MITSUBISHI ELECTRIC

INVERTER

A800
F800
SynRM DRIVING FUNCTION MANUAL

FR-A820-00046(0.4K)-04750(90K)-SYN
FR-A840-00023(0.4K)-06830(280K)-SYN
FR-A842-07700(315K)-12120(500K)-SYN
FR-F820-00046(0.75K)-04750(110K)-SYN
FR-F840-00023(0.75K)-06830(315K)-SYN
FR-F842-07700(355K)-12120(560K)-SYN

SynRM Driving Function

The FR-A800-SYN and FR-F800-SYN inverters have the SynRM driving functions, in addition to the functions of the standard FR-A800 and FR-F800 inverters.
This SynRM Driving Function Manual explains the functions dedicated to the FR-A800-SYN and FR-F800-SYN. For the functions not found in this Function Manual, refer to the FR-A800 or FR-F800 Instruction Manual.
In addition to this SynRM Driving Function Manual, please read the FR-A800 or FR-F800 Instruction Manual carefully. Do not use this product until you have full knowledge of this product mechanism, safety information and instructions.
Please forward this Function Manual to the end user.

A800-SYN
F800-SYN

CONTENTS

1 SynRM DRIVING FUNCTIONS OF THE FR-A800-SYN 4

1.1 Overview 4

1.2 SynRM magnetic flux vector control 4

1.3 Speed control by SynRM magnetic flux vector control 5

1.3.1 Setting procedure of SynRM magnetic flux vector control (speed control) 5
1.3.2 Setting for the SynRM magnetic flux vector control by selecting parameter initialization on the operation panel 7
1.3.3 Setting for the SynRM magnetic flux vector control by PM/SynRM parameter initialization (Pr.998) 8
1.3.4 Selection of the control method and the control mode 14
1.3.5 Applied motor (Pr.71, Pr.450) 15

1.4 Adjustment under SynRM magnetic flux vector control 16

1.4.1 Speed estimation filter 16
1.4.2 Adjusting the speed control gain 16
1.4.3 Magnetic flux command low-speed scaling factor 18
1.4.4 Adjusting gain of current controllers for the d axis and the q axis 19
1.4.5 Adjusting gain of a magnetic flux controller 19

1.5 Automatic restart after instantaneous power failure / flying start with the SynRM 20

1.6 Optimum excitation control when driving a SynRM 20

1.7 Offline auto tuning for a SynRM 21

1.8 Specifications 27

1.8.1 Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification) 27
1.8.2 Control specifications 28

2 DIFFERENCES BETWEEN THE FR-A800-SYN AND THE STANDARD MODEL 29

2.1 Specification comparison among control methods 29

2.2 Applicable standards 31

3 SynRM DRIVING FUNCTIONS OF THE FR-F800-SYN 32

3.1 Overview 32

3.2 SynRM magnetic flux vector control 32

3.3 Speed control by SynRM magnetic flux vector control 33

3.3.1 Setting procedure of SynRM magnetic flux vector control (speed control) 33
3.3.2 Setting for the SynRM magnetic flux vector control by selecting parameter initialization on the operation panel 35
3.3.3 Setting for the SynRM magnetic flux vector control by PM/SynRM parameter initialization (Pr.998) 36

3.3.4 Selection of the control method and the control mode 42
3.3.5 Applied motor (Pr.71, Pr.450) 43

3.4 Adjustment under SynRM magnetic flux vector control 44

3.4.1 Speed estimation filter 44
3.4.2 Adjusting the speed control gain 44
3.4.3 Magnetic flux command low-speed scaling factor 46
3.4.4 Adjusting gain of current controllers for the d axis and the q axis 47
3.4.5 Adjusting gain of a magnetic flux controller 47

3.5 Automatic restart after instantaneous power failure / flying start with the SynRM 48

3.6 Optimum excitation control when driving a SynRM 48

3.7 Offline auto tuning for a SynRM 49

3.8 Specifications 55

3.8.1 Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification) 55
3.8.2 Control specifications 56

4 DIFFERENCES BETWEEN THE FR-F800-SYN AND THE STANDARD MODEL 57

4.1 Specification comparison among control methods 58

4.2 Applicable standards 58

1 SynRM DRIVING FUNCTIONS OF THE FR-A800-SYN

1.1 Overview

This Function Manual describes the synchronous reluctance motor driving functions. For the functions not found in this Function Manual, refer to the FR-A800 Instruction Manual (Detailed).

◆Abbreviation/term

Abbreviation/term	Description
SynRM	Synchronous reluctance motor
SynRM magnetic flux vector control	Inverter's control method and function name for driving the SynRM
RF-SR	Mitsubishi Electric synchronous reluctance motor RF-SR series

◆SynRM driving function parameter list

The following parameters and settings can be used for the SynRM driving functions. Set the parameters according to the application.

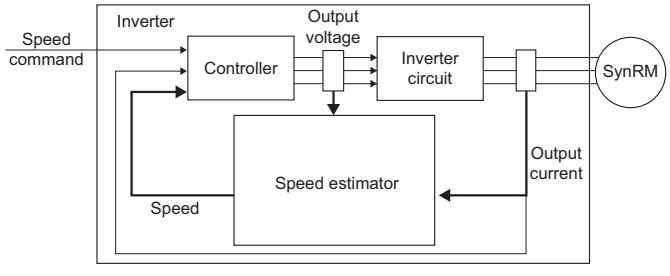
Pr.	Pr. group	Name	Setting range	Minimum setting increments	Initial value	Refer to page
71	**C100**	**Applied motor**	4140, 7090*1	1	0	15
450	**C200**	**Second applied motor**	4140, 7090*1	1	9999	15
545	**G258**	**Magnetic flux control P gain**	0% to 500%	1%	100%	19
546	**G259**	**Magnetic flux control integral time**	0 to 5 s	0.001 s	0.2 s	19
998	**E430**	**PM/SynRM parameter initialization**	4014, 4114, 7009, 7109*1	1	0	8

*1 For other settings, refer to the FR-A800 Instruction Manual (Detailed).

1.2 SynRM magnetic flux vector control

- Highly efficient motor control is enabled by using the inverter and the SynRM, which is more efficient than an induction motor.
- A speed detector such as an encoder is not required as the inverter estimates and controls the motor speed by the calculation from the inverter output voltage and current.
- Just performing PM/SynRM parameter initialization automatically and collectively changes the parameters required to perform SynRM magnetic flux vector control.

Schematic diagram of SynRM magnetic flux vector control



NOTE

SynRM magnetic flux vector control requires the following conditions.

- The SynRM is used.
- One motor is driven by one inverter.
- The wiring length from the inverter to the motor is 100 m or less.
- A surge voltage suppression filter (FR-ASF/FR-BMF) or sine wave filter (MT-BSL/BSC) is not used.
- If the carrier frequency setting is high, uneven rotation may occur at a low speed. In such a case, set a smaller value in **Pr.72 PWM frequency selection**.

1.3 Speed control by SynRM magnetic flux vector control

1.3.1 Setting procedure of SynRM magnetic flux vector control (speed control)

The inverter is set for an induction motor in the initial setting. Follow the following procedure to change the setting for the SynRM magnetic flux vector control.

◆Driving the RF-SR

◆Operating procedure

1 **Set Pr.570 Multiple rating setting.**

When driving the Mitsubishi Electric synchronous reluctance motor RF-SR series, refer to the following table to set **Pr.570 Multiple rating setting**.

Motor	Inverter	Pr.570 Multiple rating setting (0: SLD rating, 1: LD rating)
RF-SR5K30S (200 V) RF-SR5K30HS (400 V)	FR-A820-00250(3.7K)-SYN (200 V) FR-A840-00126(3.7K)-SYN (400 V)	0: SLD rating
	FR-A820-00340(5.5K)-SYN (200 V) FR-A840-00170(5.5K)-SYN (400 V)	1: LD rating
RF-SR7K30S (200 V) RF-SR7K30HS (400 V)	FR-A820-00340(5.5K)-SYN (200 V) FR-A840-00170(5.5K)-SYN (400 V)	0: SLD rating
	FR-A820-00490(7.5K)-SYN (200 V) FR-A840-00250(7.5K)-SYN (400 V)	1: LD rating
RF-SR11K30S (200 V) RF-SR11K30HS (400 V)	FR-A820-00490(7.5K)-SYN (200 V) FR-A840-00250(7.5K)-SYN (400 V)	0: SLD rating
	FR-A820-00630(11K)-SYN (200 V) FR-A840-00310(11K)-SYN (400 V)	1: LD rating
RF-SR15K30S (200 V) RF-SR15K30HS (400 V)	FR-A820-00630(11K)-SYN (200 V) FR-A840-00310(11K)-SYN (400 V)	0: SLD rating
	FR-A820-00770(15K)-SYN (200 V) FR-A840-00380(15K)-SYN (400 V)	1: LD rating

2 **Perform inverter reset and All parameter clear.**

3 **Set the motor capacity (kW) of the motor to be used in Pr.80 Motor capacity.**

4 **Configure the initial parameter setting for the SynRM.**

Two methods are available to perform parameter initialization: using IPM/SynRM initialization mode (" PMSM ") on the operation panel, and using **Pr.998 PM/SynRM parameter initialization**.

To configure the initial setting using **Pr.998 PM/SynRM parameter initialization**, set "4014 or 4114" in **Pr.998**. (Refer to page 8.)

To configure the initial setting using IPM/SynRM initialization mode on the operation panel, refer to page 7.

5 **Set parameters such as the acceleration/deceleration time and multi-speed setting.**

Set parameters such as the acceleration/deceleration time and multi-speed setting as required.

6 **Set the operation command.**

Select the start command and speed command.

7 **Perform the test operation.**

◆Driving a SynRM other than RF-SR

◆Operating procedure

1 Set the applied motor. (Pr.9, Pr.71, Pr.80, Pr.81, Pr.83, Pr.84)

Set "7090" (synchronous reluctance motor other than RF-SR) in **Pr.71 Applied motor**. Set **Pr.9 Rated motor current, Pr.80 Motor capacity, Pr.81 Number of motor poles, Pr.83 Rated motor voltage, and Pr.84 Rated motor frequency** according to the motor specifications. (Setting "9999 (initial value)" in **Pr.80 or Pr.81** selects V/F control.)

2 Perform the offline auto tuning for a SynRM. (Pr.96) (Refer to page 21.)

Set "1" (offline auto tuning without rotating motor (for other than RF-SR)) in **Pr.96**, and perform tuning.

3 Configure the initial setting for the SynRM magnetic flux vector control using Pr.998. (Refer to page 8.)

When the setting for the SynRM is selected in **Pr.998 PM/SynRM parameter initialization**, the SynRM magnetic flux vector control is selected. The [PM] indicator on the operation panel (FR-DU08) is turned ON when the SynRM magnetic flux vector control is set.

Setting	Description
7009	Parameter settings (in rotations per minute) for a SynRM other than RF-SR
7109	Parameter settings (in frequencies) for a SynRM other than RF-SR

4 Set parameters such as the acceleration/deceleration time and multi-speed setting.

Set parameters such as the acceleration/deceleration time and multi-speed setting as required.

5 Set the operation command.

Select the start command and speed command.

6 Perform the test operation.

NOTE

- To change to the SynRM magnetic flux vector control, perform PM/SynRM parameter initialization first. If parameter initialization is performed after setting other parameters, some of those parameters are initialized too. (Refer to page 9 for the parameters that are initialized.)
- To use a motor capacity that is one rank lower than the inverter capacity, set **Pr.80 Motor capacity** before performing PM/SynRM parameter initialization.
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the magnetic pole position detection.

1.3.2 Setting for the SynRM magnetic flux vector control by selecting parameter initialization on the operation panel

The following shows the procedure to initialize the parameter settings for the Mitsubishi Electric synchronous reluctance motor RF-SR by selecting IPM/SynRM initialization mode on the operation panel.

◆Operating procedure

1 Turning ON the power of the inverter

The operation panel is in the monitor mode.

2 Changing the operation mode

Press [PU EXT] to choose the PU operation mode.

The [PU] indicator turns ON.

3 Selecting the parameter setting mode

Press [MODE] to choose the parameter setting mode.

The [PRM] indicator is ON.

4 IPM/SynRM initialization mode selection

Turn until " PMSM " (IPM/SynRM initialization mode) appears.

5 Displaying the set value

Press [SET] to read the present set value.

" 0 " (initial value) appears.

6 Changing the setting value

Turn to change the value to " 40 14 ", and press [SET] to confirm it.

" 40 14 " and " PMSM " are displayed alternately. The setting is completed.

NOTE

- If parameters are initialized for the SynRM in the IPM/SynRM initialization mode, the **Pr.998 PM/SynRM parameter initialization** setting is automatically changed.
- If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. After initializing SynRM parameters, check the setting value of **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.
- To set a speed by adjusting frequencies or to monitor it, use **Pr.998 PM/SynRM parameter initialization**. Alternatively, change the **Pr.144 Speed setting switchover** setting after parameter initialization in the IPM/SynRM initialization mode.
- To initialize the parameter settings for a motor different from the currently set motor after initializing SynRM parameters, set the multiple rating setting again and perform All parameter clear before initializing the parameter settings. Then set the parameters required for the motor to be used.

POINT

- The [PM] indicator (controlled motor type LED indicator) on the operation panel (FR-DU08) is turned ON when the SynRM magnetic flux vector control is set.

1.3.3 Setting for the SynRM magnetic flux vector control by PM/SynRM parameter initialization (Pr.998)

Use **PM/SynRM parameter initialization** to set the parameters required for driving the Mitsubishi Electric synchronous reluctance motor RF-SR.

Offline auto tuning enables the operation with a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor.

Pr.	Name	Initial value	Setting value	Description	
998 **E430**	**PM/SynRM parameter initialization**	0	0	Parameter settings (in frequencies) for an induction motor	The setting of the motor parameters is changed to the setting required to drive an induction motor.
			3003, 3103	Parameter settings for the IPM motor MM-CF	*1
			4014	Parameter settings (in rotations per minute) for the Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	The setting of the motor parameters is changed to the setting required to drive the Mitsubishi Electric synchronous reluctance motor RF-SR.
			4114	Parameter settings (in frequencies) for the Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	
			7009	Parameter settings (in rotations per minute) for a SynRM other than RF-SR (after tuning)	The setting of the motor parameters is changed to the setting required to drive a synchronous reluctance motor other than RF-SR. (Set **Pr.71 Applied motor** and perform offline auto tuning in advance. (Refer to page 21.))
			7109	Parameter settings (in frequencies) for a SynRM other than RF-SR (after tuning)	
			8009, 8109	Parameter settings for an IPM motor other than MM-CF (after tuning)	*1
			9009, 9109	Parameter settings for an SPM motor (after tuning)	

*1 For details, refer to the FR-A800 Instruction Manual (Detailed).

- To use a motor capacity that is one rank lower than the inverter capacity, set **Pr.80 Motor capacity** before performing PM/SynRM parameter initialization.
- When **Pr.998** = "4014, 7009", the monitor is displayed and the frequency is set using the motor rotations per minute (r/min). To set/monitor in frequencies (Hz), set **Pr.998** = "4114, 7109".
- When using a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor, set **Pr.998** = "7009 or 7109".

NOTE

- If the setting of **Pr.998 PM/SynRM parameter initialization** is changed, some parameters will be initialized too. (Refer to the "List of the target parameters for the PM/SynRM parameter initialization".)
- To change back to the parameter settings required to drive an induction motor, perform Parameter clear or All parameter clear.
- If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. After initializing SynRM parameters, check the setting value of **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.
- If the setting of **Pr.998 PM/SynRM parameter initialization** is changed between "4014, 7009 (rotations per minute)" and "4114, 7109 (frequency)", all the relevant parameters are initialized to the setting values in "List of the target parameters for the PM/SynRM parameter initialization". The purpose of **Pr.998** is not to change the display units. Use **Pr.144 Speed setting switchover** to change the display units between rotations per minute and frequency. Using **Pr.144** enables switching the units between rotations per minute and frequency without initializing the setting of the motor parameters. Example) Changing the **Pr.144** setting between "4" and "104" switches the display units between frequency and rotations per minute.
- For an inverter out of the applicable capacity range of the Mitsubishi Electric synchronous reluctance motor RF-SR, the settings "4014 and 4114" are disabled.
- **Pr.998 PM/SynRM parameter initialization** is used for change of parameter settings for use of the SynRM as the first motor. When the SynRM is used as the second motor, parameters for the second motor must be set individually.
- To initialize the parameter settings for a motor different from the currently set motor after initializing SynRM parameters, set the multiple rating setting again and perform All parameter clear before initializing the parameter settings. Then set the parameters required for the motor to be used.

◆List of the target parameters for the PM/SynRM parameter initialization (RF-SR)

The parameter settings in the following table are changed to the settings required to perform the SynRM magnetic flux vector control by selecting the SynRM magnetic flux vector control with the IPM/SynRM initialization mode on the operation panel or with **Pr.998 PM/SynRM parameter initialization**.

Performing Parameter clear or All parameter clear sets back the parameter settings to the settings required to drive an induction motor.

