

# Inverter FREQROL Basics (Function)

This course is for those who will build an inverter system using the FR series inverters. This course will teach you about the inverter functions, parameter roles, and how to set the parameters, using the FR-E700 series inverter as an example.

## Introduction Purpose of the Course

This course is intended for those who will build an inverter system using the FR series inverters. This course will teach you about the inverter functions, parameter roles, and how to set the parameters, using the E700 series inverter as an example.

## Introduction Course Structure



The contents of this course are as follows.

We recommend that you start from Chapter 1.

### **Chapter 1 Role of Parameters**

Learn about the roles and settings of parameters.

### **Chapter 2 Preventing Incorrect Operations**

Learn about the parameters useful for preventing incorrect operations.

### **Chapter 3 Adjustment before Starting the Motor**

Learn about the parameters to be set before starting the motor.





### **Chapter 4 Adjustment According to the Operation**

Learn about the parameters to be adjusted according to operation after startup.

### **Final Test**

Passing grade: 60% or higher.

**Introduction** **How to Use This e-Learning Tool**

Go to the next page		Go to the next page.
Back to the previous page		Back to the previous page.
Move to the desired page		"Table of Contents" will be displayed, enabling you to navigate to the desired page.
Exit the learning		Exit the learning. Window such as "Contents" screen and the learning will be closed.

## Introduction **Cautions for Use**

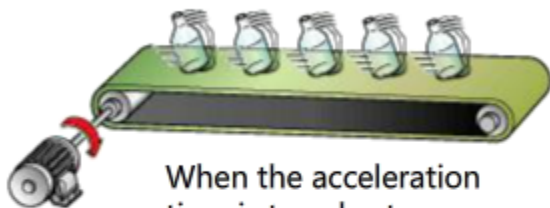


### **Safety precautions**

When you learn by using actual products, please carefully read the safety precautions in the corresponding manuals.

## Chapter 1 Role of Parameters

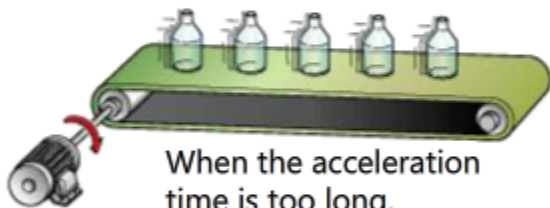
Parameters are the settings that determine the behavior of the inverter. You can perform simple variable-speed operations without changing the initial parameter settings.



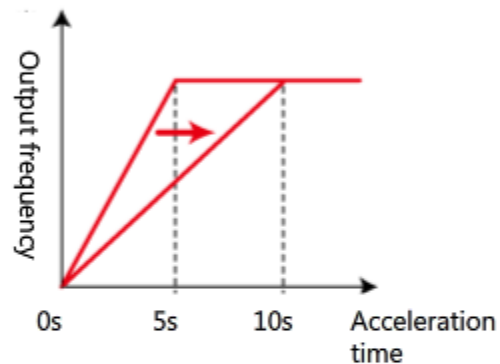
When the acceleration time is too short.



Change a parameter.  
(Setting it to accelerate slowly.)



When the acceleration time is too long.



The parameters are classified into the following two types. In the initial setting, all parameters are displayable.

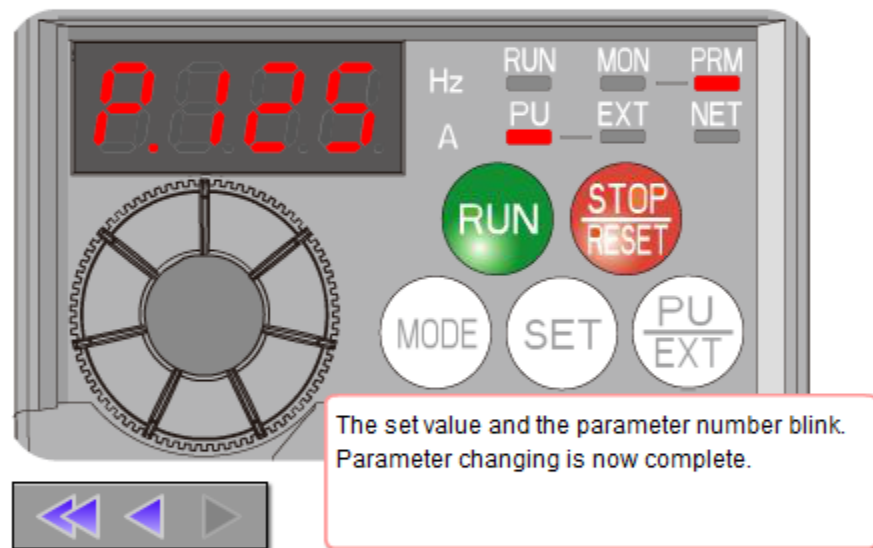
Type	Description
Simple mode parameters	12 parameters that set the basic functions.
Extended parameters	Parameters that set complex functions according to the application.

## 1.1

## Setting Parameters from the Operation Panel

Parameters can be set on the operation panel of the inverter, using keys and the setting dial. The details are given in Chapter 5 of the FREQROL Basics (Operation) course.

Let's change the Pr.125 setting from "60Hz" to "50Hz", using the operation panel shown below. This is also a good review exercise for those who already took the FREQROL Basics (Operation) course.

**Note**



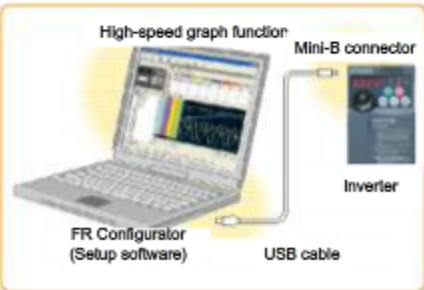
In Chapters 3 and 4, you will simulate how the parameter settings affect the inverter operation. In those chapters, parameter settings are adjusted with sliding switches due to the structure of this e-Learning course, but on actual inverters, the parameter settings are adjusted using keys and the setting dial, as shown in this page. Please keep this point in mind.

## 1.2

## Setting Parameters Using External Devices



In addition to the operation panel, you can also use an optional external parameter unit or a personal computer containing FR Configurator (setup software) to set parameters.

Product		Image	Description
External parameter unit	FR-PU07		<ul style="list-style-type: none"> <li>• Direct input from the ten-key pad. The display of operation status and the help function are useful for parameter setting.</li> <li>• Can display up to eight languages.</li> <li>• Can save the parameter values of up to three inverters.</li> <li>• A parameter unit with battery pack (FR-PU07BB) enables parameter setting and copying without powering ON the inverter.</li> </ul>
	FR-PU07BB		
	FR-PA07		<p>External connection type operation panel The function is the same as the operation panel on the inverter.</p>
FR Configurator (Setup software)			<p>The wizard (interactive form) function of FR Configurator (setup software) helps to set up parameters. High-speed sampling can be implemented if you use the high-speed graph function via USB.</p>



**1.3****Summary of This Chapter**

Here is what you have learned in Chapter 1.  
Please review the following important points:

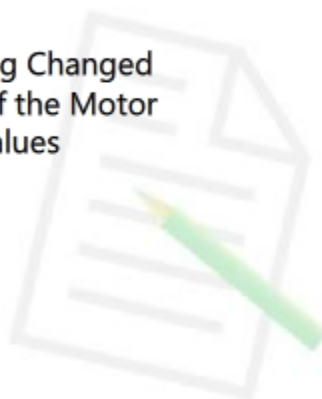
Role of parameter	<ul style="list-style-type: none"><li>• Parameters are the settings that determine the behavior of the inverter.</li><li>• You can perform simple variable-speed operations without changing the initial parameter settings.</li><li>• Parameters are classified into two types: simple mode parameters for basic settings, and extended parameters for complex settings.</li><li>• In the initial setting, all parameters are displayable.</li></ul>
Setting parameters using the operation panel	Parameters can be set from the operation panel on the inverter, using keys and the setting dial.
Setting parameters using external devices	You can also set parameters by connecting an optional external parameter unit or a personal computer containing FR Configurator (setup software) to the inverter.

## Chapter 2 Preventing Incorrect Operations

In Chapter 2, you will learn the parameters useful for preventing incorrect operations.

### Contents of Chapter 2

- 2.1 Limiting Displayable Parameters
- 2.2 Preventing Parameters from Being Changed
- 2.3 Limiting the Rotation Direction of the Motor
- 2.4 Resetting Parameters to Initial Values



In the initial setting, all parameters are displayable.

Displayable parameters can be limited to prevent unrelated parameters and those already set from being changed accidentally.

In "Pr.160 User group read selection", set the parameter type you want to display.

To limit displayable parameters to the simple mode parameters only, set "9999".

To limit displayable parameters to the parameters registered in the user group, set "1".

For information on how to register parameters in the user group or deregister them, refer to the "FR-E700 Instruction Manual (Applied)".

Parameter No.	Name	Initial value	Setting range	Description
Pr.160	User group read selection	0	9999	Displays only simple mode parameters.
			0	Displays simple mode parameters and extended parameters.
			1	Displays only the parameters that are registered in the user group.
Pr.172	User group registered display/batch clear	0	(0 to 16)	Displays the number of parameters registered in the user group.
			9999	Batch-clears the user group registration.
Pr.173	User group registration	9999	0 to 999, 9999	Set a parameter number to be registered in the user group.
Pr.174	User group clear	9999	0 to 999, 9999	Set a parameter number to be deleted from the user group.

