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Mitsubishi Electric Corporation **Industrial** Robot

MELFA Technical News

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January 2018

Subject: Precautions of replacement from RV-3SD/3SDJ to RV-4FR-D/4FRL-D

Applicable to: RV-3SD, RV-3SDJ
RV-4FR-D, RV-4FRL-D

Thank you for your continued support of Mitsubishi industrial MELFA series robots.
This Technical News explains in detail the precautions for the replacement of **RV-3SD/3SDJ** vertical multiple-joint type robots with **RV-4FR-D** or **RV-4FRL-D** robots.

Contents

Precautions for the replacement of RV-3SD/3SDJ with RV-4FR-D or RV-4FRL-D.

1. Configurations of the models (Compatible model for replacement)

The following shows the compatible models of robot arms and controllers for the replacement of RV-3SD/3SDJ to RV-4FR-D or RV-4FRL-D.

Model	Controller
RV-3SD	CR1DA-721
RV-3SDJ	CR1DA-731

Model	Controller
RV-4FR-D, RV-4FRL-D	CR800-04VD

2. Specifications comparison

2.1 Specifications of the robot arm

The following table compares the robot arm specifications between old and new models.

Type		Unit	Specifications			
			Old models		FR series	
Model			RV-3SD/3SDC	RV-3SDJ/3SDJC	RV-4FR/4FRM/4RFC-D	RV-4FRL/4FRLM/4FRLC-D
Machine class			None: Standard (oil mist) Note 4)/C: Clean Note 5)		None: Standard/M: Oil mist Note 4)/C: Clean Note 5)	
Protection degree			Standard: IP65/C: Class 10 (0.3μm)		Standard: IP40/M: IP67/C: ISO class 3	
Degree of freedom			6	5	6	
Installation style			Floor type, ceiling type, (wall type Note 6)		Floor type, ceiling type, (wall type Note 6)	
Structure			Vertical multiple-joint type		Vertical multiple-joint type	
Drive system			AC servo motor (with J1 to J3, J5 axis brake)		AC servo motor (with all axes brake)	
Position detection method			Absolute encoder		Absolute encoder	
Load capacity		kg	3		4	
Arm length		mm	245 + +270	245 + +300	235 + +275	310 + +335
Maximum reach radius		mm	642	641	515	649
Operating range	J1	deg	340 (±170)		480 (±240)	
	J2		225 (-90 to +135)		240 (±120)	
	J3		191 (-20 to +171)	273 (-100 to +173)	161 (0 to +161)	164 (0 to +164)
	J4		320 (±160)	-	400 (±200)	
	J5		240 (±120)		240 (±120)	
	J6		720 (±360)		720 (±360)	
Maximum speed	J1	degree /sec	250		450	420
	J2		187		450	336
	J3		250		300	250
	J4		412	-	540	
	J5		412		623	
	J6		660		720	
Maximum composite speed Note 1)		mm/sec	5500	5300	9027	9048
Cycle time Note 2)		sec	0.63	0.61	0.36	0.36
Positioning repeatability		mm	±0.02		±0.02	
Ambient temperature		°C	0 to 40		0 to 40	
Mass		kg	37	33	39	41
Tolerable moment	J4	Nm	5.83	-	6.66	
	J5		5.83	5.83	6.66	
	J6		3.9	3.9	3.96	
Tolerable inertia	J4	kg, m2	0.137	-	0.2	
	J5		0.137	0.137	0.2	
	J6		0.047	0.047	0.1	
Tool wiring			Hand: 8 input points/8 output points (forearm), 8 spare wires: AWG#27 (0.1mm^2)		Hand: 8 input points/8 output points Signal line of the multi-function hand sensor and force sensor (24-pin)	
Tool pneumatic piping			Primary: φ6 × 2 Secondary: φ4 × 8		Primary: φ6 × 2 Secondary: φ6 × 8, φ4 × 4 (wrist inside)	
Machine cable			5m (connector on both ends)		5m (connector on both ends)	
Paint			Color: Light gray (Reference Munsell color: 0.08GY7.64/0.81)		Color: Light gray (Reference Munsell color: 0.6B7.6/0.2)	

Note 1) Value of mechanical interface side when synthesizing all axes

Note 2) Value of 1kg of load and back-and-forth movement for a vertical distance of 25mm and horizontal distance of 300mm

Note 3) Can also be used a as a spare line (0.2sq 4-pair cable) for conventional models.

