Motoman XRC 2001 Controller

RCS Module Instructions

Part Number:	147595-1
Release Date:	December 9, 2005
Document Version:	1
Document Status:	Final

MOTOMAN a YASKAWA company

Motoman, Incorporated
805 Liberty Lane
West Carrollton, OH 45449
TEL: (937) 847-6200
FAX: (937) 847-6277
24-Hour Service Hotline: (937) 847-3200

Chapter 1
Introduction

1.1 About This Document

This manual provides information for the RCS Module and contains the following sections:

SECTION 1 - INTRODUCTION
Provides general information about the structure of this manual, a list of reference documents, and customer service information.

SECTION 2 - SAFETY
This section provides information regarding the safe use and operation of Motoman products.

SECTION 3 - RCS MODULE INSTRUCTIONS
Provides detailed instructions for the RCS Module.

SECTION 3 - RCS MODULE for IGRIP
Provides detailed instructions for the RCS Module for IGRIP.

SECTION 3 - RCS MODULE for ROBCAD
Provides detailed instructions for the RCS Module for ROBCAD.

1.2 Reference to Other Documentation

For additional information refer to the following:

- NX100 Controller Manual (P/N 149201-1)
- Concurrent I/O Manual (P/N 149230-1)
- Operator's Manual for your application
- Vendor manuals for system components not manufactured by Motoman

1.3 Customer Service Information

If you are in need of technical assistance, contact the Motoman service staff at (937) 847-3200. Please have the following information ready before you call:

- Robot Type (EA1400, HP50, etc.)
- Application Type (handling, welding, etc.)
- Robot Serial Number (located on back side of robot arm)
- Robot Sales Order Number (located on back of controller)

Chapter 2
Safety

2.1 Introduction

It is the purchaser's responsibility to ensure that all local, county, state, and national codes, regulations, rules, or laws relating to safety and safe operating conditions for each installation are met and followed.

We suggest that you obtain and review a copy of the ANSI/RIA National Safety Standard for Industrial Robots and Robot Systems. This information can be obtained from the Robotic Industries Association by requesting ANSI/RIA R15.06-1999. The address is as follows:

Robotic Industries Association
900 Victors Way
P.O. Box 3724
Ann Arbor, Michigan 48106
TEL: (734) 994-6088
FAX: (734) 994-3338
INTERNET: www.roboticsonline.com

Ultimately, the best safeguard is trained personnel. The user is responsible for providing personnel who are adequately trained to operate, program, and maintain the robot cell. **The robot must not be operated by personnel who have not been trained!**

We recommend that all personnel who intend to operate, program, repair, or use the robot system be trained in an approved Motoman training course and become familiar with the proper operation of the system.

This safety section addresses the following:

- Standard Conventions (Section 2.2)
- General Safeguarding Tips (Section 2.3)
- Mechanical Safety Devices (Section 2.4)
- Installation Safety (Section 2.5)
- Programming, Operation, and Maintenance Safety (Section 2.6)

2.2 Standard Conventions

This manual includes the following alerts – in descending order of severity – that are essential to the safety of personnel and equipment. As you read this manual, pay close attention to these alerts to insure safety when installing, operating, programming, and maintaining this equipment.

DANGER!
Information appearing in a DANGER concerns the protection of personnel from the immediate and imminent hazards that, if not avoided, will result in immediate, serious personal injury or loss of life in addition to equipment damage.

WARNING!
Information appearing in a WARNING concerns the protection of personnel and equipment from potential hazards that can result in personal injury or loss of life in addition to equipment damage.

CAUTION!
Information appearing in a CAUTION concerns the protection of personnel and equipment, software, and data from hazards that can result in minor personal injury or equipment damage.

Note: Information appearing in a Note provides additional information which is helpful in understanding the item being explained.

2.3 General Safeguarding Tips

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. All personnel involved with the operation of the equipment must understand potential dangers of operation. General safeguarding tips are as follows:

- Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation of this robot, the operator's manuals, the system equipment, and options and accessories should be permitted to operate this robot system.
- Do not enter the robot cell while it is in automatic operation. Programmers must have the teach pendant when they enter the robot cell.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).
- The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- In accordance with ANSI/RIA R15.06-1999, section 4.2.5, Sources of Energy, use lockout/tagout procedures during equipment maintenance. Refer also to Section 1910.147 (29CFR, Part 1910), Occupational Safety and Health Standards for General Industry (OSHA).

2.4 Mechanical Safety Devices

The safe operation of the robot, positioner, auxiliary equipment, and system is ultimately the user's responsibility. The conditions under which the equipment will be operated safely should be reviewed by the user. The user must be aware of the various national codes, ANSI/RIA R15.06-1999 safety standards, and other local codes that may pertain to the installation and use of industrial equipment. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. The following safety equipment is provided as standard:

- Safety fences and barriers
- Light curtains and/or safety mats
- Door interlocks
- Emergency stop palm buttons located on operator station, robot controller, and programming pendant

Check all safety equipment frequently for proper operation. Repair or replace any non-functioning safety equipment immediately.

2.5 Installation Safety

Safe installation is essential for protection of people and equipment. The following suggestions are intended to supplement, but not replace, existing federal, local, and state laws and regulations. Additional safety measures for personnel and equipment may be required depending on system installation, operation, and/or location. Installation tips are as follows:

- Be sure that only qualified personnel familiar with national codes, local codes, and ANSI/RIA R15.06-1999 safety standards are permitted to install the equipment.
- Identify the work envelope of each robot with floor markings, signs, and barriers.
- Position all controllers outside the robot work envelope.
- Whenever possible, install safety fences to protect against unauthorized entry into the work envelope.
- Eliminate areas where personnel might get trapped between a moving robot and other equipment (pinch points).
- Provide sufficient room inside the workcell to permit safe teaching and maintenance procedures.

2.6 Programming, Operation, and Maintenance Safety

All operators, programmers, plant and tooling engineers, maintenance personnel, supervisors, and anyone working near the robot must become familiar with the operation of this equipment. Improper operation can result in personal injury and/or damage to the equipment. Only trained personnel familiar with the operation, manuals, electrical design, and equipment interconnections of this robot should be permitted to program, operate, and maintain the system. All personnel involved with the operation of the equipment must understand potential dangers of operation.

- Inspect the robot and work envelope to be sure no potentially hazardous conditions exist. Be sure the area is clean and free of water, oil, debris, etc.
- Be sure that all safeguards are in place. Check all safety equipment for proper operation. Repair or replace any non-functioning safety equipment immediately.
- Do not enter the robot cell while it is in automatic operation. Be sure that only the person holding the programming pendant enters the workcell.
- Check the E-STOP button on the programming pendant for proper operation before programming. The robot must be placed in Emergency Stop (E-STOP) mode whenever it is not in use.
- Back up all programs and jobs onto suitable media before program changes are made. To avoid loss of information, programs, or jobs, a backup must always be made before any service procedures are done and before any changes are made to options, accessories, or equipment.

- Any modifications to PART 1, System Section, of the robot controller concurrent I/O program can cause severe personal injury or death, as well as damage to the robot! Do not make any modifications to PART 1, System Section. Making any changes without the written permission of Motoman will VOID YOUR WARRANTY!
- Some operations require standard passwords and some require special passwords. Special passwords are for Motoman use only. YOUR WARRANTY WILL BE VOID if you use these special passwords.
- The robot controller allows modifications of PART 2, User Section, of the concurrent I/O program and modifications to controller parameters for maximum robot performance. Great care must be taken when making these modifications. All modifications made to the controller will change the way the robot operates and can cause severe personal injury or death, as well as damage the robot and other parts of the system. Double-check all modifications under every mode of robot operation to ensure that you have not created hazards or dangerous situations.
- Check and test any new or modified program at low speed for at least one full cycle.
- This equipment has multiple sources of electrical supply. Electrical interconnections are made between the controller and other equipment. Disconnect and lockout/tagout all electrical circuits before making any modifications or connections.
- Do not perform any maintenance procedures before reading and understanding the proper procedures in the appropriate manual.
- Use proper replacement parts.
- Improper connections can damage the robot. All connections must be made within the standard voltage and current ratings of the robot I/O (Inputs and Outputs).

Notes

Specification Document of YASKAWA's RCS-Module for YASNAC XRC

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

YASKAWA ELECTRIC CORPORATION

MANUAL NO. HW9482495 ◇2

1. Introduction

This manual has been described the specification of RCS-Module which YASKAWA Electric Corporation supports the RRS I/F specifications. You wish for the warning enough to handling because there is the following limitations when this manual is used.

(1) Information described to this manual might be changed without a previous notice for the product improvement.

(2) The reproduction or copy is prohibited to any part of this manual without agreement by the document of YASKAWA Electric Corporation.

2. Contents of YASKAWA's RCS-Module

2-1 Directory

The construction of Yasukawa's RCS-Module is as follows.