## List of simple mode parameters

Parameter No.	Name
Pr.0	Torque boost
Pr.1	Maximum frequency
Pr.2	Minimum frequency
Pr.3	Base frequency
Pr.4	Three-speed setting (high speed)
Pr.5	Three-speed setting (middle speed)
Pr.6	Three-speed setting (low speed)

Parameter No.	Name
Pr.7	Acceleration time
Pr.8	Deceleration time
Pr.9	Electronic thermal O/L relay
Pr.79	Operation mode selection
Pr.125	Terminal 2 frequency setting gain frequency
Pr.126	Terminal 4 frequency setting gain frequency
Pr.160	User group read selection

## 2.2

## Preventing Parameters from Being Changed

You can disable parameter write and prevent parameters from being changed accidentally.

Set "1 (write-disable)" in "Pr.77 Parameter write selection".

Parameter No.	Name	Initial value	Setting range	Description
Pr.77	Parameter write selection	0	0	Parameter write is enabled only during stop.
			1	Parameter write is disabled.
			2	Parameter write is enabled regardless of the operation status and the operation mode.

If a parameter writing is tried.

An error occurs and the parameter is not written.



### Precaution

The following parameters can be written even when the parameter write is set to disabled.

Parameter No.	Name
Pr.22	Stall prevention operation level
Pr.75	Reset selection/disconnected PU detection/PU stop selection
Pr.77	Parameter write selection
Pr.79	Operation mode selection
Pr.160	User group read selection

## 2.3

# Limiting the Rotation Direction of the Motor

You can prevent the motor from rotating in the opposite direction even if an incorrect start signal (forward rotation or reverse rotation) is input.

This function is effective for a motor that rotates in one direction only.

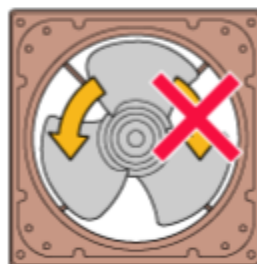
Set the rotation direction in "Pr.78 Reverse rotation prevention selection".

Parameter No.	Name	Initial value	Setting range	Description
Pr.78	Reverse rotation prevention selection	0	0	Forward and reverse rotations are enabled.
			1	Reverse rotation is disabled.
			2	Forward rotation is disabled.

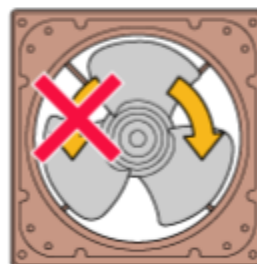
Parameter setting "0"  
Forward/reverse  
rotation enabled



Parameter setting "1"  
Reverse rotation  
disabled



Parameter setting "2"  
Forward rotation  
disabled

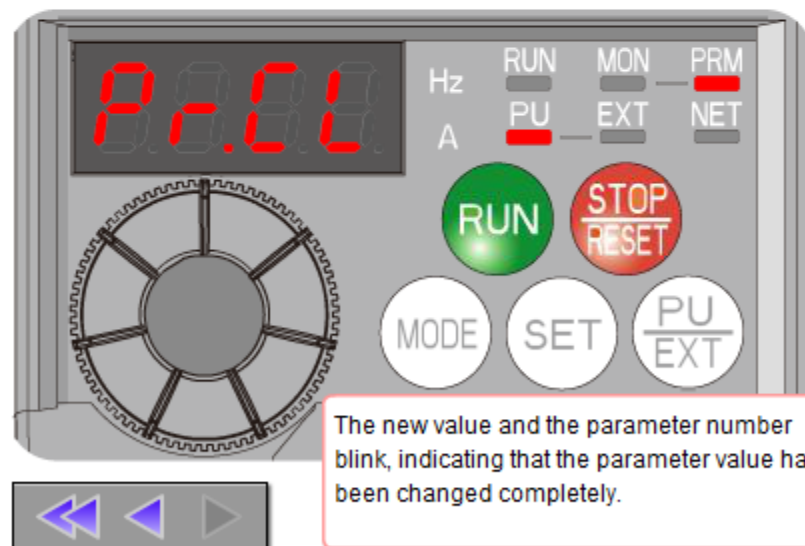


## 2.4 Resetting Parameters to Initial Values

When a problem cannot be solved, etc., parameters can be reset to their initial setting values. The reset parameters are different between Parameter Clear and All Parameter Clear. For details, refer to the parameter list in the "FR-E700 Instruction Manual (Applied)".

Parameter No.	Name	Initial value	Setting range	Description
Pr.CL	Parameter Clear	0	0	Clears no parameters.
			1	Resets the parameters to their initial values.
ALLC	All Parameter Clear	0	0	Clears no parameters.
			1	Resets the parameters to their initial values.

Simulate the execution of "Pr.CL Parameter Clear using the operation panel below.



### Precaution

Once parameters are cleared, their settings cannot be restored. To back up parameters, use an external parameter unit (FR-PU07) or FR Configurator (setup software).

Here is what you have learned in Chapter 2.  
Please review the following important points:

Limiting displayed parameters	<ul style="list-style-type: none"><li>• All parameters are displayable in the initial setting.</li><li>• Displayable parameters can be limited to prevent unrelated parameters and those already set from being changed accidentally.</li><li>• Set the parameter display mode using "Pr.160 User group read selection". To display only the simple mode parameters, set "9999", and to display only the parameters registered in the user group, set "1".</li></ul>
Preventing parameters from being changed	<ul style="list-style-type: none"><li>• You can disable parameter write and prevent parameters from being changed accidentally. Set "1" (write-disable) in "Pr.77 Parameter write selection".</li><li>• Some parameters can be changed even when parameter write is disabled.</li></ul>
Limiting the rotation direction of the motor	<ul style="list-style-type: none"><li>• Prevent the motor from rotating in the opposite direction, which could be caused by incorrect input of a start signal (forward rotation or reverse rotation). This function is effective for the motor that rotates in one direction only.</li><li>• Set the rotation direction in "Pr.78 Reverse rotation prevention selection".</li></ul>
Resetting parameters to initial values	<ul style="list-style-type: none"><li>• Parameters can be reset to their initial values when a problem cannot be solved, etc.</li><li>• The reset parameters are different between Parameter Clear and All Clear.</li><li>• Once parameters are cleared, they cannot be restored.</li><li>• An external parameter unit (FR-PU07) or FR Configurator (setup software) can back up parameters.</li></ul>



## Chapter 3 Adjustment before Starting the Motor



In Chapter 3, you will learn about parameters to be set before starting the motor.

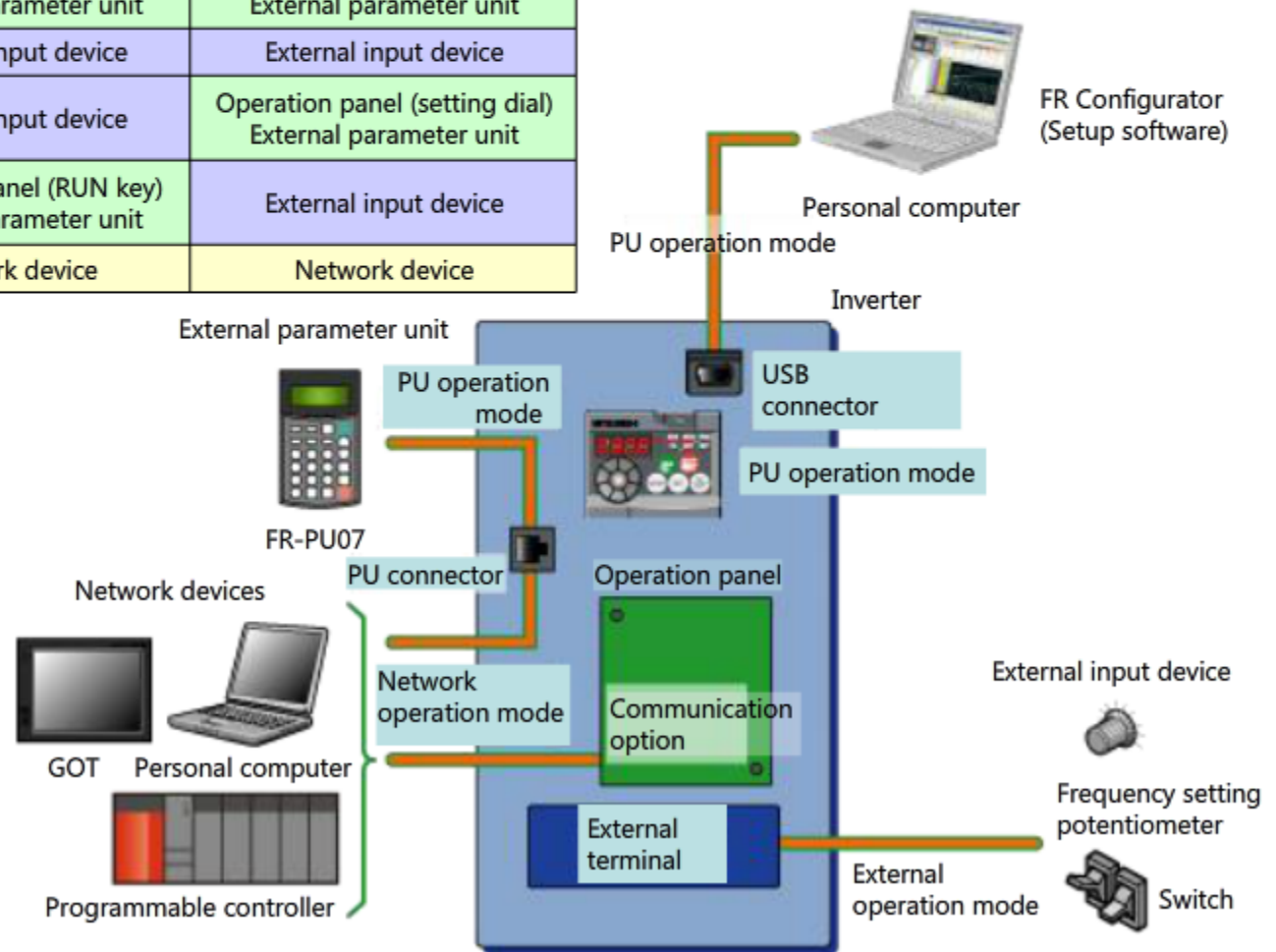
### Contents of Chapter 3

- 3.1 Selecting the Operation Mode
  - 3.1.1 PU operation mode
  - 3.1.2 External operation mode
  - 3.1.3 Combined operation mode
  - 3.1.4 Network (NET) operation mode
- 3.2 Changing the Speed Using External Input
  - 3.2.1 Changing the speed using the digital input
  - 3.2.2 Changing the speed using the analog voltage input
  - 3.2.3 Changing the speed using the analog current input
- 3.3 Operating the Motor under Optimal Condition
- 3.4 Protecting the Motor from overheating

# 3.1 Selecting the Operation Mode

A start command and a frequency command are required for the inverter to control a motor. Turning ON a start command rotates the motor, and turning ON a frequency command determines the rotation speed of the motor. In the FR-E700 series, combinations of the start command and the frequency command determine the operation mode.

