



Robot-motion Safety Controller

RSC1

Instruction Manual
Version **2.01**

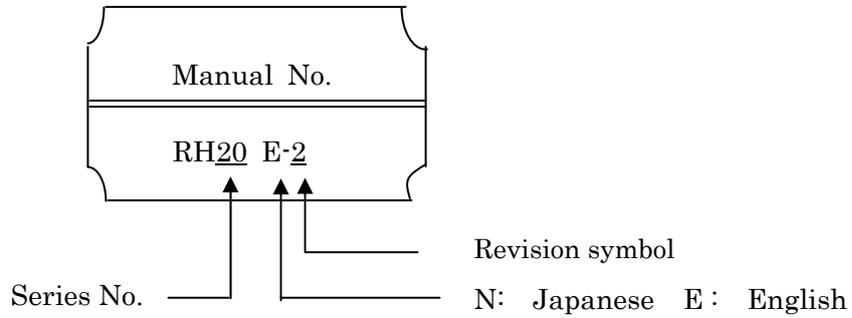
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REVISION HISTORY OF INSTRUCTION MANUAL

Revision symbol of Instruction Manual is added to Manual Identification Number which is printed on the cover sheet.



Revision symbol	Date of revision	Content of revision
1	September 2007	Manual version: 1.04 <ul style="list-style-type: none"> • The First Edition printed
2	March 2008	Manual version: 2.01 It applies since the system software version 2.00. <ul style="list-style-type: none"> • "Stop monitoring function" is added. • "Area forecast control" is added. • "Ball excluded from tool monitoring" is changed. • Notice in case of wiring is added. • Explanation of the Transformation Matrix Parameter is added.

Preface

This instruction manual contains the description of Robot-motion Safety Controller (RSC1).

Descriptions, control technical correlations, details on external control units, installation and operating information or similar have been provided to the best of our knowledge. However, this does not mean that you may assume warranted characteristics or other properties under liability law which extend beyond the "General Terms of Delivery for Products and Services of the Electrical Industry". We trust you will understand that the user must therefore check our information and recommendations before using the equipment.

In order to guarantee the safe operation of the product, these and all associated instruction manuals must be read thoroughly and understood. They must be stored in a safe place after reading and be accessible at the workplace at any time.

Please ensure that this instruction manual is made accessible to the end users of the equipment.

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1 Overview

This chapter describes the structure of the instruction manual, and the overview of RSC1.

1.1 Preliminary remarks

Before reading this instruction manual thoroughly, please read through chapter 2 carefully. Understanding the information and procedures described in this chapter is essential for the correct use of the RSC1 described in the following. Please always remember that faulty installation or parameter setting can lead to serious injuries / damage to man and machine.

The terms and abbreviations used in this document are standard terms used in electrical engineering insofar as not described in more detail.

1.2 Definition of terms

The definition of the terms and the abbreviations used most frequently in this document are described below.

RSC	This is the abbreviation of Robot-motion Safety Controller. And RSC1 is the model type.
RC	Robot controller: Processes robot program, calculates travel position and sends travel instructions to each axis.
RSU	Robot Safety Unit. Located inside the robot controller, the RSU is a unit which processes the emergency stop signal and etc.
A Contact	<i>Designation of an N/O contact</i>
B Contact	<i>Designation of an N/C contact</i>
Cat.	Abbreviation for category (1 to 4 as in EN 954-1).
TCP	Tool Center Point. Point defined for a given application with regard to the mechanical interface coordinate system

1.3 Structure of the document

This manual is subdivided into 11 chapters. There is an additional table of contents preceding every chapter in which the individual sections are shown separately.

1.3.1 Page lay-out

All pages have the same lay-out in principle.

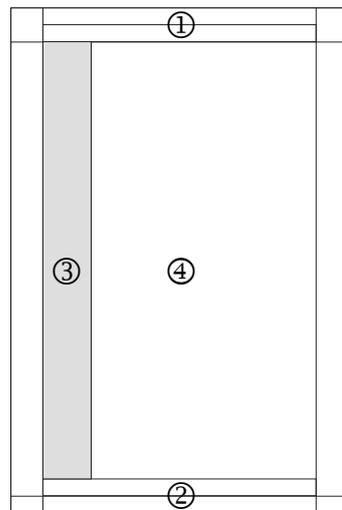


Figure 1-1 Page lay-out of the document

① **Headline**

The number and the name of the respective chapter are located top right and top left respectively.

② **Baseline**

The page number within the chapter is shown bottom right.

③ **Margin**

This area contains important information, cross-references to other parts of the text and bibliographic references and the information content of text passages.

④ **Texts / Pictures / Tables**

Texts, pictures and tables are named within a chapter with the chapter number and an additional index and, if necessary, a brief accompanying text.

1.3.2 Explanation of symbols



Safety warnings

Text passages with a STOP symbol contain important warnings which must be heeded under all circumstances. Failure to heed these warnings may place the controller in a state which no longer provides adequate protection for man and/or machine. Please read through such text sections with particular care.



Warnings

A CAUTION sign gives you important information and warnings which guarantee the trouble-free operation of the RSC1 when heeded. Failure to heed these warnings does not restrict the safe operation of the RSC1.



Information

This symbol indicates useful additional information intended to facilitate the commissioning/servicing of the RSC1 or to provide a deeper insight into the mode of operation of the controller.

x.x.x / x-xx



Cross references

This symbol refers to other text passages within the document which contain additional information. The first digit describes the chapter and the second the page within the chapter.

1.4 Product description

The RSC1 is a device which monitors the motion space and speed of industrial robots (to be referred to below as robot), stopping the robot if it should deviate from a specified motion space or speed.

RSC1 provides safety function suitable for SIL2 according to IEC61508 and IEC62061, Category3 according to EN954-1, PL d according to ISO13849-1.

The RSC1 is installed inside the robot control panel, and has the robot's movement command value inputted into it so as to enable it to judge the accuracy of robot speed and movement position. Actual motor rotation position is inputted also, in order to enable it to confirm the accuracy of the command value.

By referring to the movement command value, the RSC1 calculates the flange position of the tip of the robot arm or the tool center position, and controls the conditions to stop the robot, depending on the outcome of that calculation. .

1.4.1 RCS1 Feature List

No	Item	Contents	Safety function
1	Speed monitoring	<p>It monitors that a flange and TCP speed are below safety speed (250 or less m/s). An emergency stop is outputted when safety speed is exceeded. If safety speed is 250 or less m/s, it can be set up with a parameter.</p> <p>This monitoring becomes valid, when the safety input signal "250" is ON.</p>	Safety function
2	Axial limit (SAL). monitoring	<p>Each axial operating area is monitored. When a robot exceeds the area set up with the parameter, an emergency stop is outputted.,</p> <p>This monitoring is always valid.</p>	Safety function
3	Area limit (SSL) monitoring	<p>The robot operation area is monitored in area. An emergency stop is outputted when the robot exceeds the set-up area. An area consists of a permission area (one piece) of a eight-sided square pillar and prohibition areas (eight pieces) of four-sided square pillars. Robot's monitoring places are globes on a flange, TCP and a flange (maximum: 20 pieces), and points on a joint (maximum: 3 pieces).</p> <p>The globe on TCP and a flange (maximum: 20 pieces) can be set up to 9 sets, and can be changed.</p> <p>This monitoring is always valid.</p>	Safety function
4	Collaboration area monitoring (SSF)	<p>A robot operation area is monitored in area. When a robot exceeds the set-up area, an emergency stop signal is outputted.</p> <p>The area consists of a permission area (one piece) of eight-sided square pillars, and it is set up with a different parameter from SSL. Robot's monitoring positions are the same as SSL.</p> <p>When the safety incoming signal "SSF" is ON, this monitoring becomes valid.</p>	Safety function

No	Item	Contents	Safety function
5	Stop monitoring function	With this function, stoppage of each axis of the robot is monitored. If the axis movement exceeds an allowable motion width specified for each axis in a parameter, an emergency stop output is issued. This monitor is valid when the "Stop_mon" safety input signal is turned off.	Safety function
6	TOOL change function	The monitoring ball set can be exchange up to 9 sets (1 set : a TCP and 20 monitoring balls).	-

Table 1-1 RCS1 feature List.



RSC1 calculates positions, such as TCP of a robot, from the encoder values of each robot axis, the speed monitoring and the area monitoring are implemented based on it.

Therefore, system integrator, who use the RSC1 must validate the safety functions of the whole safety loops. (e.g. To guarantee that there is no gap (position difference) between robot arms and motor encoders.)

When calculating for positions, such as TCP, because the error resulting from mechanical gaps, backlash, mechanical deflection of a drive system, etc. are not taken into consideration. There is the position difference caused by errors between calculated position and actual position.

When using the soft limits of SAL,SSL and SSF, soft limit area have to be established based upon the response time mentioned in Chapter 11.4 and as well as expected stop positions considering the robot's stopping characteristics.

Never use a Robot over the worker position. The software limit can not protect a worker from a Robot fall down caused by the gravity.

1.5 Example of check for absence of deviation between robot arm and encoder

Preparation

Indicate whether a robot is in a working reference position for each motor axis.

"The robot's mechanism is actually at the working reference position" is confirmed using the marking for each axis. (Refer to the figure below).

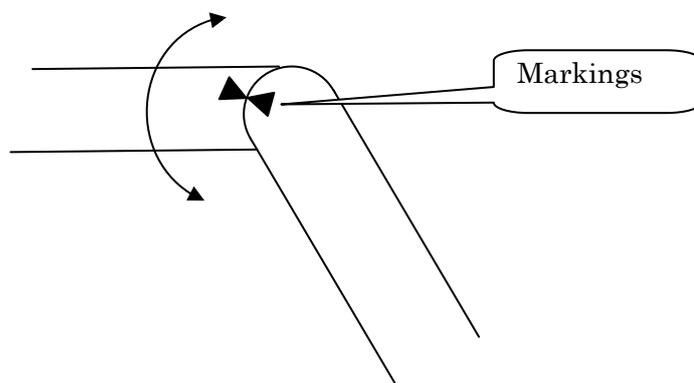


Figure 1-1 the marking for each axis

Confirmation

Move a robot to the robot working reference position

And the operator confirms that the robot is actually at the reference position by visual Marking-matching for all axes.

1.6 Safety Integrity Level

The Safety Integrity Level (SIL) to DIN EN 61508 is one of 4 levels to specify the requirements of safety integrity of the safety functions which are assigned to all elements of the chain. Level 4 is the highest and level 1 the lowest safety integrity level.

The Safety Integrity Level is defined for the following operating modes:

with low demand rate: whereby the rate of demand to the safety related system is no more from once per year and is no greater than double the frequency of the repeat check.

with high demand rate/continuous demand: whereby the rate of demand to the safety related system is no more than once per year or is greater than double the frequency of the repeat check.

RSC1 suitable for high and low demand mode of operation.

The average probability of a failure of a safety function with low demand rate is specified by the PFD factor (average probability of failure to perform its design function on demand).

The average probability of a failure with a function with high/continuous demand rate is specified by the PFH factor (average probability of a dangerous failure per hour).

The following is an overview of the RSC1 values

This value contains encoder. The encoder for the communication of "A format of Nikon" can be used for RSC1. However, other modules (robot controller, servo amplifier, motor, and etc) do not contain this value.

Safety function : A two-channel safety input affects a safety output	
Demand rate	Failure probability
low	PFD = $3.63 * 10^{-3}$
high/continuous	PFH = $1.83 * 10^{-7}$

Table 1-2 Overview of the failure probabilities

RSC1 provides safety function suitable for

- SIL2 according to IEC61508 and IEC62061.
- Category3 according to EN954-1.
- PL d according to ISO13849-1

The interval of the proof test of RSC1 is 20 years.

1.7 Periodic inspection



It is recommend to check the safety functions within suitable intervals(e.g. every 6 month, every year, etc.).

Please execute at least the following check items.

1. Check of all safety functions of the whole safety loops.
2. Check of the installation (e.g. pollution, wiring, loosening of fixing screws and/or PE terminal, damage, etc.)

1.8 Modification



Whenever the safety loops are modified, each party is responsible for the validation of safety functions of the whole safety loops.

This applies

e.g.

- Whenever the system integrator modify the safety loops, the system integrator is responsible for the validation after the modification
- Whenever the machine users modify the safety loops(e.g. parameter setting change, etc.), the machine users is responsible for the validation after the modification.

2 Important information

This chapter contains important warnings and information for the safe and correct use of the RSC1.

2.1 Safety warnings

Graded safety warnings

Safety warnings are marked in this instruction manual by a symbol and the keyword CAUTION or WARNING in the margin of the page. The safety warnings are printed in bold type and in a box.

2.1.1 Definitions



Safety warnings

Text passages with a STOP symbol contain important warnings which must be heeded under all circumstances. Failure to heed these warnings may place the controller in a state which no longer provides adequate protection for man and/or machine. Please read through such text sections with particular care.



Warnings

A CAUTION sign gives you important information and warnings which guarantee the trouble-free operation of the RSC1. Failure to heed these warnings does not restrict the safe operation of the RSC1

2.1.2 Danger through misuse



The consequences of incorrect use may be personal injury to the user or third parties as well as damage to the controller, the product or to the environment. Only use the RSC1 for its intended purpose!

2.1.3 Dangers from modification and retrofitting.



The RSC1 has been designed and constructed by us to operate safely.

It is not therefore permitted to make modifications or to retrofit the equipment.

This may affect the correct operation of the RSC1 with the consequence of personal injury, property or environmental damage and loss of any liability.

2.1.4 Authorized persons

Only sufficiently qualified and instructed persons may operate the RCS1.

An electrical technician must perform commissioning.

Only qualified personnel may perform service, maintenance, troubleshooting and error correction work.

Operators

An operator is a duly instructed person.

The operator switches the system on and off.

The operator is the actual beneficiary of the safety function.

Commissioners

The commissioner is an electrical technician.

The commissioner

- performs commissioning under increased safety measures,
- sets the device parameters
- and performs the requisite tests.

Maintenance technicians

The maintenance technician is a qualified skilled worker. He

- services the electrical and mechanical components of the controller,
- performs maintenance work and
- looks for errors and eliminates them.

2.1.5 Password protection of the parameter



The writing of a RSC parameter can be implemented using RSCwin(software). In RSCwin, in order to avoid writing parameter by a non-authorized worker, it has a password protection function.

2.1.6 Electrical connections

The RSC1 must be connected to an electrical power supply.



CAUTION: Electrical voltage.

An electrician must connect the system to the mains.

The power supply (24 VDC) for the RSC1 must meet one of the following demands:

- Safety mains transformer to DIN EN 61558/VDE 0570 Part 2-6: "Special requirements on safety transformers for general applications (IEC 61558-2-6:1997)".
- Switch mode power supply to DIN EN 60950-1 : "Information technology equipment - Safety - Part 1" and to DIN EN 50178 : "Electronic Equipment for Use in Power Installations". Furthermore the power supply unit must be suitable for supplying its SELV circuits in accordance with DIN EN 60950-1.

And the power supply which acquires the certification of UL1310 (NEC CLASS 2) must be used for the power supply (24VDC) of RSC1.

The mains must be appropriately fused!

The RSC1 satisfies the pertinent provisions of the EMC Directive.

2.1.7 Shock-hazard protection



The RSC1 is intended for use in control circuits to DIN EN 60204 for a rated voltage of 24 VDC. The appropriate requirements placed on shock-hazard protection must be satisfied for the applications.

2.1.8 Maintenance

Maintenance work



Incorrect maintenance could lead to death, injury, damage to property or damage to the environment. Only qualified persons may perform maintenance, troubleshooting and error elimination work. Switch off the power supply to the RCS1. Directly after completing maintenance work replace all protective cladding and safety equipment and check that they function correctly.

Spare parts

The use of unsuitable spare parts could lead to death, injury, damage to property or harm to the environment. Spare parts must comply with the technical requirements set by the manufacturer. Only use original JTEKT spare parts.

2.1.9 Disposal

Electrical waste (components, screens, etc.) can damage the environment. Dispose of electrical resources correctly or commission a specialised company to do so.

2.1.10 Liability

The contents of the following instruction manual are subject to technical modification, which may arise particularly due to constant further development of the products from JTEKT. JTEKT assumes no liability for any printing errors or any other inaccuracies which may be contained in this instruction manual unless these are serious faults which JTEKT demonstrably already knew about. The applicable national and international standards and provisions must be observed under all circumstances in addition to the instructions contained in the instruction manual.

N.B.

Incorrect use - liability exclusion.

JTEKT shall not be liable for damage caused through incorrect use or application of the product.

The exact knowledge of the contents of this instruction manual is similarly viewed to be correct use. In particular, the information and safety warnings contained in this instruction manual must be heeded.

If products are used in connection with other components such as safety modules, controllers or sensors, the respective user information must be heeded.

3 System description

3.1 System configuration

The RSC1 monitors the operations of the robot based on the signal sent from the rotary encoder advising of the servo-controlled motor rotation angle (Actual Value) and comparing this to the movement command value sent to the servo section from the robot controller (Setting Value).

The rotary encoder attached to the motor is optical and is used in detecting the angle. Encoder signals are inputted into the RSC1 in the same format as signals are inputted into the servo section.

Encoder signals are transmitted by the encoder as serial signals.

3.2 Configuration of main devices

The RSC1 monitors the speed and robot tool center, flange position etc, basing it's calculations on the value sent by the rotary encoder indicating motor rotation angle of the motor which rotates based on a travel command, and the travel command for each robot axis which is sent from the RC's CPU to the servo.

Generally speaking, the RSC1 and peripheral control equipment comprises of 1 RC unit and 1 Robot, (a 1 to 1 ration (Figure 3-1)).

Depending on the equipment, there are cases where a multi-arm controller (multiaxial servo amp or multiaxial controllers) is used and in such cases the RC controls multiple robots, as shown in Figure 3-2 .

In these circumstances, rather than one RSC1 monitoring the coordinates and speed of one robot the RC may be adjusted to combine several RSCs.

The RSC1 is activated when designated sections (WP) such as coordinate monitoring and speed monitoring, robot tool center (TCP) and the flange (FLG) are given.

It monitors constantly when soft limit monitoring has been initiated.

RC 1 unit to Robot 1 unit configuration

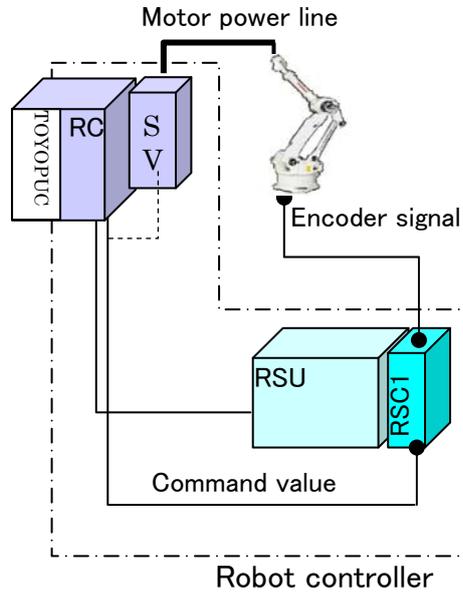


Figure 3-1 RC 1 unit to Robot 1 unit configuration

Multi arm controller configuration (Max. 6 units)

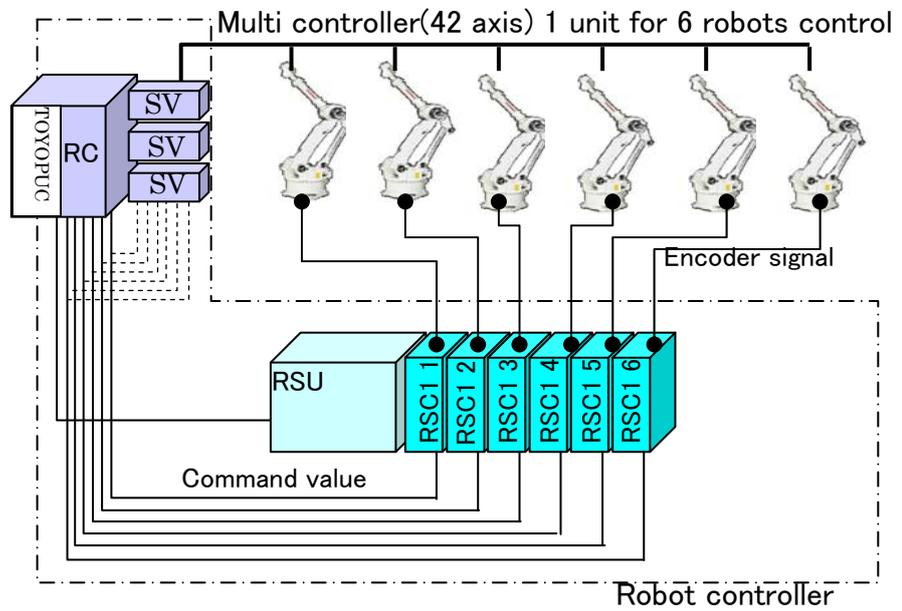


Figure 3-2 Multi arm controller configuration

3.3 The appearance and wiring of RSC1

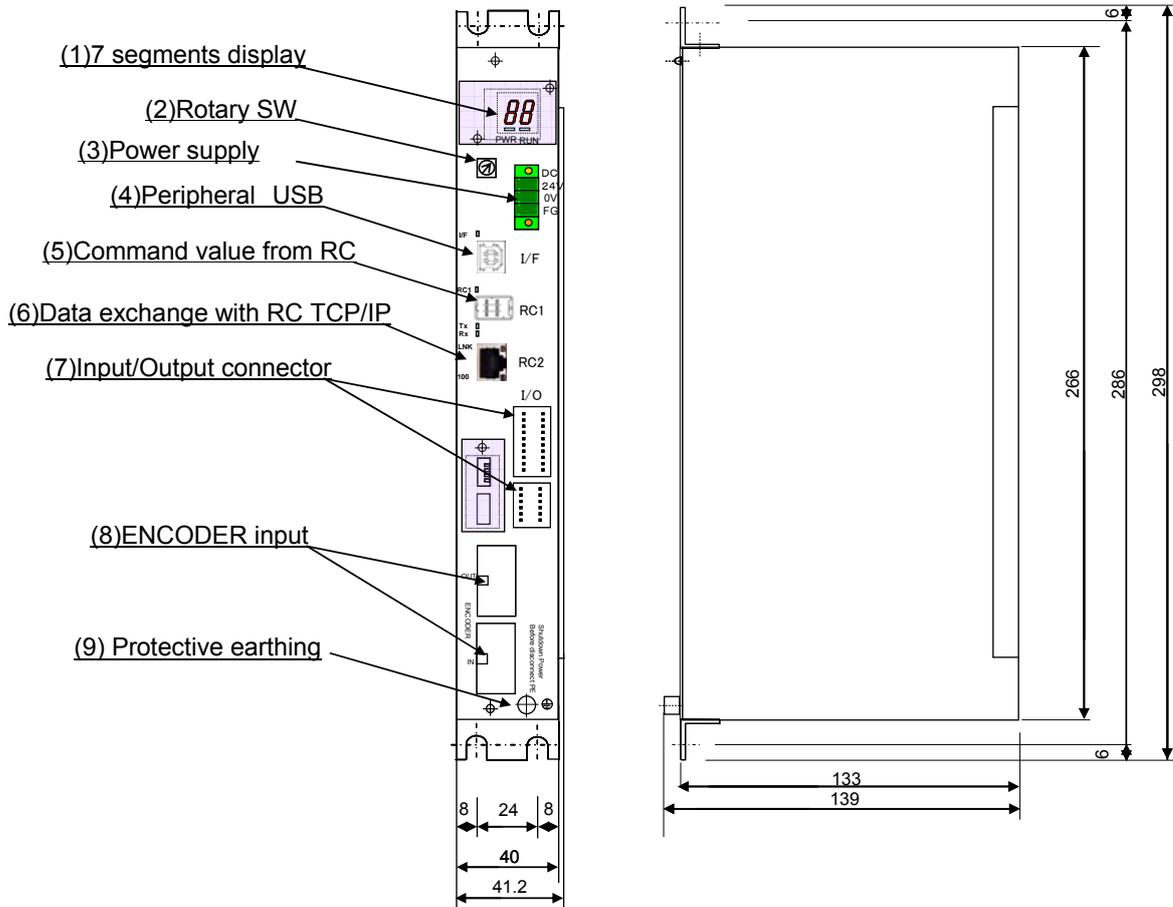


Figure 3-3 The appearance of RSC1

3.3.1 7 segments display

RSC status display is performed.

3.3.2 Rotary SW

The connecting robot number is set up. 1, 2, 3, 4, 5, and 6 can be set.

3.3.3 Power supply (DC24V,0V,FG)

RSC operational power supply (Terminal DC24V,0V)

Terminal FG must be earthed.

DC24V(DC21.6~26.4V), less than 12W

Terminal block: FKCT2.5/3-STF-5.08 (Phoenix Contact GmbH&Co.KG)

(It is attached to the module.)

Wire-end ferrules:AI0.75-10GY(Phoenix Contact GmbH&Co.KG)

Size of wire:0.75mm²(AWG18)

Maximum length:3m (In control box)

The fuse of 2A is built into RSC1. When the fuse breaks, the fuse cannot be exchanged.

3.3.4 Peripheral USB (I/F)

Parameter setting and writing of RSC, and the USB connector for connection with the personal computer used for the contents check of RSC1.

RSC1 Connector: USB Standard B Receptacle

External connector: USB Standard B Plug

Size of wire: USB2.0 Standard

Maximum length:3m

3.3.5 Command value from RC (RC1)

The connector that receives the command value of movement of each axis of the robot transmitted from RC (robot controller). Although it is USB specification, the exclusive connector is used in order to avoid incorrect insertion and disconnection prevention

Pin No	Signal name	Pin No	Signal name
A1	D+	B1	D-
A2	GND	B2	GND
A3	NC	B3	NC

Please connect the shield of the communication cable of USB with "GND of pin №B2".

RSC1 Connector: S06B-J21DK-GGXR (J.S.T. Mfg. Co.,Ltd.)

External connector:J21DF-06V-KX(J.S.T. Mfg. Co.,Ltd.) (Prepared by customer)

Size of wire: 0.2 mm²(AWG24) or more

Maximum length:3m(In control box)

3.3.6 Data exchange with RC TCP/IP (RC2)

The Ethernet connector is for information exchange with RC. I/O data exchange with RC and the check of initial data are performed through this communication.

Transmission speed is decided with Auto-Negotiation. (10M/100M)

RSC1 Connector: TM11R-5M2-88LP(HIROSE ELECTRIC CO.,Ltd.)

External connector:RJ45(Prepared by customer)

Size of wire: 0.2 mm²(AWG24) or more

Maximum length:3m(In control box)

3.3.7 Input/Output connector (I/O)

RSC1 has one safety output (cat.3), three safety input (cat.3), one non-safety output, and six non-safety input. All I/O is 24V operation. All input/output modules require an external 24 volt DC supply voltage for the functionalities of the inputs/outputs. It is advisable to secure this supply by means of an external fuse.

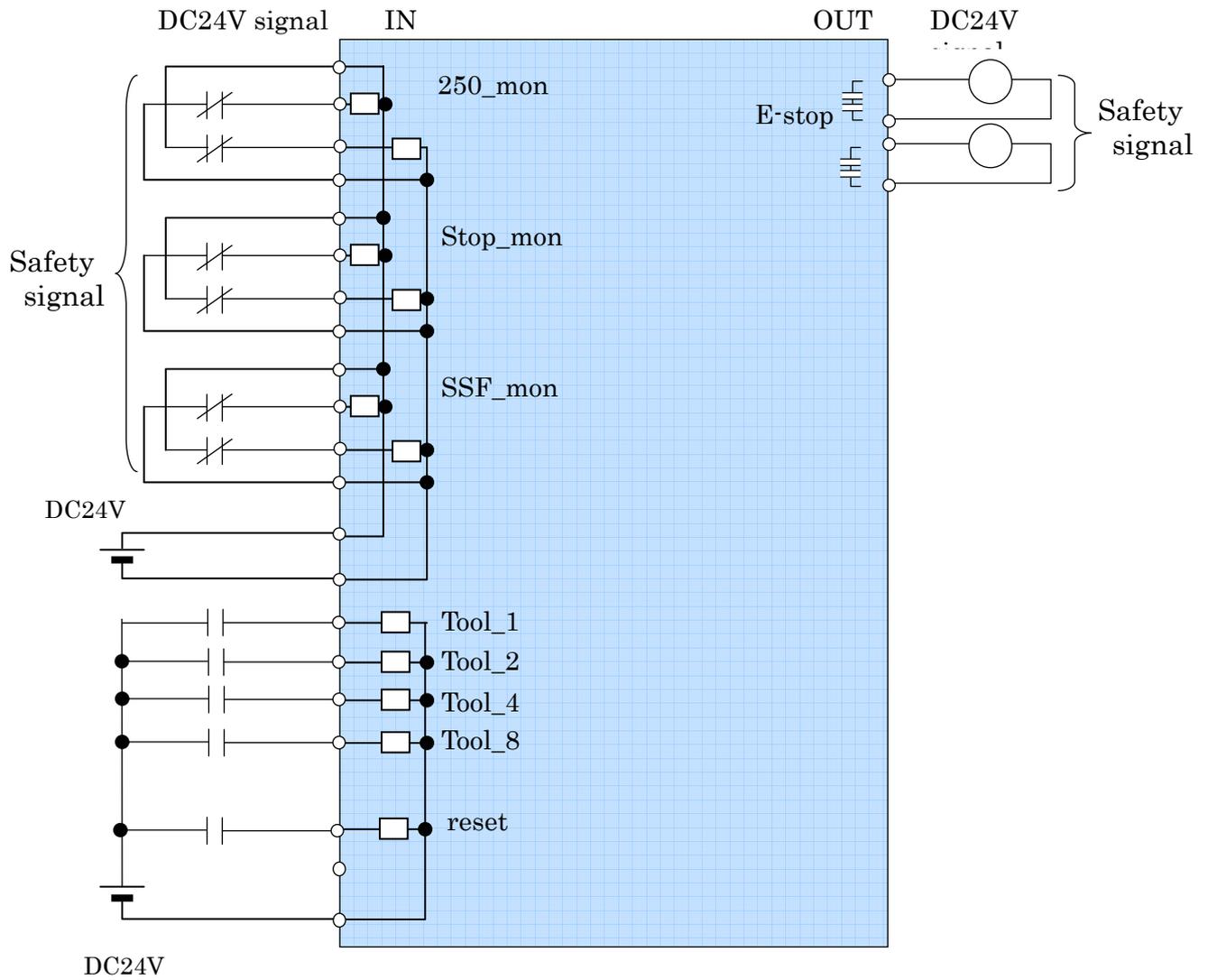


Figure 3-4 Input/Output of RSC1

Input signal			
No.	Signal	Description	Cat.
1	250_mon:	When this signal is OFF, a robot's TCP speed is monitored 250 or less mm/s. The monitoring becomes valid after 1 second from OFF.	Cat.3
2	Stop_mon	Stoppage of each axis of the robot is monitored if this signal is turned off. Monitoring starts immediately after the signal is turned off.	Cat.3
3	SSF_mon:	When this signal is OFF, the robot operation is monitored inside of the defined area. The monitoring becomes valid after 1 second from OFF.	Cat.3
4	Reset:	When this signal is ON, the errors detected by RSC are reset. The robot command through Ethernet can also implement this reset function.	
5	Tool_1 to Tool_8	A TCP position and WP are changed by a robot's Tool number, and a movement point is calculated. Tool number is Hexadecimal	
Output Signal			
No.	Signal	Description	Cat.
1	E-Stop:	A B contact signal. It is come by off when it exceeds from RSC monitoring conditions.	Cat.3

- Signal arrangement

The safety signal is redandant.

RSC1 Connector: 1376137-1 (Tyco Electronics AMP)

: 1376020-1 (Tyco Electronics AMP)

External connector: 1-1318118-9(Tyco Electronics AMP) (Prepared by customer)

: 1-1318118-6(Tyco Electronics AMP) (Prepared by customer)

Size of wire: 0.3 mm²(AWG22) or more

Maximum length:30m

Connector :1376137-1(Tyco Electronics AMP)

Pin No	Signal name	Pin No	Signal name	Remarks
A1	ES1-1	B1	ES1-2	E-Stop output(ES1-1-ES1-2) B contact
A2	ES2-1	B2	ES2-2	E-Stop output(ES1-1-ES2-2) B contact
A3		B3		
A4	250_mon +	B4	COM+	250mmMonitoring input B contact
A5	250_mon-	B5	COM-	250mmMonitoring input B contact
A6	Stop_mon+	B6	COM+	Stop_monitoring input B contact
A7	Stop_mon-	B7	COM-	Stop_monitoring input B contact
A8	SSF_mon+	B8	COM+	SSF Monitoring input B contact
A9	SSF_mon-	B9	COM-	SSF Monitoring input B contact
A10	IN-P(0V)	B10	IN+P(24V)	24V power supply for safety inputs

Connector:1376020-1(Tyco Electronics AMP)

Pin No	Signal name	Pin No	Signal name	Remarks
A1	Tool_1	B1	Tool_2	TOOL No. input A contact
A2	Tool_4	B2	Tool_8	TOOL No. input A contact
A3		B3	Reset	Error reset A co ntact
A4	IN-P2(0V)	B4	NC	24V power supply for input -common
A5	NC	B5	NC	
A6	NC	B6	NC	

NC=Non connect



I/O signals remarks

- For A-contact, the signal implements the function at ON.
For B-contact, the signal implements the function at Off.
- The terminal of 24V power supply for safety input should be connected.