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		4014 RF-SR (3000 r/min specification)	4114 RF-SR (3000 r/min specification)	4014	0, 4114
		FM	CA				
1	Maximum frequency	120 Hz		Maximum motor rotations per minute*1	Maximum motor frequency*1	1 r/min	0.01 Hz
4	Multi-speed setting (high speed)	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
9	Electronic thermal O/L relay	Inverter rated current		Rated motor current*2		0.01 A	
13	Starting frequency	0.5 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
15	Jog frequency	5 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
18	High speed maximum frequency	120 Hz		Maximum motor rotations per minute*1	Maximum motor frequency*1	1 r/min	0.01 Hz
20	Acceleration/deceleration reference frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
22	Stall prevention operation level	150%*3		Torque limit level*4		0.1%	
37	Speed display	0		0		1	
55	Frequency monitoring reference	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
56	Current monitoring reference	Inverter rated current		Rated motor current*2		0.01 A	
71	Applied motor	0		4140		1	
80	Motor capacity	9999		Motor capacity*5		0.01 kW	
81	Number of motor poles	9999		Number of motor poles*6		1	
84	Rated motor frequency	9999		Rated motor rotations per minute*6	Rated motor frequency*6	1 r/min	0.01 Hz
85	Excitation current break point (magnetic flux command break point)	—		9999		1 r/min	0.01 Hz
86	Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)	—		9999		0.1%	
116	Third output frequency detection	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
125 (903)	Terminal 2 frequency setting gain frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
126 (905)	Terminal 4 frequency setting gain frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
144	Speed setting switchover	4		Number of motor poles + 100 (**Pr.81** + 100)	Number of motor poles (**Pr.81**)	1	
240	Soft-PWM operation selection	1		0		1	
263	Subtraction starting frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
266	Power failure deceleration time switchover frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
374	Overspeed detection level	9999		Maximum motor rotations per minute*1 + 10 Hz*7	Maximum motor frequency*1 + 10 Hz	1 r/min	0.01 Hz

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		4014 RF-SR (3000 r/min specification)	4114 RF-SR (3000 r/min specification)	4014	0, 4114
		FM	CA				
386	Frequency for maximum input pulse	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
505	Speed setting reference	60 Hz	50 Hz	Rated motor frequency		0.01 Hz	
545	Magnetic flux control P gain	—		100%		1%	
546	Magnetic flux control integral time	—		0.2 s		0.001 s	
557	Current average value monitor signal output reference current	Inverter rated current		Rated motor current*2		0.01 A	
820	Speed control P gain 1	60%		30%		1%	
821	Speed control integral time 1	0.333 s		0.333 s		0.001 s	
823	Speed detection filter 1 (speed estimation filter 1)	—		0.011 s		0.001 s	
824	Torque control P gain 1 (current loop proportional gain)	100%		100%		1%	
825	Torque control integral time 1 (current loop integral time)	5 ms		20 ms		0.1 ms	
870	Speed detection hysteresis	0 Hz		0.5 Hz*7	0.5 Hz	1 r/min	0.01 Hz
874	OLT level setting	—		Torque limit level*4		0.1%	
885	Regeneration avoidance compensation frequency limit value	6 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
893	Energy saving monitor reference (motor capacity)	Applicable motor capacity		Motor capacity (**Pr.80**)		0.01 kW	
C14 (918)	Terminal 1 gain frequency (speed)	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
1121	Per-unit speed control reference frequency	120 Hz		Maximum motor rotations per minute*1	Maximum motor frequency*1	1 r/min	0.01 Hz

—: Not changed

*1 When a value other than "9999" is set in **Pr.702 Maximum motor frequency**, the same value as the **Pr.702** setting value is set.

*2 Rated current of the RF-SR (3000 r/min specification). Refer to "Mitsubishi Electric synchronous reluctance motor RF-SR" on page 27. However, when a value other than "9999" is set in **Pr.859 Torque current/Rated PM motor current**, the same value as the **Pr.859** setting value is set.

*3 110% for SLD, 120% for LD, 150% for ND, and 200% for HD (Refer to "**Pr.570 Multiple rating setting**" in the FR-A800 Instruction Manual (Detailed).)

*4 110% when SLD is selected in **Pr.570 Multiple rating setting**. 120% when LD, ND, or HD is selected.

*5 If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.

*6 When a value other than "9999" is set, the set value is not changed.

*7 The setting value is converted from frequency to rotations per minute. The value is converted according to the **Pr.144 Speed setting switchover** setting.

◆SynRM specification list

Item	Motor model
	RF-SR (3000 r/min specification)
Rated motor rotations per minute (frequency)	3000 r/min (100 Hz)
Maximum motor rotations per minute (frequency)	5400 r/min (180 Hz)
Number of motor poles	4
Rated motor current and others	Refer to "Mitsubishi Electric synchronous reluctance motor RF-SR series" on page 27.

- For details on **Pr.998 PM/SynRM parameter initialization** not found in this Function Manual, refer to the FR-A800 Instruction Manual (Detailed).
- After performing parameter initialization in the procedure described above, set the acceleration/deceleration time and operation commands as required.
- After changing the parameters, perform test operation.

NOTE

- The speed setting range for the RF-SR (3000 r/min specification) is from 0 to 5400 r/min (0 to 180 Hz).
- The carrier frequency is limited to 2, 6, 10, or 14 kHz under SynRM magnetic flux vector control. (4 kHz during fast-response operation.)
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the motor position detection.
- When PM/SynRM parameter initialization is performed with the setting in units of rotations per minute, the parameters not listed in the list of the target parameters for the PM/SynRM parameter initialization and the monitor items are also set and displayed in rotations per minute.

◆List of the target parameters for the PM/SynRM parameter initialization (other than RF-SR)

The parameter settings in the following table are changed to the settings required to perform the SynRM magnetic flux vector control by selecting the SynRM magnetic flux vector control with **Pr.998 PM/SynRM parameter initialization**.
Performing Parameter clear or All parameter clear sets back the parameter settings to the settings required to drive an induction motor.

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		7009 (SynRM other than RF-SR)	7109 (SynRM other than RF-SR)	7009	7109
		FM	CA				
1	Maximum frequency	120 Hz*1 60 Hz*2		Maximum motor rotations per minute*3	Maximum motor frequency*3	1 r/min	0.01 Hz
4	Multi-speed setting (high speed)	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
13	Starting frequency	0.5 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
15	Jog frequency	5 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
18	High speed maximum frequency	120 Hz*1 60 Hz*2		Maximum motor rotations per minute*3	Maximum motor frequency*3	1 r/min	0.01 Hz
20	Acceleration/deceleration reference frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
22	Stall prevention operation level	150%*4		Torque limit level*4*6		0.1%	
37	Speed display	0		0		1	
55	Frequency monitoring reference	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
56	Current monitoring reference	Inverter rated current		**Pr.859**		0.01 A*1 0.1 A*2	
71	Applied motor	0		—		1	
80	Motor capacity	9999		—		0.01 kW*1 0.1 kW*2	
81	Number of motor poles	9999		—		1	
84	Rated motor frequency	9999		—		1 r/min	0.01 Hz
85	Excitation current break point (magnetic flux command break point)	—		9999		1 r/min	0.01 Hz
86	Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)	—		9999		0.1%	
116	Third output frequency detection	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
125 (903)	Terminal 2 frequency setting gain frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
126 (905)	Terminal 4 frequency setting gain frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
144	Speed setting switchover	4		Number of motor poles + 100 (**Pr.81** + 100)	Number of motor poles (**Pr.81**)	1	
240	Soft-PWM operation selection	1		0		1	
263	Subtraction starting frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
266	Power failure deceleration time switchover frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
374	Overspeed detection level	9999		Maximum motor rotations per minute*3 + 10 Hz*5	Maximum motor frequency*3 + 10 Hz	1 r/min	0.01 Hz
386	Frequency for maximum input pulse	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
505	Speed setting reference	60 Hz	50 Hz	**Pr.84**		0.01 Hz	
545	Magnetic flux control P gain	—		100%		1%	

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		7009 (SynRM other than RF-SR)	7109 (SynRM other than RF-SR)	7009	7109
		FM	CA				
546	**Magnetic flux control integral time**	—		0.2 s		0.001 s	
557	**Current average value monitor signal output reference current**	Inverter rated current		**Pr.859**		0.01 A*1 0.1 A*2	
820	**Speed control P gain 1**	60%		30%		1%	
821	**Speed control integral time 1**	0.333 s		0.333 s		0.001 s	
823	**Speed detection filter 1 (speed estimation filter 1)**	—		0.011 s		0.001 s	
824	**Torque control P gain 1 (current loop proportional gain)**	100%		100%		1%	
825	**Torque control integral time 1 (current loop integral time)**	5 ms		20 ms		0.1 ms	
870	**Speed detection hysteresis**	0 Hz		0.5 Hz*5	0.5 Hz	1 r/min	0.01 Hz
874	**OLT level setting**	—		Torque limit level*4		0.1%	
885	**Regeneration avoidance compensation frequency limit value**	6 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
893	**Energy saving monitor reference (motor capacity)**	Applicable motor capacity		Motor capacity (**Pr.80**)		0.01 kW*1 0.1 kW*2	
C14 (918)	**Terminal 1 gain frequency (speed)**	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
1121	**Per-unit speed control reference frequency**	120 Hz*1 60 Hz*2		Maximum motor rotations per minute*3	Maximum motor frequency*3	1 r/min	0.01 Hz

*1 Initial value for the FR-A820-03160(55K) or lower and the FR-A840-01800(55K) or lower.

*2 Initial value for the FR-A820-03800(75K) or higher and the FR-A840-02160(75K) or higher.

*3 When a value other than "9999" is set in **Pr.702 Maximum motor frequency**, the same value as the **Pr.702** setting value is set. When **Pr.702** = "9999 (initial value)", the **Pr.84 Rated motor frequency** setting is used as the maximum motor frequency (rotations per minute).

*4 110% for SLD, 120% for LD, 150% for ND, and 200% for HD (Refer to "**Pr.570 Multiple rating setting**" in the FR-A800 Instruction Manual (Detailed).)

*5 The setting value is converted from frequency to rotations per minute. The value is converted according to the **Pr.144 Speed setting switchover** setting.

*6 Depending on the applicable motor and the operating and installation conditions, the operation may become unstable before the torque limit operation. In such a case, set a smaller value in **Pr.22 Stall prevention operation level**.

NOTE

- The carrier frequency is limited to 2, 6, 10, or 14 kHz under SynRM magnetic flux vector control. (4 kHz during fast-response operation.)
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the motor position detection.
- When PM/SynRM parameter initialization is performed with the setting in units of rotations per minute, the parameters not listed in the list of the target parameters for the PM/SynRM parameter initialization and the monitor items are also set and displayed in rotations per minute.

1.3.4 Selection of the control method and the control mode

Select SynRM magnetic flux vector control by using parameters.

Motor capacity Pr.80 (Pr.453), Number of motor poles Pr.81 (Pr.454)	Applied motor Pr.71 (Pr.450)	Control method selection		Control method	Control mode
		Pr.800 setting	Pr.451 setting		
Other than 9999	4140 (RF-SR) 7090 (SynRM other than RF-SR)	9, 109	—	SynRM magnetic flux vector control test operation	
		20, 110*1*2*3		SynRM magnetic flux vector control	Speed control
		—	9999	The setting value of **Pr.800** is used for the second motor. (SynRM magnetic flux vector control (speed control) when **Pr.800** = "9 or 109")	
	Other than the above	Refer to the FR-A800 Instruction Manual (Detailed).			
9999*2	—	—	—	V/F control (Same as that of the FR-A800 standard model)	

*1 The setting values of "100" and above are used when the fast-response operation is selected. For details on the fast-response operation, refer to the FR-A800 Instruction Manual (Detailed).

*2 V/F control is applied when **Pr.80** or **Pr.81** is "9999" regardless of the **Pr.800** setting.
When **Pr.71 Applied motor** is set to the RF-SR, SynRM magnetic flux vector control is enabled even if **Pr.80** ≠ "9999" or **Pr.81** = "9999".

*3 The operation for the setting of "20" is performed when "0 to 6, or 10 to 14" is set.
The operation for the setting of "110" is performed when "100 to 106, or 111 to 114" is set.

◆SynRM magnetic flux vector control test operation (Pr.800 = "9, 109")

- A test operation for speed control is available without connecting a motor to the inverter.
- The speed calculation changes to track the speed command, and such speed changes can be checked on the operation panel or by outputting it as analog signals to terminal FM/CA or AM.

NOTE

- Since current is not detected and voltage is not output, the monitor items related to current and voltage, such as output current and output voltage, cannot be monitored, and the relevant output signals do not work.
- Under SynRM magnetic flux vector control, the output frequency becomes the same value as the command frequency.

1.3.5 Applied motor (Pr.71, Pr.450)

By setting these parameters and the parameters for the control method in accordance with the motor to be used, appropriate electronic thermal O/L relay characteristics and the motor constant necessary for control are set.

Pr.	Name	Initial value	Setting range	Description
71 **C100**	**Applied motor**	0	0 to 6, 13 to 16, 20, 23, 24, 30, 33, 34, 40, 43, 44, 50, 53, 54, 70, 73, 74, 330, 333, 334, 4140*1, 7090*1, 8090, 8093, 8094, 9090, 9093, 9094	By selecting a motor, the thermal characteristic and motor constant of each motor are set.
450 **C200**	**Second applied motor**	9999	0, 1, 3 to 6, 13 to 16, 20, 23, 24, 30, 33, 34, 40, 43, 44, 50, 53, 54, 70, 73, 74, 330, 333, 334, 4140*1, 7090*1, 8090, 8093, 8094, 9090, 9093, 9094	Set this parameter when using the second motor (the same specifications as **Pr.71**).
			9999	The function is disabled.

*1 The setting value "4140, 7090" is dedicated to the SynRM driving function.

◆Setting the applied motor

Refer to the following table and set the parameters according to the applied motor.

Applied motor		Motor	Motor constant value range (increment)	Electronic thermal O/L relay operation characteristic
Pr.71 setting	**Pr.450 setting**			
4140		Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	**Pr.859** (**Pr.860**) Rated motor current 0 to 500 A, 9999 (0.01 A) **Pr.90** (**Pr.458**) Motor constant (R1) 0 to 50 Ω, 9999 (0.001 Ω) **Pr.92** (**Pr.460**) Motor constant (d-axis inductance) 0 to 500 mH, 9999 (0.01 mH) **Pr.93** (**Pr.461**) Motor constant (q-axis inductance) 0 to 500 mH, 9999 (0.01 mH)	Characteristics dedicated to RF-SR (3000 r/min specification)
7090		Synchronous reluctance motor other than RF-SR		Characteristics for constant-torque motors
—	9999 (initial value)	No second applied motor		
Other than the above		Refer to the FR-A800 Instruction Manual (Detailed).		

NOTE

- When the Mitsubishi Electric synchronous reluctance motor RF-SR is used, setting is not required for the motor constant parameters (**Pr.859**, **Pr.90**, **Pr.92**, **Pr.93**, **Pr.860**, **Pr.458**, **Pr.460**, and **Pr.461**).
- To drive a synchronous reluctance motor other than the RF-SR, offline auto tuning must be performed. Offline auto tuning automatically sets the motor constant parameters (**Pr.859**, **Pr.90**, **Pr.92**, **Pr.93**, **Pr.860**, **Pr.458**, **Pr.460**, and **Pr.461**).

1.4 Adjustment under SynRM magnetic flux vector control

1.4.1 Speed estimation filter

Set the time constant of primary delay filter for the estimated speed value under SynRM magnetic flux vector control.

Pr.	Name	Initial value	Setting range	Description
823 G215*1	Speed detection filter 1 (speed estimation filter 1)	0.001 s	0	Without filter
			0.001 to 0.1 s	Set the time constant of primary delay filter for the estimated speed value under SynRM magnetic flux vector control.
833 G315*1	Speed detection filter 2 (speed estimation filter 2)	9999	0 to 0.1 s	Second function of **Pr.823** (enabled when the RT signal is ON)
			9999	Same as **Pr.823** setting

*1 The setting is available even when a Vector control compatible option is not installed. For the specifications under Vector control, refer to the FR-A800 Instruction Manual (Detailed).

◆Stabilizing speed estimation under SynRM magnetic flux vector control (Pr.823, Pr.833)

Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is.

If there is ripple for the estimated speed value, gradually raise the setting value until the estimated speed value stabilizes. The estimated speed value is oppositely destabilized if the setting value is too large.

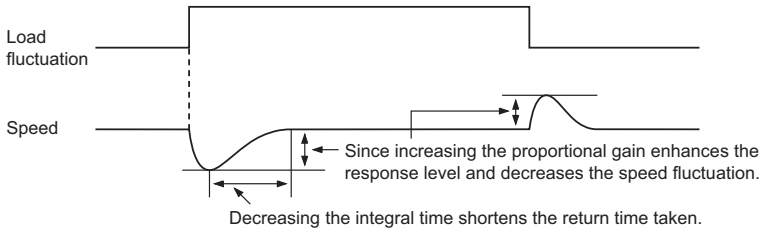
1.4.2 Adjusting the speed control gain

The speed control gain can be adjusted for the conditions such as abnormal machine vibration, acoustic noise, slow response, and overshoot.