Operation mode	Start command source	Frequency (speed) command source
PU operation mode	Operation panel (RUN key) External parameter unit	Operation panel (setting dial) External parameter unit
External operation mode	External input device	External input device
Combined operation mode (Combination 1)	External input device	Operation panel (setting dial) External parameter unit
Combined operation mode (Combination 2)	Operation panel (RUN key) External parameter unit	External input device
Network operation mode	Network device	Network device



## 3.1 Selecting the Operation Mode

Set the operation mode using "Pr.79 Operation mode selection".

In the initial setting, Pr.79 is set to "0 (PU/External switching mode)", which allows you to switch between the PU and External operation modes by pressing the PU/EXT key on the operation panel.

The following table lists the available operation modes. This course will cover the operation modes of the settings "0 to 4".

Parameter No.	Name	Initial value	Setting range	Description	
Pr.79	Operation mode selection	0	0	PU/External switching mode. Press the PU/EXT key on the operation panel to switch between the PU and External operation modes. At power-ON, the inverter is in the External operation mode.	
			1	PU operation mode (fixed)	
			2	External operation mode (fixed) The operation can be performed by switching between the External and NET operation modes.	
			3	External/PU combined operation mode 1	
				Frequency command source	Start command source
			Setting dial on the operation panel		External signal input (terminals STF and STR)
			4	External/PU combined operation mode 2	
				Frequency command source	Start command source
			External signal input (Terminals 2, 4, JOG, multi-speed selection, etc.)		RUN key on the operation panel
			6	Switchover mode. Switching among the PU, External, and NET operation modes is enabled while continuing operation.	
7	External operation mode (PU operation interlock). X12 signal ON: Switches to the PU operation mode (shuts off the outputs in the External operation mode). X12 signal OFF: Prohibits switching to the PU operation mode.				

### Supplementary Information

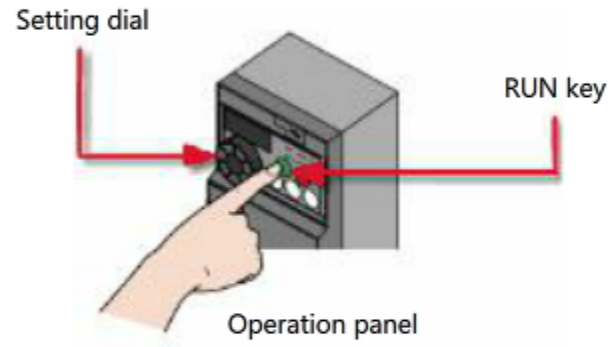
You can learn how to wire the external input device in Chapter 4 of the FREQROL Basics (Operation) course.

# 3.1.1 PU Operation Mode

In PU operation mode, the inverter's start and frequency commands are input from the operation panel of the inverter. The inverter can take a role of both a controller and a driver in a simple system. The setting dial can be used to change the frequency (rotation speed) during operation.

The basic configuration of the PU operation mode is shown below.

Start command source	Operation panel (RUN key)
Frequency command source	Operation panel (setting dial)



### Parameter setting

To use the PU operation mode, set either of the following values in "Pr.79 Operation mode".

Value	Operation mode	Description
0	External/PU switching mode	Select this mode when you want to use the PU/EXT key on the operation panel to switch between the PU and External operation modes. When this value is set, the inverter starts in External operation mode at power-ON. Use the PU/EXT key to switch to the PU operation mode.
1	PU operation mode (fixed)	Select this mode to be fixed to PU operation mode.

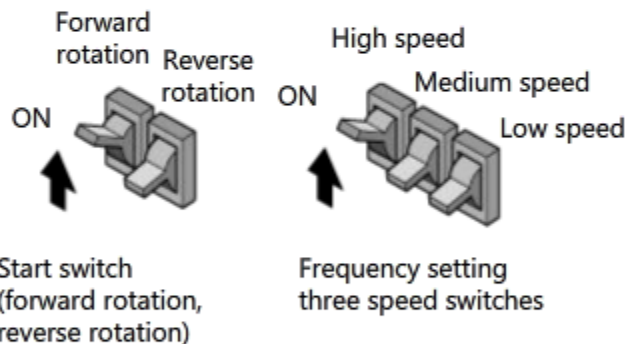
## 3.1.2 External Operation Mode

In External operation mode, external input devices (such as a switch or potentiometer) are used to input a start command and a frequency command to the inverter. This operation mode is useful when the inverter has to be installed inside an enclosure and the direct operation of the operation panel is impossible, etc. The basic configuration of the External operation mode is shown below.

### Changing the frequency using three speed switches

Start command source	Start switch
Frequency command source	Three speed switches

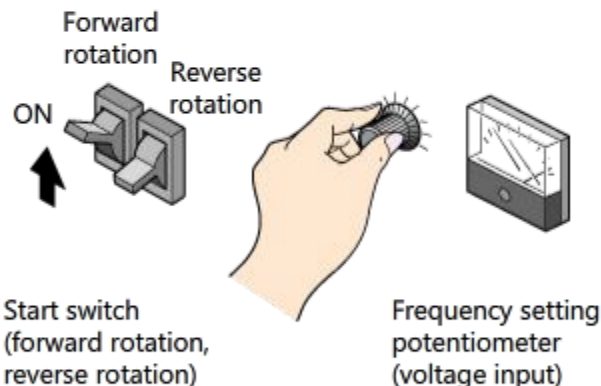
External input device



### Changing the frequency using a potentiometer (voltage input)

Start command source	Start switch
Frequency command source	Potentiometer (voltage input)

External input device



### Parameter setting

To use the External operation mode, set either of the following values in "Pr.79 Operation mode".

Value	Operation mode	Description
0	External/PU switching mode	Select this mode when you want to use the PU/EXT key on the operation panel to switch between the PU operation and external operation modes. When this value is set, the inverter starts in the External operation mode at power-ON.
2	External operation mode (fixed)	Select this mode to always select the External operation mode.

## 3.1.3 Combined Operation Mode

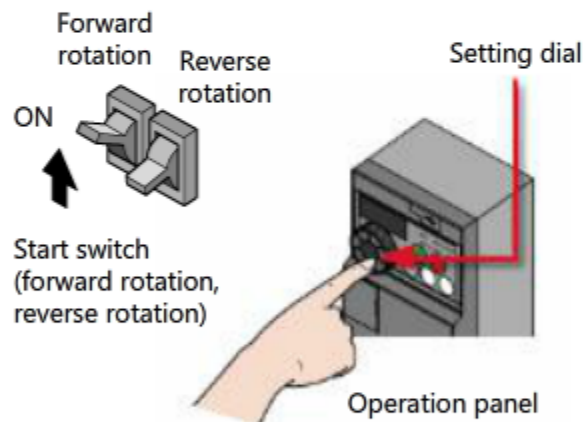
In the combined operation mode, the PU and External operation modes are combined. For Combination 1, for example, a start command is input using the external switches and a frequency command is input using the setting dial on the operation panel.

The basic configurations of the combined operation modes are shown below.

### Combination 1

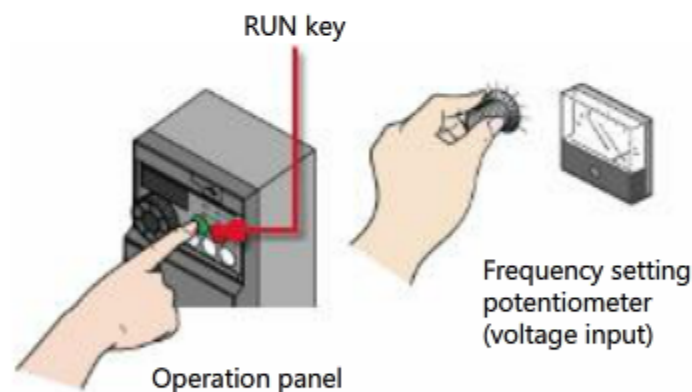
Start command source	Start switch
Frequency command source	Setting dial on the operation panel

External input device



### Combination 2

Start command source	RUN key on the operation panel
Frequency command source	Potentiometer (voltage input)



### Parameter setting

To use the combined operation mode, set either of the following values in "Pr.79 Operation mode".

