard browser

RAPID instructions

There are no RAPID instructions included in this option.

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4 General RobotWare

4.1 RobotWare Add-In prepared [988-1]

General

The option *RobotWare Add-In prepared* makes it possible to run licensed Add-Ins from 3rd party developers on the IRC5 controller.

Features

Add-Ins allow to create installable supplemental software packages that extend the capabilities offered by RobotWare, making ABB's robot controllers even smarter and even more user-friendly. Creating RobotWare Add-Ins is also the recommended way for 3rd party developers to add new features into RobotWare.

An Add-In can include a number of RAPID modules, system modules, or program modules which hold the basic code for the Add-In. The Add-In also includes some files for loading and configuration at start up. The Add-In may also include *.xml* files with event log messages in different languages.

An Add-In can also consist of more advanced coding, such as *C#* code, for FlexPendant applications. This manual will cover the first case, with coding done in RAPID only. For more advanced coding, use RobotStudio SDK applications.

> **Note**
>
> The RobotWare option *RobotWare Add-In prepared* is only needed for licensed Add-Ins. It is not needed for open Add-Ins or Add-Ins delivered together with RobotWare, for example track motion and positioners.

For more information, see *Application manual - RobotWare Add-Ins*.

Application

Add-Ins can be used for any application, equipment, or functionality that extends the capabilities offered by RobotWare.

Performance

There is no specific performance data available for this option.

Requirements

Unlicensed, open, Add-Ins

What you need from ABB to package and run your own open Add-In is:

- RobotWare Add-In Packaging tool

Licensed Add-Ins

What you need from ABB to package and run your own licensed Add-In is:

- RobotWare Add-In Packaging tool
- a license certificate for the RobotWare Add-In Packaging tool for your Add-In name

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4.1 RobotWare Add-In prepared [988-1]
Continued

- RobotWare option *RobotWare Add-In prepared*

To license the Add-In, you will also need:

- License Generator
- a publisher certificate.
- a licensing certificate for the License Generator

RAPID instructions

There are no RAPID instructions included in this option.

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5 Motion Performance

5.1 Advanced robot motion [687-1]

About Advanced robot motion

The option *Advanced robot motion* gives you access to:

- *Advanced Shape Tuning*, see *Advanced Shape Tuning on page 40*.
- *Wrist Move*, see *WristMove on page 42*.
- Changing *Motion Process Mode* from RAPID, see *Motion Process Mode on page 46*.

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5.2 Advanced Shape Tuning

General

> **Note**
>
> This functionality is included in the option *Advanced robot motion*, see *Advanced robot motion [687-1] on page 39*.

Advanced Shape Tuning offers the possibility to compensate for frictional effects that might appear at low speed cutting robot motion (10-100 mm/s). This is especially useful when cutting advanced shapes, for example, small circles, or other similar applications when path accuracy is crucial. Friction tuning can be used to improve path accuracy of the robot in cutting applications.

The option gives the user access to tuning parameters and the possibility to change the tuning parameters for each axis during program execution with RAPID commands in the robot program. The option also includes RAPID instructions for automatic fine tuning of friction level for each specific shape. The software automatically repeats the movement until the best friction level for each axis has been found. After the tuning has been completed each robot axis has a unique set of tuning values for each shape. The tuning is performed by the user and for each specific shape.

Features

- Very accurate path performance for advanced motion at low speed, e.g. shape cutting
- Automatic tuning of the friction level using RAPID
- Access to tuning parameters
- Tuning axis by axis
- Change tuning from RAPID program

Application

Friction effects typically arise when cutting small, advanced shapes like for example circles. The major source of friction effects comes changing direction of axis movement. The effects appear in the form of up to 0.5 mm path deviations.

Typical applications are cutting of small shapes, such as holes, slots, rectangles. Other applications may be high precision gluing or dispense of small geometries.

Performance

Using *Advanced Shape Tuning*, typically a 0.5 mm path deviation can be reduced to about 0.1 mm. This however, requires careful tuning of the friction level (see *Operating manual - IRC5 with FlexPendant* for tuning procedure, and the instruction `TuneServo` described in *Technical reference manual - RAPID Instructions, Functions and Data types*). Note that even with careful tuning, there is no guarantee that "perfect" paths will always be generated.

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Requirements

There are no hardware or software requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
FricIdInit	Instruction to start the friction level identification
FricIdEvaluate	Function that will return the friction level that produced the best results
FricIdSetFricLevels	Instruction to set friction levels

Change of tuning from RAPID is done with standard parameters.

Instruction	Description
TuneServo	*Technical reference manual - RAPID Instructions, Functions and Data types*

Limitations

- For the large serial link robots, no significant effects can be expected by applying *Advanced Shape Tuning*.
- For a MultiMove system, friction tuning can only be done for one robot at a time.
- The movement sequence for which friction tuning is done must begin and end with a fine point.
- The tuning process requires about 15 iterations of the movement per axis.
- The movement sequence between `FricIdInit` and `FricIdEvaluate` cannot be longer than 4 seconds.

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5.3 WristMove

General

> **Note**
>
> This functionality is included in the option *Advanced robot motion*, see *Advanced robot motion [687-1] on page 39*.

WristMove is an interpolation method that only uses two axes to perform the movement. It is favorable to use in applications where one need to improve the accuracy for small shapes, for example in cutting applications. For shapes like small holes, the friction effects from the main axes (axes 1-3) of the robot may cause path deviations. *WristMove* is a method to limit the axes movement to only use two wrist axes, and thereby minimizing the friction effects on the path. In addition, a movement with *WristMove* interpolation is faster than corresponding movement without *WristMove* as less robot weight needs to be moved. The user can define which axis pair to be used for the specific movement.

Features

- Interpolation method to only use a pair of two axes. Allowable combinations, Axis5/Axis6, Axis4/Axis5 or Axis4/Axis6
- Support for any shape consisting of circular arc and straight lines, e.g. holes, slots, rectangles, etc.
- Lead in - Lead out -> any shape
- Activate interpolation mode prior to shape generation
- Used together with RAPID instruction `CirPathMode` and movement instructions for circular arcs, that is, `MoveC`, `TrigC`, `CapC`, etc

Application

WristMove is an option that can be used in cutting applications, like laser cutting, water jet cutting, routing, etc, to improve the accuracy for small shapes. The solution is a flexible, easy-to-use software feature that can be applied in any application where the robot needs to perform small shape movements.

The option can help to reduce path deviations up to or above 50% in favorable circumstances

Performance

WristMove is especially useful in cutting small holes, or other similar movements, with radius up to 25 mm. For these kinds of movements one can expect an accuracy of about ±0.1 mm when using *WristMove* at normal cutting speeds. This accuracy is the radial deviation between the actual movement and the programmed circle. This however, requires careful usage of the *WristMove* option (see *Operating manual - IRC5 with FlexPendant* for details, and the instruction `CirPathMode` described in *Technical reference manual - RAPID Instructions, Functions and Data types*). Note that even with careful usage, there is no guarantee that "perfect" paths will always be generated.

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WristMove can potentially improve cycle time as a movement with *WristMove* is faster than a corresponding movement without *WristMove* interpolation. The reason is that less robot weight needs to be moved in order to achieve the movement.

Requirements

There are no specific hardware or software requirements for this option.

RAPID instructions

There are no RAPID instructions included in this option.

Change of interpolation mode is done by setting parameters in RAPID instruction `CirPathMode`.

Limitations

- *WristMove* cannot be used if the work object is moving
- *WristMove* cannot be used if the robot is mounted on a track that is moving
- Can only use movement instructions for circular arcs, that is, `MoveC`, `TrigC`, `CapC` etc
- When cutting holes, or other shapes, the edges will be conical depending on the robot movement and the distance between tool and workobject
- The tool's height above the surface and the distance to the cutting point will vary during the cut due to the movement of only two axes
- *WristMove* cannot be used on robots with non-spherical wrist, for example, YuMi

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5.4 Absolute Accuracy, floor mounted [603-1]

Purpose

Absolute Accuracy is a calibration concept that improves TCP accuracy. The difference between an ideal robot and a real robot can be several millimeters, resulting from mechanical tolerances and deflection in the robot structure. *Absolute Accuracy* compensates for these differences.

Here are some examples of when this accuracy is important:

- Exchangeability of robots
- Offline programming with no or minimum touch-up
- Online programming with accurate movement and reorientation of tool
- Accurate cell alignment for MultiMove coordinated motion
- Programming with accurate offset movement in relation to, for example, vision systems or offset programming
- Re-use of programs between applications

The option *Absolute Accuracy* is integrated in the controller algorithms and does not need external equipment or calculation.

Note

The performance data is applicable to the corresponding RobotWare version of the individual robot.

Note

Singularities might appear in slightly different positions on a real robot compared to RobotStudio, where *Absolute Accuracy* is off compared to the real controller.

What is included

Every *Absolute Accuracy* robot is delivered with:

- compensation parameters saved in the robot memory
- a birth certificate representing the *Absolute Accuracy* measurement protocol for the calibration and verification sequence.

A robot with *Absolute Accuracy* calibration has a label with this information on the manipulator.

Absolute Accuracy supports floor mounted, wall mounted, and ceiling mounted installations. The compensation parameters that are saved in the robot memory differ depending on which Absolute Accuracy option is selected.

When is *Absolute Accuracy* being used

Absolute Accuracy works on a robot target in Cartesian coordinates, not on the individual joints. Therefore, joint based movements (e.g. `MoveAbsJ`) will not be affected.

If the robot is inverted, the Absolute Accuracy calibration must be performed when the robot is inverted.

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Absolute Accuracy active

Absolute Accuracy will be active in the following cases:

- Any motion function based on robtargets (e.g. `MoveL`) and ModPos on robtargets
- Reorientation jogging
- Linear jogging
- Tool definition (4, 5, 6 point tool definition, room fixed TCP, stationary tool)
- Work object definition

Absolute Accuracy not active

The following are examples of when Absolute Accuracy is not active:

- Any motion function based on a jointtarget (`MoveAbsJ`)
- Independent joint
- Joint based jogging
- Additional axes
- Track motion

Note

In a robot system with, for example, an additional axis or track motion, the Absolute Accuracy is active for the manipulator but not for the additional axis or track motion.

RAPID instructions

There are no RAPID instructions included in this option.

Absolute Accuracy and MultiMove

If the main robot in a MultiMove system has the Absolute Accuracy option, it opens up Absolute Accuracy capability for all the robots in the system. However, each robot needs to be calibrated individually.

Note

Note that this is the only RobotWare option that is relevant for an additional robot.

Note

It is possible to mix robots with and without the option Absolute Accuracy arbitrarily in a MultiMove system.

Performance data

The performance data is described in the product specification for the respective manipulator.

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5.5 Motion Process Mode

General

> **Note**
>
> This functionality is included in the option *Advanced robot motion*, see *Advanced robot motion [687-1] on page 39*.

The purpose of *Motion Process Mode* is to simplify application specific tuning, i.e. to optimize the performance of the robot for a specific application.

For most applications the default mode is the best choice.

Available motion process modes

A motion process mode consists of a specific set of tuning parameters for a robot. Each tuning parameter set, that is each mode, optimizes the robot tuning for a specific class of applications.

There following modes are predefined:

- *Optimal cycle time mode* – this mode gives the shortest possible cycle time and is normally the default mode.
- *Accuracy mode* – this mode improves path accuracy. The cycle time will be slightly increased compared to *Optimal cycle time mode*. This is the recommended choice for improving path accuracy on small and medium size robots, for example IRB 2400 and IRB 2600.
- *Low speed accuracy mode* – this mode improves path accuracy. The cycle time will be slightly increased compared to *Accuracy mode*. This is the recommended choice for improving path accuracy on large size robots, for example IRB 4600.
- *Low speed stiff mode* - this mode is recommended for contact applications where maximum servo stiffness is important. Could also be used in some low speed applications, where a minimum of path vibrations is desired. The cycle time will be increased compared to *Low speed accuracy mode*.
- *Press tending mode* – Changes the *Kv Factor*, *Kp Factor* and *Ti Factor* in order to mitigate tool vibrations. This mode is primarily intended for use in press tending applications where flexible grippers with a large extension in the y-direction are used.

There are also four modes available for application specific user tuning:

- *MPM User mode 1 – 4*

Selection of mode

The default mode is automatically selected and can be changed by changing the system parameter *Use Motion Process Mode* for type *Robot*.

Changing the *Motion Process Mode* from RAPID is only possible if the option *Advanced Robot Motion* is installed. The mode can only be changed when the robot is standing still, otherwise a fine point is enforced.

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The following example shows a typical use of the RAPID instruction `MotionProcessModeSet`.

```
MotionProcessModeSet OPTIMAL_CYCLE_TIME_MODE;
! Do cycle-time critical movement
MoveL *, vmax, ...;
...

MotionProcessModeSet ACCURACY_MODE;
! Do cutting with high accuracy
MoveL *, v50, ...;
...
```


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6 Motion Coordination

6.1 MultiMove Coordinated [604-1]

General

The option *MultiMove Coordinated* makes a robot system a MultiMove system with coordinated robots functionality.

A MultiMove system is a system where a common controller controls up to four robots, each equipped with its own drive module. MultiMove exists in two different modes - Independent and Coordinated.

With the *MultiMove Coordinated* option, a MultiMove system is able to work together on a common work piece and coordinated in a common workobject. *MultiMove Coordinated* also includes all *MultiMove Independent* functionality.

Features

- Up to four robots simultaneously coordinated with a common work object
- Up to seven simultaneous motion tasks, handing for example four robots, one positioner and two single additional axes
- The work object can be in motion during processing. This motion can be executed by an additional axis, a multi-axis positioner or by one or several of the robots in the MultiMove group
- Any of the robots in a MultiMove group can work independently while others work coordinated. Which robots are coordinated and which are independent can change dynamically during the cycle
- Coordination is active both in automatic and manual mode. In the latter case, this means that robots can maintain their position and orientation in relation to the work object when this is moved by the joystick
- Calibration features to define coordinate systems between robots or positioners
- Synchronizing of movements in different tasks. This means that the different movements will be executed synchronized and in the same time
- MultiMove user interface on FlexPendant
- RobotWare - Multitasking
- RobotWare - Multiple Axis Positioner

Application

- Multi robot processing on a work piece mounted on a positioner.
- Processing by one or multiple robots on a work piece handled by another robot. (Flex positioner)
- Moving of heavy or flimsy objects by multiple robots.

Performance

The motion performance of robots in a MultiMove group is equivalent to that of a single robot system, in terms of speed and acceleration. The total path accuracy

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when one robot is moving the work object and another is doing processing on the same, will consist of a superimposition of the two robot's accuracy. This means an error, which is less than or equal to the sum of those of the individual robots.

Regarding absolute accuracy, see *Requirements on page 50*.

For very demanding RAPID processing, there may be a slight impact on cycle time, compared to a single robot system.The impact on the cycle time is higher when robots are running in independent mode compared to coordinated mode.

Requirements

- For communication with additional drive units, the hardware option 710-1 is required.
- This option is relevant and required only for systems, when coordination between robots and/or manipulators, controlled from different tasks, is needed. Each RAPID task can control one robot and up to six external axes (positioners without TCP).
- Coordination between robots, controlled from different tasks but working in a common moveable workobject, is only possible within synchronized movement sequences (see instructions below). When working in a stationary workobject, no synchronization is needed, and the option *MultiMove Independent* can be used.
- The accuracy of coordinated motion is obviously depending on the position accuracy of each robot. To achieve the best possible coordination between robots, it is highly recommended to use *Absolute Accuracy* [603-1] on the robots involved.

Limitations

A MultiMove system is to be regarded as *one machine*, in the sense that all robots involved are always in the same state, since there is only one common safety system. MultiMove can thus not be applied for robots in different cells.

When a robot is moved by an additional axis, e.g. a track, the track and the robot must be controlled by the same task. This implies that the same additional axis cannot move multiple robots. There are two exceptions where such a set-up is, after all, possible:

- The robots are working independently and the robots in other tasks than the one controlling the additional axis are not dependent on knowing their position in the world coordinate system.
- All robots moved by the same additional axis are working synchronized all the time (i.e. using `SyncMoveOn` and attaching an `identno` to each `Move` instruction). The only possible exception (outside a `SyncMoveOn/SyncMoveOff` sequence) is using `MoveAbsJ`.

A maximum of two IRB 360 can be used in a MultiMove system.

This option is not available with IRC5C Compact controller.

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RAPID instructions

RAPID instructions included in this option:

Instruction	Description
SyncMoveOn	Activation of synchronized movement sequence for two or more robots and manipulators
SyncMoveOff	Deactivation of synchronized movement sequence
SyncMoveUndo	Deactivation of synchronized movement sequence from any place in the RAPID program

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6.2 MultiMove Independent [604-2]

General

The option *MultiMove Independent* makes a robot system a MultiMove system with independent robots functionality.

A MultiMove system is a system where a common controller controls up to four robots, each equipped with its own drive module. MultiMove system exists in two different modes - Independent and Coordinated.

With *MultiMove Independent*, the robots run independently of each other, i.e. controlled by separate RAPID tasks. It is also possible to run positioners independently (controlled by separate RAPID tasks.)

Features

- Up to four robots in a MultiMove System
- Up to seven simultaneous motion tasks, handing for example four robots, one positioner and two single additional axes
- The robots in the MultiMove system work independently of each other
- MultiMove user interface on FlexPendant
- RobotWare - Multitasking
- RobotWare - Multiple Axis Positioner

Application

Multi robot processing where each robot is working independently, controlled by separate RAPID tasks.

Performance

The motion performance of robots in a MultiMove system is equivalent to that of a single robot system, in terms of speed and acceleration. For very demanding RAPID processing, there may be an impact on cycle time, compared to a single robot system. In some applications where the RAPID processing requirements are high and requirements on the robot performance are also high, for example pick and place with two IRB 360 robots, the cycle time impact can be higher.

Requirements

- For communication with additional drive units, the hardware option 710-1 is required.

Limitations

A MultiMove system is to be regarded as *one machine*, in the sense that all robots involved are always in the same state, since there is only one common safety system. MultiMove can thus not be applied for robots in different cells.

When a robot is moved by an additional axis, e.g. a track, the track and the robot must be controlled by the same task. This implies that the same additional axis

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cannot move multiple robots. There are two exceptions where such a set-up is, after all, possible:

- The robots are working independently and the robots in other tasks than the one controlling the additional axis are not dependent on knowing their position in the world coordinate system.
- All robots moved by the same additional axis are working synchronized all the time (i.e. using `SyncMoveOn` and attaching an `identno` to each `Move` instruction). The only possible exception (outside a `SyncMoveOn/SyncMoveOff` sequence) is using `MoveAbsJ`.

A maximum of two IRB 360 can be used in a MultiMove system.

This option is not available with IRC5C Compact controller.

RAPID instructions

There are no RAPID instructions included in this option.

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6.3 Tracking unit interface [1552-1]

General

The option Tracking unit interface is required to setup conveyor tracking applications using remote Conveyor Tracking units. This option is included in Conveyor Tracking units, option *Conv.Tracking unit Int.* [1550-1] and option *Conv. Tracking unit Ext.* [1551-1].

Features

- Connect to remote Conveyor Tracking units over an Ethernet connection
- RobICI, a high performance communication protocol

Application

Any application where conveyor tracking is used, for example painting, arc welding, picking, and other applications.

Performance

A Conveyor Tracking Module is able to communicate with up to 40 robot controllers in parallel.

Requirements

- A remote Conveyor Tracking unit DSQC2000
- One of the software options that enables conveyor tracking functionality: *Conveyor Tracking* [606-x] or *Prep. for PickMaster 3* [642-1]

RAPID instructions

There are no RAPID instructions included in this option.

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6.4 Conveyor Tracking [606-1]

General

The option *Conveyor Tracking* (also known as line tracking) contains functionality which makes the robot follow a work object on a moving conveyor. While tracking the conveyor, the programmed TCP speed, relative to the work object, will be maintained even when the conveyor speed is changing slowly.

Features

- Linear and circular conveyors
- Up to 4 conveyors simultaneously. Switch between tracking the one or the other
- Up to 254 objects can be organized in an object queue that can be manipulated by RAPID instructions
- Possibility to define a start window in which an object must be before tracking can start
- A maximum tracking distance may be specified
- If the robot is mounted on a parallel track motion, the system can be configured such that the track will follow the conveyor and maintain the relative position to the conveyor.
- Tracking of a conveyor can be activated *on the fly*, that is it is not necessary to stop in a fine point.

Application

Any application where conveyors are used for example painting, arc welding, picking and other applications.

Performance

At 150 mm/s constant conveyor speed, the TCP will stay within 2 mm of the path as seen with no conveyor motion. When the robot is stationary relative to the conveyor, the TCP will remain 0.7 mm of the intended position.

Note

Make sure that the robot is within its dynamic limits with the added conveyor motion and that the conveyor is accurately calibrated.

Requirements

The following hardware components are required for measuring the conveyor position:

- DeviceNet
- Encoder card DSQC 377B or DSQC 2000

See the product specification for the respective robot.

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RAPID instructions

RAPID instructions included in this option:

Instruction	Description
WaitWObj	Connects to a work object in the start window
DropWObj	Disconnects from the current object

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6.5 Indexing Conveyor Control [606-2]

General

The option *Indexing Conveyor Control* offers functionality which makes the robot follow a work object on a fast moving indexing conveyor. An indexing conveyor has a number of equally sized partitions or pockets, where the handled objects are placed. To receive an object in such a pocket requires that the conveyor is momentarily stopped to get the object, and then very quickly moved to receive a new object in the next pocket etc. This kind of fast stopping and moving in specific distances is called *indexing*. While the conveyor is indexing, the robot will be tracking the objects on the conveyor, and the position, relative to the work object, will be maintained even when the conveyor speed is changing during indexing.

Features

- Linear conveyors
- Up to two IRB 360 in a MultiMove setup, working with separate indexing conveyors
- Up to 2 indexing conveyors and up to 2 regular conveyors may be handled simultaneously. Switch between tracking the one or the other.
- Indexing conveyors are controlled by the robot system, i.e. no encoder board is needed.
- Synchronizing of the indexing conveyor with the incoming objects through digital input.
- Up to 100 objects can be organized in an object queue that can be manipulated by RAPID instructions.
- Possibility to define a start window in which an object must be before tracking can start.
- A maximum tracking distance may be specified.
- Tracking of a conveyor can be activated *on the fly*, that is it is not necessary to stop in a fine point.
- Can work independently or in combination with PickMaster 3.

Application

Any application where high speed indexing conveyors are used, for example small parts handling and other applications. Normally, in a box loading application, an in feeder will place the objects on the indexing conveyor with high rate frequency. After that the robot is picking the objects from the indexing conveyor and placing them on an out feeder conveyor.

Performance

In a typical case with box widths of 50 mm, 2 kg robot payload, product feeding frequency of 7.5 Hz and with accelerations/decelerations up to 35 m/s2, the TCP will stay within 2 mm of the path as seen with no conveyor motion.

(Make sure that the robot is within its dynamic limits with the added conveyor motion and that the conveyor is accurately calibrated.)

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Requirements

Since the indexing conveyor is controlled by the robot system, there is no need for an encoder board. However, if also handling parts on a regular conveyor, hardware components for measuring the conveyor position are needed like DeviceNet option and encoder board DSQC 377B. See the product specification for the respective robot.

For the synchronization of the indexing conveyor with the incoming objects, a synchronization pulse shall be provided at a digital input minimum 200 ms in advance (depending on robot pay load).

To ensure accuracy, the conveyor transmission must follow specific rules (see *Application manual - Conveyor tracking*).

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
WaitWObj	Connects to a work object in the start window
DropWObj	Disconnects from the current object
IndCnvInit	Initiation of conveyor
IndCnvEnable	Enabling indexing mode
IndCnvDisable	Disabling indexing mode
IndCnvReset	Resetting indexing mode back to normal mode
IndCnvAddObject	Adding an object to object queue

Limitations

Indexing conveyor control is only available for IRB 360.

Indexing conveyor should be equipped with an ABB motor package or similar, see *Application manual - Additional axes and standalone controller*.

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6.6 Sensor Synchronization [607-1]

General

Sensor Synchronization adjusts the robot speed to an external moving device (for example a press or conveyor) with the help of a sensor. The option can also be used for synchronizing two robots with each other.

This *Sensor Synchronization* option simplifies programming and improves productivity of any loading /unloading application, since it provides automatic sensor status check and speed adjustment.