Directory of executable program for each CAR-Tool:

<YASKAWA_RCS_Top>¥<CAR-Maker Dir>

Directory of supported manipulator's parameter files:

<YASKAWA_RCS_Top>¥XRC

Directory of otherfiles:

<YASKAWA_RCS_Top>¥blackbox

2-2 Parameter File Name

On the Yaskawa's RCS-Module, each default file name of parameter which supports only one robot without travel axis or rotate axis is renamed from "All.prm" (standard name of robot parameter in Yaskawa) to "Manipulator Strings.prm" (e.g. The parameter file name of Motoman SK16-J00 is renamed from "All.prm" to "SK16_J00.prm") Please refer to Fig.1 for the Manipulator Strings.

Each default file name of tool data, user frame data and weaving condition data is also similarly changed to the manipulator's string.

3. Install

Please install the RCS-Modules according to following when using them with CAR-Tool.

Make Target Directory:

mkdir <CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin

Copy files

copy <YASKAWA_RCS_Top>¥<CAR-Maker Dir>¥rcssrv_YASKAWA_XRC__1.XX
<CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin¥rcssrv_YASKAWA_XRC__1.XX

copy <YASKAWA_RCS_Top>¥XRC¥*.*
<CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin

copy <YASKAWA_RCS_Top>¥blackbox¥*.*
<CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin

If you need to install new parameter file for RCS-Module(e.g. New parameter for MOTOMAN SK16-J00)

copy All.prm <CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin¥SK16_J00.prm

copy Tool.cnd <CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin¥SK16_J00.tol

copy Uframe.cnd <CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin¥SK16_J00.uf

copy Weav.cnd <CAR-Maker RRS_Top>¥YASKAWA_XRC__1.XX¥bin¥SK16_J00.wev

Repeat the above step for other manipulator types and copy files into files named <CAR-Maker RRS_Top> ¥YASKAWA_XRC__1.XX¥bin¥<Manip_Str>.prm, <Manip_Str>.tol, <Manip_Str>.uf, <Manip_Str>.web where <Manip_Str> is described Fig.1.

Note:If you use a <Manip_Str> other than one of these in Fig.1 RRS initialization will fail!

4. RCS Entry Function and Development Environment

The specification described to this manual corresponds to the following version numbers.

(1) RRS I/F version number supported by the RCS-Module

Version 1.3

(2) Version number of the RCS-Module

Version 1.01

(3) Name of the RCS Entry Function

rcsYM01

(4) Robot Controller Name and its version supported by RCS-Module

Robot Controller Name : YASNAC XRC

Version X2.01A(JP/US)-00

(5) Development Environment

Microsoft Visual C++ 5.0

Project Type: Win32 Console Application

5. Valid Manipulator Strings

The type of the valid manipulator strings are shown in Fig. 1. It is necessary to distinguish the uppercase and lowercase letters to these character strings.

No.	Manipulator Name	Manipulator Strings (Type)
1	Motoman SK16-J00	SK16_J00
2	Motoman SK45-J00	SK45_J00
3	Motoman UP6-A00	UP6_A00
4	Motoman UP60E-A00	UP60E_A00
5	Motoman UP60E-A10	UP60E_A10
6	Motoman UP60E-B00	UP60E_B00
7	Motoman UP60E-B10	UP60E_B10
8	Motoman UP120E-A00	UP120E_A00
9	Motoman UP130-A00	UP130_A00
10	Motoman UP165-A00	UP165_A00
11	Motoman UP200-A00	UP200_A00
12	Motoman UP200R-A00	UP200R_A00
13	Motoman SP100-J00	SP100_J00
14	Motoman SK300-J00	SK300_J00

15	Motoman SV3-J00	SV3_J00

Fig.1 Valid Manipulator Strings

6. List of Supported RRS Services

The supported RRS services are shown in Fig.2.

Category	Service Name	Op. Code	Support
Base Services			
	INITIALIZE	101	Yes
	RESET	102	Yes
	TERMINATE	103	Yes
	GET_ROBOT_STAMP	104	Yes
	GET_HOME_JOINT_POSITION	166	No
	GET_RCS_DATA	105	No
	MODIFY_RCS_DATA	106	No
	SAVE_RCS_DATA	107	Yes
	LOAD_RCS_DATA	108	Yes
Kinematic and Conversion Services			
	GET_INVERSE_KINEMATIC	109	Yes
	GET_FORWARD_KINEMATIC	110	Yes
	MATRIX_TO_CONTROLLER_POSITION	111	No
	CONTROLLER_POSITION_TO_MATRIX	112	No
	GET_CELL_FRAME	113	Yes
	MODIFY_CELL_FRAME	114	Yes
	SELECT_WORK_FRAMES	115	Yes
Principal Motion Services			
	SET_INITIAL_POSITION	116	Yes
	SET_NEXT_TARGET	117	Yes
	GET_NEXT_STEP	118	Yes
	SET_INTERPOLATION_TIME	119	No
Motion Modification Services			
	SELECT_MOTION_TYPE	120	Yes
	SELECT_TARGET_TYPE	121	Yes
	SELECT_TRAJECTORY_MODE	122	No
	SELECT_ORIENTATION_INTERPOLATION_MODE	123	No
	SELECT_DOMINANT_INTERPOLATION	124	No
	SET_ADVANCE_MOTION	127	No
	SET_MOTION_FILTER	128	No
	SET_OVERRIDE_POSITION	129	No
	REVERSE_MOTION	130	No
	SET_PAYLOAD_PARAMETER	160	No
	SELECT_TIME_COMPENSATION	165	No
	SET_CONFIGURATION_CONTROL	161	No
Motion Parameter Services			
	SET_JOINT_SPEEDS	131	Yes
	SET_CARTESIAN_POSITION_SPEED	133	Yes
	SET_CARTESIAN_ORIENTATION_SPEED	134	Yes
	SET_JOINT_ACCELERATIONS	135	No
	SET_CARTESIAN_POSITION_ACCELERATION	137	No
	SET_CARTESIAN_ORIENTATOIN_ACCELERATION	138	No
	SET_JOINT_JERK	162	No
	SET_MOTION_TIME	156	No
	SET_OVERRIDE_SPEED	139	No
	SET_OVERRIDE_ACCELERATION	155	No

Fly-By and Point Accuracy Services			
	SELECT_FLYBY_MODE	140	Yes
	SET_FLYBY_CRITERIA_PARAMETER	141	No
	SELECT_FLYBY_CRITERIA	142	No
	CANCEL_FLYBY_CRITERIA	143	No
	SELECT_POINT_ACCURACY	144	Yes
	SET_POINT_ACCURACY_PARAMETER	145	No
	SET_REST_PARAMETER	164	No
	GET_CURRENT_TARGETID	163	Yes
Tracking Services			
	SELECT_TRACKING	146	No
	SET_CONVEYOR_POSITION	147	No
Condition Handling Services			
	DEFINE_EVENT	148	Yes
	CANCEL_EVENT	149	Yes
	GET_EVENT	150	Yes
	STOP_MOTION	151	Yes
	CONTINUE_MOTION	152	Yes
	CANCEL_MOTION	153	Yes
Message Services			
	GET_MESSAGE	154	Yes
Weaving Services			
	SELECT_WEAVING_MODE	157	No
	SELECT_WEAVING_GROUP	158	No
	SET_WEAVING_GROUP_PARAMETER	159	No
Special Services			
	DEBUG	1000	Yes
	EXTENDED_SERVICE	1001	No

Fig.2 List of Supported RRS Services

7. Valid Coordinate Frame Name

The valid frame IDs are shown in Fig.3.

No.	Frame ID	YASKAWA's Name	Available
1	TOOL[xx] *1)	TOOL No.xx *1)	Yes
2	FLANGE	-	No
3	BASE	ROBOT	Yes
4	TRANSLATOR	-	No
5	TRANS_BASE	BASE	No
6	WORLD	-	No
7	OBJECT[yy] *2)	USER Frame No.yy *2)	Yes

Fig.3 Valid Coordinate Frame IDs

*1) xx means Tool number from 0 to 23.

E.g. TOOL[0], TOOL[1], TOOL[2], ..., TOOL[23]

*2) yy means User frame number from 1 to 24.

E.g. OBJECT[1], OBJECT [2], OBJECT [3], ..., OBJECT [24]

8. Parameter ID Information

The reading and writing of specific parameters are not supported in this version. Therefore, parameter ID information is not described.

9. Robot Configuration

Motoman SK model manipulator with 6 axis has following unique names.