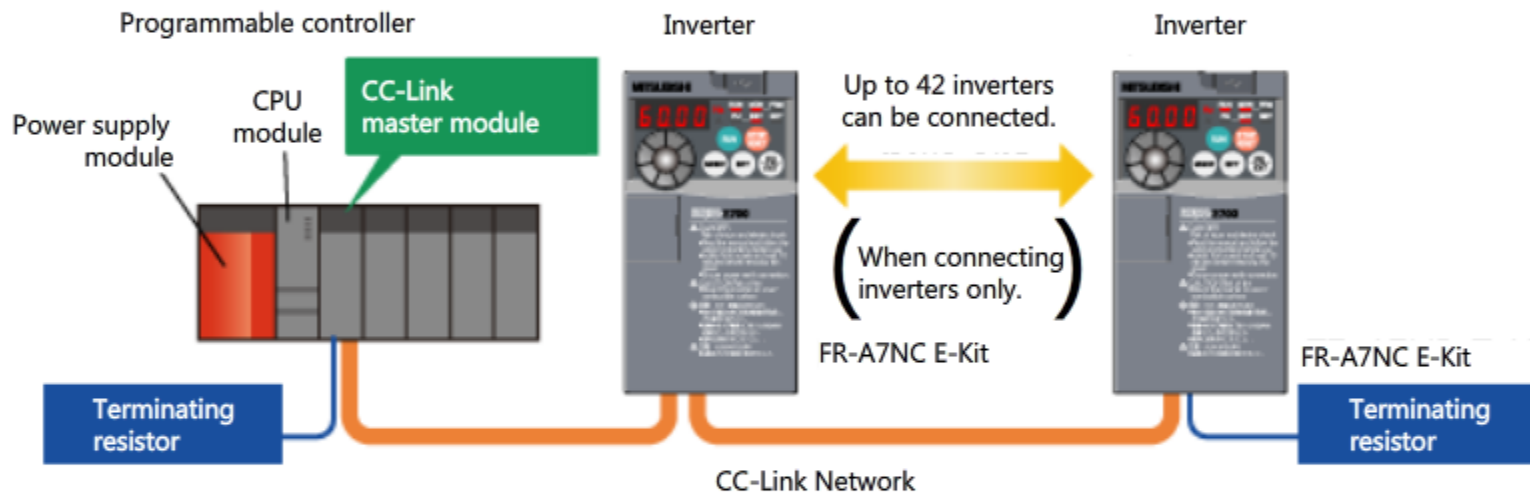
Value	Operation mode	Description
3	External/PU combined operation mode 1	Select this mode to use "Combination 1".
4	External/PU combined operation mode 2	Select this mode to use "Combination 2".



## 3.1.4 NET (Network) Operation Mode

In NET operation mode, a start command and frequency command are input from a personal computer, programmable controller, or GOT (HMI) through network via the PU connector (RS-485 communication) of the inverter or a communication option.

### Example of CC-Link Network connection



### Parameter setting

To use the NET operation mode, set the following value in "Pr.79 Operation mode".

Value	Operation mode	Description
2	External operation mode (fixed)	<p>After setting this value, the External operation mode is selected.</p> <p>To switch to the NET operation mode, send a command from a network device connected to the inverter.</p> <p>The command sending procedure varies depending on the network used.</p> <p>For more information, refer to the "FR-E700 Instruction Manual (Applied)".</p>

## 3.2 Changing the Speed Using External Input

Let's learn how to set the parameters needed to command an inverter frequency (speed) using external inputs. External inputs are categorized into two types: digital inputs and analog inputs.

External input type		Input device example
Digital input	Multi-speed setting (speeds 1 to 3)	Switch, relay, programmable controller, etc.
	Multi-speed setting (speeds 4 to 15)	
Analog input	Voltage input	Frequency setting potentiometer, etc.
	Current input	Instrument, etc.

To change the frequency using external inputs, set the appropriate value in "Pr.79 Operation mode" as shown below.

Setting value	Operation mode
0	External/PU switching mode
2	External operation mode fixed
4	External/PU combined operation mode 2

See Section 3.1 for details of each operation mode.

### Supplementary Information

Digital and analog inputs can be used together.

When analog and digital inputs are used together, the **digital input** is given priority over the **analog input**.



## 3.2.1 Changing the Speed Using Digital Input

Motor speeds can be set in parameters in advance, and these pre-set speeds can be switched using external digital inputs during operation.

You can combine the signals of terminals RH, RM, and RL to set the speeds (frequencies) 1 to 7.

In the initial setting, 3 speeds (speed 1 (high speed) to speed 3 (low speed)) are set enabled.

The table below lists the signal combinations of speeds 1 to 7 and the parameter numbers where individual frequencies are set.

Parameter No.	Name	Signal			Initial value	Setting range	Description
		RH	RM	RL			
Pr.4	Multi-speed setting (speed 1: high speed)	ON	OFF	OFF	60Hz	0 to 400Hz	Frequency when RH turns ON.
Pr.5	Multi-speed setting (speed 2: medium speed)	OFF	ON	OFF	30Hz		Frequency RM turns ON.
Pr.6	Multi-speed setting (speed 3: low speed)	OFF	OFF	ON	10Hz		Frequency when RL turns ON.
Pr.24	Multi-speed setting (speed 4)	OFF	ON	ON	9999	0 to 400Hz, 9999	<ul style="list-style-type: none"> <li>The frequencies (0 to 400Hz) of speeds 4 to 7 can be set by the combination of terminals RH, RM, and RL.</li> <li>9999: Not used</li> </ul>
Pr.25	Multi-speed setting (speed 5)	ON	OFF	ON			
Pr.26	Multi-speed setting (speed 6)	ON	ON	OFF			
Pr.27	Multi-speed setting (speed 7)	ON	ON	ON			

### Supplementary Information

With REX signal, in addition to the RH, RM, and RL signals, you can set up to 15 speeds.

To use the REX signal, assign the "REX signal" to an unused terminal.

For details, refer to the "FR-700 Instruction Manual (Applied)".

### Precaution

If two or more speeds are selected simultaneously in the multi-speed setting (speeds 1 to 3), the frequency corresponding to the lower-speed signal is given priority.

For example, when the RH and RM signals are turned ON, the RM signal (Pr.5) is given priority.

## 3.2.2 Changing the Speed Using Analog Voltage Input

You can use analog voltage inputs from external devices (frequency setting potentiometer, etc.) to adjust the running frequency. Two input voltage ranges are available: 0V to 5VDC (initial value) and 0V to 10VDC.

Use the following parameters to set the magnitude (slope) of the output frequency to the input voltage.

Parameter No.	Name	Initial value	Setting range	Description
Pr.125	Terminal 2 frequency setting gain frequency	60Hz	0 to 400Hz	Set the frequency of the terminal 2 input gain (maximum).
Pr.C2	Terminal 2 frequency setting bias frequency	0Hz	0 to 400Hz	Set the frequency on the bias side of terminal 2 input.
Pr.C3	Terminal 2 frequency setting bias	0%	0 to 300%	Set the converted % of the bias side voltage of terminal 2 input.
Pr.C4	Terminal 2 frequency setting gain	100%	0 to 300%	Set the converted % of the gain side voltage of terminal 2 input.

The magnitude (slope) of the output frequency is determined by connecting the start point (Pr.C2, Pr.C3) and end point (Pr.125, Pr.C4).

For example, the initial setting (start point 0Hz and 0% (0V)), end point 60Hz and 100% (5V)) produces the slope shown in [Figure 1](#).

Setting the start point to "10Hz, 30% (0.5V)" and the end point to "50Hz, 90% (4.5V)" will produce the slope shown in [Figure 2](#).

Fig. 1

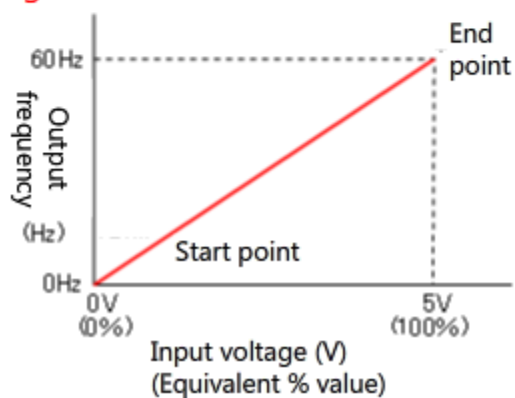
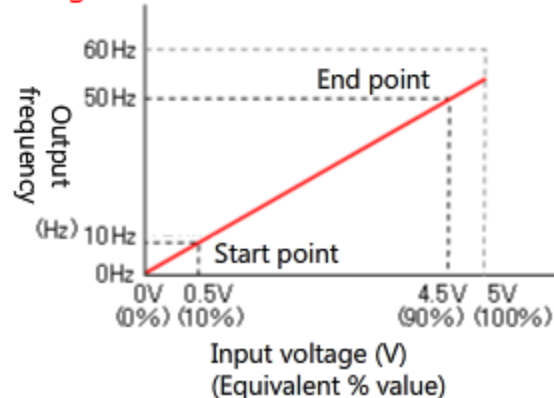