Note 4) Please contact a Mitsubishi Electric dealer since the environment resistance may not be secured depending on the characteristics of oil you use. In addition, an air purge is required. For the details, refer to the specifications manual.

Note 5) Preservation of cleanliness levels depends on conditions of a downstream flow of 0.3m/s in the clean room and internal robot suctioning. A φ8-mm coupler for suctioning is provided at the back of the base.

Note 6) In the wall type specification, operation range of the J1-axis is restricted.

Precautions for the replacement of RV-3SD/3SDJ with RV-4FR-D or RV-4FRL-D.

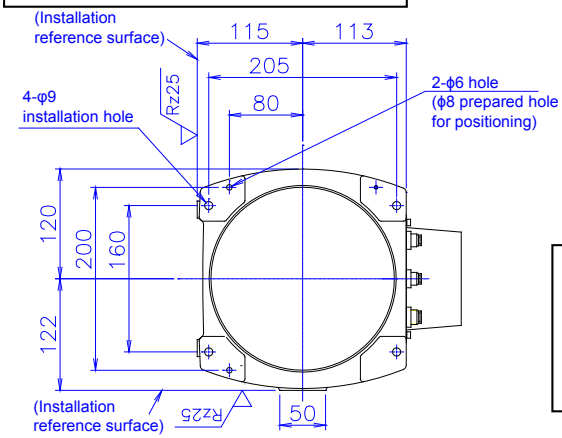
2.2 Dimensions of the robot arm and diagram of the operating range

2.2.1 Robot arm installation dimensions and mechanical interface

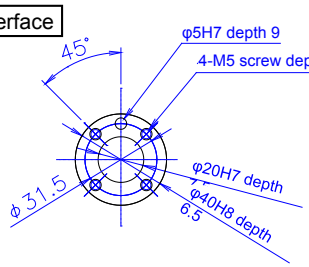
The installation dimensions and mechanical interface have changed. Refer to the following diagrams.

Old models: RV-3SD/3SDJ

Installation dimensions of the robot arm



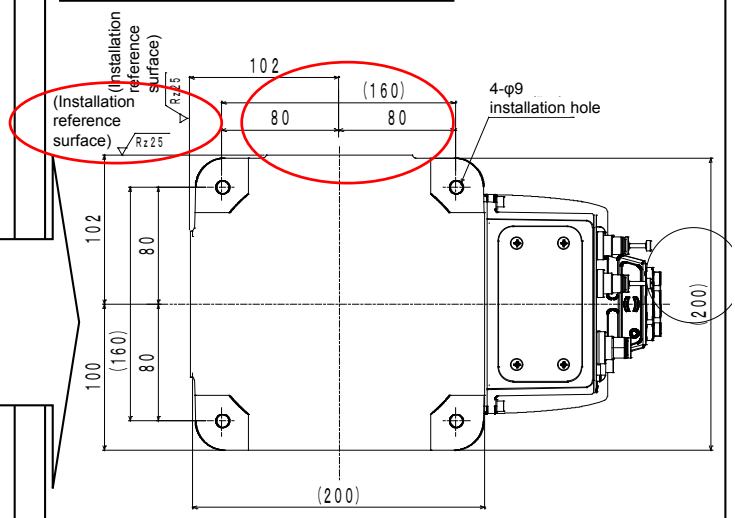
Mechanical interface



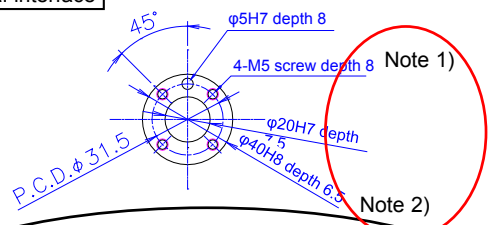
Note 1) Thread engagement should be within 7.5 to 8.5mm.

New models: RV-4FR-D, RV-4FRL-D

Installation dimensions of the robot arm



Mechanical interface



Note 1) Thread engagement should be within 7.5 to 8mm.