Axis No.	Axis Name
1	S
2	L
3	U
4	R
5	B
6	T

Fig.4 Axis Name

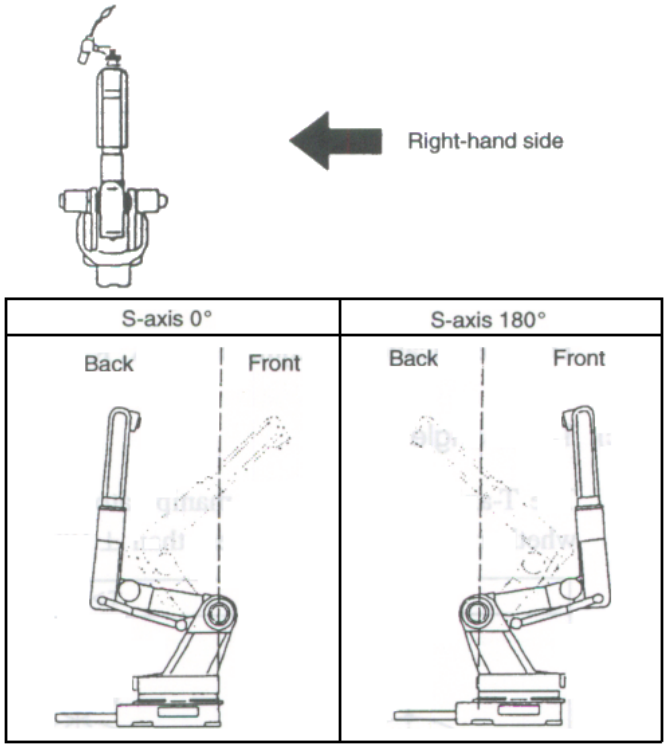
YASKAWA has defined the configuration of the robot as follows by the state of these axis.

No.	Robot Configuration	Note
1	0 : Front, 1 : Back	Relation between S-axis and control point
2	0 : Upper arm, 1 : Lower arm	Type composed L-axis and U-axis
3	0 : Flip, 1 : No-flip	R-axis position
4	0 : R-axis < 180 deg, 1 : R-axis >= 180 deg	R-axis angle
5	0 : T-axis < 180 deg, 1 : T-axis >= 180 deg	T-axis angle
6	0 : S-axis < 180 deg, 1 : S-axis >= 180 deg	S-axis angle

Fig.5 Robot Configuration

If manipulator's position data is described in XYZ format, a number of solutions are obtained from the manipulator's structure to move it to the described position. In order to select one among some solutions, it is necessary to specify the robot configuration. There are up to six kinds of configuration in the YASNAC XRC system. These configurations also depends the robot models.

1) Front/Back: Relationship between the S-axis and control point

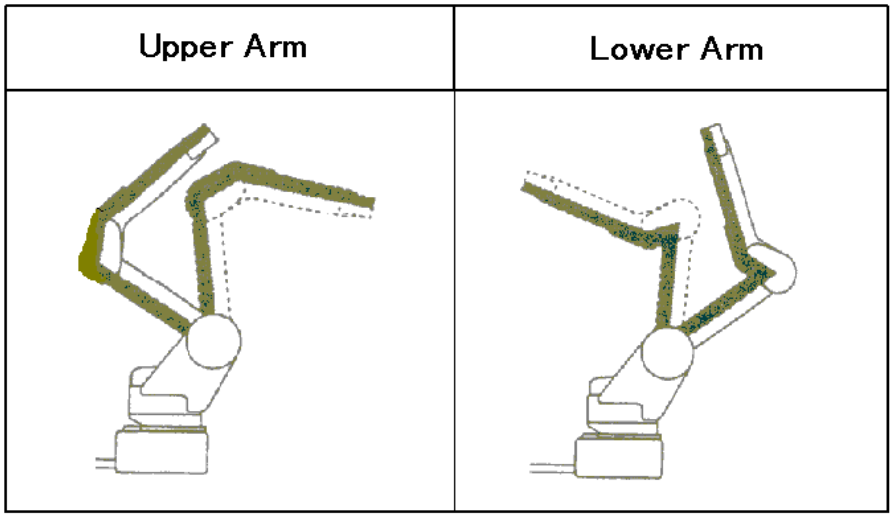


This specifies in which side of the S-axis rotation center the B-axis rotation center locates

when the L-axis and U-axis are viewed from the right-hand side. When viewed from the right-hand side, the right of the S-axis rotation center is called “Front”, and the left is called “Back”. The diagram above shows the S-axis at 0 deg. and at 180 deg, and as can be seen from this, this is the specification when the L-axis and the U-axis are seen constantly from the right-hand side. This specification is required for SK, K. SV and S model robots .*)

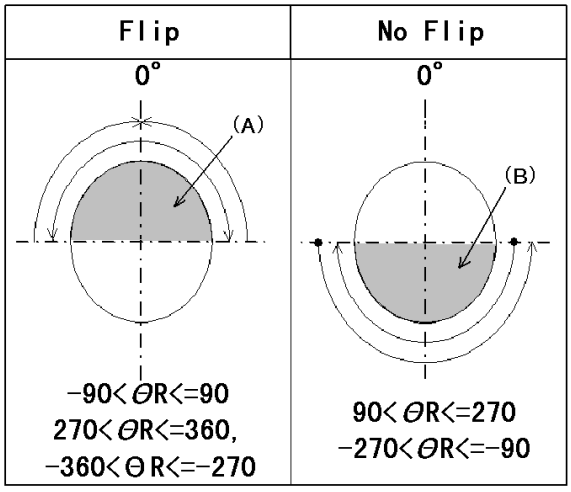
2) Upper arm/Lower arm: Configuration comprised of an L and U axis

This specifies the configuration comprised of L-axis and U-axis when the L-axis and U-axis are viewed from the right-hand side. The configuration where the **GRAY** side of the diagram below is the outside is called “Upper arm”, and the configuration where the **GRAY** side is the inside is called “Lower arm”. This specification is required for SV and S model robots. It is not required for SK and K model robots.(SK and K model is always “Upper arm” configuration.)*)



3) Flip/No flip: R-axis position

When the R-axis is in the position at (A) as shown in the diagram below, this is called “Flip”; when it is in the (B) position, it is called “No-Flip”. However, in robot which the R-axis can move more than +/-180 deg. even in position (A), it is necessary to specify whether the R-axis is from -90 deg. to 90 deg. , or from 270 deg. to 360 deg. and then from -360 deg. to -270 deg. The



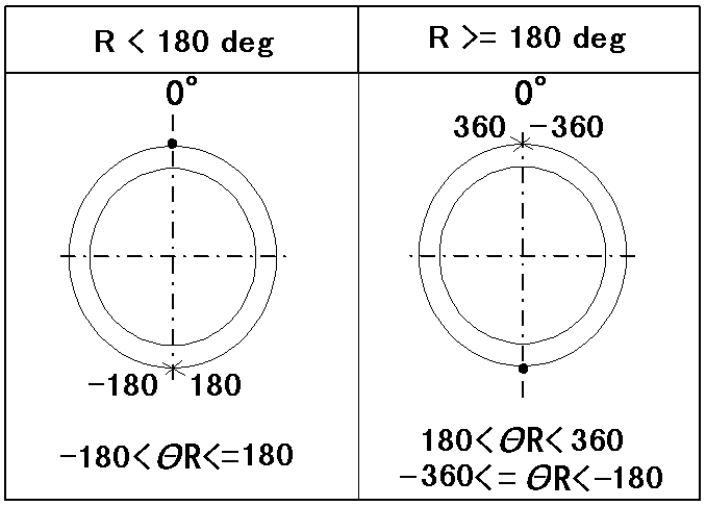
same is true for the (B) position. It is specified in configuration 4).

Note:θR is the angle when the R-axis zero position is 0 deg.

This specification is required for SK, K, SV model robots. It is not required for S model robot.*)

4) R-axis angle

This specifies whether the R-axis angle is less than +/- 180 deg. or greater than +/- 180 deg.

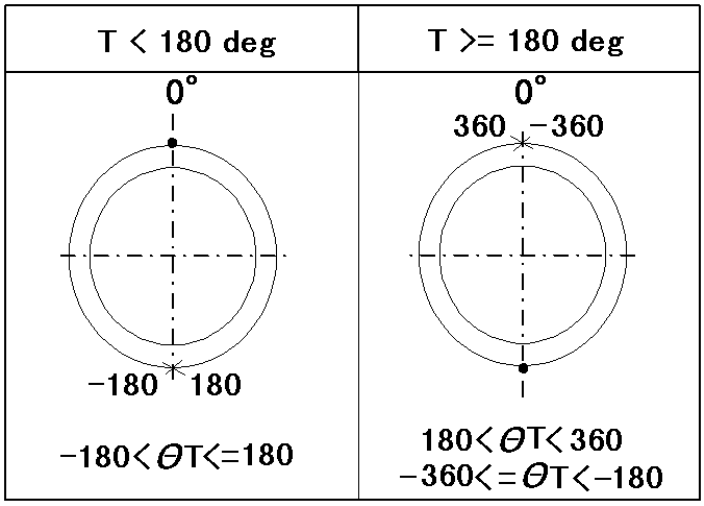


Note:θR is the angle when the R-axis zero position is 0 deg.

This specification is required for SK, K, SV and S model robots.*)

5) T-axis angle

This configuration is specified for manipulators which have three wrist axes. This pecifies whether the T-axis angle is less than +/- 180 deg. or greater than +/- 180 deg.