Pr.	Name	Initial value	Setting range	Description
820 G211	Speed control P gain 1	60%	0% to 1000%	The proportional gain during speed control is set. (Setting this parameter higher improves the trackability for speed command changes. It also reduces the speed fluctuation caused by external disturbance.)
821 G212	Speed control integral time 1	0.333 s	0 to 20 s	The integral time during speed control is set. (Setting this parameter lower shortens the return time to the original speed when the speed fluctuates due to external disturbance.)
830 G311	Speed control P gain 2	9999	0% to 1000%	Second function of **Pr.820** (enabled when the RT signal is ON)
			9999	The **Pr.820** setting is applied to the operation.
831 G312	Speed control integral time 2	9999	0 to 20 s	Second function of **Pr.821** (enabled when the RT signal is ON)
			9999	The **Pr.821** setting is applied to the operation.

- **Pr.820 Speed control P gain 1** = "30%" is equivalent to 60 rad/s (speed response of a single motor). Setting a larger value in this parameter improves gain, but setting a too large value causes vibration and acoustic noise.
- Setting a smaller value in **Pr.821 Speed control integral time 1** shortens the return time to the original speed during speed fluctuation, but setting it too low causes overshoot.

• Actual speed gain is calculated as follows when load inertia is applied.



$$\text{Actual speed gain} = \text{Speed gain of a single motor} \times \frac{JM}{JM+JL}$$

JM: Motor inertia
JL: Load inertia converted as the motor axis inertia

◆Adjustment procedure

1 Change the Pr.820 setting while checking the conditions.

2 If it cannot be adjusted well, change Pr.821 setting, and perform step 1 again.

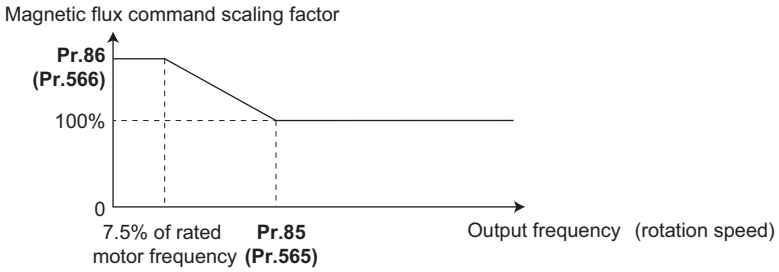
No.	Movement / condition	Adjustment method	
1	Load inertia is too high.	Set **Pr.820** and **Pr.821** higher.	
		Pr.820	If acceleration is slow, set about 80% to 90% of the maximum value without any vibration/acoustic noise while increasing the setting value by 10%.
		Pr.821	If overshoots occur, set about 80% to 90% of the maximum value without overshooting while increasing the setting value by twice.
2	Vibration or acoustic noise are generated from machines.	Set **Pr.820** lower and **Pr.821** higher.	
		Pr.820	Set about 80% to 90% of the maximum value without any vibration/noise while decreasing the setting value by 10%.
		Pr.821	If overshoots occur, set about 80% to 90% of the maximum value without overshooting while increasing the setting value by twice.
3	Response is slow.	Set **Pr.820** higher.	
		Pr.820	If acceleration is slow, raise the setting by 5% and then set the value to 80% to 90% of the setting immediately before vibration/noise starts occurring.
4	Return time (response time) is long.	Set **Pr.821** lower.	
		Set about 80% to 90% of the maximum value without overshooting or unstable movements while decreasing the setting value of **Pr.821** by half.	
5	Overshoots or unstable movements occur.	Set **Pr.821** higher.	
		Set about 80% to 90% of the maximum value without overshooting or unstable movements while increasing the setting value of **Pr.821** by twice.	

1.4.3 Magnetic flux command low-speed scaling factor

Under SynRM magnetic flux vector control, the magnetic flux command scaling factor in the low-speed range can be adjusted.

Pr.	Name	Initial value	Setting range	Description
85 G201	**Excitation current break point (magnetic flux command break point)**	9999	0 to 400 Hz	Set the frequency at which increased excitation is started.
			9999	When the RF-SR is selected: A pre-determined frequency is applied according to the motor selected. When a SynRM other than RF-SR is selected: 50% of the rated motor frequency is applied.
86 G202	**Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)**	9999	0% to 300%	Set a magnetic flux command scaling factor at 0 Hz.
			9999	When the RF-SR is selected: A pre-determined scaling factor is applied according to the motor selected. When a SynRM other than RF-SR is selected: 100% is applied.
565 G301	**Second motor excitation current break point (second motor magnetic flux command break point)**	9999	0 to 400 Hz	Set a magnetic flux command break point when the RT signal is ON.
			9999	A pre-determined frequency is applied according to the second motor selected.
566 G302	**Second motor excitation current low-speed scaling factor (second motor magnetic flux command low-speed scaling factor)**	9999	0% to 300%	Set a magnetic flux command low-speed scaling factor when the RT signal is ON.
			9999	A pre-determined scaling factor is applied according to the second motor selected.

- Under SynRM magnetic flux vector control, excitation current in the low-speed range can be increased to improve torque or frequency (speed) accuracy.
- Increased excitation is applied when the output frequency (rotation speed) is equal to or lower than the setting in **Pr.85 Excitation current break point (magnetic flux command break point)**. Set a magnetic flux command scaling factor when the output frequency is 7.5% of the **Pr.84 Rated motor frequency** setting in **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)**. For the settings when using the second motor (the RT signal is ON), use **Pr.565 Second motor excitation current break point (second motor magnetic flux command break point)** and **Pr.566 Second motor excitation current low-speed scaling factor (second motor magnetic flux command low-speed scaling factor)**.



- When a SynRM other than RF-SR is selected and the motor operation is unstable in the low-speed range, gradually increase the setting value of **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)** from 100% within the range where the operation does not become unstable. If the overcurrent protective function (E.OC[]) is activated during acceleration, gradually increase the setting value of **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)** from 100% within the range where E.OC[] does not occur. Note that setting a too large value in **Pr.86** may activate the electronic thermal O/L relay function.

NOTE

- Under SynRM magnetic flux vector control, **Pr.14 Load pattern selection** and **Pr.617 Reverse rotation excitation current low-speed scaling factor** are disabled.
- For details on Advanced magnetic flux vector control and Real sensorless vector control, refer to the FR-A800 Instruction Manual (Detailed).

1.4.4 Adjusting gain of current controllers for the d axis and the q axis

The gain of a current controller for SynRM magnetic flux vector control can be adjusted.
Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is.

Pr.	Name	Initial value	Setting range	Description
824 G213	**Torque control P gain 1 (current loop proportional gain)**	100%	0% to 500%	Set the proportional gain of the current controller.
825 G214	**Torque control integral time 1 (current loop integral time)**	5 ms	0 to 500 ms	Set the integral time of the current controller.
834 G313	**Torque control P gain 2 (current loop proportional gain 2)**	9999	0% to 500%	Set the proportional gain of the current controller when the RT signal is ON.
			9999	The **Pr.824** setting is applied to the operation.
835 G314	**Torque control integral time 2 (current loop integral time 2)**	9999	0 to 500 ms	Set the integral time of the current controller when the RT signal is ON.
			9999	The **Pr.825** setting is applied to the operation.

- Use **Pr.824 Torque control P gain 1 (current loop proportional gain)** to adjust the proportional gain of the current controllers for the d axis and the q axis.
  Setting a larger value in this parameter improves the trackability for current command changes. It also reduces the current fluctuation caused by external disturbances.
- Use **Pr.825 Torque control integral time 1 (current loop integral time)** to set the integral time of current controllers for the d axis and the q axis.
  Setting a smaller value in this parameter shortens the time to recover the original current value if the current fluctuates due to external disturbance.

1.4.5 Adjusting gain of a magnetic flux controller

The gain of a magnetic flux controller for SynRM magnetic flux vector control can be adjusted.
Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is. Adjust the gain of a magnetic flux controller if adjustment of the speed control gain or current control gain does not stabilize the operation.

Pr.	Name	Initial value	Setting range	Description
545 G258	**Magnetic flux control P gain**	100%	0% to 500%	Set the proportional gain of the magnetic flux controller.
546 G259	**Magnetic flux control integral time**	0.2 s	0 to 5 s	Set the integral time of the magnetic flux controller.

- Use **Pr.545 Magnetic flux control P gain** to adjust the proportional gain of the magnetic flux controller.
  Setting a larger value in this parameter improves the motor's trackability for magnetic flux command changes. It also improves the motor's behavior in response to external disturbance.
- Use **Pr.546 Magnetic flux control integral time** to set the integral time of the magnetic flux controller.
  Setting a smaller value in this parameter improves the motor's behavior in response to external disturbance if the magnetic flux fluctuates due to external disturbance.

1.5 Automatic restart after instantaneous power failure / flying start with the SynRM

Refer to "Automatic restart after instantaneous power failure/flying start with a PM motor" in Chapter 5 in the FR-A800 Instruction Manual (Detailed), and read "IPM motor" as "SynRM" in the descriptions.

POINT

- SynRM is not a motor with interior permanent magnets. Voltage is not generated when the motor coasts or at a flying start. Operation starts at 0 Hz in the low-speed range (frequency equal to or lower than 10% of the rated motor frequency). The time required for restart may be about one second longer than in the medium- and high-speed range.

1.6 Optimum excitation control when driving a SynRM

The inverter will automatically perform energy saving operation without setting detailed parameters.
This control method is suitable for applications such as fans and pumps.

Pr.	Name	Initial value	Setting range	Description
60 **G030**	**Energy saving control selection**	0	0, 4	Normal operation
			9	Optimum excitation control

- Setting **Pr.60** = "9" will select the Optimum excitation control.
- The Optimum excitation control is a control method to decide the output voltage by controlling the magnetic flux so that the motor becomes more efficient.

NOTE

- The energy saving effect may be insufficient when the Optimum excitation control is used for a motor other than the Mitsubishi Electric RF-SR series synchronous reluctance motor.
- The Optimum excitation control may make the motor operation unstable in the low-speed range depending on the driving conditions. If the motor operation is unstable, change the driving conditions or disable this function.
- For details on the operation under V/F control or Advanced magnetic flux vector control, refer to the FR-A800 Instruction Manual (Detailed).

1.7 Offline auto tuning for a SynRM

The offline auto tuning for a SynRM enables the optimal operation of a synchronous reluctance motor other than the Mitsubishi Electric RF-SR series.

- Automatic measurement of motor constants (offline auto tuning) enables optimal operation of motors for SynRM magnetic flux vector control even when motor constants vary or when the wiring distance is long.

Pr.	Name	Initial value	Setting range	Description
71 C100	**Applied motor**	0	0 to 6, 13 to 16, 20, 23, 24, 30, 33, 34, 40, 43, 44, 50, 53, 54, 70, 73, 74, 330, 333, 334, 4140, 7090, 8090, 8093, 8094, 9090, 9093, 9094	By selecting a motor, the thermal characteristic and the motor constant for each motor are set. 4140: RF-SR 7090: SynRM other than RF-SR
80 C101	**Motor capacity**	9999	0.4 to 55 kW*2	Set the applied motor capacity.
			0 to 3600 kW*3	
			9999	V/F control
81 C102	**Number of motor poles**	9999	2, 4, 6, 8, 10, 12	Set the number of motor poles.
			9999	V/F control
9 C103	**Electronic thermal O/L relay**	Inverter rated current*1	0 to 500 A*2	Set the rated motor current.
			0 to 3600 A*3	
83 C104	**Rated motor voltage**	200/ 400 V*4	0 to 1000 V	Set the rated motor voltage (V).
84 C105	**Rated motor frequency**	9999	10 to 400 Hz	Set the rated motor frequency (Hz).
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
702 C106	**Maximum motor frequency**	9999	0 to 400 Hz	Set the permissible speed (frequency) of the motor.
			9999	When the RF-SR is selected: RF-SR motor's maximum frequency is used. When a SynRM other than RF-SR is selected: **Pr.84** setting is used.
707 C107	**Motor inertia (integer)**	9999	10 to 999, 9999	Set the motor inertia. When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR motor's inertia is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
724 C108	**Motor inertia (exponent)**	9999	0 to 7, 9999	
96 C110	**Auto tuning setting/ status**	0	0, 101	No offline auto tuning
			1	Offline auto tuning is performed without the motor rotating (motor other than RF-SR).
			11	Offline auto tuning is performed without the motor rotating (under V/F control or for RF-SR).
90 C120	**Motor constant (R1)**	9999	0 to 50 Ω, 9999*2	Tuning data (The value measured by offline auto tuning is automatically set.) When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
			0 to 400 mΩ, 9999*3	
92 C122	**Motor constant (L1)/ d-axis inductance (Ld)**	9999	0 to 500 mH, 9999*2	
			0 to 50 mH, 9999*3	
93 C123	**Motor constant (L2)/ q-axis inductance (Lq)**	9999	0 to 500 mH, 9999*2	
			0 to 50 mH, 9999*3	
859 C126	**Torque current/Rated PM motor current/ Rated SynRM current**	9999	0 to 500 A, 9999*2	
			0 to 3600 A, 9999*3	
717 C182	**Starting resistance tuning compensation**	9999	0% to 200%, 9999	
721 C185	**Starting magnetic pole position detection pulse width**	9999	0 to 6000 μs, 10000 to 16000 μs, 9999	
725 C133	**Motor protection current level**	9999	100% to 500%	Set the maximum current (OCT) level of the motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.

Offline auto tuning for a SynRM

Pr.	Name	Initial value	Setting range	Description
450 C200	**Second applied motor**	9999	0, 1, 3 to 6, 13 to 16, 20, 23, 24, 30, 33, 34, 40, 43, 44, 50, 53, 54, 70, 73, 74, 330, 333, 334, 4140, 7090, 8090, 8093, 8094, 9090, 9093, 9094	Set this parameter when using the second motor. (Same specifications as **Pr.71**) 4140: RF-SR 7090: SynRM other than RF-SR
			9999	The function is disabled.
453 C201	**Second motor capacity**	9999	0.4 to 55 kW*2	Set the capacity of the second motor.
			0 to 3600 kW*3	
			9999	V/F control
454 C202	**Number of second motor poles**	9999	2, 4, 6, 8, 10, 12	Set the number of poles of the second motor.
			9999	V/F control
51 C203	**Second electronic thermal O/L relay**	9999	0 to 500 A*2	Set the rated current of the second motor.
			0 to 3600 A	
			9999	The second electronic thermal O/L relay is disabled.
456 C204	**Rated second motor voltage**	200/ 400 V*4	0 to 1000 V	Set the rated voltage (V) of the second motor.
457 C205	**Rated second motor frequency**	9999	10 to 400 Hz	Set the rated frequency (Hz) of the second motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
743 C206	**Second motor maximum frequency**	9999	0 to 400 Hz	Set the permissible speed (frequency) of the second motor.
			9999	When the RF-SR is selected: RF-SR motor's maximum frequency is used. When a SynRM other than RF-SR is selected: **Pr.457** setting is used.
744 C207	**Second motor inertia (integer)**	9999	10 to 999, 9999	Set the motor inertia of the second motor. When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR motor's inertia is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
745 C208	**Second motor inertia (exponent)**	9999	0 to 7, 9999	
463 C210	**Second motor auto tuning setting/status**	0	0, 101	No offline auto tuning
			1	Offline auto tuning is performed without the motor rotating (motor other than RF-SR).
			11	Offline auto tuning is performed without the motor rotating (under V/F control or for RF-SR).
458 C220	**Second motor constant (R1)**	9999	0 to 50 Ω, 9999*2	Tuning data of the second motor. (The value measured by offline auto tuning is automatically set.) When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
			0 to 400 mΩ, 9999*3	
460 C222	**Second motor constant (L1)/d-axis inductance (Ld)**	9999	0 to 500 mH, 9999*2	
			0 to 50 mH, 9999*3	
461 C223	**Second motor constant (L2)/q-axis inductance (Lq)**	9999	0 to 500 mH, 9999*2	
			0 to 50 mH, 9999*3	
860 C226	**Second motor torque current/Rated PM motor current**	9999	0 to 500 A, 9999*2	
			0 to 3600 A, 9999*3	
741 C282	**Second starting resistance tuning compensation**	9999	0% to 200%, 9999	
742 C285	**Second motor magnetic pole detection pulse width**	9999	0 to 6000 µs, 10000 to 16000 µs, 9999	
746 C233	**Second motor protection current level**	9999	100% to 500%	Set the maximum current (OCT) level of the second motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.

*1 For the FR-A820-00077(0.75K) or lower and the FR-A840-00038(0.75K) or lower, the 85% of the inverter rated current is set.

*2 For the FR-A820-03160(55K) or lower and the FR-A840-01800(55K) or lower.

*3 For the FR-A820-03800(75K) or higher and the FR-A840-02160(75K) or higher.

*4 The initial value differs according to the voltage class (200/400 V).

POINT

- The settings are valid under SynRM magnetic flux vector control.
- Offline auto tuning enables the operation with a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor. (To drive a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor, offline auto tuning must be performed.)
- Tuning is enabled even when a load is connected to the motor.
- Reading/writing of the motor constants tuned by offline auto tuning are enabled. The offline auto tuning data (motor constants) can be copied to another inverter using the operation panel.
- The offline auto tuning status can be monitored on the operation panel or the parameter unit.