If not connected, the error is caused.

- B contact input: (250 mm Monitoring input, SSF Monitoring input, Stop_monitoring input) becomes effective, when they are not connected

If these functions are not used, please connect to 24V terminal.

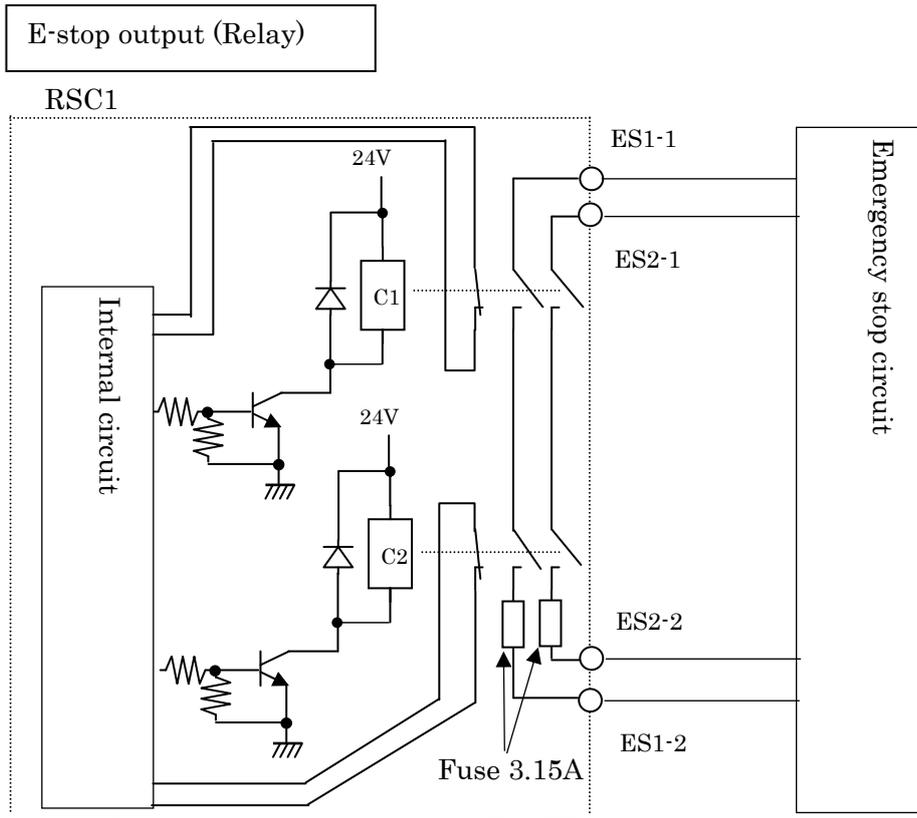


Figure 3-5 E-stop output

The ratings current of the built-in relay used is 6A(The ratings current as RSC1 is 1A).

Position	Description
Name	Safety output
Type	E-stop output B Contact
Supply voltage	24 V DC± 10 %
Output current	MAX 1A
Fusing	Internal fuse 3.15A Nomal blow type

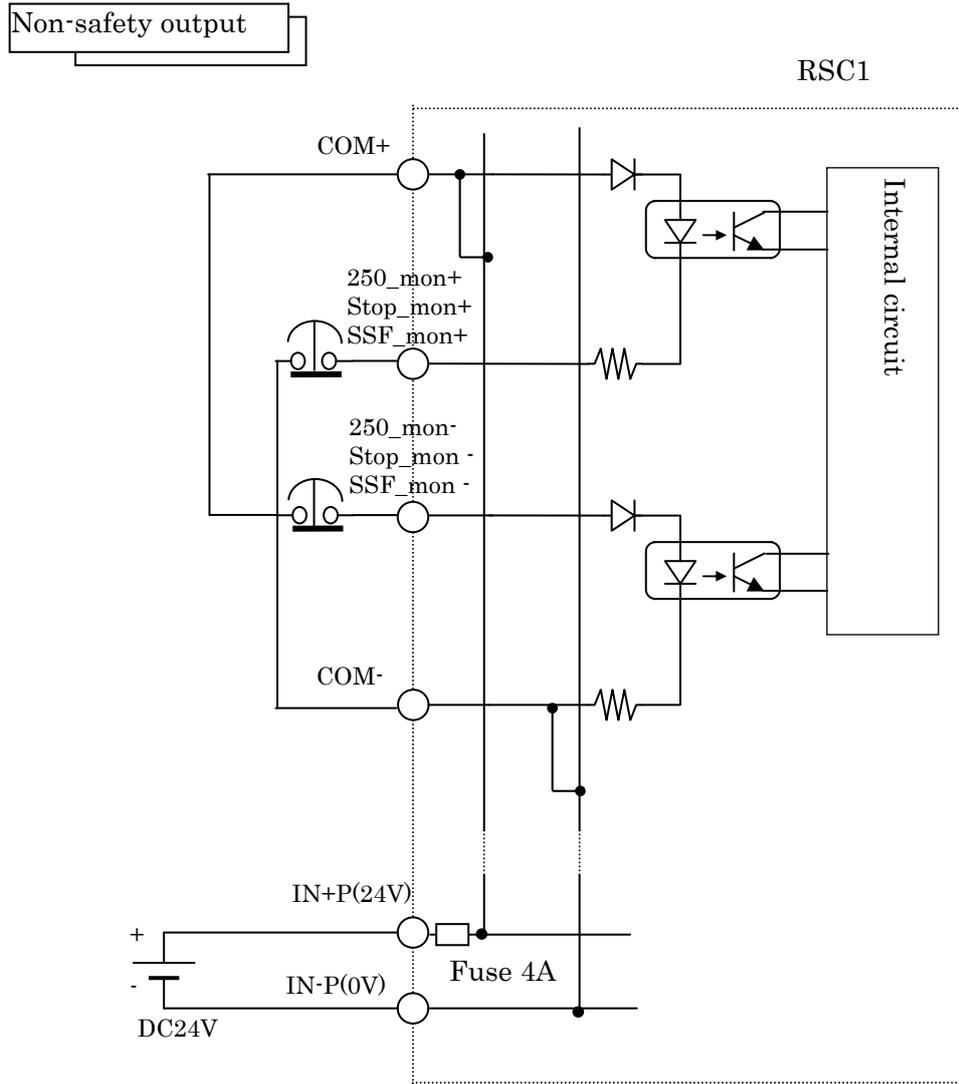


Figure 3-6 Safety input

Position	Description
Name	Safety input
Type	250_mon B Contact Stop_mon B Contact SSF_mon B Contact
Supply voltage	24 V DC± 10 %
Input current	5mA
Fusing	Internal fuse 4A Nomal blow type

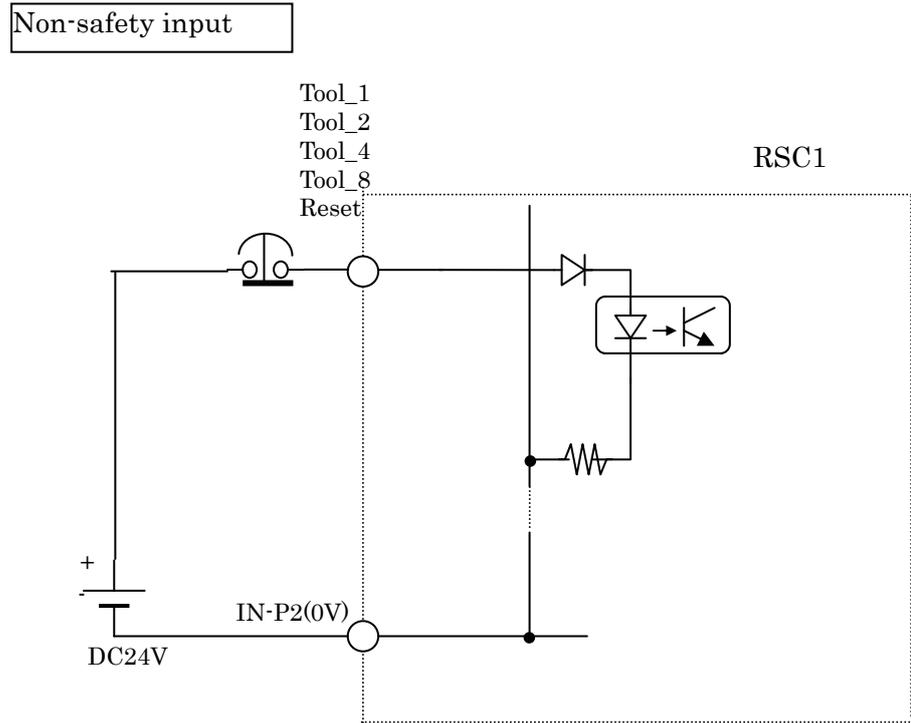


Figure 3-7 Non-safety input

Position	Description
Name	Non-safety input
Type	Tool_1 A Contact Tool_2 A Contact Tool_4 A Contact Tool_8 A Contact Reset A Contact
Supply voltage	24 V DC± 10 %
Input current	5mA

3.3.8 ENCODER(OUT,IN)

The angle information are inputted from the rotary encoder attached to the motor of robot each axis .Although a rotary encoder signal is inputted into RC, the signal information is taken from the path.

The encoder for the communication of "A format of Nikon" can be used for RSC1

OUT

RSC1 Connector: S20B-J21DK-GGYR(J.S.T. Mfg. Co.,Ltd)

External connector: J21DF-20V-KY(J.S.T. Mfg. Co.,Ltd.) (It is attached to the module.)

Size of wire: 0.3 mm²(AWG22) or more

Maximum length:30m

IN

RSC1 Connector: S20B-J21DK-GGXR(J.S.T. Mfg. Co.,Ltd)

External connector: J21DF-20V-KX(J.S.T. Mfg. Co.,Ltd.) (Prepared by customer)

Size of wire: 0.3 mm²(AWG22) or more

Maximum length:30m

The same pin No.of 2 connectors is connected inside RSC1.

pinNo	signal name	pinNo	signal name
A1	SD+ ENC1	B1	SD- ENC1
A2	SD+ ENC2	B2	SD- ENC2
A3	SD+ ENC3	B3	SD- ENC3
A4	SD+ ENC4	B4	SD- ENC4
A5	SD+ ENC5	B5	SD- ENC5
A6	SD+ ENC6	B6	SD- ENC6
A7	SD+ ENC7	B7	SD- ENC7
A8	SD+ ENC8	B8	SD- ENC8
A9	GND(SG)	B9	GND(SG)
A10	NC	B10	NC

3.3.9 Protective earthing(PE)

Terminal PE must be earthed.

Size of wire: 2.5 mm²(AWG13) or more

Maximum length:3m

Size of screw:M4

Tightening torque:1.2Nm

Terminal:Ring tongue terminal

3.4 Installation

3.4.1 Ambient conditions

11.1 /10-1



The following ambient conditions must be observed or avoided for the perfect operation of the RSC1. Complete information is contained in chapter 11.1.

Position	Description
Temperature range	0 to 55°C
Air humidity	30 to 85 % RH
Air pressure	86 kPa to 106 kPa
Degree of pollution	2 to DIN EN 50178 (VDE 0160)
Place of installation	Metal switch cabinet protective class at least IP 53 and NEMA type3

Table 3-1 Admissible ambient conditions

3.4.2 Assembly

Installation position

In order to guarantee sufficient ventilation and comfortable assembly/dismantling of the individual modules, please leave a free space of at least 50 mm above and beneath the station. A distance of 50 mm must similarly be maintained to the left, right and to the front.

However, when two or more RSC1 is set up, the right and left can be continuously set up.

The installation method is only a length installation.

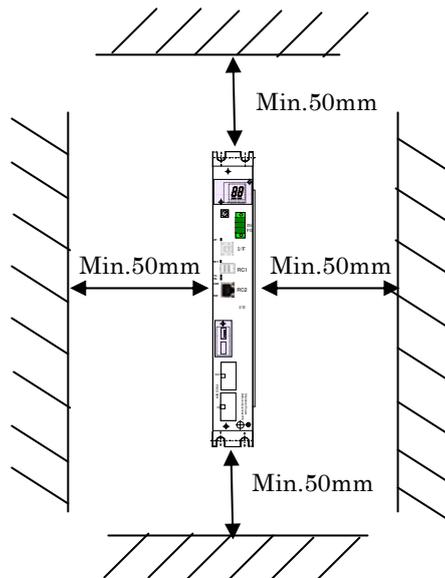


Figure 3-8 Installaion position

Assembly

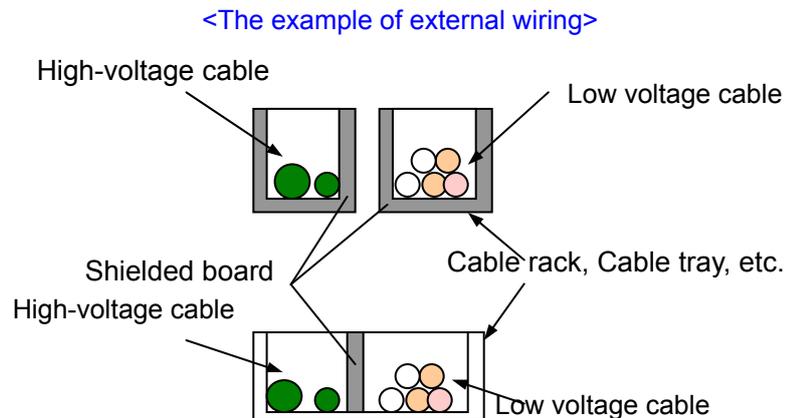
RSC1 is attached to the switch cabinets by means of M5 threaded screws. Select a location which is as far as possible away from the power level and other disturbing radiation and heat sources of the switch cabinet.

And tightening torque is 3Nm.

RSC1 is installed near the robot controller in a robot control panel.

Wiring Precautions

The main body and cables (I/O cable, I/O power supply cable and communication cable) should be arranged and connected apart from equipment and cable which cause strong electric field and magnetic field. When the separation is insufficient, it causes the error. When separation distance cannot be maintained, please separate with the grounded metal shielded board. The example of shielded board is shown in the following figure.



High-voltage cable : Power line of a motor, Power supply line beyond AC100V etc.

Low voltage cable : I/O cable, I/O power supply cable and communication cable etc.

The I/O cable, I/O power supply cable and communication cable should be connected with power OFF.

4 Area judgment

The area monitoring function is described in this section. The area monitoring function means a function that makes the robot emergency stop when the robot, which is a target to be monitored, enters the prohibited area.

The area monitoring function of the RSC1 has the following three types:

- SSL
- SSF
- SAL

Among these, SSL and SSF are the function for checking interference of the monitoring point of the robot with the area. SAL is the function for checking if each axis coordinate is within the predetermined range. These functions are described in details.

4.1 1.1 Definition of Coordinate System

Coordinate systems used by the RSC1 are defined here. The RSC1 uses the following coordinate systems:

- Controller coordinate system
 - Coordinate system serving as a reference to the monitoring area setting or robot installation position
- Robot base coordinate system
 - Coordinate system determined with the robot installation position serving as a original
- Link coordinate system;
 - Link coordinate system;
- Flange coordinate system.
 - Coordinate system determined with the flange point serving as an original

The relationship among coordinate systems is shown in the figure below.

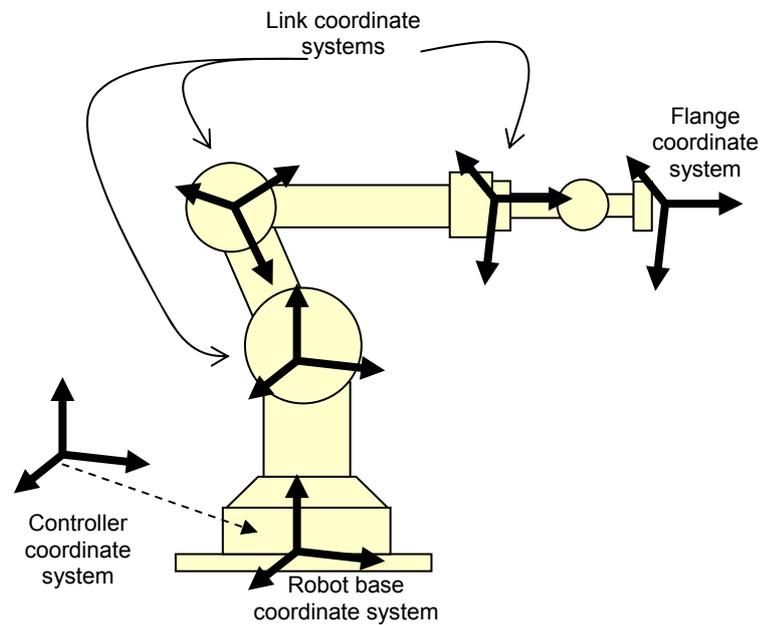


Figure 4-1 Definition of Coordinate System

4.1.1 Controller coordinate System

This is the coordinate system for defining the areas to be monitored by the RSC1 or robot installation position. For example, all lines for setting the area are defined in reference to the controller coordinate system.

4.1.2 Robot base coordinate system

The robot base coordinate system is a coordinate system where the point at which the robot monitored by the RSC1 is installed is the original. The position relationship of the robot base coordinate system with the controller original is defined in RSC parameters.

For the parameter entry method, refer to the separate RSC parameter operation manual.

4.1.3 Link coordinate system

The link coordinate system indicates the coordinate system after n times of coordinate transformations from the robot installation position to robot flange point. For example, the 0th link coordinate system agrees to the robot base coordinate system. In a system where the robot is expressed with seven homogeneous transformation matrices, the seventh link coordinate system agrees to the flange coordinate system.

4.1.4 Flange coordinate system

The flange coordinate system is a coordinate system where the flange point of the robot is the original. This coordinate system is obtained through coordinate transformations of homogeneous transformation matrices from the robot installation position to the robot flange point. Tool settings are defined in this flange coordinate system.

4.2 2 Target of Monitoring

The RSC1 sets the following monitoring points to the robot and judges if the robot is inside or outside of the area by checking the positional relationship between these set points with areas:

- Flange point;
- TOOL (TCP/TOOL ball);
- Arm interference monitoring point.

The current monitoring point can be known with use of PC software. For the PC software operation method, refer to the separate PC software operation manual.

Each monitoring point is provided with data described below.

4.2.1 Flange Point

The RSC1 defines one point indicating the flange of the robot. The flange point is designated as an original of the flange coordinate system.

Please be noted that the flange point is always defined as an original of the flange coordinate system. Therefore, it is not possible for users to change the position. Users cannot cancel the flange point settings either.

4.2.2 TOOL

[Ref. parameter No. : 0279~1025]

The RSC1 can define up to nine tools installed to the robot. The defined tools can be changed by changing over the TOOL numbers.

Each tool is provided with the following data.

- TCP (Tool Center Point);
 - One TCP can be defined per TOOL.
- Ball.
 - Up to 20 balls can be defined per TOOL.

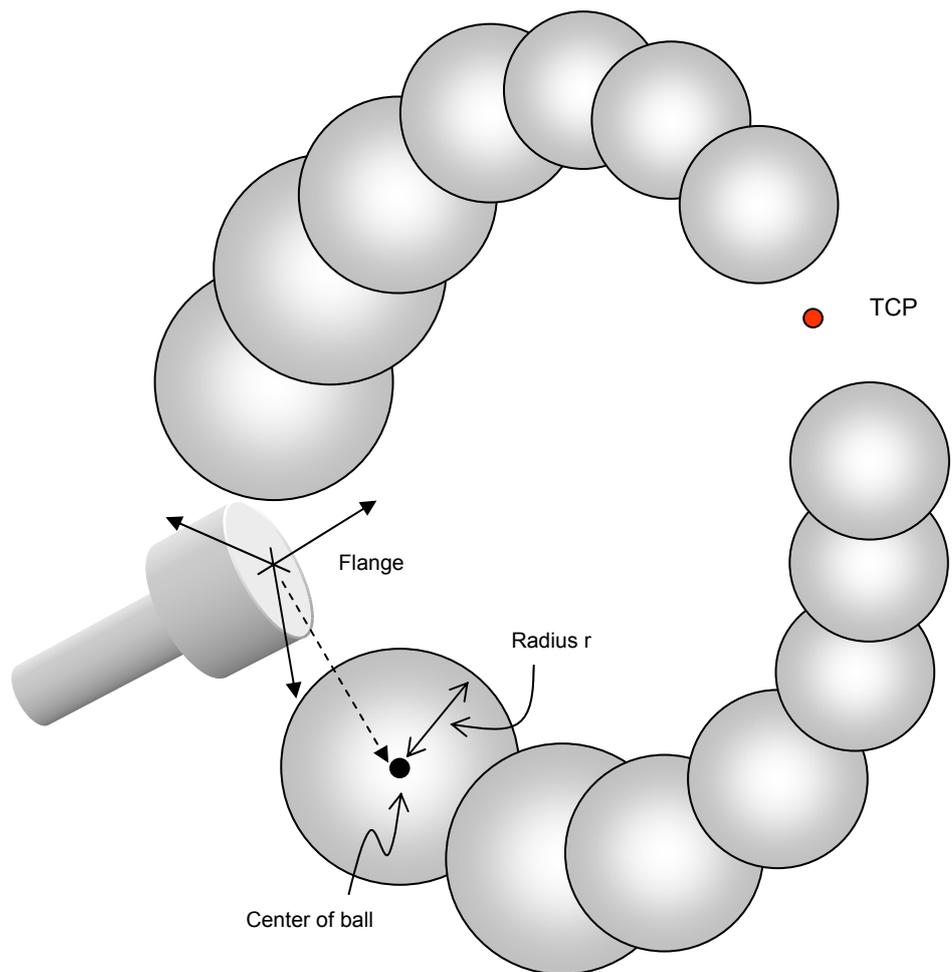


Figure 4-2 Definition of Tool

TCP

With the RSC1, one TCP can be defined for each tool. The TCP is defined in the flange coordinate system.

To define the TCP, it is necessary to set RSC parameters. A setting example is shown below.

Name of parameter	Value
Tool 4, TCP, X coordinate	10000
Tool 4, TCP, Y coordinate	20000
Tool 4, TCP, Z coordinate	30000

This example shows a case where the TCP of TOOL 4 is set at (100, 200, 300) position [unit: mm] in the flange coordinate system.

Ball

The RSC1 can define up to 20 balls for each TOOL, which expresses the shape of the tool. The TOOL ball is defined by the flange coordinate system. The tool balls are set in such a way as to wrap-up the whole TOOL so that interference between the tool and area can be checked. The RSC1 checks the positional relationship between balls and areas in order to monitor interference between the TOOL and areas.

To define the TOOL ball, it is necessary to set RSC parameters. A setting example is shown below:

Name of parameter	Value
TOOL 6, ball 5, X coordinate	10000
TOOL 6, ball 5, Y coordinate	20000
TOOL 6, ball 5, Z coordinate	30000
TOOL 6, ball 5, radius	40000

This example shows the setting of ball 5 of TOOL 6. This ball is set to locate at (100, 200, 300) position [unit: mm] in the flange coordinate system and has a radius of 400mm.

The following example judges that "there is no setting of ball 5 for TOOL 6."

Name of parameter	Value
TOOL 6, ball 5, X coordinate	0
TOOL 6, ball 5, Y coordinate	0
TOOL 6, ball 5, Z coordinate	0
TOOL 6, ball 5, radius	0

[Reference]

The RSC1 does not allow a complete inclusion of a ball in another ball for the same TOOL. For example, the following settings are not allowed:

Name of parameter	Value
TOOL 6, ball 5, X coordinate	10000
TOOL 6, ball 5, Y coordinate	20000
TOOL 6, ball 5, Z coordinate	30000
TOOL 6, ball 5, radius	400000
TOOL 6, ball 7, X coordinate	10100
TOOL 6, ball 7, Y coordinate	20200
TOOL 6, ball 7, Z coordinate	30300
TOOL 6, ball 7, radius	1000

In this case, ball 7 is completely included in ball 5. Therefore these settings are not allowed.

4.2.3 Arm Interference Monitoring Point

[Ref. Parameter No. : 0267~0278]

The RSC1 can have up to three monitoring points on the robot arm. The RSC1 issues an emergency stop signal if the arm interference monitoring point interferes with SSL or SSF. With this function, interference of the back of the arm, or the like, with areas is detected.

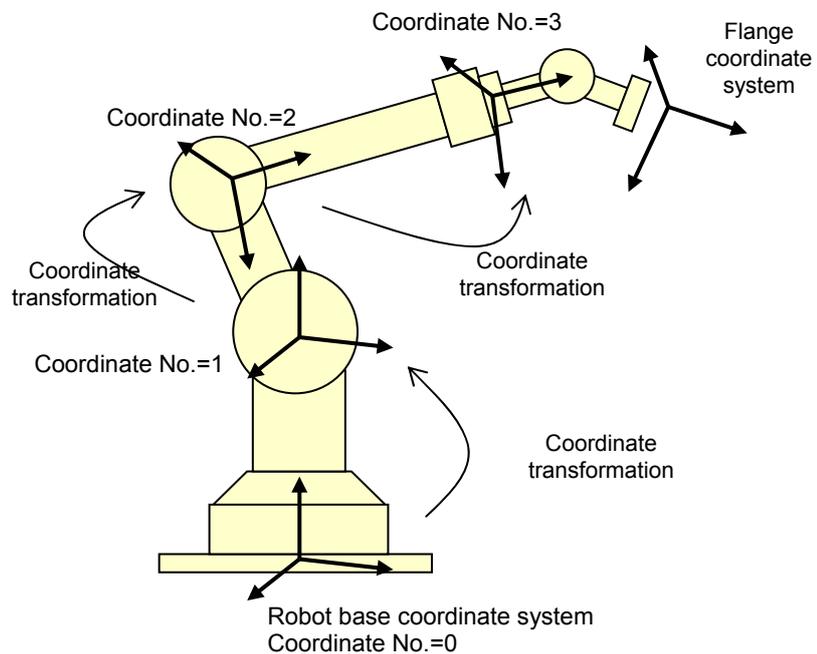


Figure 4-3 Definition of coordinate No.

To define the arm interference monitoring point, it is necessary to set RSC1 parameters. A setting example is shown below:

Name of parameter	Value
Arm interference monitoring point 1. Designate the coordinate number of coordinate transformation.	2
Arm interference monitoring point 1. X coordinate of designated coordinate system	10000
Arm interference monitoring point 1. Y coordinate of designated coordinate system	20000
Arm interference monitoring point 1. Z coordinate of designated coordinate system	30000

In this example, arm interference point 1 is set at (100, 200, 300) position [unit: mm] in the coordinate system of "coordinate number 2." "Coordinate number 2" indicates the fourth link coordinate system. That is, it is the coordinate system obtained after four coordinate transformations with homogeneous transformation matrices.

The following example means that "there is no definition of arm interference monitoring point 2."

Name of parameter	Value
Arm interference monitoring point 2. Designate the coordinate number of coordinate transformation.	0
Arm interference monitoring point 2. X coordinate of designated coordinate system	0
Arm interference monitoring point 2. Y coordinate of designated coordinate system	0
Arm interference monitoring point 2. Z coordinate of designated coordinate system	0

4.3 SSL

SSL (Software Area Limit) is one of the functions provided for the RSC1 to monitor the operation area of the robot. With the SSL, the robot operation range defined in a robot program is set as an area and the RSC1 issues an emergency stop signal if the robot interferes with the area. The SSL has the following two areas.

- Restricted area;
- Partial restricted area.

4.3.1 Restricted Area

[Ref. Parameter No. : 0043~0079]

The restricted area is the internal area surrounded by up to eight lines viewed from a "restricted area reference point." The upper and lower limits in the perpendicular direction can be also set. For the "restricted area reference point," refer to Appendix.

For example, suppose that the following area is set on a plane:

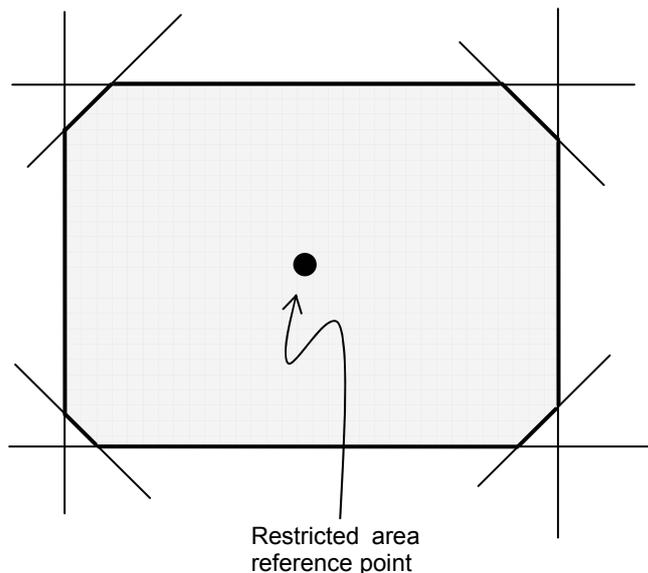


Figure 4-4 Restricted Area(1)

At this time, the whole area including the perpendicular direction is expressed in the following way.

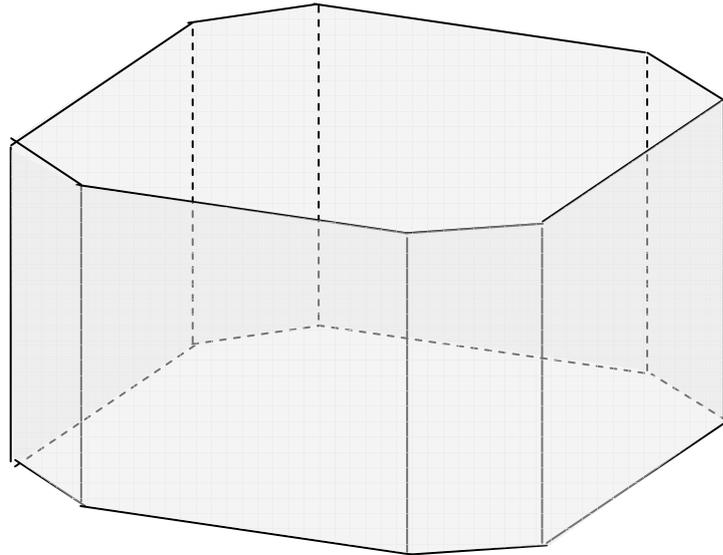


Figure 4-5 Restricted Area(2)

The RSC1 issues an emergency stop signal if the robot gets out of one area.
 Only one restricted area can be defined at a time.

4.3.2 3.1.1 How to set the restricted area

The restricted area is defined with the following RSC parameters.

Name	Setting
X coordinate of restricted area reference point	Restricted area reference point setting
Y coordinate of restricted area reference point	
Restricted area valid / invalid	Area validity flag
Upper limit of Z of restricted area	Z-direction area setting
Lower limit of Z of restricted area	
Restricted line 1, X1	Area line setting
Restricted line 1, Y1	
Restricted line 1, X2	
Restricted line 1, Y2	
:	
Restricted line 8, X2	
Restricted line 8, Y2	

A line specifying the area is expressed by the coordinates which indicate the starting and ending points. For parameter, designate coordinates of the starting point at (x1, y1) and those of the end point at (x2, y2).

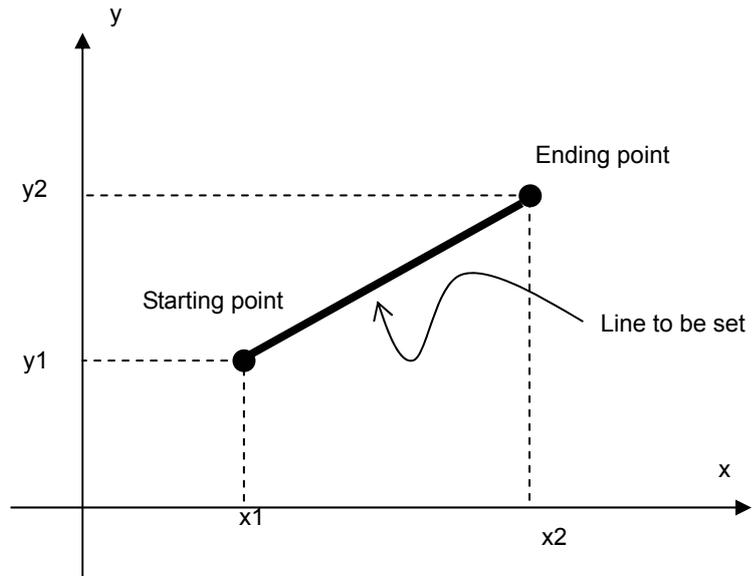


Figure 4-6 Restricted Area(starting point and ending point)

However, the area line cannot be set in such a way that it passes through the "restricted area reference point."