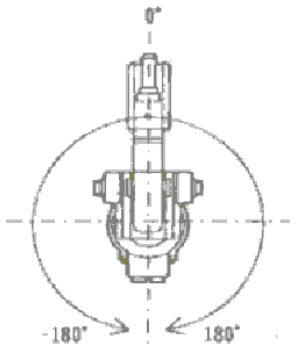
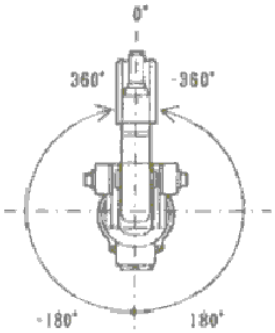


Note:θT is the angle when the T-axis zero position is 0 deg.

This specification is required for SK, K and SV model robots. It is not required for S model robot.*) These specifications [1),4),5]] specify the positions of R-, B-, T-axis.

6) S-axis angle

This specifies whether the S-axis angle is less than +/- 180 deg. or greater than +/- 180 deg.

S < 180 deg	S >= 180 deg
	
−180<θS<=180	180<θS<=360 −360<=θS<−180

Note:θS is the angle when the S-axis zero position is 0 deg.

This specification is required for the robots which working range is greater than +/- 180 deg.

*) Yaskawa's RCS-Module support SK and UP models only in this version.

9. Robot Configuration String

The string which describes the mode of the robot configuration can specify the robot configuration under following conditions.

a) Relative job permission parameter

If relative job is not permitted in robot parameter, specification of robot configuration is not valid.

b) Relative job operation method parameter

This parameter specifies how to operate relative job, and can be one of the following values:

0: PREVIOUS STEP WITH PRIORITY (B-axis sign constant)

1: CONFIGURATION WITH PRIORITY

2: PREVIOUS STEP WITH PRIORITY (R-axis moving amount minimum)

If this parameter is set 0 or 2, robot makes near side rotation.

c) To define each configuration

The configuration string is defined by parameter state of each number's configuration. See Fig.5. Each number corresponds to the bit data. For example, No2. is 1 (Lower Arm) and No4. is 1 (R-axis >= 180 deg) and others are all 0, the character string becomes "10".

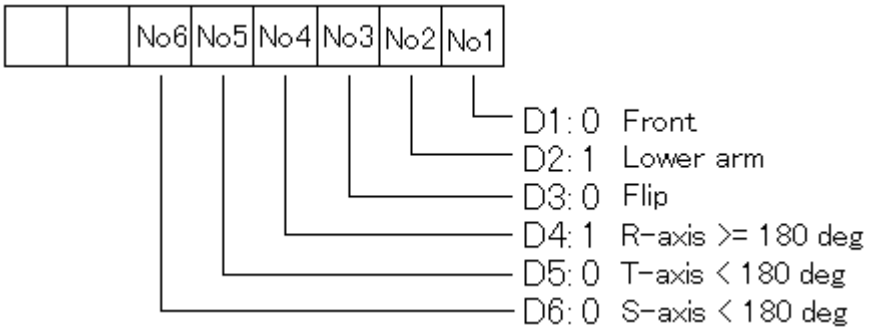


Fig.6 Robot Configuration String

10. Others

CAR-Maker has to pay attention following items about RRS services.

No.	Item	Note
1	Flyby mode (SELECT_FLYBY_MODE ON/OFF)	YASKAWA's controller has two trajectory mode. One is "Smooth mode". This is a default mode and connects the path smoothly. The other is "Deceleration stop mode". If SELECT_FLYBY_MODE service selects ON, "Smooth mode" is selected. And the service selects OFF, "Deceleration stop mode" is selected. When CAR-Maker uses "TIMER" or "END" instruction in a program, SELECT_FLYBY_MODE OFF service has to be called before SET_NEXT_TARGET. See ANNEX A Example for Trajectory Execution.

ANNEX A: Trajectory Execution (Linear Motion)

It is an easy program to support trajectory example as follows.

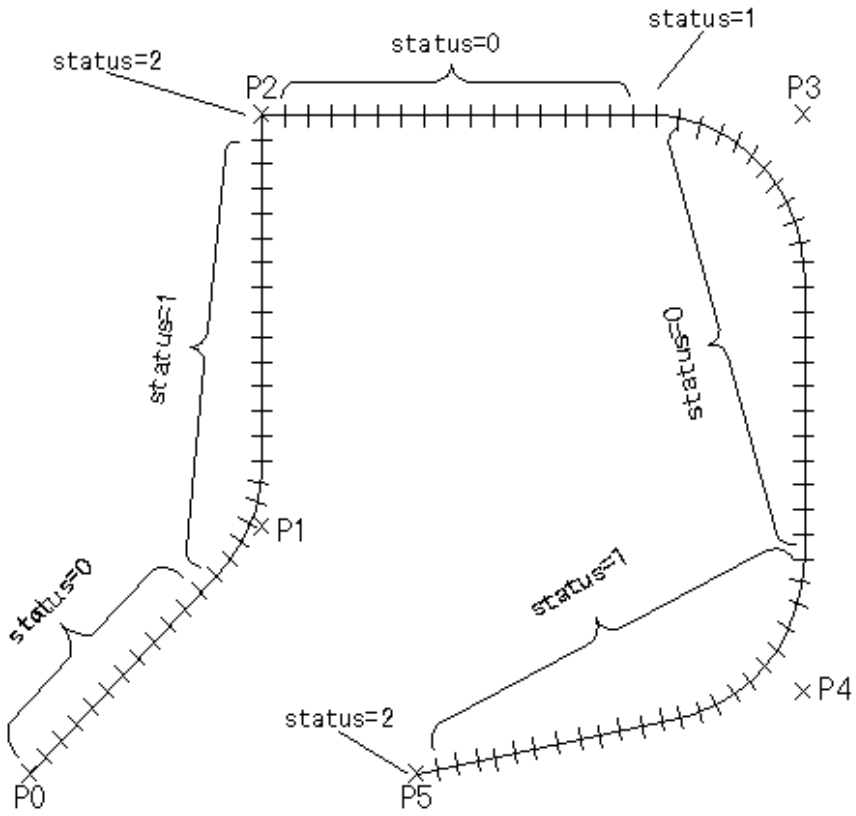


Fig.7 Example for Trajectory Execution(Linear Motion)

The trajectory of Fig.7 RRS service call are:

No.	RRS service call	Contents
1	SET_INITIAL_POSITION P0	Set initial position.(start position: P0)
2	SELECT_FLYBY_MODE ON	Flyby mode ON("smooth mode")
3	SET_NEXT_TARGET P1	Set next target position(P1).
4	GET_NEXT_STEP	Return 1 (Need more data)
5	SELECT_FLYBY_MODE OFF	Deceleration stop next target position(P2).

6	SET_NEXT_TARGET P2	Set next target position(P1).
7	SELECT_FLYBY_MODE ON	Flyby mode ON(“smooth mode”)
8	GET_NEXT_STEP until status 2	Get the interpolated position step and another information and repeat this service call until status = 2. Reaches P2.
9	SET_NEXT_TARGET P3	Set next target position (P3).
11	SET_NEXT_TARGET P4	Set next target position (P4).
10	GET_NEXT_STEP	Return 1 (Need more data)
12	GET_NEXT_STEP until status 1	Get the interpolated position step and another information and repeat this service call until status = 1. Reaches before P3。
13	SELECT_FLYBY_MODE OFF	Deceleration stop next target position(P5).
14	SET_NEXT_TARGET P5	Set next target position (P5).
15	GET_NEXT_STEP until status 2	Get the interpolated position step and another information and repeat this service call until status = 2. Reaches P5.

The trajectory of Fig.7 YASKAWA’s INFORM are:

No	RRS service call	Contents
1	NOP	No Operation
2	MOVL (P1)	Liner Motion to P1. (Default Smooth)
3	MOVL (P2)	Liner Motion to P2. (Deceleration Stop for next TIMER instruction)
4	TIMER	Timer
5	MOVL (P3)	Liner Motion to P3.(Default Smooth)
6	MOVL (P4)	Liner Motion to P4.(Default Smooth)
7	MOVL (P5)	Liner Motion to P1.
8	END	End of Program.

Notes: The default mode of trajectory by Yasukawa's controller is smooth mode. The deceleration stop to the target position is generated by the TIMER instruction and END of the program.

ANNEX B: Trajectory Execution (Circular Motion)

It is an easy program to support trajectory example as follows.