Fig. 2

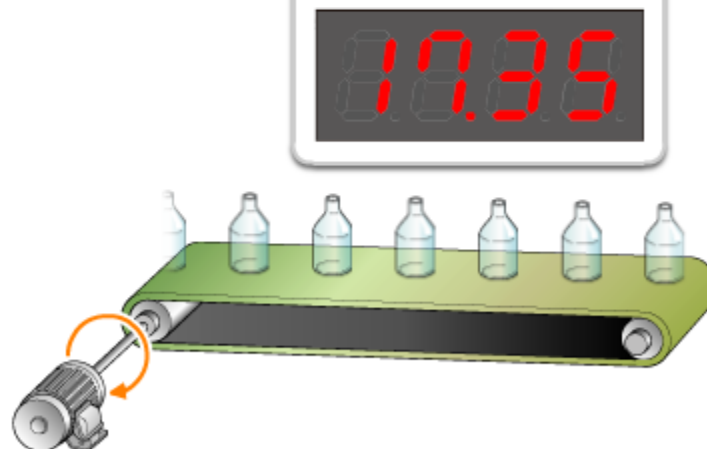
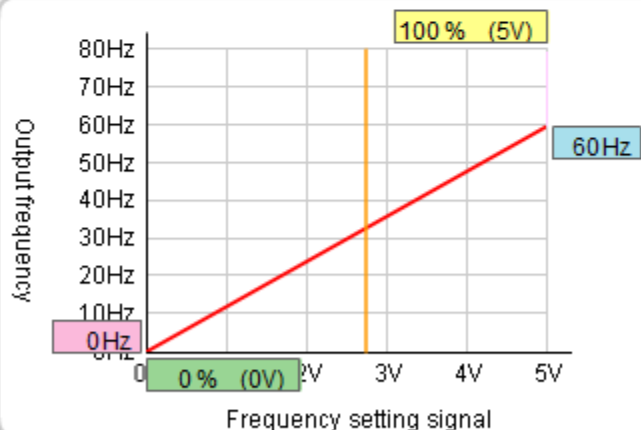
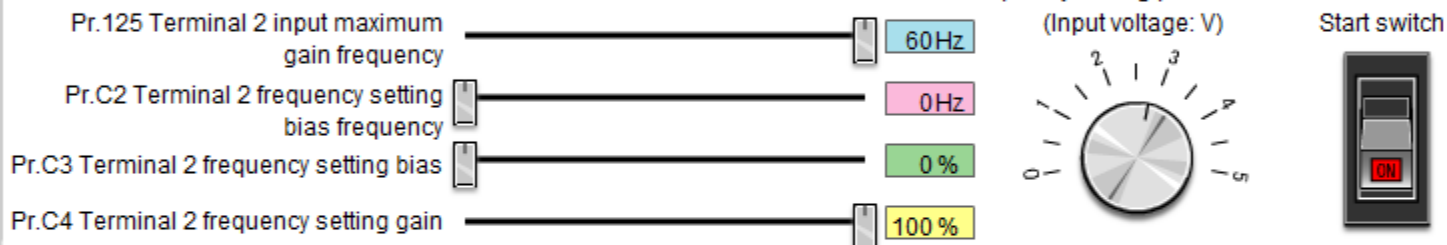


## 3.2.2 Changing the Speed Using Analog Voltage Input

Use the simulator to check how the magnitude (slope) of the input voltage determines the inverter operation. (This example uses input voltage of "0 to 5 V".)

The conveyor is accelerated up to the specified frequency.

### Parameter setting



## 3.2.3 Changing the Speed Using Analog Current Input

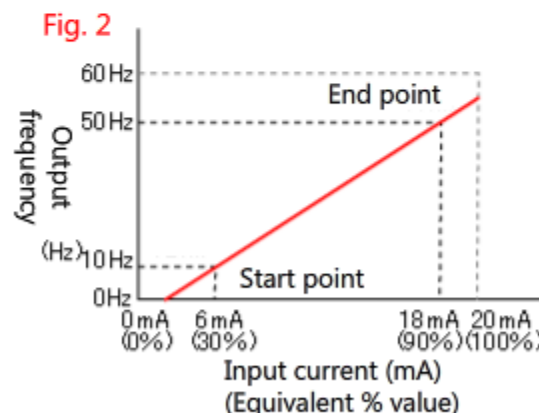
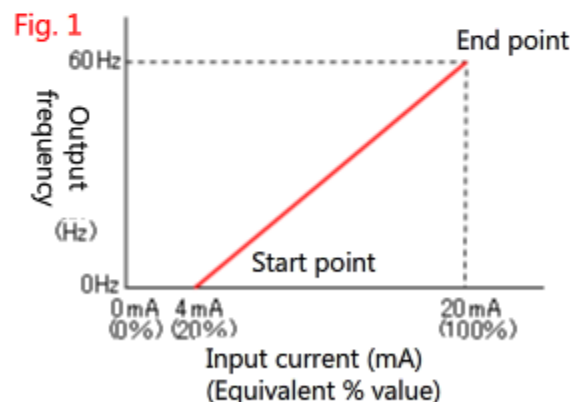
You can use analog current inputs from external devices (measuring instrument, etc.) to adjust the running speed of the motor. For the analog current input, 4mA to 20mA DC can be used.

Use the following parameters to set magnitude (slope) of the output frequency against the input current.

Parameter No.	Name	Initial value	Setting range	Description
Pr.126	Terminal 4 frequency setting gain frequency	60Hz	0 to 400Hz	Sets the frequency of the terminal 4 input gain (maximum).
C5	Terminal 4 frequency setting bias frequency	0Hz	0 to 400Hz	Sets the bias frequency of the terminal 4 input.
C6	Terminal 4 frequency setting bias	20%	0 to 300%	Sets the percent value equivalent to the bias current of the terminal 4 input.
C7	Terminal 4 frequency setting gain	100%	0 to 300%	Sets the percent value equivalent to the gain current of the terminal 4 input.

The magnitude (slope) of the output frequency is determined by connecting the start point (Pr.C5, Pr.C6) and end point (Pr.126, Pr.C7).

For example, the initial setting (start point: 0Hz, 20% (4mA)), end point: 60Hz, 100% (20mA)) produces the slope shown in [Figure 1](#). Setting the start point to "10Hz, 30% (6mA)" and the end point to "50Hz, 90% (18mA)" will produce the slope shown in [Figure 2](#).



### Supplementary Information

To use the current input (terminal 4), assign the "AU signal" to an unused terminal and input the signal. For more information, refer to the "FR-E700 Instruction Manual (Applied)".

## 3.3

## Operating the Motor under Optimal Condition

To run a motor under the optimal condition, match the inverter output (frequency, voltage) with the motor rating. The following parameters must be set before starting the motor.

In "Pr.3 Base frequency", set the rated frequency written on the motor's rating plate.

In "Pr.19 Base frequency voltage", usually set "9999" (initial value), which selects the same voltage as the power supply voltage. If the rated motor voltage differs from the power supply voltage, set the rated motor voltage.

Parameter No.	Name	Initial value	Setting range	Description
Pr.3	Base frequency	60Hz	0 to 400Hz	Sets the rated frequency (50/60Hz) of the motor.
Pr.19	Base frequency voltage	9999	0 to 1000V	Set the base voltage.
			8888	Sets 95% of the power supply voltage.
			9999	Sets the same voltage as the power supply voltage.

#### Example of rating plate on Mitsubishi high-speed motor

See the red circled area below. Set the HERTZ value as the base frequency, and the VOLT value as the base frequency voltage.

1.5	kW	6	POLE
HERTZ		400	
VOLT		200	
AMP			
RPM			

## 3.4

## Protecting the Motor from Overheating

For the electronic thermal relay setting, set appropriate thermal characteristic according to the motor. Doing so will protect the motor from overheating.

This setting is also effective when the motor's cooling ability reduces in a low-speed operation. The following parameters must be set before starting the motor.

Set the rated motor current in "Pr.9 Electronic thermal O/L relay". When using a standard motor, set the rated current at **200V/50Hz**, which is indicated on the motor's rating plate. The power supply frequency does not have to be considered here.

In "Pr.71 Applied motor", set the appropriate motor type.

Parameter No.	Name	Initial value	Setting range	Description
Pr.9	Electronic thermal O/L relay	Rated current of inverter *	0 to 500A	When using a standard motor, set the rated current at <b>200V/50Hz</b> printed on the motor's rating plate.
Pr.71	Applied motor	0	0	Sets the thermal characteristics suitable for the standard motor.
			1	Sets the thermal characteristics suitable for the Mitsubishi torque motor.
			3 to 6, 13 to 16, 23, 24, 40, 43, 44, 50, 53, 54	For details of the setting values "3 to 54", refer to the "FR-E700 Instruction Manual (Applied)".

\* When the inverter capacity is 0.75K or lower, 85% of the rated current is set.

## 3.4


## Protecting the Motor from Overheating



Forward

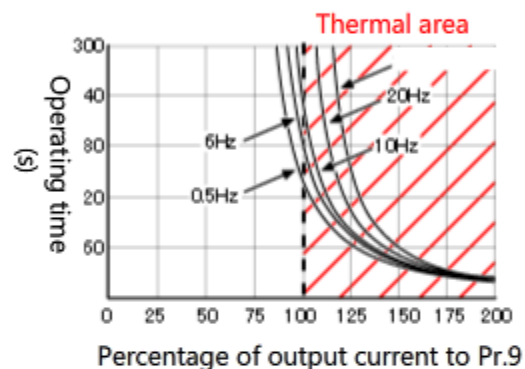
## Rating plate example of Mitsubishi standard motor

HERTZ is the rated frequency, VOLT is the rated voltage, and AMP is the rated current. In the red circled area, you can see that the rated frequency (HERTZ) is "50", and the rated voltage (VOLT) is "200". Thus, the rated current (AMP) to be set in "Pr.9 Electronic thermal O/L relay" is "2.0A".

<b>0.4 kW</b>		<b>4 POLE</b>	
<b>71-1395</b>			
<b>HERTZ</b>	<b>50</b>	<b>60</b>	<b>60</b>
<b>VOLT</b>	<b>200</b>	<b>200</b>	<b>220</b>
<b>AMP</b>	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>
<b>RPM</b>	<b>1410</b>	<b>1690</b>	<b>1700</b>

## Precaution

If the motor temperature becomes too high, a thermal error (ETHM) will occur.