The robot TCP speed will be adjusted in correlation to the sensor output, so that the robot will reach the programmed robtargets at the same time as the external device reaches the programmed position. The synchronization is started/stopped with a RAPID instruction combined with movement instructions (fine points or corner zones).

Features

- Synchronize robot with sensor: Up to 4 sensors/robot
- On-the-fly activation
- Valid for any type of movement
- RAPID access to sensor and queue data
- Object queue, see *Conveyor Tracking*

Application

- Synchronization of robots and press equipment

Performance

The TCP will stay within +/- 50ms delay of the taught sensor position, for linear sensors and constant sensor speed.

RAPID instructions

RAPID instructions included in this option:

Instruction	Instruction
SyncToSensor	Start/stop synchronization
WaitSensor	Connect to an object in the start window
DropSensor	Disconnect from current object

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6.7 Analog Synchronization [607-2]

General

Analog Synchronization adjusts the robot speed to an external moving device (for example a machine) with the help of an analog linear sensor attached to the moving device. This *Analog Synchronization* option simplifies programming and improves productivity of any loading/unloading application, since it provides automatic sensor status check and speed adjustment.

The robot TCP speed will be adjusted in correlation to the sensor output, so that the robot will reach the programmed robtargets at the same time as the external device reaches the programmed position. The synchronization is started/stopped with a RAPID instruction combined with movement instructions (fine points or corner zones).

Features

- Synchronized move in
- Supervised move out
- On-the-fly activation
- Valid for any type of movement

Application

When *Analog Synchronization* is used, the work flow of robot and machines overlap to save time. With *Analog Synchronization*, at machine opening, as soon as there is enough space for the robot between the machine platens, the sensor triggers the robot to start to move into the machine, synchronized with the moving platen of the machine. Time is saved by the robot’s early entering.

At machine closing, as soon as the part has been gripped, the robot starts to move out of the machine. When the robot has reached the machine closing point on its synchronized path, the machine starts to close. The machine closes safely while the robot moving out. Time is also saved by the machine's early closing. Applicable to injection moulding, die-cast or other machine tending or material handling.

Performance

The TCP will stay within +/- 50ms delay of the taught sensor position, for linear sensors and constant sensor speed.

Requirements

See the product specification for the robot controller:

- Analog linear sensor with analogue signal between 0 and 10 V (for example Balluf)
- Fieldbus coupler to connect the sensor to the IRC5
- Analog I/O card (3rd party DeviceNet solution)
- Optional: *Electronic position switches*

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RAPID instructions

RAPID instructions included in this option:

Instruction	Instruction
SyncToSensor	Start/stop synchronization
WaitSensor	Connect to an object in the start window
DropSensor	Disconnect from current object

Limitations

- 607-1 and 607-2 cannot be combined.

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7 Motion Events

7.1 World Zones [608-1]

General

The *World Zones* option is used to define in which area in space the TCP is operating, or the current joint configuration.

Features

- Set input/output signal, when TCP or joint within or outside zone
- Stop robot when reaching a zone border
- Cubical, Cylindrical, Spherical and Joint zones
- Set I/O when the robot is in home position and configuration
- Automatic activation at start-up or activated/deactivated from RAPID program
- Active in automatic and manual mode
- For a MultiMove system, each robot will have its own world zones, independent of each other

Application

Application	Description
Home position	When the robot is started from a PLC, the PLC will check that the robot is inside the volume of the home configuration. In this way other equipment may move safely in the cell.
Protection of equipment	A zone may enclose other cell equipment, and thus prevent the robot from moving into that area.
Robots working in the same area	Handshaking between robots ensures that only one robot at a time is working within a zone. This functionality also ensures efficiency in these operations, since robots can be put waiting for another robot to finish its work within the zone and immediately enter the zone, when the first is finished.

Performance

For safety reasons, this software function shall not be used for protection of personnel. Use hardware protection equipment.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
WZBoxDef	Define a cubical world zone
WZCylDef	Define a cylindrical world zone
WZLimSup	Activate world zone limit supervision
WZSpDef	Define a spherical world zone

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7.1 World Zones [608-1]
Continued

Instruction	Description
WZDOSet	Activate world zone digital output
WZDisable	Deactivate world zone supervision
WZEnable	Activate world zone supervision
WZFree	Erase world zone supervision
WZHomeJointDef	Define a global zone in joint coordinates
WZLimJointDef	Define a global zone in joint coordinates, for limitation of work area

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8 Motion Functions

8.1 Independent Axis [610-1]

General

The *Independent Axis* option is used to make an external axis (linear or rotating) run independently of the other axes in the robot system.

The option also includes the function *Axis Reset*, which can reset the axis position counter from RAPID. *Axis Reset* is useful for repeated maneuvers, where mechanical reset of the axis (mechanically turning back the axis) would mean loss of cycle time in the process.

Features

- Movement of an axis, independent of the robot motion
- Independent movements, programmed with absolute or relative positions
- Continuous rotational/linear movement of an axis
- Speed regulation of the independent axis
- Reset of Axis position counter (axes 4, 6 and additional (rotating) axes)

Application

Application	Description
Welding: Independent Axis	A robot is working with different stations (additional axes). First, a work object located at station 1 is welded. When this operation is completed, station 1 is moved to a position where it is easy to change the work object and at the same time the robot welds the work object at station 2. Station 1 is moved independently of the robot's movement, which simplifies operator work and reduces the cycle time.
Plasma spraying: Independent Axis	A robot is spraying an object, which is rotated continuously by an additional axis in front of the robot. The speed of the additional axis can be changed during the process for optimal results.
Polishing: Axis Reset	When polishing, a large work area is sometimes needed on the robot axis 6 in order to be able to carry out final polishing without stopping. Assume that the axis has rotated 3 turns, for example. It can now be reset using this function, without having to physically rotate it back again. Obviously this will reduce cycle times.

Performance

The movements will be made with the same performance as additional axes without *Independent Axis*.

Requirements

There are no software or hardware requirements for this option.

Limitations

If an axis has a gear ratio which is not an integer number, fine calibration is required after resetting the revolution counter on the serial measurement board, if a precise axis position is needed in the application.

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Internal and customer cabling and equipment may limit the ability to use independent axis functionality on axis 4 and 6. For information about what capability a specific robot's axis 4/6 has, please contact ABB.

The option is not possible to use together with:

- SafeMove[I]
- IRB 910SC (4-axis SCARA robot)
- Tool change
- World Zones

[I] *Independent Axis* can in some cases be combined with SafeMove2 if the additional axis does not move the robot, and the additional axis is not monitored by SafeMove. Contact your local ABB sales office team for additional information.

Note

The collision detection is deactivated when at least one axis is run in independent joint mode. This is also the case when an external axis that runs in same motion task runs as independent joint.

RAPID instructions

RAPID instructions included in this option:

Instructions	Description
IndCMove	Running an axis continuously
IndDMove	Running an axis independently a specified distance
IndRMove	Running an axis Independently to a position within one revolution, without taking into consideration the number of turns the axis had rotated earlier
IndAMove	Running an axis Independently to an absolute position
IndInpos	Checking whether or not an independent axis has reached the programmed position
IndSpeed	Checking whether or not an independent axis has reached the programmed speed
IndReset	Change an axis to dependent mode and/or reset the working area

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8.2 Path Recovery [611-1]

General

The *Path Recovery* option is used to store all system data, when an interrupt occurs (fault message or other) and restore them after necessary actions have been taken.

Features

- Store path data (all current system information)
- Restore path data (all system information, as was before interrupt/fault)

Application

Application	Description
Service of welding guns	When an error message occurs, the position/path data can be stored and the robot moves automatically to a service area. After service, the robot moves back to the exact same position, including all system data and continues welding.

Performance

There is no specific performance data available for this option.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
StorePath	Stores the path when an interrupt occurs
RestoPath	Restores the path after an interrupt
PathRecStart	Start the path recorder
PathRecStop	Stop the path recorder
PathRecMoveBwd	Move path recorder backwards
PathRecMoveFwd	Move path recorder forward

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8.3 Path Offset [612-1]

General

Path Offset (path corrections) changes the robot path according to the input from a sensor. The robot can thus follow/track a contour, such as an edge or a weld.

The path corrections will take effect immediately when receiving data from the sensor, also during movement between two positions. The path corrections are entered from the RAPID program. *Path Offset* can be made in the path coordinate system.

Features

- Track a robot path at a user set offset
- Read current path offset
- Change path offset in action

Application

Application	Description
Path offset	Mainly used in arc welding, to track a work object at a certain distance. A sensor is used to define the robot input for path correction during motion. The input can be defined via an analog input, a serial channel or similar. Multitasking or interrupts are used to read this information at specific intervals. Based on the input value, the path can then be adjusted

Performance

Minimum offset: 0.1 mm.

Note

The instruction `CorrWrite` is intended with low speed and moderate values of correction. Too aggressive values will be clamped. The correction values should be tested in RobotStudio to confirm the performance.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
CorrCon	Activating path correction
CorrDisCon	Deactivating path correction
CorrRead	Read current path correction
CorrWrite	Changing path correction
CorrClear	Removes all correction generators

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8.4 SoftMove [885-1]

General

SoftMove is a cartesian soft servo option that allows the robot to be compliant or floating in order to adjust to external forces or variations in work objects. *SoftMove* can lower the stiffness of the robot in one or several pre-defined cartesian direction(s) (in relation to either the tool or the work object) while keeping the original behavior in the other directions. The behavior of the softness is controlled by two parameters *Stiffness* and *Damping*. With *SoftMove*, the robot is compliant in the specified direction(s) only which facilitates high accuracy and reliability. The option reduces robot programming time and enables effective interaction between robot and machine, which reduces cycle time.

Features

SoftMove is used to set up softness in one of the following directions:

- one of the Cartesian directions (x, y or z)
- one of the Cartesian planes (xy, xz or yz)
- all directions (xyz)
- the plane xy and rotational around the z axis

Applications

Machine tending of different machines, for example die casting machines, injection moulding machines, machine tools, etc. Extraction of parts from machine

- Insertion of parts into the machine – robot holds or pushes
- Extraction of parts from machine
- Placing/picking a work object in a tool
- Placing a molded or cast part in a fixture
- Tool exchanging on peripheral machines
- Absorbing of shocks and vibrations

Assembly functions

- Framing - a robot holds and presses a part towards the rest of the car body while another process attaches the part to the body
- Simple assembly functions not requiring searching or fitting

Welding

- Hold-and-Weld
- Hotplate welding

Press tending

- Follow movement of press

Polishing/Grinding

- Simple polishing and grinding applications with low process forces not requiring process feedback

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8.4 SoftMove [885-1]
Continued

RAPID instructions

See *Application manual - SoftMove*.

Limitations

Collision Detection is deactivated when *SoftMove* is activated.

Activation and deactivation of *SoftMove* can only be done in fine points.

SoftMove does not work for 4-axis robots, for example IRB 360, IRB 660 and IRB 910SC.

SoftMove does not work together with:

- *MultiMove Coordinated*
- Tracking functionality such as, `CorrWrite`, *Conveyor Tracking*, seam tracking and *WeldGuide*.
- Force control options

`CSSAct` does not activate motion control. A movement instruction is required to activate the motion control.

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9 Motion Supervision

9.1 Collision Detection [613-1]

General

Collision Detection is a software option, which reduces collision impact forces on the robot. In this way, the robot and external equipment can be protected from severe damage.

Features

- Protection of robot and equipment
- Protection from collisions from any direction
- Robot movement stops and the robot moves back, along the programmed path
- Can reduce the collision force to 30%

Application

Abnormal torque levels on any robot axis are detected and will cause the robot to stop quickly and thereafter back off to relieve forces between the robot and environment.

Performance

The sensitivity (with default tuning) is comparable to the mechanical alternative (mechanical clutch) and it is in most cases much better. In addition, *Collision Detection* has the advantages of no added stick-out and weight, no need for connection to the e-stop circuit, no wear, the automatic backing off after collision and, finally, the adjustable tuning.

Tuning is normally not required, but the sensitivity can be changed from RAPID or manually. *Collision Detection* can also be switched off completely for part of a program. This may be necessary when strong process forces are acting on the robot.

Limitation

This option is available for robot types and is never active for external axis (track motions, positioners and any other external axes).

RAPID instructions

RAPID instruction included in this option:

Instruction	Description
MotionSup	Changing the sensitivity of the collision detection or activating/deactivating the function.

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9.2 Collision Avoidance

General

The function Collision Avoidance is included in Collision Detection [613-1] and monitors a detailed geometric model of the robot and other equipment to prevent collisions. By defining additional geometric models present in the robot work envelope Collision Avoidance will ensure that if two geometric models come too close to each other, the controller warns about a predicted collision and stops the robot.

The function is useful for example when setting up and testing programs, or for programs where positions are not static but created from sensors, such as cameras (non-deterministic programs).

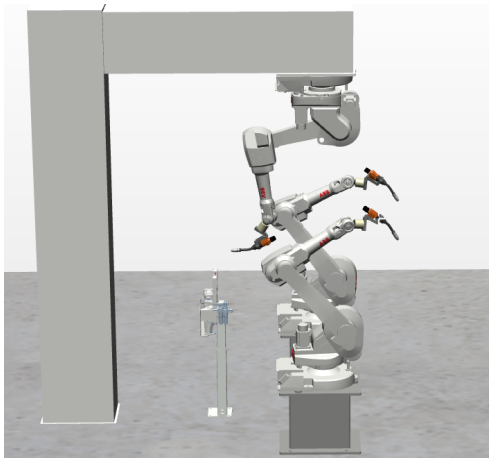
Collision Avoidance is however no guarantee for avoiding collisions since it requires proper modelling of the robot cell.

Note

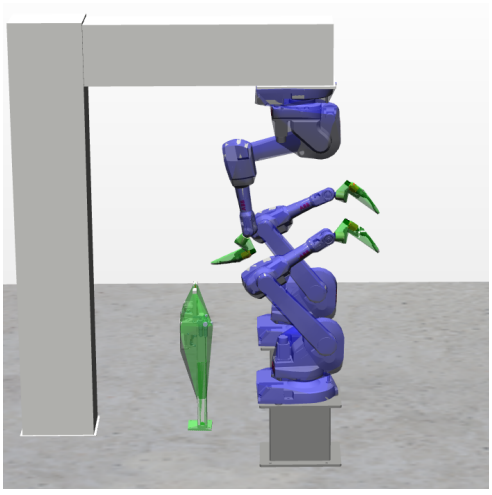
The user must always be careful to avoid collisions with external equipment, since a collision could damage the mechanical structure of the arm.

Features

Besides the robot itself the function will monitor up 10 objects that is created via the configurator in RobotStudio. Typical objects to be monitored are tool mounted on the robot flange, additional equipment mounted on the robot arm (typically axis 3) or static volume around the robot.



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In the above example there are geometric models of the robot arms, the tools mounted on the tool flanges, and the BullsEye equipment on the floor. The second figure illustrates the volumes monitored by Collision Avoidance.

Trigger signals

A non-moving collision object can be configured with a trigger signal. The value of the trigger signal reflects which robots are in contact with the collision object.

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More specifically, the value of a trigger signal should be interpreted as a bit pattern, where bit *k* is high if robot *k* is in contact with the collision object. For example, if the trigger signal has the value 6, which is 110 in binary, it means that ROB_2 and ROB_3 are in contact with the collision object. Trigger signals can be used to implement safe workspace sharing between multiple robots.

A trigger signal can be configured with two timing behaviors: *immediate* or *on-arrival*. If configured with *immediate* behavior, then the trigger signal is changed as quickly as possible, well before the robot has physically reached the position where it comes into contact with the collision object. If configured with *on-arrival* behavior, then the trigger signal changes state when the robot physically reaches the position where it comes in contact with the zone.

Limitations

CAUTION

Collision Avoidance shall not be used for safety of personnel.

- *Collision Avoidance* is a function included in the option *Collision Detection*.
- Paint robots, IRB 6620LX, and delta robots are not supported.
- *Collision Avoidance* cannot be used in manual mode together with responsive jogging. The system parameter *Jog Mode* must be changed to *Standard*.
- Only stationary/non-moving objects can be configured with a trigger signal. A trigger signal must correspond to a group signal. Furthermore, each collision object must have its own trigger signal.
- There is no support for applications that do corrections to the path, such as conveyor tracking, WeldGuide, Force Control, SoftMove, SoftAct etc.
- The *Collision Avoidance* functionality between 2 robots (or more) can only be achieved when using a MultiMove system.

RAPID instructions

RAPID instruction included in this option:

Instruction	Description
IsCollFree	Can be used to check whether a specified jointtarget is collision free or not. Multiple jointtarget can be specified in MultiMove systems.

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10 Communication

10.1 FTP & SFTP Client [614-1]

General

Note

In the specification form, this option is called *FTP, SFTP and NFS client*, since these functions are merged into a common option.

The option makes it possible to read information from a remote computer, directly from the controller.

Once the application protocol is configured, the remote computer can be accessed in the same way as the controller's internal hard disk.

Performance

There is no specific performance data available for this option.

Requirements

The FTP implementation has a limited set of FTP servers supported. The following servers are supported:

- FileZilla
- MS IIS
- Linux Ubuntu

RAPID instructions

There are no RAPID instructions included in this option.

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10.2 NFS Client

General

> **Note**
>
> This option is merged into option 614-1 FTP, SFTP and NFS client.

The option *NFS client* (Network File System) makes it possible to read information from a remote computer, directly from the controller.

Once the application protocol is configured, the remote computer can be accessed in the same way as the controller's internal hard disk.

Performance

There is no specific performance data available for this option.

Requirements

The NFS implementation has a limited set of NFS servers supported. The following servers are supported:

- OmniNFS version 4.3 (Windows XP SP2)
- Distinct, version 3.0 (Windows XP SP2)
- nsf (HP-UX, version 10.20)

RAPID instructions

There are no RAPID instructions included in this option.

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10.3 PC Interface [616-1]

General

Note

This option includes also *Socket Messaging* (see *Socket Messaging on page 83*).

PC Interface provides the communication interface between the robot controller and network connected PCs.

Features

- Manual robot backup to a networking PC (included in RobotStudio)
- OPC Server interface for SCADA integration is included in RobotWare Download package.
- Communication interface for use with ABB Industrial Software Products; WebWare and PC-SDK.
- *RAPID Message Queue* (see description in *RAPID Message Queue on page 101*).

Application

Application	Description
RobotStudio	RobotStudio - offers manual tools for commissioning of robots, including activities like update/booting of the systems software, system parameter update, RAPID programming and recording of the robot log file. With the PC Interface option RobotStudio can connect to a controller over a LAN. If the PC Interface option is missing, RobotStudio only connects through the local service port.
IRC5 OPC Server	IRC5 OPC Server is an OPC interface to the IRC5 controller (according to the OPC standard).
WebWare Server	WebWareTM Server - offers a 24 hours a day solution for automated backup and version control of robot programs as well as local and remote access to production reports and diagnostic information using a standard Internet browser.
PC - SoftWare Developer Kit	PC-SDK, which is included in RobotStudio, allows system integrators and end-users to program their own operator interfaces for the IRC5 robot controller. These custom applications are either added to the general functionality of the FlexPendant using FP-SDK or run as independent PC applications using PC-SDK. The PC Interface option is required to use a custom PC-based application with a robot.

Requirements

Application needs to be developed with the software product: PC-SDK.

RAPID instructions

RAPID instruction included in this option:

Instruction	Description
SCWrite	Sends a message to the network PC

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10.4 IoT Data Gateway [1582-1]

General

The option *IoT Data Gateway* [1582-1] is needed to enable IoT Gateway to communicate with RobotWare.

IoT Gateway is an application that share information from the robot controller with other parts of the process/production unit. The information can be configured according to the OPC UA standard format or MQTT with a customer defined format.

The IoT Gateway application software is deployed/installed on a customer Windows PC or Server, connected to the same network as the robot controller(s) and can access data from multiple robot controllers at the same time (each robot controller is required to have the option *IoT Data Gateway*).

The application software package is available for download at the ABB Developer Center (robotstudio.com), *https://developercenter.robotstudio.com*

In the download package, an Application manual (3HAC078375-001) and video tutorial are available illustrating the configuration and usage of the IoT Gateway.

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10.5 FlexPendant Interface [617-1]

General

FlexPendant Interface provides the possibility to download and run user-developed operator interfaces on the FlexPendant.

Features

- Download and execute operator interfaces on the FlexPendant
- Application specific operator interface visible as a new entry in the ABB-menu of the FlexPendant
- *RAPID Message Queue* (see *Multitasking [623-1] on page 85*)

Application

Application	Description
FlexPendant - Software Developer Kit	FP-SDK, which is included in RobotStudio, allows system integrators and end-users to program their own operator interfaces for the IRC5 robot controller. These custom applications are either added to the general functionality of the FlexPendant using FP-SDK or run as independent PC applications using PC-SDK. The FlexPendant Interface option is required to execute a FlexPendant application on the FlexPendant.

FP-SDK is entirely integrated with Visual Studio 2005. The visual design support of Visual Studio 2005 is used to build the graphical user interface of the FlexPendant application. The functionality targeting the robot controller is developed in the .NET programming languages C# or Visual Basic, which are available in VS 2005. A FlexPendant application can be deployed to a customer as an additional option or added to the HOME directory by the Installation Manager wizard.

Performance

There is no specific performance data available for this option.

Requirements

Application needs to be developed with the software product: FP-SDK.

RAPID instructions

There are no RAPID instructions included in this option.

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10.6 Field bus Command Interface [618-1]

General

> **Note**
>
> This functionality is included in RobotWare-OS.

Field bus Command Interface is an option, which is used when transferring commands or messages other than I/O signals from the controller to/from units connected via the physical DeviceNet.

Features

- Open a DeviceNet unit
- Read from a DeviceNet unit
- Write to a DeviceNet unit
- Close a DeviceNet unit

Application

The option will be used for example when an intelligent control unit for external equipment is connected to the robot controller via the DeviceNet bus.

After such a unit is configured as a device on DeviceNet, it can be handled like other communication devices for example using the RAPID commands `Open\Bin`, `Close`, `ReadRawBytes`, `WriteRawBytes`.

Performance

The *Fieldbuses Command Interface* can handle data blocks of a size of 1024 bytes.

Requirements

This option requires the DeviceNet option and the option *File and Serial Channel Handling*. See *File and Serial Channel Handling on page 24*.

RAPID instructions

RAPID instructions included in this option:

For open and close, the standard `Open` and `Close` instructions shall be used.

Instruction	Description
PackDN Header	Pack the header of a DeviceNet message

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10.7 RobotStudio App Connect [688-1]

General

RobotStudio App Connect provides the possibility to use standard commercially available tablets for commissioning at the shop floor as an alternative to the FlexPendant.

Features

Enables the possibility to interact with the robot controller using RobotStudio Online apps.

Application

RobotStudio Online is a suite of apps for Windows tablets to interact with the IRC5 controller.

The following RobotStudio Online apps are available for free download at the Windows Store:

RobotStudio Online Manage

RobotStudio Online Manage is a tool to manage ABB industrial robots with IRC5 controllers on a network. The network can be partitioned into groups. Status information will be shown either for an individual robot controller or for a group.

Features:

- Show status for one or several robot controllers
- Show event logs with color coded event log messages
- Show the controller data and properties
- Save diagnostics data
- Take a backup
- Locate robot controllers
- Input/Output signal view
- Launch another RobotStudio Online app

RobotStudio Online Adjust

RobotStudio Online Adjust is a tool for calibration and definition of frames for an ABB industrial robot with an IRC5 controller.

Features:

- Base frame definition
- Tool, workobject and payload definition
- Fine calibration
- Revolution counter update
- Execute service routines

RobotStudio Online Jog

RobotStudio Online Jog is a tool for manual positioning (jogging) of the ABB industrial robot with an IRC5 robot controller. The robot can be moved using different settings and directions.

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10.7 RobotStudio App Connect [688-1]
Continued

Features:

- Jog individual axis
- Jog a tool linearly
- Reorient a tool
- Change settings
- Jog supervision
- Align tool to workobject

RobotStudio Online Tune

RobotStudio Online Tune is a tool for shop floor editing of RAPID programs.

Features:

- Start and step through a RAPID program
- Cut, copy and paste RAPID
- Comment and uncomment RAPID lines
- Manipulating program pointer
- Load and unload of RAPID programs and modules

Performance

There is no specific performance data available for this option.

Requirements

- The controller needs to be connected to a wireless network
- To move the robot in manual mode (that is jogging or program execution) the options [976-1] T10 or [983-1] Jokab are required as mandated by safety regulations.