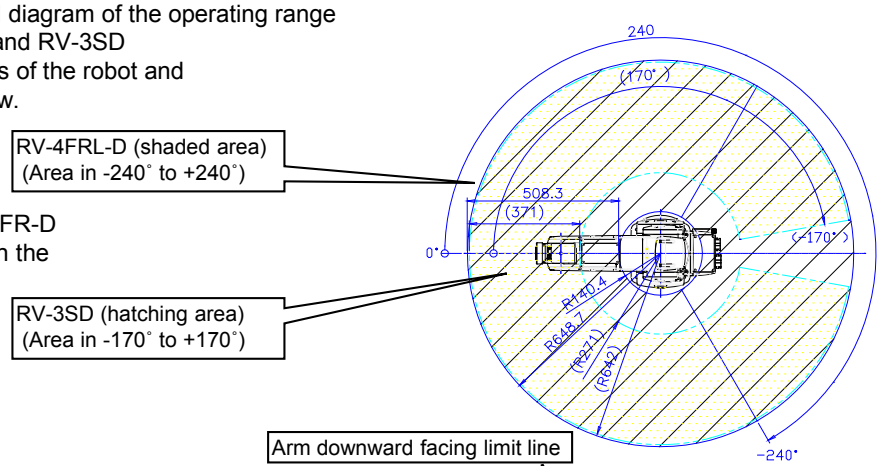
Note 2) This value indicates the dimensions of standard specification. The dimensions for oil mist specification and clean specification are 3.5mm, and 6.5mm for SH** specification.

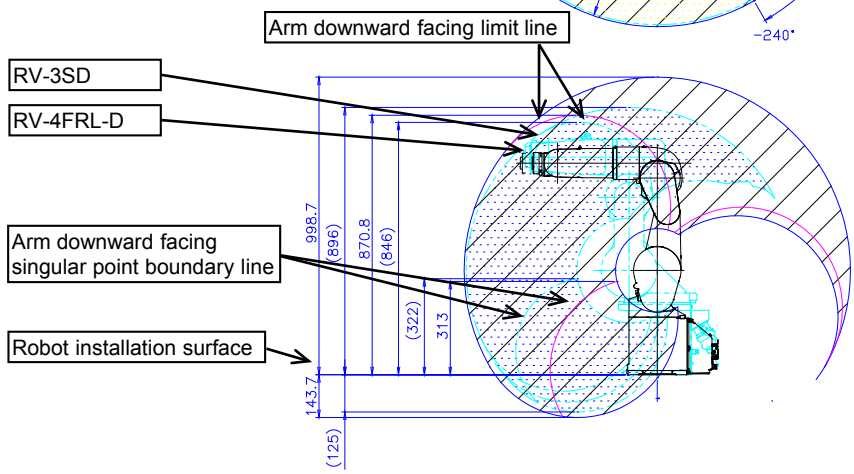
2.2.2 Dimensions of the robot arm and diagram of the operating range

1) Comparison between RV-4FRL-D and RV-3SD

The major differences in dimensions of the robot and operating range are described below.

- RV-3SD can be replaced with RV-4FR-D because its operating range is within the one of RV-4FR-D.