Here is what you have learned in Chapter 3.  
Please review the following important points:

<b>Operation mode types and selection</b>	<ul style="list-style-type: none"> <li>• A start command and a frequency command are required for inverter control.</li> <li>• Turning ON a start command rotates the motor, and a frequency command determines the rotation speed of the motor.</li> <li>• In FR-E700, combinations of start command and frequency command determine the operation mode.</li> <li>• You can use "Pr.79 Operation mode selection" to set the operation mode.</li> <li>• In the initial setting, Pr.79 is set to "0" (PU/External switchover mode), which allows you to switch between the PU and External operation mode by pressing the PU/EXT key on the operation panel.</li> </ul>
<b>Setting by digital input (multi-speed setting)</b>	<ul style="list-style-type: none"> <li>• Multiple running speeds can be set in advance and can be switched during operation with external digital inputs.</li> <li>• Combinations of RH, RM, and RL terminals set the speeds (frequencies) 1 to 7.</li> <li>• In the initial setting, the multi-speed setting (speed 1 (high speed) to speed 3 (low speed)) is set enabled.</li> </ul>
<b>Setting by analog voltage input</b>	<ul style="list-style-type: none"> <li>• The running speed can be changed by analog voltage inputs from an external input device (frequency setting potentiometer etc.).</li> <li>• Two input voltage ranges of 0V to 5VDC (initial value) and 0V to 10VDC are available.</li> <li>• Magnitude (slope) of the output frequency to the input voltage can be set by parameters.</li> </ul>
<b>Setting by analog current input</b>	<ul style="list-style-type: none"> <li>• The running speed can be changed by analog current inputs from an external input device (measuring instrument, etc.).</li> <li>• 4mA to 20mADC can be used as input current.</li> <li>• Magnitude (slope) of the output frequency to the input current can be set by parameters.</li> </ul>
<b>Setting the base frequency and base frequency voltage</b>	<ul style="list-style-type: none"> <li>• Match the inverter output (frequency, voltage) with the motor rating to run the motor under the optimal condition. Set these parameters before power ON.</li> <li>• In "Pr.3 Base frequency", set the rated frequency printed on the motor's rating plate.</li> <li>• In "Pr.19 Base frequency voltage", usually set "9999" (initial value), which selects the same voltage as the power supply voltage. If the rated motor voltage differs from the power supply voltage, set the rated motor voltage.</li> </ul>
<b>Setting the electronic thermal O/L relay</b>	<ul style="list-style-type: none"> <li>• Set appropriate thermal characteristic to the electronic thermal relay to protect the motor from overheating.</li> <li>• Doing this will protect the motor even in the low speed operation where the motor's cooling ability is low.</li> <li>• The related parameters must be set before starting the motor.</li> <li>• Set the rated motor current in "Pr.9 Electronic thermal O/L relay". When using a standard motor, set the rated current printed on the motor's rating plate (200V/50Hz) regardless of the power supply frequency.</li> <li>• Set the motor type in "Pr.71 Applied motor" to set the optimum thermal characteristic.</li> </ul>



## Chapter 4 Adjustment According to the Operation

In Chapter 4, you will learn about parameters required to adjust the operation after start.

### Contents of Chapter 4

- 4.1 Limiting the Motor Speed
- 4.2 Rotating the Motor at 120Hz or Higher Frequency
- 4.3 Adjusting Acceleration/Deceleration of Motor According to Load
- 4.4 Operating Fans and Pumps in Energy-saving Mode
- 4.5 Taking Countermeasure for Start-up Torque Shortage
- 4.6 Limiting the Output Current

## 4.1 Limiting the Motor Speed

In actual operation, a frequency (speed) that cannot be followed by the connected machine or motor may be commanded, or a fan motor has to be always run at a certain speed or higher to keep the specified temperature. In such cases, you can set "Pr.1 Maximum frequency" and "Pr.2 Minimum frequency".

Example: When the maximum frequency is set to 60Hz, the motor runs at 60Hz even when the 80Hz is commanded.

Parameter No.	Name	Initial value	Setting range	Description
Pr.1	Maximum frequency	120Hz	0 to 120Hz	Set the maximum frequency.
Pr.2	Minimum frequency	0Hz	0 to 120Hz	Set the minimum frequency.

## 4.1 Limiting the Motor Speed

Use the simulator to check how the maximum/minimum frequency settings affect the inverter operation.

The conveyor is accelerated up to the specified frequency.

### Parameter setting

Pr.1 Maximum frequency  120Hz

Pr.2 Minimum frequency  0Hz

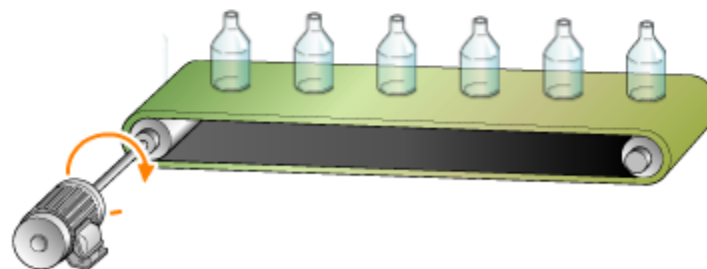
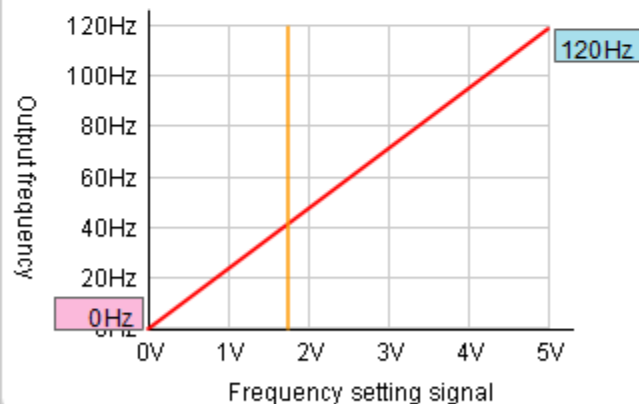
Frequency setting potentiometer  
(Input voltage: V)



Start switch



120.0



## 4.2

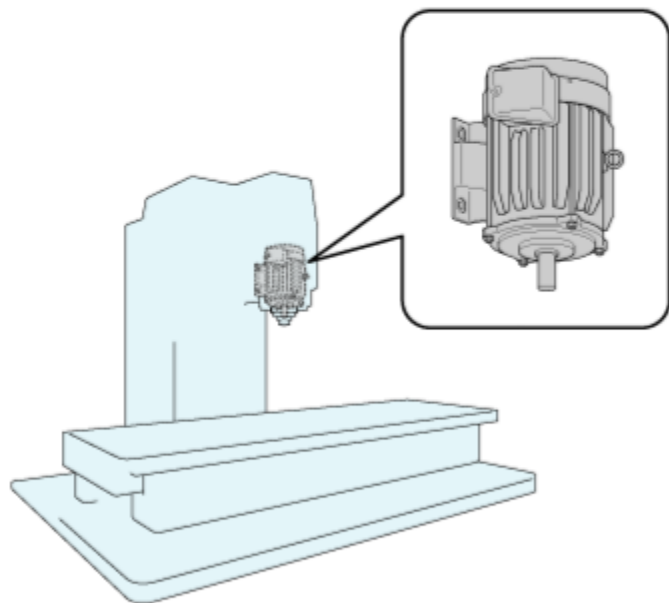
## Operating the Motor at 120Hz or Higher Frequency

In the initial setting, 120Hz or a higher frequency cannot be commanded.

To run the motor at frequency higher than 120Hz, set a frequency higher than 120Hz in "Pr.18 High speed maximum frequency".

This setting may be useful for a spindle motor of a machine tool, etc.

Parameter No.	Name	Initial value	Setting range	Description
Pr.18	High speed maximum frequency	120Hz	120 to 400Hz	Set 120Hz or a higher output frequency.

**Precaution**

When this Pr.18 (maximum frequency) is changed, Pr.1 (maximum frequency) is automatically changed.

## 4.3 Adjusting Acceleration/Deceleration of Motor According to Load

You can set the optimal acceleration/deceleration time according to the load.

In "Pr.7 Acceleration time", set the time to reach "Pr.20 Acceleration/deceleration reference frequency" from the stop status (0Hz).

In "Pr.8 Deceleration time", set the time to reach the stop status (0Hz) from "Pr.20 Acceleration/deceleration reference frequency".

Parameter No.	Name	Initial value		Setting range	Description
Pr.7	Acceleration time	3.7K or lower	5s	0 to 3600s	Set the motor acceleration time. This is the time period to reach Pr.20 from the stop status.
		5.5K, 7.5K	10s		
		11K, 15K	15s		
Pr.8	Deceleration time	3.7K or lower	5s	0 to 3600s	Set the motor deceleration time. This is the time period to reach the stop status from Pr.20.
		5.5K, 7.5K	10s		
		11K, 15K	15s		
Pr.20	Acceleration/deceleration reference frequency	60Hz		1 to 400Hz	Set the reference frequency for the acceleration/deceleration time.

Use the following formulas to determine the acceleration and deceleration time for Pr.7 and Pr.8.

Acceleration time setting =

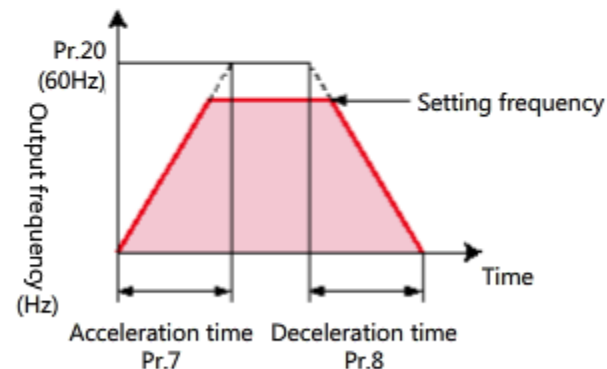
$\text{Pr.20} / (\text{set frequency} - \text{Pr.13} (*)) \times \text{acceleration time from the stop to the set frequency}$

\* Pr.13 Starting frequency (initial value 0.5Hz). Refer to the manual for details.

Deceleration time setting =

$\text{Pr.20} / (\text{set frequency} - \text{Pr.10} (*)) \times \text{deceleration time from the set frequency to the stop}$

\* Pr.10 DC injection brake operation frequency (initial value 3Hz). Refer to the manual for details.



### Precaution

Setting the acceleration time or deceleration time too short (sudden acceleration or deceleration) may cause overcurrent and a trip.