RAPID instructions

There are no RAPID instructions included in this option

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10.8 Socket Messaging

General

The purpose of *Socket Messaging* is to allow a RAPID program to exchange TCP/IP messages over a network, with a C/C++ program on another computer or a RAPID program on another robot controller.

Socket Messaging sends and receives messages over the permanent Ethernet channel of the robot controller (which can simultaneously be used for other network traffic, for example communication with RobotStudio or WebWare Server).

Socket Messaging is a standard supported by for example UNIX and Microsoft Windows.

Features

- Creating and closing of sockets
- Setting up of a communication session
- Sending and receiving data

Application

Sockets can be used for any kind of network communication between computers/controllers. Typical examples are:

- Two robot controllers exchanging interlocking information
- Communication between a robot controller and peripheral devices like sensors, bar code readers or process controllers
- Intertask communication within the same controller

Performance

There is no specific performance data available for this option.

Requirements

There are no hardware or software requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
SocketCreate	Create a new socket and assign it to a `socketdev` variable
SocketClose	Close a socket and release all resources
SocketBind	Bind the socket to a specified port number
SocketListen	Make the computer act as a server and accept incoming connections
SocketConnect	Make a connection request to a remote computer
SocketAccept	Accept an incoming connection request
SocketSend	Send data via a socket connection to a remote computer
SocketReceive	Receive data and store it

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10.8 Socket Messaging
Continued

Instruction	Description
SocketGetStatus	Returns the current state of a `socketdev` variable

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11 Engineering Tools

11.1 Multitasking [623-1]

General

The *Multitasking* option gives the possibility of executing up to 20 programs (tasks) in parallel, including the main program. *Multitasking* can be used to control peripheral equipment or other processes concurrently with robot motion.

Features

- Automatic start at power on
- START/STOP commands for task execution
- Tasks are programmed using standard RAPID instructions
- Priorities can be set between tasks
- All input and output signals and the file system are accessible for each task
- *RAPID Message Queue*

Application

Application	Description
Supervision	A task can be used to continuously monitor certain signals even when the main program has stopped, thus taking over the job traditionally allocated to a PLC.
Operator dialogue	An operator dialogue might be required at the same time as the robot is performing, for example welding. By putting this operator dialogue into a parallel task, the operator can specify input data for the next work cycle without having to stop the robot.
Control of external equipment	The robot can control a piece of external equipment in parallel with the normal program execution.

Performance

It is possible to configure if the task shall react on START/STOP requests or if it shall start automatically. In the later case it will not stop at emergency stops, which can be useful for some applications.

Note

The response time of *Multitasking* does not match that of a PLC. *Multitasking* is primary intended for less demanding tasks.

The normal response time is 5-120 ms. The longer time is for cases when heavy calculation of movement is performed.

Requirements

There are no software or hardware requirements for this option.

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RAPID instructions

RAPID instructions included in this option:

Instruction	Description
WaitSyncTask	Synchronize several program tasks at a special point in each program.

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11.2 Continuous Application Platform [624-1]

General

Continuous Application Platform (CAP) is a software platform for time critical application, where a continuous process, for example arc welding, must be synchronized with the TCP movement of the robot.

Target users are advanced application software engineers and system integrators, for example for arc welding, laser welding, or laser cutting. The main advantages are achieved in the following areas:

- Development time
- Program execution time
- Similar look and feel for application
- Stable software kernel (RobotWare)

Features

- Special RAPID instructions and data types
- A single instruction for motion and process control
- Supports encapsulation of the process and motion in RAPID wrappers provided to the end-user
- Flying start/Flying end support

Application

Creation of advanced application software with a continuous process to be synchronized with robot movement, for example arc welding, laser cutting, or laser welding.

Performance

Part of the RobotWare kernel and RAPID instructions: CAP is designed to support fast and quality secured continuous application demands. The application developer defines the degree of ease-of-use by hiding process complexity from the end-user.

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

See *Application manual - Continuous Application Platform*

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11.3 Optical Tracking [813-1]

General

The option *Optical Tracking* is identical to the option *Optical Tracking Arc [660-1]*, except for that it is integrated with the CAP movement instructions instead of with the arc welding movements.

This means that *Optical Tracking* can be used together with customized process instructions, which are using the CAP option, see *Continuous Application Platform [624-1] on page 87*.

For further description, see *Optical Tracking Arc [660-1] on page 150*.

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11.4 Tracking Interface [1553-1]

General

The new *Tracking Interface* option makes it possible for a customer to use external equipment as source of robot path corrections. The interface is easy to access: either by using analog input or output signals, or simply RAPID persistent data to provide corrections. The interface is set up simply using a RAPID instruction. The new *Tracking Interface* can be used together with both CAP and RW Arc.

Some areas of use are e.g. height control for Plasma welding or TIP TIG welding.

Features

CapAPTrSetupAI is used to setup an At-Point-Tracker controlled by analog input signals.

CapAPTrSetupAO is used to setup an At-Point-Tracker controlled by analog output signals.

CapAPTrSetupPERS is used to setup an At-Point-Tracker controlled by persistent variables.

Requirements

Arc [633-4] or CAP [624-1]

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11.5 Discrete Application Platform [625-1]

General

Discrete Application Platform (DAP) is a software platform for time critical application, where certain actions shall be performed at specific robot positions.

Target users are advanced application software engineers and system integrators, for example for spot welding, drilling, measuring, quality control. The main advantages are achieved in the following areas:

- Development time
- Program execution time
- RAPID program memory needed
- Similar look and feel between application
- Tested kernel software

Features

- Specialized RAPID instructions and data types
- A single instruction for motion and process execution
- Combination of fine point positioning with execution of up to 4 parallel processes
- Specialized process for monitoring of external process devices, like spot welding controllers
- Supports encapsulation of the process and motion, in shell-routines provided to the end-user

Application

Creation of software for advanced application with a discrete behavior, such as spot welding, drilling, measuring, quality control.

Performance

The DAP platform is designed to have an internal kernel, administrating the fast and quality secured process sequence skeleton. The kernel calls RAPID routines, which are prepared by the application developer to fulfill the specific tasks. The application developer regulates the degree of flexibility of the end-user.

Requirements

In order to use DAP, the option *MultiTasking* needs to be installed.

RAPID instructions

Application manual - Discrete Application Platform

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11.6 Sensor Interface [628-1]

General

The *Sensor Interface* option can be used to integrate sensor equipment for adaptive control, like path correction or process tuning. For communication between the sensor and the robot controller two different communication links are available: serial link (RS 232) and Ethernet.

If the RS232 link is used, the sensors have to be adapted to the ABB standard application protocol, LTAPP. Sensors that are adapted to LTAPP are available from companies like Servo Robot, Meta and Scout.

The Ethernet link is available for optical sensors from ServoRobot, which use the application protocol Robo-Com Light, defined by ServoRobot.

The communication link makes it easy to exchange data between the robot controller and the sensor system, using predefined numbers for different data like x,y,z offset values, gap between sheets, time stamp etc.

If the Ethernet link, available for optical sensors from ServoRobot, is installed and configured, then the application protocol Robo-Com Light, defined by ServoRobot, will be used (see *Optical Tracking Arc [660-1] on page 150*).

Features

- Interrupt routines, based on sensor data changes
- Read/write sensor data from/to sensors using RAPID functions
- Store/retrieve sensor data as a block to/from a mass memory
- Seam tracking functionality, when combined with option *Path Offset [612-1]*
- Easy calibration with dedicated FlexPendant interface

Application

Sensor Interface can be used in any application to read/control a sensor during execution, and to react on changes in certain data, like path offset or process supervisory data, thus making adaptive seam tracking and process control possible.

Performance

There is no specific performance data available for this option.

Requirements

External sensors, communicating with the robot controller via serial link, using application protocol LTAPP, or Ethernet, using Robo-Com Light protocol.

For calibration, the hardware option calibration plate [1250-1] is required.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
IVarValue	Used to order and enable an interrupt when the value of a variable accessed via the serial sensor interface has been changed

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11.6 Sensor Interface [628-1]
Continued

Instruction	Description
ReadBlock	Used to read a block of data from a device connected to the serial sensor interface
ReadVar	Used to read a variable from a device connected to the serial sensor interface
WriteBlock	Used to write a block of data to a device connected to the serial sensor interface
WriteVar	Used to write a variable to a device connected to the serial sensor interface

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11.7 Robot Reference Interface

General

Note

Robot Reference Interface is included in the RobotWare option *Externally Guided Motion*, see *Externally Guided Motion [689-1] on page 95*.

Robot Reference Interface (RRI) is an option which enables high performance data exchange between the robot controller and an external device using Ethernet link with Internet Protocol (IP). The supported data exchange provides the possibility to periodically send planned and actual robot position data as well as the exchange of other RAPID variables.

Features

The message contents are represented in XML format and are configurable using appropriate configuration files.

Data distributed from controller to external device

- Planned robot position (Cartesian TCP or Joint values with time stamp)
- Actual robot position (feedback from drives)
- Additional application data, which can be any RAPID data or operation mode status
- Data obtained from external device to controller
- Application data

Application

This option can be used for a number of different applications where accurate information about planned and actual robot position are essential. Some examples:

- High precision measuring devices, mounted on the robot, where the relevance of the collected data is based on a real time knowledge of the actual position of the robot.
- Remote laser welding, where a laser equipment with moveable laser head is held by and moved by the robot. Such an equipment can then superimpose a complex pattern over the robot movements, based on accurate robot position information.

Performance

The cyclic communication channel can be executed in the high-priority network environment of the IRC5 Controller which ensures a stable data exchange up to 250Hz.

Requirements

External devices communicating with the controller via Ethernet link, using TCP/IP.

Specific application protocol (CDP – Cyclic Data Protocol) used.

Continues on next page

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Limitations

- No support for external axis positions
- No support for MultiMove
- No support for *Absolute Accuracy*

RAPID instructions

Instruction	Description
SiConnect	Establishes connection to the specified device (sensor sens)
SiSetCyclic	Initializes sending of any data at the specified rate Installs hooks in the Motion domain (sensor sens, anytype data, num rate)
SiGetCyclic	Initializes receiving of any type data at the specified rate (sensor sens, anytype data, num rate)
SiClose	Close connection to the specified device. Removes installed hooks in Motion domain. (sensor sens)

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11.8 Externally Guided Motion [689-1]

General

Externally Guided Motion (EGM) offers three different features:

- EGM Position Stream is available for UdpUc communication only. It provides the possibility to periodically send planned and actual mechanical unit (e.g. robot, positioner, track motion …) position data from the robot controller. The message contents is specified by the Google Protobuf definition file egm.proto. The cyclic communication channel (UDP) can be executed in the high-priority network environment of the IRC5 Controller which ensures a stable data exchange up to 250 Hz.
- EGM Position Guidance is designed for advanced users and provides a low level interface to the robot controller, by by-passing the path planning that can be used when high responsiveness to robot movements are needed. EGM can be used to read positions from and write positions to the motion system at a high rate, every 4 ms with a control lag of 10–20 ms depending on the robot type. The references can either be specified using joint values or a pose. The pose can be defined in any work object for robots.

  EGM Position Guidance can be combined with Logical settings (setting I/O:s etc.) or enabling other control modes e.g. using Force Control assembly instructions. This can be achieved by using optional argument to not wait for EGM convergence (\NoWaitCond).
- EGM Path Correction gives the user the possibility to correct a programmed robot path. The device or sensor that is used to measure the actual path has to be mounted on the tool flange of the robot and it must be possible to calibrate the sensor frame.

  The corrections are performed in the path coordinate system, which gets its x-axis from the tangent of the path, the y-axis is the cross product of the path tangent, and the z-direction of the active tool frame and the z-axis is the cross product of x-axis and y-axis.

  EGM Path correction has to start and end in a fine point. The sensor measurements can be provided at multiples of about 48 ms.

Features

The RobotWare option *Externally Guided Motion* gives you access to:

- Instructions to start and stop EGM Position Stream.
- Instructions to set up, activate, and reset EGM Position Guidance.
- Instructions to set up, activate, and reset EGM Path Correction.
- Instructions to initiate EGM Position Guidance movements, synchronized with RAPID execution or not, and to stop them.
- Instructions to perform EGM Path Correction movements.
- A function to retrieve the current EGM state.
- System parameters to configure EGM and set default values.
- Support of *Absolute Accuracy*.

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- Including Robot Reference Interface (RRI).

Application

The purpose of EGM Position Stream is to provide external equipment with the current and planned positions of mechanical units that are controlled by the robot controller.

Some example of applications are:

- Laser Welding, where the Laser head is controlling the Laser beam dynamically.
- Any robot mounted equipment that controls the "robot"-TCP with an external controller.

The purpose of EGM Position Guidance is to use external devices to generate position data for one or several robots. The robots will be moved to that given position.

Some examples of applications are:

- Place an object (e.g. car door or window) at a location (e.g. car body) that was given by an external sensor.
- Bin picking. Pick objects from a bin using an external sensor to identify the object and its position.

The purpose of EGM Path Correction is to use external robot mounted devices to generate path correction data for one or several robots. The robots will be moved along the corrected path, which is the programmed path with added measured corrections.

Some examples of applications are:

- Seam tracking.
- Tracking of objects moving near a known path.

Performance

EGM Position Stream can be used to read positions from and write positions to the motion system at a high rate, every 4 ms

EGM Position Guidance can be used to read positions from and write positions to the motion system at a high rate, every 4 ms with a control lag of 10–20 ms depending on the robot type.

EGM Path Correction can handle sensor measurements at a rate of about 48 ms.

Requirements

External devices communicating with the controller via Analog Signals, Group signals or an Ethernet link (UDP). For the Ethernet link, the application protocol (UdpUc – UDP UniCast) is used.

Limitations

EGM does not support coordinated MultiMove.

Limitations for EGM Position Stream

- EGM Position Stream is available with UdpUc communication only.

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- Tool data and load data cannot be changed dynamically during an active position stream.
- It is not possible to stream positions of coordinated MultiMove systems.
- Absolute Accuracy is not supported if streaming is started using `EGMStreamStart`, but it is supported if it started using `EGMActXXX\StreamStart`.
- EGM Position Stream is not compatible with EGM Path Correction.
- It is not allowed to activate or deactivate mechanical units if EGM Position Stream is active.

Limitations for EGM Position Guidance

- Has to start and to end in a fine point.
- The first movement that is performed after a controller restart cannot be an EGM movement.
- Pose mode supports 6-axis robots, 4-axis palletizer robots, YuMi robots, and SCARA robots.
- It is not possible to perform linear movements using EGM Position Guidance, since EGM Position Guidance does not contain interpolator functionality. The actual path of the robot will depend on the robot configuration, the start position, and the generated position data.
- EGM Position Guidance does not support MultiMove coordinated.
- There is a limitation of one mechanical unit per motion task.
- It is not possible to use EGM Position Guidance to guide a mechanical unit in a moving work object.
- If the robot ends up near a singularity, i.e. when two robot axes are nearly parallel, the robot movement will be stopped with an error message. In that situation the only way is to jog the robot out of the singularity.
- When EGM is active, Motion Supervision can behave differently than during normal movements. The recommended action after a collision is to disable EGM and start the EGM sequence from the beginning.

Limitations for EGM Path Correction

- Supports only 6-axis robots.
- Has to start and to end in a fine point.
- The external device has to be robot mounted.
- Corrections can only be applied in the path coordinate system.
- Only position correction in y and z can be performed. It is not possible to perform orientation corrections, nor corrections in x (which is the path direction/tangent).
- When EGM is active, Motion Supervision can behave differently than during normal movements. The recommended action after a collision is to disable EGM and start the EGM sequence from the beginning.

Limitation for RRI

- Only supports 6- and 4-axis robots in the first RAPID task (T_ROB1).

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RAPID instructions

For information about the included RAPID instructions, functions, and data types see *3HAC073319-001*.

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11.9 MultiFunction [824-1]

General

MultiFunction provides a discount package of a number of popular RobotWare options.

Features

- 608-1 World Zones
- 611-1 Path Recovery
- 617-1 FlexPendant Interface
- 623-1 Multitasking

Requirements

There are no software or hardware requirements for this option.

RAPID instructions

See the respective options listed above.

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11.10 Production Screen [637-1]

General

Production Screen is a user-friendly HMI that upgrades your FlexPendant to a graphical user-interface. The software is based on widgets or graphical elements that are used to execute features of your choosing. You can create widgets or choose them from a wide selection of downloads in the add-in section in RobotStudio.

With *Production Screen* you can use several widgets at once just by toggling between them. In the portal's working area, you can add widgets that control applications like arc welding, spot welding and dispensing. The variety of widget content is endless, including features for control, monitoring and notification.

Features

- Application-independent FlexPendant portal, launches apps and displays widgets.
- Window handling, new navigation feature.
- Operator information available in an easy, accessible way.
- Seamless integration of Spot, Arc, Dispense, Production Manager, and other applications.
- Possible to customize the appearance on-screen.
- Possible to create widgets using ScreenMaker or Visual Studio.

Application

Production Screen can be used in all applications to upgrade the FlexPendant to a graphical user-interface.

Performance

There is no specific performance data available for this option.

Requirements

- A FlexPendant of type SxTPU3.
- ScreenMaker in RobotStudio.

Limitations

Production Screen is only used to launch applications. A separate tool like Screen Maker is required to create the applications.

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11.11 RAPID Message Queue

General

RAPID Message Queue is included in the following options:

- *Multitasking*
- *PC Interface*

The purpose of *RAPID Message Queue* is to communicate with another RAPID task or an external client. Some examples of application:

- Sending data between two RAPID tasks executing on the same controller.
- Sending data between a RAPID task and a PC application executing on a PC connected to the robot controller via Ethernet.

Features

- Configuration of communication channels and message queues using DIPC (Distributed Inter-Process Communication) techniques for distributed program executing
- Sending and receiving messages with specific RAPID commands for synchronous and asynchronous communication
- Interrupt controlled message handling

Applications

RAPID Message Queue can be used for any kind of application software running on a PC. It will facilitate communication based on specific RAPID instructions for easy programming and fast response based on interrupt hand-ling. Typical examples are:

- Fast and easy communication with peripheral devices like sensors, bar code readers and process controllers
- Efficient inter task communication within the same controller

Performance

No performance data available.

Requirements

No specific requirements for this option.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
RMQFindSlot	Find the identity number of a RAPID task or an external client
RMQSendMessage	Send data to the queue of a RAPID task or an external client
RMQGetMessage	Get the first message from the RAPID Message Queue
RMQSendWait	Send a message and wait for the answer
RMQGetMsgHeader	Extract header information from a message

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11.11 RAPID Message Queue
Continued

Instruction	Description
RMQGetMsgData	Extract data from a message
IRMQMessage	Order and enable interrupts for a specific data type
RMQReadWait	Wait for the first message from the RAPID Message Queue and return this
RMQResetQueue	Empty the RAPID Message Queue

Function	Description
RMQGetSlotName	Get the name of a RMQ client from the identity number of the client

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11.12 Production Framework [1243-1]

General

Production Framework is a customizable modular platform for order based external control of an ABB robot system.

It shares some features with the older product *Production Manager* but is generally more focused on providing a flexible and customizable platform rather than a provided-as-is fixed solution.

The main purpose of the framework is to handle orders from an external source, typically a PLC in charge of managing the various equipment in the cell. These orders are then executed by the framework by running user-specified RAPID routines.

Features

- Safely transferring orders from the TRAP execution level to normal execution level
- A state-based production loop
- Events, which can be used by the programmer to run code at various times in the production loop, or when certain system events occur
- Multi-tasking and MultiMove abstraction layer for easier (compared to using the basic RAPID API) synchronization of orders and events that are running on several RAPID tasks
- Aborting orders
- Enqueueing orders
- Customizable order constraints
- General logging
- Traceability
- Running independently on any RAPID task, including background tasks
- Flexible architecture with customizable features

Add-In distributed

This option requires an Add-In (Production Framework), available through the RobotStudio Add-In repository.

Requirements

- Multitasking [623-1]
- Production Screen [637-1] is required if selecting graphical user interface in *Production Framework* (recommended)

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12 Motor Control

12.1 Tool Control [1180-1]

General

Tool Control can be used to control a servo tool, for example in servo driven grippers or spot welding applications. *Tool Control* makes it possible to close the tool to a specific plate or part thickness and force, and maintain the force during the process until the tool is requested to be opened.

Target users are advanced system integrators who want to develop customer specific application software based on servo motors, such as spot welding packages and advanced grippers.

Features

- Position control (gap)
- Force control
- Force can be applied in both inward and outward direction
- Quick Start code package
- Tool can be configured to be kept closed at stop to avoid dropping gripped pieces or to open to avoid jamming

Performance

The tool is configured as an external axis, which ensures optimal performance, regarding path following and speed.

The option *Tool Change* can be added to the system in order to allow a switch between two or more servo tools which will then utilize the same drive unit and measurement board.

Requirements

A specific servo tool parameter file must be installed in the controller for each servo tool. The parameters need to be tuned and optimized for each system, regarding system behavior and motion/process performance.

For information on drive module & measurement board see *Application manual - Additional axes and standalone controller*.

Limitations

- *Tool Control* can only be applied to one robot in a MultiMove configuration.

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
STClose	Close a servo tool with a predefined force an thickness
STOpen	Open a servo tool
STCalib	Calibrate a servo tool

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12.1 Tool Control [1180-1]
Continued

Instruction	Description
STTune	Tune motion parameters for a servo tool
STTuneReset	Reset tuned motion parameters
STIsClosed	Test if a servo tool is closed
STIsOpen	Test if a servo tool is open
STCalcTorque	Calculate the motor torque for a servo tool
STCalcForce	Calculate the programmable force for a servo tool

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12.2 Servo Tool Change [630-1]

General

Servo Tool Change enables an on-line change of tools (external axes), for a certain drive- and measurement system. The control is switched between the axes by switching the motor cables from one servomotor to another. The switch is performed on-line during production.

Main advantages:

- Flexibility in the production process. One robot handles several tools.
- Minimized equipment. A single drive-measurement system shared by many tools.

Features

- On-line change of tools
- Up to 8 different tools

Application

Application	Description
Servo gun changing	Robot held servo guns, designed for different reach and weld forces, equipped with different brands and sizes of servo motors, may be held and operated by a robot, switching from one servo gun to another.
Servo Tool Change	Can be used as an independent option, or as an addition to the RobotWare Spot Servo options.

Performance

When switching tools, the following steps are performed (switching from Axis 1 to Axis 2):

- Axis 1 is deactivated using the RAPID instruction `DeactUnit`
- Axis 1 is disconnected from the motor cables
- Axis 2 is connected to the motor cables
- Axis 2 is activated using RAPID instruction `ActUnit`
- After activation, axis 2 is ready to run

The motor position at the moment of deactivation of one axis is saved and restored next time the axis is activated.

Note

The motor position must not change more than half a motor revolution, when the axis is disconnected. In RobotWare Spot Servo, there is a calibration routine, which handles larger position changes.

Requirements

Servo Tool Change requires a mechanical wrist interface, a tool changer.

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A MOC service parameter, *Disconnect deactive* (type *Measurement channel*), must be defined as *YES* for each tool (external axis) used with this function.

Limitations

- *Servo Tool Change* can only be applied to one robot in a MultiMove configuration
- *Servo Tool Change* can be used up to 8 different tools but is limited by 14 axes in total for the drive module. For example, if the robot is on a track motion or if another additional axis is connected to a drive module it reduces the number of allowed tools that can be used with servo disconnect.

RAPID instructions

There are no RAPID instructions included in this option.

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13 Vision

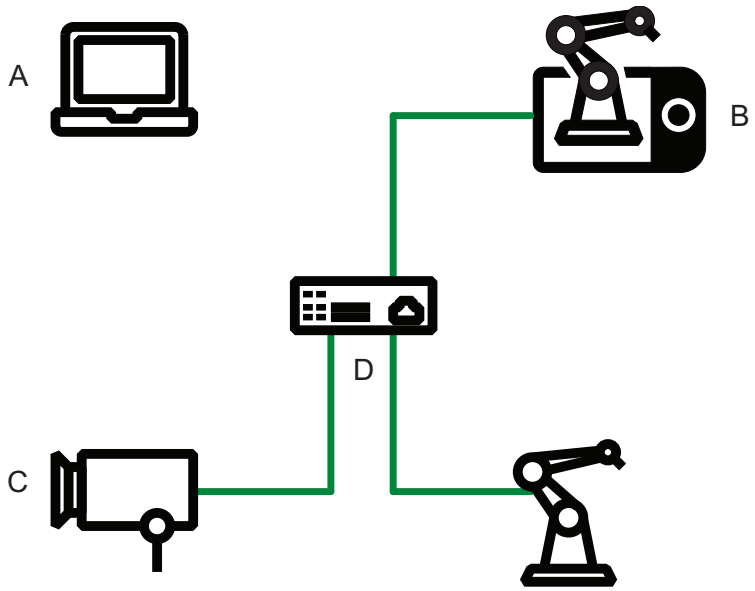
13.1 Integrated Vision

General

The purpose of ABB's Integrated Vision system is to provide a robust and easy-to-use vision system for general purpose Vision Guided Robotics (VGR) applications.