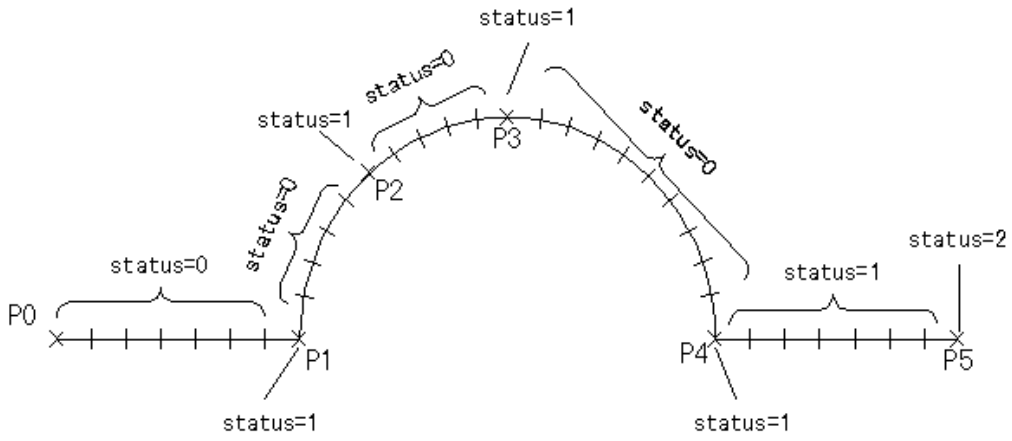


Fig.8 Example for Trajectory Execution(Circular Motion)

The trajectory of Fig.8 RRS service call are:

No	RRS service call	Contents
1	SET_INITIAL_POSITION P0	Set initial position.(start position:P0)
2	SELECT MOTION_TYPE LNR	Set liner motion.
3	SET_NEXT_TARGET P1	Set next target position(P1).
4	GET_NEXT_STEP until status 1	No answer the interpolated position step. ElapsedTime=0.
5	SELECT MOTION_TYPE CIR	Set circular motion.
6	SET_NEXT_TARGET P2	Set next target position(P2).
7	GET_NEXT_STEP until status 1	Repeat this service call until status = 1. Reaches P1.
8	SET_NEXT_TARGET P3	Set next target position(P3).
9	GET_NEXT_STEP until status 1	Repeat this service call until status = 1. Reaches P2.
10	SET_NEXT_TARGET P4	Set next target position(P4).
11	GET_NEXT_STEP until status 1	Repeat this service call until status = 1. Reaches P3.
12	SELECT MOTION_TYPE LNR	Set liner motion.
13	SELECT FLY_BY OFF	Deceleration stop next target position(P5).
14	SET_NEXT_TARGET P5	Set next target position(P5).
15	GET_NEXT_STEP until status 2	Repeat this service call until status = 2. Reaches P5.

Notes:

The movement P1 to P2 is circular interpolation that formed with P1, P2 and P3.

The movement P2 to P3 is circular interpolation that formed with P2, P3 and P4.

The movement P3 to P4 is circular interpolation that formed with P2, P3 and P4.

The trajectory of Fig.8 YASKAWA's INFORM are:

No	RRS service call	Contents
1	NOP	No Operation
2	MOVC (P1)	Liner Motion to P1. The movement to this target position is a liner interpolation.
3	MOVC (P2)	Circular Motion to P2.
4	MOVC (P3)	Circular Motion to P3.(Default Smooth)。
5	MOVC (P4)	Circular Motion to P4.(Default Smooth)
6	MOVL (P5)	Liner Motion to P5.
7	END	End of Program.

Notes:

The movement of the first MOVC instruction is linear interpolation.

SERVICE SPECIFICATIONS

The function and the Input/Output parameter which should be noted when Yasukawa's RCS module is used are described as follows. When these each function or the Input/Output parameter is not described, the specification is as same as the RRS interface specification.

Name: INITIALIZE

Opcode: 101

Input-Data:	Type/Dimens.	Description
RobotNumber	int	1 to number of robot.
ModulePathName	PathName	Default path is described in “2-1 Directory”.
ManipulatorType	String	CAR-Tool has to define the valid manipulator Type. See Fig.2
CARRRSVersion	int	10300

Output-Data:	Type/Dimens.	Description
RCSRRSVersion	int	10300
RCSVersion	Int	10100

Remarks:

Path Name:
If path name length is 0, it means current directory.

The Rule to Access the Robot Parameter:
(1) In case of available robot path name
Access with following strings.
“RobotPathName” + “ManipulatorType ” + ”_” + “RobotNumber(two digit or more)” + “.prm”
e.g. SK16:
“RobotPathName” + ”SK16_J00_01.prm”
Note: The last character of “RobotParhName” is “¥”.
(“¥” : “/” for UNIX, “¥” for MS-DOS)
If access is failed Rcs-Module accesses with following strings.
(2) Access to default robot parameter
Access with following strings.
“ModulePathName” + “ManipulatorType” + “.prm”
e.g. SK16:
“ModulePathName” + ”SK16_J00.prm”
Note: The last character of “ModulePathName” is “¥”.
(“¥” : “/” for UNIX, “¥” for MS-DOS)
If access is succeeded, Rcs-Module returns status 3. Else returns –56.

The Rule to Access the Robot Data File:
Three data files are needed by RCS-Module. Those are tool data, user frame data and weaving condition data. The extension of each file is “.tol”, “.uf”, “.wev”. The rule to access these data file is same as robot parameter.

The usage of RCSVersion:
The version numbers correspond to 6 decimal numbers.
Sample version number “654321” means follows.
21: Lower Version Number
When minor version up is executed, this number is counted up.
43: Minor Version Number
When major version up is executed, this number is counted up.

65: Major Version Number
When main entry function is changed, this number is changed.

Name: RESET

Opcode: **102**

Remarks: All messages and events are reset.

Name: TERMINATE

Opcode: 103

Remarks: none

Name: GET_ROBOT_STAMP

Opcode: **104**

Output-Data:	Type/Dimens.	Description
ManipulatorType	String	See Fig. 1
Controller	String	“YASNAC XRC”
Software	String	“2.01A(JP/US)-00”

Remarks: none

Name: GET_HOME_JOINT_POSITION

Opcode: **166**

Remarks: The service is not supported.

Name: GET_RCS_DATA

Opcode: **105**

Remarks: The service is not supported.

Name: MODIFY_RCS_DATA

Opcode: **106**

Remarks: The service is not supported.

Name: SAVE_RCS_DATA

Opcode: 107

Remarks: none

Name: LOAD_RCS_DATA

Opcode: 108

Remarks: none

Name: GET_INVERSE_KINEMATIC

Opcode: **109**

Input-Data:	**Type/Dimens.**	**Description**
Configuration	String	See Fig.6(Robot Configuration String)

Remarks: none

Name: GET_FORWARD_KINEMATIC

Opcode: **110**

Output-Data:	**Type/Dimens.**	**Description**
Configuration	String	See Fig.6(Robot Configuration String)

Remarks: none

Name: MATRIX_TO_CONTROLLER_POSITION

Opcode: 111

Remarks: The service is not supported.

Name: CONTROLLER_POSITION_TO_MATRIX

Opcode: 112

Remarks: The service is not supported.

Name: GET_CELL_FRAME

Opcode: 113

Input-Data:	Type/Dimens.	Description
Storage	int	Following values are available. 1: get from memory.
FirstNext	int	Following values are available. 0: Give data as specified by FrameID.
FrameID	string	Following FrameIDs are available. 1.TOOL e.g. TOOL[0],TOOL[1],...,TOOL[23] 7.OBJECT e.g. OBJECT[1],OBJECT[2],...,OBJECT[24] NOTE: Calculate TCP frame by GET_FORWARD_KINEMATIC

Output-Data:	Type/Dimens.	Description
FrameType	int	Following values are returned. 1: robot.

Remarks: none

Name: MODIFY_CELL_FRAME

Opcode: **114**

Input-Data:	Type/Dimens.	Description
Storage	int	Following values are available. 1: Modify in memory.
FrameID	string	See Fig.3(Valid Coordinate Frame IDs) Following FrameIDs are available. 1. TOOL e.g. TOOL[0],TOOL[1],...,TOOL[23] 7. OBJECT e.g. OBJECT[1], OBJECT [2],...,OBJECT [24]

Remarks: none

Name: SELECT_WORK_FRAMES

Opcode: **115**

Input-Data:	Type/Dimens.	Description
ToolID	string	See Fig.3(Valid Coordinate Frame IDs) Following FrameIDs are available. 1. TOOL e.g. TOOL[0], TOOL[1], TOOL[2], ..., TOOL[23]
ObjectID	string	See Fig.3(Valid Coordinate Frame IDs) Following FrameIDs are available. 3. BASE 7. OBJECT e.g. OBJECT[1], OBJECT[2], OBJECT [3], ..., OBJECT [24]

Remarks: none

Name: SET_INITIAL_POSITION

Opcode: 116

Input-Data:	Type/Dimens.	Description
JointPos	JointPos Type	If this set as additional axis information for the Cartesian position, AxesFlags is not available. Because valid axes are set in robot parameter and RCS-Module uses this. External axes are not supported in this version.