# 4.3 Adjusting Acceleration/Deceleration of Motor According to Load

Use the simulator to check how the acceleration or deceleration time settings affect the inverter operation.

The conveyor operates as follows:

- (1) Accelerates in the parameter-set acceleration time to the specified frequency.
- (2) Performs constant speed operation upon completion of acceleration.
- (3) When the start switch is set to OFF, decelerates in the parameter-set deceleration time.

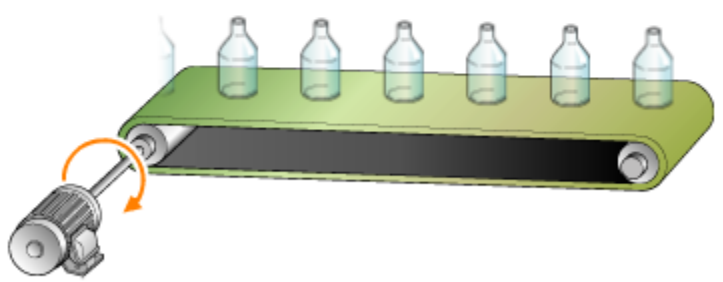
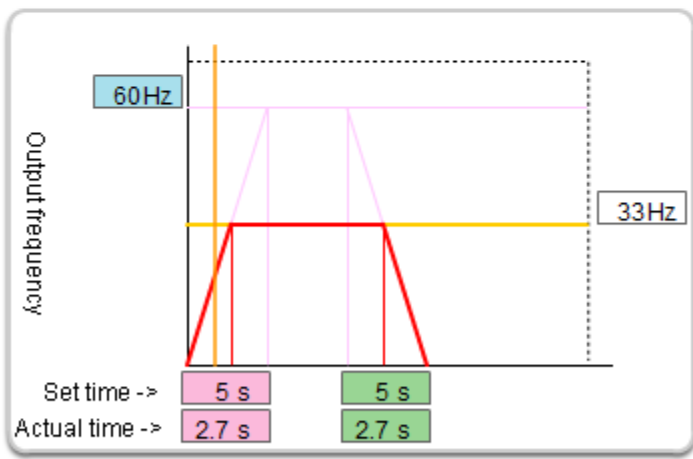
Note: The simulator automatically sets the start switch to OFF.

**Parameter setting**

Pr.20 Acceleration/ deceleration reference frequency		60Hz
Pr.7 Acceleration time		5 s
Pr.8 Deceleration time		5 s

Frequency setting potentiometer (Input voltage: V) Start switch

20.01



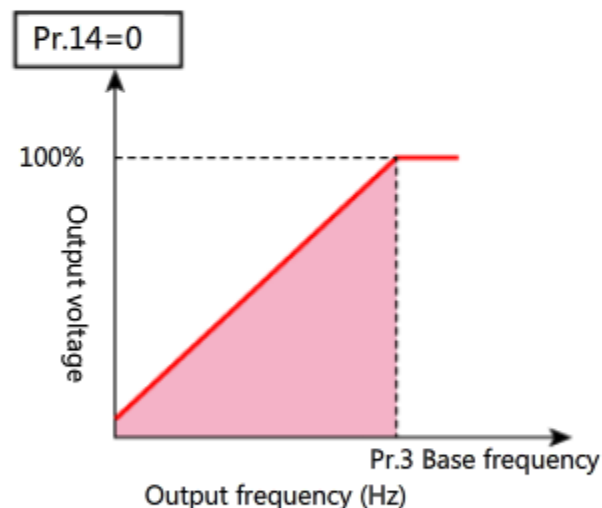
## 4.4

## Operating Fans and Pumps in Energy-saving Mode

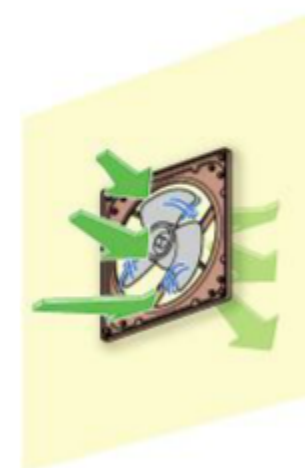
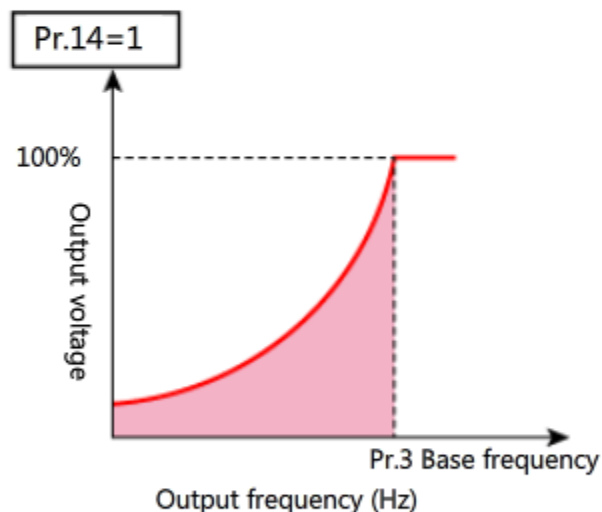
When a fan or pump is used, setting "1" (variable torque load) in "Pr.14 Load pattern selection" will provide an energy-saving effect of about 3% to 5%.

Parameter No.	Name	Initial value	Setting range	Description
Pr.14	Load pattern selection	0	0	Constant-torque load.
			1	Variable-torque load.
			2	Constant-torque lift operation (reverse rotation boost 0%).
			3	Constant-torque lift operation (forward rotation boost 0%).

## Constant-torque load



## Variable-torque load



## Precaution

Selecting "1" (variable-torque load) reduces the generatable torque.  
A heavy-loaded machine may not be accelerated due to the lack of starting torque.  
In that case, select "0" (constant-torque load).

## 4.5 Taking Countermeasure for Start-up Torque Shortage

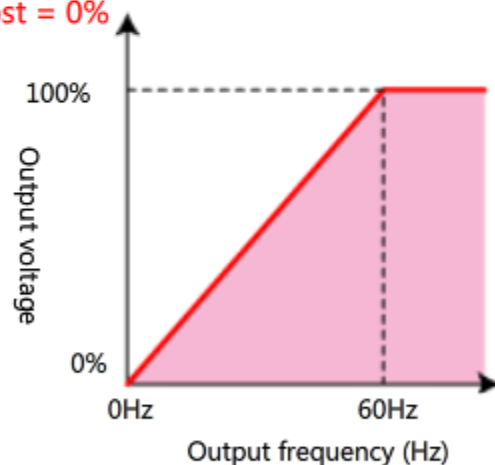
Changes in output frequency and output voltage are proportional to each other. Thus, in low-speed (frequency) region where the voltage is low, the motor output torque is also small. If a heavy load is to be accelerated in such low-speed region, the start torque may be insufficient.

As a countermeasure, use "Pr.0 Torque boost" to compensate for the output voltage at 0Hz output frequency.

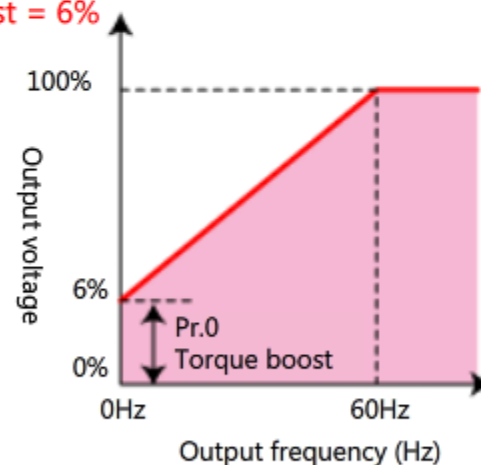
The initial torque boost setting varies depending on the inverter capacity. (See the initial values in the following table.) When the starting torque is insufficient, increase the torque boost value.

Parameter No.	Name	Initial value	Setting range	Description
Pr.0	Torque boost	0.1K to 0.75K	6%	The output voltage at 0Hz output frequency (stop status). Set a value in %. * 100% = Pr.9 Base frequency voltage (See Section 3.3 for details.)
		1.5K to 3.7K	4%	
		5.5K, 7.5K	3%	
		11K, 15K	2%	

Torque boost = 0%



Torque boost = 6%



### Precaution

- Adjust the parameter setting gradually (in about 0.5% increments) while checking the motor condition.
- When using a light load or a high-efficiency motor, increasing the torque boost too much may cause overcurrent or overheating and may also trip the inverter.
- For a light load, decreasing the torque boost will usually improve the motor efficiency.



## 4.5

## Overcoming the Shortage of Start-up Torque

Use the simulator to check how the torque boost setting affects the inverter operation.  
Setting an appropriate torque boost will solve the torque shortage problem at operation start.

The torque boost was so large that the operation has been stopped due to overcurrent.  
Click the "Start again" button.

▶ Start again

Parameter setting

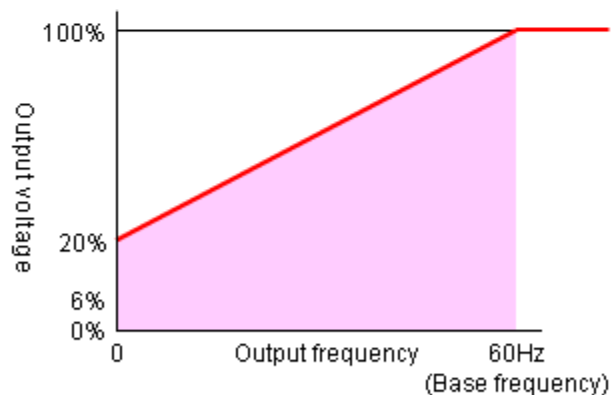
Pr.0 Torque boost

0%     6%     20%

Start switch



8.000



## 4.6

## Limiting the Output Current

Moving a heavy load may cause overcurrent and may also trip the inverter.