The system includes a complete software and hardware solution that is fully integrated with the ABB robot controller and the RobotStudio programming environment. The vision capability is based on the Cognex In-Sight® smart camera family, with embedded image processing and an Ethernet communication interface.

RobotStudio is equipped with a vision programming environment that exposes the full palette of Cognex EasyBuilder® functionality with robust tools for 2D part location, part inspection, and identification. The RAPID programming language is extended with dedicated instructions and error tracing for camera operation and vision guidance.



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Position	Description
A	PC (configuration from RobotStudio)
B	FlexPendant (monitoring and simple maintenance)
C	ABB Smart camera
D	IRC5 (connect up to 3 cameras)

Additional information

For more information about the option *Integrated Vision*, see *Product specification - Integrated Vision*.

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13.2 Prepared for FlexLoader Vision [1554-1]

General

The option Prepared for FlexLoader Vision enables the use of the PC-based FlexLoader Vision function package with one IRC5 controller.

The option is used as licensing mechanism for the application software. The FlexLoader function packages themselves are ordered separately, typically from the application center for machine tool tending or your local ABB sales contact.

For further information see product specification FlexLoader Vision (3HAC064614-001).

Features

- PC-based architecture, scalable up to 4 cameras
- Pre-pick collision avoidance
- Supports user-defined grippers
- Out of reach prevention
- Choice of moving and rolling part avoidance
- User defined parameter to robot or external PLC
- Supports both 2D and 3D sensors
- Simple and intuitive user interface designed for machine tool tending
- Handles an unlimited number of components without mechanical fixtures
- Teach-in time of new workpieces is less than 10 minutes
- Faster changeover time between components
- Parameterized teach-in interface for lathe applications provides a quick and easy user experience
- Pre-programmed robot code provides short installation time
- Single point of operating control

Application

FlexLoader Vision is a robot guiding vision system for machine tool tending applications. It identifies the workpiece location and orientation from the picking area and guides the robot with precision in the robot cell. It allows a complete teach-in that is very simple and intuitive from beginning to end. It is well-proven with high speed, short teach-in times and reliable production in a user friendly way.

The FlexLoader Vision can be used for both 2D and semi-oriented 3D applications. The system reverts complex 3D images to well-known 2D images in order to increase the usability for the operator. No CAD files are required to teach-in new components.

FlexLoader Vision is part of most function packages in the FlexLoader product family, offering a wide range of machine tool tending solutions.

Performance

See product specification FlexLoader Vision (3HAC064614-001).

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Requirements

Required RobotWare options

- PC Interface [616-1]
- World Zones [608-1]
- FlexPendant Interface [617-1]
- Multitasking [623-1]

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13.3 High Speed Alignment [1586-1]

General

High Speed Alignment (Visual Servoing) is a PC-based software which allows to increase the robot accuracy for high precision assembly and alignment applications.

Visual servoing involves the use of one or more cameras and a computer vision system to control the position of the robot's end-effector relative to the workpiece as required by the task.

Features

- Enabling 6-axis robots for high precision assembly
- Improved alignment speed compared to traditional look-then-move approach.
- Reduced variance of alignment speed compared to look-then-move approach.
- Easy commissioning with auto calibration and tuning for servoing purpose.
- Compatible with a wide number of vision sensors.

Application

Assembly for high accuracy needed applications, especially in Electronics.

- Assembly applications
- Alignment of components
- Picking/placing a work object in a tool
- Placing a part in a fixture

Requirements

The option *High Speed Alignment* requires option *EGM [689-1]* and *PC Interface [616-1*].

Limitations

High Accuracy assembly only verified for IRB 120.

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14 Application options

14.1 MultiProcess [634-1]

General

MultiProcess is used for applying *RobotWare Arc* or *RobotWare Dispense* or *RobotWare Spot* (max two robots) to multiple robots in a MultiMove system.

Features

MultiProcess enables process capabilities on any number of robots. The setup of which robot(s) that should have capabilities is done in the *Additional MultiMove selections* part of the specification form. It can also be carried out at the final installation in RobotStudio.

Requirements

Option 633-4 Arc 6 or 641-1 Dispense or 635-6 Spot 6 must be specified, as well as any of the options:

- 604-1 MultiMove Coordinated or
- 604-2 MultiMove Independent

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14.2 Arc 6 [633-4]

General

RobotWare Arc comprises a large number of dedicated arc welding functions, which make the robot well suited for arc welding.

RobotWare Arc is a simple yet powerful option since both the positioning of the robot and the process control and monitoring are handled in one and the same instruction. I/O signals, timing sequences and weld error actions can be easily configured to meet the requirements of a specific installation.

Features

- Adaptation to different equipment. The robot can handle different types of weld controllers and other welding equipment. Normally communication with the welding controller uses parallel signals but a serial interface is also available.
- Advanced process control. Voltage, wire feed rate, and other process data can be controlled individually for each weld or part of a weld. The process data can be changed at the start and finish of a welding process in such a way that the best process result is achieved.
- Testing the program. When testing a program, welding, weaving or weld guiding can all be blocked. This provides a way of testing the robot program without having the welding equipment connected.
- Automatic weld retry. A function that can be configured to order one or more automatic weld retries after a process fault.
- Weaving[I]. The robot can implement a number of different weaving patterns up to 10 Hz depending on robot type. These can be used to fill the weld properly and in the best possible way. Weaving movement can also be ordered at the start of the weld in order to facilitate the initial striking of the arc.
- Wire burn back and rollback. These are functions used to prevent the welding wire sticking to the work object.
- Fine adjustment during program execution. The welding speed, wire feed rate, voltage and weaving can all be adjusted whilst welding is in progress. This makes trimming of the process much easier because the result can be seen immediately on the current weld. This can be done in both manual and automatic mode.
- RobotWare Arc can be applied to several robots in a MultiMove system (requires option *MultiProcess*).
- Seam Displacement allows the operator to shift seams in relation to a reference frame. The displacement are applied via FlexPendant operators screens without stopping production.
- Weld error recovery. During robot production process errors sometimes arise causing the robot to stop. The Weld Error Recovery feature provides several different solutions for process error recovery, which allows operators through dialogs to automatically move the robot out of the error location to a service

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position. The dialogs, normally presented on the FlexPendant, may also be acknowledged from remote sources like PLC or host computer. After the process error is corrected the robot automatically returns back to the error location and continues production. This will help minimizing production downtime.

- Configurable units. Possibility to choose your own set of units for wire feed, length and velocity.
- *Weld Data Monitoring* is used to supervise the welding parameters and to synchronize the collected data to the actual weld, and welded part.

I Not available for IRB 1410.

Interface signals digital outputs

The following process signals are, if installed, handled automatically by RobotWare Arc. The robot can also support dedicated signals for workpiece manipulators and sensors.

Process signals/Digital outputs	Description
Power on/off	Turns weld on or off
Gas on/off	Turns gas on or off
Wire feed on/off	Turns wire feed on or off
Wire feed direction	Feeds wire forward/backward
Weld error	Weld error
Error information	Digital outputs for error identification
Weld program number	Parallel port for selection of program number, or 3-bit pulse port for selection of program number, or Serial CAN/Devicenet communication

Interface signals digital inputs

Process signals/Digital inputs	Description
Arc OK	Arc established; starts weld motion
Voltage OK	Weld voltage supervision
Current OK	Weld current supervision
Water OK	Water supply supervision
Gas OK	Gas supply supervision
Wire feed OK	Wire supply supervision
Manual wire feed	Manual command for wire feed
Weld inhibit	Blocks the welding process
Weave inhibit	Blocks the weaving process
Stop process	Stops/inhibits execution of arc welding instructions
Wire stick error	Wire stick supervision
Supervision inhibit	Program execution without supervision
Torch collision	Torch collision supervision

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14.2 Arc 6 [633-4]
Continued

Interface signals group outputs

Group outputs	Description
Schedule Port	Weld schedule sent to power source
Mode Port	Weld mode sent to power source

Interface signals analog outputs

Analog outputs	Description
Voltage	Weld voltage
Wire feed	Velocity of wire feed
Current	Weld current

Interface signals analog inputs

Analog inputs (cont.)	Description (cont.)
Voltage	Weld voltage measurement for monitoring and supervision
Current	Weld current measurement for monitoring and supervision

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
ArcLStart	Arc welding start with linear movement
ArcL	Arc welding with linear movement
ArcLEnd	Arc welding end with linear movement
ArcCStart	Arc welding start with circular movement
ArcC	Arc welding with circular movement
ArcCEnd	Arc welding end with circular movement
ArcKill	Aborts the process and is intended to be used in error handler
ArcRefresh	Updates the weld references to new value

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14.2.1 Included Power Source functions

14.2.1.1 AristoMig integrated

General

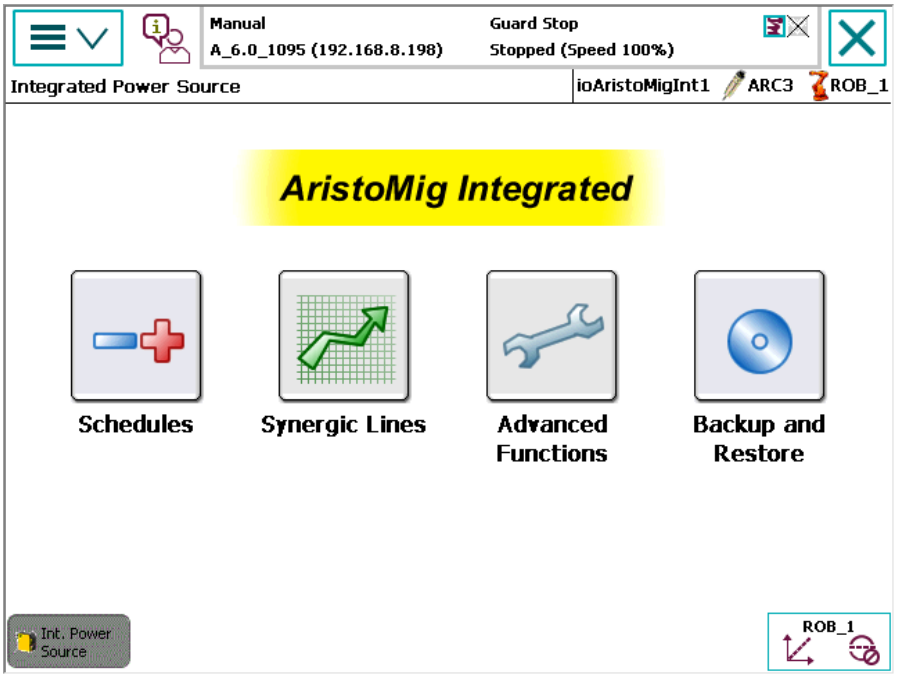
The option *AristoMig integrated* is a user interface for programming one or more Esab AristoMig with a W8 ABB interface.

Features

The *AristoMig integrated* option has the following functionality:

- Create and edit schedules.
- Create user defined synergic lines.
- Reading service information and executing service functions.
- Backup and restore of SID files.

Application



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14.2.1.2 ABB RPC S Integrated

General

The option *ABB RPC S Integrated* is a software option for managing the RPC S 400 Power source.

Features

The *ABB RPC S Integrated* option has the following functionality:

- Create and edit schedules.
- Monitoring of current and voltage.
- Backup and restore of schedules in the RPC S 400 Power source.

Requirements

The following RobotWare options are required for the *ABB RPC S Integrated* option:

- *Arc*
- *Standard I/O welder*

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14.2.1.3 Fronius TPS Integrated

General

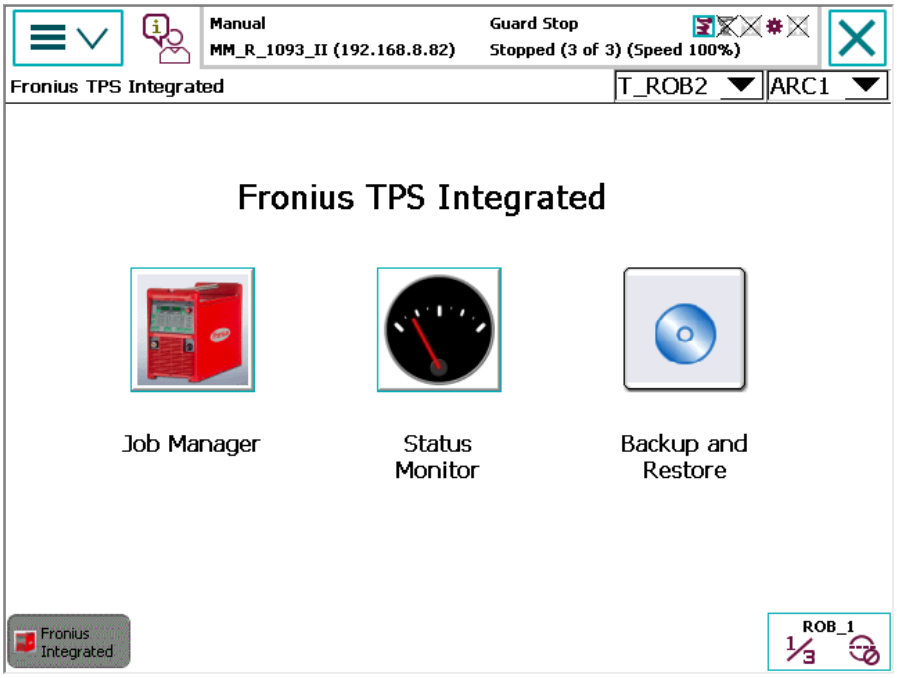
The option *Fronius TPS Integrated* is a programming and administrative interface for Fronius power sources on the FlexPendant.

Features

The *Fronius TPS Integrated* option has the following functionality:

- Administrate power source jobs.
- Monitor power source runtime information.
- Backup and restore of jobs defined in the power source.

Application



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Requirements

The following RobotWare options are required for the *Fronius TPS Integrated* option:

- *EtherNet/IP Scanner/Adapter*

The power source has to meet the following requirements:

- Fronius power source TPS 4000i/5000i with EtherNet communication support
- EtherNet/IP communication interface with software version 1.07.9 or later.
- PowerMAG-OS version 4.3018 or later.

Limitations

The option *Fronius TPS Integrated* cannot be used together with the Fronius external programming device RCU5000i.

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14.2.1.4 Fronius TPSi

General

ABB Robotics IRC5 interface to Fronius TPS 320i/400i/500i/600i with RI-FB inside/i interface.

Features

ABB Robotics interface to Fronius TPSi welders. The package contains a RobotWare Add-in, a RobotStudio Add-in and complete documentation. In the RobotStudio Add-in, it is possible to connect to the TPSi via the Fronius Web Interface and edit weld parameters.

The welder information is then transferred to the Robot Controller and is used to drive a Welder dedicated editor on the ABB FlexPendant.

Supported welder modes are JobMode and ProgramMode.

In JobMode, a specific job is sent from the Controller to the welder. The job is edited via Fronius web-interface.

In ProgramMode, the desired synergic line is selected in the editor. Then the wire feed speed or the current should be used as set values. Other parameters to set and tune are ArcLength Correction, Pulse/Dynamic Correction and Arc Length Stabilizer (for PMC process).

These parameters can be tuned online and the result can immediately be observed. The range of the tunable parameters can also be seen in the editor.

The Fronius TPSi Package consists of the following software components:

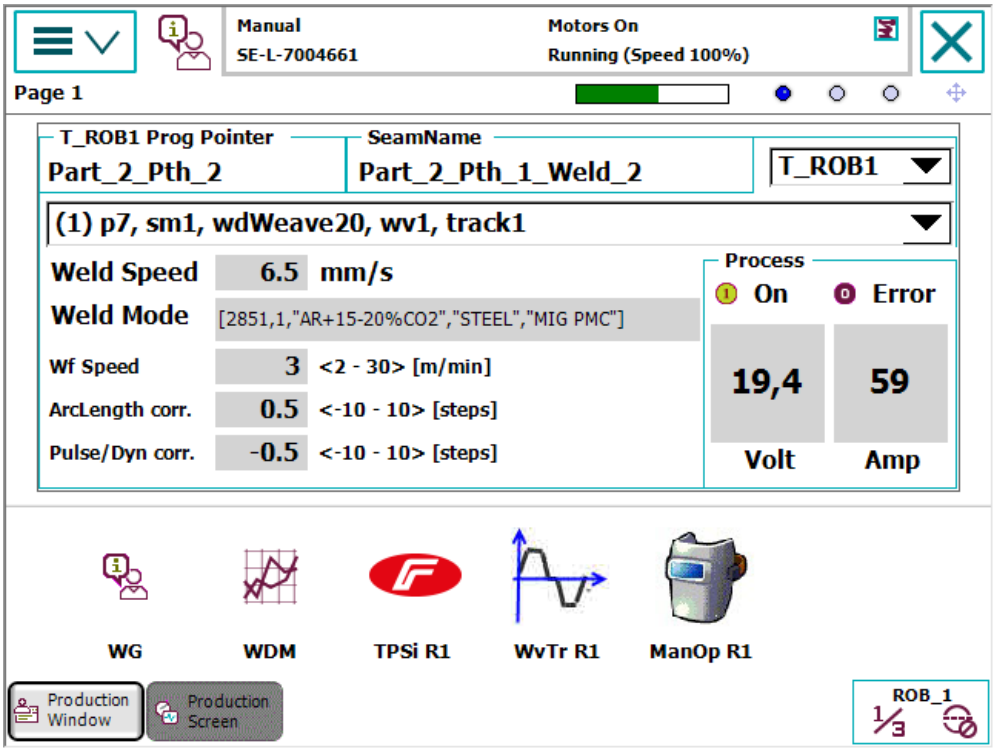
- Ready to weld Interface to control a TPS 320i, TPS 400i, TPS 500i and TPS 600i welder
- RobotStudio Add-In to select different weld modes (Synergic lines) used with the welder
- Graphical Weld data editor
- Graphical Weave and Track data editor
- Graphical Application for manual functions such as:
- Process blocking
- Wire feed (Forward / Backward)
- Purge Gas
- Graphical Widget displaying run-time data.
- Support for Weld Units (m/min for wirefeed speed) and Imperial Units (ipm for wirefeed speed).

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Application

See start screen with run-time data Widget:



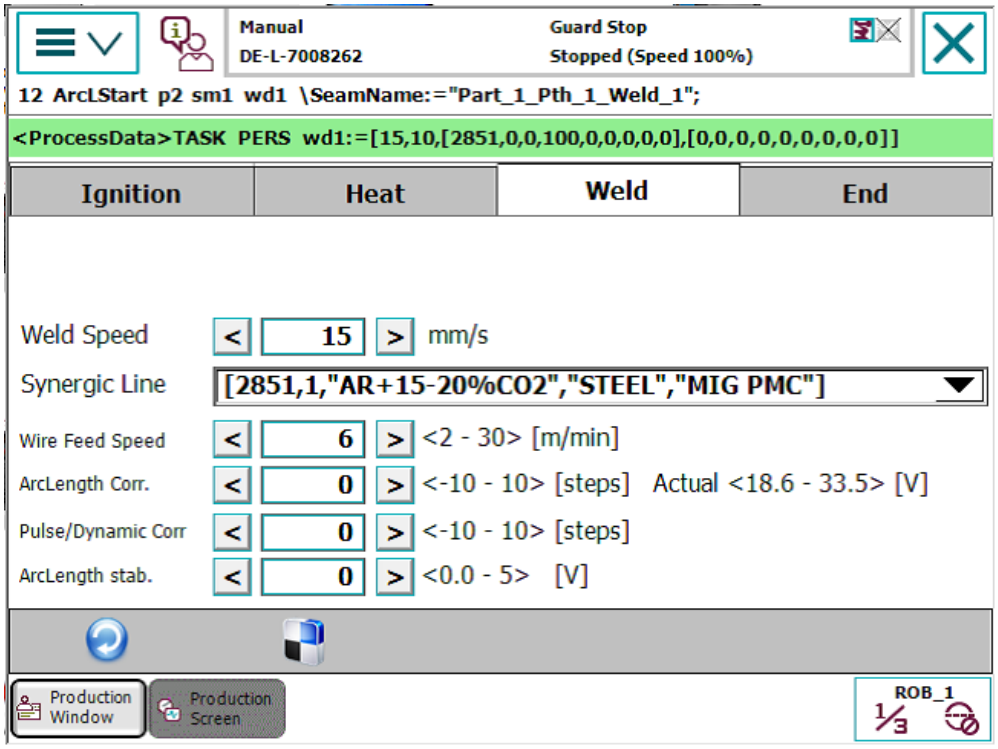
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Weld Data Editor in ProgramMode:

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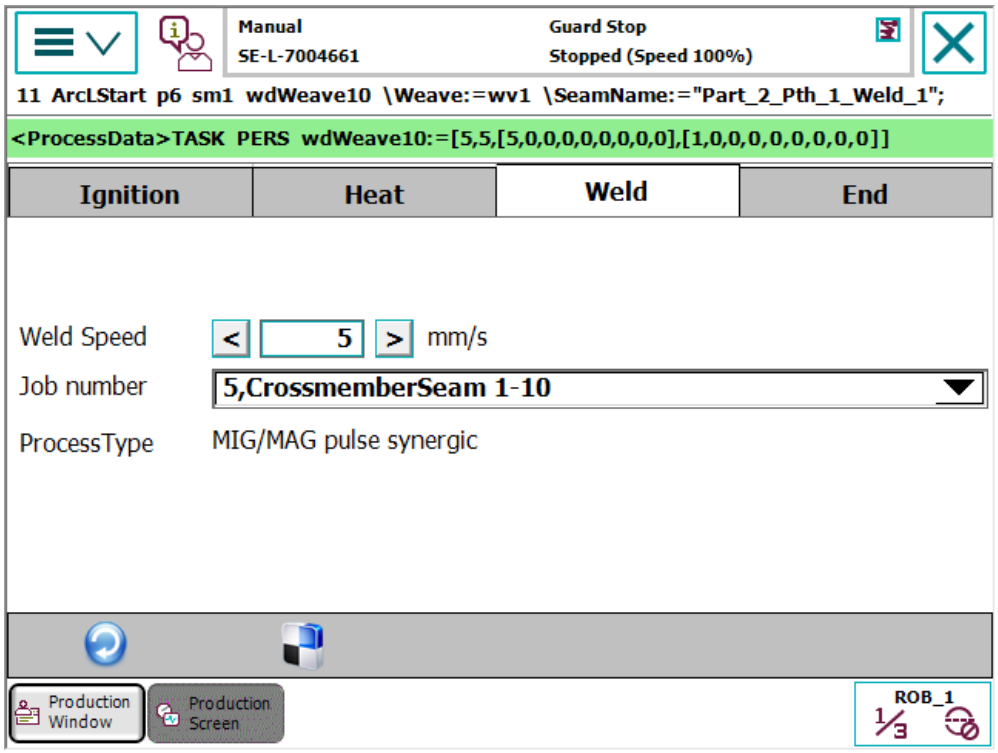
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14.2.1.4 Fronius TPSi
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Weld Data Editor in JobMode:



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Requirements

Power Source prerequisites:

- Power Source Firmware 1.7.4 or higher.
- RI FB Inside/I interface for Device Net / Profi-Bus / Profi-Net or EtherNet/IP.

Robot system prerequisites:

- IRC5 robot controller with main computer DSQC1000 or above.
- RobotWare version 6.05 or higher with the following options:
- RobotWare Arc [633-4]
- One of the following Industrial Networks:
- DeviceNet Master/Slave [709-1]
- EtherNet/IP Scanner/Adapter [841-1]
- PROFINET Controller/Device [888-2]
- PROFIBUS Controller [969-1]

The following option is recommended to use the Partdata concept within the WeldData editor:

- Production Manager [812-1]

RobotStudio version 6.06 or higher.

The Fronius TPSi package is distributed as a RobotWare add-in, and can be downloaded in the add-in section in RobotStudio.

Limitations

Only the first Arc System is supported with this interface. To connect more than one welder per robot, use the Arc sub-option *Standard I/O Welder*.