■ Limitation in the Z direction of area

Specifying "0" for both the upper and lower Z limits of the restricted area will invalidate monitoring in the Z direction. That is, how far the robot may travel in the Z direction, that will not bring the robot out of the area. In this case, the whole area becomes the one shown in the figure below.

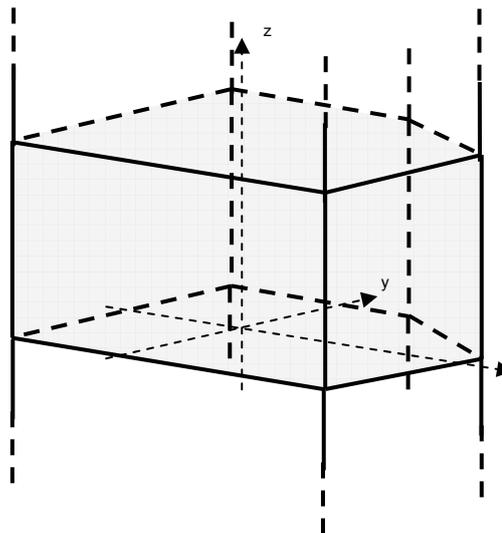


Figure 4-7 Limitation in the Z direction of area

4.3.3 Setting example of restricted area

To set the area shown in the figure below, enter the following parameters.

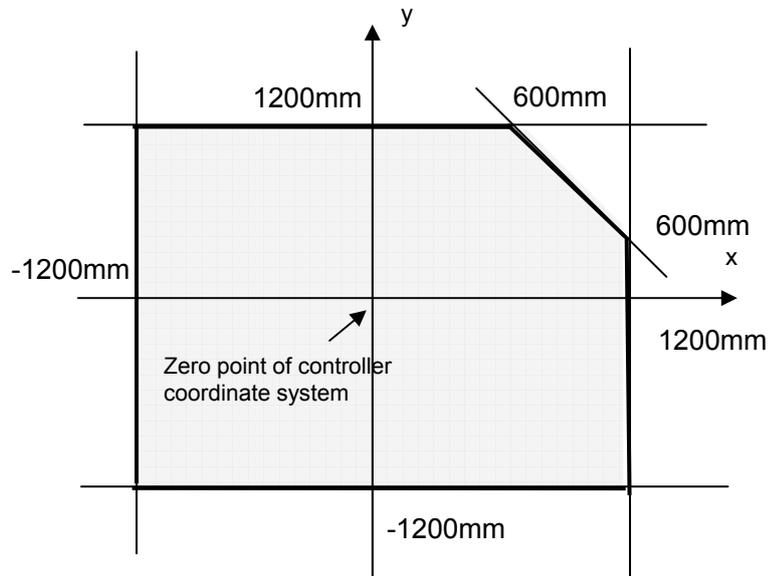


Figure 4-8 Setting example of restricted area(1)

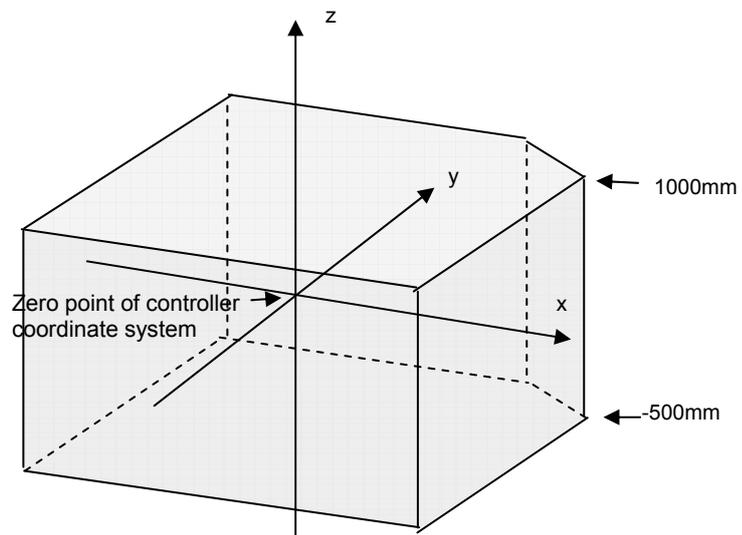


Figure 4-9 Setting example of restricted area(2)

Name	Setting	Name	Setting
X coordinate of restricted area reference point	0	Restricted line 4, X1	120000
Y coordinate of restricted area reference point	0	Restricted line 4, Y1	120000
Restricted area valid / invalid	1	Restricted line 4, X2	-120000
Upper limit of Z of restricted area	100000	Restricted line 4, Y2	120000
Lower limit of Z of restricted area	-50000	Restricted line 5, X1	60000
Restricted line 1, X1	-120000	Restricted line 5, Y1	120000
Restricted line 1, Y1	120000	Restricted line 5, X2	120000
Restricted line 1, X2	-120000	Restricted line 5, Y2	60000
Restricted line 1, Y2	-120000	Restricted line 6, X1	0
Restricted line 2, X1	-120000	Restricted line 6, Y1	0
Restricted line 2, Y1	-120000	:	:
Restricted line 2, X2	120000	Restricted line 8, X2	0
Restricted line 2, Y2	-120000	Restricted line 8, Y2	0
Restricted line 3, X1	120000		
Restricted line 3, Y1	-120000		
Restricted line 3, X2	120000		
Restricted line 3, Y2	120000		

* The unit of the setting is 0.01mm.

4.3.4 How to recover from outside of limit

If the RSC1 detects the outside of restricted area limits, 'E5' of LED blinks. 'RUN' of LED also blinks.



In this case, follow the procedures below to return.

- (1) Press the over-trouble button to invalidate RSC1 monitoring.
- (2) Return the robot to within the area.
- (3) Reset the RSC. The RSC error is removed.

If resetting fails at step (3), check the error history if errors other than 'E5' do not present. If one is found, there is other error other than 'out of restricted area limit error', which is expected to cause not to be reset. In this case, refer to the remedy of the corresponding error.

For the error history checking method, refer to the separate PC software operation manual.

4.3.5 Partial Restricted Area

[Ref. Parameter No. : 0115~0266]

The partial restricted area is the internal area of a polygon surrounded by up to four lines. The upper and lower limits of the vertical height can be specified, too. Up to eight partial restricted areas can be specified. If the robot enters a partial restricted area, the RSC1 issues an emergency stop signal.

For example, suppose the following area is to be specified on a plane.

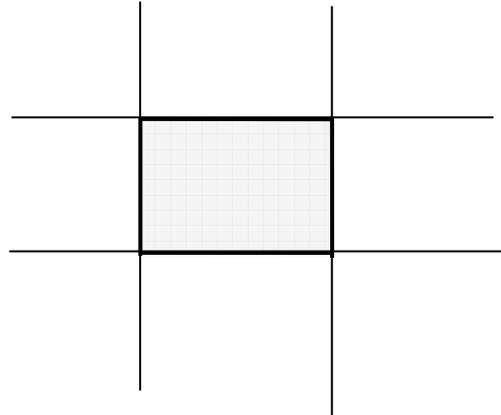


Figure 4-10 Partial Restricted Area(1)

At this time, the whole area including the vertical height is shown below.

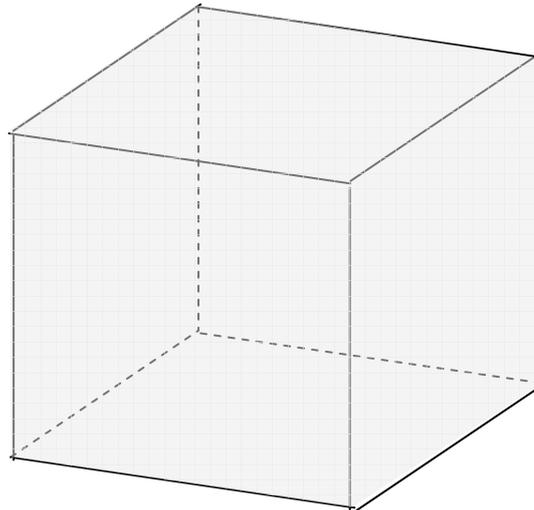


Figure 4-11 Partial Restricted Area(2)

The RSC1 can handle up to eight similar areas simultaneously.

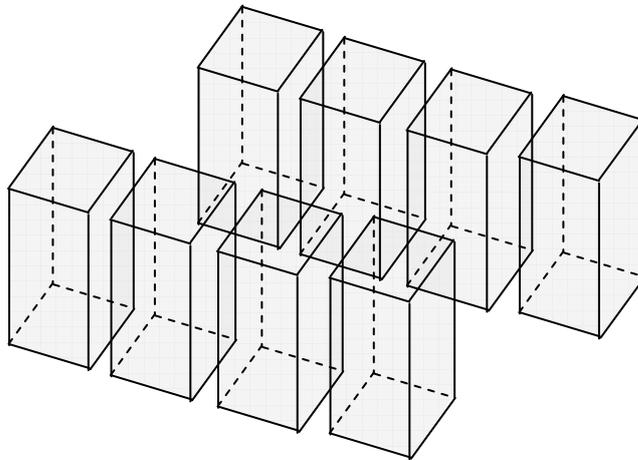


Figure 4-12 Partial Restricted Area(3)

4.3.6 How to set the partial restricted area

The partial restricted area is specified with the following parameters.

Name	Setting
Partial restricted area 1 valid / invalid	Area validity flag
Upper limit of Z of partial restricted area 1	Z-direction setting of area
Lower limit of Z of partial restricted area 1	
Partial restricted area 1, line 1, X1	Area line setting
Partial restricted area 1, line 1, Y1	
Partial restricted area 1, line 1, X2	
Partial restricted area 1, line 1, Y2	
:	
Partial restricted area 1, line 4, X2	
Partial restricted area 1, line 4, Y2	

* For areas 2 to 8, set similar parameters.

The partial restricted area is the inside of an area surrounded by up to four lines. If the specified lines do not create an area successfully, the PC software issues a warning when parameters are written. If this happens, examine the settings.

To define the line for setting the area, designate the coordinates of the starting and last points.

Specify the coordinates of the starting point with the (x1, y1) parameter, and set those of the last point with the (x2, y2) parameter.

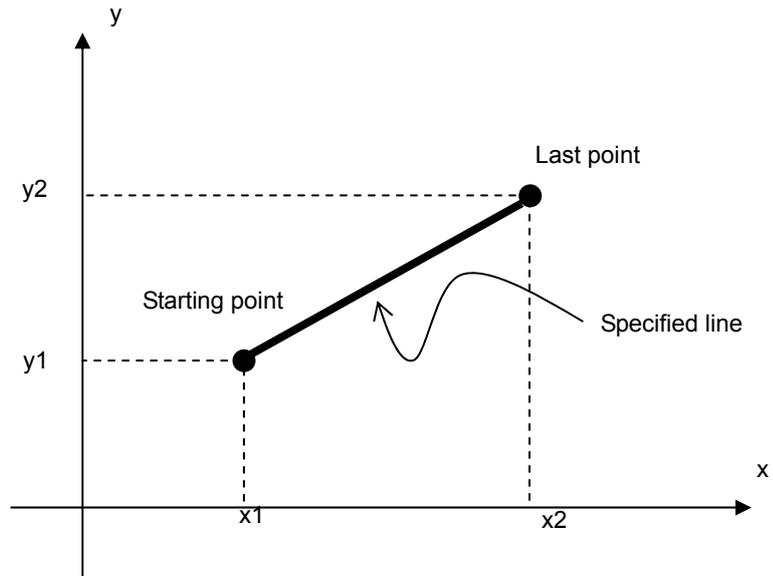


Figure 4-13 Partial Restricted Area(starting point and last point)

■ Limitation in the Z direction of area

Specify "0" for both the upper and lower Z limits of the partial restricted area to always validate monitoring in the Z direction. That is, if the robot interferes with the area, a limit violation error is caused without relations to the Z position of the robot. In this case, the whole area is supposed to be the one shown in the figure below.

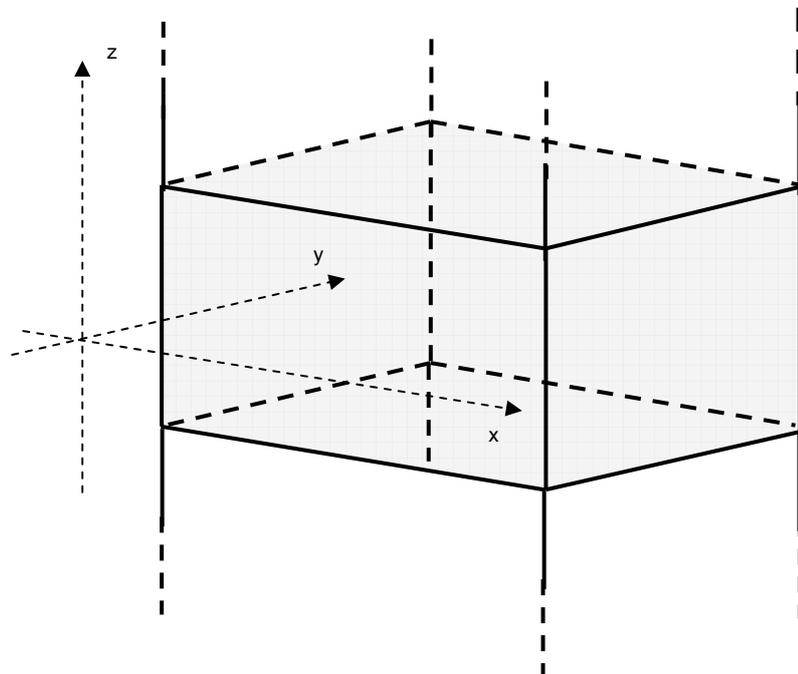


Figure 4-14 Limitation in the Z direction of Partial Restricted Area

4.3.7 Setting example of partial restricted area

To set the area shown in the figure below, enter the following parameters.

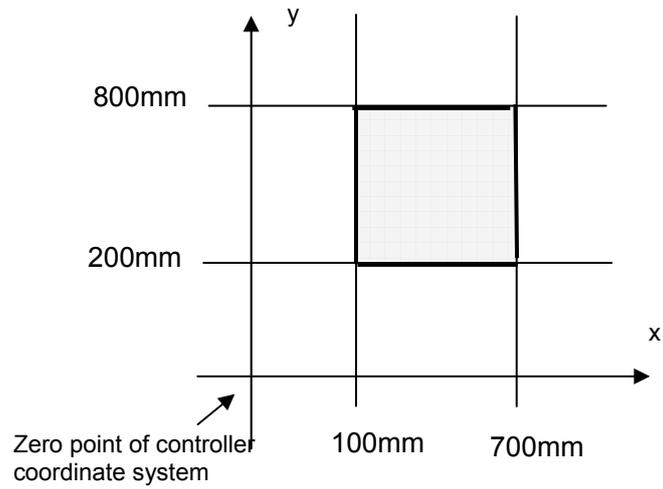


Figure 4-15 Setting example of partial restricted area(1)

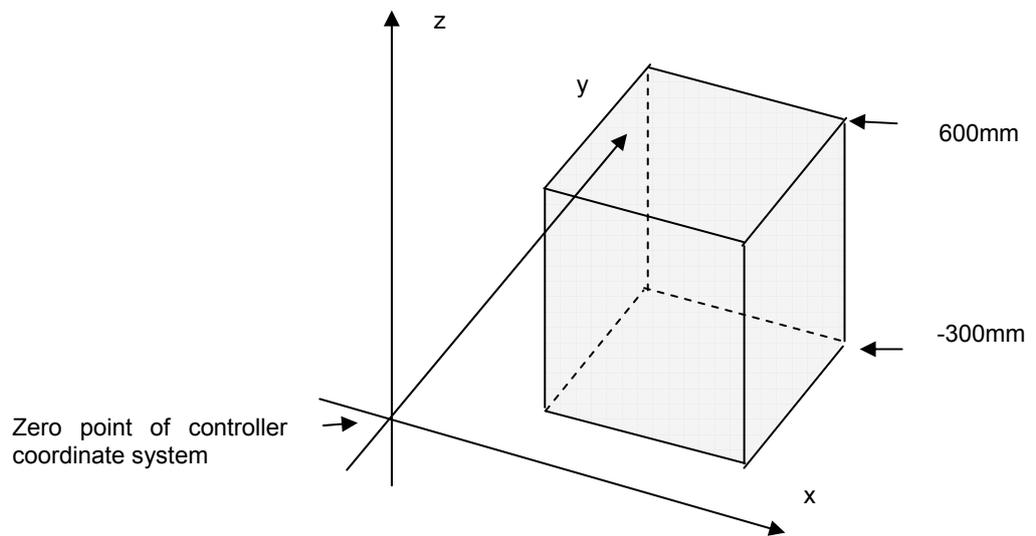


Figure 4-16 Setting example of partial restricted area(2)

Name	Setting	Name	Setting
Partial restricted area 1 valid / invalid	1	Partial restricted area 1, line 3, X1	70000
Upper limit of Z of partial restricted area 1	60000	Partial restricted area 1, line 3, Y1	80000
Lower limit of Z of partial restricted area 1	-30000	Partial restricted area 1, line 3, X2	10000
Partial restricted area 1, line 1, X1	10000	Partial restricted area 1, line 3, Y2	80000
Partial restricted area 1, line 1, Y1	20000	Partial restricted area 1, line 4, X1	10000
Partial restricted area 1, line 1, X2	70000	Partial restricted area 1, line 4, Y1	80000
Partial restricted area 1, line 1, Y2	20000	Partial restricted area 1, line 4, X2	10000
Partial restricted area 1, line 2, X1	70000	Partial restricted area 1, line 4, Y2	20000
Partial restricted area 1, line 2, Y1	20000		
Partial restricted area 1, line 2, X2	70000		
Partial restricted area 1, line 2, Y2	80000		

* The unit of the setting is 0.01mm.

4.3.8 How to recover from outside of limit

When the RSC1 detects the outside of partial restricted area limits, 'E4' blinks at the LED.



In this case, follow the procedure below to return.

- (1) Press the over-trouble button to invalidate RSC1 monitoring.
- (2) Return the robot to within the area.
- (3) Reset the RSC1. The RSC1 error is removed.

If resetting fails at step (3), check the error history for errors other than 'E4'. If one is found, there is another error and resetting fails. In this case, refer to the remedy of the corresponding error.

For the error history checking method, refer to the separate PC software operation manual.

4.4 SSF

[Ref. Parameter No. : 0080~0114]

Functions provided for the RSC1 to monitor the operation area of the robot include SSF (Software Safety Fence) besides SSL. This is an area for monitoring interference between persons and robot. If the robot interferes with this area, the RSC1 outputs an emergency stop signal.

The SSF area is outside the area, which is surrounded by up to eight lines, around the "restricted area reference point." The upper and lower limits in the vertical direction can be specified, too.

Only one SSF area can be given at a time.

Monitoring of the SSF begins one second after the "SSF_mon" input signal of the RSC1 changes to validate monitoring. See the LED indication of the RSC1 to check if SSF monitoring is valid. At this time, the right hand digit of the LED shows the following.



This indication is repeated twice per second.

4.4.1 How to Specify the SSF

The SSF is specified with the following parameters.

Name	Setting
Restricted area reference point, X coordinate	Restricted area reference point setting
Restricted area reference point, Y coordinate	
SSF area valid / invalid	Area validity flag
Upper limit of Z of SSF area	Z direction setting of area
Lower limit of Z of SSF area	
SSF line 1, X1	Area line setting
SSF line 1, Y1	
SSF line 1, X2	
SSF line 1, Y2	
:	
SSF line 8, X2	
SSF line 8, Y2	

Indicate the area setting line with the coordinates of the starting and last points. Designate the coordinates of the starting line with (x1, y1) and those of the end point with (x2, y2).

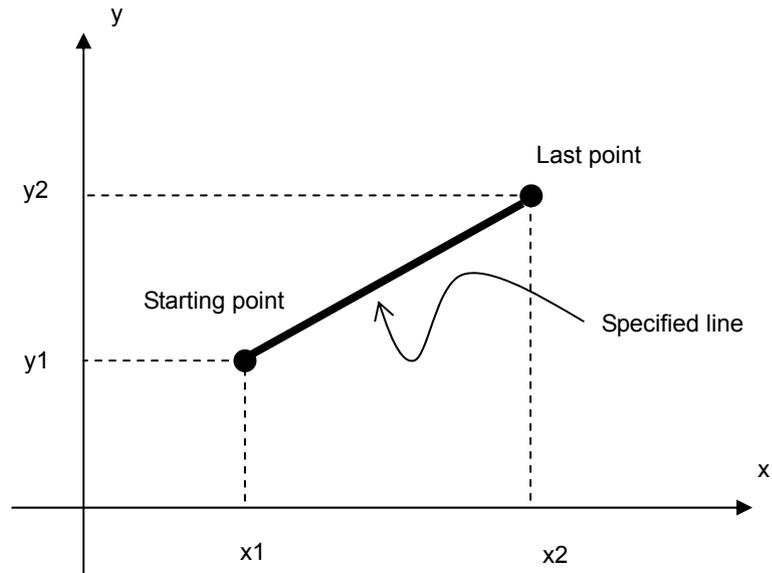


Figure 4-17 SSF(starting point and last point)

The area line passing through the "restricted area reference point" may not be specified.

To validate SSF monitoring, the following setting is necessary.

Item	Condition
"SSF_mon" input of RSC1	The signal on the monitoring valid side is input.

SSF monitoring becomes valid actually one second after the "SSF_mon" signal has changed. On the contrary, SSF monitoring becomes invalid immediately when the signal is switched to invalidate monitoring.

■ Reference

The RSC1 is stopped in an emergency if inconsistency in the SSF_mon input between the MP-A and MP-B signals continues for a certain time. Specify the time to the "input error detection time (SSF_mon)" RSC parameter. The SSF_mon input is a normally closed contact signal.

The SSF is the internal area, which is specified with up to eight lines, around the restricted area reference point. Therefore limitations and setting method of the area are the same as those of the "restricted area." (The restricted area reference point is a common parameter between both.)

■ Limitation in the Z direction of area

Specify "0" for both the upper and lower Z limits of the SSF area to invalidate monitoring in the Z direction. That is, Z travel of the robot does not cause exclusion

from the area. In this case, the whole area is supposed to be the one shown in the figure below.

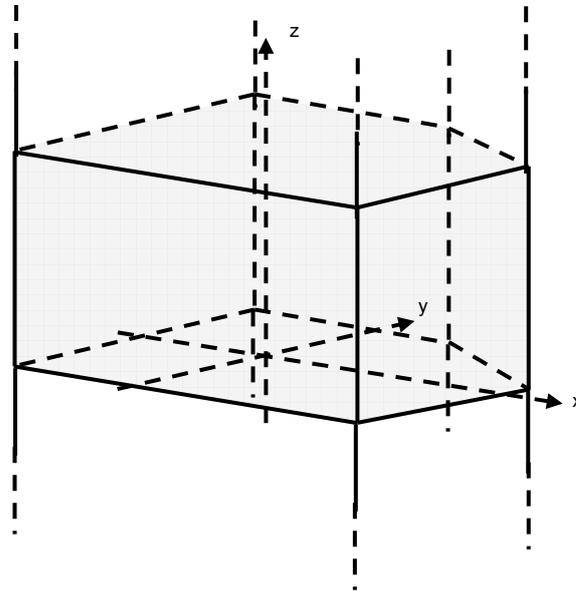


Figure 4-18 Limitation in the Z direction of SSF

4.4.2 SSF Setting Example

For the SSF setting example, refer to the setting example of the restricted area. The setting method of the restricted area is the same as that of the SSF. Follow the procedure to form the area similarly.

4.4.3 How to Recover from Outside of Limit

If the RSC1 detects the outside of the SSF area, 'E6' blinks at the LED.



In this case, follow the procedure below to return.

- (1) Press the over-trouble button to invalidate RSC1 monitoring.
- (2) Return the robot to within the area.
- (3) Reset the RSC1. The RSC1 error is removed.

If resetting fails at step (3), check error history for errors other than 'E6'. If one is found, there is another error and resetting fails. In this case, refer to the remedy of the corresponding error.

For the error history checking method, refer to the separate PC software operation manual.

4.5 SAL

[Ref. Parameter No. : 0021~0036]

The RSC1 is provided with a function (SAL; Software Axis Limit) for monitoring the operation range of each axis of the robot. The SAL function monitors so that each axis of the robot operates within the predetermined range. If movement overshoots the parameter range, the RSC1 issues an emergency stop signal.

The RSC1 always monitors the SAL. However, monitoring is invalid for axes where both the upper and lower limit parameter values of the axis are "0."

4.5.1 How to Specify the SAL

To set the SAL with RSC1 parameters, specify the following items.

Name	Setting
Upper limit value of J1	Upper and lower limit values of each axis
Lower limit value of J1	
:	
Upper limit value of J8	
Lower limit value of J8	

Axes for which above parameters are specified are always monitored.

4.5.2 SAL Setting Example

- Specifying SAL to a certain axis Jn (rotary axis)

Name	Value
Upper limit value of Jn	12000
Lower limit value of Jn	-9000

In this case, the Jn joint value is checked to be within the range from 120 to -90 degrees.

- Specifying SAL to a certain axis Jn (linear axis)

Name	Value
Upper limit value of Jn	12000
Lower limit value of Jn	-9000

In this case, the Jn joint value is checked to be within the range from 120 to -90mm.

- To refrain from SAL monitoring of a certain axis Jn

Name	Value
Upper limit value of Jn	0
Lower limit value of Jn	0

In this case, no limit check is made as to Jn.

[Note]

SAL is applied to the joint value before "drag correction of internal joint value." Take this into consideration when using "drag correction of internal joint value."

As for drag correction of the internal joint value, refer, too, to the section describing "RSC1 parameter - drag correction of internal joint value."

4.5.3 How to Recover from Outside of Limit

If the RSC1 detects the outside of SAL limits, the LED shows the following.

(1) In case of SAL upper limit error

This error is caused if the upper limit of the SAL in a certain axis is exceeded. At this time, 'E2' blinks at the LED.

E2

(2) In case of SAL lower limit error

This error is caused if the lower limit of the SAL in a certain axis is exceeded. At this time, 'E3' blinks at the LED.

E3

In the above case, follow the procedure below to return.

- (1) Press the over-trouble button to invalidate RSC1 monitoring.
- (2) Return the robot to within the area.
- (3) Reset the RSC1. The RSC1 error is removed.

If resetting fails at step (3), check the error history for errors other than 'E2' or 'E3'. If one is found, there is another error and resetting fails. In this case, refer to the remedy of the corresponding error.

For the error history checking method, refer to the separate PC software operation manual.

4.6 Restricted Area Reference Point

The restricted area and SSF area are always specified so that the "restricted area reference point is in the area." These areas are configured "inside the lines" when viewed from the restricted area reference point." For example, the inside area surrounded by thick lines is the area in the case shown in the figure below.

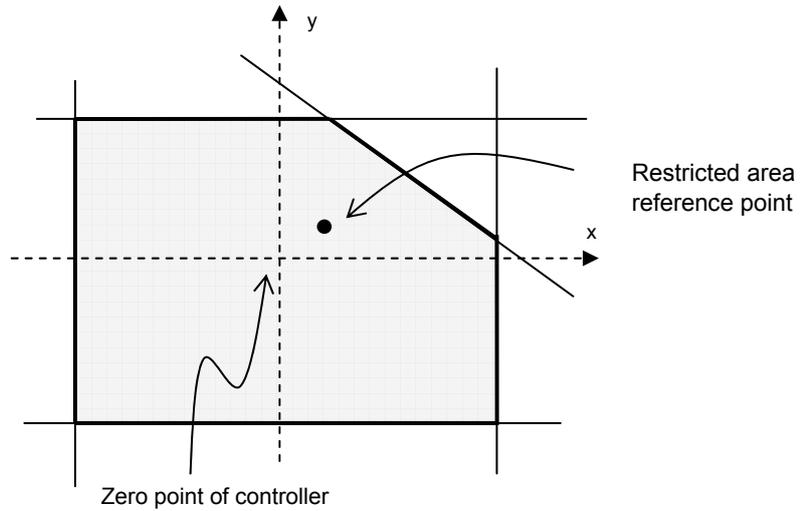


Figure 4-19 4.6 Restricted Area Reference Point

When setting the restricted area or SSF, use this parameter to determine the area. The restricted area reference point is common between the restricted area and SSF.

For this parameter, refer to the section describing "RSC parameter - restricted area reference point."

4.7 LED Indication during Area Monitoring

The RSC1 indicates at the LED whether it monitors the area or not. Refer to the following to judge if area monitoring is in progress or not.

Item	Condition
Area monitoring is in progress	The "restricted area validity" RSC parameter is "0" and all of "partial restricted area 1 to 8 valid / invalid" are "0" and "SSF area valid / invalid" is "0" and both "upper and lower Jn limit values" are "0."
Area monitoring is not in progress	Cases other than above

■ LED indication in case of "area monitoring is in progress"

In this case, the left hand digit of the LED shows the following ("8"-shape rotation).



■ LED indication in case of "area monitoring is not in progress"

In this case, the left hand digit of the LED shows the following (rectangular rotation).



4.8 Area forecast control

[Ref. Parameter No.: 1172 to 1173]

When an emergency stop is caused during robot motion, the point where the emergency stop is caused differs from the point where the robot is actually stopped. This is because the robot continues to move slightly due to performance of the brake, inertia and other particulars of the robot. If the robot is moving out of an area, the point where the robot is actually stopped is out of the area.

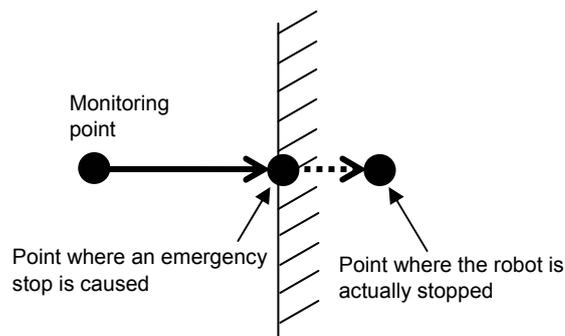


Figure 4-20 In case of emergency stop due to area interference (without position forecast)

RSC1 has a function for forecasting the position where the monitoring point of the robot is actually stopped.

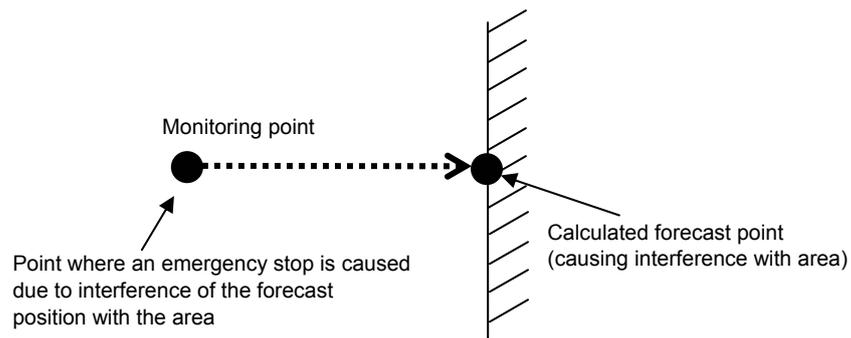


Figure 4-21 In case of emergency stop due to area interference (with position forecast)

RSC1 calculates the forecast position of all monitoring points if the forecast function is validated. Area judgment of SSL and SSF is made in relation to the forecast position of the monitoring point.

4.8.1 How to validate area forecast control function

To validate area forecast control, enter the following.

- Enter the "free running time" and "braking deceleration" RSC parameters.
(The forecast function does not work if both parameters are zero.)
- Supply the "250mm_mon" input on the "invalid speed monitoring" side.
(The forecast function is invalid during safe speed monitoring even if the "free running" and braking deceleration RSC parameters are set.)

Designate the sum of the worst response time (43ms) of RSC and the worst response time of RC as a "free running time" RSC parameter. For example, if the response time of RC is 30ms, designate 73ms (43 + 30) as the parameter.

- * If the forecast position of the coordinates of the monitoring point obtained from the command value is calculated, the sum of the parameter and the command value period is used for calculation.

To refrain from using the forecast function, enter "0" for both the "free running time" and "braking deceleration" RSC parameters.

4.8.2 How to set parameters for area forecast control

The following RSC parameters are used for area forecast control.

Item	Description	Unit	Range	Reception from robot
Command value period	Indicates the reception period of command value. An existing RSC parameter is used.	μs	1000 to 50000	Y
Free running time	Sum of response time of RSC and response time of RC	ms	0 to 1000	Y
Braking deceleration	Braking acceleration of TCP	mm/s ²	0 to 100000	Y

RSC1 uses the above parameters to calculate forecast monitoring points in the following way.