You can use the "Stall prevention operation" to prevent such trip.

When output current exceeds the value set in "Pr.22 Stall prevention operation level", this function automatically changes the inverter output frequency to reduce the output current.

The initial value of the stall prevention operation level is 150% of the rated inverter current.

When a trip is often caused by overcurrent, lower the stall prevention operation level.

Parameter No.	Name	Initial value	Setting range	Description
Pr.22	Stall prevention operation level	150%	0	The stall prevention operation is disabled.
			0.1 to 200%	Set the output current at which the stall prevention operation activates. * 100% = Rated inverter current

#### What is a trip?

The operation which is activated by the protection circuit of the inverter. When the protection circuit detects an abnormality, inverter outputs are shut off.

#### What is a stall?

The condition where the motor rotation is stopped because the rotation torque is insufficient to rotate an excessive load, etc.

#### Supplementary information

When the stall prevention operation activates, "OL" is displayed on the monitor of the operation panel.

## 4.6

## Limiting the Output Current

Use the simulator to check how the stall prevention operation level affects the inverter operation.

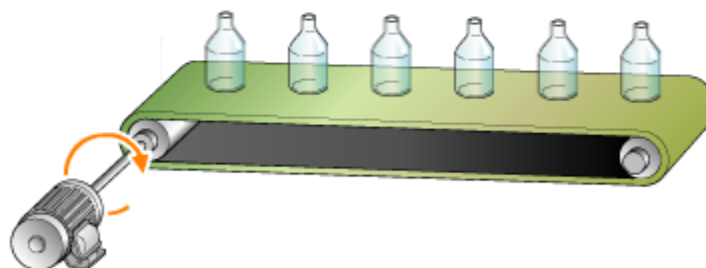
The output current has exceeded the stall prevention operation level so the stall prevention operation is now active. The conveyor acceleration is interrupted and decelerated until the output current is decreased.

## Parameter setting

Pr.22 Stall prevention operation level

- When the stall prevention operation level is too low
- When the stall prevention operation level is adequate
- When the stall prevention operation level is too high

## Start switch



Here is what you have learned in Chapter 4.  
Please review the following important points:

Setting the maximum and minimum frequencies	When a frequency (speed) that cannot be followed by the connected machine or motor is commanded, or when a fan motor has to be always run at certain speed to keep certain temperature, Pr.1 Maximum frequency" and "Pr.2 Minimum frequency" are useful.
Changing the maximum frequency	<ul style="list-style-type: none"> <li>• In the initial setting, 120Hz or a higher frequency cannot be commanded. To run the motor at higher frequency than 120Hz, set a value higher than 120Hz in "Pr.18 High speed maximum frequency".</li> <li>• This setting may be useful for a spindle motor of a machine tool, etc.</li> </ul>
Setting the acceleration/deceleration time and acceleration/deceleration reference frequency	<p>Set the optimal acceleration/deceleration time according to the load.</p> <ul style="list-style-type: none"> <li>• "Pr.7 Acceleration time": Time period to reach "Pr.20 Acceleration/deceleration reference frequency" from the stop status (0Hz).</li> <li>• "Pr.8 Deceleration time": Time period to reach the stop status (0Hz) from "Pr.20 Acceleration/deceleration reference frequency".</li> </ul>
Setting the load pattern	When a fan or pump is used, setting "1" (Variable torque load) in "Pr.14 Load pattern selection" will provide an energy-saving effect of about 3% to 5%.
Setting the torque boost	<ul style="list-style-type: none"> <li>• Changes in output frequency and output voltage are proportional to each other. Thus, in low-speed (frequency) region, where the voltage is low, the motor output torque is also small. If a heavy load is to be accelerated in such low-speed region, the starting torque may not be insufficient. As a countermeasure, use "Pr.0 Torque boost" to compensate for the output voltage at 0Hz output frequency.</li> <li>• The initial torque boost setting varies depending on the inverter capacity.</li> <li>• When the starting torque is insufficient, increase the torque boost value.</li> </ul>
Setting the stall prevention operation level	<ul style="list-style-type: none"> <li>• Moving a heavy load may cause overcurrent and inverter trip. Use the "stall prevention operation" to prevent such trips.</li> <li>• When output current exceeds the value set in "Pr.22 Stall prevention operation level", this function automatically changes the inverter output frequency to reduce the output current.</li> <li>• The initial value of the stall prevention operation level is 150% of the rated inverter current. When a trip is often caused by overcurrent, lower the stall prevention operation level.</li> </ul>

Now that you have completed all of the lessons of the **Inverter FREQROL Basics (Function)** Course, you are ready to take the final test. If you are unclear on any of the topics covered, please take this opportunity to review those topics.

**There are a total of 8 questions (23 items) in this Final Test.**

You can take the final test as many times as you like.

### How to score the test

After selecting the answer, make sure to click the **Answer** button. Your answer will be lost if you proceed without clicking the Answer button. (Regarded as unanswered question.)

### Score results

The number of correct answers, the number of questions, the percentage of correct answers, and the pass/fail result will appear on the score page.

Correct Answers : 2

Total Questions : 9

Percentage : 22%

To pass the test, you have to answer **60%** of the questions correct.

Proceed

Review

Retry

- Click the **Proceed** button to exit the test.
- Click the **Review** button to review the test. (Correct answer check)
- Click the **Retry** button to retake the test again.

The following explains the roles of parameters and how to prevent accidental operations.  
Fill in the blanks of the explanation.

Parameters are the settings that determine the  of the inverter.

The parameters are classified into the following two types.

: 12 parameters that set the basic functions

: Parameters that set complex functions according to the application

can be displayed on the FR-E700 series inverter in the initial setting.

To limit the displayable parameters, use .

To prevent parameters from being changed by accidental operation, set .

Suppose the start command and frequency command are input under the following specifications, choose the optimal "Pr.79 Operation mode".

#### Specifications

- Start command: RUN key on the operation panel
- Frequency command: External frequency setting potentiometer (voltage input)

- "0: PU external switching mode"
- "1: PU operation mode fixed"
- "2: External operation mode fixed"
- "3: External/PU combined operation mode 1"
- "4: External/PU combined operation mode 2"

[Answer](#)[Back](#)

Frequency is set by external digital input.

Choose the parameter settings under the following specifications:

#### Specifications

- Output frequency when the terminal RH signal is ON: 80Hz
- Output frequency when the terminal RM signal is ON: 60Hz
- Output frequency when the terminal RL signal is ON: 40Hz

"Pr.4 Multi-speed setting (speed 1)":

"Pr.5 Multi-speed setting (speed 2)":

"Pr.6 Multi-speed setting (speed 3)":

Answer

Back



Frequency is set by analog voltage input to terminal 2 from the external frequency setting potentiometer. Choose the parameter settings under the following specifications:

#### Specifications

- Input voltage: 0 to 5V
- Output frequency when input voltage is 0.5V: 10Hz
- Output frequency when input voltage is 4.5V: 50Hz

"Pr.125 Terminal 2 frequency setting gain frequency":

"Pr.C2 Terminal 2 frequency setting bias frequency":

"Pr.C3 Terminal 2 frequency setting bias":

"Pr.C4 Terminal 2 frequency setting gain":

Answer

Back

To allow the inverter to operate under the optimal conditions, choose "Pr.3 Base frequency" and "Pr.19 Base frequency voltage" in accordance with the following specifications:

#### Specifications

- Type of motor: High-speed motor
- Rated frequency of motor: 400Hz
- Rated voltage of motor: 200V
- Power supply voltage/frequency: 220V/60Hz

"Pr.3 Base frequency":

"Pr.19 Base frequency voltage":

Answer

Back

To protect the motor from overheating, choose "Pr.9 Electronic thermal O/L relay" and "Pr.71 Applied motor" under the following specifications:

#### Specifications

- Motor type: Standard motor
- Rated motor current: See the table "Rated current of motor" below.
- Power supply voltage/frequency: 220V/60Hz

"Pr.9 Electronic thermal O/L relay":

"Pr.71 Applied motor":

#### Rated current of motor

Power	200V/50Hz	200V/60Hz	220Hz/60Hz
Rated current	15.4A	14.4A	13.8A

Answer

Back

## Test

## Final Test 7



Set the acceleration/deceleration time when the setting frequency is 50Hz.

Choose "Pr.7 Acceleration time" and "Pr.8 Deceleration time" when the actual acceleration time and deceleration time meet the following specifications:

**Specifications**

- Setting frequency: 50Hz
- Acceleration time from the stop to the setting frequency: 5 s
- Deceleration time from the setting frequency to the stop: 10 s

"Pr.7 Acceleration time":

"Pr.8 Deceleration time":

"Pr.20 Acceleration/deceleration reference frequency": 60Hz

"Pr.13 Starting frequency": 0.5Hz

"Pr.10 DC injection brake operation frequency": 3Hz

[Answer](#)[Back](#)

The following explains how to overcome the shortage of start torque and how to prevent a trip.  
Fill in the blanks of the explanation.

When a heavy load is to be moved, the start torque may be too small to implement acceleration.

--Select-- ▾ the torque boost value to overcome the shortage of start torque.

Note that --Select-- ▾ the torque boost value may cause overcurrent and then a trip.

Moving a heavy load may cause overcurrent and then a trip.

--Select-- ▾ the stall prevention operation level to limit output current and prevent a trip from occurring

Answer

Back

You have completed the Final Test. Your results are as follows.  
To end the Final Test, proceed to the next page.

Correct answers : 0

Total questions : 8

Percentage : 0%

Proceed

Review

Retry

**You failed the test.**

You have completed the **Inverter FREQROL Basics (Function)** Course.

Thank you for taking this course.

We hope you enjoyed the lessons and the information you acquired in this course will be useful in the future.

You can review the course as many times as you want.

[Review](#)

[Close](#)