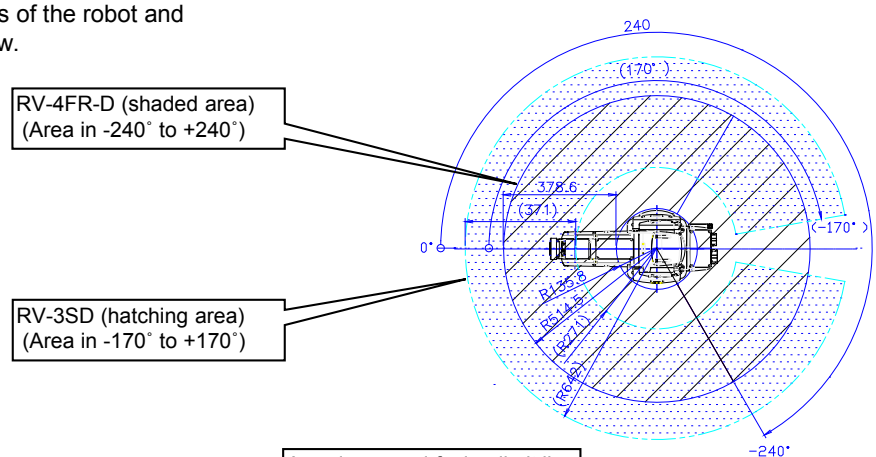


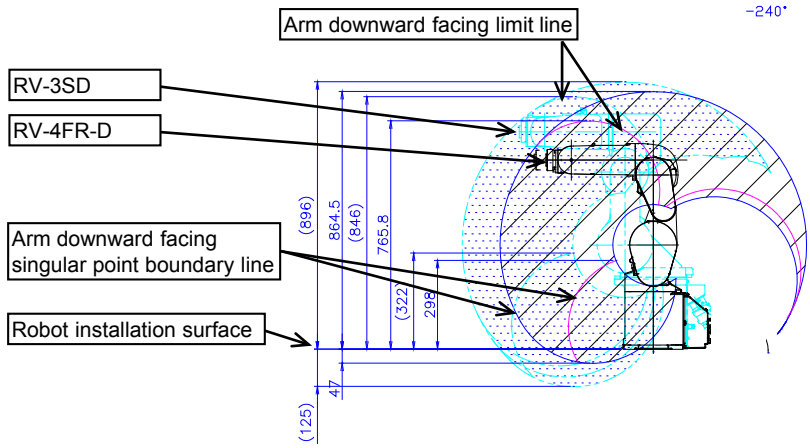


2) Comparison between RV-4FR-D and RV-3SD

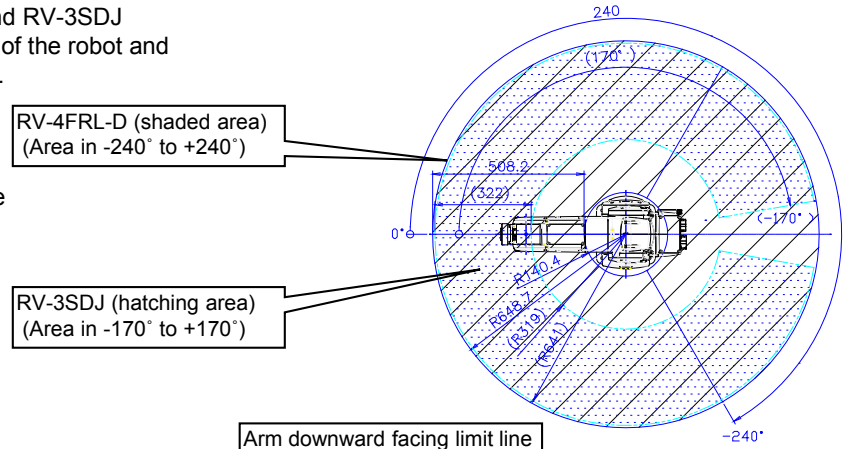
The major differences in dimensions of the robot and operating range are described below.

- The operating range of RV-3SD exceeds the one of RV-4FR-D.
- The model whose operating range is within the one of RV-4FR-D can be replaced.



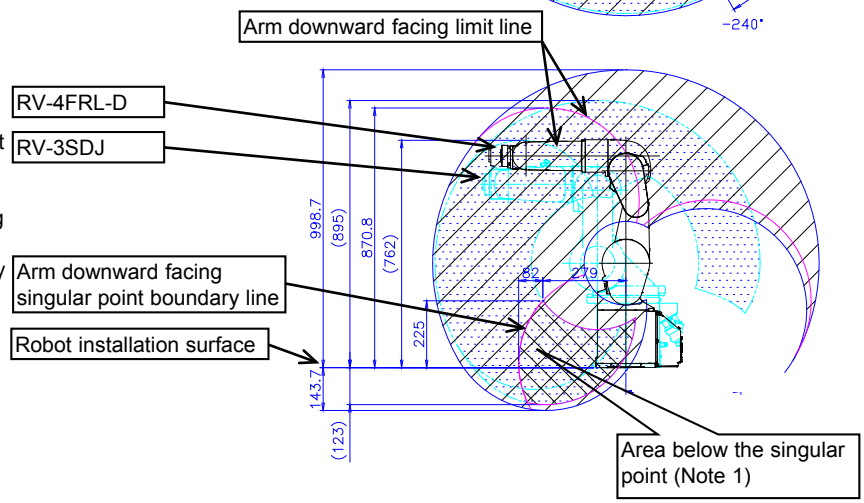


3) Comparison between RV-4FRL-D and RV-3SDJ
The major differences in dimensions of the robot and operating range are described below.