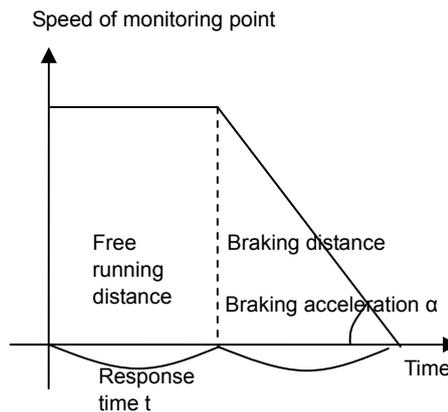
[In case of TCP/flange/tool ball]

The forecast position of the monitoring point is calculated in the following equation.

$$\text{Forecast position} = \text{Current position} + \text{Stopping distance}$$

The above equation is calculated for each of the x, y and z components. The stopping distance is calculated in the following way.

$$\text{Stopping distance} = \text{Free running distance} + \text{Braking distance}$$

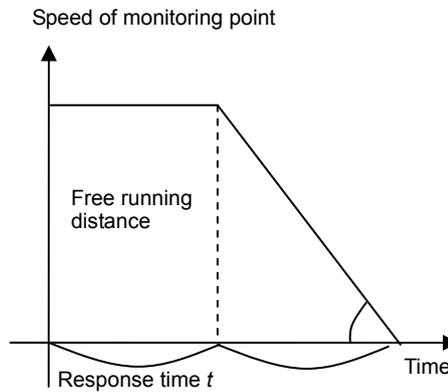


The speed v of the monitoring point is calculated for each monitoring point. The free running time t and braking deceleration α are designated in RSC parameters. Therefore the stopping distance is the area enclosed in the v - t graph shown above.

* The value of free running time t is the sum of the RSC parameter and the command value period in view of forecast calculation of the monitoring point position. The value designated in an RSC parameter is used as a command value period.

[In case of arm interference monitoring point]

The calculation method of the forecast position of the arm monitoring point is the same as that of the TCP, flange and tool ball in principle. However, the stopping distance calculation method varies.



The stopping distance of the arm monitoring point is the area enclosed in the v-t graph shown above. The speed v of the monitoring point is calculated for each monitoring point. The response time t is designated in an RSC parameter. In case of arm monitoring point, the braking acceleration parameter is not used. Instead, deceleration time v / α is used. As a deceleration time, the largest one among TCP, flange and tool ball is adopted for calculation.

■ Example of parameter setting

[If area forecast control function is valid]

If the area forecast control function is used, designate RSC parameters in the following way.

- Delay of RC (if the delay from judgment of emergency stop to actual braking is 30ms)
- Delay of RSC (worst value: 43ms)
- Braking acceleration (if the acceleration of the brake caused by emergency stop is 2000mm/s in the worst case)

Item	Value
Free running time	73
Braking deceleration	2000

[If the area forecast control function is invalid]

If the area forecast control function is not used, designate RSC parameters in the following way.

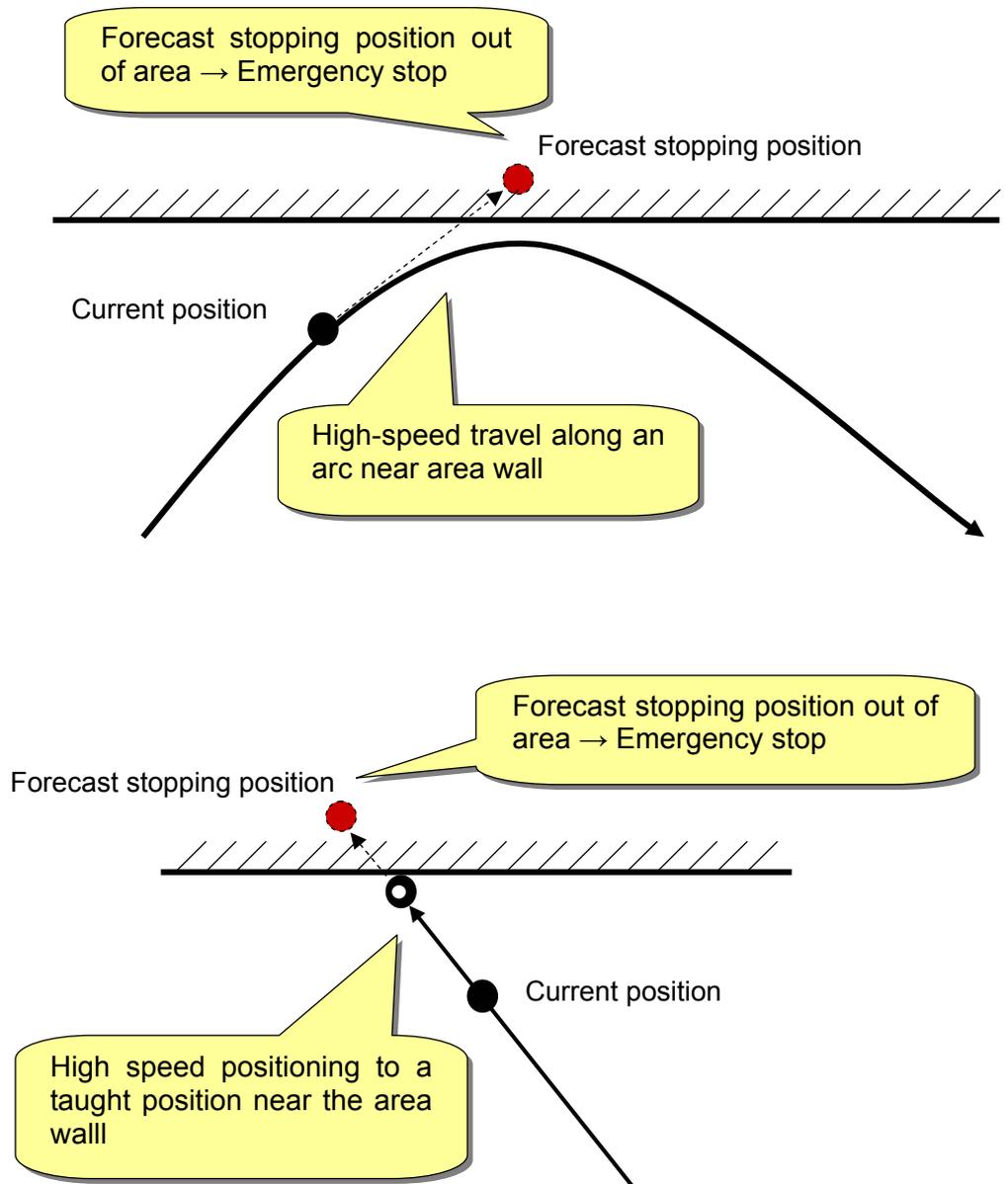
In this case, the forecast function does not work and an emergency stop is caused when the monitoring point interferes with the area.

Item	Value
Free running time	0
Braking deceleration	0



The area forecast control function does not guarantee that there is no penetration of the area. The forecast stopping position is calculated every 15ms with values specified in parameters and, if the forecast stopping position exceeds the area, an emergency stop is caused. Therefore if the actual behavior (free running time and braking deceleration) is different from the one specified with parameters, the area may be passed. The forecasting model of RSC1 supposes linear stop in the 3D area if an emergency stop is caused without consideration of the gravity and behavior of each axis. Take the above description into consideration when using this forecast control function.

If the forecast control function is validated, an emergency stop may be caused at a position where no emergency stop would be caused if the function is invalid.



5 Velocity monitoring

[Ref. Parameter No. : 0017]

The velocity monitoring function of the RSC1 is explained in this section.

RSC1 has a function (velocity monitoring function) for monitoring the velocity of the monitoring point specified in the robot. If the velocity of the monitoring point exceeds the preset limit in a system where velocity monitoring is valid, the RSC1 issues an emergency stop signal.

5.1 Monitoring Point

The RSC1 monitors the velocity of the following points.

- Flange point;
- TCP.

For the TCP setting method, refer to the separate RSC parameter operation manual.

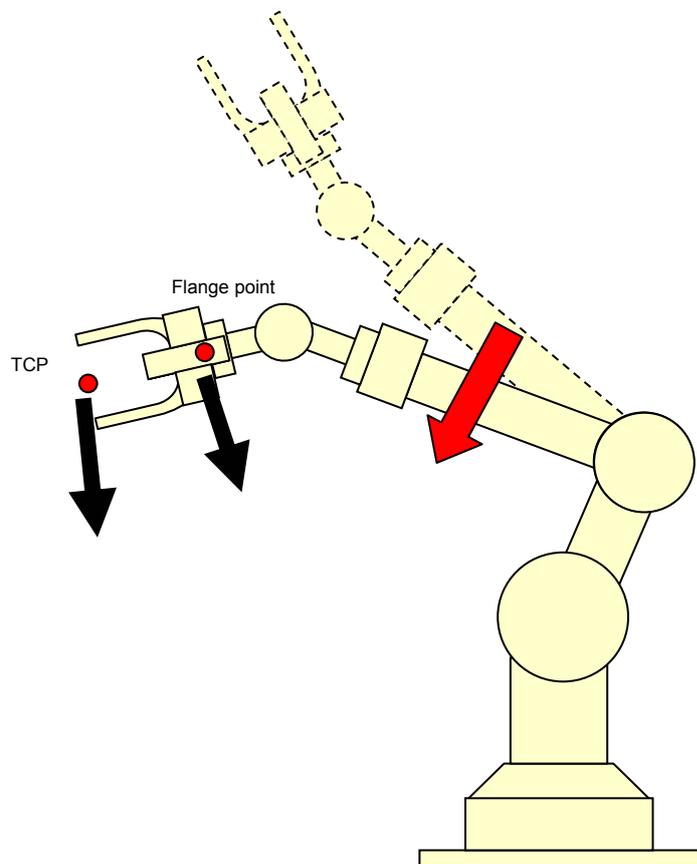


Figure 5-1 Velocity monitoring points

5.2 Setting Method

The RSC1 monitors the velocity if "monitoring is valid" with the "250" input signal. Note that the "250" signal is a normally closed contact signal.

The upper velocity limit used in velocity monitoring is determined with an RSC1 parameter. Use the following parameter. If the velocity of the TCP or flange point becomes larger than the value specified in the parameter, the RSC1 issues an emergency stop signal.

Name	Unit	Range
Safe velocity	0.01mm/s	100 to 25000

For instance, enter "25000" in the parameter if you intend to set the safe velocity at 250.00mm/s.

■ How to check the velocity monitoring state

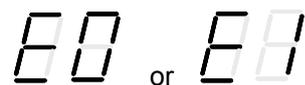
When the velocity monitoring function of the RSC1 is valid, the right hand digit of the 7-segment LED shows the followings (rotary indication):



The velocity monitoring function is activated one second after the "250mm_mon" signal is switched to validate monitoring. If the "250mm_mon" signal is invalidated in the monitoring mode, monitoring is stopped immediately.

5.3 How to Recover from Error

If an excessive velocity of the monitoring point is detected, the RSC1 makes the LED blink..



'E0' indicates that the velocity of the TCP is excessive, while 'E1' indicates that the velocity of the flange point is excessive. If the velocity of both the TCP and flange point is excessive, 'E0' and 'E1' blink alternately.

To recover from the error, reset the RSC1.

If resetting fails to recover from the error, check the error history of the RSC1. If an error other than 'E0' or 'E1' is found, remove the cause of the error. For the error history checking method, refer to the separate PC software operation manual.

6 TOOL Monitoring

[Ref. Parameter No. : 1182~1188]

In RSC1 the judgment of monitoring zone and speed is made by using the TOOL-related information set in the parameters and as such, changing TOOLS with the robot in operation may affect safety monitoring. Due to this reason, there is a need for RSC1 to be aware that the TOOL has changed.

There are two ways of telling whether a TOOL has been changed – ‘Change of TOOL number in the command value data’ and ‘Change of TOOL number in the non-safety input signal’. In RSC whether or not a TOOL has been changed is monitored by verifying two TOOL numbers of command value and signal input. This is the TOOL Monitoring function.

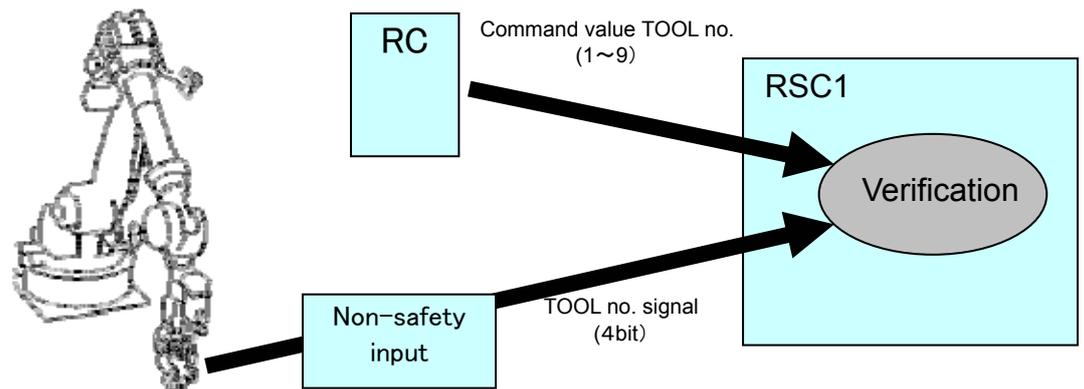


Figure 6-1 Tool monitoring

6.1 TOOL Monitoring method selection

There are below three patterns of monitoring modes prepared to allow the TOOL Monitoring function to be flexible across a wide range of uses.

6.1.1 TOOL Monitoring valid mode

RSC parameter [TOOL MONITORING MODE] set value = [2]

Command value and signal input TOOL numbers are verified and an emergency stop executed if found not to match.

However, verification of the tool number is not made if a tool change area (ball excluded from tool monitoring) can be specified and the flange point is located in the area.

Ball excluded from tool monitoring

If the tool in the robot is changed, the "command value tool number" and the "tool number signal" do not reach RSC simultaneously. For this reason, tool change causes disagreement of tool numbers, resulting in an emergency stop of the robot.

To suppress emergency stop even in tool change, a "ball excluded from tool monitoring" described below can be specified.

The ball excluded from tool monitoring is a virtual ball having a center at the flange point of the robot when disagreement of tool numbers is found, and it is defined as follows. The ball does not move even if the flange moves with tool number disagreement.

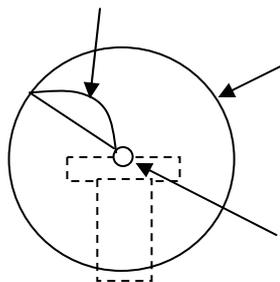


Figure 6-2 Definition of ball excluded from tool monitoring

Designate the radius of the ball excluded from tool monitoring, as a parameter. Tool monitoring does not proceed if both the flange point specified in the command value and that calculated with the actual value are located in the space.

If the flange point moves out of the ball excluded from tool monitoring while there is tool number disagreement between the command value and signal input, an emergency stop is caused.

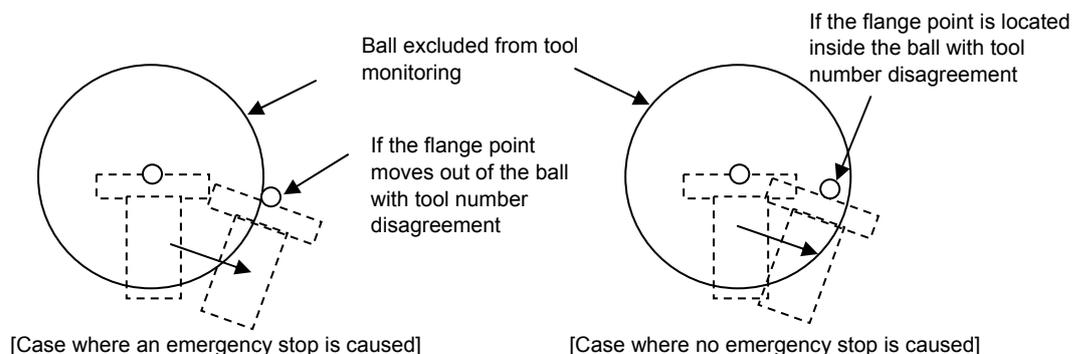


Figure 6-3 Case causing an emergency stop and case not causing an emergency stop

6.1.2 TOOL monitor invalid mode

RSC parameter [TOOL monitor mode] set value = [1]

No monitoring of TOOL numbers, such TOOL number verification of command value and input value, etc.

【Supplementary】

For Safety monitoring, such as zone, speed etc judgment is made using TCP information in the command value and TOOL number 1 ball.

【Restrictions】

TOOL 2 to 9 in RSC parameters are not to be set. No balls should be set to TOOL 2-9 of RSC parameters. Only TCP information is able to be set for TOOL 2 to 9. Furthermore, TOOL 2 to 9 TCP must be included somewhere in TOOL 1.

【Example of use】

A case when the TOOL itself has function of doing multiple works.

In such a case, a change in the TOOL itself is not produced; what is changed is only the function which it performs, therefore the monitoring points of the zone, speed etc safety monitoring may also change. In this mode it has been possible to respond to such situations by setting only the TCP for each TOOL number and changing the TOOL number whenever there is a function change in order to change the object of safety monitoring.

6.1.3 TOOL 1 fixed mode

RSC parameter [TOOL monitor mode] set value = [0]

No TOOL number verification of command values and signal input, only monitoring to confirm that the command value TOOL number is 1. If TOOL number of the command value is not 1, an emergency stop will be executed.

【Supplementary】

TOOL number 1 information is used to make judgment for safety monitoring of zone, speed, etc.

【Example of use】

When TOOL change is not required

This mode is used in the case where TOOL change is not required, and it is possible to remove the non-safety input signal. (However, caution must be taken, as by doing this, the reset input is also removed)

7 Stop monitoring

[Ref. Parameter No.: 1164 to 1171]

7.1 What is stop monitoring?

RSC1 is provided with a function (stop monitoring function) for monitoring "whether the robot is stopped or not." If stop monitoring is valid and axial motion distance exceeds a certain threshold, an emergency stop is caused. The threshold can be defined with an RSC parameter for each axis.

7.2 How to make stop monitoring valid

To make stop monitoring valid, enter the following.

Connect the "Stop_mon" input of RSC to the "stop monitoring valid" side.

(Stop monitoring is not conducted if the "Stop_mon" input is on the "stop monitoring invalid" side.)

Enter the "stop judgment value" RSC parameter.

(If the stop judgment value is 0, stop monitoring of the axis is invalid.)

7.2.1 Parameter setting example

Suppose that stop monitoring of axis 1 is invalid and the stop judgment value of axis 2 is set at 0.5 degrees (or 0.5mm, in case of a linear axis). In this case, enter the following parameters.

Item	Value	Unit
Stop judgment value J1	0	0.01 deg. or 0.01mm
Stop judgment value J2	50	0.01 deg. or 0.01mm

If the "Stop_mon" input is on the "stop monitoring valid" side with these parameter settings, RSC1 moves in the following way.

- No stop monitoring error is caused even if axis 1 moves.
- If axis 2 moves beyond +0.5 or -0.5 degrees, a stop monitoring error is caused, resulting in an emergency stop.

7.3 How to return from outside of limit

If RSC detects the outside of the stop monitoring limit, the LED blinks 'E7'.



In this case, follow the procedure below to return from the outside of the limit.

- (1) Connect the "Stop_mon" signal input to the "stop monitoring invalid" side.
- (2) Supply a reset input to RSC.

If resetting does not occur upon step (2), refer to the error log to check if there is an error other than 'E7'. If there is, there is an error other than the "stop monitoring limit error" and therefore resetting does not succeed. In this case, refer to the remedy for the corresponding error(s).



RSC 1 causes an emergency stop if the preset judgment value is exceeded. The traveling distance from the point where stop monitoring is validated to the point where the robot is actually stopped due to an emergency stop depends on the response time described in Section 11.4 (command period + 43msec) and the performance of the robot. Obtain a risk assessment of the traveling distance when the system is completed.



The stop monitoring function of RSC 1 is not a function regulated in safety standard of the robot (ISO 10218-1: 2006). The stop monitoring function belongs to safety level Cat. 3. Build a system so that consistency is kept with the result of risk assessment of the system.

8 RSC Parameter

An outline of RSC parameters is described here.

8.1 What Are RSC Parameters?

The RSC parameter is the "data used by RSC1 for safety monitoring" and it is compulsory for the operation of the RSC1. To operate the RSC1, write parameter data to the RSC1 according to monitoring conditions.



Parameters are important data for safety functions.

Please understand each parameter meaning. When change the parameter, please care about the meaning of parameters.

Safety functions of RSC1 operate properly if parameters are set properly. After setting the parameters, it is necessary to confirm if the safety functions are performing correctly on the actual system, and this should be done by the same person (system integrator or customer) who sets up the parameters.

RSC parameters are configured with the following data.

- Data about the target robot of monitoring by RSC1
 - Example: Arm length, tool data, area limitation, etc.
- Configuration data characteristic to RSC1
 - Example: Upper limit of robot operation speed, IP address of RSC1, etc.

RSC1 performs safety monitoring according to RSC parameters set in the RSC1 itself. Accordingly evaluate RSC parameter settings fully as to satisfaction of the safety standard when operating the RSC1. If some RSC parameters are wrong, the intended safety monitoring function may not work.

The RSC parameter is written in the nonvolatile memory inside RSC1. Once written, RSC parameter data is retained even after the power is turned off. The memory is provided for each of two processors (MP-A and MP-B) of the RSC1 and the RSC parameter is stored in each of them.

8.2 Description of Data Given by RSC Parameters

The RSC parameter consists of the following pieces of data. These pieces of data are divided into two major groups: "data loaded from robot" and "data characteristic to the RSC1." The RSC1 refers to the RSC parameter when it needs the data in safety monitoring processes.

[Data loaded from robot]	[Data characteristic to RSC1]
<ul style="list-style-type: none"> • Zeroing data of command/encoder value • Communication method and speed of command/encoder value • Allowable operation range of each axis • Robot installation position • Data about monitoring area • Tool shape data • Type of each axis • Drag correction • Data about homogeneous transformation matrix • Stop judgment value • Allowable encoder value deviation width between power-on and previous shutdown • Parameter for verification of flange-to-flange distance 	<ul style="list-style-type: none"> • Safe speed • Data about SSF area • Tool monitoring mode • Ball excluded from tool monitoring • Entry error detection time • IP address of RSC1 • Sub-net mask • IP address of RC

9 /9-1



* For detail description of these parameters, refer to the section describing "RSC Parameter Reference."

8.3 Writing the RSC Parameter

To enter the RSC parameter to RSC1, use special PC software ("RSCwin") . Connect the RSC1 with a PC via a USB cable. Connect the peripheral equipment "I/F" connector on the front panel of the RSC1 with the PC via a USB cable.



For the PC software operation method, refer to the separate manual (Instruction Manual No.: RE22E) prepared for the PC software.

The RSC parameter can be edited with PC software. Created and edited RSC parameters can be saved in a file at the PC.

The RSC parameter is transferred from the PC to the RSC1 with PC software so that it is entered in the RSC1. The procedure is called "RSC parameter writing."

* The RSC1 contains two processors (MP-A and MP-B). The RSC parameter is written to the memory of each processor. However, it is not necessary for users to be conscious of this because the PC software handles automatically.

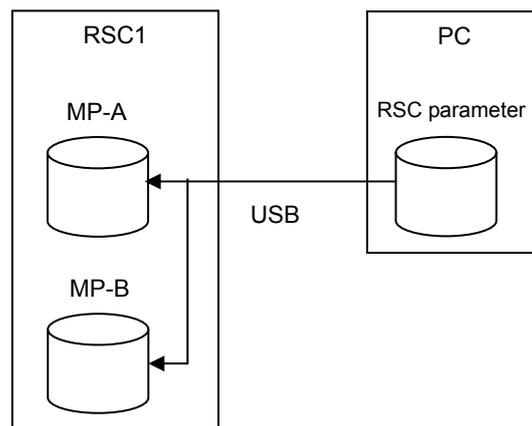


Figure 8-1 RSC parameter writing



If a parameter/s is/are written , RSC1 will stop operation, "2F" is displayed on 7 segments display. The written parameters are effective after once turns OFF the power and turns ON.



When a parameter/s is/are changed, please confirm that the written parameter contents work properly.

8.4 Loading the RSC Parameter

RSC parameters retained in the RSC1 can be transferred to the PC via RSC1, and backed up in a file. This procedure is called "RSC parameter loading." RSC parameters can be loaded during operation of the RSC1.

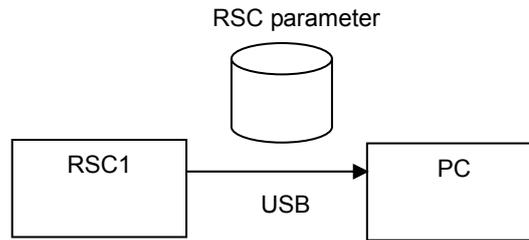


Figure 8-2 RSC parameter loading

8.5 Loading the RC Parameter

The PC software has a function of converting parameters held by the robot (RC parameters) to create a template of RSC parameters. This function is called "RC parameter loading." Use the RC parameter loading function to load RC parameters from the robot controller via the RSC to the PC and convert them into RSC parameters. The RSC parameters thus created can be edited by the user.

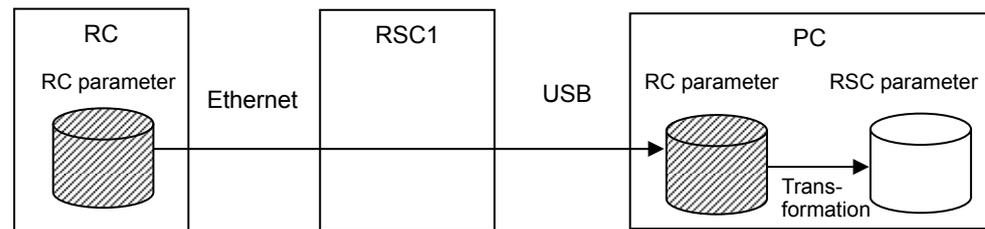


Figure 8-3 RC parameter loading

RC parameters can be transferred to the PC offline on a recording medium. In this case, too, the PC software can convert RC parameters into RSC parameters.

8.6 Example of RSC Parameter Setting Method

An example of RSC parameter setting is shown below.

■ Example 1: At system startup

- (1) Load RC parameters from the target robot of RSC1 into the PC.
- (2) Edit desired RSC parameters.
- (3) Write RSC parameters into the RSC1.

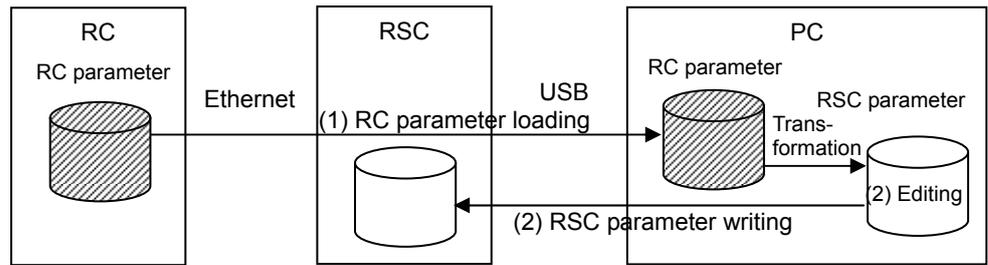


Figure 8-4 System startup operation example

■ Example 2: At RSC1 replacement

- (1) Prepare the RSC parameter backup file having been created.
- (2) Replace the RSC1 and write RSC parameters.

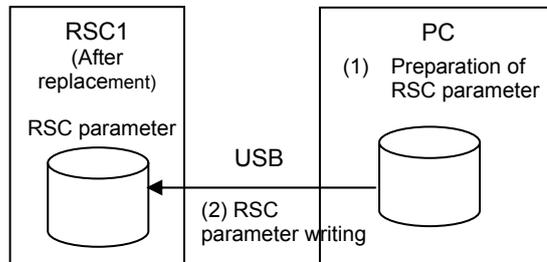


Figure 8-5 RSC1 replacement operation example

■ Example 3: RSC1 parameter modification

- (1) Load RSC parameters from the RSC1 into the PC.
- (2) Edit desired RSC parameters.
- (3) Write RSC parameters into the RSC1.