Tuning of weld speed and weld parameters is no longer supported by RobotWare Arc GUI, this is done in the Fronius Weld data editor.

JobMode with Correction is not supported.

The Fronius TPSi Web Browser interface is a licensed option from Fronius.

To be able to connect to the Fronius TPSi Welder via the Web Browser interface in the RobotStudio Add-in, this option is needed. Contact Fronius for more information.

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14.2.1.5 Fronius TPS 4000/5000

General

The *Fronius TPS 4000/5000* user interface is a standard arc programming tool used for operating and managing one or more TPS/TP-type of power sources.

The Fronius TPS and TS welding machines are totally digitized, microprocessor-controlled inverter power sources. An interactive power-source manager is coupled with a digital signal processor, and together they control and regulate the entire welding process.

The communication is performed through a robot DeviceNet interface, which allows the operator to program the main process parameters from the robot FlexPendant.

The operator can through this software can for example call for pre-programmed jobs (called schedules in robot controller), which prior have been made in on the Fronius power source operator panel.

This software option is using the RobotWare standard seam and weld data types to supply welding process information to the power supply.

The arc option *Fronius TPS 4000/5000* interface provides complete access to all Fronius modes.

The arc option *Fronius TPS 4000/5000* gives the user access to following Fronius modes:

1 Job mode
2 Job mode with correction
3 Standard program mode
4 Pulsed program mode
5 Manual

Job mode

All weld parameters, including start and end data, are stored in the Fronius power source.

The user can in this mode select a pre-programmed *job* in the Fronius power source, and use this job as the weld data in the FlexPendant.

Job mode with correction

All weld parameters, including start and end data, are stored in the Fronius power source. Same functionality as Job Mode, but the user can also get access to wire feed speed and voltage in the "weld data" to "trim" the synergic values specified in the Job.

Standard program mode

Standard synergic welding, were the user specifies wire feed speed and Fronius power source will select an appropriate voltage. Voltage may be trimmed using the voltage field. This mode gives RW - Arc the control over start and end data.

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Pulsed program mode

Pulsed synergic welding, were the user specifies wire feed speed and Fronius power source will select an appropriate voltage. Voltage may be trimmed using the voltage field. This mode gives RW - Arc the control over start and end data. Depending on how the system is configured, appropriate fields will be masked or exposed in weld data and seam data so that the user only sees the fields valid for the mode that is selected.

Arc errors display

The Fronius interface displays in the error number provided by Fronius in the arc errors displayed on the FlexPendant.

Robot software requirement

The RobotWare option *Arc* is required for the *Fronius TPS 4000/5000* option.

Minimum Fronius power source hard- and software requirements

- Fronius Welding Power Source (TPS/TS 4000 or 5000)
- Fronius Wire feed Systems (VR1500)
- Fronius Software option, Jobexplorer
- Fronius Interface (Bus Systems and standard discrete)

Optional

Fronius Remote Control Units (RCU 4000 and 5000)

Note

The above Fronius equipment and software options are not included in RW Fronius TPS 4000/5000.

For more information see separate Application manual-Fronius TPS 4000/5000 IRC5 Interface.

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14.2.1.6 Standard I/O Welder

General

The *Standard I/O Welder* user interface is a standard arc programming tool used for operating and managing one or more I/O-based power sources. The communication is performed through a robot I/O based interface, which allows the operator to program the main process parameters from the robot FlexPendant. The operator can through this software set required wire feed speed, voltage level and welding speed for each specific weld in the robot program. Following main tasks can be handled from the FlexPendant, *Standard I/O Welder* process user interface:

- Set required wire feed speed, voltage level and absolute welding speed.

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14.2.1.7 Lincoln ArcLink

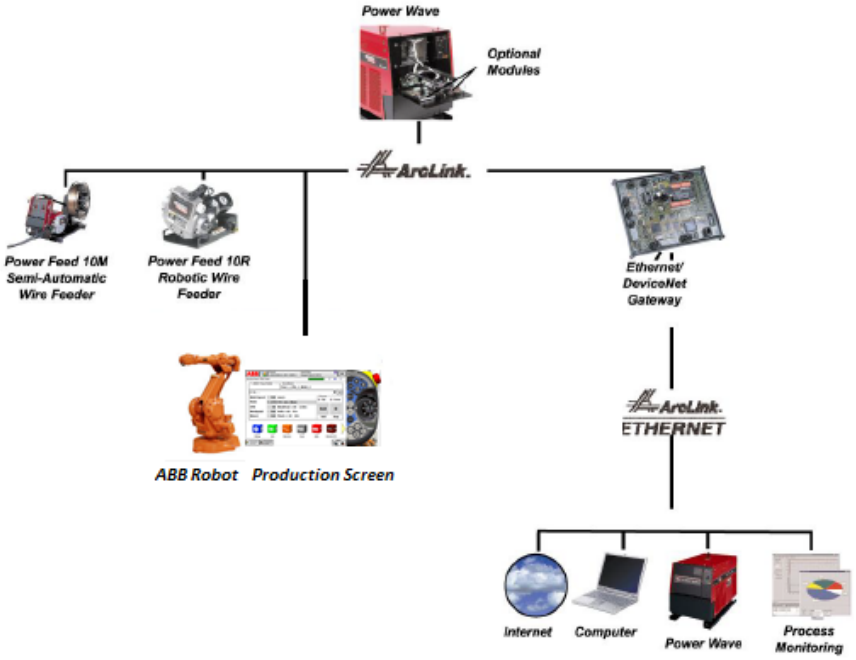
General

Lincoln ArcLink is digital communications system used in Lincoln Electric Power Wave welding systems.

ArcLink is specially designed for the arc welding environment and is the best method to communicate to cell components such as semiautomatic wire feeders or robots. ArcLink is simply the way each piece "talks" to each other in a Power Wave system. The Power Wave welding systems also provide "gateways" to allow other digital networks such as Ethernet to connect to the ArcLink system.

ArcLink integrates all welding components for seamless, time-critical data transfer. The strength of ArcLink lies in the ability to communicate with each system component in a pre-defined welding language. ArcLink brings modularity to welding systems and provides a single, intelligent connection between all modules.

ArcLink also allows for networking capabilities through gateways (such as Ethernet) to allow simultaneous monitoring of multiple welding cells, which establishes a means for developing supervisory or monitoring tools.



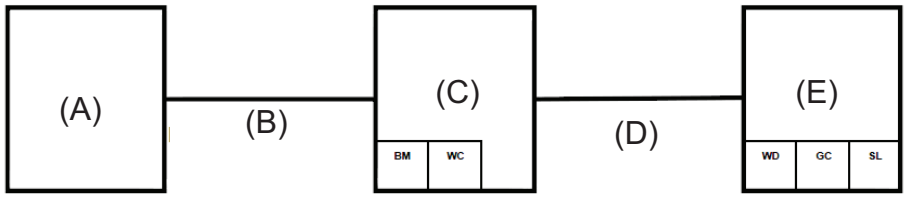
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An ArcLink bus can consist of a CAN and Ethernet bus together; some nodes on CAN and others on Ethernet as in the figure below. ArcLink/XT adds Ethernet capability to the ArcLink CAN bus.

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14.2.1.7 Lincoln ArcLink
Continued



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Pos	Description
A	Robot
B	Ethernet - UPD (ArcLink/XT)
C	Power Source
D	CAN (ArcLink)
E	Wire feeder

Working principle

ArcLink uses peer-to-peer, event-driven messaging, which broadcasts on an as-needed basis.

Peer-to-peer messaging frees space on the data highway, reducing message traffic. Because ArcLink logic is based on a Controller Area Network (CANIIB) standard; it inherits the benefits of priority-based, deterministic messaging and noise immunity. This means that critical messages are guaranteed to reach their destination with minimum delay, even in the presence of electrical noise.

Features

File transfer

Weld files can be saved, shared, or modified.

Data acquisition

Weld data is collected and stored for Production Monitoring purposes.

Advanced Diagnostics

ArcLink provides the capability to monitor component failures system wide.

Ease of Installation

ArcLink uses one control cable for communications, component power, and electrode voltage sensing connections. ArcLink is used in the control cable connection between the weld power source and the wire feeder. It provides flexibility of physical configuration so that any component may be connected to any other component in the system.

ArcLink/XT uses one Ethernet cable for communication between the robot controller and weld power source.

Power Wave

The Power Wave welding systems are extensively used in Robotic Arc Welding applications. It is provided with a number of PC tools, ranging from diagnostics to advanced production monitoring. In addition to this, Power Wave uses ArcLink, a

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digital communications system which was specially designed for arc welding environment. The Power Wave welding systems also provide "gateways" to allow other digital networks such as DeviceNet and Ethernet to connect to the ArcLink system. The unit is not supplied by ABB Robotics.



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Requirements

The following RobotWare options are required for the *Lincoln ArcLink* option:

- *Arc*
- *PC Interface*, (necessary for *Socket Messaging*)
- *Production Manager*
- *Production Screen*

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14.2.1.8 SKS Synchroweld

General

The option SKS Synchroweld is a software option for managing the SKS Synchroweld powersource with the Fieldbus 5 interface.

Features

Synchroweld unites robot and welding machine to a procedural entity. This combination is made possible because thanks to Synchroweld the welding machine knows the actual welding speed, that is, the TCP speed of the robot and its external axes. The speed information is directly processed in the weld controller.

Synchroweld opens up new welding process options.

Advantages of SyncroWeld

Optimum welding results with constant weld penetration and identical appearance at all points of the weld seam (even at the torch reorientation points).

Constant energy input per length – the energy provided in time remains constant during welding.

Process optimization – visualization of the actual TCP speed during welding supports easy optimization of the process.

Work made easier and time saved – even with complicated weld seam geometries only one welding program and one welding speed setting is required.

Application

The SKS graphical user interface on the FlexPendant is called SKS Interface.

The SKS Interface shows valuable process information, such as:

- Real-time voltage and current
- Real-time wire feed speed
- Real-time welding speed
- Reference Speed
- Active Schedule (Group/Part/Program)
- Active Signal status
- Power source status
- Average Energy

The SKS Interface also includes a welddata editor that allows the user to change the following data:

- Group port value
- Part port value
- Schedule port value (Program Number)

Finally the relay contacts and digital inputs of the Feldbus 5 interface can be controlled from here if configured.

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Requirements

IRC5 controller RobotWare 6.01 or higher with RobotWare Arc Fieldbus Interface (DeviceNet, PROFIBUS, PROFINET)

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14.2.1.9 Fronius TPSi Seam tracking

General

This is ABB Robotic's IRC5 Seam tracking interface to the Fronius TPSi welders.

Features

The *Fronius TPSi Seam tracking* Add-In is a powerful software based TAST (Through Arc Seam Tracking) RobotWare Add-in option. The function is based on a feedback signal provided by the TPSi power source. This feedback signal is representing a wire stick-out value to support both vertical and lateral seam tracking and is used as a sensor to indicate variations in the welding current which is caused by changes in welding current and voltage.

Supported track types:

- Centerline tracking
- Height only tracking
- Y corrections tracking only
- Inverted Centerline tracking

There is support for MultiPass welding.

The version is Fronius TPSi Seamtracking 1.00 and can be found in the add-in section in RobotStudio.

User documentation is included in the distribution.

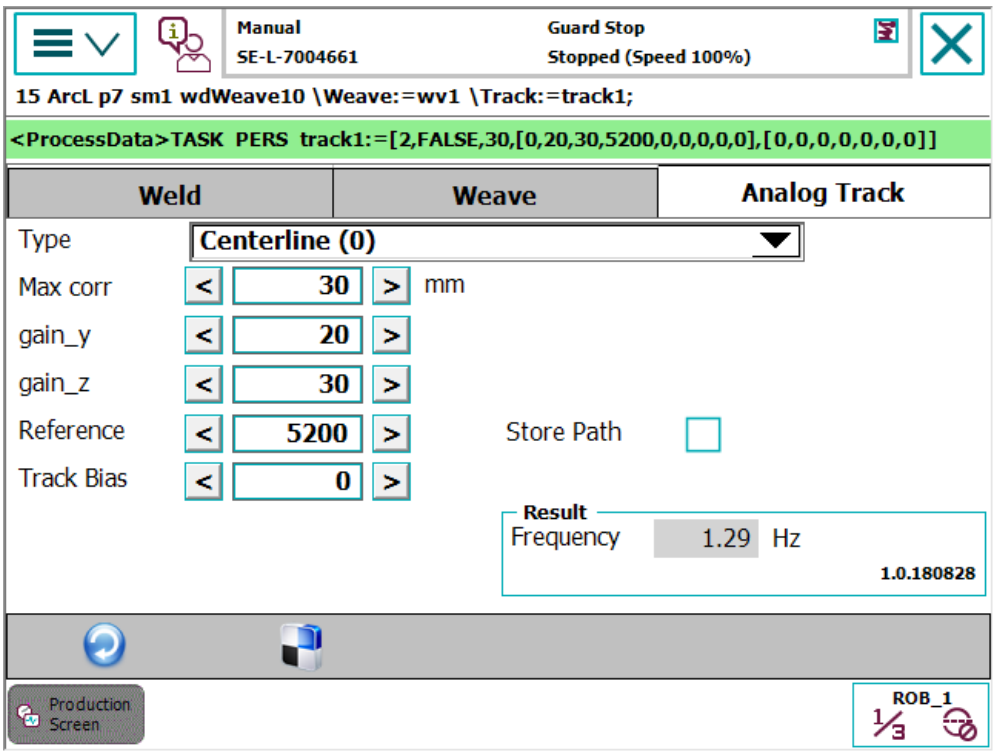
Application

There are dedicated FlexPendant user applications for editing track data related parameters and run-time information from the tracking process.

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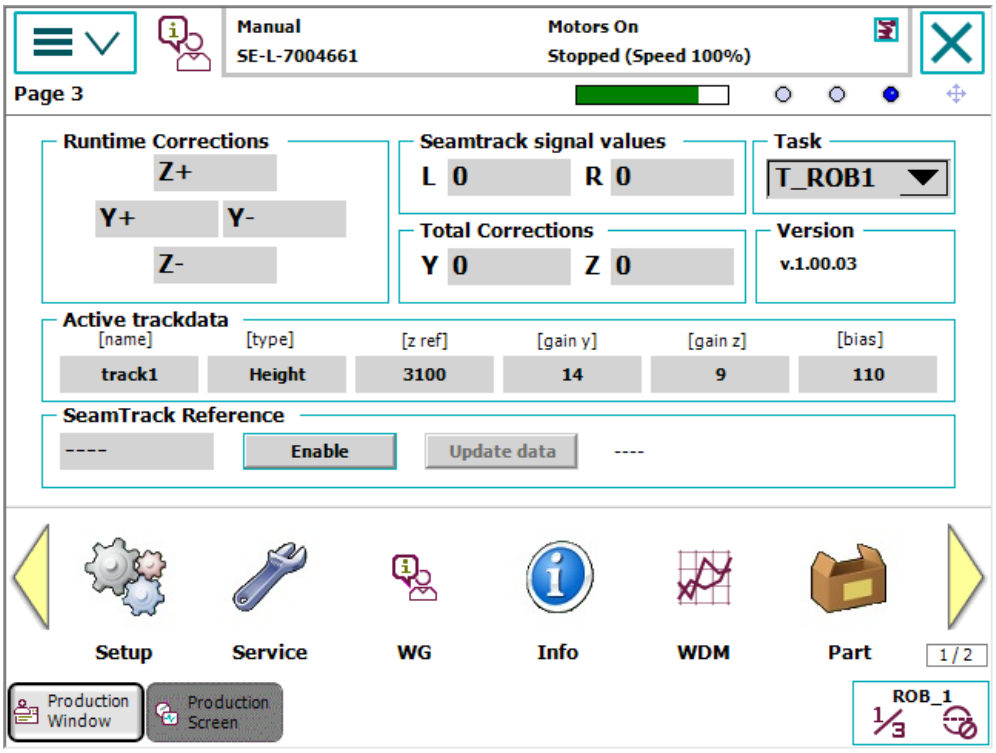
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Weave and track data editor



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Run-time widget with information about the tracking process



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14.2.1.9 Fronius TPSi Seam tracking
Continued

Requirements

- The Fronius TPSi Seam tracking Add-in also needs the Fronius TPSi Add-in to work properly.
- The RobotWare option 1553-1 *Tracking Interface* (licensed option) is needed for this functionality.

Limitations

- There is an incompatibility with the RobotWare option [659-1] *Production Monitoring* in the current release of the TPS/i interface. Seam tracking will not be possible if the option [659-1] *Production Monitoring* is installed. In RobotWare 6.08 this is solved.
- The Weldguide option [815-2] *Weldguide MultiPass* cannot be used in the same task. Either 1553-1 *Tracking interface* or [815-2] *Weldguide Multipath* can be used. In a MultiMove environment each task can have one of these options.
- There is an incompatibility with the option [660-1] *Optical tracking Arc*. This means that *Optical tracking Arc* cannot be used in the same system as this tracker.
- Adaptive functionality is not yet supported.
- Limited support of track modes. Only the modes listed above are supported.
- Aluminum welding and TPSi Seam tracking is not supported until further notice.

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14.2.2 Other included functions and options

14.2.2.1 Torch Service Equipment

General

The *Torch Service Equipment* software option provides automatic cleaning of the welding torch. It automatically clears and reduces buildup of spatter, which ensures continuous and reliable operation of the robot cell. The *Torch Service Equipment* option includes software that is loaded into all arc welding motion tasks.

> **Note**
>
> The *Torch Service Equipment* software loads unique equipment drivers, but the RAPID instruction interface is the same regardless of hardware selected.

Torch Service Equipment software maximizes arc on time and minimizes down time since it can be programmed to clean automatically between weld or station interchanges. This reduces the need to manually disassemble and clear the nozzle. *Torch Service Equipment* software makes it possible to perform torch cleaning during positioner interchange, which reduces cycle time. Once *Torch Service Equipment* is programmed the operator can decide how often the cleaning process needs to take place to prolong the contact tip and gas nozzle life.

ABB - TC 2013

This software option will give the user the possibility to define torch cleaning and anti spatter procedures in a robot system for the hardware option, *ABB - TC 2013*. The hardware option is available in separate application product price list.

The following main tasks can be handled from the *ABB - TC 2013* software options:

- Procedure for automatic cleaning of gas nozzle interior wall and the exterior of the contact tip and face of the gas diffuser for quick removal of weld spatter.
- Procedure for anti spatter spray program to provide longer interval between torch cleaning.
- Procedure for define automatic wire cutting for consistent wire electrode extension (wire stick-out).

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14.2.2.1 Torch Service Equipment
Continued

Binzel - TC97

This software option can be used to define torch cleaning and anti spatter procedures in a robot system for the hardware option, Binzel - TC97. The hardware option is available in the separate price list for application products.



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The following main tasks can be handled with the Binzel - TC97 software:

- Procedure for automatic cleaning of the interior wall of the gas nozzle, the exterior of the contact tip, and the face of the gas diffuser for quick removal of weld spatter.
- Procedure for anti spatter spray program to provide longer interval between torch cleaning.

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14.2.2.2 Production Monitoring

General

The *Production Monitoring* option enables logging of production information in a WebWare Server database. The database is stored on a WebWare Server and is displayed on a regular web page through the WebWare Client. Access to this information will help users improve part quality and production throughput.

Features

The *Production Monitoring* option provides detailed, automated data collection for every weld seam on each part produced. This feature has driven standardization of process measurement to a new level, by proactive manage welding production rather than just react to problems.

Key features include:

- Online reporting of production data and faults
- Logging of production data for part traceability
- Real-time reporting via standard web browser
- Fixed cost deployment without added software development expense

The *Production Monitoring* option provides a systematic way to capture the production data needed to achieve continuous improvement goals.

Typical applications include:

- Cycle time analysis
- Tracking production output
- Quantify lost production time
- Monitor equipment utilization rates
- Archiving of production data for traceability
- Data capture to document acceptance criteria

WebWare tables in Production Monitor

Production Monitor promotes WebWare Server tables that contain statistical results. For example, RobotWare Arc will provide a table of *Cycle Results* that combines information from `CycleEvents` data with `SeamResults` data to create the *Cycle Result* table.

Event Tables:

- Event tables provide specific, time-stamped information that occur in the system. These include start and end events for cycles, service routine calls and setup routine calls. These tables are characterized by having records for start events and end events. To determine the duration of an event from start to end requires calculations based on the data stored in the database.

Result Tables:

- Result tables contain data that is calculated on the fly within RAPID. These tables provide useful information about production without making SQL queries from multiple tables. These tables are typically written after an event has finished and usually include a Duration column that provides the time

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that elapsed during the event. Often the columns included in these tables will contain fields that are accumulated over the duration of an action.

Event Table

Every component that writes to tables in the WebWare database includes a column for an Event ID. This number is incremented by the underlying Execution Engine each time the engine executes an event. The Events include the execution of a part cycle, a service routine or a setup routine. When the underlying structure reacts to a command, it assigns an index value to that event and makes that variable available to all components. The component includes that Event ID in its database table so that SQL queries may be made based on that key. For example, when the underlying structure reacts to a command, a start event is generated and logged in the event table.

The event table contains the records for all responses from requests to the Execution Engine.

These include part cycle calls, service routine calls and setup calls. Records will be added for all start and end events. An EventType field will be used to differentiate between part cycle calls, service routine calls and setup routine calls.

Column Name	Data Type	Description
EventID	Long Integer	A number supplied by the Execution Engine. May be used as a key
EventType	Integer	Enumeration for Cycle, Service and Setup types
Condition	Integer	Enumeration for Start or End
UserID	string	User that is logged-in
RobotID	string	Task name
ControllerID	string	Controller Name
Time	DateTime	Time stamp

Cycle Events table

The *CycleEvents* table contains the records for all part cycles executed by the Execution Engine. A CycleID field will be used as a serial number for parts. This number may be provided to the underlying structure from an external device, or by simple increments in the Execution Engine.

Column Name	Data Type	Description
EventID	Long Integer	A number supplied by the Execution Engine. May be used as a key
CycleID	Long Integer	A number supplied by the Execution Engine. May be used as a key
Condition	Integer	Enumeration for Start or End
Part	string	Path to, and name of, part procedure
PartDescription	string	From `partdata` description

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Column Name	Data Type	Description
PartCount	Integer	Count at time of event. A *Start* condition will show the part count before running the part. An *End* condition should show an incremented `PartCount`.
Station	Integer	From `partdata` station
UserID	string	User that is logged-in
RobotID	string	Task name
ControllerID	string	Controller Name
Time	DateTime	Time stamp

Seam Results Table

The SeamResults table contains a record for each weld seam that is finished. It provides information about the seam from RobotWare Arc. The value in the CycleID field will match the value in the CycleEvents table. This number may be provided to the underlying structure from an external device, or by simple increments in the Execution Engine. The value will be "0" if the seam was not executed within the context of a cycle. Cycle information from the Execution Engine will be included in the table, if those values are available. Otherwise the fields will be set to "0" or "-" depending on the data type.

Column Name	Data Type	Description
EventID	Long Integer	A number supplied by the Execution Engine. May be used as a key
CycleID	Long Integer	A number supplied by the Execution Engine. May be used as a key
Part	string	Path to, and name of, part procedure
PartDescription	string	From partdata description
Station	Integer	From partdata station
SeamName	string	Name supplied in Arc instruction
ArcStartDuration	number	How long it takes to ignite arc
NominalArcStart	number	Nominal length of time to ignite arc
SeamLen	number	Length of actual weld completed for the seam
NominalSeamLen	number	Saved nominal length of seam
Duration	number	Time in seconds to complete seam
NominalDuration	number	Saved nominal time in seconds to complete part
ArcStarts	Integer	Number of arc starts for the seam - ideally 1
Stops	Integer	Number of stops during welding for any reason
Completed	boolean	True if all welds finished to completion
UserID	string	User that is logged in
RobotID	string	Task name
ControllerID	string	Controller Name

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14.2.2.2 Production Monitoring
Continued

Column Name	Data Type	Description
Time	DateTime	Time stamp

Cycle Results Table

The *CycleResults* table contains a record for each part cycle made by the Execution Engine. It provides more information about the cycle based on information provided by RobotWare Arc. The value in the CycleID field will match the value in the CycleEvents table. This number may be provided to the underlying structure from an external device, or by simple increments in the Execution Engine. The underlying structure provides procedure hooks that allow Process Applications like Arc to be informed about cycle events. This table is written by RobotWare Arc. Other process applications may have similar, but slightly different, CycleResults tables.