Remarks: none

Name: SET_NEXT_TARGET

Opcode: 117

Input-Data:	Type/Dimens.	Description
TargetParam	int	Following values are available. 0: unused.
JointPos	JointPos Type	If this set as additional axis information for the Cartesian position, AxesFlags is not available. Because valid axes are set in robot parameter and RCS-Module uses this. External axes are not supported in this version.

Remarks:

Limit to the Last Target Position

The motion type of the last target position must not be circular. If target motion is end in circular motion, set same position again with linear interpolation.

Name: GET_NEXT_STEP

Opcode: **118**

Remarks: none

Name: SET_INTERPORATION_TIME

Opcode: **119**

Remarks: The service is not supported.

Name: SELECT_MOTION_TYPE

Opcode: 120

Input-Data:	Type/Dimens.	Description
MotionType	int	Following values are available. 1: Joint interpolation. 2: Linear interpolation. 4: Circular-via.

Remarks: none

Name: SELECT_TARGET_TYPE

Opcode: **121**

Input-Data:	Type/Dimens.	Description
TargetType	int	Following values are available. 0: Absolute with respect to the object frame.

Remarks: none

Name: SELECT_TRAJECTORY_MODE

Opcode: **122**

Remarks: The service is not supported.

Name: SELECT_ORIENTATION_INTERPOLATION_MODE

Opcode: 123

Remarks: The service is not supported.

Name: SELECT_DOMINANT_INTERPOLATION

Opcode: 124

Remarks: The service is not supported.

Name: SET_ADVANCED_MOTION

Opcode: **127**

Remarks: The service is not supported.

Name: SET_MOTION_FILTER

Opcode: **128**

Remarks: The service is not supported.

Name: SET_OVERRIDE_POSITION

Opcode: **129**

Remarks: The service is not supported.

Name: REVERSE_POSITION

Opcode: **130**

Remarks: The service is not supported.

Name: SET_PAYLOAD_PARAMETER

Opcode: **160**

Remarks: The service is not supported.

Name: SELECT_TIME_COMPENSATION

Opcode: 165

Remarks: The service is not supported.

Name: SET_CONFIGURATION_CONTROL

Opcode: 161

Remarks: The service is not supported.

Name: SET_JOINT_SPEEDS

Opcode: 131

Input-Data:	Type/Dimens.	Description
AllJointFlags	int	Following values are available. 1:ignore JointFlags, use first real value for all joints.
SpeedPercent	Real32	0.01 to 100.00% RCS-Module can not accept different speed of each joint. So CAR-Tool has to specified the same speed to each joint.

Remarks: none

Name: SET_CARTESIAN_POSITION_SPEED

Opcode: 133

Input-Data:	Type/Dimens.	Description
SpeedValue	Real	0.1 to 1500.0 mm/sec Max Speed is depend on the manipulator's parameter.

Remarks: none

Name: SET_CARTESIAN_ORIENTATION_SPEED

Opcode: 134

Input-Data:	Type/Dimens.	Description
SpeedValue	Real	0.1 to 360.0 degree/sec Max Speed is depend on the manipulator's parameter.

Remarks: none

Name: SET_JOINT_ACCELERATIONS

Opcode: **135**

Remarks: The service is not supported.

Name: SET_CARTESIAN_POSITION_ACCELERATION

Opcode: 137

Remarks: The service is not supported.

Name: SET_CARTESIAN_ORIENTATION_ACCELERATION

Opcode: 138

Remarks: The service is not supported.

Name: SET_JOINT_JERKS

Opcode: **162**

Remarks: The service is not supported.

Name: SET_MOTION_TIME

Opcode: **156**

Remarks: The service is not supported.

Name: SET_OVERRIDE_SPEED

Opcode: **139**

Remarks: The service is not supported.

Name: SET_OVERRIDE_ACCELERATION

Opcode: **155**

Remarks: The service is not supported.

Name: SELECT_FLYBY_MODE

Opcode: 140

Remarks: See “10. Others No.1” and ANNEX A:

Name: SELECT_FLYBY_CRITERIA_PARAMETER

Opcode: 141

Remarks: The service is not supported.

Name: SELECT_FLYBY_CRITERIA

Opcode: **142**

Remarks: The service is not supported.

Name: CANCEL_FLYBY_CRITERIA

Opcode: **143**

Remarks: The service is not supported.

Name: SELECT_POINT_ACCURACY

Opcode: 144

Remarks: YASKAWA's controller has five point accuracy mode. There are position level 0 to 4. They are defined in the parameter, and they can not be modified by SET_POINT_ACCURACY_PARAMETER service.
If CAR-Maker does not want to select one of them, he has to call SELECT_FLYBY_MODE ON. RCS-Module selects "Smooth mode" instead of point accuracy. See "10. Others No.1" and ANNEX A:

Name: SET_POINT_ACCURACY_PARAMETER

Opcode: 145

Remarks: The service is not supported.

Name: SET_REST_PARAMETER

Opcode: **164**

Remarks: The service is not supported.

Name: GET_CURRENT_TARGETID

Opcode: **163**

Remarks: none

Name: SELECT_TRACKING

Opcode: **146**

Remarks: The service is not supported.

Name: SET_CONVEYOR_POSITION

Opcode: **147**

Remarks: The service is not supported.

Name: DEFINE_EVENT

Opcode: **148**

Input-Data:	Type/Dimens.	Description
TargetID	int	Following values are available. 0: event tied to the next target. NOTE: Each target can hold five events maximum. One RCS-Module can hold sixteen events altogether.
TypeOfEvent	int	Following values are available. 1: Time.

Remarks: none

Name: CANCEL_EVENT

Opcode: 149

Remarks: none

Name: GET_EVENT

Opcode: 150

Remarks: none

Name: STOP_MOTION

Opcode: 151

Remarks: none

Name: CONTINUE_MOTION

Opcode: 152

Remarks: none

Name: CANCEL_MOTION

Opcode: 153

Remarks: none

Name: GET_MESSAGE

Opcode: 154

Remarks: none

Name: SELECT_WEAVING_MODE

Opcode: **157**

Remarks: The service is not supported.

Name: SELECT_WEAVING_GROUP

Opcode: 158

Remarks: The service is not supported.

Name: SET_WEAVING_GROUP_PARAMETER

Opcode: 159

Remarks: The service is not supported.

Name: DEBUG

Opcode: **1000**

Remarks: none

Name: EXTENDED_SERVICE

Opcode: **1001**

Remarks: The service is not supported.

YASNAC XRC RCS-Module for IGRIP

Installation Manual

Upon receipt of the product and prior to installing the product, read these instructions thoroughly, and retain for future reference.

Manual No.: HW0480729

General Precautions

- Diagrams and photos in this manual are used as examples only and may differ from the actual delivered product.
- This manual may be modified when necessary because of improvement of the product, modification, or changes in specifications.
  Such modification is made as a revision by renewing the manual No.
- To order a copy of this manual, if your copy has been damaged or lost, contact your YASKAWA representative stating the manual No. on the front page.
- YASKAWA is not responsible for any modification of the product made by the user since that will void guarantee.
- Software supplied with this manual is intended for use by licensed operators only and may only be used or copied according to the provisions of the license.
- Reproduction of any part of this manual without the consent of YASKAWA is forbidden.

Trade Mark

- MS Windows NT is a registered trademark of Microsoft Corporation, U.S.A.
- Names of the products described in this manual are registered trademarks or trademarks of the companies.

Contents

1 Introduction

The RCS-Module uses the Realistic Robot Simulation (RRS) of IGRIP to simulate the YASNAC XRC manipulator quite accurately (hereinafter called the XRC RCS-Module). This manual describes how to install and start up the XRC RCS-Module.

Note: For details of the IGRIP's RRS function, contact DELMIA Japan, Ltd., the developer and retailer of the IGRIP.

1.1 System Requirements

The XRC RCS-Module requires the following system configuration:

- PC-AT-compatible personal computer and monitor on which the PC edition of IGRIP runs
- 10 MB of free hard disk space
- CD-ROM drive
- Hardware Lock Key (Refer to "1.2 Hardware Lock Key.")
- OS on which PC edition of IGRIP runs
- INTERIX (Refer to "1.3 INTERIX.")

1.2 Hardware Lock Key

This product includes one license of the XRC RCS-Module for one personal computer that has IGRIP installed.
For proper operation, connect the hardware lock key that is provided to the personal computer using either of the following methods.

- Connect the XRC RCS-Module's hardware lock key directly to the IGRIP's hardware lock key.
- Connect the XRC RCS-Module's hardware lock key to the printer port of the personal computer, and then connect the IGRIP's hardware lock key to the other end of the Module hardware lock key.

1.3 INTERIX

INTERIX is software that can create a UNIX environment on a personal computer.
The IGRIP RRS function runs in a UNIX environment when operating on the personal computer and carries out data communications with the XRC RCS-Module.
Install INTERIX before using the IGRIP RRS function.

Note 1. For details using INTERIX with IGRIP, contact DELMIA Japan, Ltd., the developer and retailer of the IGRIP.