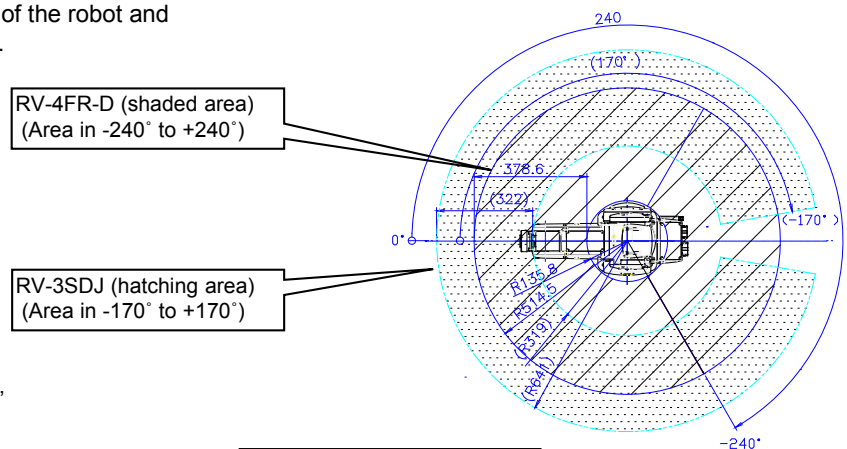


• RV-3SDJ can be replaced with RV-4FR-D because its operating range is within the one of RV-4FR-D. However, note that the operation is restricted (Note 1) around and below the singular point.

Note 1: Since RV-4FRL-D is a 6-axis robot, it has a singular point in the lower part of the operating area.
- At and around the singular point, the operation is disabled due to the restriction.
- To operate the arm in the lower area out of the singular point and its surroundings, use the singular point passing function (which enables passing only when the arm passes on the singular point, and disables passing only when the arm passes around the singular point) and move the arm to the lower area.
Consider using this method.

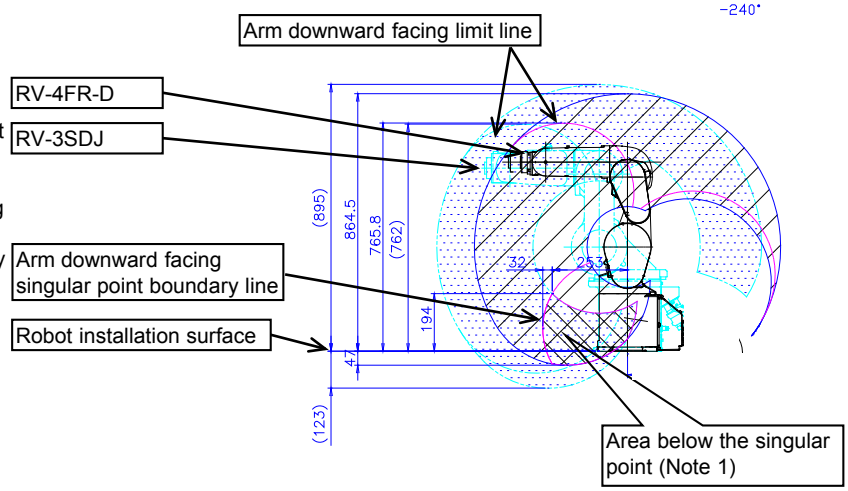


4) Comparison between RV-4FR-D and RV-3SDJ
The major differences in dimensions of the robot and operating range are described below.



• The operating range of RV-3SDJ exceeds the one of RV-4FR-D.
• The model whose operating range is within the one of RV-4FR-D can be replaced.
However, note that the operation is restricted (Note 1) around and below the singular point.

Note 1: Since RV-4FR-D is a 6-axis robot, it has a singular point in the lower part of the operating area.
- At and around the singular point, the operation is disabled due to the restriction.
- To operate the arm in the lower area out of the singular point and its surroundings, use the singular point passing function (which enables passing only when the arm passes on the singular point, and disables passing only when the arm passes around the singular point) and move the arm to the lower area.
Consider using this method.