◆Before performing offline auto tuning

Check the following points before performing offline auto tuning:

- Check that SynRM magnetic flux vector control is selected.
- Check that a motor is connected. (Check that the motor is not rotated by an external force during tuning.)
- The rated motor current should be equal to or less than the inverter rated current. (The motor capacity must be 0.4 kW or higher.)
  If a motor with substantially low rated current compared with the inverter rated current, however, is used, speed and torque accuracies may deteriorate due to torque ripples, etc. Set the rated motor current to about 40% or higher of the inverter rated current.
- The maximum frequency under SynRM magnetic flux vector control is 400 Hz.
- The motor may rotate slightly during offline auto tuning. (It does not affect the tuning performance.) Before tuning, make sure that it is safe even if the motor rotates. (Caution is required especially in vertical lift applications.)
- When the motor shaft is fixed, tuning accuracy may deteriorate. Driving a motor using low-accuracy tuning result may make the motor operation unstable. Perform tuning without fixing the motor shaft.
- Tuning may be disabled depending on the motor characteristics.

◆Settings

- To perform tuning, set the following parameters about the motor.

First motor Pr.	Second motor Pr.	Name	Setting for a SynRM other than RF-SR	Setting for RF-SR
80	**453**	Motor capacity	Motor capacity (kW)	Set by PM/SynRM parameter initialization.*1
81	**454**	Number of motor poles	Number of motor poles (2 to 12)	
9	**51**	Electronic thermal O/L relay	Rated motor current (A)	
84	**457**	Rated motor frequency	Rated motor frequency (Hz)	
83	**456**	Rated motor voltage	Rated motor voltage (V)	Initial value (200 V or 400 V)
71	**450**	Applied motor	7090	Set by PM/SynRM parameter initialization.*1 4140
96	**463**	Auto tuning setting/status	1	11

*1 For the settings by PM/SynRM parameter initialization, refer to page 8.

NOTE

- Under SynRM magnetic flux vector control, tuning cannot be performed even when **Pr.96** = "101".
  When the Mitsubishi Electric synchronous reluctance motor RF-SR is set to the applied motor, tuning cannot be performed even when **Pr.96** = "1".

- Set the following parameters when the motor constants are known in advance.

First motor Pr.	Second motor Pr.	Name	Setting for a SynRM other than RF-SR	Setting for RF-SR
702	**743**	Maximum motor frequency	Maximum motor frequency (Hz)	9999 (initial value)
707	**744**	Motor inertia (integer)	Motor inertia*2 Jm = **Pr.707** × 10^(-**Pr.724**) (kg·m^2)	9999 (initial value)
724	**745**	Motor inertia (exponent)		
725	**746**	Motor protection current level	Maximum current level of the motor (%)	9999 (initial value)

*2 The setting is valid only when a value other than "9999" is set in both **Pr.707** (**Pr.744**) and **Pr.724** (**Pr.745**).

◆Performing tuning

POINT

- Before performing tuning, check the monitor display of the operation panel or parameter unit if the inverter is in the state ready for tuning. The motor starts by turning ON the start command while tuning is unavailable.

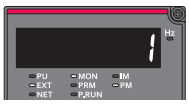
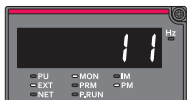
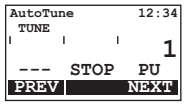
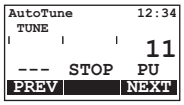
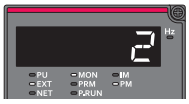
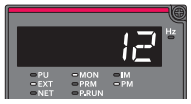
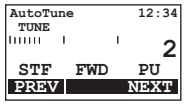
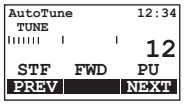
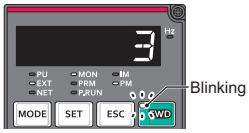
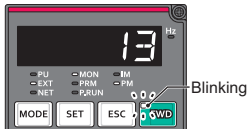
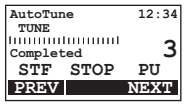
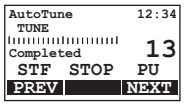
- In the PU operation mode, press FWD / REV on the operation panel.

  For External operation, turn ON the start command (STF signal or STR signal). Tuning starts.

NOTE

- Satisfy the required inverter start conditions to start offline auto tuning. For example, stop the input of the MRS signal.
- To force tuning to end, use the MRS or RES signal or STOP RESET on the operation panel. (Turning OFF the start signal (STF signal or STR signal) also ends tuning.)
- During offline auto tuning, only the following I/O signals are valid (initial value).
  Input terminals <valid signals>: STP (STOP), OH, MRS, RT, RES, STF, STR, S1, and S2
  Output terminals: RUN, OL, IPF, FM/CA, AM, A1B1C1, and So (SO)
- When the rotation speed and the output frequency are selected for terminals FM/CA and AM, the progress status of offline auto tuning is output in 15 steps from FM/CA and AM.
- Do not perform ON/OFF switching of the Second function selection (RT) signal during offline auto tuning. Auto tuning will not be performed properly.
- Since the Inverter running (RUN) signal turns ON when tuning is started, pay close attention especially when a sequence which releases a mechanical brake by the RUN signal has been designed.
- When executing offline auto tuning, input the operation command after switching ON the main circuit power (R/L1, S/L2, T/L3) of the inverter.
- While **Pr.79 Operation mode selection** = "7", turn ON the PU operation external interlock (X12) signal for tuning in the PU operation mode.
- Setting offline auto tuning (**Pr.96** = "1 or 11") will make pre-excitation invalid.

- During tuning, the monitor is displayed on the operation panel as follows.

Pr.96 (Pr.463) setting	1	11	1	11
	Operation panel (FR-DU08) display		LCD operation panel (FR-LU08) display	
(1) Setting				
(2) During tuning				
(3) Normal completion				

- When offline auto tuning ends, press STOP RESET on the operation panel during PU operation. For External operation, turn OFF the start signal (STF signal or STR signal). This operation resets the offline auto tuning, and the PU's monitor display returns to the normal indication. (Without this operation, next operation cannot be started.)

NOTE

- The motor constants measured once during offline auto tuning are stored as parameters and their data are held until offline auto tuning is performed again. However, the tuning data is cleared when performing All parameter clear.

- If offline auto tuning has ended in error (refer to the following table), motor constants are not set.
  Perform an inverter reset and perform tuning again.

Error display	Error cause	Countermeasures
8	Forced end	Set **Pr.96** (**Pr.463**) = "1 or 11" and retry.
9	Inverter protective function operation	Make the setting again.
92	The converter output voltage fell to 75% of the rated voltage.	Check for the power supply voltage fluctuation. Check the **Pr.83 Rated motor voltage** (**Pr.456 Rated second motor voltage**) setting.
93	Calculation error. The motor is not connected.	Check the motor wiring and make the setting again.

- When tuning is ended forcibly by pressing STOP RESET or turning OFF the start signal (STF or STR) during tuning, offline auto tuning does not end properly. (The motor constants have not been set.)
  Perform an inverter reset and perform tuning again.

NOTE

- An instantaneous power failure occurring during tuning will result in a tuning error.
  After power is restored, the inverter starts normal operation. Therefore, when the STF (STR) signal is ON, the motor starts forward (reverse) rotation.
- Any fault occurring during tuning is handled as in the normal operation. However, if the retry function is set, no retry is performed even when a protective function that performs a retry is activated.
- The set frequency monitor displayed during the offline auto tuning is 0 Hz.

⚠CAUTION

- **Note that the motor may start running suddenly.**

◆Parameters updated by tuning results after tuning

First motor Pr.	Second motor Pr.	Name	Pr.96 (Pr.463) = 1	Pr.96 (Pr.463) = 11	Description
90	**458**	Motor constant (R1)	○	○	Resistance per phase
92	**460**	Motor constant (L1)/d-axis inductance (Ld)	○	—	d-axis inductance
93	**461**	Motor constant (L2)/q-axis inductance (Lq)	○	—	q-axis inductance
717	**741**	Starting resistance tuning compensation	○	○	
721	**742**	Starting magnetic pole position detection pulse width	○	—	
859	**860**	Torque current/Rated PM motor current	○	—	
96	**463**	Auto tuning setting/status	○	○	

◆Changing the motor constants

- The motor constants can be set directly when the motor constants are known in advance, or by using the data measured during offline auto tuning.
- The changed settings are stored in the EEPROM as the motor constant parameters.
- Set desired values as the motor constant parameters.

First motor Pr.	Second motor Pr.	Name	Setting range	Setting increments	Initial value
90	**458**	Motor constant (R1)	0 to 50 Ω, 9999*1	0.001 Ω*1	9999
			0 to 400 mΩ, 9999*2	0.01 mΩ*2	
92	**460**	Motor constant (L1)/d-axis inductance (Ld)	0 to 500 mH, 9999*1	0.01 mH*1	
			0 to 50 mH, 9999*2	0.001 mH*2	
93	**461**	Motor constant (L2)/q-axis inductance (Lq)	0 to 500 mH, 9999*1	0.01 mH*1	
			0 to 50 mH, 9999*2	0.001 mH*2	
859	**860**	Torque current/Rated PM motor current	0 to 500 A, 9999*1	0.01 A*1	
			0 to 3600 A, 9999*2	0.1 A*2	

*1 For the FR-A820-03160(55K) or lower and the FR-A840-01800(55K) or lower.
*2 For the FR-A820-03800(75K) or higher and the FR-A840-02160(75K) or higher.

NOTE

- If "9999" is set, tuning data will be invalid. The RF-SR constant is used for the Mitsubishi Electric synchronous reluctance motor RF-SR, and the inverter internal constant is used for a synchronous reluctance motor other than RF-SR.

1.8 Specifications

1.8.1 Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)

◆Motor specifications

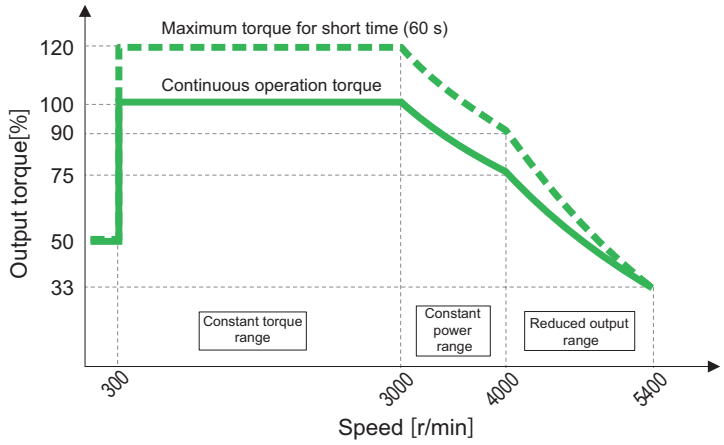
Motor model	200 V class RF-SR[]30S / 400 V class RF-SR[]30HS	5K	7K	11K	15K
Applicable inverter (LD rating)	200 V class FR-A820-[]-SYN	00340 (5.5K)	00490 (7.5K)	00630 (11K)	00770 (15K)
	400 V class FR-A840-[]-SYN	00170 (5.5K)	00250 (7.5K)	00310 (11K)	00380 (15K)
Continuous characteristics*1	Rated output power (kW)	5.5	7.5	11.0	15.0
	Rated torque (N·m)	17.51	23.87	35.01	47.75
Rated speed (r/min)*1		3000			
Maximum speed (r/min)		5400			
Number of poles		4			
Maximum torque		120% 60 s			
Rated current (A)*2	200 V class	22.2	30.8	45.6	60.2
	400 V class	11.1	15.4	22.8	30.1

*1 The rated output power or speed is not guaranteed at low supply voltages.

*2 The rated current is the value used to operate the inverter functions. Set the value in the table above in the parameter in which the rated motor current is to be set.

◆Motor torque characteristic

The torque characteristics of the RF-SR (3000 r/min specification) driven by the inverter (LD rating) are shown in graph form as follows.



NOTE

- The characteristics above assume that the wiring length between the inverter and the motor is 5 m or less and the DC bus voltage inside the inverter is equal to or higher than the specified value (282 V or higher for the 200 V class or 565 V or higher for the 400 V class). The maximum torque may be reduced under the following conditions.
  - The wiring length between the inverter and the motor is long.
  - The DC bus voltage of the inverter drops.

1.8.2 Control specifications

The following table shows the control specifications added to this inverter. For the control specifications not found in the table, refer to "Common specifications" in Chapter 8 in the FR-A800 Instruction Manual (Detailed).

Item	Description
Control method	SynRM magnetic flux vector control
Output frequency range	0.2 to 590 Hz (The upper frequency limit is 400 Hz under SynRM magnetic flux vector control.)
Starting torque	50% (SynRM magnetic flux vector control)
Torque limit level	Torque limit value can be set (0% to 400% variable). (SynRM magnetic flux vector control)

2 DIFFERENCES BETWEEN THE FR-A800-SYN AND THE STANDARD MODEL

Some functions of the FR-A800 standard model are changed in this inverter. The functions not found in Chapter 1 are the same as those of the FR-A800 standard model. For the functions added in and after August 2022, only the following functions are supported.

◆Extended detection time of the output current and zero current

The setting range of the **Pr.151 Output current detection signal delay time** and **Pr.153 Zero current detection time** is extended.

Pr.	Name	Initial value	Setting range	Description
151 M461	**Output current detection signal delay time**	0 s	0 to 300 s	Set the output current detection time. Enter the time from when the output current reaches the set current or higher to when the Output current detection (Y12) signal is output.
153 M463	**Zero current detection time**	0.5 s	0 to 300 s	Set the time from when the output current drops to the **Pr.152** setting or lower to when the Zero current detection (Y13) signal is output.

2.1 Specification comparison among control methods

The following table shows the main differences in specifications among control methods.

Item	SynRM magnetic flux vector control (RF-SR)	PM sensorless vector control (MM-CF)		Induction motor control
Applicable motor	Mitsubishi Electric synchronous reluctance motor RF-SR series (3000 r/min, 5.5 to 15 kW) SynRM other than the above are supported by offline auto tuning.	IPM motor MM-CF series IPM motors other than the above are supported by offline auto tuning.		Induction motor
Maximum starting torque	50%	High frequency superposition control	150%	200% (FR-A820-00250(3.7K) or lower and FR-A840-00126(3.7K) or lower), or 150% (FR-A820-00340(5.5K) or higher and FR-A840-00170(5.5K) or higher) (under Real sensorless vector control or Vector control)
		Current synchronization operation	50%	
Zero speed control	Not available	High frequency superposition control	Available	Available (under Real sensorless vector control or Vector control)
		Current synchronization operation	Not available	
Automatic restart after instantaneous power failure	No startup waiting time*1	No startup waiting time*1		Startup waiting time exists.
Startup delay	Startup delay of about 0.1 s for initial tuning.	Startup delay of about 0.1 s for initial tuning.		No startup delay (when online auto tuning is not performed at startup).
Driving by the commercial power supply	Not available*2	Not available*2		Available (Other than Vector control dedicated motor.)
Number of connectable motors	1	1		Multiple motors can be driven (under V/F control).

Specification comparison among control methods

Item		SynRM magnetic flux vector control (RF-SR)	PM sensorless vector control (MM-CF)		Induction motor control
Operation during coasting		Voltage is not generated across motor terminals.	Voltage is generated across motor terminals.*3		Voltage is not generated across motor terminals.
Torque control		Not available	Not available		Available (under Real sensorless vector control or Vector control)
Position control		Not available	High frequency superposition control	Available	Available (under Real sensorless vector control or Vector control)
			Current synchronization operation	Not available	
Vector control		Not available	Available (A Vector control compatible option and a motor with encoder are required.)		Available (A Vector control compatible option and a motor with encoder are required.)
Offline auto tuning		Available	High frequency superposition control	Not available	Available
			Current synchronization operation	Available	
Torque bias		Not available	Not available		Available (under Real sensorless vector control or Vector control)
Speed feed forward control / model adaptive speed control		Not available	High frequency superposition control	Available	Available (under Real sensorless vector control or Vector control)
			Current synchronization operation	Not available	
Energy saving control	**Energy saving contol**	Not available	Not available		Available (under V/F control)
	Optimum excitation control	Available			Available (under V/F control or Advanced magnetic flux vector control)

*1 Using the regeneration avoidance function or retry function together is recommended.

*2 Do not connect the motor to a commercial power supply.

*3 High voltage is generated at the motor terminals while the motor is running even when the power of the inverter is turned OFF. Before wiring or inspection, confirm that the motor is stopped.

◆Functions available under SynRM magnetic flux vector control

Functions available under SynRM magnetic flux vector control are the same as those available under PM sensorless vector control, except for the following functions. For information not found in this manual, read "PM sensorless vector control" in the FR-A800 Instruction Manual (Detailed) as "SynRM magnetic flux vector control".