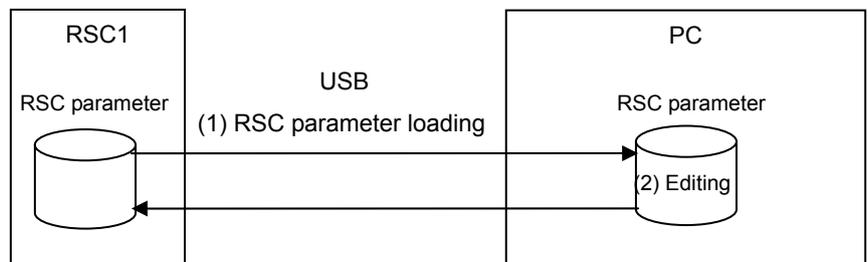


Figure 8-6 RSC1 parameter modification

8.7 RSC Parameter List

RC : Reception from robot

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
1	J1 encoder value at zeroing posture	UI32	Pulse			Y	
2	J2 encoder value at zeroing posture	UI32	Pulse			Y	
3	J3 encoder value at zeroing posture	UI32	Pulse			Y	
4	J4 encoder value at zeroing posture	UI32	Pulse			Y	
5	J5 encoder value at zeroing posture	UI32	Pulse			Y	
6	J6 encoder value at zeroing posture	UI32	Pulse			Y	
7	J7 encoder value at zeroing posture	UI32	Pulse			Y	
8	J8 encoder value at zeroing posture	UI32	Pulse			Y	
9	J1 command value at zeroing posture	UI32	Pulse			Y	
10	J2 command value at zeroing posture	UI32	Pulse			Y	
11	J3 command value at zeroing posture	UI32	Pulse			Y	
12	J4 command value at zeroing posture	UI32	Pulse			Y	
13	J5 command value at zeroing posture	UI32	Pulse			Y	
14	J6 command value at zeroing posture	UI32	Pulse			Y	
15	J7 command value at zeroing posture	UI32	Pulse			Y	
16	J8 command value at zeroing posture	UI32	Pulse			Y	
17	Safe speed	I32	0.01mm/s	100	25000		25000
18	Command value loading period	I32	μs	1000	50000	Y	
19	Encoder communication method (0 = 1:1, 1 = 1:N)			0=1:1 1=1:N		Y	
20	Encoder communication speed (0 = 2.5Mbps, 1 = 4Mbps)			0=2.5Mbps 1=4Mbps		Y	
21	Upper limit value of J1	I32	0.01° or 0.01mm	-5000000	5000000	Y	
22	Lower limit value of J1	I32	0.01° or 0.01mm	-5000000	5000000	Y	
23	Upper limit value of J2	I32	0.01° or 0.01mm	-5000000	5000000	Y	
24	Lower limit value of J2	I32	0.01° or 0.01mm	-5000000	5000000	Y	
25	Upper limit value of J3	I32	0.01° or 0.01mm	-5000000	5000000	Y	
26	Lower limit value of J3	I32	0.01° or 0.01mm	-5000000	5000000	Y	
27	Upper limit value of J4	I32	0.01° or 0.01mm	-5000000	5000000	Y	
28	Lower limit value of J4	I32	0.01° or 0.01mm	-5000000	5000000	Y	
29	Upper limit value of J5	I32	0.01° or 0.01mm	-5000000	5000000	Y	
30	Lower limit value of J5	I32	0.01° or 0.01mm	-5000000	5000000	Y	
31	Upper limit value of J6	I32	0.01° or 0.01mm	-5000000	5000000	Y	
32	Lower limit value of J6	I32	0.01° or 0.01mm	-5000000	5000000	Y	
33	Upper limit value of J7	I32	0.01° or 0.01mm	-5000000	5000000	Y	
34	Lower limit value of J7	I32	0.01° or 0.01mm	-5000000	5000000	Y	
35	Upper limit value of J8	I32	0.01° or 0.01mm	-5000000	5000000	Y	
36	Lower limit value of J8	I32	0.01° or 0.01mm	-5000000	5000000	Y	
37	X travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
38	Y travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000	5000000	Y	
39	Z travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000	5000000	Y	
40	Rotation angle O from controller coordinate to robot base coordinate	F32	0.01°	-5000000	5000000	Y	
41	Rotation angle A from controller coordinate to robot base coordinate	F32	0.01°	-5000000	5000000	Y	
42	Rotation angle T from controller coordinate to robot base coordinate	F32	0.01°	-5000000	5000000	Y	
43	x coordinate of restricted area reference point	I32	0.01mm	-5000000	5000000	Y	
44	Y coordinate of restricted area reference point	I32	0.01mm	-5000000	5000000	Y	
45	Restricted area valid / invalid		-	0: Invalid 1: Valid		Y	
46	Upper limit of z of restricted area	I32	0.01mm	-5000000	5000000	Y	
47	Lower limit of z of restricted area	I32	0.01mm	-5000000	5000000	Y	
48	Restricted line 1 x1	I32	0.01mm	-5000000	5000000	Y	
49	Restricted line 1 y1	I32	0.01mm	-5000000	5000000	Y	
50	Restricted line 1 x2	I32	0.01mm	-5000000	5000000	Y	
51	Restricted line 1 y2	I32	0.01mm	-5000000	5000000	Y	
52	Restricted line 2 x1	I32	0.01mm	-5000000	5000000	Y	
53	Restricted line 2 y1	I32	0.01mm	-5000000	5000000	Y	
54	Restricted line 2 x2	I32	0.01mm	-5000000	5000000	Y	
55	Restricted line 2 y2	I32	0.01mm	-5000000	5000000	Y	
56	Restricted line 3 x1	I32	0.01mm	-5000000	5000000	Y	
57	Restricted line 3 y1	I32	0.01mm	-5000000	5000000	Y	
58	Restricted line 3 x2	I32	0.01mm	-5000000	5000000	Y	
59	Restricted line 3 y2	I32	0.01mm	-5000000	5000000	Y	
60	Restricted line 4 x1	I32	0.01mm	-5000000	5000000	Y	
61	Restricted line 4 y1	I32	0.01mm	-5000000	5000000	Y	
62	Restricted line 4 x2	I32	0.01mm	-5000000	5000000	Y	
63	Restricted line 4 y2	I32	0.01mm	-5000000	5000000	Y	
64	Restricted line 5 x1	I32	0.01mm	-5000000	5000000	Y	
65	Restricted line 5 y1	I32	0.01mm	-5000000	5000000	Y	
66	Restricted line 5 x2	I32	0.01mm	-5000000	5000000	Y	
67	Restricted line 5 y2	I32	0.01mm	-5000000	5000000	Y	
68	Restricted line 6 x1	I32	0.01mm	-5000000	5000000	Y	
69	Restricted line 6 y1	I32	0.01mm	-5000000	5000000	Y	
70	Restricted line 6 x2	I32	0.01mm	-5000000	5000000	Y	
71	Restricted line 6 y2	I32	0.01mm	-5000000	5000000	Y	
72	Restricted line 7 x1	I32	0.01mm	-5000000	5000000	Y	
73	Restricted line 7 y1	I32	0.01mm	-5000000	5000000	Y	
74	Restricted line 7 x2	I32	0.01mm	-5000000	5000000	Y	
75	Restricted line 7 y2	I32	0.01mm	-5000000	5000000	Y	
76	Restricted line 8 x1	I32	0.01mm	-5000000	5000000	Y	
77	Restricted line 8 y1	I32	0.01mm	-5000000	5000000	Y	
78	Restricted line 8 x2	I32	0.01mm	-5000000	5000000	Y	
79	Restricted line 8 y2	I32	0.01mm	-5000000	5000000	Y	
80	SSF area valid / invalid			0: Invalid 1: Valid			
81	Upper limit of z of SSF area	I32	0.01mm	-5000000	5000000		
82	Lower limit of z of SSF area	I32	0.01mm	-5000000	5000000		
83	SSF line 1 x1	I32	0.01mm	-5000000	5000000		

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
84	SSF line 1 y1	I32	0.01mm	-5000000	5000000		
85	SSF line 1 x2	I32	0.01mm	-5000000	5000000		
86	SSF line 1 y2	I32	0.01mm	-5000000	5000000		
87	SSF line 2 x1	I32	0.01mm	-5000000	5000000		
88	SSF line 2 y1	I32	0.01mm	-5000000	5000000		
89	SSF line 2 x2	I32	0.01mm	-5000000	5000000		
90	SSF line 2 y2	I32	0.01mm	-5000000	5000000		
91	SSF line 3 x1	I32	0.01mm	-5000000	5000000		
92	SSF line 3 y1	I32	0.01mm	-5000000	5000000		
93	SSF line 3 x2	I32	0.01mm	-5000000	5000000		
94	SSF line 3 y2	I32	0.01mm	-5000000	5000000		
95	SSF line 4 x1	I32	0.01mm	-5000000	5000000		
96	SSF line 4 y1	I32	0.01mm	-5000000	5000000		
97	SSF line 4 x2	I32	0.01mm	-5000000	5000000		
98	SSF line 4 y2	I32	0.01mm	-5000000	5000000		
99	SSF line 5 x1	I32	0.01mm	-5000000	5000000		
100	SSF line 5 y1	I32	0.01mm	-5000000	5000000		
101	SSF line 5 x2	I32	0.01mm	-5000000	5000000		
102	SSF line 5 y2	I32	0.01mm	-5000000	5000000		
103	SSF line 6 x1	I32	0.01mm	-5000000	5000000		
104	SSF line 6 y1	I32	0.01mm	-5000000	5000000		
105	SSF line 6 x2	I32	0.01mm	-5000000	5000000		
106	SSF line 6 y2	I32	0.01mm	-5000000	5000000		
107	SSF line 7 x1	I32	0.01mm	-5000000	5000000		
108	SSF line 7 y1	I32	0.01mm	-5000000	5000000		
109	SSF line 7 x2	I32	0.01mm	-5000000	5000000		
110	SSF line 7 y2	I32	0.01mm	-5000000	5000000		
111	SSF line 8 x1	I32	0.01mm	-5000000	5000000		
112	SSF line 8 y1	I32	0.01mm	-5000000	5000000		
113	SSF line 8 x2	I32	0.01mm	-5000000	5000000		
114	SSF line 8 y2	I32	0.01mm	-5000000	5000000		
115	Partial restricted area 1 valid / invalid		-	0: Invalid 1: Valid		Y	
116	Upper limit of z of partial restricted area 1	I32	0.01mm	-5000000	5000000	Y	
117	Lower limit of z of partial restricted area 1	I32	0.01mm	-5000000	5000000	Y	
118	Partial restricted area 1, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
119	Partial restricted area 1, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
120	Partial restricted area 1, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
121	Partial restricted area 1, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
122	Partial restricted area 1, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
123	Partial restricted area 1, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
124	Partial restricted area 1, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
125	Partial restricted area 1, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
126	Partial restricted area 1, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
127	Partial restricted area 1, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
128	Partial restricted area 1, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
129	Partial restricted area 1, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
130	Partial restricted area 1, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
131	Partial restricted area 1, line 4, y1	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
132	Partial restricted area 1, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
133	Partial restricted area 1, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
134	Partial restricted area 2 valid / invalid		-	0: Invalid 1: Valid		Y	
135	Upper limit of z of partial restricted area 2	I32	0.01mm	-5000000	5000000	Y	
136	Lower limit of z of partial restricted area 2	I32	0.01mm	-5000000	5000000	Y	
137	Partial restricted area 2, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
138	Partial restricted area 2, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
139	Partial restricted area 2, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
140	Partial restricted area 2, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
141	Partial restricted area 2, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
142	Partial restricted area 2, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
143	Partial restricted area 2, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
144	Partial restricted area 2, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
145	Partial restricted area 2, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
146	Partial restricted area 2, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
147	Partial restricted area 2, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
148	Partial restricted area 2, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
149	Partial restricted area 2, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
150	Partial restricted area 2, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
151	Partial restricted area 2, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
152	Partial restricted area 2, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
153	Partial restricted area 3 valid / invalid		-	0: Invalid 1: Valid		Y	
154	Upper limit of z of partial restricted area 3	I32	0.01mm	-5000000	5000000	Y	
155	Lower limit of z of partial restricted area 3	I32	0.01mm	-5000000	5000000	Y	
156	Partial restricted area 3, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
157	Partial restricted area 3, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
158	Partial restricted area 3, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
159	Partial restricted area 3, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
160	Partial restricted area 3, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
161	Partial restricted area 3, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
162	Partial restricted area 3, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
163	Partial restricted area 3, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
164	Partial restricted area 3, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
165	Partial restricted area 3, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
166	Partial restricted area 3, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
167	Partial restricted area 3, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
168	Partial restricted area 3, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
169	Partial restricted area 3, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
170	Partial restricted area 3, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
171	Partial restricted area 3, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
172	Partial restricted area 4 valid / invalid		-	0: Invalid 1: Valid		Y	
173	Upper limit of z of partial restricted area 4	I32	0.01mm	-5000000	5000000	Y	
174	Lower limit of z of partial restricted area 4	I32	0.01mm	-5000000	5000000	Y	
175	Partial restricted area 4, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
176	Partial restricted area 4, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
177	Partial restricted area 4, line 1, x2	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
178	Partial restricted area 4, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
179	Partial restricted area 4, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
180	Partial restricted area 4, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
181	Partial restricted area 4, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
182	Partial restricted area 4, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
183	Partial restricted area 4, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
184	Partial restricted area 4, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
185	Partial restricted area 4, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
186	Partial restricted area 4, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
187	Partial restricted area 4, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
188	Partial restricted area 4, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
189	Partial restricted area 4, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
190	Partial restricted area 4, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
191	Partial restricted area 5 valid / invalid		-	0: Invalid 1: Valid		Y	
192	Upper limit of z of partial restricted area 5	I32	0.01mm	-5000000	5000000	Y	
193	Lower limit of z of partial restricted area 5	I32	0.01mm	-5000000	5000000	Y	
194	Partial restricted area 5, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
195	Partial restricted area 5, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
196	Partial restricted area 5, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
197	Partial restricted area 5, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
198	Partial restricted area 5, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
199	Partial restricted area 5, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
200	Partial restricted area 5, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
201	Partial restricted area 5, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
202	Partial restricted area 5, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
203	Partial restricted area 5, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
204	Partial restricted area 5, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
205	Partial restricted area 5, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
206	Partial restricted area 5, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
207	Partial restricted area 5, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
208	Partial restricted area 5, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
209	Partial restricted area 5, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
210	Partial restricted area 6 valid / invalid		-	0: Invalid 1: Valid		Y	
211	Upper limit of z of partial restricted area 6	I32	0.01mm	-5000000	5000000	Y	
212	Lower limit of z of partial restricted area 6	I32	0.01mm	-5000000	5000000	Y	
213	Partial restricted area 6, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
214	Partial restricted area 6, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
215	Partial restricted area 6, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
216	Partial restricted area 6, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
217	Partial restricted area 6, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
218	Partial restricted area 6, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
219	Partial restricted area 6, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
220	Partial restricted area 6, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
221	Partial restricted area 6, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
222	Partial restricted area 6, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
223	Partial restricted area 6, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
224	Partial restricted area 6, line 3, y2	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
225	Partial restricted area 6, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
226	Partial restricted area 6, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
227	Partial restricted area 6, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
228	Partial restricted area 6, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
229	Partial restricted area 7 valid / invalid		-	0: Invalid 1: Valid		Y	
230	Upper limit of z of partial restricted area 7	I32	0.01mm	-5000000	5000000	Y	
231	Lower limit of z of partial restricted area 7	I32	0.01mm	-5000000	5000000	Y	
232	Partial restricted area 7, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
233	Partial restricted area 7, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
234	Partial restricted area 7, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
235	Partial restricted area 7, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
236	Partial restricted area 7, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
237	Partial restricted area 7, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
238	Partial restricted area 7, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
239	Partial restricted area 7, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
240	Partial restricted area 7, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
241	Partial restricted area 7, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
242	Partial restricted area 7, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
243	Partial restricted area 7, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
244	Partial restricted area 7, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
245	Partial restricted area 7, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
246	Partial restricted area 7, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
247	Partial restricted area 7, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
248	Partial restricted area 8 valid / invalid		-	0: Invalid 1: Valid		Y	
249	Upper limit of z of partial restricted area 8	I32	0.01mm	-5000000	5000000	Y	
250	Lower limit of z of partial restricted area 8	I32	0.01mm	-5000000	5000000	Y	
251	Partial restricted area 8, line 1, x1	I32	0.01mm	-5000000	5000000	Y	
252	Partial restricted area 8, line 1, y1	I32	0.01mm	-5000000	5000000	Y	
253	Partial restricted area 8, line 1, x2	I32	0.01mm	-5000000	5000000	Y	
254	Partial restricted area 8, line 1, y2	I32	0.01mm	-5000000	5000000	Y	
255	Partial restricted area 8, line 2, x1	I32	0.01mm	-5000000	5000000	Y	
256	Partial restricted area 8, line 2, y1	I32	0.01mm	-5000000	5000000	Y	
257	Partial restricted area 8, line 2, x2	I32	0.01mm	-5000000	5000000	Y	
258	Partial restricted area 8, line 2, y2	I32	0.01mm	-5000000	5000000	Y	
259	Partial restricted area 8, line 3, x1	I32	0.01mm	-5000000	5000000	Y	
260	Partial restricted area 8, line 3, y1	I32	0.01mm	-5000000	5000000	Y	
261	Partial restricted area 8, line 3, x2	I32	0.01mm	-5000000	5000000	Y	
262	Partial restricted area 8, line 3, y2	I32	0.01mm	-5000000	5000000	Y	
263	Partial restricted area 8, line 4, x1	I32	0.01mm	-5000000	5000000	Y	
264	Partial restricted area 8, line 4, y1	I32	0.01mm	-5000000	5000000	Y	
265	Partial restricted area 8, line 4, x2	I32	0.01mm	-5000000	5000000	Y	
266	Partial restricted area 8, line 4, y2	I32	0.01mm	-5000000	5000000	Y	
267	Arm interference monitoring point 1. Designate the coordinate number of coordinate transformation.	I32	-	0	10	Y	
268	Arm interference monitoring point 1. X coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
269	Arm interference monitoring point 1. Y coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
270	Arm interference monitoring point 1. Z coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
271	Arm interference monitoring point 2. Designate the coordinate number of coordinate transformation.	I32	-	0	10	Y	
272	Arm interference monitoring point 2. X coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
273	Arm interference monitoring point 2. Y coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
274	Arm interference monitoring point 2. Z coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
275	Arm interference monitoring point 3. Designate the coordinate number of coordinate transformation.	I32	-	0	10	Y	
276	Arm interference monitoring point 3. X coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
277	Arm interference monitoring point 3. Y coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
278	Arm interference monitoring point 3. Z coordinate of designated coordinate system	I32	0.01mm	-5000000	5000000	Y	
279	TOOL 1, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
280	TOOL 1, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
281	TOOL 1, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
282	TOOL 1, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
283	TOOL 1, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
284	TOOL 1, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
285	TOOL 1, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
286	TOOL 1, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
287	TOOL 1, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
288	TOOL 1, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
289	TOOL 1, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
290	TOOL 1, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
291	TOOL 1, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
292	TOOL 1, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
293	TOOL 1, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
294	TOOL 1, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
295	TOOL 1, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
296	TOOL 1, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
297	TOOL 1, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
298	TOOL 1, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
299	TOOL 1, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
300	TOOL 1, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
301	TOOL 1, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
302	TOOL 1, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
303	TOOL 1, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
304	TOOL 1, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
305	TOOL 1, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
306	TOOL 1, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
307	TOOL 1, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
308	TOOL 1, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
309	TOOL 1, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
310	TOOL 1, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
311	TOOL 1, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
312	TOOL 1, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
313	TOOL 1, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
314	TOOL 1, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
315	TOOL 1, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
316	TOOL 1, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
317	TOOL 1, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
318	TOOL 1, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
319	TOOL 1, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
320	TOOL 1, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
321	TOOL 1, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
322	TOOL 1, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
323	TOOL 1, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
324	TOOL 1, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
325	TOOL 1, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
326	TOOL 1, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
327	TOOL 1, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
328	TOOL 1, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
329	TOOL 1, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
330	TOOL 1, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
331	TOOL 1, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
332	TOOL 1, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
333	TOOL 1, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
334	TOOL 1, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
335	TOOL 1, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
336	TOOL 1, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
337	TOOL 1, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
338	TOOL 1, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
339	TOOL 1, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
340	TOOL 1, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
341	TOOL 1, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
342	TOOL 1, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
343	TOOL 1, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
344	TOOL 1, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
345	TOOL 1, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
346	TOOL 1, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
347	TOOL 1, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
348	TOOL 1, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
349	TOOL 1, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
350	TOOL 1, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
351	TOOL 1, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
352	TOOL 1, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
353	TOOL 1, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
354	TOOL 1, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
355	TOOL 1, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
356	TOOL 1, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
357	TOOL 1, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
358	TOOL 1, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
359	TOOL 1, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
360	TOOL 1, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
361	TOOL 1, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
362	TOOL 2, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
363	TOOL 2, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
364	TOOL 2, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
365	TOOL 2, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
366	TOOL 2, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
367	TOOL 2, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
368	TOOL 2, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
369	TOOL 2, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
370	TOOL 2, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
371	TOOL 2, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
372	TOOL 2, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
373	TOOL 2, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
374	TOOL 2, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
375	TOOL 2, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
376	TOOL 2, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
377	TOOL 2, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
378	TOOL 2, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
379	TOOL 2, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
380	TOOL 2, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
381	TOOL 2, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
382	TOOL 2, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
383	TOOL 2, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
384	TOOL 2, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
385	TOOL 2, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
386	TOOL 2, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
387	TOOL 2, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
388	TOOL 2, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
389	TOOL 2, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
390	TOOL 2, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
391	TOOL 2, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
392	TOOL 2, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
393	TOOL 2, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
394	TOOL 2, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
395	TOOL 2, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
396	TOOL 2, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
397	TOOL 2, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
398	TOOL 2, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
399	TOOL 2, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
400	TOOL 2, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
401	TOOL 2, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
402	TOOL 2, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
403	TOOL 2, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
404	TOOL 2, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
405	TOOL 2, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
406	TOOL 2, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
407	TOOL 2, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
408	TOOL 2, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
409	TOOL 2, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
410	TOOL 2, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
411	TOOL 2, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
412	TOOL 2, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
413	TOOL 2, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
414	TOOL 2, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
415	TOOL 2, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
416	TOOL 2, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
417	TOOL 2, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
418	TOOL 2, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
419	TOOL 2, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
420	TOOL 2, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
421	TOOL 2, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
422	TOOL 2, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
423	TOOL 2, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
424	TOOL 2, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
425	TOOL 2, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
426	TOOL 2, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
427	TOOL 2, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
428	TOOL 2, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
429	TOOL 2, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
430	TOOL 2, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
431	TOOL 2, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
432	TOOL 2, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
433	TOOL 2, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
434	TOOL 2, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
435	TOOL 2, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
436	TOOL 2, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
437	TOOL 2, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
438	TOOL 2, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
439	TOOL 2, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
440	TOOL 2, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
441	TOOL 2, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
442	TOOL 2, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
443	TOOL 2, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
444	TOOL 2, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
445	TOOL3, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
446	TOOL3, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
447	TOOL3, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
448	TOOL3, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
449	TOOL3, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
450	TOOL3, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
451	TOOL3, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
452	TOOL3, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
453	TOOL3, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
454	TOOL3, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
455	TOOL3, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
456	TOOL3, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
457	TOOL3, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
458	TOOL3, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
459	TOOL3, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
460	TOOL3, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
461	TOOL3, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
462	TOOL3, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
463	TOOL3, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
464	TOOL3, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
465	TOOL3, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
466	TOOL3, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
467	TOOL3, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
468	TOOL3, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
469	TOOL3, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
470	TOOL3, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
471	TOOL3, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
472	TOOL3, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
473	TOOL3, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
474	TOOL3, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
475	TOOL3, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
476	TOOL3, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
477	TOOL3, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
478	TOOL3, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
479	TOOL3, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
480	TOOL3, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
481	TOOL3, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
482	TOOL3, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
483	TOOL3, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
484	TOOL3, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
485	TOOL3, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
486	TOOL3, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
487	TOOL3, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
488	TOOL3, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
489	TOOL3, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
490	TOOL3, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
491	TOOL3, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
492	TOOL3, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
493	TOOL3, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
494	TOOL3, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
495	TOOL3, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
496	TOOL3, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
497	TOOL3, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
498	TOOL3, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
499	TOOL3, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
500	TOOL3, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
501	TOOL3, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
502	TOOL3, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
503	TOOL3, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
504	TOOL3, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
505	TOOL3, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
506	TOOL3, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
507	TOOL3, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
508	TOOL3, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
509	TOOL3, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
510	TOOL3, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
511	TOOL3, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
512	TOOL3, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
513	TOOL3, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
514	TOOL3, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
515	TOOL3, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
516	TOOL3, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
517	TOOL3, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
518	TOOL3, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
519	TOOL3, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
520	TOOL3, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
521	TOOL3, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
522	TOOL3, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
523	TOOL3, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
524	TOOL3, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
525	TOOL3, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
526	TOOL3, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
527	TOOL3, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
528	TOOL4, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
529	TOOL4, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
530	TOOL4, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
531	TOOL4, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
532	TOOL4, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
533	TOOL4, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
534	TOOL4, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
535	TOOL4, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
536	TOOL4, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
537	TOOL4, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
538	TOOL4, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
539	TOOL4, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
540	TOOL4, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
541	TOOL4, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
542	TOOL4, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
543	TOOL4, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
544	TOOL4, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
545	TOOL4, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
546	TOOL4, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
547	TOOL4, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
548	TOOL4, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
549	TOOL4, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
550	TOOL4, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
551	TOOL4, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
552	TOOL4, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
553	TOOL4, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
554	TOOL4, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
555	TOOL4, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
556	TOOL4, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
557	TOOL4, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
558	TOOL4, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
559	TOOL4, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
560	TOOL4, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
561	TOOL4, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
562	TOOL4, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
563	TOOL4, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
564	TOOL4, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
565	TOOL4, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
566	TOOL4, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
567	TOOL4, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
568	TOOL4, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
569	TOOL4, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
570	TOOL4, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
571	TOOL4, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
572	TOOL4, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
573	TOOL4, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
574	TOOL4, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
575	TOOL4, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
576	TOOL4, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
577	TOOL4, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
578	TOOL3, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
579	TOOL4, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
580	TOOL4, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
581	TOOL4, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
582	TOOL4, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
583	TOOL4, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
584	TOOL4, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
585	TOOL4, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
586	TOOL4, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
587	TOOL4, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
588	TOOL4, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
589	TOOL4, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
590	TOOL4, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
591	TOOL4, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
592	TOOL4, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
593	TOOL4, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
594	TOOL4, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
595	TOOL4, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
596	TOOL4, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
597	TOOL4, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
598	TOOL4, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
599	TOOL4, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
600	TOOL4, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
601	TOOL4, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
602	TOOL4, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
603	TOOL4, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
604	TOOL4, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
605	TOOL4, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
606	TOOL4, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
607	TOOL4, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
608	TOOL4, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
609	TOOL4, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
610	TOOL4, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
611	TOOL5, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
612	TOOL5, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
613	TOOL5, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
614	TOOL5, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
615	TOOL5, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
616	TOOL5, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
617	TOOL5, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
618	TOOL5, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
619	TOOL5, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
620	TOOL5, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
621	TOOL5, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
622	TOOL5, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
623	TOOL5, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
624	TOOL5, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
625	TOOL5, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
626	TOOL5, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
627	TOOL5, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
628	TOOL5, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
629	TOOL5, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
630	TOOL5, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
631	TOOL5, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
632	TOOL5, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
633	TOOL5, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
634	TOOL5, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
635	TOOL5, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
636	TOOL5, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
637	TOOL5, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
638	TOOL5, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
639	TOOL5, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
640	TOOL5, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
641	TOOL5, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
642	TOOL5, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
643	TOOL5, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
644	TOOL5, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
645	TOOL5, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
646	TOOL5, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
647	TOOL5, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
648	TOOL5, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
649	TOOL5, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
650	TOOL5, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
651	TOOL5, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
652	TOOL5, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
653	TOOL5, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
654	TOOL5, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
655	TOOL5, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
656	TOOL5, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
657	TOOL5, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
658	TOOL5, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
659	TOOL5, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
660	TOOL5, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
661	TOOL5, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
662	TOOL5, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
663	TOOL5, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
664	TOOL5, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
665	TOOL5, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
666	TOOL5, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
667	TOOL5, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
668	TOOL5, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
669	TOOL5, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
670	TOOL5, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
671	TOOL5, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
672	TOOL5, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
673	TOOL5, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
674	TOOL5, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
675	TOOL5, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
676	TOOL5, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
677	TOOL5, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
678	TOOL5, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
679	TOOL5, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
680	TOOL5, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
681	TOOL5, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
682	TOOL5, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
683	TOOL5, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
684	TOOL5, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
685	TOOL5, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
686	TOOL5, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
687	TOOL5, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
688	TOOL5, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
689	TOOL5, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
690	TOOL5, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
691	TOOL5, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
692	TOOL5, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
693	TOOL5, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
694	TOOL6, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
695	TOOL6, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
696	TOOL6, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
697	TOOL6, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
698	TOOL6, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
699	TOOL6, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
700	TOOL6, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
701	TOOL6, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
702	TOOL6, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
703	TOOL6, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
704	TOOL6, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
705	TOOL6, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
706	TOOL6, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
707	TOOL6, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
708	TOOL6, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
709	TOOL6, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
710	TOOL6, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
711	TOOL6, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
712	TOOL6, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
713	TOOL6, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
714	TOOL6, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
715	TOOL6, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
716	TOOL6, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
717	TOOL6, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
718	TOOL6, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
719	TOOL6, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
720	TOOL6, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
721	TOOL6, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
722	TOOL6, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
723	TOOL6, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
724	TOOL6, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
725	TOOL6, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
726	TOOL6, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
727	TOOL6, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
728	TOOL6, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
729	TOOL6, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
730	TOOL6, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
731	TOOL6, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
732	TOOL6, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
733	TOOL6, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
734	TOOL6, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
735	TOOL6, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
736	TOOL6, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
737	TOOL6, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
738	TOOL6, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
739	TOOL6, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
740	TOOL6, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
741	TOOL6, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
742	TOOL6, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
743	TOOL6, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
744	TOOL6, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
745	TOOL6, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
746	TOOL6, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
747	TOOL6, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
748	TOOL6, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
749	TOOL6, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
750	TOOL6, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
751	TOOL6, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
752	TOOL6, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
753	TOOL6, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
754	TOOL6, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
755	TOOL6, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
756	TOOL6, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
757	TOOL6, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
758	TOOL6, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
759	TOOL6, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
760	TOOL6, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
761	TOOL6, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
762	TOOL6, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
763	TOOL6, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
764	TOOL6, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
765	TOOL6, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
766	TOOL6, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
767	TOOL6, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
768	TOOL6, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
769	TOOL6, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
770	TOOL6, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
771	TOOL6, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
772	TOOL6, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
773	TOOL6, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
774	TOOL6, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
775	TOOL6, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
776	TOOL6, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
777	TOOL7, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
778	TOOL7, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
779	TOOL7, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
780	TOOL7, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
781	TOOL7, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
782	TOOL7, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
783	TOOL7, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
784	TOOL7, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
785	TOOL7, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
786	TOOL7, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
787	TOOL7, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
788	TOOL7, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
789	TOOL7, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
790	TOOL7, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
791	TOOL7, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
792	TOOL7, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
793	TOOL7, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
794	TOOL7, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
795	TOOL7, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
796	TOOL7, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
797	TOOL7, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
798	TOOL7, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
799	TOOL7, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
800	TOOL7, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
801	TOOL7, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
802	TOOL7, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
803	TOOL7, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
804	TOOL7, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
805	TOOL7, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
806	TOOL7, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
807	TOOL7, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
808	TOOL7, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
809	TOOL7, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
810	TOOL7, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
811	TOOL7, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
812	TOOL7, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
813	TOOL7, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
814	TOOL7, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
815	TOOL7, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
816	TOOL7, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
817	TOOL7, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
818	TOOL7, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
819	TOOL7, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
820	TOOL7, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
821	TOOL7, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
822	TOOL7, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
823	TOOL7, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
824	TOOL7, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
825	TOOL7, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
826	TOOL7, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
827	TOOL7, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
828	TOOL7, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
829	TOOL7, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
830	TOOL7, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
831	TOOL7, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
832	TOOL7, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
833	TOOL7, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
834	TOOL7, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
835	TOOL7, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
836	TOOL7, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
837	TOOL7, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
838	TOOL7, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
839	TOOL7, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
840	TOOL7, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
841	TOOL7, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
842	TOOL7, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
843	TOOL7, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
844	TOOL7, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
845	TOOL7, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
846	TOOL7, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
847	TOOL7, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
848	TOOL7, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
849	TOOL7, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
850	TOOL7, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
851	TOOL7, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
852	TOOL7, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
853	TOOL7, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
854	TOOL7, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
855	TOOL7, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
856	TOOL7, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
857	TOOL7, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
858	TOOL7, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
859	TOOL7, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
860	TOOL8, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
861	TOOL8, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
862	TOOL8, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
863	TOOL8, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
864	TOOL8, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
865	TOOL8, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
866	TOOL8, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
867	TOOL8, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
868	TOOL8, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
869	TOOL8, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
870	TOOL8, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
871	TOOL8, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
872	TOOL8, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
873	TOOL8, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
874	TOOL8, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
875	TOOL8, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
876	TOOL8, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
877	TOOL8, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
878	TOOL8, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
879	TOOL8, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
880	TOOL8, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
881	TOOL8, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
882	TOOL8, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
883	TOOL8, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
884	TOOL8, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
885	TOOL8, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
886	TOOL8, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
887	TOOL8, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
888	TOOL8, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
889	TOOL8, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
890	TOOL8, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
891	TOOL8, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
892	TOOL8, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
893	TOOL8, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
894	TOOL8, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
895	TOOL8, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
896	TOOL8, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
897	TOOL8, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
898	TOOL8, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
899	TOOL8, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
900	TOOL8, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
901	TOOL8, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
902	TOOL8, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
903	TOOL8, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
904	TOOL8, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
905	TOOL8, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
906	TOOL8, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	
907	TOOL8, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
908	TOOL8, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
909	TOOL8, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
910	TOOL8, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
911	TOOL8, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
912	TOOL8, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
913	TOOL8, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
914	TOOL8, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
915	TOOL8, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
916	TOOL8, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
917	TOOL8, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
918	TOOL8, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
919	TOOL8, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
920	TOOL8, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
921	TOOL8, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
922	TOOL8, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
923	TOOL8, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
924	TOOL8, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
925	TOOL8, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
926	TOOL8, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
927	TOOL8, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
928	TOOL8, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
929	TOOL8, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
930	TOOL8, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
931	TOOL8, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
932	TOOL8, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
933	TOOL8, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
934	TOOL8, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
935	TOOL8, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
936	TOOL8, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
937	TOOL8, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
938	TOOL8, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
939	TOOL8, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
940	TOOL8, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
941	TOOL8, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
942	TOOL8, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
943	TOOL9, TCP, X coordinate	I32	0.01mm	-5000000	5000000	Y	
944	TOOL9, TCP, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
945	TOOL9, TCP, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
946	TOOL9, ball 1, X coordinate	I32	0.01mm	-5000000	5000000	Y	
947	TOOL9, ball 1, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
948	TOOL9, ball 1, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
949	TOOL9, ball 1, radius	I32	0.01mm	-5000000	5000000	Y	
950	TOOL9, ball 2, X coordinate	I32	0.01mm	-5000000	5000000	Y	
951	TOOL9, ball 2, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
952	TOOL9, ball 2, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
953	TOOL9, ball 2, radius	I32	0.01mm	-5000000	5000000	Y	
954	TOOL9, ball 3, X coordinate	I32	0.01mm	-5000000	5000000	Y	
955	TOOL9, ball 3, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
956	TOOL9, ball 3, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
957	TOOL9, ball 3, radius	I32	0.01mm	-5000000	5000000	Y	
958	TOOL9, ball 4, X coordinate	I32	0.01mm	-5000000	5000000	Y	
959	TOOL9, ball 4, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
960	TOOL9, ball 4, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
961	TOOL9, ball 4, radius	I32	0.01mm	-5000000	5000000	Y	
962	TOOL9, ball 5, X coordinate	I32	0.01mm	-5000000	5000000	Y	
963	TOOL9, ball 5, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
964	TOOL9, ball 5, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
965	TOOL9, ball 5, radius	I32	0.01mm	-5000000	5000000	Y	
966	TOOL9, ball 6, X coordinate	I32	0.01mm	-5000000	5000000	Y	
967	TOOL9, ball 6, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
968	TOOL9, ball 6, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
969	TOOL9, ball 6, radius	I32	0.01mm	-5000000	5000000	Y	
970	TOOL9, ball 7, X coordinate	I32	0.01mm	-5000000	5000000	Y	
971	TOOL9, ball 7, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
972	TOOL9, ball 7, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
973	TOOL9, ball 7, radius	I32	0.01mm	-5000000	5000000	Y	
974	TOOL9, ball 8, X coordinate	I32	0.01mm	-5000000	5000000	Y	
975	TOOL9, ball 8, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
976	TOOL9, ball 8, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
977	TOOL9, ball 8, radius	I32	0.01mm	-5000000	5000000	Y	
978	TOOL9, ball 9, X coordinate	I32	0.01mm	-5000000	5000000	Y	
979	TOOL9, ball 9, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
980	TOOL9, ball 9, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
981	TOOL9, ball 9, radius	I32	0.01mm	-5000000	5000000	Y	
982	TOOL9, ball 10, X coordinate	I32	0.01mm	-5000000	5000000	Y	
983	TOOL9, ball 10, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
984	TOOL9, ball 10, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
985	TOOL9, ball 10, radius	I32	0.01mm	-5000000	5000000	Y	
986	TOOL9, ball 11, X coordinate	I32	0.01mm	-5000000	5000000	Y	
987	TOOL9, ball 11, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
988	TOOL9, ball 11, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
989	TOOL9, ball 11, radius	I32	0.01mm	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
990	TOOL9, ball 12, X coordinate	I32	0.01mm	-5000000	5000000	Y	
991	TOOL9, ball 12, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
992	TOOL9, ball 12, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
993	TOOL9, ball 12, radius	I32	0.01mm	-5000000	5000000	Y	
994	TOOL9, ball 13, X coordinate	I32	0.01mm	-5000000	5000000	Y	
995	TOOL9, ball 13, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
996	TOOL9, ball 13, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
997	TOOL9, ball 13, radius	I32	0.01mm	-5000000	5000000	Y	
998	TOOL9, ball 14, X coordinate	I32	0.01mm	-5000000	5000000	Y	
999	TOOL9, ball 14, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1000	TOOL9, ball 14, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1001	TOOL9, ball 14, radius	I32	0.01mm	-5000000	5000000	Y	
1002	TOOL9, ball 15, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1003	TOOL9, ball 15, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1004	TOOL9, ball 15, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1005	TOOL9, ball 15, radius	I32	0.01mm	-5000000	5000000	Y	
1006	TOOL9, ball 16, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1007	TOOL9, ball 16, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1008	TOOL9, ball 16, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1009	TOOL9, ball 16, radius	I32	0.01mm	-5000000	5000000	Y	
1010	TOOL9, ball 17, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1011	TOOL9, ball 17, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1012	TOOL9, ball 17, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1013	TOOL9, ball 17, radius	I32	0.01mm	-5000000	5000000	Y	
1014	TOOL9, ball 18, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1015	TOOL9, ball 18, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1016	TOOL9, ball 18, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1017	TOOL9, ball 18, radius	I32	0.01mm	-5000000	5000000	Y	
1018	TOOL9, ball 19, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1019	TOOL9, ball 19, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1020	TOOL9, ball 19, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1021	TOOL9, ball 19, radius	I32	0.01mm	-5000000	5000000	Y	
1022	TOOL9, ball 20, X coordinate	I32	0.01mm	-5000000	5000000	Y	
1023	TOOL9, ball 20, Y coordinate	I32	0.01mm	-5000000	5000000	Y	
1024	TOOL9, ball 20, Z coordinate	I32	0.01mm	-5000000	5000000	Y	
1025	TOOL9, ball 20, radius	I32	0.01mm	-5000000	5000000	Y	
1026	J1 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1027	J1 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1028	J1 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1029	J1 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1030	J2 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1031	J2 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1032	J2 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1033	J2 command value + per-bit signed change of joint value	F32	0.01°/bit or			Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
			0.01mm/bit				
1034	J3 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1035	J3 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1036	J3 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1037	J3 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1038	J4 driving type (0: no axis. 1: rotary. 2: linear)		0.01° or 0.01mm	0=No axis 1=Rotary 2=Linear		Y	
1039	J4 joint value at zeroing posture	I32	0.01°/bit or 0.01mm/bit	-5000000	5000000	Y	
1040	J4 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1041	J4 command value + per-bit signed change of joint value	F32	0.01° or 0.01mm			Y	
1042	J5 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1043	J5 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1044	J5 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1045	J5 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1046	J6 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1047	J6 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1048	J6 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1049	J6 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1050	J7 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1051	J7 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1052	J7 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1053	J7 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1054	J8 driving type (0: no axis. 1: rotary. 2: linear)			0=No axis 1=Rotary 2=Linear		Y	
1055	J8 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000	5000000	Y	
1056	J8 encoder value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1057	J8 command value + per-bit signed change of joint value	F32	0.01°/bit or 0.01mm/bit			Y	
1058	Target axis No. of drag correction 1	I32		0	8	Y	
1059	Reference axis No. of drag correction 1	I32		0	8	Y	
1060	Correction coefficient of drag correction 1	F32				Y	
1061	Target axis No. of drag correction 2	I32		0	8	Y	
1062	Reference axis No. of drag correction 2	I32		0	8	Y	
1063	Correction coefficient of drag correction 2	F32				Y	
1064	Target axis No. of drag correction 3	I32		0	8	Y	
1065	Reference axis No. of drag correction 3	I32		0	8	Y	
1066	Correction coefficient of drag correction 3	F32				Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
1067	Target axis No. of drag correction 4	I32		0	8	Y	
1068	Reference axis No. of drag correction 4	I32		0	8	Y	
1069	Correction coefficient of drag correction 4	F32				Y	
1070	Target axis No. of drag correction 5	I32		0	8	Y	
1071	Reference axis No. of drag correction 5	I32		0	8	Y	
1072	Correction coefficient of drag correction 5	F32				Y	
1073	Target axis No. of drag correction 6	I32		0	8	Y	
1074	Reference axis No. of drag correction 6	I32		0	8	Y	
1075	Correction coefficient of drag correction 6	F32				Y	
1076	Target axis No. of drag correction 7	I32		0	8	Y	
1077	Reference axis No. of drag correction 7	I32		0	8	Y	
1078	Correction coefficient of drag correction 7	F32				Y	
1079	Target axis No. of drag correction 8	I32		0	8	Y	
1080	Reference axis No. of drag correction 8	I32		0	8	Y	
1081	Correction coefficient of drag correction 8	F32				Y	
1082	Target axis No. of drag correction 1 of internal joint value	I32		0	8	Y	
1083	Reference axis No. of drag correction 1 of internal joint value	I32		0	8	Y	
1084	Correction coefficient of drag correction 1 of internal joint value	F32				Y	
1085	Target axis No. of drag correction 2 of internal joint value	I32		0	8	Y	
1086	Reference axis No. of drag correction 2 of internal joint value	I32		0	8	Y	
1087	Correction coefficient of drag correction 2 of internal joint value	F32				Y	
1088	Target axis No. of drag correction 3 of internal joint value	I32		0	8	Y	
1089	Reference axis No. of drag correction 3 of internal joint value	I32		0	8	Y	
1090	Correction coefficient of drag correction 3 of internal joint value	F32				Y	
1091	Target axis No. of drag correction 4 of internal joint value	I32		0	8	Y	
1092	Reference axis No. of drag correction 4 of internal joint value	I32		0	8	Y	
1093	Correction coefficient of drag correction 4 of internal joint value	F32				Y	
1094	Type of first transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)					Y	
1095	Axis No. of 1st transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1096	θ_0 of 1st transformation matrix	F32	0.01°	-5000000	5000000	Y	
1097	d_0 of 1st transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1098	k_0 of 1st transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1099	a_0 of 1st transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1100	α_0 of 1st transformation matrix	F32	0.01°	-5000000	5000000	Y	
1101	Type of 2nd transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)					Y	
1102	Axis No. of 2nd transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1103	θ_0 of 2nd transformation matrix	F32	0.01°	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
1104	d_0 of 2nd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1105	k_0 of 2nd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1106	a_0 of 2nd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1107	α_0 of 2nd transformation matrix	F32	0.01°	-5000000	5000000	Y	
1108	Type of 3rd transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1109	Axis No. of 3rd transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1110	θ_0 of 3rd transformation matrix	F32	0.01°	-5000000	5000000	Y	
1111	d_0 of 3rd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1112	k_0 of 3rd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1113	a_0 of 3rd transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1114	α_0 of 3rd transformation matrix	F32	0.01°	-5000000	5000000	Y	
1115	Type of 4th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1116	Axis No. of 4th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1117	θ_0 of 4th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1118	d_0 of 4th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1119	k_0 of 4th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1120	a_0 of 4th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1121	α_0 of 4th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1122	Type of 5th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1123	Axis No. of 5th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1124	θ_0 of 5th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1125	d_0 of 5th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1126	k_0 of 5th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1127	a_0 of 5th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1128	α_0 of 5th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1129	Type of 6th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1130	Axis No. of 6th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1131	θ_0 of 6th transformation matrix	F32	0.01°	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
1132	d_0 of 6th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1133	k_0 of 6th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1134	a_0 of 6th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1135	α_0 of 6th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1136	Type of 7th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1137	Axis No. of 7th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1138	θ_0 of 7th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1139	d_0 of 7th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1140	k_0 of 7th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1141	a_0 of 7th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1142	α_0 of 7th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1143	Type of 8th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1144	Axis No. of 8th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1145	θ_0 of 8th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1146	d_0 of 8th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1147	k_0 of 8th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1148	a_0 of 8th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1149	α_0 of 8th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1150	Type of 9th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1151	Axis No. of 9th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1152	θ_0 of 9th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1153	d_0 of 9th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1154	k_0 of 9th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1155	a_0 of 9th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1156	α_0 of 9th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1157	Type of 10th transformation matrix (0: end of transformation matrix. 1: with axis. 2: without axis)			0=End of transformation matrix 1=With axis 2=Without axis		Y	
1158	Axis No. of 10th transformation matrix (If the type is "1," designate the axis number of an existing axis among 1 to 8.)	I32		0	8	Y	
1159	θ_0 of 10th transformation matrix	F32	0.01°	-5000000	5000000	Y	