2.3 Specifications of the controller

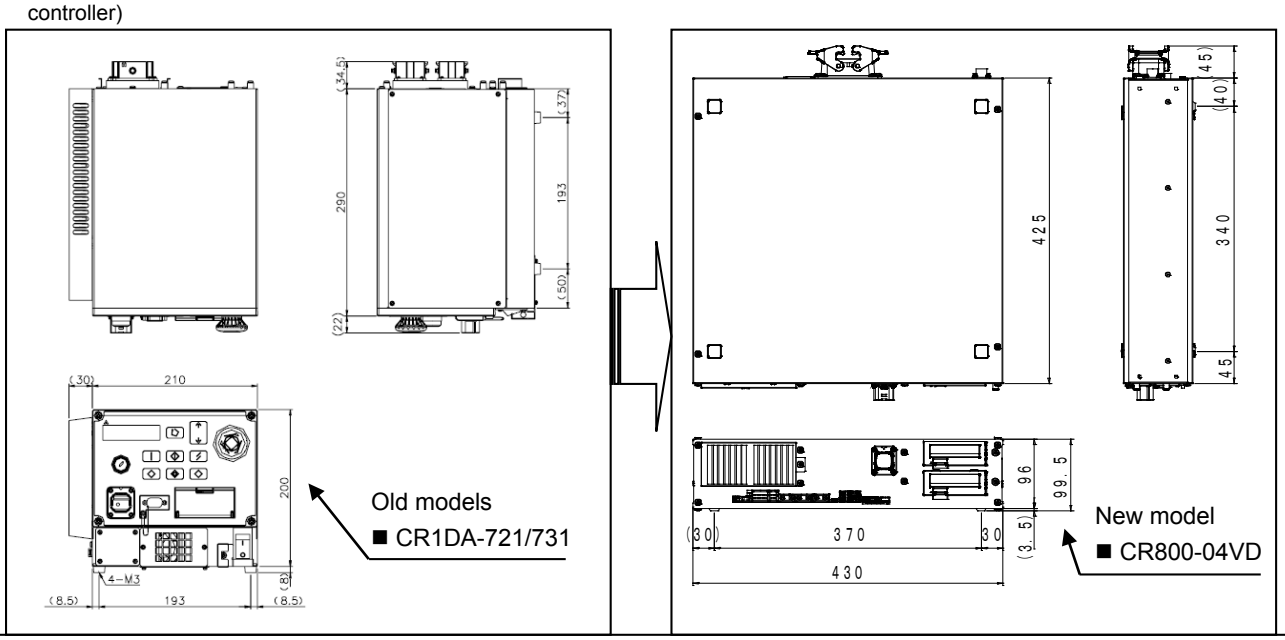
Please note that the controller model is new, and the dimensions and others have changed. For the details, refer to the following.

Item		Unit	Specifications	
			Old models	FR series
			RV-3SD/3SDJ	RV-4FR-D, RV-4FRL-D
Controller model			CR1DA-721/731	CR800-04VD
Routing control method			PTP control, CP control	PTP control, CP control
Number of control axis			Simultaneously 6	Simultaneously 6
Programming language			MELFA-BASIC IV, V	MELFA-BASIC V, VI
Memory capacity	Programmed positions	point	13,000	39,000
	Number of steps	step	26,000	78,000
	Number of programs		256	512
External input/output (standard)	General-purpose input/output	point	Input 0/output 0 (Max. 256/256: option)	Input 0/output 0 (Max. 256/256: option)
	Dedicated input/output		Assigned to general-purpose input/output	Assigned to general-purpose input/output
	Dedicated stop input		1	1
	Hand open/close		Input 8/output 0 (when using pneumatic hand interface: 8/8)	Input 8/output 8
	Emergency stop input		1 (duplication)	1 (duplication)
	Door switch input		1 (duplication)	1 (duplication)
	Enabling device input		1 (duplication)	0
	Emergency stop output		1 (duplication)	1 (duplication)
	Mode output		1 (duplication)	1 (duplication)
	Robot error output		1 (duplication)	1 (duplication)
	Mode selector switch input		0	1 (duplication)
	Additional axis synchronization		1 (duplication)	1 (duplication)
Interface	RS-232	port	1	-
	RS-422	port	1 (for T/B)	1 (for T/B)
	Ethernet	port	1 (for T/B)/ 1 (for customer) 10BASE-T/100BASE-TX	1 (for T/B)/ 1 (for customer) 10BASE-T/100BASE-TX/1000BASE-T
	USB	port	1	1
	Memory expansion slot	SLOT	1	-
	Expansion slot	SLOT	1	2
	Robot input/output link	ch	1	1
	Additional axis function	ch	1 (SSCNETIII)	1 (SSCNETIII/H)
	Communication I/F between R/C	ch	-	2
	Encoder input	ch	2	2
Input power supply	Voltage range	V	Single phase, 180 to 253 VAC (*1)	Single phase, 200 to 230 VAC (*1)
	Power capacity	kVA	1	1
Outside dimensions		mm	240(W)×290(D)×200(H)	430(W)×425(D)×99.5(H)
Mass		kg	Approx. 9	Approx. 12.5
Construction [Protection specification]			Self-contained floor type, open type [IP20]	Self-contained floor type, open type [IP20]
Grounding		Ω	100 or less (D class grounding)	100 or less (D class grounding)

*1: The rate of power-supply voltage fluctuation is within 10%.