Column Name	Data Type	Description
EventID	Long Integer	A number supplied by the Execution Engine
CycleID	Long Integer	A number supplied by the Execution Engine
Part	string	Path to, and name of, part procedure
PartDescription	string	From partdata description
PartCount	Integer	Count at time of event. A *Start* condition will show the part count before running the part. An *End* condition should show an incremented `PartCount`.
Station	Integer	From partdata station
WeldLen	number	Accumulated weld lengths for all welds in part
NominalWeldLen	number	Saved accumulated weld lengths for all welds in part
Duration	number	Time in seconds to complete part
NominalDuration	number	Saved time in seconds to complete part
Welds	Integer	Number of welds completed during the part cycle
NominalWelds	Integer	Saved number of welds completed during the part cycle
ArcStarts	Integer	Number of arc starts during the cycle
WeldStops	Integer	Number of stops during welding for any reason
Completed	boolean	True if all welds finished to completion
AccumArcTime	number	Total arc time for the robot
AccumArcStarts	number	Total number of arc starts for the robot
UserID	string	User that is logged in
RobotID	string	Task name
ControllerID	string	Controller Name
Time	DateTime	Time stamp

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Requirements

Robot controller requirements	PC requirements
PC Interface option	WebWare Server 4.5 or higher. For complete PC requirements, see WebWare Server Administrator's Guide.

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14.2.2.3 Additional Arc System, Two additional

General

The *Additional Arc Systems* software option is designed to prepare a robot system to control two or three arc systems. An example of that could be to control a MIG/MAG process equipment together with a TIG process equipment through one robot. In order to prepare the software communication to control two or three arc systems with the same robot, ABB has developed software options, in which one or two additional process equipment can be defined.

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14.2.2.4 Included options

The option *Arc 6* [633-4] includes the options below:

- *637-1 Production Screen* [637-1]
- *FlexPendant Interface* [617-1] if the option is not selected with option *MultiFunction* [824-1]
- *Cont. Appl. Platform* [624-1]

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14.3 Arc options

General

RobotWare Arc Options is a collection of software applications, designed to simplify the use of different hardware options to improve productivity and lower the cost of owning and operating an ABB arc welding system. Some of the software options need to be purchased together with specific hardware option available in separate IRC5 Application product prices list, and other software option can be purchased individually. This document will describe these software Arc options in terms of basic functionality and if it is connected to a specific hardware.

The software is distributed with RobotWare and is activated when building a system using the Installation Manager.

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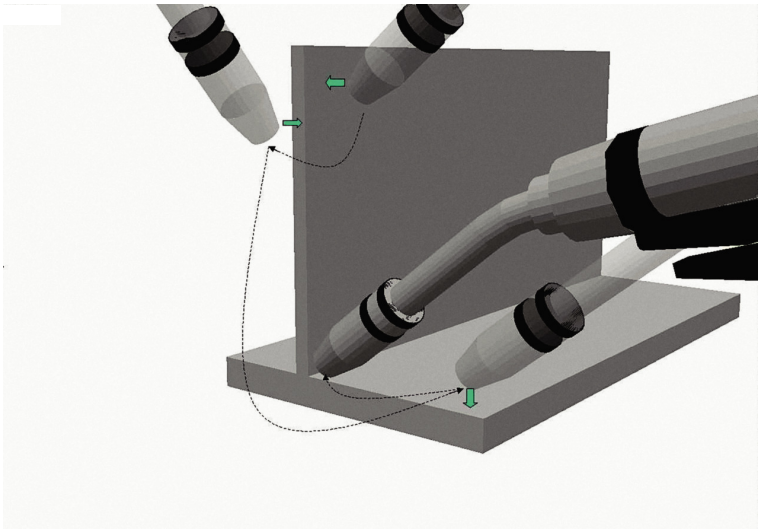
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14.3.1 SmarTac - I/O version [657-1]

General

This software option will give the user the possibility to define search procedures in a robot system for the American hardware option. The hardware option is available in separate Application product price list.

The SmarTac™ software option is designed to control an electrical tactile sensor for locating weld joint positions. It uses the standard gas nozzle on the torch as a sensor. Several search instructions are included, which enable you to shift welds based on search results in run-time.



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Features

With SmarTac a part feature may be "searched" using part of the torch. Typically the welding wire or the gas cup is used as the sensing portion of the torch. Searches are programmed into a weld sequence. Each search consists of two robtargets; one for the start location and one for the expected location of the part feature. While searching the torch feature (gas cup or wire) is energized with about 38VDC. When the torch feature makes contact with the part (at ground potential) an input is set in the robot controller. When the input is detected, robot location is stored and motion stops.The Search instructions included in the SmarTac software are designed to return "offset" information. In other words, the result of a search is the distance between where the original search location was programmed and where the robot has now found the part.Using SmarTac effectively can dramatically reduce fixture costs. It can also help account for part variability that cannot otherwise be controlled.

Hardware

The main component is an electronic sensor board, which detects contact with the part feature to be located. The SmarTac board can be ordered as an add-on unit and is installed in the robot cabinet. Different hardware is used on the European and North American markets, but the functionality is identical.

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14.3.1 SmarTac - I/O version [657-1]

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Note

Note! The hardware options are not included in below specified software option.

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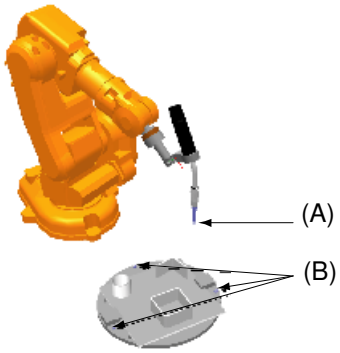
14.3.2 Navigator [814-1]

General

Navigator is a product designed to accurately perform calibration of external axes and fixtures. It consists of two main features, *Frame Definition* and *Coordinate Measurement*.

Frame Definition (WorkObject calibration)

Tooling balls are typically mounted on the fixture and the measuring probe is mounted on the robot. The probe TCP is defined using the BullsEye TCP calibration device.



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Position	Description
A	Probe
B	Tooling Balls

The robot is then used to measure a number of reference points (tooling balls). Letting the robot locate tooling balls placed on the fixture performs the frame definition. The procedure can be totally automated and user independent. Thus, the manual step of pointing out reference positions for frame definition is replaced by automated search methods.

Coordinate Measurement (Robot CMM)

The main purposes for coordinate measurement with Navigator is to calibrate a series of fixtures, but can also be used for measuring part variations:

- A: Fixture line up. A master fixture is created and manually mechanically adjusted. The robot is then used to measure a number of reference points (surfaces). The points measured on the master fixture are called nominal points. Then the master fixture is removed and a clone fixture is mounted in the same robot cell. The robot is then ordered to measure the same reference points on the new not mechanically adjusted fixture. The referenced points are compared to the nominal points and a report created describing how the clone fixture should be mechanically adjusted to be an exact copy of the nominal. This procedure can be repeated for unlimited number of clone fixtures.

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14.3.2 Navigator [814-1]
Continued

- B: Production batch monitoring. Instead of measuring fixture points the nominal points are created on a master part. Subsequent parts/batches are thereafter checked periodically for deviation from the master part. The result is logged, which creates a possibility to automatically stop production.

Hardware

The *Navigator* hardware for frame definition consists of the measurement probe (for example gas nozzle equipped with a tooling ball) and mounting holes on the fixture for the tooling balls. This hardware is sold separately.

Expected performance

The repeatability accuracy of localization of a single sphere is in the same magnitude as the robots repeatability accuracy, which is estimated to 0.05 [mm]. The expected repeatability accuracy of calibration of the base frame for an external rotational axis is maximum 0.16 [mm] and an average of 0.09 [mm]. The expected maximum position deviation of an entire cell calibration including probe TCP calibration, external axis calibration and workobject/fixture calibration is 0.24 [mm] and the average position deviation is 0.13 [mm]. These numbers are based on empirical tests and should only serve as an estimate of expected performance. ABB cannot be held responsible for deviations from these values. For best performance the robot should be equipped with BullsEye TCP calibration and SmarTac tactile sensor.

Requirements

A tactile sensor (preferably SmarTac).

RAPID instructions

RAPID instructions included in this option:

Instruction	Description
SearchSpL	`SearchSpL` is an instruction for tactile measuring the position of the center of a sphere (for example tooling ball). The robot moves with linear motion to the starting point for the search pattern. From the starting point the robot moves in a downward spiral pattern until the probe touches the tooling ball. The pattern is repeated several times and the center of the tooling ball is calculated.
SearchSpJ	`SearchSpJ` is an instruction for tactile measuring the position of the center of a sphere (for example tooling ball). The robot moves with joint motion to the starting point for the search pattern. From the starting point the robot moves in a downward spiral pattern until the probe touches the tooling ball. The pattern is repeated several times and the center of the tooling ball is calculated.

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Instruction	Description
Measure_1D	`Measure_1D` is an instruction used for tactile measuring a point perpendicular to its plane. The robot will make a linear movement to the position `ApprPoint`. The search equipment will be activated and motion will start towards the point to measure, `NominalPoint`. The robot will continue past the search point for a maximum total search distance twice the distance between `ApprPoint` and `NominalPoint`. Once the feature is sensed, motion stops, and the distance between `NominalPoint` and search position is logged and displayed on the FlexPendant. If the argument `\UpdateNominal` is used the `NominalPoint` will get the value of the search.

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14.3.3 Optical Tracking Arc [660-1]

General

The option *Optical Tracking Arc* is a software option that allows integration of external optical sensors, which can be used for real time seam tracking. For communication between the sensor and the robot controller two different communication links are available: serial link (RS 232) and Ethernet.

If the RS232 link is used, the sensors have to be adapted to the ABB standard application protocol, LTAPP. Sensors that are adapted to LTAPP are available from companies like Servo Robot, Meta, and Scout.

The Ethernet link is available for optical sensors from ServoRobot, which use the application protocol Robo-Com Light, defined by ServoRobot.

Features

Key features include:

- Easy calibration with dedicated FlexPendant interface and calibration plate, art. No. 3HAC032252-001. Contact ABB Robotics.
- Contour tracking integrated with arc welding movements.
- Adaptive process control during path motion and tracking.
- TCP/IP enabled to facilitate plug and play capability, using the Ethernet link.
- Separate sensors can be installed for each robot in a MultiMove system (if using serial link, the number of serial ports may be limited).
- Includes all features of the option *Sensor Interface [628-1]*.

Performance

Designed to work for normal arc welding applications. Real performance, i.e. path following accuracy, is however depending on current speed, curvature, look ahead, sampling frequency etc.

Requirements

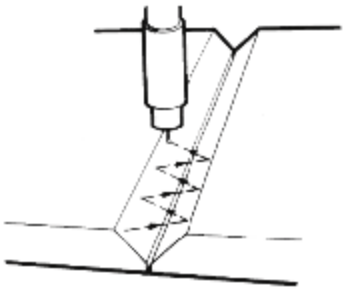
For calibration, the hardware option calibration plate [1250-1] is required.

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14.3.4 WeldGuide [815-2]

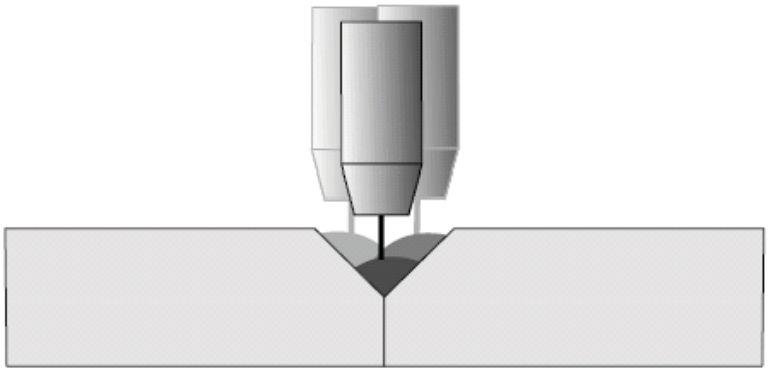
General

The WeldGuide, is a "Thru-Arc" joint tracking RobotWare arc option to be used together with the optional AWC (Advanced Weld Control) unit which is an optional hardware integrated into the robot controller. It is designed to track welding joint variations due to cast components or other pre-process problems and will in an automatic mode monitor track the weld joint during welding.



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Sometimes multiple weld passes are required due to the required weld size and thickness of the material being joined. WeldGuide makes this easy by tracking the first pass and storing the actual tracked path so it can offset for subsequent passes.



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Features

The main feature is the "Thru-Arc" tracking capability which divides in following specific software features.

The first weld pass is recorded by making a weld with normal arc instructions. The interval between stored path points is dictated by the weave length. Multi-pass welding can be used in conjunction with seam tracking. The replayed path can be offset in either the plus or minus "Y" and "Z" seam coordinates and rotated plus or minus "X" and "Y" in seam coordinates. Replayed paths can also be executed in the forward or reverse direction. The start and end path points can be lengthened

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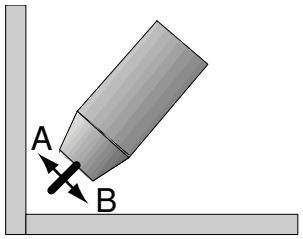
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14.3.4 WeldGuide [815-2]
Continued

or shortened by a specified distance in millimeters. If the path is lengthened, the new end point is projected outward by using the last two points that were stored in the path. Lengthening and shortening the path allows for the weld to be tied into previous welds or the parent material itself.

Center line Tracking

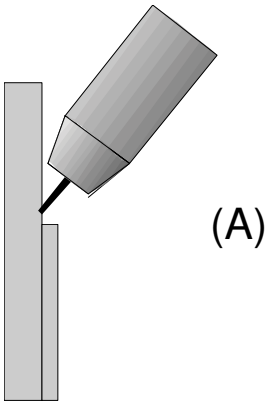
The WeldGuide software is controlling the measurement of current and voltage (impedance) at the respective end position of the robot weave width as the torch weaves across the weld joint. These measurements are in real time analyzed by the WeldGuide software which then will result in robot path adjustments to ensure that the arc stays in the weld joint along the whole weld path. See Figure below.



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Single-Side Tracking

The WeldGuide software can also control tracking from a single side, tracking data samples of just one wall, to follow the robot path during welding. In addition the amount of penetration in the side plate can be programmed. See Figure below.



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Pos	Description
A	WeldGuide takes data samples of just one wall.

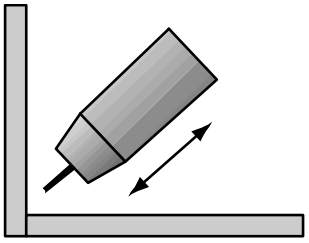
Torch-To-Work Tracking

In Torch to Work mode using the WeldGuide software the same contact tip to work length is maintained. The contact tip to work distance is specified as voltage and current settings in the weld data. Weaving is not required for this type of tracking.

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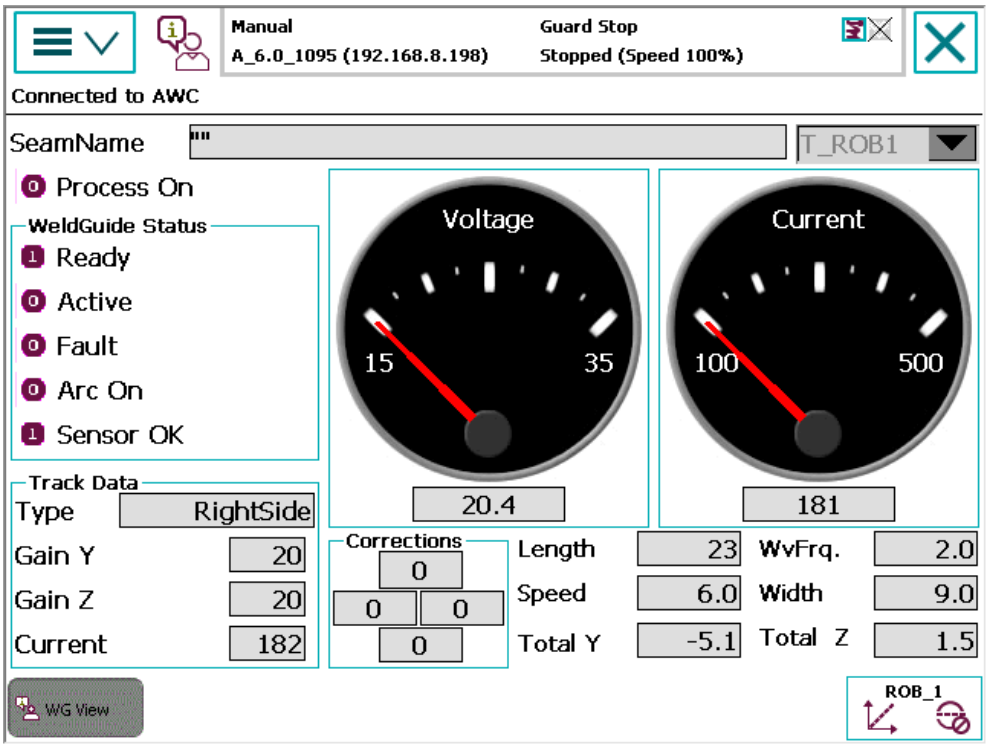
But because the correction calculations are synchronized with the weave pattern, a weave with almost zero width is required. See Figure below.



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Operator user interface

The WeldGuide feature is easily activated through the operator FlexPendant unit, which is an easy to use graphical user interface. Through the FlexPendant the operator can access weld data, such as wire feed speed, voltage, travel speed. With this software option the operator will also get access to specific WeldGuide track data parameters, which is easily selected and adjusted from the display.



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Requirements

The option WeldGuide for RobotWare Arc communicates within the robot controller through the RS232 serial port. The robot hardware option *[714-1] RS232 to 422 converter* is needed as the hardware AWC unit communicates through an RS484 serial connection. WeldGuide parameters are factory downloaded using the provided parameters disk, and the AWC Companion software installed on a laptop PC,

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14.3.4 WeldGuide [815-2]
Continued

following the hardware option delivery. Parameters can be transferred between the PC and the WeldGuide software through the serial port.

Note

The RW Arc option *WeldGuide* does not include the AWC hardware option.

For more information see separate product application price list.

Limitations

The following limitations apply for WeldGuide (815-1 or 815-2) in a MultiMove system:

- If more than one robot is to be equipped with WeldGuide, multiple serial channels are needed. This is available on request only (based on the previous main computer).
- Multiple WeldGuides can not be used when the workpiece is held by a mechanical unit (robot or positioner). This limitation applies also when the workpiece is stationary during welding.

RAPID instructions

RAPID instructions included in this option:

For more information, see *Operating manual - Seam tracking with Weldguide III and MultiPass*.

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14.4 BullsEye [652-1]

General

BullsEye™ provides completely automated Tool Center Point (TCP) definition for welding robots controlled by the IRC5 robot controller. By checking and updating the TCP alignment at regular intervals the robot will always operate with an accurate TCP.

Features

The following main tasks can be handled from the BullsEye software options:

- Definition of tool data.
- Definition and programming of QuickCheck™ procedures.
- Definition and programming of full scan sequence and update the tool data.
- Programming of extended Electrode Extension (Wire Stick-out) on existing tool data.
- Instruction to view the deviation in tool data that has been checked over time.

Description

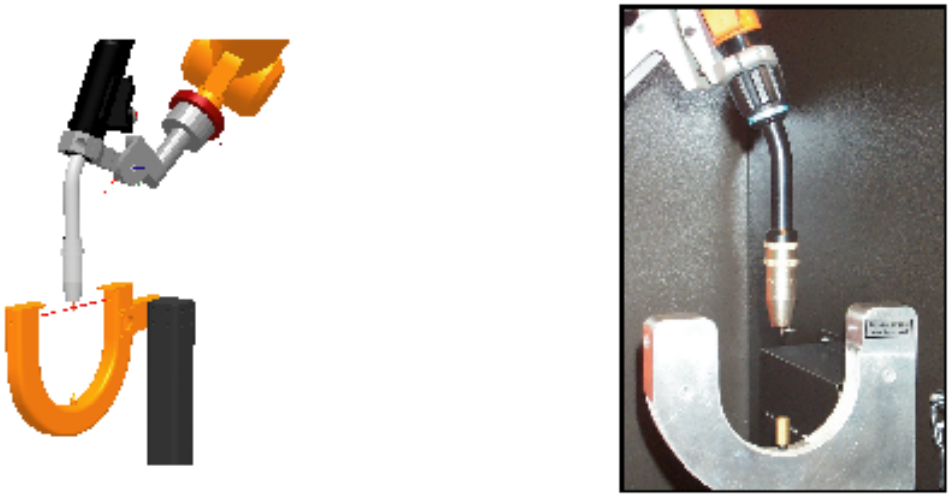
The robot moves the welding wire across an optical beam in several different orientations and the TCP is calculated through triangulation. At designed intervals, the robot can be programmed to zero in on BullsEye, do a quick check in about 10 seconds, and go back to work. If the TCP is misaligned BullsEye automatically recalculates TCP and torch angle.

The BullsEye software option will give the user the possibility to define and program a standalone BullsEye hardware device, see below pictures of different available hardware. The BullsEye arc option includes software that is loaded into all arc welding motion tasks, which must be involved when programming a TCP (Tool Center Point) check activity in a robot system.

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14.4 BullsEye [652-1]
Continued



(A) (B)

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Pos	Description
A	North American version
B	European version

The above standalone hardware versions are available in the separate price lists for application products.

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14.5 Spot 6 [635-6]

General

The *RobotWare Spot* option is a general and flexible software platform for creation of customized and easy to use function packages for different types of spot welding systems and process equipment.

There are three different **main** Spot configurations supporting spot welding, two for servo guns and one for pneumatic guns. All Spot configurations provides dedicated spot welding instructions for fast and accurate positioning combined with gun manipulation, process start and supervision of the different gun equipment. The included instructions can be used for sequential welding with one or several gun equipment or for welding with up to four guns at the same time.

The Spot configurations are also general and can be customized extensively. They have a default "ready to use" functionality directly after installation and can be if needed, customized via process configuration.

The Spot option software is also distributed separately from RobotWare as a RobotWare Add-In, accessible from the RobotStudio Add-Ins Gallery. The SpotWare Add-in has is own release cycle and is not connected to a specific RobotWare release. This allows for faster update of the software when needed.

Features

The Spot option packages contain the following features:

- Fast and accurate positioning using the unique *QuickMove* and *TrueMove* concept.
- Gun pre-closing, gun closing will be synchronized with robot reaching the weld position to save cycle time.
- Software equalizing functions (if the Spot Servo Equalizing configuration is installed).
- Support for mechanical gun equalizing systems.
- Support functions for tip wear management.
- Constant or changeable gun force during welding for servo guns.
- Gravity compensation of gun force during welding.
- Calibration functions for servo guns.
- Detection of missing or improper plates for servo guns.
- Reverse execution with gun control.
- Manual actions for welding and gun control.
- Support for fast tool changing between up to 8 different servo guns. Note that this requires the option *630-1 Servo Tool Change*.
- Support for simultaneous welding with up to **four** guns at the same time (for MultiMove systems with 2 robots, up to two guns each for simultaneous welding).
- Several simulation possibilities for test purposes.
- Weld error recovery with automatic re-weld.

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- Default "ready to use" functionality directly after installation if a SpotPack configuration is selected.
- Wide customizing possibilities, process data types, spotdata, gundata, such as weld counters and tip wear data, for each used gun.
- Built in error handling and possibility for customizable user-defined supervision and error recovery.
- A dedicated Spot operator interface on the FlexPendant.
- Integrated weld equipment fault management (for the options *782-x Bosch Weld timer*)
- Support for Spot-welding on **two robots** in a MultiMove system, and run semi coordinated using WaitSyncTask. Note that option *634-1 MultiProcess* is required for more than one robot in a MultiMove system.
- Possibility to run some Spot functionality without a robot selected, i.e. a stand-alone controller system.
- Possibility for weld process data access. Note that option *1585-1 Process data access* is required.