Function	Description
Control method selection (**Pr.800**(**Pr.451**))	Position control is not available. Vector control with encoder is not available.
Low-speed range torque characteristic selection (**Pr.788**(**Pr.747**))	Even if the low-speed range high-torque characteristic is enabled (high frequency superposition control is applied) by **Pr.788** (**Pr.747**), the low-speed range high-torque characteristic is disabled (current synchronization operation is applied).
Easy gain tuning selection (**Pr.819**)	Easy gain tuning is disabled.
Speed feed forward control / model adaptive speed control selection (**Pr.877**)	Speed feed forward control and model adaptive speed control are disabled.
Constant output range speed control P gain compensation (**Pr.1116**)	Compensation function for the speed control P gain in the constant output range is disabled.

NOTE

- Parameter copy cannot be performed between the FR-A800-SYN and other models (such as the FR-A800 standard model).

2.2 Applicable standards

The following table shows the differences of the applicable standards from the FR-A800 standard model.

Standard/certification	FR-A800-SYN	FR-A800 standard model
UL/cUL standards	○	○
EU Directive (CE marking)	○	○
Waste Electrical and Electronic Equipment Directive (WEEE Directive)	○	○
UK certification scheme (UKCA marking)	○	○
Radio Waves Act (South Korea) (KC marking)	×	○
EAC certification	○	○
EU ErP Directive (Ecodesign Directive)	○	○
Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products (China RoHS)	○	○
Chinese standardized law	○	○
Functional safety standard "IEC 61508 SIL 2"	○	○
Functional safety standard "IEC 61508:2010 SIL 3"	×	○

○: Compliant ×: Not compliant

3 SynRM DRIVING FUNCTIONS OF THE FR-F800-SYN

3.1 Overview

This Function Manual describes the synchronous reluctance motor driving functions. For the functions not found in this Function Manual, refer to the FR-F800 Instruction Manual (Detailed).

◆Abbreviation/term

Abbreviation/term	Description
SynRM	Synchronous reluctance motor
SynRM magnetic flux vector control	Inverter's control method and function name for driving the SynRM
RF-SR	Mitsubishi Electric synchronous reluctance motor RF-SR series

◆SynRM driving function parameter list

The following parameters and settings can be used for the SynRM driving functions. Set the parameters according to the application.

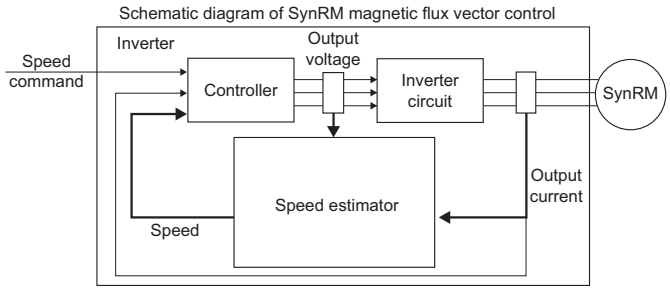
Pr.	Pr. group	Name	Setting range	Minimum setting increments	Initial value	Refer to page
71	C100	Applied motor	4140, 7090*1	1	0	43
450	C200	Second applied motor	4140, 7090*1	1	9999	43
545	G258	Magnetic flux control P gain	0% to 500%	1%	100%	47
546	G259	Magnetic flux control integral time	0 to 5 s	0.001 s	0.2 s	47
823	G215	Speed detection filter 1 (speed estimation filter 1)	0 to 0.1 s	0.001 s	0.001 s	44
833	G315	Speed detection filter 2 (speed estimation filter 2)	0 to 0.1 s, 9999	0.001 s	9999	44
998	E430	PM/SynRM parameter initialization	4014, 4114, 7009, 7109*1	1	0	36

*1 For other settings, refer to the FR-F800 Instruction Manual (Detailed).

3.2 SynRM magnetic flux vector control

- Highly efficient motor control is enabled by using the inverter and the SynRM, which is more efficient than an induction motor.
- A speed detector such as an encoder is not required as the inverter estimates and controls the motor speed by the calculation from the inverter output voltage and current.
- Just performing PM/SynRM parameter initialization automatically and collectively changes the parameters required to perform SynRM magnetic flux vector control.

Schematic diagram of SynRM magnetic flux vector control



NOTE

SynRM magnetic flux vector control requires the following conditions.

- The SynRM is used.
- One motor is driven by one inverter.
- The wiring length from the inverter to the motor is 100 m or less.
- A surge voltage suppression filter (FR-ASF/FR-BMF) or sine wave filter (MT-BSL/BSC) is not used.
- If the carrier frequency setting is high, uneven rotation may occur at a low speed. In such a case, set a smaller value in **Pr.72 PWM frequency selection**.

3.3 Speed control by SynRM magnetic flux vector control

3.3.1 Setting procedure of SynRM magnetic flux vector control (speed control)

The inverter is set for an induction motor in the initial setting. Follow the following procedure to change the setting for the SynRM magnetic flux vector control.

◆Driving the RF-SR

◆Operating procedure

1 **Set Pr.570 Multiple rating setting.**

When driving the Mitsubishi Electric synchronous reluctance motor RF-SR series, refer to the following table to set **Pr.570 Multiple rating setting**.

Motor	Inverter	Pr.570 Multiple rating setting (0: SLD rating, 1: LD rating)
RF-SR5K30S (200 V) RF-SR5K30HS (400 V)	FR-F820-00250(5.5K)-SYN (200 V) FR-F840-00126(5.5K)-SYN (400 V)	0: SLD rating
	FR-F820-00340(7.5K)-SYN (200 V) FR-F840-00170(7.5K)-SYN (400 V)	1: LD rating
RF-SR7K30S (200 V) RF-SR7K30HS (400 V)	FR-F820-00340(7.5K)-SYN (200 V) FR-F840-00170(7.5K)-SYN (400 V)	0: SLD rating
	FR-F820-00490(11K)-SYN (200 V) FR-F840-00250(11K)-SYN (400 V)	1: LD rating
RF-SR11K30S (200 V) RF-SR11K30HS (400 V)	FR-F820-00490(11K)-SYN (200 V) FR-F840-00250(11K)-SYN (400 V)	0: SLD rating
	FR-F820-00630(15K)-SYN (200 V) FR-F840-00310(15K)-SYN (400 V)	1: LD rating
RF-SR15K30S (200 V) RF-SR15K30HS (400 V)	FR-F820-00630(15K)-SYN (200 V) FR-F840-00310(15K)-SYN (400 V)	0: SLD rating
	FR-F820-00770(18.5K)-SYN (200 V) FR-F840-00380(18.5K)-SYN (400 V)	1: LD rating

2 **Perform inverter reset and All parameter clear.**

3 **Set the motor capacity (kW) of the motor to be used in Pr.80 Motor capacity.**

4 **Configure the initial parameter setting for the SynRM.**

Two methods are available to perform parameter initialization: using IPM/SynRM initialization mode (" PMSM ") on the operation panel, and using **Pr.998 PM/SynRM parameter initialization**.

To configure the initial setting using **Pr.998 PM/SynRM parameter initialization**, set "4014 or 4114" in **Pr.998**. (Refer to page 36.)

To configure the initial setting using IPM/SynRM initialization mode on the operation panel, refer to page 35.

5 **Set parameters such as the acceleration/deceleration time and multi-speed setting.**

Set parameters such as the acceleration/deceleration time and multi-speed setting as required.

6 **Set the operation command.**

Select the start command and speed command.

7 **Perform the test operation.**

◆Driving a SynRM other than RF-SR

◆Operating procedure

1 Set the applied motor. (Pr.9, Pr.71, Pr.80, Pr.81, Pr.83, Pr.84)

Set "7090" (synchronous reluctance motor other than RF-SR) in **Pr.71 Applied motor. Set Pr.9 Rated motor current, Pr.80 Motor capacity, Pr.81 Number of motor poles, Pr.83 Rated motor voltage, and Pr.84 Rated motor frequency** according to the motor specifications. (Setting "9999 (initial value)" in **Pr.80 or Pr.81** selects V/F control.)

2 Perform the offline auto tuning for a SynRM. (Pr.96) (Refer to page 49.)

Set "1" (offline auto tuning without rotating motor (for other than RF-SR)) in **Pr.96**, and perform tuning.

3 Configure the initial setting for the SynRM magnetic flux vector control using Pr.998. (Refer to page 36.)

When the setting for the SynRM is selected in **Pr.998 PM/SynRM parameter initialization**, the SynRM magnetic flux vector control is selected. The [PM] indicator on the operation panel (FR-DU08) is turned ON when the SynRM magnetic flux vector control is set.

Setting	Description
7009	Parameter settings (in rotations per minute) for a SynRM other than RF-SR
7109	Parameter settings (in frequencies) for a SynRM other than RF-SR

4 Set parameters such as the acceleration/deceleration time and multi-speed setting.

Set parameters such as the acceleration/deceleration time and multi-speed setting as required.

5 Set the operation command.

Select the start command and speed command.

6 Perform the test operation.

NOTE

- To change to the SynRM magnetic flux vector control, perform PM/SynRM parameter initialization first. If parameter initialization is performed after setting other parameters, some of those parameters are initialized too. (Refer to page 37 for the parameters that are initialized.)
- To use a motor capacity that is one rank lower than the inverter capacity, set **Pr.80 Motor capacity** before performing PM/SynRM parameter initialization.
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the magnetic pole position detection.

3.3.2 Setting for the SynRM magnetic flux vector control by selecting parameter initialization on the operation panel

The following shows the procedure to initialize the parameter settings for the Mitsubishi Electric synchronous reluctance motor RF-SR by selecting IPM/SynRM initialization mode on the operation panel.

◆Operating procedure

1 Turning ON the power of the inverter

The operation panel is in the monitor mode.

2 Changing the operation mode

Press [PU EXT] to choose the PU operation mode.

The [PU] indicator turns ON.

3 Selecting the parameter setting mode

Press [MODE] to choose the parameter setting mode.

The [PRM] indicator is ON.

4 IPM/SynRM initialization mode selection

Turn until " PMSM " (IPM/SynRM initialization mode) appears.

5 Displaying the set value

Press [SET] to read the present set value.

" 0 " (initial value) appears.

6 Changing the setting value

Turn to change the value to " 40 14 ", and press [SET] to confirm it.

" 40 14 " and " PMSM " are displayed alternately. The setting is completed.

NOTE

- If parameters are initialized for the SynRM in the IPM/SynRM initialization mode, the **Pr.998 PM/SynRM parameter initialization** setting is automatically changed.
- If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. After initializing SynRM parameters, check the setting value of **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.
- To set a speed by adjusting frequencies or to monitor it, use **Pr.998 PM/SynRM parameter initialization**. Alternatively, change the **Pr.144 Speed setting switchover** setting after parameter initialization in the IPM/SynRM initialization mode.
- To initialize the parameter settings for a motor different from the currently set motor after initializing SynRM parameters, set the multiple rating setting again and perform All parameter clear before initializing the parameter settings. Then set the parameters required for the motor to be used.

POINT

- The [PM] indicator (controlled motor type LED indicator) on the operation panel (FR-DU08) is turned ON when the SynRM magnetic flux vector control is set.

3.3.3 Setting for the SynRM magnetic flux vector control by PM/SynRM parameter initialization (Pr.998)

Use **PM/SynRM parameter initialization** to set the parameters required for driving the Mitsubishi Electric synchronous reluctance motor RF-SR.

Offline auto tuning enables the operation with a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor.

Pr.	Name	Initial value	Setting value	Description	
998 E430	PM/SynRM parameter initialization	0	0	Parameter settings (in frequencies) for an induction motor	The setting of the motor parameters is changed to the setting required to drive an induction motor.
			12,112	Parameter settings for the IPM motor MM-EFS (1500 r/min specification) or MM-THE4	*1
			14,114	Parameter settings for the IPM motor MM-EFS (3000 r/min specification)	
			4014	Parameter settings (in rotations per minute) for the Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	The setting of the motor parameters is changed to the setting required to drive the Mitsubishi Electric synchronous reluctance motor RF-SR.
			4114	Parameter settings (in frequencies) for the Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	
			7009	Parameter settings (in rotations per minute) for a SynRM other than RF-SR (after tuning)	The setting of the motor parameters is changed to the setting required to drive a synchronous reluctance motor other than RF-SR. (Set **Pr.71 Applied motor** and perform offline auto tuning in advance. (Refer to page 49.))
			7109	Parameter settings (in frequencies) for a SynRM other than RF-SR (after tuning)	
			8009, 8109	Parameter settings for an IPM motor other than MM-EFS and MM-THE4 (after tuning)	*1
			9009, 9109	Parameter settings for an SPM motor (after tuning)	

*1 For details, refer to the FR-F800 Instruction Manual (Detailed).

- To use a motor capacity that is one rank lower than the inverter capacity, set **Pr.80 Motor capacity** before performing PM/SynRM parameter initialization.
- When **Pr.998** = "4014, 7009", the monitor is displayed and the frequency is set using the motor rotations per minute (r/min). To set/monitor in frequencies (Hz), set **Pr.998** = "4114, 7109".
- When using a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor, set **Pr.998** = "7009 or 7109".

NOTE

- If the setting of **Pr.998 PM/SynRM parameter initialization** is changed, some parameters will be initialized too. (Refer to the "List of the target parameters for the PM/SynRM parameter initialization".)
- To change back to the parameter settings required to drive an induction motor, perform Parameter clear or All parameter clear.
- If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. After initializing SynRM parameters, check the setting value of **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.
- If the setting of **Pr.998 PM/SynRM parameter initialization** is changed between "4014, 7009 (rotations per minute)" and "4114, 7109 (frequency)", all the relevant parameters are initialized to the setting values in "List of the target parameters for the PM/SynRM parameter initialization". The purpose of **Pr.998** is not to change the display units. Use **Pr.144 Speed setting switchover** to change the display units between rotations per minute and frequency. Using **Pr.144** enables switching the units between rotations per minute and frequency without initializing the setting of the motor parameters. Example) Changing the **Pr.144** setting between "4" and "104" switches the display units between frequency and rotations per minute.
- For an inverter out of the applicable capacity range of the Mitsubishi Electric synchronous reluctance motor RF-SR, the settings "4014 and 4114" are disabled.
- **Pr.998 PM/SynRM parameter initialization** is used for change of parameter settings for use of the SynRM as the first motor. When the SynRM is used as the second motor, parameters for the second motor must be set individually.
- To initialize the parameter settings for a motor different from the currently set motor after initializing SynRM parameters, set the multiple rating setting again and perform All parameter clear before initializing the parameter settings. Then set the parameters required for the motor to be used.

◆List of the target parameters for the PM/SynRM parameter initialization (RF-SR)

The parameter settings in the following table are changed to the settings required to perform the SynRM magnetic flux vector control by selecting the SynRM magnetic flux vector control with the IPM/SynRM initialization mode on the operation panel or with **Pr.998 PM/SynRM parameter initialization**.

Performing Parameter clear or All parameter clear sets back the parameter settings to the settings required to drive an induction motor.

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		4014 RF-SR (3000 r/min specification)	4114 RF-SR (3000 r/min specification)	4014	0, 4114
		FM	CA				
1	Maximum frequency	120 Hz		Maximum motor rotations per minute*1	Maximum motor frequency*1	1 r/min	0.01 Hz
4	Multi-speed setting (high speed)	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
9	Electronic thermal O/L relay	Inverter rated current		Rated motor current*2		0.01 A	
13	Starting frequency	0.5 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
15	Jog frequency	5 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
18	High speed maximum frequency	120 Hz		Maximum motor rotations per minute*1	Maximum motor frequency*1	1 r/min	0.01 Hz
20	Acceleration/deceleration reference frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
22	Stall prevention operation level	*3		Torque limit level*4		0.1%	
37	Speed display	0		0		1	
55	Frequency monitoring reference	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
56	Current monitoring reference	Inverter rated current		Rated motor current*2		0.01 A	
71	Applied motor	0		4140		1	
80	Motor capacity	9999		Motor capacity*5		0.01 kW	
81	Number of motor poles	9999		Number of motor poles*6		1	
84	Rated motor frequency	9999		Rated motor rotations per minute*6	Rated motor frequency*6	1 r/min	0.01 Hz
85	Excitation current break point (magnetic flux command break point)	—		9999		1 r/min	0.01 Hz
86	Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)	—		9999		0.1%	
125 (903)	Terminal 2 frequency setting gain frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
126 (905)	Terminal 4 frequency setting gain frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
144	Speed setting switchover	4		Number of motor poles + 100 (**Pr.81** + 100)	Number of motor poles (**Pr.81**)	1	
240	Soft-PWM operation selection	1		0		1	
263	Subtraction starting frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
266	Power failure deceleration time switchover frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
374	Overspeed detection level	9999		Maximum motor rotations per minute*1 + 10 Hz*7	Maximum motor frequency*1 + 10 Hz	1 r/min	0.01 Hz
390	% setting reference frequency	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz
505	Speed setting reference	60 Hz	50 Hz	Rated motor frequency		0.01 Hz	

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		4014 RF-SR (3000 r/min specification)	4114 RF-SR (3000 r/min specification)	4014	0, 4114
		FM	CA				
545	Magnetic flux control P gain	—		100%		1%	
546	Magnetic flux control integral time	—		0.2 s		0.001 s	
557	Current average value monitor signal output reference current	Inverter rated current		Rated motor current*2		0.01 A	
820	Speed control P gain 1	—		30%		1%	
821	Speed control integral time 1	—		0.333 s		0.001 s	
823	Speed detection filter 1 (speed estimation filter 1)	—		0.011 s		0.001 s	
824	Torque control P gain 1 (current loop proportional gain)	—		100%		1%	
825	Torque control integral time 1 (current loop integral time)	—		20 ms		0.1 ms	
870	Speed detection hysteresis	0 Hz		0.5 Hz*7	0.5 Hz	1 r/min	0.01 Hz
874	OLT level setting	—		Torque limit level*4		0.1%	
885	Regeneration avoidance compensation frequency limit value	6 Hz		Rated motor rotations per minute × 10%	Rated motor frequency × 10%	1 r/min	0.01 Hz
893	Energy saving monitor reference (motor capacity)	Applicable motor capacity		Motor capacity (**Pr.80**)		0.01 kW	
C14 (918)	Terminal 1 gain frequency (speed)	60 Hz	50 Hz	Rated motor rotations per minute	Rated motor frequency	1 r/min	0.01 Hz

—: Not changed

*1 When a value other than "9999" is set in **Pr.702 Maximum motor frequency**, the same value as the **Pr.702** setting value is set.