2. Yaskawa uses INTERIX to construct a UNIX environment on a personal computer. To confirm if any other UNIX-environment-construction software may be safely used with the IGRIP, contact DELMIA Japan, the developer and retailer of the IGRIP.

1.4 Software

2 Installation of the XRC RCS-Module

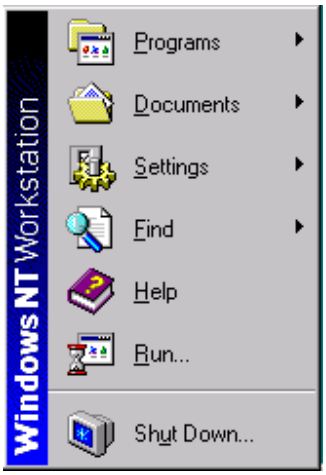
The installer (SETUP.EXE) creates a new directory in the specified hard disk and copies a series of files from the product disc to this new directory.

This section describes an example using Windows NT4 where:

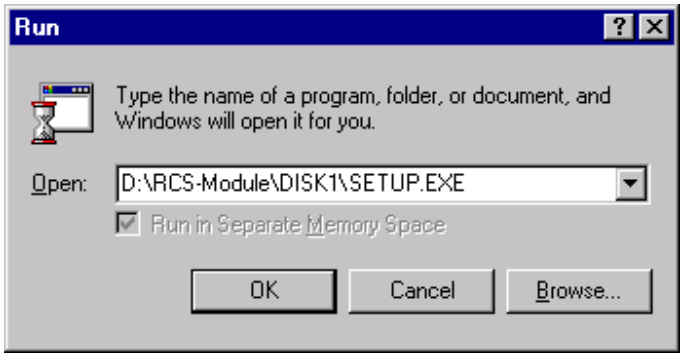
- CD-ROM drive for the product disc: **D**
- Drive for the XRC RCS-Module: **C**
- Directory for installing IGRIP: **C:\deneb**

2.1 How to Install

1. Turn ON the personal computer and the monitor power supply to start up Windows.
2. Close all programs that are running.
3. Insert the product disc into the CD-ROM drive.
4. Select [Run] from the start menu.



5. In the [Open] box, type "D:\RCS-Module\DISK1\SETUP.EXE," and click the [OK] button.

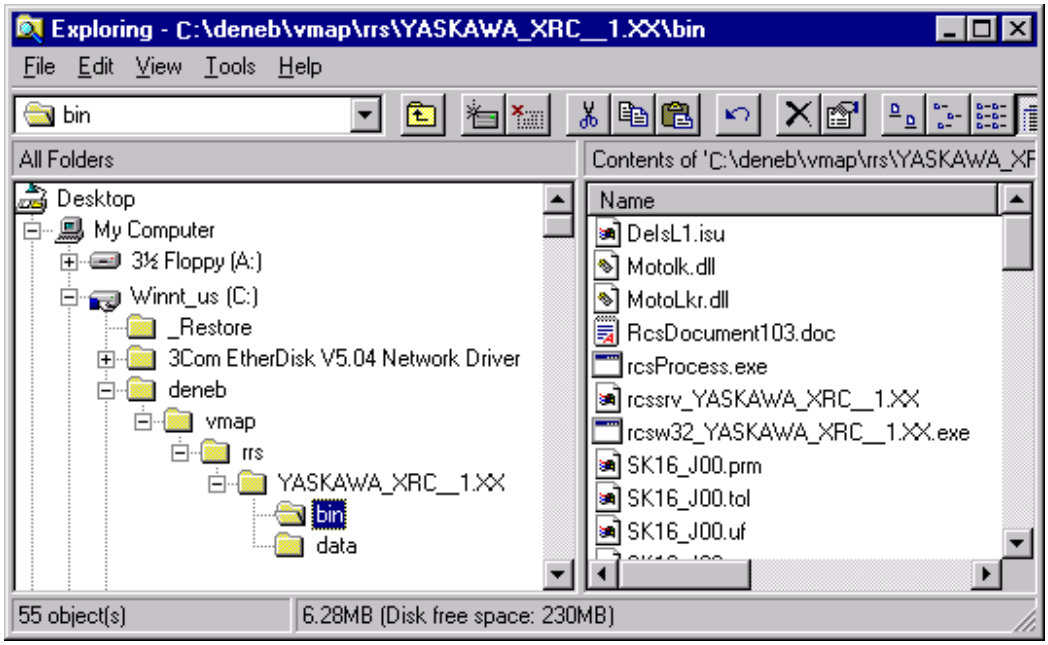


6. The installer starts up. Follow the instructions on the screen.

2.2 Installation Directory

The XRC RCS-Module's programs and the robot parameters are in the following location under the directory where IGRIP is installed.

\VMAP\RRS\YASKAWA_XRC_1.XX\bin



Note 1. After installation, the directory **\VMAP\RRS\YASKAWA_XRC_1.XX\data** is created. This is a directory to save the robot parameters from the actual manipulator, and is empty at installation.

2. After installation, do not change the names of **bin** or **data** folder. The names are lower-case sensitive. Changing the name of the folder or using upper-case characters may cause the XRC RCS-Module to malfunction.

3 Start-up of the XRC RCS-Module

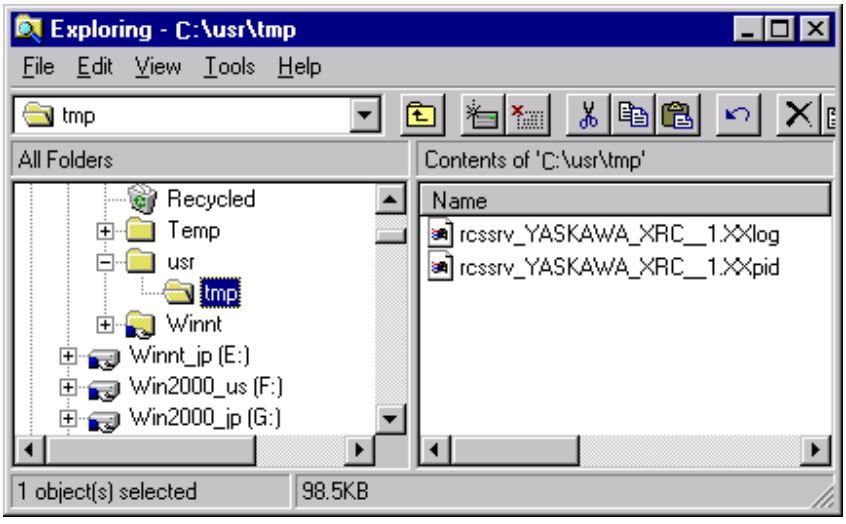
This section describes how to start up the IGRIP RRS function after installing the XRC RCS-Module.

The example assumes that IGRIP is installed in the directory **C:\deneb.**

1. Start up IGRIP.
2. Start up the program ksh (K shell) of INTERIX to start up INTERIX.
3. Make the following settings for the environment to use XRC RCS-Module from IGRIP.
   (1) Change the path in the ksh environment to:
   cd /deneb/vmap/rrs/YASKAWA_XRC__1.XX/bin
   (2) Type the following path name and execute it to set the communications environment to use the XRC RCS-Module from IGRIP.
   ./rcssrv_YASKAWA_XRC__1.XX -tcp 3300

   - A period followed by a backslash (./) indicates “current” on UNIX.
   - Although the file extension is not .EXE, it is an execute form file on UNIX.
   - Arguments are input as described in the following file in IGRIP.
     \vmap\rrs\README of the IGRIP installed directory
   - 3300 is a port number where the following is described in **\vmap\rrs\rcs.servers** of the IGRIP installed directory.
     YASKAWA_XRC__1.XX_Server1 YASKAWA_XRC__1.XX SOCKET RRS 3300

The log file and .pid file are now created in directory **C:\usr\tmp**.