2.4 Outside dimensions of the controller

The controller's outside dimensions have changed. (Left drawing: RV-3SD/3SDJ controller, right drawing: RV-4FR-D, RV-4FRL-D controller)



2.5 Options

(1) Robot arm options comparison

Item	Specifications			Compatibility
	Old models	New models	Specifications and supplementary explanation	
	RV-3SD/3SDJ	RV-4FR-D, RV-4FRL-D		
Solenoid valve set	1S-VD0□-02 (Sink type) 1S-VD0□E-02 (Source type) □: 1 to 4	1F-VD0□-02 (Sink type) 1F-VD0□E-02 (Source type) □: 1 to 4	Solenoid valve set for the pneumatic hand (1 to 4 sets, sink type) Solenoid valve set for the pneumatic hand (1 to 4 sets, source type)	×
Hand output cable	1S-GR35S-01	1F-GR35S-02	The robot side has a connector, and the other side has output cables for unprocessed solenoid valve connection. (Total length: 300mm)	×
Hand input cable	1S-HC25C-01	1F-HC35S-02	The robot side has a connector, and the other side has input cables for unprocessed hand sensor connection. (Total length: 300mm)	×
Hand curl tube	1E-ST040□C	1E-ST04□C	φ4 x□ pics, curl pneumatic tube for up to 4-set solenoid valve connection	○
External wiring set 1 for the forearm	-	1F-HB01S-01	For forearm: An external wiring box to which the hand input cable, Ethernet cable, and electrical hand/force sensor cable are connected	-
External wiring set 2 for the forearm	-	1F-HB02S-01	For forearm: An external wiring box to which the force sensor, electrical hand, and Ethernet cable are connected	-
External wiring set 1 for the base	-	1F-HA01S-01	For base: An external wiring box to which the electrical hand communication signal output, electrical hand/force sensor cable, and Ethernet cable are connected Hand input provided.	-
External wiring set 2 for the base	-	1F-HA02S-01	For base: An external wiring box to which the electrical hand communication signal output, electrical hand, force sensor, and Ethernet cable are connected Hand input not provided.	-
J1-axis operating range change	1S-DH-03	1F-DH-03	Stopper part for J1-axis operating range change	×
2m machine cable (replacement type)	1S-02UCBL-03	-	Fixed type (Set of 2 cables for power supply and signals), 2m (Provided as substitute for standard 5m cables.)	-
Machine cable (replacement type)	-	1F- □□ UCBL-41 □□: 02, 10, 15, 20	Fixed type: 2m, 10m, 15m. 20m	-
Machine cable (replacement type)	-	1F-□□LUCBL-41 □□: 10, 15, 20	Flexed type: 10m, 15m, 20m	-
Machine cable extension (Fixed type)	1S-□□CBL-03 □□: 05, 10, 15	-	Fixed type (Set of 2 cables for power supply and signals), 5m, 10m, 15m (Used for adding to standard 5m cables.)	-
Machine cable extension (Flexed type)	1S-□□LCBL-03 □□: 05, 10, 15	-	Flexed type (Set of 2 cables for power supply and signals), 5m, 10m, 15m (Used for adding to standard 5m cables.)	-