*2 Rated current of the RF-SR (3000 r/min specification). Refer to "Mitsubishi Electric synchronous reluctance motor RF-SR" on page 55. However, when a value other than "9999" is set in **Pr.859 Torque current/Rated PM motor current**, the same value as the **Pr.859** setting value is set.

*3 110% for SLD, 120% for LD, (Refer to "**Pr.570 Multiple rating setting**" in the FR-F800 Instruction Manual (Detailed).)

*4 110% when SLD is selected in **Pr.570 Multiple rating setting**. 120% when LD is selected.

*5 If the SynRM parameters are initialized while **Pr.80 Motor capacity** = "9999", the motor capacity (kW) in accordance with the setting of **Pr.570 Multiple rating setting** will be set in **Pr.80 Motor capacity**. When SynRM parameters are initialized while a value other than "9999" is set in **Pr.80 Motor capacity**, the set value is not changed.

*6 When a value other than "9999" is set, the set value is not changed.

*7 The setting value is converted from frequency to rotations per minute. The value is converted according to the **Pr.144 Speed setting switchover** setting.

◆SynRM specification list

Item	Motor model
	RF-SR (3000 r/min specification)
Rated motor rotations per minute (frequency)	3000 r/min (100 Hz)
Maximum motor rotations per minute (frequency)	5400 r/min (180 Hz)
Number of motor poles	4
Rated motor current and others	Refer to "Mitsubishi Electric synchronous reluctance motor RF-SR series" on page 55.

- For details on **Pr.998 PM/SynRM parameter initialization** not found in this Function Manual, refer to the FR-F800 Instruction Manual (Detailed).
- After performing parameter initialization in the procedure described above, set the acceleration/deceleration time and operation commands as required.
- After changing the parameters, perform test operation.

NOTE

- The speed setting range for the RF-SR (3000 r/min specification) is from 0 to 5400 r/min (0 to 180 Hz).
- The carrier frequency is limited to 2, 6, 10, or 14 kHz under SynRM magnetic flux vector control. (4 kHz during fast-response operation.)
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the motor position detection.
- When PM/SynRM parameter initialization is performed with the setting in units of rotations per minute, the parameters not listed in the list of the target parameters for the PM/SynRM parameter initialization and the monitor items are also set and displayed in rotations per minute.

◆List of the target parameters for the PM/SynRM parameter initialization (other than RF-SR)

The parameter settings in the following table are changed to the settings required to perform the SynRM magnetic flux vector control by selecting the SynRM magnetic flux vector control with **Pr.998 PM/SynRM parameter initialization**.
Performing Parameter clear or All parameter clear sets back the parameter settings to the settings required to drive an induction motor.

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		7009 (SynRM other than RF-SR)	7109 (SynRM other than RF-SR)	7009	7109
		FM	CA				
1	Maximum frequency	120 Hz*1 60 Hz*2		Maximum motor rotations per minute*3	Maximum motor frequency*3	1 r/min	0.01 Hz
4	Multi-speed setting (high speed)	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
13	Starting frequency	0.5 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
15	Jog frequency	5 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
18	High speed maximum frequency	120 Hz*1 60 Hz*2		Maximum motor rotations per minute*3	Maximum motor frequency*3	1 r/min	0.01 Hz
20	Acceleration/deceleration reference frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
22	Stall prevention operation level	*4		Torque limit level*4*6		0.1%	
37	Speed display	0		0		1	
55	Frequency monitoring reference	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
56	Current monitoring reference	Inverter rated current		**Pr.859**		0.01 A*1 0.1 A*2	
71	Applied motor	0		—		1	
80	Motor capacity	9999		—		0.01 kW*1 0.1 kW*2	
81	Number of motor poles	9999		—		1	
84	Rated motor frequency	9999		—		1 r/min	0.01 Hz
85	Excitation current break point (magnetic flux command break point)	—		9999		1 r/min	0.01 Hz
86	Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)	—		9999		0.1%	
125 (903)	Terminal 2 frequency setting gain frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
126 (905)	Terminal 4 frequency setting gain frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
144	Speed setting switchover	4		Number of motor poles + 100 (**Pr.81** + 100)	Number of motor poles (**Pr.81**)	1	
240	Soft-PWM operation selection	1		0		1	
263	Subtraction starting frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
266	Power failure deceleration time switchover frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
374	Overspeed detection level	9999		Maximum motor rotations per minute*3 + 10 Hz*5	Maximum motor frequency*3 + 10 Hz	1 r/min	0.01 Hz
390	% setting reference frequency	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz
505	Speed setting reference	60 Hz	50 Hz	**Pr.84**		0.01 Hz	
545	Magnetic flux control P gain	—		100%		1%	
546	Magnetic flux control integral time	—		0.2 s		0.001 s	

Pr.	Name	Setting value				Setting increments	
		Induction motor		SynRM (rotations per minute setting)	SynRM (frequency setting)		
		0 (initial value)		7009 (SynRM other than RF-SR)	7109 (SynRM other than RF-SR)	7009	7109
		FM	CA				
557	**Current average value monitor signal output reference current**	Inverter rated current		**Pr.859**		0.01 A*1 0.1 A*2	
820	**Speed control P gain 1**	—		30%		1%	
821	**Speed control integral time 1**	—		0.333 s		0.001 s	
823	**Speed detection filter 1 (speed estimation filter 1)**	—		0.011 s		0.001 s	
824	**Torque control P gain 1 (current loop proportional gain)**	—		100%		1%	
825	**Torque control integral time 1 (current loop integral time)**	—		20 ms		0.1 ms	
870	**Speed detection hysteresis**	0 Hz		0.5 Hz*5	0.5 Hz	1 r/min	0.01 Hz
874	**OLT level setting**	—		Torque limit level*4		0.1%	
885	**Regeneration avoidance compensation frequency limit value**	6 Hz		**Pr.84** × 10%		1 r/min	0.01 Hz
893	**Energy saving monitor reference (motor capacity)**	Applicable motor capacity		Motor capacity (**Pr.80**)		0.01 kW*1 0.1 kW*2	
C14 (918)	**Terminal 1 gain frequency (speed)**	60 Hz	50 Hz	**Pr.84**		1 r/min	0.01 Hz

*1 Initial value for the FR-F820-02330(55K) or lower and the FR-F840-01160(55K) or lower.

*2 Initial value for the FR-F820-03160(75K) or higher and the FR-F840-01800(75K) or higher.

*3 When a value other than "9999" is set in **Pr.702 Maximum motor frequency**, the same value as the **Pr.702** setting value is set. When **Pr.702** = "9999 (initial value)", the **Pr.84 Rated motor frequency** setting is used as the maximum motor frequency (rotations per minute).

*4 110% for SLD and 120% for LD (Refer to "**Pr.570 Multiple rating setting**" in the FR-F800 Instruction Manual (Detailed).)

*5 The setting value is converted from frequency to rotations per minute. The value is converted according to the **Pr.144 Speed setting switchover** setting.

*6 Depending on the applicable motor and the operating and installation conditions, the operation may become unstable before the torque limit operation. In such a case, set a smaller value in **Pr.22 Stall prevention operation level**.

NOTE

- The carrier frequency is limited to 2, 6, 10, or 14 kHz under SynRM magnetic flux vector control. (4 kHz during fast-response operation.)
- Under SynRM magnetic flux vector control, the RUN signal is output about 100 ms after turning ON the start command (STF, STR). The delay is due to the motor position detection.
- When PM/SynRM parameter initialization is performed with the setting in units of rotations per minute, the parameters not listed in the list of the target parameters for the PM/SynRM parameter initialization and the monitor items are also set and displayed in rotations per minute.

3.3.4 Selection of the control method and the control mode

Select SynRM magnetic flux vector control by using parameters.

Motor capacity Pr.80 (Pr.453), Number of motor poles Pr.81 (Pr.454)	Applied motor Pr.71 (Pr.450)	Control method selection Pr.800 setting	Control method	Control mode
Other than 9999	4140 (RF-SR) 7090 (SynRM other than RF-SR)	9, 109	SynRM magnetic flux vector control test operation	
		20, 110*1*2	SynRM magnetic flux vector control	Speed control
	Other than the above	Refer to the FR-F800 Instruction Manual (Detailed).		
9999*2	—	—	V/F control (Same as that of the FR-F800 standard model)	

*1 The setting values of "100" and above are used when the fast-response operation is selected. For details on the fast-response operation, refer to the FR-F800 Instruction Manual (Detailed).

*2 V/F control is applied when **Pr.80** or **Pr.81** is "9999" regardless of the **Pr.800** setting.
When **Pr.71 Applied motor** is set to the RF-SR, SynRM magnetic flux vector control is enabled even if **Pr.80** ≠ "9999" or **Pr.81** = "9999".

◆SynRM magnetic flux vector control test operation (Pr.800 = "9, 109")

- A test operation for speed control is available without connecting a motor to the inverter.
- The speed calculation changes to track the speed command, and such speed changes can be checked on the operation panel or by outputting it as analog signals to terminal FM/CA or AM.

NOTE

- Since current is not detected and voltage is not output, the monitor items related to current and voltage, such as output current and output voltage, cannot be monitored, and the relevant output signals do not work.
- Under SynRM magnetic flux vector control, the output frequency becomes the same value as the command frequency.

3.3.5 Applied motor (Pr.71, Pr.450)

By setting these parameters and the parameters for the control method in accordance with the motor to be used, appropriate electronic thermal O/L relay characteristics and the motor constant necessary for control are set.

Pr.	Name	Initial value	Setting range	Description
71 **C100**	**Applied motor**	0	0 to 6, 13 to 16, 20, 23, 24, 40, 43, 44, 50, 53, 54, 70, 73, 74, 210, 213, 214, 240, 243, 244, 4140*1, 7090*1, 8090, 8093, 8094, 9090, 9093, 9094	By selecting a motor, the thermal characteristic and motor constant of each motor are set.
450 **C200**	**Second applied motor**	9999	0, 1, 3 to 6, 13 to 16, 20, 23, 24, 40, 43, 44, 50, 53, 54, 70, 73, 74, 210, 213, 214, 240, 4140*1, 7090*1, 8090, 8093, 8094, 9090, 9093, 9094	Set this parameter when using the second motor (the same specifications as **Pr.71**).
			9999	The function is disabled.

*1 The setting value "4140, 7090" is dedicated to the SynRM driving function.

◆Setting the applied motor

Refer to the following table and set the parameters according to the applied motor.

Applied motor		Motor	Motor constant value range (increment)	Electronic thermal O/L relay operation characteristic
Pr.71 setting	**Pr.450 setting**			
4140		Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)	**Pr.859** (**Pr.860**) Rated motor current 0 to 500 A, 9999 (0.01 A) **Pr.90** (**Pr.458**) Motor constant (R1) 0 to 50 Ω, 9999 (0.001 Ω) **Pr.92** (**Pr.460**) Motor constant (d-axis inductance) 0 to 500 mH, 9999 (0.01 mH) **Pr.93** (**Pr.461**) Motor constant (q-axis inductance) 0 to 500 mH, 9999 (0.01 mH)	Characteristics dedicated to RF-SR (3000 r/min specification)
7090		Synchronous reluctance motor other than RF-SR		Characteristics for constant-torque motors
—	9999 (initial value)	No second applied motor		
Other than the above		Refer to the FR-F800 Instruction Manual (Detailed).		

NOTE

- When the Mitsubishi Electric synchronous reluctance motor RF-SR is used, setting is not required for the motor constant parameters (**Pr.859**, **Pr.90**, **Pr.92**, **Pr.93**, **Pr.860**, **Pr.458**, **Pr.460**, and **Pr.461**).
- To drive a synchronous reluctance motor other than the RF-SR, offline auto tuning must be performed. Offline auto tuning automatically sets the motor constant parameters (**Pr.859**, **Pr.90**, **Pr.92**, **Pr.93**, **Pr.860**, **Pr.458**, **Pr.460**, and **Pr.461**).

3.4 Adjustment under SynRM magnetic flux vector control

3.4.1 Speed estimation filter

Set the time constant of primary delay filter for the estimated speed value under SynRM magnetic flux vector control.

Pr.	Name	Initial value	Setting range	Description
823 G215	Speed detection filter 1 (speed estimation filter 1)	0.001 s	0	Without filter
			0.001 to 0.1 s	Set the time constant of primary delay filter for the estimated speed value under SynRM magnetic flux vector control.
833 G315	Speed detection filter 2 (speed estimation filter 2)	9999	0 to 0.1 s	Second function of **Pr.823** (enabled when the RT signal is ON)
			9999	Same as **Pr.823** setting

◆Stabilizing speed estimation under SynRM magnetic flux vector control (Pr.823, Pr.833)

Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is.

If there is ripple for the estimated speed value, gradually raise the setting value until the estimated speed value stabilizes.

The estimated speed value is oppositely destabilized if the setting value is too large.

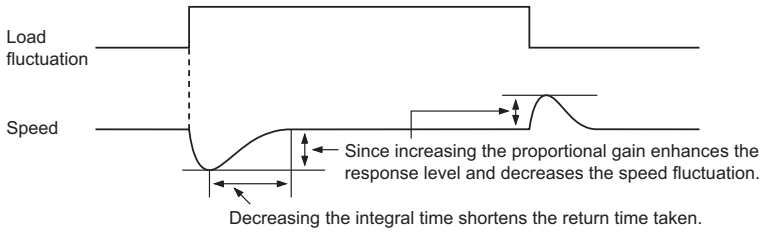
3.4.2 Adjusting the speed control gain

The speed control gain can be adjusted for the conditions such as abnormal machine vibration, acoustic noise, slow response, and overshoot.

Pr.	Name	Initial value	Setting range	Description
820 G211	Speed control P gain 1	25%	0% to 1000%	The proportional gain during speed control is set. (Setting this parameter higher improves the trackability for speed command changes. It also reduces the speed fluctuation caused by external disturbance.)
821 G212	Speed control integral time 1	0.333 s	0 to 20 s	The integral time during speed control is set. (Setting this parameter lower shortens the return time to the original speed when the speed fluctuates due to external disturbance.)
830 G311	Speed control P gain 2	9999	0% to 1000%	Second function of **Pr.820** (enabled when the RT signal is ON)
			9999	The **Pr.820** setting is applied to the operation.
831 G312	Speed control integral time 2	9999	0 to 20 s	Second function of **Pr.821** (enabled when the RT signal is ON)
			9999	The **Pr.821** setting is applied to the operation.

- **Pr.820 Speed control P gain 1** = "30%" is equivalent to 60 rad/s (speed response of a single motor). Setting a larger value in this parameter improves gain, but setting a too large value causes vibration and acoustic noise.
- Setting a smaller value in **Pr.821 Speed control integral time 1** shortens the return time to the original speed during speed fluctuation, but setting it too low causes overshoot.

• Actual speed gain is calculated as follows when load inertia is applied.



$$\text{Actual speed gain} = \text{Speed gain of a single motor} \times \frac{JM}{JM+JL}$$

JM: Motor inertia
JL: Load inertia converted as the motor axis inertia

◆Adjustment procedure

1 Change the Pr.820 setting while checking the conditions.

2 If it cannot be adjusted well, change Pr.821 setting, and perform step 1 again.

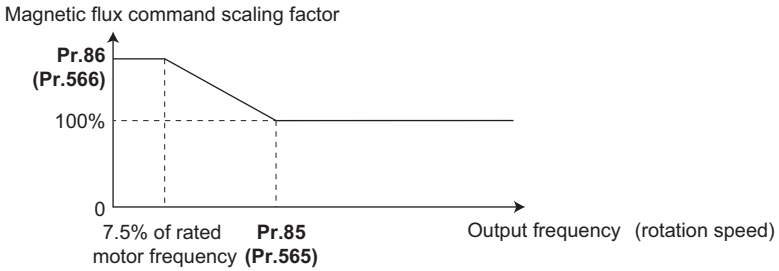
No.	Movement / condition	Adjustment method	
1	Load inertia is too high.	Set **Pr.820** and **Pr.821** higher.	
		Pr.820	If acceleration is slow, set about 80% to 90% of the maximum value without any vibration/acoustic noise while increasing the setting value by 10%.
		Pr.821	If overshoots occur, set about 80% to 90% of the maximum value without overshooting while increasing the setting value by twice.
2	Vibration or acoustic noise are generated from machines.	Set **Pr.820** lower and **Pr.821** higher.	
		Pr.820	Set about 80% to 90% of the maximum value without any vibration/noise while decreasing the setting value by 10%.
		Pr.821	If overshoots occur, set about 80% to 90% of the maximum value without overshooting while increasing the setting value by twice.
3	Response is slow.	Set **Pr.820** higher.	
		Pr.820	If acceleration is slow, raise the setting by 5% and then set the value to 80% to 90% of the setting immediately before vibration/noise starts occurring.
4	Return time (response time) is long.	Set **Pr.821** lower.	
		Set about 80% to 90% of the maximum value without overshooting or unstable movements while decreasing the setting value of **Pr.821** by half.	
5	Overshoots or unstable movements occur.	Set **Pr.821** higher.	
		Set about 80% to 90% of the maximum value without overshooting or unstable movements while increasing the setting value of **Pr.821** by twice.	