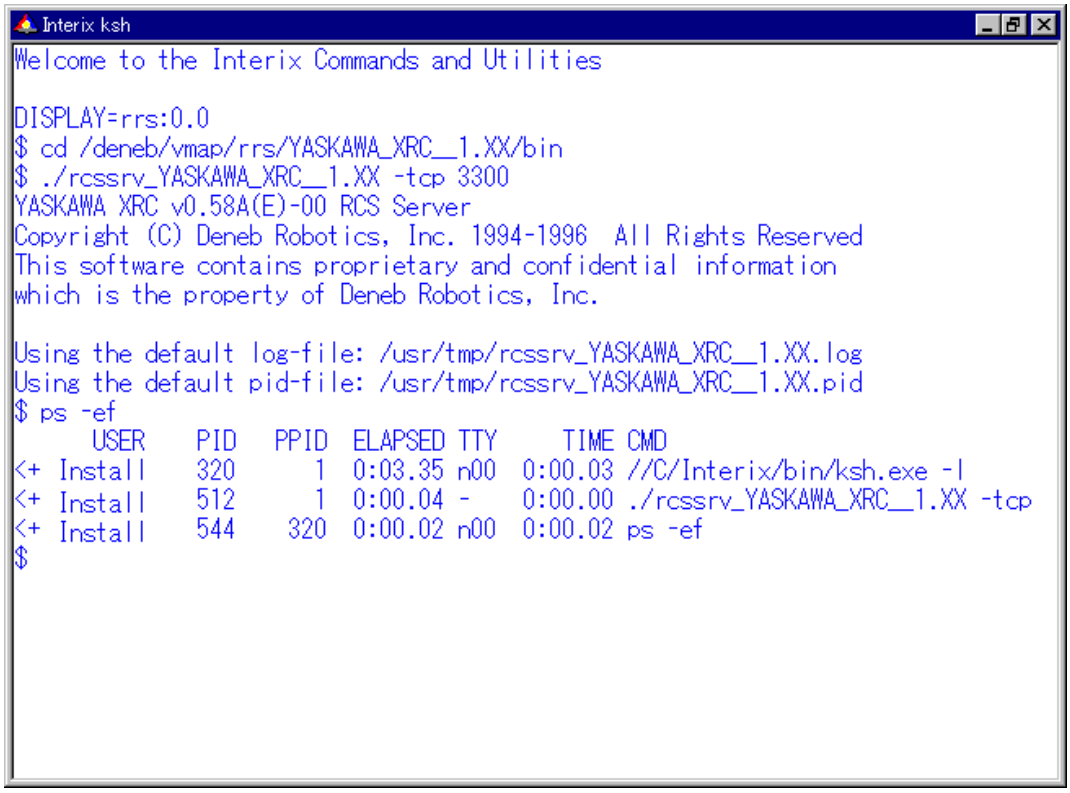


Confirmation of Start-up Process

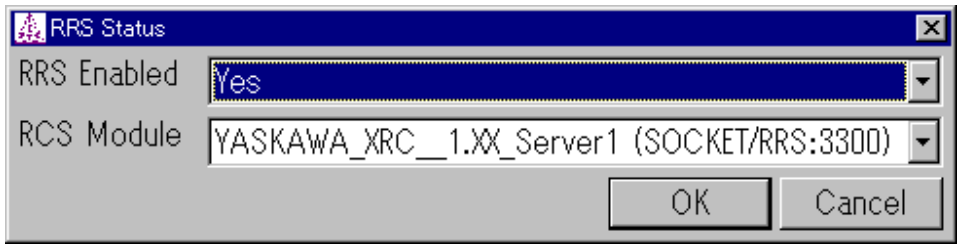
Enter the following command to view the UNIX process list.

ps – ef

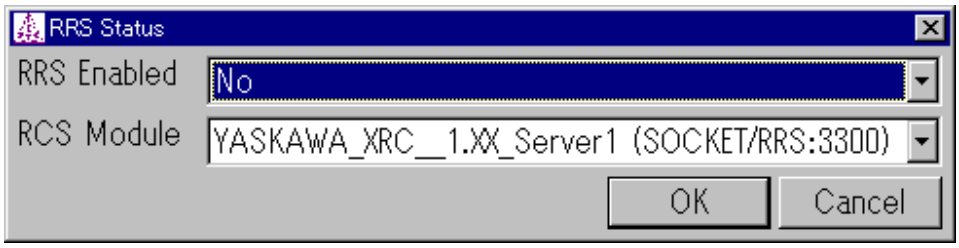
The following Interix ksh window appears.



4. Start up the IGRIP RRS function.
   (1) Select [RRS connect] of the IGRIP.
   (2) In the RRS Status window, select the settings for [RRS Enabled] and [RCS Module] as shown in the following illustration, and click the [OK] button.



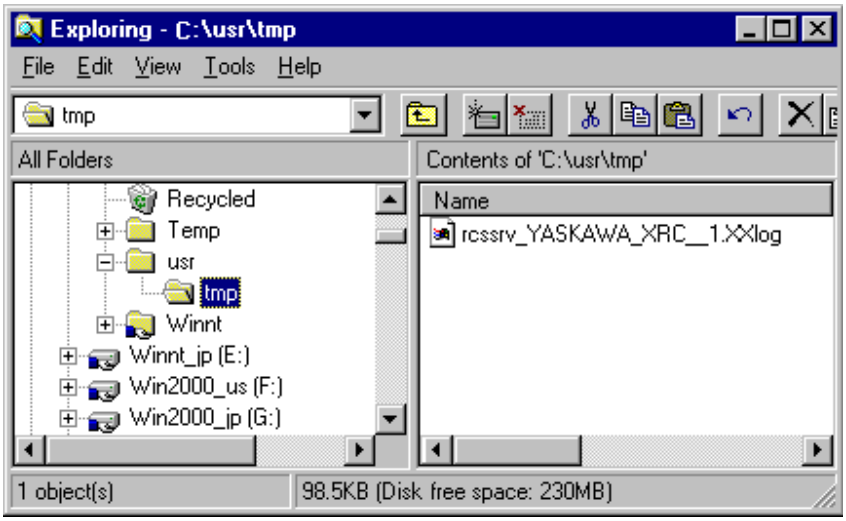
5. Terminate IGRIP RRS function.
   (1) Select [RRS connect] of the IGRIP.
   (2) In the RRS Status window, select the settings for [RRS Enabled] and [RCS Module] as shown in the following illustration, and click the [OK] button.



6. To terminate INTERIX, type “Kill 512” and open **./rcssrv_YASKAWA_XRC__1.XX** process using INTERIX ksh (K shell).

Note: 512 is the ID of ./rcssrv_YASKAWA_XRC__1.XX process. This process ID varies each time ./rcssrv_YASKAWA_XRC__1.XX process is started up. To quit INTERIX, kill the ID of ./rcssrv_YASKAWA_XRC__1.XX process.

The .pid file of directory **C:\usr\tmp** is now deleted.



Note: If Windows is shut down forcibly, the .pid file may not be deleted, and an error may result the next time the XRC RCS-Module is started. If so, manually delete the .pid file from the **tmp** folder of the directory **\usr\tmp**.

YASNAC XRC RCS-MODULE for ROBCAD

Installation Manual

Upon receipt of the product and prior to initial operation, read these instructions thoroughly, and retain for future reference.

YASKAWA

MANUAL NO. HW9482927

1. Introduction

This manual has been described the file contents and installation of RCS-Module and Robot models for ROBCAD. About specification of RCS-Module, please read "Specification Document of YASKAWA's RCS-Module for YASNAC XRC".

You wish for the warning enough to handling because there is the following limitations when this manual is used.

(1) Information described to this manual might be changed without a previous notice for the product improvement.

(2) The reproduction or copy is prohibited to any part of this manual without agreement by the document of YASKAWA Electric Corporation.

2. Supported System

OS : SGI IRIX 6.X

Simulator : ROBCAD Version 3.7 + YASKAWA XRC SPOT OLP

Robot Controller : YASNAC XRC X2.01A(JP/US)-00

3. File Contents

ReadMe.doc

This file.

rcsym.tar

RCS-Module and Robot parameter archive files packed by "tar" command.

Contents:

*.prm	Robot parameter file
*.tol	Tool data file
*.uf	User flame file
*.wev	Weaving data file
rcsmain	RCS interface module
rcsprocess	RCS main module
.YERCS	RCS-Module Setup file

robot.tar

Robot model files archive packed by "tar" command.

Each Robot models are packed by "tar" command and compressed by "gzip" command again.

Contents:

*.tar.gz ROBOT model archived and compressed

4. Install

(1) RCS-Module

Please make a new directory "rrs_bin/rcsym" under the ROBCAD directory (usually /usr/local/robcad) and unpack all files in rcsym.tar to there.

ex.)

```
#cd /usr/local/robcad
#mkdir rrs_bin
#mkdir rrs_bin/rcsym
#cd rrs_bin/rcsym
#tar xvf /CDROM/rcsym.tar
```

(2)Robot model

Please unpack all files in robot.tar to temporary directory. Each robot model is packed by "tar" and compressed by "gzip". So uncompress and unpack Robot model to suitable directory.

ex.)

```
#cd /tmp
#tar xvf /CDROM/robot.tar
#ls
up130_j00.tar.gz    up200_a00.tar.gz
#cd /usr/Robcad/LIBRARIES/ROBOTS_MOTOMAN_XRC
#gunzip -c /tmp/up130_j00.tar.gz | tar xvf -
```

5. Password Protect

RCS-Module is protected by password and can be used only on approved computer. So to use RCS-Module, please send the System ID of your computer to our agent. Then we will return the password. The password is written in the ".YERCS" file. This file is in the RCS-Module's directory.

To get System ID, please use "sysinfo" command.

ex.)

```
#sysinfo
System ID:
69  0c  83  73  00  00  00  00  00  00  00  00  00  00  00  00
```

```
00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
```

However, our password can't be used in Floating License. If in that case, please contact us specially.