No.	Item	Data type	Unit	Min. value	Max. value	R C	Initial value
1160	d ₀ of 10th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1161	k ₀ of 10th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1162	a ₀ of 10th transformation matrix	F32	0.01mm	-5000000	5000000	Y	
1163	α ₀ of 10th transformation matrix	F32	0.01°	-5000000	5000000	Y	
1164	Stop judgment value J1	UI32	0.01° or 0.01mm	0	1000	Y	
1165	Stop judgment value J2	UI32	0.01° or 0.01mm	0	1000	Y	
1166	Stop judgment value J3	UI32	0.01° or 0.01mm	0	1000	Y	
1167	Stop judgment value J4	UI32	0.01° or 0.01mm	0	1000	Y	
1168	Stop judgment value J5	UI32	0.01° or 0.01mm	0	1000	Y	
1169	Stop judgment value J6	UI32	0.01° or 0.01mm	0	1000	Y	
1170	Stop judgment value J7	UI32	0.01° or 0.01mm	0	1000	Y	
1171	Stop judgment value J8	UI32	0.01° or 0.01mm	0	1000	Y	
1172	Free running time	UI32	ms	0	1000		
1173	Braking deceleration	UI32	mm/s ²	0	100000		
1174	Allowable J1 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1175	Allowable J2 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1176	Allowable J3 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1177	Allowable J4 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1178	Allowable J5 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1179	Allowable J6 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1180	Allowable J7 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1181	Allowable J8 encoder deviation width from stored power-on value	UI32	Pulse			Y	
1182	Tool monitoring mode (0: tool 1 fixed. 1: tool monitoring invalid. 2: tool monitoring valid)			0=Tool 1 fixed 1=Tool monitoring invalid 2=Tool monitoring valid		?	
1183	Radius of ball excluded from tool monitoring	UI32	0.01mm	0	100000		
1184	Input error detection time (250mm/s monitor)	I32	0.1s	1	99		10
1185	Input error detection time (SSF monitor)	I32	0.1s	1	99		10
1186	Input error detection time (Stop monitor)	I32	0.1s	1	99		10
1187	Delay of encoder value from command value	I32	ms	0	450	Y	1
1188	Allowable flange-to-flange verification distance	I32	0.01mm	0	500000	Y	1
1189	IP address of RSC1	IPADD RESS					192.168.0.11
1190	Sub-net mask	IPADD RESS					255.255.255.0
1191	IP address of RC	IPADD RESS					192.168.0.1

9 RSC Parameter Reference

Each RSC parameter is described in details here.

9.1 Encoder Value at Zeroing Posture

[Ref. parameter No. : 0001~0008]

This parameter indicates the encoder data when the robot is at the zeroing posture. This parameter can be set from J1 to J8 for maximum eight axes.

This parameter is received from the robot. The RSC1 receives data about all axes of the robot to be monitored.

The RSC1 uses the upper 32 bits among 33 bits of encoder data (lower 1 bit is not used).

The zeroing value of each axis designated here is the same zeroing value as that RSC1 received from RC via Ethernet upon start-up.

Name	Type	Unit	Reception from robot
J1 encoder value at zeroing posture	UI32	Pulse	Y
J2 encoder value at zeroing posture	UI32	Pulse	Y
J3 encoder value at zeroing posture	UI32	Pulse	Y
J4 encoder value at zeroing posture	UI32	Pulse	Y
J5 encoder value at zeroing posture	UI32	Pulse	Y
J6 encoder value at zeroing posture	UI32	Pulse	Y
J7 encoder value at zeroing posture	UI32	Pulse	Y
J8 encoder value at zeroing posture	UI32	Pulse	Y

9.2 Command Value at Zeroing Posture

[Ref. parameter No : 0009~0016]

This parameter indicates the command value data when the robot is at the zeroing posture. This parameter can be set from J1 to J8 for maximum eight axes.

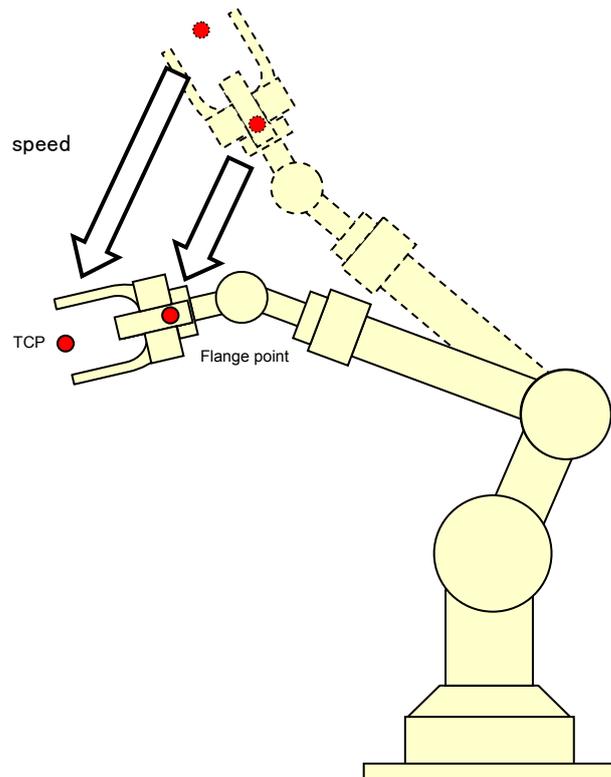
This parameter is received from the robot. The RSC1 receives data, from the robot, about all axes of the robot to be monitored.

Name	Type	Unit	Reception from robot
J1 command value at zeroing posture	UI32	Pulse	Y
J2 command value at zeroing posture	UI32	Pulse	Y
J3 command value at zeroing posture	UI32	Pulse	Y
J4 command value at zeroing posture	UI32	Pulse	Y
J5 command value at zeroing posture	UI32	Pulse	Y
J6 command value at zeroing posture	UI32	Pulse	Y
J7 command value at zeroing posture	UI32	Pulse	Y
J8 command value at zeroing posture	UI32	Pulse	Y

9.3 Safe Speed

[Ref. parameter No. : 0017]

This is a parameter used for the RSC1 to monitor the robot operation speed. The RSC1 has a function (speed monitoring function) for monitoring the flange point of the robot and the speed of TCP. If speed monitoring is valid and the speed at the flange point or at TCP exceeds the safe speed, the RSC1 issues an emergency stop signal.



This parameter is one of parameters characteristic to the RSC1 and it is not received from the robot. Change the setting according to the system design. Please be noted that the initial value of the parameter is set at 250.00mm/s.

Name	Type	Unit	Range	Initial value	Reception from robot
Safe speed	I32	0.01mm/s	100 to 25000	25000	

9.4 Command Value Loading Period

[Ref. parameter No. : 0018]

This parameter designates the time interval at which the RSC1 receives command value data via USB.

This parameter is received from the robot.

Name	Type	Unit	Range	Reception from robot
Command value loading period	I32	μs	10 to 50000	Y

9.5 Encoder Settings

[Ref. parameter No. : 0019~0020]

These parameters are for setting the specifications of the encoder onto the RSC1 with which the encoders have been installed on the robot.

Select either 1:1 or 1:N for encoder communication method.

Select the encoder baud rate between 2.5Mbps and 4Mbps for encoder communication speed.

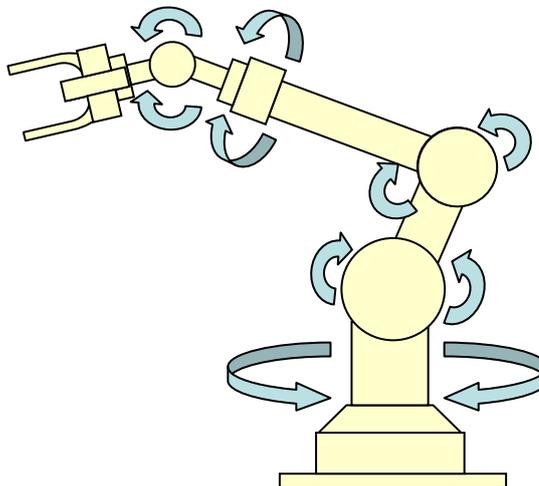
This parameter is received from the robot.

Name	Setting	Description	Reception from robot
Encoder communication method	0	1:1	Y
	1	1:N	
Encoder communication speed	0	2.5Mbps	Y
	1	4Mbps	

9.6 Operation Limits of Each Axis

[Ref. parameter No. : 0021~0036]

These parameters set a limit on each axis of the robot. The RSC1 has a function (SAL) for monitoring the operation amount of each axis. SAL uses this parameter. SAL monitors in the following way.



- If the joint value of each axis exceeds the upper limit, the RSC1 issues an emergency stop output.
- The same occurs if the joint value falls below the lower limit.

For SAL, refer to the section describing "area monitoring (axis limit)."

The RSC1 accepts entry of maximum eight axes. However, if you set "0" for both the upper and lower limits, monitor of that axis becomes invalid.

The upper limit value must be always larger than the lower limit value. However, this rule does not apply to the case where both the upper and lower limit values can be set at "0."

This parameter is received from the robot.

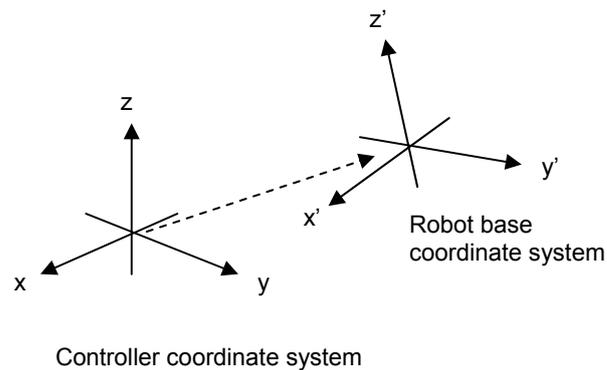
Name	Type	Unit	Range	Reception from robot
Upper limit value of J1	I32	0.01° or 0.01mm	-5000000 to 5000000	Y
Upper limit value of J1	I32	0.01° or 0.01mm	-5000000 to 5000000	Y
:	:	:	:	:
Upper limit value of J8	I32	0.01° or 0.01mm	-5000000 to 5000000	Y
Upper limit value of J8	I32	0.01° or 0.01mm	-5000000 to 5000000	Y

9.7 Robot Installation Position

[Ref. parameter No. : 0037~0042]

This parameter designates the installation position of the robot monitored by the RSC1. Use the parameter for systems where two or more robots are handled. The RSC1 can set the zero points of the robot base coordinate system at a point distant from the zero point of the controller coordinate system.

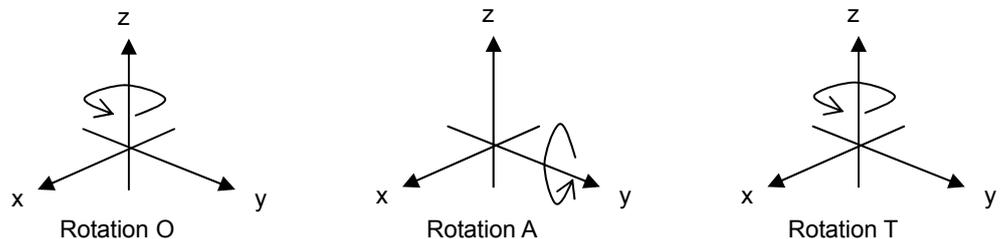
The controller coordinate serves as a basis for entry of monitoring area, etc. On the other hand, the zero point of the robot base coordinate system is the robot installation position. To define the zero point of the robot base coordinate system, use movement and rotation in reference to the controller zero point.



Follow the order below to perform coordinate transformation.

- (1) Travel in X direction
- (2) Travel in Y direction
- (3) Travel in Z direction
- (4) Rotation O
- (5) Rotation A
- (6) Rotation T

For the angle of rotation, the following transformation is performed.



If all these parameters are zero, that is, both the traveling amount and angle of rotation are zero, the robot base coordinate zero point agrees with the controller coordinate zero point.

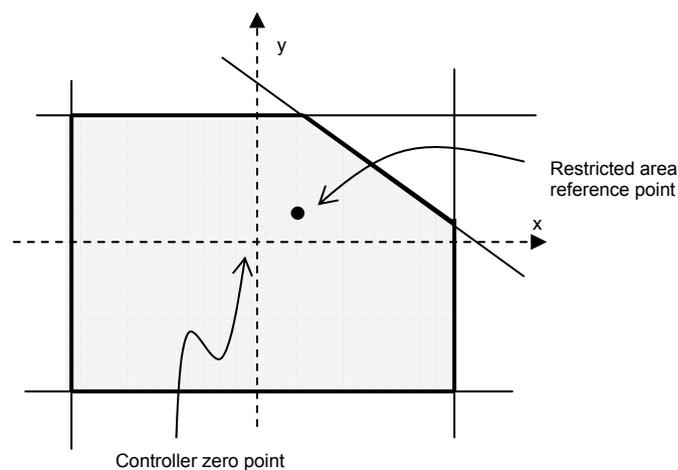
This parameter is received from the robot.

Name	Type	Unit	Range	Reception from robot
X travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000 to 5000000	Y
Y travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000 to 5000000	Y
Z travel from controller coordinate to robot base coordinate	I32	0.01mm	-5000000 to 5000000	Y
Angle O from controller coordinate to robot base coordinate	F32	0.01°	-5000000 to 5000000	Y
Angle A from controller coordinate to robot base coordinate	F32	0.01°	-5000000 to 5000000	Y
Angle T from controller coordinate to robot base coordinate	F32	0.01°	-5000000 to 5000000	Y

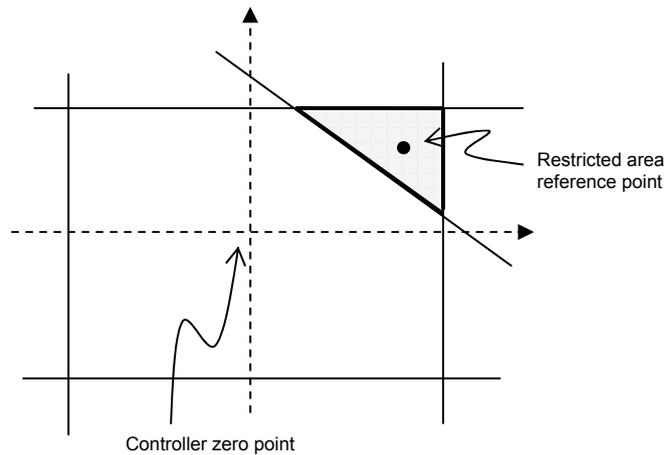
9.8 Restricted Area Reference Point

[Ref. parameter No. : 0043~0044]

This parameter is used to create an area for robot area monitoring, based on given lines. Designate the restricted area reference point in controller coordinate system. The monitoring area is set with lines, and the restricted area reference point is always supposed to be within the area. The outside of the line, when viewed from the restricted area reference point, is outside the area. For example, if the restricted area reference point is in a relationship to the line shown in the following figure, the area is the inside of the pentagon enclosed with bold lines.



If the restricted area reference point is in a relationship to the line shown in the following figure, the area is the inside of the triangle enclosed with bold lines.



Therefore designate a reference point of area creation for this parameter.

This parameter is applicable to the "restricted area" and "SSF" among all monitoring areas of RSC1. This parameter is inapplicable to the partial restricted area.

This parameter is received from the robot.

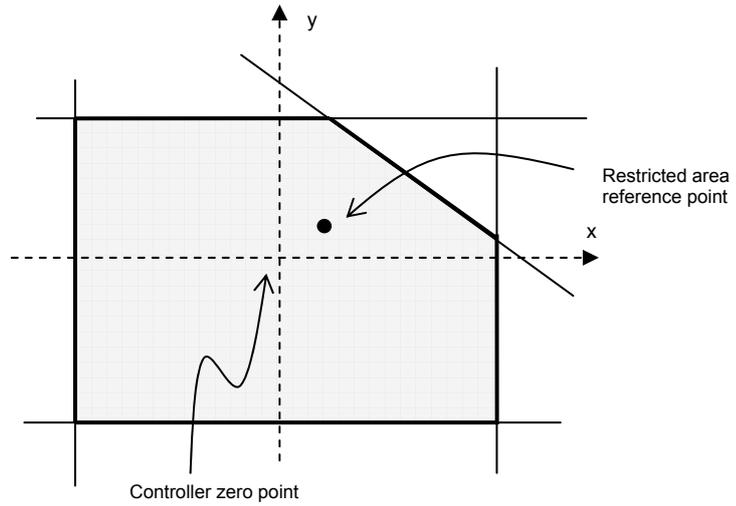
Name	Type	Unit	Range	Reception from robot
x coordinate of restricted area reference point	I32	0.01mm	-5000000 to 5000000	Y
y coordinate of restricted area reference point	I32	0.01mm	-5000000 to 5000000	Y

9.9 Restricted Area

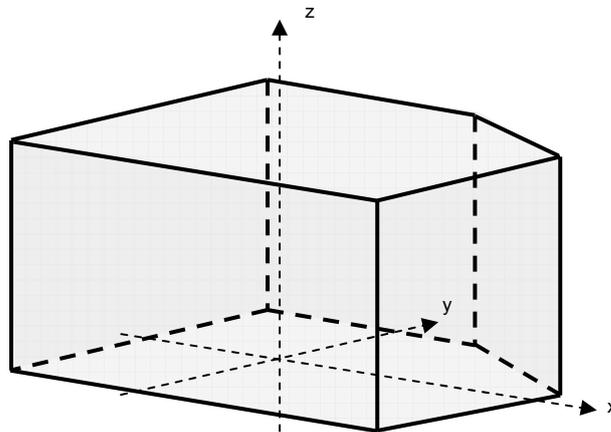
[Ref. parameter No. : 0045~0079]

This parameter is used for the area monitoring function (restricted area) of the RSC1. The RSC1 can have one restricted area. The restricted area is an area enclosed in up to eight lines, and a height limit can be set. If the robot extends beyond the restricted area, the RSC1 issues an emergency stop signal.

The restricted area is defined in the controller coordinate system. The restricted area is created so that the "restricted area reference point" parameter is always contained inside the area. For details, refer to the section describing the "restricted area reference point" parameter.



At this time, the entire area includes height restriction.



Each parameter used to set the restricted area has the following meaning.

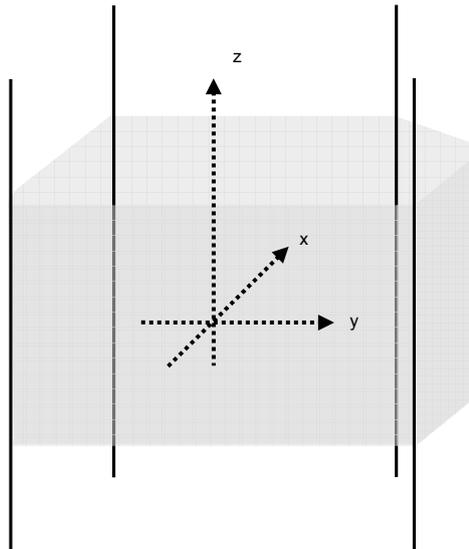
Restricted area valid/invalid

- If this flag is "valid," monitoring of the restricted area is valid
 - In this case, the RSC1 always monitors the restricted area.
- If this flag is "invalid," monitoring of the restricted area is invalid.
 - In this case, parameters such as the area line are ignored.

Name	Setting value	Description	Reception from robot
Restricted area valid/invalid	0	Restricted area invalid	Y
	1	Restricted area valid	

Upper and lower limits of z of restricted area

- The upper and lower limits of Z of restricted area can be set.
 - If the monitoring point set on the robot exceeds the upper or lower limit of the area, the RSC1 issues an emergency stop signal.
- If both the upper and lower limits are set at zero, monitoring in the Z direction is invalid.
 - That is, the robot travel in the Z direction does not cause an emergency stop.
 - In this case, the entire area is shown in the figure blow.



Line

- Designate the lines configuring the area.
 - Designate the coordinates of the starting point (x1, y1) and last point (x2, y2) of the line.

Name	Type	Unit	Range	Reception from robot
Upper limit of z of restricted area	I32	0.01mm	-5000000 to 5000000	Y
Lower limit of z of restricted area	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 1 x1	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 1 y1	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 1 x2	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 1 y2	I32	0.01mm	-5000000 to 5000000	Y
:	:	:	:	:
Restricted line 8 x1	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 8 y1	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 8 x2	I32	0.01mm	-5000000 to 5000000	Y
Restricted line 8 y2	I32	0.01mm	-5000000 to 5000000	Y

9.10 SSF Area

[Ref. parameter No. : 0080~0114]

With the RSC1, the SSF (Software Safety Fence) can be set aside from the restricted area. Set the SSF area together with the restricted area for coordinated work. For the SSF, refer to the section describing "Area Monitoring (SSF)."

The SSF area configuration method and others are the same as those of the "restricted area." As well, the SSF area is created so that the "restricted area reference point" parameter is always located inside the area. (The restricted area reference point parameter is common between the restricted area and SSF.)

The SSF area is characteristic to RSC1. Therefore data is not received from the robot.

The SSF is configured with the following parameters.

Name	Setting value	Description	Reception from robot
SSF area valid/invalid	0	SSF area invalid	
	1	SSF area valid	

Name	Type	Unit	Range	Reception from robot
Upper limit of z of SSF area	I32	0.01mm	-5000000 to 5000000	
Lower limit of z of SSF area	I32	0.01mm	-5000000 to 5000000	
SSF line 1 x1	I32	0.01mm	-5000000 to 5000000	
SSF line 1 y1	I32	0.01mm	-5000000 to 5000000	
SSF line 1 x2	I32	0.01mm	-5000000 to 5000000	
SSF line 1 y2	I32	0.01mm	-5000000 to 5000000	
:	:	:	:	
SSF line 8 x1	I32	0.01mm	-5000000 to 5000000	
SSF line 8 y1	I32	0.01mm	-5000000 to 5000000	
SSF line 8 x2	I32	0.01mm	-5000000 to 5000000	
SSF line 8 y2	I32	0.01mm	-5000000 to 5000000	

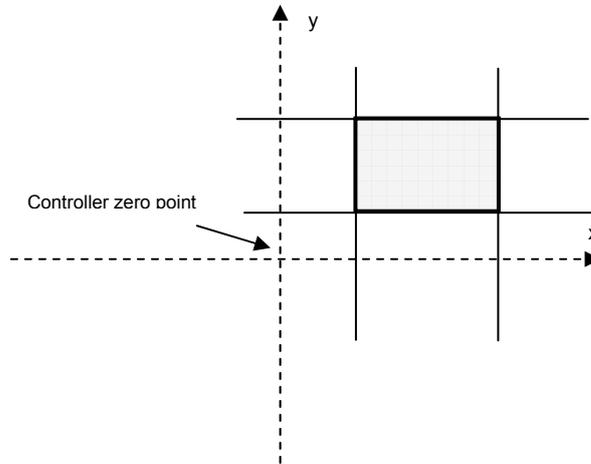
9.11 Partial Restricted Area

[Ref. parameter No. : 0115~0226]

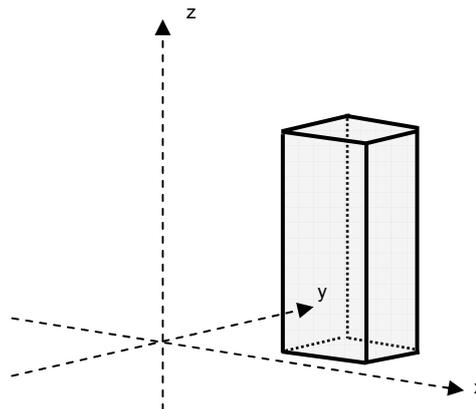
This parameter is used for the setting of the area monitoring function (partial restricted area) of the RSC1. The partial restricted area is a rectangular pillar having a rectangle in the bottom which is enclosed with four lines. The RSC1 can have up to eight partial restricted areas. If the monitoring point set on the robot enters the partial restricted area, the RSC1 issues an emergency stop signal. The partial restricted area parameters are defined in the controller coordinate system. For the partial restricted area, refer to the section describing the "Area Monitoring (Partial Restricted Area)."