3.4.3 Magnetic flux command low-speed scaling factor

Under SynRM magnetic flux vector control, the magnetic flux command scaling factor in the low-speed range can be adjusted.

Pr.	Name	Initial value	Setting range	Description
85 **G201**	**Excitation current break point (magnetic flux command break point)**	9999	0 to 400 Hz	Set the frequency at which increased excitation is started.
			9999	When the RF-SR is selected: A pre-determined frequency is applied according to the motor selected. When a SynRM other than RF-SR is selected: 50% of the rated motor frequency is applied.
86 **G202**	**Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)**	9999	0% to 300%	Set a magnetic flux command scaling factor at 0 Hz.
			9999	When the RF-SR is selected: A pre-determined scaling factor is applied according to the motor selected. When a SynRM other than RF-SR is selected: 100% is applied.
565 **G301**	**Second motor excitation current break point (second motor magnetic flux command break point)**	9999	0 to 400 Hz	Set a magnetic flux command break point when the RT signal is ON.
			9999	A pre-determined frequency is applied according to the second motor selected.
566 **G302**	**Second motor excitation current low-speed scaling factor (second motor magnetic flux command low-speed scaling factor)**	9999	0% to 300%	Set a magnetic flux command low-speed scaling factor when the RT signal is ON.
			9999	A pre-determined scaling factor is applied according to the second motor selected.

- Under SynRM magnetic flux vector control, excitation current in the low-speed range can be increased to improve torque or frequency (speed) accuracy.
- Increased excitation is applied when the output frequency (rotation speed) is equal to or lower than the setting in **Pr.85 Excitation current break point (magnetic flux command break point)**. Set a magnetic flux command scaling factor when the output frequency is 7.5% of the **Pr.84 Rated motor frequency** setting in **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)**. For the settings when using the second motor (the RT signal is ON), use **Pr.565 Second motor excitation current break point (second motor magnetic flux command break point)** and **Pr.566 Second motor excitation current low-speed scaling factor (second motor magnetic flux command low-speed scaling factor)**.



- When a SynRM other than RF-SR is selected and the motor operation is unstable in the low-speed range, gradually increase the setting value of **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)** from 100% within the range where the operation does not become unstable. If the overcurrent protective function (E.OC[]) is activated during acceleration, gradually increase the setting value of **Pr.86 Excitation current low-speed scaling factor (magnetic flux command low-speed scaling factor)** from 100% within the range where E.OC[] does not occur. Note that setting a too large value in **Pr.86** may activate the electronic thermal O/L relay function.

NOTE

- Under SynRM magnetic flux vector control, **Pr.14 Load pattern selection** and **Pr.617 Reverse rotation excitation current low-speed scaling factor** are disabled.
- For details on Advanced magnetic flux vector control, refer to the FR-F800 Instruction Manual (Detailed).

3.4.4 Adjusting gain of current controllers for the d axis and the q axis

The gain of a current controller for SynRM magnetic flux vector control can be adjusted.
Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is.

Pr.	Name	Initial value	Setting range	Description
824 G213	**Torque control P gain 1 (current loop proportional gain)**	50%	0% to 500%	Set the proportional gain of the current controller.
825 G214	**Torque control integral time 1 (current loop integral time)**	40 ms	0 to 500 ms	Set the integral time of the current controller.
834 G313	**Torque control P gain 2 (current loop proportional gain 2)**	9999	0% to 500%	Set the proportional gain of the current controller when the RT signal is ON.
			9999	The **Pr.824** setting is applied to the operation.
835 G314	**Torque control integral time 2 (current loop integral time 2)**	9999	0 to 500 ms	Set the integral time of the current controller when the RT signal is ON.
			9999	The **Pr.825** setting is applied to the operation.

- Use **Pr.824 Torque control P gain 1 (current loop proportional gain)** to adjust the proportional gain of the current controllers for the d axis and the q axis.
  Setting a larger value in this parameter improves the trackability for current command changes. It also reduces the current fluctuation caused by external disturbances.
- Use **Pr.825 Torque control integral time 1 (current loop integral time)** to set the integral time of current controllers for the d axis and the q axis.
  Setting a smaller value in this parameter shortens the time to recover the original current value if the current fluctuates due to external disturbance.

3.4.5 Adjusting gain of a magnetic flux controller

The gain of a magnetic flux controller for SynRM magnetic flux vector control can be adjusted.
Under ordinary circumstances, use the value for SynRM magnetic flux vector control, which has been set with PM/SynRM parameter initialization, as it is. Adjust the gain of a magnetic flux controller if adjustment of the speed control gain or current control gain does not stabilize the operation.

Pr.	Name	Initial value	Setting range	Description
545 G258	**Magnetic flux control P gain**	100%	0% to 500%	Set the proportional gain of the magnetic flux controller.
546 G259	**Magnetic flux control integral time**	0.2 s	0 to 5 s	Set the integral time of the magnetic flux controller.

- Use **Pr.545 Magnetic flux control P gain** to adjust the proportional gain of the magnetic flux controller.
  Setting a larger value in this parameter improves the motor's trackability for magnetic flux command changes. It also improves the motor's behavior in response to external disturbance.
- Use **Pr.546 Magnetic flux control integral time** to set the integral time of the magnetic flux controller.
  Setting a smaller value in this parameter improves the motor's behavior in response to external disturbance if the magnetic flux fluctuates due to external disturbance.

3.5 Automatic restart after instantaneous power failure / flying start with the SynRM

Refer to "Automatic restart after instantaneous power failure/flying start with a PM motor" in Chapter 5 in the FR-F800 Instruction Manual (Detailed), and read "IPM motor" as "SynRM" in the descriptions.

POINT

- SynRM is not a motor with interior permanent magnets. Voltage is not generated when the motor coasts or at a flying start. Operation starts at 0 Hz in the low-speed range (frequency equal to or lower than 10% of the rated motor frequency). The time required for restart may be about one second longer than in the medium- and high-speed range.

3.6 Optimum excitation control when driving a SynRM

The inverter will automatically perform energy saving operation without setting detailed parameters.
This control method is suitable for applications such as fans and pumps.

Pr.	Name	Initial value	Setting range	Description
60 **G030**	**Energy saving control selection**	0	0, 4	Normal operation
			9	Optimum excitation control

- Setting **Pr.60** = "9" will select the Optimum excitation control.
- The Optimum excitation control is a control method to decide the output voltage by controlling the magnetic flux so that the motor becomes more efficient.

NOTE

- The energy saving effect may be insufficient when the Optimum excitation control is used for a motor other than the Mitsubishi Electric RF-SR series synchronous reluctance motor.
- The Optimum excitation control may make the motor operation unstable in the low-speed range depending on the driving conditions. If the motor operation is unstable, change the driving conditions or disable this function.
- For details on the operation under V/F control or Advanced magnetic flux vector control, refer to the FR-F800 Instruction Manual (Detailed).

3.7 Offline auto tuning for a SynRM

The offline auto tuning for a SynRM enables the optimal operation of a synchronous reluctance motor other than the Mitsubishi Electric RF-SR series.

- Automatic measurement of motor constants (offline auto tuning) enables optimal operation of motors for SynRM magnetic flux vector control even when motor constants vary or when the wiring distance is long.

Pr.	Name	Initial value	Setting range	Description
71 C100	**Applied motor**	0	0 to 6, 13 to 16, 20, 23, 24, 40, 43, 44, 50, 53, 54, 70, 73, 74, 210, 213, 214, 240, 243, 244, 4140, 7090, 8090, 8093, 8094, 9090, 9093, 9094	By selecting a motor, the thermal characteristic and the motor constant for each motor are set. 4140: RF-SR 7090: SynRM other than RF-SR
80 C101	**Motor capacity**	9999	0.4 to 55 kW*1	Set the applied motor capacity.
			0 to 3600 kW*2	
			9999	V/F control
81 C102	**Number of motor poles**	9999	2, 4, 6, 8, 10, 12	Set the number of motor poles.
			9999	V/F control
9 C103	**Electronic thermal O/L relay**	Inverter rated current	0 to 500 A*1	Set the rated motor current.
			0 to 3600 A*2	
83 C104	**Rated motor voltage**	200/ 400 V*3	0 to 1000 V	Set the rated motor voltage (V).
84 C105	**Rated motor frequency**	9999	10 to 400 Hz	Set the rated motor frequency (Hz).
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
702 C106	**Maximum motor frequency**	9999	0 to 400 Hz	Set the permissible speed (frequency) of the motor.
			9999	When the RF-SR is selected: RF-SR motor's maximum frequency is used. When a SynRM other than RF-SR is selected: **Pr.84** setting is used.
707 C107	**Motor inertia (integer)**	9999	10 to 999, 9999	Set the motor inertia. When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR motor's inertia is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
724 C108	**Motor inertia (exponent)**	9999	0 to 7, 9999	
96 C110	**Auto tuning setting/ status**	0	0, 101	No offline auto tuning
			1	Offline auto tuning is performed without the motor rotating (motor other than RF-SR).
			11	Offline auto tuning is performed without the motor rotating (under V/F control or for RF-SR).
90 C120	**Motor constant (R1)**	9999	0 to 50 Ω, 9999*1	Tuning data (The value measured by offline auto tuning is automatically set.) When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
			0 to 400 mΩ, 9999*2	
92 C122	**Motor constant (L1)/ d-axis inductance (Ld)**	9999	0 to 500 mH, 9999*1	
			0 to 50 mH, 9999*2	
93 C123	**Motor constant (L2)/ q-axis inductance (Lq)**	9999	0 to 500 mH, 9999*1	
			0 to 50 mH, 9999*2	
859 C126	**Torque current/Rated PM motor current/ Rated SynRM current**	9999	0 to 500 A, 9999*1	
			0 to 3600 A, 9999*2	
717 C182	**Starting resistance tuning compensation**	9999	0% to 200%, 9999	
721 C185	**Starting magnetic pole position detection pulse width**	9999	0 to 6000 μs, 10000 to 16000 μs, 9999	
725 C133	**Motor protection current level**	9999	100% to 500%	Set the maximum current (OCT) level of the motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.

Pr.	Name	Initial value	Setting range	Description
450 C200	**Second applied motor**	9999	0, 1, 3 to 6, 13 to 16, 20, 23, 24, 40, 43, 44, 50, 53, 54, 70, 73, 74, 210, 213, 214, 240, 243, 244, 4140, 7090, 8090, 8093, 8094, 9090, 9093, 9094	Set this parameter when using the second motor. (Same specifications as **Pr.71**) 4140: RF-SR 7090: SynRM other than RF-SR
			9999	The function is disabled.
453 C201	**Second motor capacity**	9999	0.4 to 55 kW*1	Set the capacity of the second motor.
			0 to 3600 kW*2	
			9999	V/F control
454 C202	**Number of second motor poles**	9999	2, 4, 6, 8, 10, 12	Set the number of poles of the second motor.
			9999	V/F control
51 C203	**Second electronic thermal O/L relay**	9999	0 to 500 A*1	Set the rated current of the second motor.
			0 to 3600 A*2	
			9999	The second electronic thermal O/L relay is disabled.
456 C204	**Rated second motor voltage**	200/ 400 V*3	0 to 1000 V	Set the rated voltage (V) of the second motor.
457 C205	**Rated second motor frequency**	9999	10 to 400 Hz	Set the rated frequency (Hz) of the second motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
743 C206	**Second motor maximum frequency**	9999	0 to 400 Hz	Set the permissible speed (frequency) of the second motor.
			9999	When the RF-SR is selected: RF-SR motor's maximum frequency is used. When a SynRM other than RF-SR is selected: **Pr.457** setting is used.
744 C207	**Second motor inertia (integer)**	9999	10 to 999, 9999	Set the motor inertia of the second motor. When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR motor's inertia is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
745 C208	**Second motor inertia (exponent)**	9999	0 to 7, 9999	
463 C210	**Second motor auto tuning setting/status**	0	0, 101	No offline auto tuning
			1	Offline auto tuning is performed without the motor rotating (motor other than RF-SR).
			11	Offline auto tuning is performed without the motor rotating (under V/F control or for RF-SR).
458 C220	**Second motor constant (R1)**	9999	0 to 50 Ω, 9999*1	Tuning data of the second motor. (The value measured by offline auto tuning is automatically set.) When "9999" is set, the following value is used. When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.
			0 to 400 mΩ, 9999*2	
460 C222	**Second motor constant (L1)/d-axis inductance (Ld)**	9999	0 to 500 mH, 9999*1	
			0 to 50 mH, 9999*2	
461 C223	**Second motor constant (L2)/q-axis inductance (Lq)**	9999	0 to 500 mH, 9999*1	
			0 to 50 mH, 9999*2	
860 C226	**Second motor torque current/Rated PM motor current**	9999	0 to 500 A, 9999*1	
			0 to 3600 A, 9999*2	
741 C282	**Second starting resistance tuning compensation**	9999	0% to 200%, 9999	
742 C285	**Second motor magnetic pole detection pulse width**	9999	0 to 6000 μs, 10000 to 16000 μs, 9999	
746 C233	**Second motor protection current level**	9999	100% to 500%	Set the maximum current (OCT) level of the second motor.
			9999	When the RF-SR is selected: RF-SR constant is used. When a SynRM other than RF-SR is selected: Inverter internal data is used.

*1 For the FR-F820-02330(55K) or lower and the FR-F840-01160(55K) or lower.

*2 For the FR-F820-03160(75K) or higher and the FR-F840-01800(75K) or higher.

*3 The initial value differs according to the voltage class (200/400 V).

POINT

- The settings are valid under SynRM magnetic flux vector control.
- Offline auto tuning enables the operation with a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor. (To drive a synchronous reluctance motor other than the Mitsubishi Electric RF-SR motor, offline auto tuning must be performed.)
- Tuning is enabled even when a load is connected to the motor.
- Reading/writing of the motor constants tuned by offline auto tuning are enabled. The offline auto tuning data (motor constants) can be copied to another inverter using the operation panel.
- The offline auto tuning status can be monitored on the operation panel or the parameter unit.

◆Before performing offline auto tuning

Check the following points before performing offline auto tuning:

- Check that SynRM magnetic flux vector control is selected.
- Check that a motor is connected. (Check that the motor is not rotated by an external force during tuning.)
- The rated motor current should be equal to or less than the inverter rated current. (The motor capacity must be 0.4 kW or higher.)
  If a motor with substantially low rated current compared with the inverter rated current, however, is used, speed and torque accuracies may deteriorate due to torque ripples, etc. Set the rated motor current to about 40% or higher of the inverter rated current.
- The maximum frequency under SynRM magnetic flux vector control is 400 Hz.
- The motor may rotate slightly during offline auto tuning. (It does not affect the tuning performance.) Before tuning, make sure that it is safe even if the motor rotates. (Caution is required especially in vertical lift applications.)
- When the motor shaft is fixed, tuning accuracy may deteriorate. Driving a motor using low-accuracy tuning result may make the motor operation unstable. Perform tuning without fixing the motor shaft.
- Tuning may be disabled depending on the motor characteristics.

◆Settings

- To perform tuning, set the following parameters about the motor.

First motor Pr.	Second motor Pr.	Name	Setting for a SynRM other than RF-SR	Setting for RF-SR
80	**453**	Motor capacity	Motor capacity (kW)	Set by PM/SynRM parameter initialization.*1
81	**454**	Number of motor poles	Number of motor poles (2 to 12)	
9	**51**	Electronic thermal O/L relay	Rated motor current (A)	
84	**457**	Rated motor frequency	Rated motor frequency (Hz)	
83	**456**	Rated motor voltage	Rated motor voltage (V)	Initial value (200 V or 400 V)
71	**450**	Applied motor	7090	Set by PM/SynRM parameter initialization.*1 4140
96	**463**	Auto tuning setting/status	1	11

*1 For the settings by PM/SynRM parameter initialization, refer to page 36.

NOTE

- Under SynRM magnetic flux vector control, tuning cannot be performed even when **Pr.96** = "101".
  When the Mitsubishi Electric synchronous reluctance motor RF-SR is set to the applied motor, tuning cannot be performed even when **Pr.96** = "1".