Meaning of symbols in table ○: Same product, ×: Incompatible, -: Not supported

(2) Robot controller options comparison

Item	Specifications		CR1DA-7**/CR800-D compatibility	Remarks
	Old models	New model		
	CR1DA-721/731	CR800-04VD		
Pneumatic hand interface	2A-RZ365 (Sink) 2A-RZ375 (Source)	☆	○	
Expansion I/O unit	2A-RZ361 (Sink) 2A-RZ371 (Source)	2A-RZ361 (Sink) 2A-RZ371 (Source)	○	
External I/O cable	2A-CBL□□	2A-CBL□□	○	For expansion I/O unit
Build-in I/O interface	2D-TZ368 (Sink) 2D-TZ378 (Source)	2D-TZ368 (Sink) 2D-TZ378 (Source)	○	
External I/O cable	2D-CBL□□	2D-CBL□□	○	For built-in I/O interface
CC-Link interface	2D-TZ576	2D-TZ576	○	Ver. 2 compatible
Additional axis interface	☆	☆	☆	
Tracking function	☆	☆	☆	
Expansion memory	2D-TZ454	-	-	
Controller protection box	CR1D-MB	CR800-MB	×	
Teaching box	R32TB		○	
High-functionality teaching box	R56TB		○	
RS-232 cable (for PC support)	2D-232CBL03M	-	-	
Force sensor set	-	4F-FS002H-W200/4F-FS002H-W1000	-	SSCNETIII/H compatible
PC support software	3D-1□C-WINJ	3F-14C-WINJ	-	RT ToolBox3 Standard
		3F-15C-WINJ	-	RT ToolBox3min
		3F-16D-WINJ	-	RT ToolBox3Pro
Simulator (MELFA-Works)	3D-21C-WINJ	-	-	

Meaning of symbols in table ○ : Compatible, ☆: Standard equipment, ×: Incompatible, -: Not supported

3. Compatibility

The following table provides compatibility between old and new models.

3.1 Compatibility of the robot arm

Category	Item	Specifications		Compatibility	Remarks
		Old models	FR series		
		RV-3SD/3SDJ	RV-4FRL-D, RV-4FR-D		
Outside dimensions	Installation dimensions	Changed		×	Base depth dimension is incompatible.
	Mechanical interface	Changed		○	Compatible, however, note that the screw depth and hole depth are changed.
	Operating range	Changed		×	
Tooling	Hand wiring	Changed		×	Incompatible
	Hand piping	No change		○	
	Backup wiring	Changed		×	
Maintenance	Backup battery	A6BAT	MR-BAT6V1	×	

○: Fully compatible ×: Incompatible

3.2 Compatibility of the controller

Category	Item	Specifications		Compatibility	Remarks
		Old models	FR series		
		CR1DA-721/731	CR800-04VD		
Operation	TB	R32TB		○	
	High-functionality TB	R56TB		○	
	I/O map	0 to 9999	0 to 9999	○	
	Programming language	MELFA-BASIC V	MELFA-BASIC VI	×	
	PC support software	RT ToolBox2	RT ToolBox3	×	
Maintenance	Backup battery	Q6BAT	-	×	

○: Fully compatible ×: Incompatible

Precautions of controller specifications

Item	Specifications	
	Old models	FR series
	CR1DA-721/731	CR800-04VD
Robot language	MELFA-BASIC IV MELFA-BASIC V	MELFA-BASIC IV cannot be used directly. (RT3 converts MELFA-BASIC IV into MELFA-BASIC V or VI.) MELFA-BASIC V MELFA-BASIC VI (upper-compatible of MELFA-BASIC V) * In MELFA-BASIC VI, the description method of program is the same as MELFA-BASIC V unless the Function or Include commands are
Serial number of robot	Necessary to input (by using the T/B or RT2)	Not necessary to input (The data has been stored in the robot's internal ROM.)
Origin setting	Necessary to input (by using the T/B or RT2)	Not necessary to input (The data has been stored in the robot's internal ROM.)
Hand type	Sink type (initial value) It is necessary to set a parameter for selecting the source type.	Not set (initial value) It is necessary to select either sink or source type by setting a parameter. (If not set, an error will occur.)
Mode selector input	Provided	Provided (Customer needs to prepare a mode selector switch.) Recommended key switch: HA1K-2C2A-2 (manufactured by IDEC)
Enabling device switch input	Provided	Not provided
Battery	Using (Q6BAT, 1 pc.)	Not using (Not necessary to replace the battery)
TB dummy connector	Necessary	Not necessary After deadman turns on, the T/B can be removed without stopping the robot even during operation.

3.3 Precautions of the extension function for GOT direct connection

The start addresses of the GOT shared memory (CPU buffer memory) I/O are different between old and new models.

Item	Specifications		Remarks
	Old models	FR series	
	CR1DA-721/731	CR800-04VD	
GOT output start address (to robot)	U3E0\G10000	U3E0\G0	
Robot input signal start address	10000	10000	
Robot output signal start address	10000	10000	
GOT input start address (from robot)	U3E1\G10000	U3E1\HG0	
Memory configuration	Shared memory among GOTs	CPU buffer memory	