The partial restricted area is the inside of the area surrounded by lines, with a Z distance between the lower and upper limits.

For example, suppose that lines are set as shown in the following figure. The partial restricted area is the inside of lines, and therefore it is the inside of bold lines shown in the figure.



In this case, the appearance of the entire area including height limitation is shown below:



Each parameter of the partial restricted area has the following function:

Partial restricted area valid/invalid

- If this value is "valid," this area is valid.
- If this value is "invalid," this area is invalid.
 - The upper and lower limits and line parameters are also invalid.

Name	Setting value	Description	Reception from robot
Partial restricted area 1 valid/invalid	0	Area invalid	Y
	1	Area valid	

* Partial restricted areas 2 to 8 have the same parameters as above.

Upper/Lower limit

- Set the upper and lower limits of the area. If both settings are zero, an infinite Z distance is supposed.

Line

- Designate the starting point (x1, y1) and last point (x2, y2) of the line configuring the area.

Name	Type	Unit	Range	Reception from robot
Upper limit of z of partial restricted area 1	I32	0.01mm	-5000000 to 5000000	Y
Lower limit of z of partial restricted area 1	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 1, x1	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 1, y1	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 1, x2	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 1, y2	I32	0.01mm	-5000000 to 5000000	Y
:	:	:	:	:
Partial restricted area 1, line 8, x1	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 8, y1	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 8, x2	I32	0.01mm	-5000000 to 5000000	Y
Partial restricted area 1, line 8, y2	I32	0.01mm	-5000000 to 5000000	Y

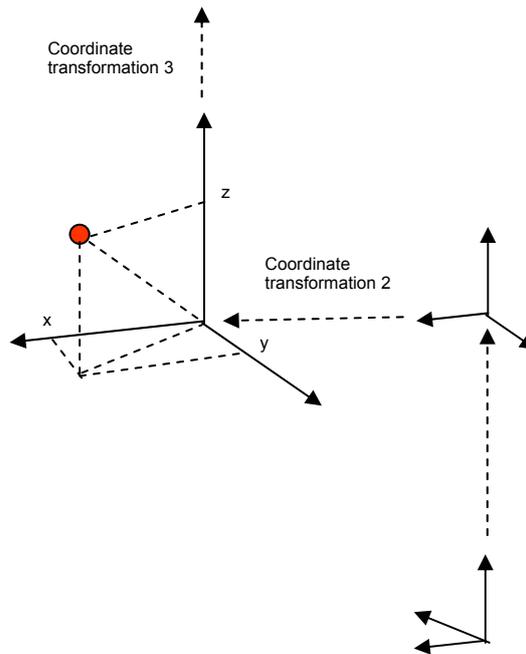
* Partial restricted areas 2 to 8 have the same parameters as above.

9.12 Arm Interference Monitoring Point

[Ref. parameter No. : 0267~0278]

The arm interference monitoring point means the monitoring point that can be set on the robot arm. If this point is set, area monitoring can be made. Suppose that a robot is expressed with seven homogeneous transformation matrices. To set the monitoring point at point (a, b, c) in the coordinate system obtained after multiplication of n matrices and transformation, set coordinate number "n," x coordinate "a," x coordinate "b," and x coordinate "c."

For example, designate coordinate number "2." The link coordinate system after two coordinate transformations is designated. Set coordinates (x, y, z) of the monitoring point viewed from this link coordinate system, as parameters.



If all of the coordinate number, x coordinate, y coordinate and z coordinate are set at "0," "absence of designation of the arm interference monitoring point" is assumed. In this case, monitoring of the interference point is not executed.

The RSC1 can define up to three arm interference monitoring points.

Name	Type	Unit	Range	Reception from robot
Arm interference monitoring point 1. Designate the coordinate number of coordinate transformation.	I32	-	0 to 10	Y
Arm interference monitoring point 1. x coordinate of designated coordinate system	I32	0.01mm	-5000000 to 5000000	Y
Arm interference monitoring point 1. y coordinate of designated coordinate system	I32	0.01mm	-5000000 to 5000000	Y
Arm interference monitoring point 1. z coordinate of designated coordinate system	I32	0.01mm	-5000000 to 5000000	Y

* Likewise, set the same parameter for arm interference monitoring points 2 and 3.

9.13 TOOL Setting

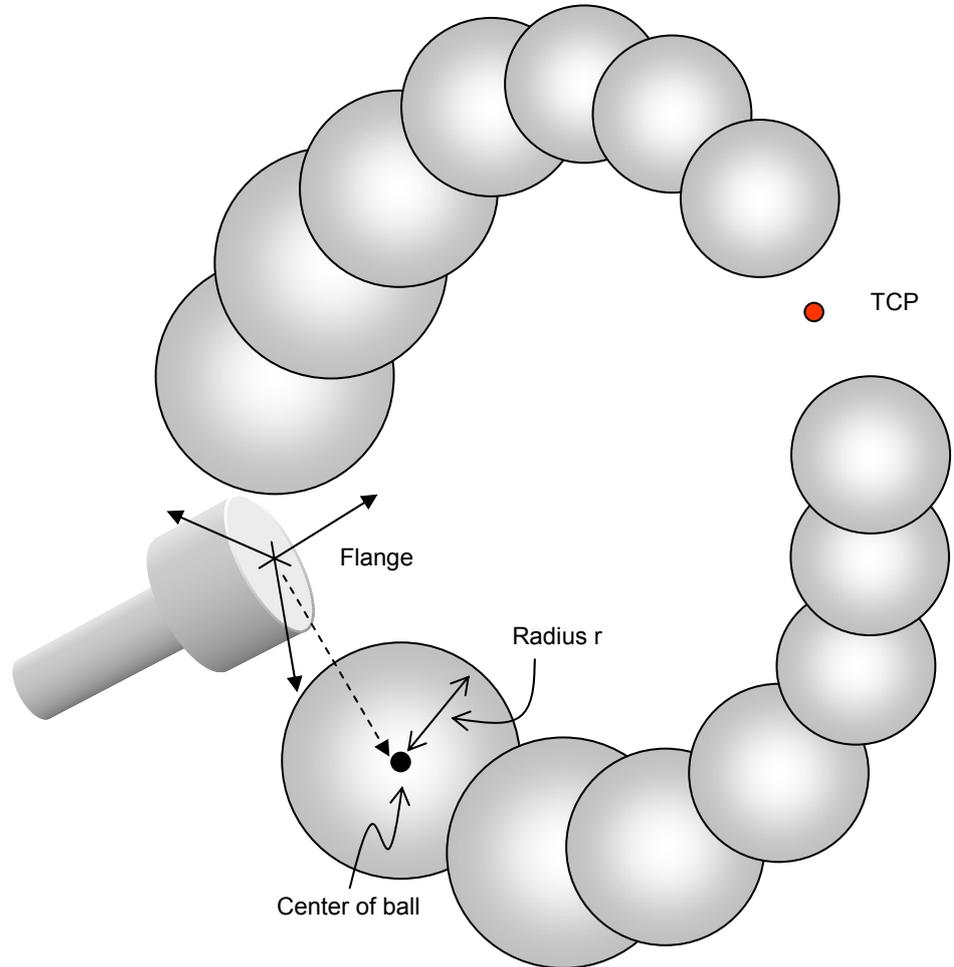
[Ref. parameter No. : 0279~1025]

The RSC1 monitors the speed and position of the tool mounted in the flange point. To define the tool, use the following parameters.

Express each tool with the following pieces of data so that the RSC1 handles the tool.

- TCP (Tool Center Point)
- 20 balls

These are defined in the flange coordinate. Because the RSC1 expresses the tool with only these pieces of data, set balls so that the entire surface of the tool is covered.



The RSC1 can retain settings about up to nine tools. The tool which is used depends on the TOOL monitoring mode. Refer to the section describing the "TOOL monitoring mode" parameter.

Name	Type	Unit	Range	Reception from robot
TOOL 1, TCP, X coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, TCP, Y coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, TCP, Z coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 1, X coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 1, Y coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 1, Z coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 1, radius	I32	0.01mm	-5000000 to 5000000	Y
:	:	:	:	:
TOOL 1, ball 20, X coordinate	I32	0.01mm	-5000000 to 5000000	Y

TOOL 1, ball 20, Y coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 20, Z coordinate	I32	0.01mm	-5000000 to 5000000	Y
TOOL 1, ball 20, radius	I32	0.01mm	-5000000 to 5000000	Y

* Likewise, set TOOLS 2 to 9 the same parameters as above.

9.14 Setting of Each Axis

[Ref. parameter No. : 1026~1057]

These parameters determine the calculation method of the joint value of each axis. The RSC1 can handle the robot having up to eight axes.

Driving type

- No axis
 - Set this value if the corresponding axis is absent.
- Rotary axis
- Linear axis

Name	Setting value	Description	Reception from robot
J1 driving type	0	No axis	Y
	1	Rotary axis	
	2	Linear axis	

* Likewise, set axis parameters J2 to J8.

* The total number of axes, the driving type setting of which is not "0," is the number of axes.

The RSC1 calculates the joint value of each axis in the following way.

$$JJ_i = (s_i - sz_i)R_i + JZ_i \text{ (Command value)}$$

$$JJ_i = (e_i - ez_i)K_i + JZ_i \text{ (Encoder value)}$$

[In case of command value]

Variable name	Description
s_i	Current command value
JZ_i	Joint value at zeroing posture
sz_i	Command value at zeroing posture
R_i	Resolution of command value data

[In case of encoder value]

Variable name	Description
e_i	Current encoder value
JZ_i	Joint value at zeroing posture
ez_i	Encoder value at zeroing posture
K_i	Encoder + per-bit signed change of joint value

(The JZ_i parameter is common between the command value and encoder value.)

Joint value JJ_i calculated here is added with drag correction to become the final joint value.

Name	Type	Unit	Range	Reception from robot
J1 joint value at zeroing posture	I32	0.01° or 0.01mm	-5000000 to 5000000	Y
J1 encoder value + per-bit signed change of joint value	F32	0.01mm/bit or 0.01° /bit	—	Y
J1 command value + per-bit signed change of joint value	F32	0.01mm/bit or 0.01° /bit	—	Y

* Likewise, set axis parameters J2 to J8.

9.15 Drag Correction

[Ref. parameter No. : 1058~1093]

The RSC1 can define up to eight drag corrections of the robot axis. With this correction, the product of the joint value of the reference axis before drag multiplied by the correction coefficient is added to the joint value of the target axis.

- Target axis: Corrected axis
- Reference axis: Movement in this axis forces movement in the target axis.

Post-correction JJ_i is calculated in the following way, based on pre-correction joint value JJ_i in the target axis i . (The pre-correction joint value of the reference axis becomes JJ_j .)

$$J_i = JJ_i + \sum_{j=1}^n (H_{ij} \times JJ_j)$$

H_{ij} is a correction coefficient of axis i forced by axis j . Up to eight H_{ij} parameters (four parameters for correction of the internal joint value) are designated with parameters. H_{ij} that is not designated is handled "0" in view of arithmetic equation.

Name	Type	Range	Reception from robot
Target axis No. of drag correction 1	I32	0 to 8	Y
Reference axis No. of drag correction 1	I32	0 to 8	Y
Correction coefficient of drag correction 1	F32	—	Y

* Likewise, set drag corrections 2 to 8.

In addition to drag correction, four "drag corrections of internal joint value" can be defined. Drag correction of the internal joint value aims at the handling of robots such as the parallel link. Calculation of correction is carried out in the same way as drag correction.

Calculation of drag correction is performed in the following order.

- (1) Drag correction
- (2) Drag correction of internal joint value

The RSC1 uses the joint value obtained after correction (2) for the calculation of coordinates and speed.

However, monitoring of the "axis limit" is made to the joint value "before drag correction of the internal joint value."

Name	Type	Range	Reception from robot
Target axis No. of drag correction 1 of internal joint value	I32	0 to 8	Y
Reference axis No. of drag correction 1 of internal joint value	I32	0 to 8	Y
Correction coefficient of drag correction 1 of internal joint value	F32	–	Y

* Likewise, set drag corrections 2 to 4 of the internal value.

Example: If the parallel link mechanism is handled

If JT2 is a parallel link and movement of JT2 always causes JT3 movement parallel to the ground, use the "internal joint value drag correction" parameter and add the following correction.

Target axis	3
Reference axis	2
Correction coefficient	1.0

9.16 Homogenous Transformation Matrix Parameter

[Ref. parameter No. : 1094~1163]

The RSC1 uses 10 homogenous transformation matrices to perform coordinate transformation to the monitoring point set for the robot. Enter parameters of these homogenous transformation matrices. In addition, designate the relationship between the axis and matrix. Further, you can define a dummy transformation matrix.

Type of matrix

The following matrix type settings are available.

- 0: end of transformation matrix
 - If this type is set for a matrix, coordinate transformation of the following matrices is canceled.
 - For those matrixes which are not set, select the "end of transformation matrix" type.
- 1: with axis
 - To indicate the axis having a matrix, set the "with axis" type and set the axis number.
 - Coordinate transformation indicated with this matrix uses the joint value of the axis designated with the "axis number" parameter.
- 2: without axis
 - To set a dummy matrix, set the "without axis" type.

- Coordinate transformation indicated with this matrix is calculated with zero joint value.

Coordinate transformation of the RSC1 is conducted in the following order.

$$\mathbf{A}_i = \mathbf{Rot}(Z, \theta_i) \mathbf{Trans}(Z, d_i) \mathbf{Trans}(Y, k_i) \mathbf{Trans}(X, a_i) \mathbf{Rot}(X, \alpha_i)$$

Each matrix has the following meaning.

Item	Description
$\mathbf{Rot}(Z, \theta_i)$	θ_i rotation around Z-axis
$\mathbf{Trans}(Z, d_i)$	d_i parallel travel in Z direction
$\mathbf{Trans}(Y, k_i)$	k_i parallel travel in Y direction
$\mathbf{Trans}(X, a_i)$	a_i parallel travel in X direction
$\mathbf{Rot}(X, \alpha_i)$	α_i rotation around X-axis

$\theta_i, d_i, k_i, a_i, \alpha_i$ of this transformation matrix is decided as follows by the type of the axis which is specified by " the axis number of the transformation matrix". Here, J_i is the joint value of the axis which was specified by " the axis number of transformation matrix i".

linear axis	rotary axis	no axis
$\theta_i = \theta_{0i}$	$\theta_i = \theta_{0i} + J_i$	$\theta_i = \theta_{0i}$
$d_i = d_{0i} + J_i$	$d_i = d_{0i}$	$d_i = d_{0i}$
$k_i = k_{0i}$	$k_i = k_{0i}$	$k_i = k_{0i}$
$a_i = a_{0i}$	$a_i = a_{0i}$	$a_i = a_{0i}$
$\alpha_i = \alpha_{0i}$	$\alpha_i = \alpha_{0i}$	$\alpha_i = \alpha_{0i}$

That is, when the joint value changes, in case of the linear axis, it moves in coordinate system Z's axial direction.

In case of the rotary axis, it becomes a turn around the Z axis of the coordinate system.

These matrices are used to calculate the n-th coordinate system (viewed from the robot base coordinate) in the following equation.

$$\mathbf{T}_n = \mathbf{A}_1 \mathbf{A}_2 \cdots \mathbf{A}_n$$

Name	Setting value	Description	Reception from robot
Type of first transformation matrix	0	End of transformation matrix	Y
	1	With axis	
	2	Without axis	
:	:	:	:
Type of 10th transformation matrix	0	End of transformation matrix	Y
	1	With axis	
	2	Without axis	

Name	Type	Unit	Range	Reception from robot
Axis No. of first transformation matrix	I32	-	0 to 8	Y
θ_0 of first transformation matrix	F32	0.01°	-5000000 to 5000000	Y
d0 of first transformation matrix	F32	0.01mm	-5000000 to 5000000	Y
k0 of first transformation matrix	F32	0.01mm	-5000000 to 5000000	Y
a0 of first transformation matrix	F32	0.01mm	-5000000 to 5000000	Y
α_0 of first transformation matrix	F32	0.01°	-5000000 to 5000000	Y

Likewise, set the second through 10th transformation matrices.

Reference: matrix parameter setting example

(1) Coordinate transformation made to rotary axis J3

Parameter	Value
Matrix type	1
Axis No.	3
θ_0	Arbitrary
d_0	Arbitrary
k_0	Arbitrary
a_0	Arbitrary
α_0	Arbitrary

Note: In matrix parameters, designate the data about coordinate transformation to the next axis.

(2) Dummy matrix for merely rotating 90° around the Z-axis

Parameter	Value
Matrix type	2
Axis No.	0
θ_0	9000
d_0	0
k_0	0
a_0	0
α_0	0

Note: The angle increment is supposed to be 0.01°.

9.17 Stop monitoring parameters

[Ref. parameter No.: 1164 to 1171]

These parameters are used for the stop monitoring process. The stop monitoring process monitors stoppage of each axis of the robot. With the stop monitoring process, to each axis value larger than the value designated with the corresponding parameter causes an emergency stop if the "Stop_mon" signal input is connected to the "stop monitoring valid" side.

For details of the stop monitoring process, refer to the separate section describing "stop monitoring."

Name	Type	Unit	Range	Reception from robot
Stop judgment value J1	UI32	0.01° or 0.01mm	0 to 1000	Y
:	:	:	:	:
Stop judgment value J8	UI32	0.01° or 0.01mm	0 to 1000	Y

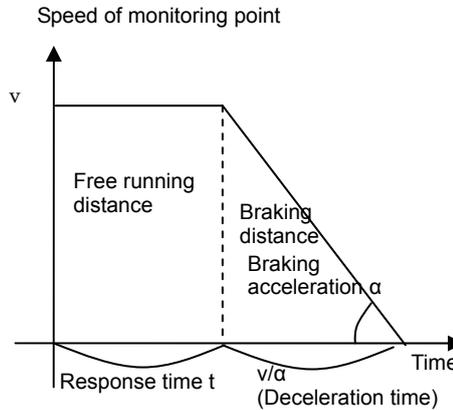
* The stop monitoring process is invalid for axes where the stop judgment value is set at "0."

9.18 Area forecast control parameters

[Ref. parameter No.: 1172 to 1173]

These parameters are used for area forecast control. With area forecast control, the position where the monitoring point is actually stopped after an emergency stop is forecast. With this function, the area judgment process can be made while the monitoring point is limited within the area.

RSC1 assumes the sum of the free running distance and braking distance shown in the figure below, as a forecast position. Area judgment is made in relation to this forecast position.



As a "free running" parameter, enter the sum of the response time (43ms) of RSC and the response time of RC. As a "braking deceleration" parameter, designate the acceleration upon deceleration of the robot.

For details of area forecast control, refer to the separate section describing "area forecast control."

Name	Type	Unit	Range	Reception from robot
Free running time	UI32	ms	0 to 1000	Y
Braking deceleration	UI32	mm/s ²	0 to 100000	Y

* To invalidate area forecast control, enter "0" for both the "free running time" and "braking deceleration."

9.19 Parameter for Robot Change Check

[Ref. parameter No. :1174~1181]

This parameter specifies allowable deviation of encoder value in each axis between previous shutdown and current power-on. This check is performed when the RSC1 is turned on. The upper 32 bits among 33 bits of encoder data is used. Suppose the allowable deviation width be w . If 32 bits of encoder data at power-on is not contained in the range from $x + w$, where x indicates 32 bits of encoder data stored at previous shutdown, to $x - w$, a motor change is assumed and the RSC1 stops after a scan. In this case, turn the power off then on again to reset.

Name	Type	Reception from robot
Allowable J1 encoder deviation width from stored power-on value	UI32	Y
:	:	:
Allowable J8 encoder deviation width from stored power-on value	UI32	Y

9.20 TOOL Monitoring Parameter

[Ref. parameter No.:1182~1183]

The RSC1 has a function (TOOL monitoring function) for checking agreement between the tool installed on the robot and the TOOL number received by RSC1.

TOOL monitoring verifies the TOOL number included in the command value message with the TOOL number received in signal input of the RSC1. The verification method includes three types from mode 0 to mode 2. Set the mode with the "TOOL monitoring mode" parameter.

For details of the TOOL monitoring process, refer to the section describing "TOOL Monitoring."

TOOL monitoring mode 0 (TOOL 1 fixed mode)

- TOOL number verification is not made.
- The TOOL number used for safety monitoring is TOOL 1.
- The TOOL number in the command value message must be "1." If not, the RSC1 is stopped in an emergency. That is, TOOL switching is not allowed in this mode.

TOOL monitoring mode 1 (TOOL monitoring invalid mode)

- TOOL number verification is not made.
- The TOOL number used for safety monitoring is the TOOL number of the command value in case of TCP or the TOOL 1 data in case of the TOOL ball.
 - The TOOL number can be switched according to the TOOL number in the command value message. In the procedure, only TCP is switched while the setting of the TOOL ball remains the same.
- However, there are limitations in the TOOL setting parameters. The TOOL parameter must satisfy the following conditions.
 - It is not possible to set the ball for TOOL 2 to 9.
 - TCP can be set for TOOL 2 to 9. If TCP is set, the TCP must be included in any ball of TOOL 1.

TOOL monitoring mode 2 (TOOL monitoring valid mode)

- TOOL number verification is made.
- Parameters of the "ball excluded from tool monitoring" are valid only in this mode. If there is the flange point of the robot in the ball, tool number monitoring is not made. Therefore tool change can be made if the flange point is in this ball.

Name	Setting value	Description	Reception from robot
Tool monitoring mode	0	Tool 1 fixed mode	
	1	Tool monitoring invalid mode	
	2	Tool monitoring valid mode	

Name	Type	Unit	Range	Reception from robot
Radius of ball excluded from tool monitoring	UI32	0.01mm	0 to 100000	

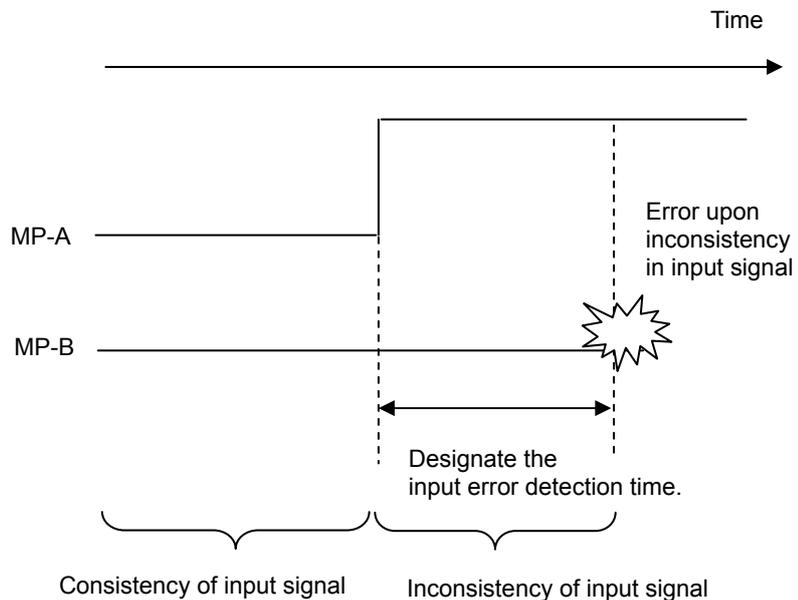
9.21 Self Diagnosis (I/O Check) Parameter

[Ref. parameter No.:1184~1186]

The Cat-3 input signal of the RSC1 includes the following.

- 250mm_mon input
- SSF_mon input
- Stop_mon input

Because of safety signal, these inputs are duplicated for MP-A and MP-B. If inconsistency is found in these input signals between MP-A and -B for a certain time, the RSC1 is stopped after a scan. Set the time with a parameter.



A scan stop of the RSC1 causes the robot to be stopped in an emergency. To recover, turn the power off then on again.

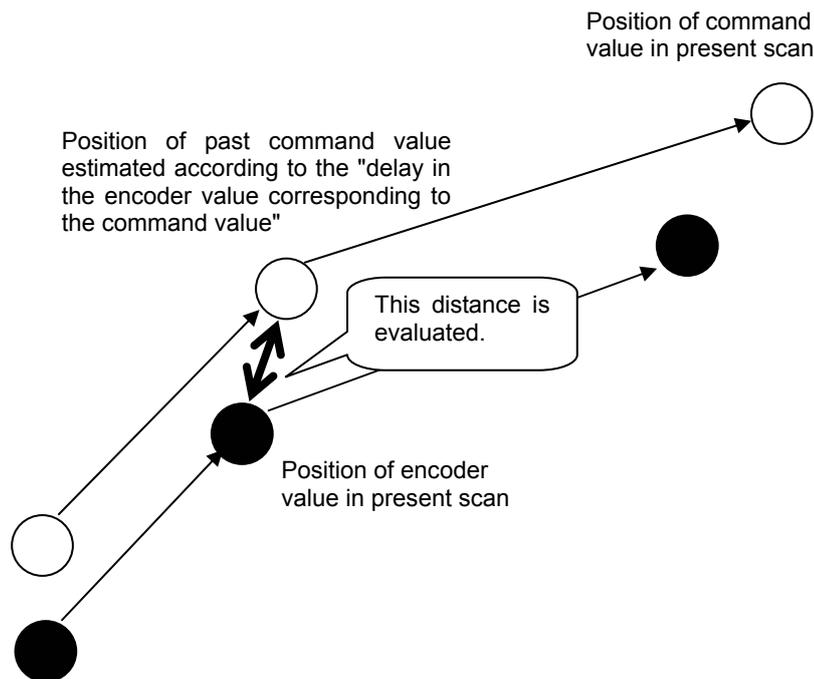
Name	Type	Unit	Range	Initial value	Reception from robot
Input error detection time (250mm/s monitor)	I32	0.1s	1 to 99	10	
Input error detection time (SSF monitor)	I32	0.1s	1 to 99	10	
Input error detection time (Stop monitor)	I32	0.1s	1 to 99	10	

9.22 Flange-to-Flange Distance Verification Function Parameter

[Ref. parameter No.:1187~1188]

These parameters are used in the flange-to-flange distance verification function. The flange-to-flange distance verification function compares the distance between the flange point calculated according to the command value and the flange point calculated according to the encoder value and, if the distance exceeds an allowable limit, the RSC1 issues an emergency stop output signal. Set the allowable limit as an "allowable flange-to-flange verification distance." Set the worst limit.

The encoder value is subject to a time delay in general when compared with the command value. Therefore what is compared with the "flange point calculated according to the encoder value" is the "flange point calculated according to the past command value estimated according to the delay in the encoder value." The RSC1 requires the delay of the encoder value corresponding to the command value of the robot.



Name	Type	Unit	Range	Initial value	Reception from robot
Delay of encoder value corresponding to command value	I32	ms	0 to 450	1	Y
Allowable flange-to-flange verification distance	I32	0.01mm	0 to 500000	1	Y

9.23 Network Parameter

[Ref. parameter No.:1189~1191]

The RSC1 is connected with the robot controller via Ethernet. For this reason, set the following parameters.

Name	Initial value	Reception from robot
IP address of RSC1	192.168.0.11	
Sub-net mask	255.255.255.0	
IP address of RC	192.168.0.1	

10 LED display

RSC1 is equipped with the following LEDs functioning as indicators.
These indicators notify the user of various pieces of information.

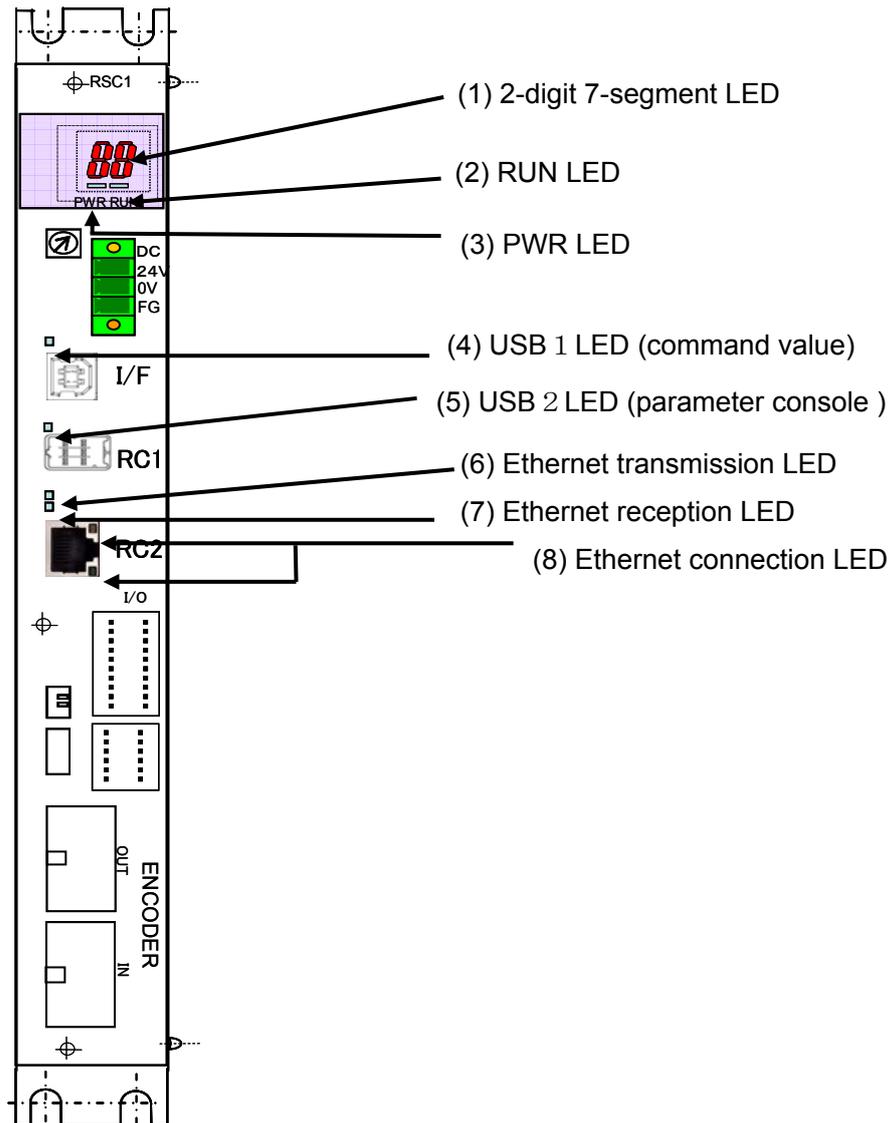


Figure 10-1 LED display

10.1 7-Segment LED Display

■ Information shown in a 7-segment LED display

1. Initialization in progress/state Lit LED
2. Robot monitoring in progress(normal operation) ----Dynamic LED display
3. Errors and warnings Blinking LED

■ The initialization state, errors and warnings are displayed in hexadecimals.

Correspondence table

0		A	
1		B	
2		C	
3		D	
4		E	
5		F	
6			
7			
8			
9			

10.1.1 Display of Initialization and normal State

The 7-segment LED lights up during initialization in progress/state(normal state) to notify the user of the current process and state.

Initialization

Initialization means the process by which necessary settings and information is executed for the RSC1 to monitor the robot.

The following table shows a part of 7-segment displays and its contents.

For the complete initialization process list, refer to the status indication code list.

10	The CPU and memory of the RSC1 are checked for errors.
13	The RSC1 circuit is checked for errors.
15	The communication link with the command value USB is being established.
19	Waiting for Ethernet communication sent from the robot controller.
1A	Waiting for the initial encoder signal.
1B	Waiting for the first command value.

Normal Status

Status display tells that the RSC1 is in the following RSC1 statuses:

2D	The RSC1 is stopped due to momentary power failure.
2F	Stop caused by PC operation (Stoppage caused by RSC parameter writing or RC parameter loading)

10.1.2 Display indicating Robot Monitoring in progress(Normal Operation)

The 7 segment LED changes dynamically in the state of the robot monitor being in progress (normal operation). This is to notify users of robot monitoring being in progress. With the display of pattern change, users can know which monitoring of those listed below is valid:

Type of robot monitoring of RSC1

- Area monitoring
- Partial restricted area monitoring
- Axis limit monitoring
- Velocity monitoring
- SSF monitoring
- Stop monitoring
- Tool change monitoring

7-segment LED indication method

Area monitoring, partial restricted area monitoring and axis limit monitoring

When monitoring is valid

If either one of the monitorings is valid, the following pattern rounds repetitively in one second at the far left 7-segment LED (tens place). (making shape of 8).



When monitoring is invalid

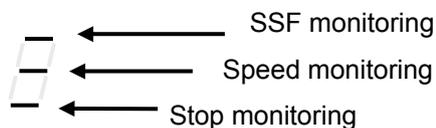
If all of these monitoring is invalid, the following pattern rounds twice in one second at the far left 7-segment LED (tens place).



SSF monitoring, speed monitoring and stop monitoring

If monitoring is valid

If monitoring is valid, the corresponding segment of the 7 segment LED on the right (units digit) lights up.