SpotWare Servo Equalizing Features

For the Spot Servo Equalizing configuration the gun equalizing features are embedded in the Spot Servo process software. Spot Servo Equalizing allows you to solve spot welding gun equalizing without mechanical equalizing hardware on the weld gun and thus provides an opportunity to reduce investment cost and improve productivity. Removed hardware on the gun also reduces weight, and in addition, no gravitational influence means easier optimizing when programming the robot path.Furthermore, with the Spot Servo Equalizing software instead of mechanical equalizing, less spare parts are required and lower maintenance costs are achieved. Spot Servo Equalizing is valid for:

- Robot mounted C- and X-type guns
- Pedestal C- and X-type guns
- Tool changing between guns with different equalizing data
- Weld position touch up - Simplifies adjustment of the programmed weld positions.
- Release of the fixed gun arm - Automatic gun arm release from the welded sheets when the robot is moving among weld points.
- Gun arm deflection compensation - The robot program compensates for the gun arm deflection automatically.
- Tip wear measurement and compensation - The robot program automatically compensates the weld gun TCP (Tool Center Point) for tip wear without using external sensors.
- The equalizing type (mechanical or software) is determined by data set in the gundata for each used gun.
- SoftMove Equalizing - The robot will be set to a "soft state" in the tool z-direction during the gun closing.

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Application

The RobotWare Spot option can be used in any spotwelding process. The robot's movement and the spotwelding process are controlled from the instructions SpotL/SpotJ and SpotML/SpotMJ.

The spot welding process is specified by:

- Spot and equipment specific data types
- Spot and equipment specific process configuration
- The I/O configuration
- RAPID routines and global data for customizing purposes
- User modules

Spot instructions

Both the robot movement and the control of the spot weld equipment are embedded in the basic spot weld instructions `SpotL` and `SpotJ`. These are used for sequential welding and are available in all spot welding options. If welding with several guns simultaneously then `SpotML` or `SpotMJ` has to be used.

Instruction	Used to
`SpotL`	Control the motion, gun closure/opening and the welding process. Move the TCP along a linear path and perform a spot welding at the end position.
`SpotJ`	Control the motion, gun closure/opening and the welding process. Move the TCP along a non-linear path and perform a spot welding at the end position.
`SpotML`	Control the motion, gun closure/opening and 1 - 4 welding processes. Move the TCP along a linear path and perform spot welding with 1 - 4 gun equipments at the end position. Only available in option *3417-2 Spot Welding Premium* or *3417-3 Spot Welding Premium* Plus.
`SpotMJ`	Control the motion, gun closure/opening and 1 - 4 welding processes. Move the TCP along a non-linear path and perform spot welding with 1 - 4 gun equipments at the end position. Only available in option *3417-2 Spot Welding Premium* or *3417-3 Spot Welding Premium* Plus.
`IndGunMove`	Set the servo gun in independent mode and thereafter move the gun to a specific independent position.
`IndGunMoveReset`	Reset the independent mode for servo gun.
`SetForce`	Close the gun a predefined time then open the gun.
`OpenHighLift`	Open the pneumatic gun to the highlift position (large gap).
`CloseHighLift`	Close the pneumatic gun to the work stroke position (small gap).
`CalibL`	Calibrate the servo gun during linear movement to the programmed position.
`CalibJ`	Calibrate the servo gun during non-linear movement to the programmed position.
`Calibrate`	Calibrate the servo gun in current position without movement.
`STTune`	Tune motion parameters for the servo gun.
`STTuneReset`	Reset tuned motion parameters for the servo gun.

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Instruction	Used to
`MeasureWearL`	Measure the tip wear and recalculates the TCP. Only available if *Spot Servo Equalizing* is installed.
`ReCalcTCP`	Calculates the tip wear and recalculates the TCP. Only available if *Spot Servo Equalizing* is installed.

Limitations

- Spot Servo Equalizing can only be applied during sequent welding (not with several guns simultaneously, SpotML).
- RobotWare Spot can be applied on two robots running independently in a MultiMove system. The spot motion instructions cannot be run synchronized, only semi coordinated motion is supported, using `WaitSyncTask`.
- The SoftMove function in Spot Equalizing has been validated on large serial link robots. The SoftMove performance depends on the specific robot.

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14.6 Movable gun arm search [1583-1]

General

The movable gun arm search method can be used as a complement to the standard software equalizing method if there is a need to compensate for programming errors, or tolerance variations, that is, the plates are not located exactly in the nominal position.

When a spot instruction with search mode activated is run, the robot will move to the programmed and nominal position, and then use the external axis for the gun to search for the plates and adjust the TCP in the tool z-direction based on search hit distance.

Prerequisites

Movable gun arm search mode is available for the `SpotL` and `SpotJ` instructions, and it is only available if the RobotWare options *Spot Welding (635-6) and Spot Servo Equalizing* configuration and *Movable gun arm search* (1583-1) are installed together.

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14.7 Process Data Access [1585-1]

General

If the additional Spot configuration Process data access is included when creating a spot system, some data from the weld process sequence and the status of the current ongoing weld will be stored in an internal data record and stored a log file when executing spot welding instructions. The process data contains various information related to the process, such as target ID, spot ID, gun force and process OK/not OK.

The data record and log file will always be updated regardless of situation, weld completed, an error situation or if the spot instruction is aborted and skipped for some reason.

Prerequisites

Process data access is only available if the RobotWare option *Spot Welding (635-6)* is installed.

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14.8 Bosch Interface [832-1]

General

The Bosch interface option is used to simplify programming and monitoring of the Bosch weld timer. The option includes a robot FlexPendant interface that could be used for setting or editing weld parameters, monitor weld status and give easy access information if weld error occurs.

The option is integrated as an add on functionality to the RobotWare Spot option:

- Option 635-6. Spot Welding

Features

The features within the option are designed to support needs during normal production conditions. Some examples of useful functions are given below:

- Features to set or edit the weld parameter
- Information about weld errors plain text and also proposal of recovery steps
- Pre-warning of electrode wear
- Information of last performed weld

Weld timers

The option is prepared to be used in combinations with the following weld timers:

Weld timer	Description
Bosch PSI 61C0.751OEM	Option 782-13, Bosch MFDC ProfiNet

The option includes both software as well as necessary additional cabling between the weld timer and the robot controller.

Limitations

This software does not replace the need for the PC software BOS5000/6000 wich is needed during setup, and to backup parameters etc.

Advanced setup and configuration can not be performed from this software, this software is a complement to the BOS5000/BOS6000 PC software.

Before using the Bosch interface option some necessary setup is needed. This is done by using a Bosch specific PC software (BOS5000/BOS6000). The PC software will also be required if extra ordinary weld faults (hardware faults) occur.

It is only possible to connect one weld timer to a robot controller since there is only one serial communication connection on the robot controller.

This option can not combined with option *MultiProcess* [634-1].

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14.9 Dispense [641-1]

General

The *RobotWare Dispense* option provides support for different types of dispensing processes such as gluing and sealing. The option provides fast and accurate positioning combined with a flexible process control. Communication with the dispensing equipment is carried out by means of digital and analog outputs. *RobotWare Dispense* is an option that can be extensively customized.

Features

- On/Off gun support
- Proportional gun support
- Handles up to 4 gun equipment in the same program
- Fast and accurate positioning and process control
- Dispensing in wet or dry mode
- Restart an interrupted dispensing sequence
- Speed proportional AO
- Different anticipated times for the DO and AO
- Equipment delay compensation for the TCP speed proportional analog signals
- Global or local flow rate correction factors
- Automatic reduction of the robot acceleration/deceleration during dispensing
- Wide opportunities of customizing the functionality to adapt to different types of dispensing equipment
- A dedicated Dispense GUI on the FlexPendant
- RobotWare Dispense can also be used in MultiMove system, where up to four dispensing robots can be controlled from the same IRC5 system.
- Dispense robots can be combined with other process application robots in one MultiMove system.

Application

RobotWare Dispense can be used in any gluing or sealing process.

The robot's movement and the dispensing process are controlled from the instructions DispL and DispC.

A dispensing process is specified by:

- Bead specific dispensing data
- Equipment specific dispensing data
- Equipment specific process configuration
- RAPID routines and global data for customizing purposes
- System Module DPUSER
- The I/O configuration

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RAPID instructions

RAPID instructions included in this option:

Instruction	Description
DispL	Move the TCP along a linear path and perform dispensing with the given data
DispC	Move the TCP along a circular path and perform dispensing with the given data

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14.10 Packaging

14.10.1 PickMaster Ready

14.10.1.1 PickMaster Cell Ready [1580-1]

General

The option *PickMaster Cell Ready*

- Checked by PickMaster Runtime when connecting to a robot, during commissioning when configuring position source and when starting a recipe
- The license is needed to enable PickMaster Runtime with vision for one robot
- Digital I/O is needed for PickMaster functions
- The option is used with Conveyor Tracking options: *Conv. Tracking unit Int.* [1550-1], *Conv. Tracking unit Ext.* [1551-1], *Tracking unit interface* [1552-1]

Includes RobotWare options

- *Conveyor Tracking* [606-1]
- *PC-Interface* [616-1]
- *PickMaster Vision Ready* [1581-1]

Limitations

The option *PickMaster Cell Ready* is not possible to combine with option:

- *Multi Move* [604-1,604-2]

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14.10.1.2 PickMaster Robot Ready [1580-2]

General

The option *PickMaster Robot Ready*

- Checked by PickMaster Runtime when connecting to one robot without vision and when starting a recipe
- The license is needed for a robot to be included in PickMaster Runtime
- Digital I/O is needed for PickMaster functions
- The option is used with Conveyor Tracking options: *Conv. Tracking unit Int.* [1550-1], *Conv. Tracking unit Ext.* [1551-1], *Tracking unit interface* [1552-1]

Includes RobotWare options

- *Conveyor Tracking* [606-1]
- *PC-Interface [*616-1]

Limitations

The option *PickMaster Robot Ready* is not possible to combine with option:

- *Multi Move* [604-1,604-2]

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14.10.2 PickMaster Vision

14.10.2.1 PickMaster Vision Ready [1581-1]

General

The option *PickMaster Vision Ready*

- Checked by PickMaster Runtime during commissioning when configuring position source and when starting a recipe
- The License is needed to receive positions generated by a sensor, either the standard vision or External Sensor
- Valid for multiple sensor driven position sources
- The option is included in *PickMaster Cell Ready* [1580-1]

Requirements

The option *PickMaster Vision Ready* requires option *PickMaster Robot Ready* [1580-2]

Limitations

The option *PickMaster Vision Ready* is not possible to combine with option:

- *Multi Move* [604-1,604-2]

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14.11 Prep. for PickMaster&PowerPac

14.11.1 PickMaster 3 [642-1]

General

Prepared for PickMaster/PickMaster 3 supports the PickMaster 3 application software residing on a PC. *Prepared for PickMaster* features together with the *PickMaster 3* application configurable integration of robots, vision and conveyors. The option contains all necessary functions and further options to interface PickMaster 3 and to run enhanced conveyor tracking. PickMaster 3 is approved for running on one IRC5 controller with multiple robots. For further information see *Product Specification - PickMaster 3*.

Feature

- Dedicated data types and instructions for efficient data transfer between PC and controller
- Built-in enhanced conveyor tracking capability with capability to control up to six conveyors. Maximum approved conveyor speed is 1400 mm/s.
- Enables run-time cell control by PickMaster with fully autonomous application startup
- Supports minimal parameterized RAPID code downloaded from PickMaster at startup
- Boundary checks and start/stop control on conveyors
- High performance camera trigger synchronization to fixed work areas and/or conveyor frames. Maximum eight work areas in total.
- Type and quality selection
- Advanced functions for mixing and sorting
- Approved for running two MultiMove robots on one controller.

Includes RobotWare options

- Advanced Rapid
- Fixed Position Events
- Tracking functionality included
- PC-Interface [616-1]

Application

Aimed for packaging applications, typically random high-speed picking and packing on the fly. Further, PickMaster 3 is the ideal standard vision integration for all robot types in material handling and machine tending applications.

Performance

See *Product specification - PickMaster® 3*.

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14.11.1 PickMaster 3 [642-1]
Continued

Requirements

Each robot operated by PickMaster requires the option *Prepared for PickMaster*.

- At least one *digital Local I/O device* options *Base Dig. 16In/16Out [1541-1] or Add-on Dig. 16In/16Out [1542-1] **
- To support conveyor tracking, software option *Tracking unit interface [1552-1]* is needed **). This option is included with *Conveyor Tracking unit options [1550-1] and [1551-1]*
- *Tracking Unit interface [1550-1] or [1551-1]* is required to support 1-4 conveyors **). This option can be shared remotely with neighboring controllers via a local network
- Cannot be combined with *Conveyor Tracking [606-1]*

* Alternativeely, one *Digital 24 VDC I/O [716-1]* or *AD Combi I/O [717-1]*

** Alternatively, one *encoder interface unit [726-1]* is needed for each conveyor work area

Limitation

For IRB 390, it is not available to select [642-1] together with *Multi Move* [604-X].

PickMaster 3 user manual

The PickMaster user manual describes the application as well as related RAPID data and instructions in detail.

RAPID data types	RAPID Instructions
itmsrc	AckItmTgt
itmsrcdat	CreateInstDat
itmtgt	FlushItmSrc
selectiondata	FreeAllItmSrc
sortdata	FreeItmSrc
	GetAllItmSrc
	GetItmTgt
	ItmSrcByName
	NewItmSrc
	NextItmTgtType
	QstartItmSrc
	QstopItmSrc
	ResetItmSrc

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14.11.2 Palletizing PowerPac [642-2]

General

Prepared for Palletizing PowerPac works with the offline Palletizing PowerPac software residing on a PC. It features a flexible ease of use application software for palletizing. *Prepared for Palletizing PowerPac* operates alone in runtime independently on the controller as a self-contained single cell application. The application is operated by the FlexPendant Palletizing application. The option contains all necessary functions and further options to interface Palletizing PowerPac and to run the application. Palletizing PowerPac is approved for running on one IRC5 controller with one single robot. For further information see *Product specification - Palletizing PowerPac*.

Features

Palletizing PowerPac offers advanced automated palletizing functions for multi-station cells and mixed pallet loads. It is configured and commissioned through a Palletizing PowerPac PC-application residing on a standard laptop computer. Palletizing PowerPac is Robot Studio Add-In, hence offers all the advantages of offline robot programming, which is found in Robot Studio.

Dedicated data types and instructions for efficient template based RAPID execution and application information exchange. Open code for user enhancements. Dedicated FlexPendant application for launching and controlling Palletizing PowerPacprojects.

- Fully autonomous operation without online PC-connection
- Dedicated palletizing production panel on the FlexPendant.
- Parametrized fly-in and –out trajectories
- Stack search functions
- Safety height calculations
- Built-in automatic application sequencer logics
- I/O inter connectivity to station controls production run orders, and equipment.
- Integrated control of generic multiple zone grippers addressing both vacuum and mechanical grippers.
- Approved for running one robot per controller Applicable on both 4 and 6 axes robots

Includes RobotWare options

- Advanced Rapid [626-1]
- Fixed Position Events [609-1]
- FlexPendant Interface [117-1]
- PC-Interface [616-1]

Application

Aimed for pelletizing applications.

Performance

See *Product specification - Palletizing PowerPac*.

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14.11.2 Palletizing PowerPac [642-2]
Continued

Requirements

Each robot operated by Palletizing PowerPac requires the option *Prepared for Palletizing PowerPac*.

- To run a palletizing application, at least one I/O device is needed to exchange signal information between the robot controller and the PLC.
- Not together with MultiMove [604-1] or [604-2]

Palletizing PowerPac user manual

The Palletizing PowerPac user manual describes the application as well as related RAPID data, functions and instructions in detail.

RAPID data types	RAPID Instruction	RAPID Functions
pm_accdata	PmAckTarget	PmCalcIntermid
pm_acktype	PmCalcArmConf	PmGetEvent
pm_actiondata	PmErrorLog	PmGetTarget
pm_actionhandle	PmGetOperation	PmGetAction
pm_actiontype	PmGetWaByWobj	PmGetWaHeight
pm_eventdata	PmStartProj	
pm_eventtype	PmWaitProjStart	
pm_movetype		
pm_offsetdata		
pm_operationdata		
pm_ophandle		
pm_singareatype		
pm_targetdata		
pm_targethandle		
pm_wadescr		

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14.12 Force Control Base [661-2]

General

Force Control Base is an option that contains the RAPID instructions required to run force control. The option contains what was previously the option *Assembly FC* and the RAPID layer of the option *Machining FC*. The *Machining FC* GUI is still a separate option, *Machining FC GUI [877-1]*.

Assembly FC

Assembly FC (Force Control) is a set of functions, which will highly facilitate the use of robots for assembly tasks. Assembly is a very demanding application where parts with very small tolerances shall fit together, e.g shafts into gear wheels. Since tolerances are in the size of robot repeatability, this normally requires high accuracy fixtures and robots with very high precision and still the risk for position failure, where parts are stuck or damaged, is very high. In many cases also parts are not fixed but can have random positions, and thus traditional position controlled robots are not possible to use.

With *Assembly FC* and a 6-DOF Force/Torque sensor the robot is equipped with "tactile" sense and thus can handle the parts like a human worker, that is search along a predefined pattern and try pushing until parts slip into position with only small contact forces used. If measured force gets larger than desired the robot would move back so as to decrease the force. This will save both installation cost and programming time but also reduce the process cycle time.

Other areas where *Assembly FC* is useful are:

- Product testing - apply the same amount of force to a product repetitive
- Part mating
- Automated fastening

Assembly FC includes functions to use different predefined assembly patterns, designed for different tasks, but also possibility to combine some of them to create new patterns for more complex assembly tasks.

Machining FC

Machining FC is a set of functions, which will highly facilitate the use of robots for machining applications. *Machining FC* includes solutions for using force control in different machining applications where the robot needs to be sensitive to process forces. *Machining FC* offers two kinds of process control, optimized for different kinds of machining, namely *FC Pressure* and *FC Speed Change*.

FC Pressure functionality

With the FC Pressure functionality the robot will always keep a constant force against a surface, resulting in that the robot will follow the curvature of the surface.

The FC Pressure functionality is for example advantageous to use in machining processes like grinding and polishing where the robot needs to obtain a defined pressure (force) between the tool and part for proper result. With FC Pressure functionality, the programmed path roughly needs to follow the surface as the robot

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position will be adjusted to achieve the defined contact force between tool and part. This will save programming time as well as improve the product quality.

FC Speed Change functionality

FC Speed Change will allow programming at the maximum process speed and automatically slow down the robot when the machining forces are too high.

The FC Speed Change functionality can for example be favorable to use in a machining process like deburring, where the robot needs to slow down when hitting excessive burr, or even retract for sequential machining. The robot is position controlled, that is it will follow the programmed path, in this functionality. With the FC Speed Change functionality the robot will vary the processing speed. This will save programming time but also reduce the process cycle time.

Functional description

Normally robots are position controlled, which means that the robot is forced to move to a certain ordered position. If the robot is prevented to reach the target, the servo will increase power until max torque or collision is detected.

With *Assembly FC* it will be possible to let the robot search along a surface while keeping a predefined contact force. Once the mounting hole is found, the part will “fall” into place and the robot will push the part in to the opening until correct position is reached.

A typical assembly task will for example be the mounting of axis and gear wheels in a clutch. Such a task will include several different movements to find the correct location and insert the axis. For any assembly task it will be possible to tailor the best optimum search pattern/movement and choose between a number of criteria for accepting/ending the operation.

With *Force Control for Machining* it will be possible to either let the robot maintain a constant force perpendicular to the path while following the surface curvature (FC Pressure) or let the robot slow down on the pre-defined path to reduce the force acting on the robot (FC Speed Change).

About FC Pressure

The purpose of FC Pressure is to make the robot sensitive to contact forces perpendicular to the move direction. The robot can “feel” its surroundings and follow the surface of the processed part to obtain a certain pressure against an object. This means that the robot will change its position in order to apply a constant force/pressure on a surface, even if the exact position of the surface is not known. Since pressure is obtained by moving the robot path, this function is more suited for polishing, grinding and cleaning, where a surface should be made even and smooth. The material that is removed and the changes of the surface topology / dimensions depends on the process parameters like tooling, applied pressure, robot speed etc.

See below some examples from foundry and metal fabrication where FC Pressure is useful:

- Grinding of faucets
- Polishing of kitchen sinks

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- Deflashing and cleaning of castings
- Deburring of castings

About FC Speed Change

In processes where path accuracy is important and where the finished result shall comply with specific dimensions, FC Speed Change is recommended. This function will be useful combined with force sensor or other input indicating excessive forces, which can negatively affect the finished result. When speed change is active and if machining forces exceed a certain value, then the path speed will automatically be reduced, thus decreasing forces, minimizing changed dimensions due to deflections of the robot arm and most probably avoid damaging the part/tool due to stress and heat. This will guarantee path accuracy even if much material shall be removed. Some examples where FC Speed Change may be used:

- (Wheel) Grinding unevenly distributed material on casted surfaces
- Milling along the edge of a work piece
- Deburring along contour of a work piece
- Deflashing unevenly distributed burr along a part line on castings
- Deburring of castings

Assembly FC features

- Sensor calibration and load identification, which will calibrate the force sensor to remove offsets such as the gravity force. RAPID instructions: `FCCalib, FCLoadId`
- Activation and deactivation of Force Control. When activating Force Control for instance the following can be set up.
- Force control coordinate system
- Damping, that is how the robot speed depends on the contact force. RAPID instructions: `FCAct, FCDeact, FCRefStart`
- Definition of reference values (desired force, torque and/or search pattern). When activating a force/torque reference, the robot will move in order to achieve the specified reference level. When activating a search reference, the robot will attempt to move according to the specified pattern, like circular, spiral or linear movement. RAPID instructions: `FCRefForce, FCRefLine, FCRefCircle, FCRefSpiral, FCRefSpringForce` etc.
- End conditions (how long to apply the force, torque and search pattern). The reference force, torque and movement is used to search for a fit. The end conditions are used to determine when this search has been successful. All conditions have a time-out that allows execution to continue even if the end condition is not met. RAPID instructions: `FCCondPos, FCCondForce, FCCondTime, FCCondWaitWhile` etc.
- Supervision, that is Force Control data can be supervised and limits set that must be met. Any data outside supervision conditions will result in an emergency stop. This can be used as a safety measurement by limiting the work area, robot speed, etc. RAPID instructions: `FCSupvForce, FCSupvPos` etc.

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- Functions providing feedback from the process, which will give a snapshot of some process data like contact forces, actual load, speed, or if the condition was met or if timed out. RAPID functions: `FCGetForce`, `FCGetProcessData`, `FCIsForceMode`
- Data types supporting the instructions and functions
- Up to four robots can be controlled independently in a MultiMove cell.

Machining FC feature

- Instructions for programming FC Pressure start, movements and stop.
- Instructions for activating/deactivating FC Speed Change.
- Instruction to setup gravity compensation and sensor offset calibration.
- Instructions for defining reference values (desired force, speed change parameters or movement).
- Instructions for defining recover function for Speed Change
- Instructions for supervision.
- Functions returning data about load, detected forces or process status.
- Data types supporting the instructions and functions

Example of setting up an assembly application

The following steps will illustrate how to set up a new assembly task:

1. Calibrate force sensor
2. Calibrate work piece weight and center of gravity
3. Done once for one type of work piece by executing a RAPID program
4. Determine start point to activate force control, that is where contact is possible
5. Determine nominal contact for magnitude and direction period during which assembly take place
6. Driving force to make two parts fit together

   No motion command necessary during this period
7. Determine the search pattern magnitude, frequency and direction
8. Determine supervision criteria

   Optional, may be used to prevent robot to move into fragile areas
9. Determine end point to deactivate force control

   Typical point for the completion of assembly
10. Activate Force Control and references and wait until criteria are fulfilled

    Robot will move until assembly end condition or time out is reached

Product

The option *Force Control Base* will include following:

- Advanced software for the force control
- A specific set of RAPID instructions for assembly
- A specific set of RAPID instructions for machining
- Manual

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The option *Force Control Base* requires the option *738-1, Prep. for Force Control*, adapted for force control.

The following is not included but must be purchased and installed separately:

- Force sensor to be mounted on mounting plate
- Cabling between robot and controller
- Interface board for the sensor, to be mounted in the controller on the axis computer

Force sensor

Force Control Base requires either a 6 DOF (Degree Of Freedom) full force/torque sensor or a 1 DOF Force sensor. The 6 DOF sensor offers more flexibility in force control directions than the 1 DOF sensor, as 1 DOF sensor only controls the force in one direction. With 1 DOF sensor it is normally very important that the tool is correctly orientated.

The choice of sensor input depends on the required flexibility of the application.

The sensor may be mounted on the robot (between the toolflange and the tool) or stationary in a room fixed position. It is not necessary to mount sensor and tool on the same place.

ABB Force sensor

ABB provides a 6 DOF force sensor that is fully integrated into the robot hardware and software.

The force sensor is included in a *Force Control Package*, which contains all required hardware and software to run the robot in force control mode. The specification of the *Force Control Package* can be found in *Product specification - Controller IRC5*.