- Set the following parameters when the motor constants are known in advance.

First motor Pr.	Second motor Pr.	Name	Setting for a SynRM other than RF-SR	Setting for RF-SR
702	**743**	Maximum motor frequency	Maximum motor frequency (Hz)	9999 (initial value)
707	**744**	Motor inertia (integer)	Motor inertia*2 Jm = **Pr.707** × 10^(-**Pr.724**) (kg·m^2)	9999 (initial value)
724	**745**	Motor inertia (exponent)		
725	**746**	Motor protection current level	Maximum current level of the motor (%)	9999 (initial value)

*2 The setting is valid only when a value other than "9999" is set in both **Pr.707** (**Pr.744**) and **Pr.724** (**Pr.745**).

◆Performing tuning

POINT

- Before performing tuning, check the monitor display of the operation panel or parameter unit if the inverter is in the state ready for tuning. The motor starts by turning ON the start command while tuning is unavailable.

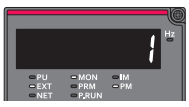
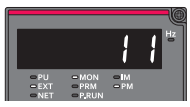
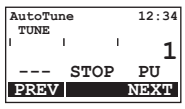
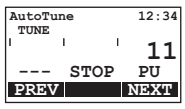
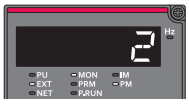
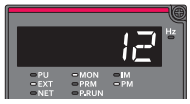
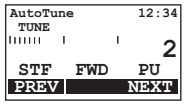
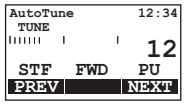
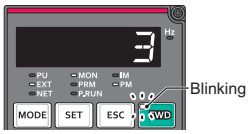
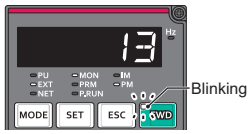
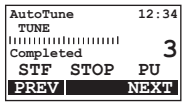
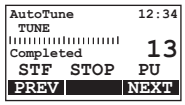
- In the PU operation mode, press FWD / REV on the operation panel.

  For External operation, turn ON the start command (STF signal or STR signal). Tuning starts.

NOTE

- Satisfy the required inverter start conditions to start offline auto tuning. For example, stop the input of the MRS signal.
- To force tuning to end, use the MRS or RES signal or STOP RESET on the operation panel. (Turning OFF the start signal (STF signal or STR signal) also ends tuning.)
- During offline auto tuning, only the following I/O signals are valid (initial value).
  Input terminals <valid signals>: STP (STOP), OH, MRS, RT, RES, STF, STR, S1, and S2
  Output terminals: RUN, OL, IPF, FM/CA, AM, A1B1C1, and So (SO)
- When the rotation speed and the output frequency are selected for terminals FM/CA and AM, the progress status of offline auto tuning is output in 15 steps from FM/CA and AM.
- Do not perform ON/OFF switching of the Second function selection (RT) signal during offline auto tuning. Auto tuning will not be performed properly.
- Since the Inverter running (RUN) signal turns ON when tuning is started, pay close attention especially when a sequence which releases a mechanical brake by the RUN signal has been designed.
- When executing offline auto tuning, input the operation command after switching ON the main circuit power (R/L1, S/L2, T/L3) of the inverter.
- While **Pr.79 Operation mode selection** = "7", turn ON the PU operation external interlock (X12) signal for tuning in the PU operation mode.
- Setting offline auto tuning (**Pr.96** = "1 or 11") will make pre-excitation invalid.

- During tuning, the monitor is displayed on the operation panel as follows.

Pr.96 (Pr.463) setting	1	11	1	11
	Operation panel (FR-DU08) display		LCD operation panel (FR-LU08) display	
(1) Setting				
(2) During tuning				
(3) Normal completion				

- When offline auto tuning ends, press STOP RESET on the operation panel during PU operation. For External operation, turn OFF the start signal (STF signal or STR signal). This operation resets the offline auto tuning, and the PU's monitor display returns to the normal indication. (Without this operation, next operation cannot be started.)

NOTE

- The motor constants measured once during offline auto tuning are stored as parameters and their data are held until offline auto tuning is performed again. However, the tuning data is cleared when performing All parameter clear.

- If offline auto tuning has ended in error (refer to the following table), motor constants are not set.
  Perform an inverter reset and perform tuning again.

Error display	Error cause	Countermeasures
8	Forced end	Set **Pr.96** (**Pr.463**) = "1 or 11" and retry.
9	Inverter protective function operation	Make the setting again.
92	The converter output voltage fell to 75% of the rated voltage.	Check for the power supply voltage fluctuation. Check the **Pr.83 Rated motor voltage** (**Pr.456 Rated second motor voltage**) setting.
93	Calculation error. The motor is not connected.	Check the motor wiring and make the setting again.

- When tuning is ended forcibly by pressing STOP RESET or turning OFF the start signal (STF or STR) during tuning, offline auto tuning does not end properly. (The motor constants have not been set.)
  Perform an inverter reset and perform tuning again.

NOTE

- An instantaneous power failure occurring during tuning will result in a tuning error.
  After power is restored, the inverter starts normal operation. Therefore, when the STF (STR) signal is ON, the motor starts forward (reverse) rotation.
- Any fault occurring during tuning is handled as in the normal operation. However, if the retry function is set, no retry is performed even when a protective function that performs a retry is activated.
- The set frequency monitor displayed during the offline auto tuning is 0 Hz.

⚠CAUTION

- **Note that the motor may start running suddenly.**

◆Parameters updated by tuning results after tuning

First motor Pr.	Second motor Pr.	Name	Pr.96 (Pr.463) = 1	Pr.96 (Pr.463) = 11	Description
90	**458**	Motor constant (R1)	○	○	Resistance per phase
92	**460**	Motor constant (L1)/d-axis inductance (Ld)	○	—	d-axis inductance
93	**461**	Motor constant (L2)/q-axis inductance (Lq)	○	—	q-axis inductance
717	**741**	Starting resistance tuning compensation	○	○	
721	**742**	Starting magnetic pole position detection pulse width	○	—	
859	**860**	Torque current/Rated PM motor current	○	—	
96	**463**	Auto tuning setting/status	○	○	

◆Changing the motor constants

- The motor constants can be set directly when the motor constants are known in advance, or by using the data measured during offline auto tuning.
- The changed settings are stored in the EEPROM as the motor constant parameters.
- Set desired values as the motor constant parameters.

First motor Pr.	Second motor Pr.	Name	Setting range	Setting increments	Initial value
90	**458**	Motor constant (R1)	0 to 50 Ω, 9999*1	0.001 Ω*1	9999
			0 to 400 mΩ, 9999*2	0.01 mΩ*2	
92	**460**	Motor constant (L1)/d-axis inductance (Ld)	0 to 500 mH, 9999*1	0.01 mH*1	
			0 to 50 mH, 9999*2	0.001 mH*2	
93	**461**	Motor constant (L2)/q-axis inductance (Lq)	0 to 500 mH, 9999*1	0.01 mH*1	
			0 to 50 mH, 9999*2	0.001 mH*2	
859	**860**	Torque current/Rated PM motor current	0 to 500 A, 9999*1	0.01 A*1	
			0 to 3600 A, 9999*2	0.1 A*2	

*1 For the FR-F820-02330(55K) or lower and the FR-F840-01160(55K) or lower.
*2 For the FR-F820-03160(75K) or higher and the FR-F840-01800(75K) or higher.

NOTE

- If "9999" is set, tuning data will be invalid. The RF-SR constant is used for the Mitsubishi Electric synchronous reluctance motor RF-SR, and the inverter internal constant is used for a synchronous reluctance motor other than RF-SR.

3.8 Specifications

3.8.1 Mitsubishi Electric synchronous reluctance motor RF-SR (3000 r/min specification)

◆Motor specifications

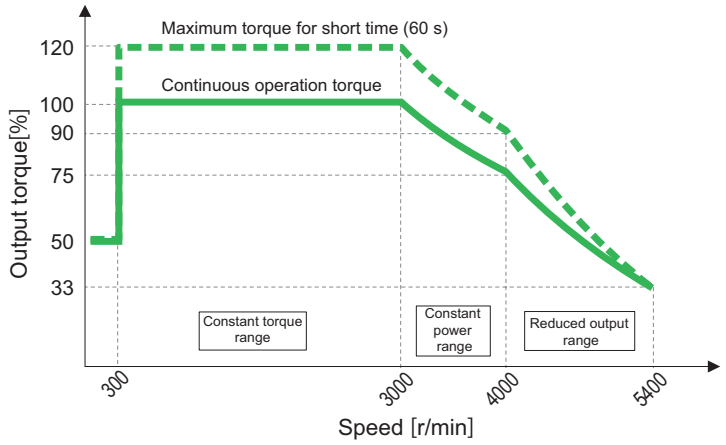
Motor model	200 V class RF-SR[]30S / 400 V class RF-SR[]30HS	5K	7K	11K	15K
Applicable inverter (LD rating)	200 V class FR-F820-[]-SYN	00340 (7.5K)	00490 (11K)	00630 (15K)	00770 (18.5K)
	400 V class FR-F840-[]-SYN	00170 (7.5K)	00250 (11K)	00310 (15K)	00380 (18.5K)
Continuous characteristics*1	Rated output power (kW)	5.5	7.5	11.0	15.0
	Rated torque (N·m)	17.51	23.87	35.01	47.75
Rated speed (r/min)*1		3000			
Maximum speed (r/min)		5400			
Number of poles		4			
Maximum torque		120% 60 s			
Rated current (A)*2	200 V class	22.2	30.8	45.6	60.2
	400 V class	11.1	15.4	22.8	30.1

*1 The rated output power or speed is not guaranteed at low supply voltages.

*2 The rated current is the value used to operate the inverter functions. Set the value in the table above in the parameter in which the rated motor current is to be set.

◆Motor torque characteristic

The torque characteristics of the RF-SR (3000 r/min specification) driven by the inverter (LD rating) are shown in graph form as follows.



NOTE

- The characteristics above assume that the wiring length between the inverter and the motor is 5 m or less and the DC bus voltage inside the inverter is equal to or higher than the specified value (282 V or higher for the 200 V class or 565 V or higher for the 400 V class). The maximum torque may be reduced under the following conditions.
  - The wiring length between the inverter and the motor is long.
  - The DC bus voltage of the inverter drops.

3.8.2 Control specifications

The following table shows the control specifications added to this inverter. For the control specifications not found in the table, refer to "Common specifications" in Chapter 8 in the FR-F800 Instruction Manual (Detailed).

Item	Description
Control method	SynRM magnetic flux vector control
Output frequency range	0.2 to 590 Hz (The upper frequency limit is 400 Hz under SynRM magnetic flux vector control.)
Starting torque	50% (SynRM magnetic flux vector control)
Torque limit level	Torque limit value can be set (0% to 400% variable). (SynRM magnetic flux vector control)

4 DIFFERENCES BETWEEN THE FR-F800-SYN AND THE STANDARD MODEL

Some functions of the FR-F800 standard model are changed in this inverter. The functions not found in Chapter 3 are the same as those of the FR-F800 standard model. For the functions added in and after August 2022, only the following functions are supported.

◆Extended detection time of the output current and zero current

The setting range of the **Pr.151 Output current detection signal delay time** and **Pr.153 Zero current detection time** is extended.

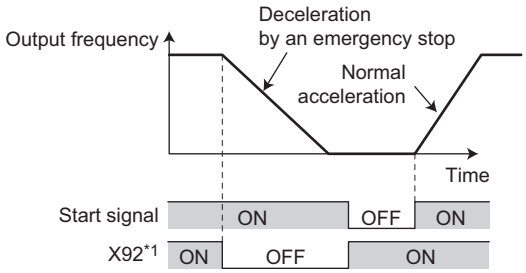
Pr.	Name	Initial value	Setting range	Description
151 **M461**	**Output current detection signal delay time**	0 s	0 to 300 s	Set the output current detection time. Enter the time from when the output current reaches the set current or higher to when the Output current detection (Y12) signal is output.
153 **M463**	**Zero current detection time**	0.5 s	0 to 300 s	Set the time from when the output current drops to the **Pr.152** setting or lower to when the Zero current detection (Y13) signal is output.

◆Emergency stop function (Pr.1103)

When a fault occurs in the superordinate controller, the motor can be decelerated by the signal input via an external terminal.

Pr.	Name	Initial value	Setting range	Description
815 **H710**	**Torque limit level 2**	9999	0% to 400%	Set the torque limit level at a deceleration by turning ON the X92 signal.
			9999	The torque limit set to **Pr.22** is valid.
1103 **F040**	**Deceleration time at emergency stop**	5 s	0 to 3600 s	Set the motor deceleration time at a deceleration by turning ON the X92 signal.

- The motor will decelerate to stop according to the settings of **Pr.1103 Deceleration time at emergency stop** and **Pr.815 Torque limit level 2** when the Emergency stop (X92) signal is turned OFF (when the contact is opened).
- To input the X92 signal, set "92" in any of **Pr.178 to Pr.189 (Input terminal function selection)** to assign the function to a terminal.
- The X92 signal is a normally closed input (NC contact input).
- "PS" is displayed on the operation panel during activation of the emergency stop function.



*1 ON/OFF indicates the input status of the physical terminal.

NOTE

- The X92 signals can be assigned to an input terminal by setting **Pr.178 to Pr.189 (Input terminal function selection)**. Changing the terminal assignment may affect other functions. Set parameters after confirming the function of each terminal.

4.1 Specification comparison among control methods

The following table shows the main differences in specifications among control methods.

Item		SynRM magnetic flux vector control (RF-SR)	PM sensorless vector control (MM-EFS)	Induction motor control
Applicable motor		Mitsubishi Electric synchronous reluctance motor RF-SR series (3000 r/min, 5.5 to 15 kW) SynRM other than the above are supported by offline auto tuning.	IPM motor MM-EFS series (1500 r/min specification or 3000 r/min specification) IPM motors other than the above are supported by offline auto tuning.	Induction motor
Maximum starting torque		50%	50%	120% (Advanced magnetic flux vector control)
Automatic restart after instantaneous power failure		No startup waiting time*1	No startup waiting time*1	Startup waiting time exists.
Startup delay		Startup delay of about 0.1 s for initial tuning.	Startup delay of about 0.1 s for initial tuning.	No startup delay (when online auto tuning is not performed at startup).
Driving by the commercial power supply		Not available*2	Not available*2	Available
Number of connectable motors		1	1	Multiple motors can be driven (under V/F control).
Operation during coasting		Voltage is not generated across motor terminals.	Voltage is generated across motor terminals.*3	Voltage is not generated across motor terminals.
Energy saving control	Energy saving contol	Not available	Not available	Available (under V/F control)
	Optimum excitation control	Available		Available (under V/F control or Advanced magnetic flux vector control)

*1 Using the regeneration avoidance function or retry function together is recommended.
*2 Do not connect the motor to a commercial power supply.
*3 High voltage is generated at the motor terminals while the motor is running even when the power of the inverter is turned OFF. Before wiring or inspection, confirm that the motor is stopped.

◆Functions available under SynRM magnetic flux vector control

Functions available under SynRM magnetic flux vector control are the same as those available under PM motor control, except for the following function. For information not found in this manual, read "PM motor control" in the FR-F800 Instruction Manual (Detailed) as "SynRM magnetic flux vector control".

NOTE

• Parameter copy cannot be performed between the FR-F800-SYN and other models (such as the FR-F800 standard model).

4.2 Applicable standards

The following table shows the differences of the applicable standards from the FR-F800 standard model.

Standard/certification	FR-F800-SYN	FR-F800 standard model
UL/cUL standards	○	○
EU Directive (CE marking)	○	○
Waste Electrical and Electronic Equipment Directive (WEEE Directive)	○	○
UK certification scheme (UKCA marking)	○	○
Radio Waves Act (South Korea) (KC marking)	×	○
EAC certification	○	○
EU ErP Directive (Ecodesign Directive)	○	○
Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products (China RoHS)	○	○
Chinese standardized law	○	○
Functional safety standard "IEC 61508 SIL 2"	○	○
Functional safety standard "IEC 61508:2010 SIL 3"	×	○

○: Compliant ×: Not compliant

REVISIONS

*The manual number is given on the bottom left of the back cover.

Revision Date	*Manual Number	Revision
May 2023	IB(NA)-0601007ENG-A	First edition
Mar. 2024	IB(NA)-0601007ENG-B	Added • Optimum excitation control when driving a SynRM • Offline auto tuning for a SynRM • Synchronous reluctance motor other than RF-SR (Pr.71 (Pr.450) = "7090", Pr.998 = "7009, 7109") • Applicable inverters FR-A820-00046(0.4K) to FR-A820-00167(2.2K), FR-A820-01250(22K) to FR-A820-04750(90K), FR-A840-00023(0.4K) to 00083(2.2K), FR-A840-00620(22K) to 06830(280K), FR-A842-07700(315K) to 12120(500K) FR-F820-00046(0.75K) to FR-F820-00167(3.7K), FR-F820-00930(22K) to FR-F820-04750(110K), FR-F840-00023(0.75K) to 00083(3.7K), FR-A840-00470(22K) to 06830(315K), FR-F842-07700(355K) to 12120(560K))

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