If monitoring is invalid

If monitoring is invalid, the corresponding segment of the 7 segment LED on the right (units digit) is unlit.

Tool change monitoring

The tool change monitoring is not displayed.

10.1.3 Error Display

The error code blinks at the 7-segment LED to notify users of the error.

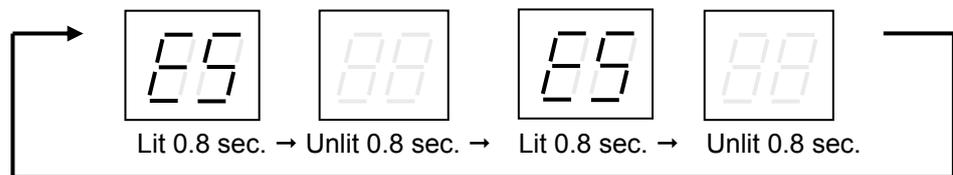
* For detail error code, refer to troubleshooting.

* For error notification, refer to the error notification function.

Interval of blink

If there is only one error

The error code is lit (for 0.8 sec.) and unlit (for 0.8 sec.) alternately

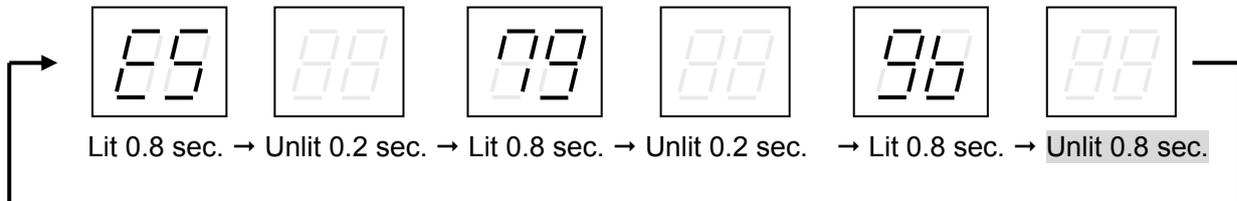


If there are multiple errors

Example: 3 errors

The first error code is lit (for 0.8 sec.) then unlit (for 0.2 sec.), the second code is lit (for 0.8 sec.) then unlit (for 0.2 sec.), and the third code is lit (for 0.8 sec.) then unlit (for 0.8 sec.). This pattern is repeated.

The unlit interval between each round is 0.8 sec. This is to distinguish what errors start and end in a series.



10.2 Display of RUN LED

The RUN LED lights up, blinks or is unlit while indicating the robot state.

- Lit

Indicates that the robot is in the monitoring area specified with RSC parameters.

- Blink

Indicates that the robot is outside the monitoring area specified with RSC parameters.

- Unlit

Indicates that the robot is in a state in which emergency stop cannot be removed due to some error.

10.3 Indication of PWR LED

The PWR LED lights up to indicate the power supply state of the RSC1.

10.4 USB 1 LED (Parameter Console)

The lit LED indicates that the hardware on the other side of connection (PC) has been recognized.

10.5 USB 2 LED (Command Value)

The lit LED indicates that the hardware of the other side of connection (RC) had been recognized at the time of initialization.

* If the command value USB connector is unplugged or disconnected after the completion of initialization, an error is detected and the corresponding error output is issued. Lighting state of the USB 2 LED cannot be guaranteed.

10.6 Ethernet LED

The Ethernet LEDs have transmission LED, reception LED and connection LED:

- Transmission LED

Lit during information transmission.

- Reception LED

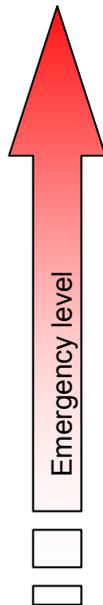
Lit during information reception.

- Connection LED

The lit LED indicates that the linkage with the other side of the connection is established.

10.7 Error notification function

Error level



- Monitoring stop level

Error, such as disconnection of the command value USB connector, or similar error, that hinders correct safety monitoring of the robot. It is impossible to perform error resetting for resetting the emergency stop. Only way to recover the error is to turn the power off then on again.

- Robot emergency stop level

The error occurs mainly as a result of the system monitoring function; one of the typical errors belonging to this level is excess of the safe velocity of the robot. To reset the emergency stop, perform error resetting at the RC or supply an unsafe reset input.

- Warning level

Errors of this level are nothing to do with the system monitoring, such an error as the PC communication error. Because of non-relation to the system monitoring, no actions other than addition to the error history are executed when an error of this level occurs. The emergency stop is not activated.

The error code indicated at the 7-segment LED is either at the robot emergency stop level or at the monitoring stop level. The error at the warning level is not indicated at the LED.

Error history

The RSC1 is equipped with a buffer where error information is stored in the event of an error, and up to 32 pieces of error information are retained. If the information exceeds 32 pieces, earlier error information is overwritten. However, if the earliest error - which is emergency level or monitoring stop level - is now present, new errors are not added to the error history. (If the earliest error is present and it is at the warning level, the error is overwritten.)

Each piece of error information registers the error code, MP identification value, date and time of occurrence, presence flag, and auxiliary parameters 0 to 4.

The error history can be monitored from a PC (parameter console) through USB communication. It can be monitored, too, from the RC.

10.8 Initialization and normal State code list

Code	RSC1 status
03	Interprocessor communication 1 is under initialization.
04	Interprocessor communication 2 is under initialization.
05	Backup data is reading.
06	Parameter processing is under initialization.
07	IO output is under initialization
08	Error log processing is under initialization.
09	Condition monitoring processing is under initialization.
0A	USB for personal computer communications is under initialization.
0B	Interprocessor communication 2 preparation is processing.
0F	The password of RSC is being processed.
10	Self-diagnostics for RSC1 CPU and memory etc is under processing. When there is no past self-diagnostics processing history in backup, the processing time may takes about 18 seconds.
11	Reading parameters
12	Reading rotary switches
13	IO check is under processing.
14	Ethernet communication is under preparation.
15	Command value USB communication is under preparation. When command value USB is not connected, waits for a connection for maximum 120 seconds.
16	Reading IO input
17	Current time set is under initialization.
18	Encoder signal receiving is under preparation.
19	Waiting communication with the robot controller via Ethernet or already communication. When communication with RC cannot be done, waiting for communication for maximum 120 seconds.
1A	Waiting encoder signal receiving or already receiving. Wait the first encoder signal for maximum 10 seconds.
1B	Waiting the command value or already receiving. Wait the first command value for maximum 3 seconds.
1C	TOOL number processing is under initialization.
1D	The robot or RC replacement check is under processing.
1E	The coordination calculation for a robot monitoring etc. are preparing.
1F	Whether a robot monitoring is available or not are judging
2D	It shows that there was the instant power stoppage due to momentary power failure. In order to monitor a robot, please power off a robot once.
2E	In spite of the scanning stop by an error generation, the error log for displaying does not exist. It is, also caused by erasing of the error history. In order to monitor a robot, please power off a robot once.
2F	Operation monitoring is stopped by RSC parameter writing from PC software, or RC parameter read-out operation. In order to monitor a robot, please power off a robot once.

10.9 Error code list

Code	Error	Error contents	Countermeasures
33	Interprocessor communication initialization failure 1	The error occurred in the preparation processing of interprocessor communication.	- please exchange a RSC1 -please call the service.
34	Interprocessor communication initialization failure 2	The error occurred in the preparation processing of interprocessor communication.	- please exchange a RSC1 - please call the service.
35	No backup data	There is no backed-up data. It certainly occurs at the first power On.	-It can be reset by a power supply Off-On -If the error could not be reset by Power Off-On, please exchange a RSC1 -Please call the service.
36	Parameter processing initialization failure	The error occurred in the parameter preparation processing.	- please exchange a RSC1 -please call the service.
37	IO output initialization processing failure	The error occurred in the IO output preparation processing.	- please exchange a RSC1 -please call the service.
38	Error log processing initialization failure	The error occurred in the error log preparation processing.	- please exchange a RSC1 -please call the service.
39	Condition monitoring processing initialization failure	The error occurred in the status-monitoring preparation processing.	- please exchange a RSC1 -please call the service.
3A	Initialization failure of USB for personal computer communications	The error occurred in the communication preparation processing with a parameter setting device.	- please exchange a RSC1 -please call the service.
3B	Interprocessor communication preparation processing failure 2	The error occurred in the preparation processing of interprocessor communication.	- please exchange a RSC1 -please call the service.
3C	Interprocessor communication failure during initialization.	The error occurred in interprocessor communication initialization.	- please exchange a RSC1 -please call the service.
43	Interprocessor communication initialization failure 1	The error occurred in the preparation processing of interprocessor communication.	- please exchange a RSC1 -please call the service.
44	Interprocessor communication initialization failure 2	The error occurred in the preparation processing of interprocessor communication.	-please exchange a RSC1 -please call the service.

Code	Error	Error contents	Countermeasures
45	No backup data	There is no backed-up data.	-It can be reset by a power supply Off-On -If the error could not be reset by Power Off-On, please exchange a RSC1 -Please call the service.
46	Parameter processing initialization failure	The error occurred in the parameter preparation processing.	-please exchange a RSC1 -please call the service.
47	IO output initialization processing failure	The error occurred in IO output preparation processing.	-please exchange a RSC1 -please call the service.
48	Error log processing initialization failure	The error occurred in the preparation processing of error log processing.	-please exchange a RSC1 -please call the service.
49	Condition monitoring processing initialization failure	The error occurred in the status-monitoring preparation processing.	-please exchange a RSC1 -please call the service.
4A	Initialization failure of USB IF for personal computer communications	The error occurred in the preparation processing of communication with a parameter setting device.	-please exchange a RSC1 -please call the service.
4B	Interprocessor communication 2 preparation processing failure	The error occurred in the preparation processing of interprocessor communication.	-please exchange a RSC1 -please call the service.
50	Watchdog timer overflow	The watchdog timer, which checks a system overrun, detected the system overrun	-please exchange a RSC1 -please call the service.
51	Overvoltage error (3.3V)	Overvoltage occurred at 3.3V power supply.	-please exchange a RSC1 -please call the service.
52	Overvoltage error (5V)	Overvoltage occurred at 5V power supply.	-please exchange a RSC1 -please call the service.
53	Internal processing time time-out	It exceeds the time, which is defined for internal processing.	-please exchange a RSC1 -please call the service.
55	Robot number transmission, interprocessor communication error	Interprocessor communication failed at robot number transmission processing.	-please exchange a RSC1 -please call the service.
56	RSC1 operation status, interprocessor communication error	Interprocessor communication failed in status-monitoring processing.	-please exchange a RSC1 -please call the service.
57	I/O output, interprocessor communication error	Interprocessor communication failed in IO output processing.	-please exchange a RSC1 -please call the service.
58	I/O check, interprocessor communication error	Interprocessor communication failed in IO check processing.	-please exchange a RSC1 -please call the service.

Code	Error	Error contents	Countermeasures
59	Schedule management, timer synchronization error	Interprocessor communication failed in schedule management processing.	-please exchange a RSC1 -please call the service.
5A	Main module, interprocessor communication error	Interprocessor communication failed in initialization	-please exchange a RSC1 -please call the service.
5B	Operation part, interprocessor communication error	Interprocessor communication failed in data processing.	-please exchange a RSC1 -please call the service.
5C	Tool number input, interprocessor communication error	Interprocessor communication failed in tool number input process.	-please exchange a RSC1 -please call the service.
5D	I/O Port filtering, interprocessor communication error	Interprocessor communication failed in IO input process.	-please exchange a RSC1 -please call the service.
5E	Robot diagnosis, interprocessor communication error	Interprocessor communication failed in the robot diagnostic process.	-please exchange a RSC1 -please call the service.
60	Ethernet chip writing error	Writing to the Ethernet chip has been failed.	-please exchange a RSC1 -please call the service.
61	Ethernet chip System. Open failure	Errors have occurred in an Ethernet chip.	-please exchange a RSC1 -please call the service.
62	The MAC address is not specified.	The MAC address is not specified in RSC.	-please replace RSC 1. -please contact the service division.
65	Error log addition error	An error addition to error log buffer failed.	-please exchange a RSC1 -please call the service.
66	Error log acquisition error	Acquisition of the error log failed.	-please exchange a RSC1 -please call the service.
67	Error log overwrite error	Error log overwriting failed.	-please exchange a RSC1 -please call the service.
6A	Current time initialization error	Current time set initialization processing failed.	-please exchange a RSC1 -please call the service.
6B	Current time acquisition error	Current time acquisition failed.	-please exchange a RSC1 -please call the service.
6C	Current time set point error	The current time setting failed.	-please exchange a RSC1 -please call the service.
70	CPU error	Errors have occurred in CPU.	-please exchange a RSC1 -please call the service.

Code	Error	Error contents	Countermeasures
71	memory error	Errors have occurred in memory.	-please exchange a RSC1 -please call the service.
72	CPU status exchange failure	The internal status of CPU is error.	-please exchange a RSC1 -please call the service.
73	Firmware CRC error	The written firmware data are error.	-please exchange a RSC1 -please call the service.
74	RSC parameter CRC error	The written RSC1 parameter data is error. Parameter writing may not have been performed properly.	- Please rewrite a RSC1 parameter arbitrarily using a parameter setting device. - Please restart by rewriting. - When the error caused again, please exchange a RSC1
76	CRC error in "self diagnosis" password/MAC address	The written MAC address data is faulty (on MP-B side). The written password data is faulty (on MP-A side).	-please exchange a RSC1 -please call the service.
77	Initialization failure in "power down backup"	Access to FROM failed.	-please exchange a RSC1 -please call the service.
7A	Power-source monitoring process error	24V powerfail was detected during I/O check processing of RSC1.	- Please confirm whether the I/O input connector is connected properly. - When the connector connected properly, please exchange a RSC1. -Please call the service.
7B	Pulse check error	Input circuit error was detected during I/O check processing of RSC1.	- Please confirm whether the I/O input connector is connected properly. - When the connector connected properly , please exchange a RSC1. -Please call the service.
7C	Readback error	The emergency stop circuit error was detected during RSC1 I/O check processing.	-please exchange a RSC1 -please call the service.
7D	Relay contact check error	The emergency stop relay error was detected during I/O check processing of RSC1.	-please exchange a RSC1 -please call the service.
7E	Crosscheck error	The short circuit of safety input circuit was detected during I/O check processing of RSC1.	- Please confirm the I/O wiring. - Please call the service.

Code	Error	Error contents	Countermeasures
7F	Input mismatching check error	The redundant safety input circuit data mis-matching was detected during I/O check processing of RSC1.	<ul style="list-style-type: none"> - Please confirm the 250 mm/s Monitor input of a safety input, a Stop_mon input, and a SSF Monitor input. - If the above-mentioned items are confirmed OK, please restart.
80	First-time encoder data receiving time-out	The encoder data transmitted from RC have not receipt.	<ul style="list-style-type: none"> - Please confirm whether the encoder cable is connected properly. - Please confirm whether there are any errors in RC. - If the above-mentioned items are confirmed OK, please restart. - If the error caused again, please exchange a RSC1.
81	FPGA operation error	There is Errors are in FPGA operation.	<ul style="list-style-type: none"> -please exchange a RSC1 -please call the service.
87	Command value axes number error	The number of command value axes data transmitted from RC and the number of RSC1 settings axes parameter are not matching.	<ul style="list-style-type: none"> - Please review RSC1 parameter: the driving shaft type JO (0: no axis, 1: rotation, 2: liner). - Please review, and write it and restart.
88	Parameter error(axes number / tool number)	The number of command value data axes and TOOL number transmitted from RC are inappropriate.	<ul style="list-style-type: none"> - Please confirm whether there is any problem of USB communication interface signals. - Confirm the above-mentioned items and OK, please restart. -If the error caused again, please exchange a RSC1
89	"Command value input section" CRC error	CRC error has occurred in the command value telegram transmitted from RC.	<ul style="list-style-type: none"> - Please confirm whether there is any problem in a USB communication interface signals. - If OK, please restart. -If the error caused again, please exchange a RSC1
8A	Robot number transmitting failure	USB transmission of command value failed in transmitting a robot number to RC at RSC1 starting.	<ul style="list-style-type: none"> -please exchange a RSC1 -please call the service.
8B	First command value receive time out	The command value data transmitted from RC has not been receipt once.	<ul style="list-style-type: none"> - Please confirm that USB has not slipped out. - Please confirm that there are no errors in RC. - If the above-mentioned items are confirmed OK , please restart.-If the error caused again, - please exchange a RSC1

Code	Error	Error contents	Countermeasures
8C	USB communication impossible.	Command value USB communication is not available.	<ul style="list-style-type: none"> - Please confirm that USB has not slipped out and that USB is not disconnected. - If the above-mentioned items are confirmed OK, please restart. -If the error caused again, please exchange a RSC1
8D	Command value byte-number corruption	The number of data bytes of the command value data transmitted from RC is incorrect.	<ul style="list-style-type: none"> - Please confirm whether there is any problem with USB communication interface signal quality. - If the above-mentioned items are confirmed OK, please restart. -If the error caused again, please exchange a RSC1
8E	USB Device recognition time-out	Command value USB device recognition cannot be performed.	<ul style="list-style-type: none"> - Please confirm that USB has not slipped out. - Please confirm that there are no errors in RC. - If the above-mentioned items are confirmed OK, please restart. -If the error caused again, please exchange a RSC1
8F	Command value receive time out	Errors were detected by RC command value transmission.	<ul style="list-style-type: none"> - Please confirm that there are no errors in RC. - If there are no errors in RC, please restart. - If the error caused again, please exchange a RSC1
91	There is no password data.	The password is not written to RSC. This error is always caused when the power is turned on for the first time.	<ul style="list-style-type: none"> - Please turn the power off then on again. - If the error persists even after the power is turned off then on, please replace RSC 1. - Please contact the service division.
92	RSC parameter read failure	Reading of a RSC parameter was not completed.	<ul style="list-style-type: none"> - Using a parameter setting device, please rewrite RSC parameters and restart. -If the error caused again, please exchange a RSC1
93	Robot number error	The robot number at starting is different from the number of the last time starting.	<ul style="list-style-type: none"> - It can be reset by power supply Off-On <p><Need Marking-Check></p>
94	Encoder data movement error	There is some difference of encoder data at starting and data of last time power stoppage	<ul style="list-style-type: none"> - It can be reset by power supply Off-On <p><Need Marking-Check></p>

Code	Error	Error contents	Countermeasures
95	Parameter and RC zeroing data mismatch..	The zeroing data set by RSC parameter is different from RC transmitted zeroing data.	<ul style="list-style-type: none"> - Please set the RSC parameter of "the encoder values at zeroing posture of JO" same as the zeroing data of RC. -This data is acquirable from RC. <p><Need Marking-Check></p>
96	TCP Communication Retry count over	Ethernet communication with RC was not performed.	<ul style="list-style-type: none"> - Please confirm that the Ethernet cable is connected properly. (Please confirm that Ethernet connection LED of RSC1 lights up) - Please confirm that there are no errors in RC. - If the above-mentioned items are confirmed OK , Please restart. -If the error caused again, please exchange a RSC1
97	Rotary switch number error	A rotary switch setting (robot number) is not in useful range (1-6).	<ul style="list-style-type: none"> - Please set a rotary switch within available range (1-6), and restart. -If the error caused again, please exchange a RSC1 <p><Need Marking-Check></p>
9A	Parameter setting range over error	The setting value by RSC parameter exceeds setting range.	<ul style="list-style-type: none"> - Using a parameter setting device, refer to the parameter number which comes from the error detailed information. Please confirm that the value is within setting tolerance. -If exceeds it, please modify the parameter exceeding the setting tolerance, and rewrite and restart.
9B	Monitoring area parameter setting error	The monitoring area parameter set by RSC parameter is not correct.	<ul style="list-style-type: none"> - Using a parameter setting device, refer to the parameter number which comes from the error detailed information. Please confirm that the value is conforming to the conditions. -If violates the conditions, please modify the parameter, and rewrite and restart.

Code	Error	Error contents	Countermeasures
9C	Parameter error at TOOL monitoring invalid.	When TOOL monitoring invalid has been set by RSC parameter, TOOL setting by a parameter is not correct.	<ul style="list-style-type: none"> - Please confirm that TOOL globe is not set for TOOL 2-9. - Please confirm that all TCP of TOOL 1-9 are contained in the globe of TOOL 1. - Please modify TOOL settings of RSC parameter, and rewrite and restart.
9D	Operation part internal error	An error occurred at internal-operation.	<ul style="list-style-type: none"> -please exchange a RSC1 -please call the service.
E0	Safety speed over (TCP)	When TOOL monitoring invalid has been set by RSC parameter, TOOL setting by a parameter is not correct. The error occurred at internal-operation. TCP speed exceeded the RC parameter setting "safety speed" in speed monitoring.	<ul style="list-style-type: none"> - It can reset by the reset from RC, or reset by a signal input.
E1	Safety speed over (flange point)	The flange point speed exceeds the RSC parameter set "safety speed".	<ul style="list-style-type: none"> - It can reset by the reset from RC, or reset by a signal input.
E2	Axis upper limit over	There is an axis whoes joint value exceeds the setting upper limit joint value .	<ul style="list-style-type: none"> - After returning a relative axis within limits, it can reset of RC or a signal input.
E3	Axis lower limit over	There is an axis whoes joint value is less than the lower setting joint value.	<ul style="list-style-type: none"> - After returning a relative axis within limits, it can reset of RC or a signal input.
E4	Outside of a SSL area limit (partial restricted area)	The monitoring point entered in the partial restricted area during the RSC1 area monitoring	<ul style="list-style-type: none"> - After leaving the robot from a partial restricted area, it can be reset by reset of RC or a signal input.
E5	Outside of a SSL area limit (restriction area)	There is a monitoring point which exceeds the restriction area during the RSC1 area monitoring.	<ul style="list-style-type: none"> - After returning a robot to restriction area, it can be reset by reset of RC or a signal input.
E6	Outside of a SSF area limit	There is a monitoring point which exceeds the SSF area during the RSC1 area monitoring.	<ul style="list-style-type: none"> - After returning a robot to SSF area, it can be reset by reset of RC or a signal input.
E7	"Calculation unit" stop monitoring error	The robot has moved beyond the limit specified with the "stop judgment value" RSC parameter in the stop monitoring mode.	<ul style="list-style-type: none"> - Please connect the Stop_mon safety input to the stop monitoring invalid side and reset RC or supply a reset signal.

Code	Error	Error contents	Countermeasures
E8	TOOL verification error	The TOOL number in the command value data from RC and the TOOL number of a non-safety input are not matching.	<ul style="list-style-type: none"> - When TOOL monitoring mode is 0, please confirm that the TOOL number of a command value is 1. If the TOOL number of a command value is 1, it can reset by reset of RC or a signal input.. - When the TOOL monitoring mode of RSC1 is 2, please confirm whether the TOOL number of a command value and the TOOL number of a signal input are matching. If the both are matching condition, it can be reset by reset of RC or a signal input.
E9	Distance error between flanges	The flange point calculated from a command value and each encoder value exceeded the tolerance of "maximum flange verification distance " set by the RSC parameter	<ul style="list-style-type: none"> - Please confirm the setting value of "flange verification distance maximum tolerance" of RSC parameter. - Please confirm the setting value of "the delay of the encoder value for a command value" in RSC parameter. - It can be reset by reset of RC or a signal input. - When parameter rewriting is implemented, please restart. <p><Need Marking-Check></p>
FA	Encoder receiving timeout error	An Error has been detected during encoder receiving processing.	<ul style="list-style-type: none"> - Please confirm whether there is any problem in encoder communication interface signals quality. - It can be reset by reset of RC or a signal input. <p><Need Marking-Check></p>
FB	Encoder receiving timeout error 2	An Error has been detected during encoder receiving processing.	<ul style="list-style-type: none"> - Please confirm whether there is any problem in encoder communication interface signals quality. - It can be reset by reset of RC or a signal input. <p><Need Marking-Check></p>
FC	Encoder status error	An encoder malfunction has occurred.	<ul style="list-style-type: none"> - It can be reset by reset of RC or a signal input. <p><Need Marking-Check></p>

Code	Error	Error contents	Countermeasures
FD	Encoder data reading Retry count over	An Error has been detected during encoder receiving processing.	<ul style="list-style-type: none">- Please confirm whether there is any problem in encoder communication interface signals quality.- It can be reset by reset of RC or a signal input. <Need Marking-Check>

11 Technical data

11.1 General data

Position	Description				
Supply voltage	24V DC $\pm 10\%$ (NEC Class2)				
Power input	max. 0.5A				
Wattage	max. 12W				
Ambient temperature	0 – 55°C				
Air humidity	30 – 85%RH (non-condensing)				
Air pressure	86 kPa to 106 kPa				
Altitude	Less than 1,000m				
Ambient atmosphere	No aggressive gasses permitted				
Installation site	Metal switch cabinet protective class at least IP 53 and NEMA type3				
Proof test	20 years				
Mode of operation	High demand rate or continuous demand limited by the system reaction time (high demand or continuous mode)				
Oscillations	IEC61131-2 /IEC60068-2-6	Frequency	acceleration	Amplitude	Runs
		5 9Hz	-	0.35 mm	10 cycles (1 octave/min)
		9...150Hz	1,0 g	-	
Shock impact	IEC61131-2/IEC60068-2-7 (15G,11ms, X,Y,Z Direction, Three times for each)				
Voltage interruption	Maximum 10ms at intervals of minimum 1 second				
Transportation and storage	-25 – 70°C, 5 – 95%RH (non-condensing)				

Table 11-1 General technical data

11.2 Electromagnetic compatibility

RSC1 is tested by standard IEC61000-6-2 and IEC62061.

Position	Norm	Specification	Performance Criterion
Discharge of static electricity	IEC61000-4-2	IEC61000-6-2 Contact discharge: ± 4 kv	A
		IEC62061 Contact discharge: ± 6 kv	FS
Electromagnetic HF field	IEC61000-4-3	IEC61000-6-2 80 .. 1000MHz 10V/m	A
		1400 ..2000MHz 3V/m	A
		2000 ..2700MHz 1V/m	A
		IEC62061 80 .. 1000MHz 20V/m	FS
		1400 ..2000MHz 6V/m	FS
		2000 ..2700MHz 3V/m	FS
Fast transient	IEC61000-4-4	IEC61000-6-2 Signal connections : ± 1 kV	A
		DC24V POWER : ± 2 kV	A
		Function ground : ± 1 kV	A
		IEC62061 Signal connections : ± 2 kV	FS
		DC24V POWER : ± 4 kV	FS
		Function ground : ± 2 kV	FS
Surge voltages	IEC61000-4-5	IEC61000-6-2 DC24V POWER line toline: ± 0.5 kV	A
		DC24V POWER line to earth: ± 0.5 kV	A
		IEC62061 DC24V POWER line toline: ± 1.0 kV	FS
		DC24V POWER line to earth: ± 2.0 kV	FS
High frequency	IEC61000-4-6	IEC61000-6-2	
		IEC62061 Signal connections :0.15-80MHz/10 V	A
		DC24V POWER : 0.15-80MHz/10 V	A
		Function ground: 0.15-80MHz / 10 V	A

Table 11-2 Electromagnetic compatibility

11.3 I/O specification

Position	Description
Name	Safety output
Type	E-stop output B Contact
Supply voltage	24 V DC± 10 %
Output current	MAX 1A
Fusing	Internal fuse 3.15A Nomal blow type

Table 11-3 Safety output

Position	Description
Name	Safety input
Type	250_mon B Contact Stop_mon B Contact SSF_mon B Contact
Supply voltage	24 V DC± 10 %
Input current	5mA
Fusing	Internal fuse 4A Nomal blow type

Table 11-4 Safety input

Position	Description
Name	Non-safety input
Type	Tool_1 A Contact Tool_2 A Contact Tool_4 A Contact Tool_8 A Contact Reset A Contact
Supply voltage	24 V DC± 10 %
Input current	5mA
Fusing	Internal fuse 4A Nomal blow type

Table 11-5 Non-safety input

11.4 reaction time

The cycle of a command value + 43ms.

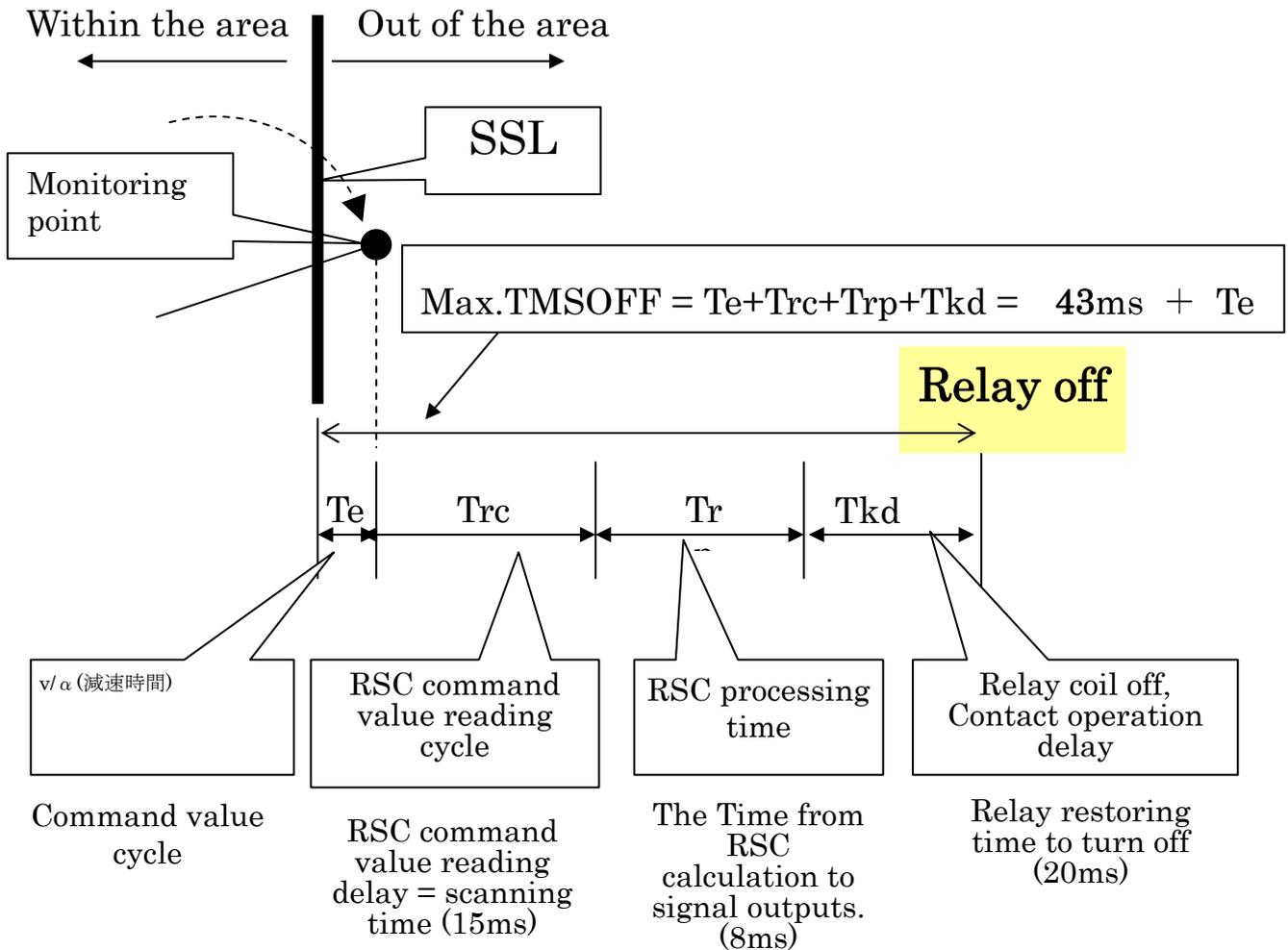


Figure 11-1 reaction time



This response time shows maximum reaction time of RSC1.

At the time of a system design, please evaluate the distance, which a robot needs to stop completely, based on this response time, And execute the risk-assessments of system.

11.5 Considered standards

Standard	Name
DIN EN 61508; 1-4	Functional safety of safety-related electrical, electronic, programmable, electronic systems
IEC62061	Safety of machinery – Functional safety of safety-related electrical, electronic and programmable electronic control systems
DIN EN 954-1 cat.3	Safety of machines - safety-related parts of control systems Part 1: General design principles
ISO13849-1 PL d	Safety of machines - safety related parts of control systems Part 1: General design principles
ISO 10218-1	SRobots for industrial environments — Safety requirements — Part 1: Robot
IEC/EN 60204-1	Safety of machines – electrical equipment of machines Part 1: General requirements
UL508 for NRTL US	Industrial Control Equipment
CAN/CSA C22.2 No.14 And No.142 for NRTL Canada	Industrial Control Equipment
NRTL test(Canada+US)&certif ication acc. to NFPA79	Electrical Standard for Industrial Machinery

Table 11-6 Considered standards

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An approval under the law may be required exportation of the products