ATI Force sensor

The ABB alternative 6 DOF sensors are ATI Force/Torque sensors of model Delta, Theta and Omega. See *http://ati-ia.com/* for more information.

The following items need to be ordered from ATI in order to complete the Force Control installation:

ATI provides the following Sensor product range adapted to ABB Force Control.

Items to complete the Force Control installation	Description
Sensor including adapter plate for ABB robot	See details of part number below
Connection cable	See details of part number below
ABB data disk	9030-05-1005

ATI Sensor Type, including adapter plate for ABB tool flange

Robot	Proposed sensor type
IRB 120	Mini45

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Robot	Proposed sensor type
IRB 140 IRB 2400L IRB 1600 IRB 2400-10/-16 IRB 2600	Delta
IRB 4400 IRB 4600	Theta Omega160
IRB 66XX	Omega160, Omega190, Omega250
IRB 7600	Omega250

These sensors and adapter plates are only recommendations. For correct selection depending on robot type, ATI should be consulted.

ATI IP-environment protection

Sensors are available in the following protection classes: IP60, Dust protection, IP65, Wet spray protection, IP65V, with Viton seals for applications with exposure to solvents and aggressive oils and IP68 for underwater protection (10m).

ATI Sensor Part number

The part number shall be:

Part number	Description
9105-TIF-Type-IPxx	Where: Type is equal to sensor type according to table in *ATI Sensor Type, including adapter plate for ABB tool flange on page 177*. IPxx is chosen according to *ATI IP-environment protection on page 178*.

ATI Cable Part number

The part number shall be:

Part number	Description
9105-C-Lx-AM-yy	Where: Lx has to be chosen L for IP60, IP65 and IP68, LV for IP65V yy will be chosen according cable length in meters that is required (from measuring board to sensor). Standard lengths available are 12, 17, 20, 25, 27, 32, 35 and 40 m (robot floor cable + 5 meter for small robots and 10 meters for large robots). Other lengths are available on request.

Limitations for Force Control Base

- *Force Control Base* is not available for IRB 260, IRB 360, IRB 460, IRB 660, IRB 760 and IRB 910SC.
- *Force Control Base* requires IRC5 controller (all variants).
- The total load, that is the sum of gravitational forces and external contact forces, must not exceed limits as specified in the load diagrams for a specific robot.
- If Force Control is used together with Electronic Position Switches, the function Operational Safety Range must be used. See the EPS manual.

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When the robot is force controlled, the following functionality is *not* accessible:

- *Arc*
- *Collision Detection*
- *Conveyor tracking*
- *Independent axes*
- *MultiMove Coordinated*
- Joint soft servo (instruction `SoftAct`)
- *Path Offset*
- *Path Recovery*
- *PickMaster*
- RAPID instructions such as `FCAct`, `FCDeact`, `FCConditionWaitWhile`, and `FCRefStop` can only be called from normal level in a motion task.
- *Sensor* or *Analog synchronization*
- *Sensor interface*
- *SoftMove*
- Tracking functionality like *Conveyor Tracking*, *Optical Tracking*, and *Weld Guide*.
- Force controlled pressure applications (FCPressL etc) and Force controlled speed change applications (FCSpdChgAct etc) cannot be combined with EGM instructions.
- *World Zones*

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14.13 RW Machining

14.13.1 Machining FC GUI [877-1]

General

Machining FC GUI is a set of instructions, which will highly facilitate the use of robots for machining applications. *Machining FC GUI* includes solutions for using force control in different machining applications where the robot needs to be sensitive to process forces. *Machining FC* provides a Graphical User Interface (GUI) supporting a new solution for solving difficulties in programming complex 3D paths through lead-through programming.

Lead-through programming

Lead-through programming: allow easy, quick and accurate creation of complex robot paths. It is supported by an icon based Graphical User Interface where the user first leads the robot by hand and then the robot automatically generates the path.

The *Machining FC GUI* requires a sensor input that measures the process forces that will adjust the behavior of the robot.

- The GUI requires a 6DOF sensor mounted on the robot.

About the Lead-through programming

Main components in the lead-through programming tool are:

- Lead-through
- Automatic Path Learning
- Testing of the path running the actual process
- Export of the final result to include in the original robot program

These features use online active force control technique, which means that the programming becomes less time consuming and more effective. The programming technique offered by this option is by teaching certain geometric targets by lead-through dragging and collision free jogging of the robot. Then the robot goes into a self-learning mode where the robot automatically follows the previous taught geometric positions exerting a pressure perpendicular to the work object and at the same time recording the path.

Machining FC GUI features

- Graphical User Interface on the FlexPendant for easy, quick and accurate programming

Examples of setting up a machining function

The following steps will illustrate how to set up a new FC Pressure task:

1. Identify the load and calibrate the system
2. Move to a point close to contact
3. Set up desired force and start movement towards the surface
4. Move linear or circular performing the process with contact.

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5 Leave surface and deactivate force control.

All of the above steps are supported in the GUI for lead-through programming through icon based programming wizard.

The following steps will illustrate how to set up a new FC Speed Change task:

1 Configure the parameters for speed change controller
2 Identify the load and calibrate the sensor (if 6DOF sensor is used)
3 Define recover function
4 Activate FC Speed Change
5 Execute the machining task; move along the path performing the process.
6 Deactivate FC Speed Change.

All of the above steps are supported in the GUI for lead-through programming through icon based programming wizard.

Product

The *Machining FC GUI* software option includes following:

- Advanced software for the force control
- An icon based Graphical User Interface supporting lead-through programming
- Manual

The option *Machining FC GUI* requires the option *Force Control Base*.

Limitations

- Force Control can not be activated when the robot is running in *MultiMove Coordinated* mode.
- The total load, that is the sum of gravitational forces and external contact forces, must not exceed limits as specified in the load diagrams for a specific robot.
- Force Control shall not and can not be activated simultaneously with the following functions:
  - *Sensor* or *Analog synchronization*
  - *Sensor interface*
  - *Conveyor tracking*
  - *Independent axes*
  - *SoftMove*
  - *Path Offset*
  - CAP with *Optical tracking*
  - *Arc*
  - *PickMaster*

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14.13.2 Machining Standard [877-2]

General

Machining Software provides the auto-calibration function that allows users to define calibration toolkits (eg. probe), cutters, external axis and work objects. The calibrated data can be copied to and reused in RAPID for other projects, which simplifies the calibration process.

Key features

Machining Standard provides the following main features:

- Web-based access to machining projects (using PC)
- Dedicated Machining application for working with machining projects (using FlexPendant)
- Auto-calibration on calibration toolkit, cutters, external axis and work objects

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14.13.3 Machining Premium [877-3]

General

Machining Software complements the Machining PowerPac - Machining Functionality (hereinafter referred as Machining PowerPac) add-in in RobotStudio. After creating programs in Machining PowerPac, users can synchronize or load the programs to Machining Software and then perform program tuning in web browser on PC or in the dedicated Machining application on FlexPendant. Different from Machining PowerPac that provides offline programming functions, Machining Software can load the tuned programs to the connected controller (virtual or real) directly. This improves programming efficiency and reduce the onsite commissioning time.

Key features

Machining Premium provides the following main features:

- Web-based access to machining projects (using PC)
- Dedicated Machining application for working with machining projects (using FlexPendant)
- Tuning programs created by Machining PowerPac, including path smoothing and instruction editing
- Auto-calibration on calibration toolkit, cutters, external axis and work objects

Versions

Machining Software provides two versions, Machining Standard (option 877-2) and Machining Premium (option 877-3), with different user access to functions. The following table lists the main functions to which the two options can access.

Function		Standard	Premium
File operations	File loading	X	X
	File export	X	X
Program tuning	Path smoothing		X
	Wave path setting		X
	Instruction editing		X
Auto-calibration	Toolkit calibration	X	X
	Cutter calibration	X	X
	Work object calibration	X	X

Note

Only one version can be installed on a controller at a time.

For the web-based Machining Software, if the version is changed, clean the browser cache and restart the browser to make the new version take effect. Otherwise, a version incompatibility message will be displayed.

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14.14 PROFIenergy [963-1]

General

PROFIenergy is a profile of the PROFINET communications protocol that allows the power consumption of automation equipment in manufacturing (such as robot assembly cells, laser cutters and sub-systems such as paint lines) to be managed over a PROFINET network. It offers an open and standardized means of controlling energy usage during planned and unplanned breaks in production. PROFINET is an open standard for Industrial Ethernet. PROFINET satisfies requirements for automation technology. PROFINET solutions can be implemented for factory and process automation, for safety applications, and for the entire range of drive technology right up to clock-synchronized motion control.

Application

For details, see *Application manual - PROFIenergy Device*.

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14.15 RobotWare Cutting [951-1]

General

RobotWare Cutting is a software product primarily developed for laser cutting and other similar cutting methods requiring advanced robot motion performance. The software provides an interactive user interface on the Flexpendant that helps program, configure and operate an ABB Robot in cutting applications.

The *RobotWare Cutting* software contains motion performance tools, such as automatic friction tuning, iterative learning control, and *WristMove*, which can substantially improve the path accuracy in laser cutting applications. The software also contains dedicated user interfaces that will help program and configure the motion performance tool set. To help the programmer the software incorporate simplified shape generation through a library of pre-defined shapes and cut instructions. These have automatic optimization and interaction to the other cutting components (friction tuning, iterative learning control, equipment classes, etc). To facilitate integration of external equipment such as cutting heads, laser sources, etc the software include pre-defined communication interfaces, equipment class templates, between the robot controller and the equipment. The pre-defined cut instructions and external equipment can be configured through user screens on the Flexpendant, which helps the programmer to program, install and configure a robotic cutting application. In addition the software supports standard ABB Robot motion features for example *TrueMove*, *QuickMove* and BullsEye.

ABB also offer a cutting add-in to the RobotStudio PC tool. The cutting add-in, called *RobotStudio Cutting PowerPac* currently includes feature based 2D cut instruction generation, wizard to generate customized 2D cut shape based on CAD models, free form path generation from the edges, simulation and pre-defined virtual signals for the cutting equipment.

Features

User interface

- Intuitive user interface for online programming
- Predefined 2D shape generation Instructions
- Auto shape tuning integrated with cut instructions
- Standard cutting and laser equipment interfaces
- HMI - Quick argument checking and editing

Customizable operator interface made by Screen maker

- General laser equipment operator interface
- Cell logic (support by Product Manger)

Shape generation

- Library of pre-defined shapes and cut instructions (Circle, Slot, Rectangle, Hexagon, CAD)
- Free-Form Cut Instructions (Linear, Circular)
- Automatic optimization and interaction to other cutting components

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Equipment interfaces

- Standard Laser Equipment functions controlled from dedicated equipment classes
- General cutting process interface for customized cutting equipment

Advanced shape tuning - automatic friction compensation

- Automatic tuning for optimum motion performance for a specific shape at a specific location

ILC - Iterative learning control

- Shape perimeter adjustment & compensation

Speed modulation

- Laser power can be modulated by TCP speed

Additional features (require additional robot options)

- WristMove - Movement method that only use two robot axes to move the tool
- BullsEye - Allows the operator to automatically define an accurate TCP

Application

The software is primarily targeting laser cutting applications. From a robotics perspective, laser cutting is typically characterized by high motion performance requirements, complex paths and shapes, and advanced equipment integration.

RobotWare options

RW Cutting includes the following RobotWare options:

- 602-1 Advanced Shape Tuning
- 617-1 FlexPendant Interface
- 611-1 Path recovery

Additional options that may be required for special use cases:

- 623-1 Multitasking
- 616-1 PC interface
- 812-1 Production Manager, in Installation Manager

Limitations

- *RobotWare Cutting* is not available as MultiMove system.
- *RobotWare Cutting* is available for IRC5 and all 6-axes ABB robots.
- The *RobotWare Cutting* option will not improve the motion performance for large robots.
- As a general rule of thumb, typically no improvement of motion performance can be achieved for circle diameters smaller than 3 mm or cutting speed above 400 mm/s. The unique conditions (robot, tools, material, fixtures, etc) in the cutting application will determine the overall performance.
- The software is not designed for cutting applications with high contact forces.
- Available languages are English and Chinese. Operator interface can be customized to any language with RobotStudio ScreenMaker.

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- *RobotWare Cutting* requires an additional option license that is delivered with the controller.
- *RobotWare Cutting* does not work together with option 633-4 Arc 6.

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14.16 RobotWare Machine Tending [1167-1]

General

RobotWare Machine Tending is a software product for programming, installation and operation of ABB robots in machine tending and material handling applications. The software can make it easier to manage the robot and the peripheral equipment in handling applications, both for the operator as well as for the programmer. It provides a RAPID framework and graphical user interface for programming and configuration.

The RAPID framework is modular and flexible as it is fully integrated with ABB's standard programming language. A set of RAPID data types, instructions and functions are provided in the *RobotWare Machine Tending* facilitating integration to application programs.

The software also provides an easy to understand and customizable graphical operator interface that facilitate trouble-free operation. The graphical user interface gives the users an overview of operating states of the stations and production processes. *RobotWare Machine Tending* has functions for production monitoring and control, hot edit, safe home run, production statistics, control over gripper actuation, selection of production cycles, user authorization, error handling, etc.

Features

Graphical user interface

- Visualization of the operating states and production processes
- Operation screen with information and status of stations and production cycles, and robot movements
- Customizable graphical user interface
- Gripper actuation and gripper monitoring
- Cycle handling and program control – Definition and selection of production cycles
- Execution of setup and service routines
- Advanced Hot Edit – modification of robot positions
- Automatic and safe HomeRun
- Error handling and messaging tasks
- Production statistics and other information available in the program
- Event log
- Signal status
- Status and error indication in colors

RAPID program framework

- Modular functions based on standard RAPID syntax - Data types, instructions and functions covering the following
  - Software engine that controls the program and necessary data to display graphic elements on the user interface
  - Instructions and functions signal handling, and parametrization and instructions to execute movement routines

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  - Data types, instructions and functions, for actuating and controlling the robot grippers
  - Association of events with routines
  - Declaration of signals and variables
  - Automatically return the robot to home from any position
- The RAPID framework provides several features such as
  - Different operating modes
  - Pre-condition check of part handling in production
  - Move robot to pre-defined service positions with help of digital input signals

Process configuration

- Configuration and parameterization of the machine tending process
  - Influence the appearance of the graphical user interface
  - Parameters with which the signals can be set for the remote operation of the RWMT-functions as well as other functional values
  - Parameters for signals and movements to positions, e.g. home position, safe position, and up to three service positions
  - Definition of the external interface, which is necessary to execute a pre-selected program or service request
  - Modify behavior of automatic and safe home run
- Configure the graphical user interface to start customized FlexPendant applications
- Pre-configured configuration files for Euromap and SPI

Performance

RobotWare Machine Tending has a modularized machine tending program structure, which essentially consists of three components:

- graphical user interface
- RAPID data types, instructions and functions
- process configuration

The user interface gives the operator and programmer an overview of the handling cell with all its stations such as the processing machines, conveyors, control stations, etc and it also contains control functions. A library of RAPID data types, instructions and functions supports creating the robot programs and designing the details of the user interface. *RobotWare Machine Tending* functionality can easily be modified through the process configuration, for example the graphical user interface appearance or the digital signal assignments that controls the most common functionality.

This gives a very powerful and flexible programming tool. Users can utilize advanced programming possibilities to create and modify stations, grippers and configuring program execution. The architecture of *RobotWare Machine Tending* makes it possible to integrate the software into existing robot automation cells, because the software only adds of additional data, commands and functions in the robot program.

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14.16 RobotWare Machine Tending [1167-1]
Continued

RobotWare Machine Tending works best together with the PC tool *RobotStudio Machine Tending PowerPac*. With the *RobotStudio Machine Tending PowerPac* users can program, simulate, and configure machine tending programs in an offline environment. The *Machine Tending PowerPac* is seamlessly integrated with the *RobotWare Machine Tending* software, which facilitates easy deployment, installation and operation.

Requirements

- RobotWare 5.15 and later
- Software option *617-1 FlexPendant interface* (included)
- Software option *608-1 World Zones*

Optional:

- Software option *623-1 Multitasking*
  - If interface signals or RAPID variables needs to be set to a specific value when operation mode changes, e.g. when using Euromap interface for injection molding machines

Limitations

- *RobotWare Machine Tending* cannot be used with *MultiMove Coordinated*
- *RobotWare Machine Tending* is available on all 6-axis robots.
- *RobotWare Machine Tending* is available on following 4-axis robots, IRB 260, IRB 460, IRB 660 and IRB 760.
- *RobotWare Machine Tending* requires an additional option license that is delivered with the controller
- Application manual available in English. Additional languages will follow.
- Operating manual available in multiple languages.
- Default operator interfaces on the FlexPendant is available in English, but it is possible to customize to any language by the user.

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14.17 Prepared for PaintWare [1594-1]

General

The option *Prepared for PaintWare* is intended for applications where industrial robots work together with paint robots. This option enables the same I/O functionality as the paint robots have, thereby streamlining the integration.

The following options are included automatically:

- PC Interface [616-1]
- World Zones [608-1]
- Multitasking [623-1]

Requirements

This option is available for the following controllers:

- Single cabinet [700-3]
- Panel mounted modules [700-5]
- Compact 2nd generation [700-8]

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14.18 Other functions

14.18.1 Production Manager

General

Production Manager is a process independent middle-layer software running on the IRC5 controller.

Production Manager is working between the operating system of the robot and the end user application – that is true production ready software.

Production Manager is a software package, written in RAPID, used for production control.

Production Manager can be used in autonomous cells or in a PLC controlled production line

Production Manager has a highly modular structure that allows partners/line builders/customers to plug in applications. *Production Manager* provides no real value to the end-user without an application built on top of it. However, it provides a tremendous value to systems integrators, line builders and application developers, especially to secure compatibility with other applications and to avoid development of redundant functionality. *Production Manager* also decreases time to market for new features to be developed and provides the following benefits and features.

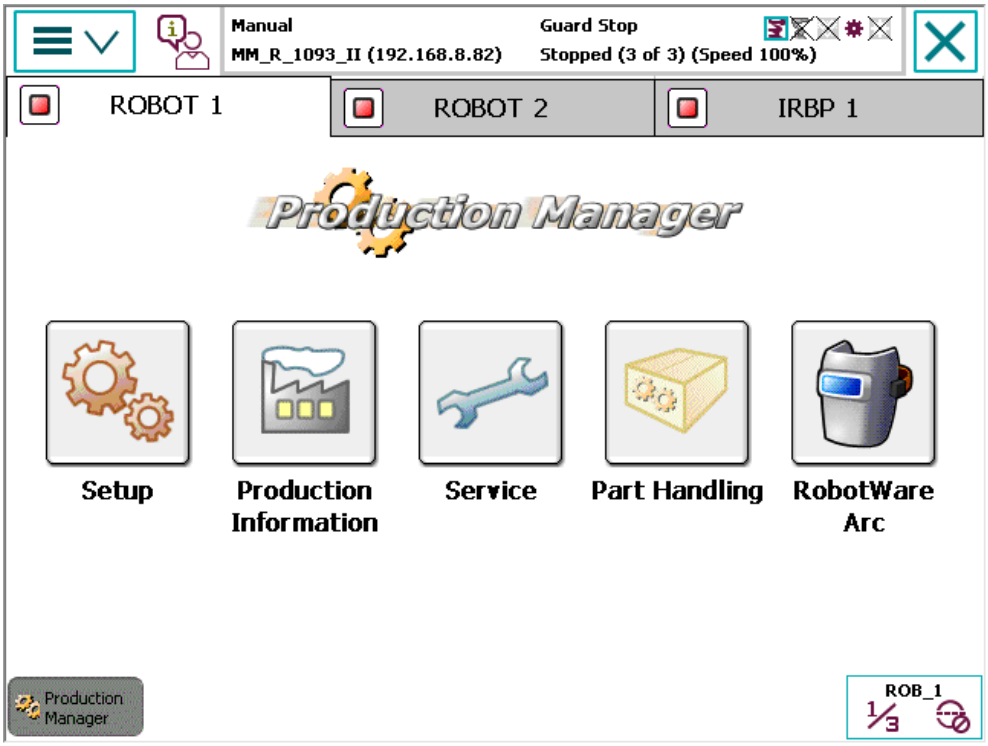
Production Manager can be selected in Installation Manager as an option.

Features

- Production Manager includes a FlexPendant user interface for running setup and service routines, managing part handling (Select, Test, Create, Edit), displaying production information, links to application interfaces etc.

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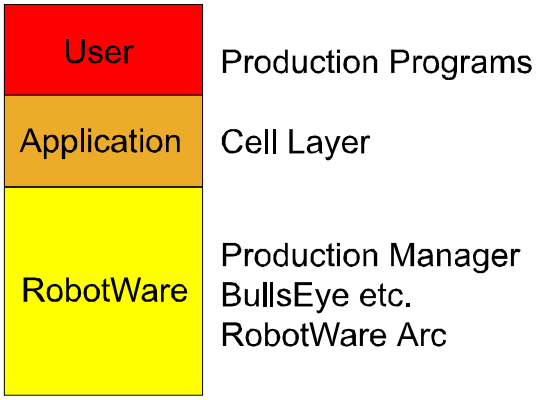
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- The possibility to automatically add entries to the *Production Manager* menu system (such as custom setup/service routines) enables a seamless plug-in behavior for add-on utilities.
- Part Handling. A *part* is a user defined set of RAPID code that performs some kind of task/production/etc. The GUI finds and lists the different parts (*Part* data instances) in the system. When selected, the part in question is "activated" for execution. Each motion task has its own *Part Go* signal. Setting this signal triggers the execution of the selected *Part*.
- Utilization of strong concepts provided by *Production Manager*, such as part handling and production cycle enables logging of production statistics. This creates a perfect situation for monitoring and traceability of production.
- One of the strengths of *Production Manager* is the ability to handle MultiMove synchronization and interlock issues. This is typically one of the main challenges for the system integrators when integrating a line or cell with multiple robots.
- OpReady & PLC interface.
- UAS Support
- One of the most important technical innovations that Production Manager provides is a three-tier architecture for application development, which enables application developers to separate application RAPID code from the end-user’s RAPID code.

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14.18.1 Production Manager
Continued



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Application code

The application code that defines a complete system is developed in RAPID based on *Production Manager*, and is implemented as a middle-layer software between RobotWare and the user code. Application code is called "Cell Layer".

A typical cell layer includes:

- Call to execution engine from main procedure (`ExecEngine;`)
- Configuration of *Production Manager* on FlexPendant
- Definition of robot positions, such as home and service
- Supervision of home and service positions
- Definition of workstations for station interchange
- I/O signals for Operator Ready signals and/or PLC interface Definition of safety signals, such as light beams and curtains
- Supervision of safety signals
- Definition of service and setup routines (menu data)
- Miscellaneous user defined routines before and after part execution

Cell layer code is booted into the system and is built-in, which creates a transparent behavior with several benefits:

- User domain is clean and uncluttered
- Additional Option is revision controlled
- Additional Option code not included in system backup
- Possible to upgrade Additional Option without having the Restore function revert to old version

User code

The user code consists mainly of motion and process programs. Each program typically performs a processing task (arc welding, spot welding, laser cutting, painting etc…) for production of a part. These programs are called "Part Programs".

RAPID instructions

	Instructions	Description
ExecEngine		Run production loop

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	Instructions	Description
GetNextPart	`(\num gapTaskNo, num station, VAR partdata retData\VAR string instanceName)`	Get active part for station in task.
SetNextPart	`(\num gapTaskNo,num station, PERS partdata newData)`	Activate part for station in task.
UpdateNextPart	`(\num station, partdata updData)`	Update active part for station in task.
bool AtSafe	`(\num taskNumber)`	Task at safe (manipulator).
bool AtService	`(\num taskNumber)`	Task at service (manipulator).
num AtState	`(\num taskNumber)`	Task state. `GAP_STATE_UNKN:=0;` Unknown state/not running `GAP_STATE_IDLE:=1;` Executing but idle `GAP_STATE_SETUP:=2;` Executing setup routine `GAP_STATE_PART:=3;` Executing part `GAP_STATE_SERV:=4;` Executing service routine
num AtStation	`(\num taskNumber)`	Task at station.
num NextStation	`(\num taskNumber)`	Next station for task.
RunMenu	`(\num gapTaskNo,VAR menudata menu)`	Run menu from RAPID in task.
GapSetupStop	`(\switch NoRegain)`	Stop if tasks state is `GAP_STATE_SETUP`.

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