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AC Variable Speed Drive

Web Control Manual

SV-iS7

Safety Instructions

- Read this manual carefully before installing, wiring, operating, servicing or inspecting this equipment..
- Keep this manual within easy reach for Quick reference.

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About This Manual

This manual discusses the specifications, features, installation, operation, and maintenance of the iS7 Web Control. This manual is designed for users who already have a basic understanding of inverters.

Please read this manual before using your inverter to fully understand the performance, functionality, installation, and operation of this product. In addition to this, please ensure that the end user and maintenance manager have read this manual.

Safety Precautions

Safety Precautions help you prevent accidents and use this product properly. Make sure you adhere to all Safety Precautions outlined in this manual.

There are two types of symbols used in this manual: Warning symbols and Caution symbols. These symbols indicate the following.

Precaution		Definition
	Warning	**This symbol indicates the possibility of electric shock.**
	Caution	**This symbol indicates a protective conductor terminal.**

The symbols displayed on the inverter and in the manual indicate the following.

Note
Failure to adhere to caution information may result in serious consequences, depending on the situation.

The symbols displayed on the inverter and in the manual indicate the following.

Symbol	Definition
	This symbol indicates a potential danger.
	This symbol indicates the possibility of electric shock.

After reading this manual, please store it in a location where it can be easily found.

Please read this manual carefully to ensure the safe and effective use of the iS7 Web Control.

Warning

- **Do not open the cover while the power is on or at any time during operation.**
  Doing so may result in an electric shock.
- **Do not operate the inverter while the cover is open.**
  Exposing the high voltage terminal or charging area to the external environment may result in an electric shock.
- **Do not open the cover even when the power supply has been switched off. This excludes necessary maintenance or regular inspection.**
  Opening the cover may result in an electric shock even if the power supply is off. The inverter may hold a charge long after the power supply has been switched off.
- **Do not conduct maintenance or inspection without first ensuring that the DC voltage of the inverter has been fully discharged. To ensure this, use a voltage tester at least ten minutes after the power supply has been cut off.**
  Doing so may result in an electric shock. (DC 30 V or less)
- **Do not operate switches on the inverter with wet hands.**
  Doing so may result in an electric shock.
- **Do not use the inverter if the cable has been damaged.**
  Doing so may result in an electric shock.
- **Do not place heavy objects on the cable.**
  Placing heavy objects on the cable could damage its sheath and may result in an electric shock.

Caution

- **Do not install the product near any flammable materials.**
  Mounting the inverter on or near flammable materials may start a fire.
- **Switch off the power supply to a faulty inverter.**
  Failure to switch off the power supply to a faulty inverter may start a fire.
- **Do not touch the inverter while the power supply is on or within ten minutes of switching the power supply off.**
  Touching the inverter during this period may result in a burn due to the high operating temperatures of this product.
- **Do not supply power to a faulty inverter even after it has been installed.**
  Doing so may result in an electric shock.
- **Make sure that foreign substances, such as screws, metal, water, and oil, do not enter the inverter.**
  Introducing foreign substances to the inverter may start a fire.

Usage Precautions

Transportation and Installation

- Transport the product in a manner appropriate for its weight.
- Install the product according to the procedures described in this manual.
- Do not open the access panel during transport.
- Do not place heavy objects on the product.
- Install the product in the direction specified by this manual.
- This inverter is a precision instrument. Do not drop it or expose it to hard impact.
- The inverter requires a special Class 3 grounding construction.
- Immediately place any detached PCB on a protective conductor if you must remove it for installation or repair. The inverter can be damaged by static electricity.
- Do not expose the inverter to snow, rain, mist or dust.
- Do not obstruct the vents for the cooling fan. This could result in the inverter overheating.
- Make sure that power to the inverter is turned off before installation.
- Ensure that all cables are in good condition. This will minimize the risk of fire or electric shock. Do not use poor quality cables or extend the length of the existing cable.

Only operate the inverter under the following conditions.

Item		Details
Environment	Temperature	-10℃ - 50℃ (Provided no ice or frost has formed.)
	Humidity	90% RH or less (Provided no condensation has formed.)
	Storage temperature	-20 - 65℃
	Environment	There should be no corrosive or flammable gas, oil residue, dust, etc.
	Altitude/Vibrations	Altitude of 1,000 m or lower/vibrations of 5.9 m/sec² (= 0.6 g) or less
	Ambient pressure	70 - 106 kPa

Wiring

- Do not install a phase advance capacitor, surge filter, or radio noise filter on the output of the inverter.
- Connect the output side terminals (R, S and T) in the correct order.
- The inverter may be damaged if these terminals are incorrectly connected.
- Be careful. Connecting the input side (terminals DCP, DCN) into the output side (terminals R, S, T) incorrectly may damage the inverter.

⚠ Caution
Wiring or inspection must be performed by a qualified technician.

- Fully install the inverter before wiring.

Starting the Inverter

- Do not supply a voltage to any terminal if it exceeds the range outlined in the manual. Excess voltage may damage the inverter.

Usage

- Do not modify the interior workings of the inverter.

Disposal

- Dispose of the inverter according to your local regulations regarding the disposal of industrial waste.
- Recycle all recyclable components contained in this inverter to preserve energy and resources.
- The packing materials and metal components of this product are recyclable in most areas. Plastic parts are recyclable or may be burned in a controlled environment, depending on local regulations.

Cleaning

- Turn off the inverter prior to cleaning. Clean the inverter with a dry cloth. Never use water or a wet cloth to clean the inverter.

■ Long-term Storage

If you are not planning on using the inverter for a long period of time, store it under the following conditions:

- Store the inverter in an area which complies with the recommended storage environment guidelines. (See page vi.)
- If the storage period exceeds three months, store the inverter at a temperature of between -10 and 30˚C to prevent thermal degradation of the electrolytic capacitor.
- Package the inverter to prevent moisture from accumulating inside it. Ensure that the inverter is stored with a relative humidity of less than 70% by placing a desiccant (silica gel) packet inside the packaging.
- If the inverter is exposed to humidity or dust (e.g. if it is installed on construction equipment), detach it from the equipment before storing it under the conditions set forth on page vi.

⚠Caution
If the inverter is not supplied with electricity for a long period of time, the electrolytic condenser may suffer from thermal degradation. To prevent this from happening, connect the power supply to the inverter for 30 - 60 minutes at least once a year. Do not perform any wiring or other operation on the output (secondary) side of the inverter.

Table of Contents

1. Precautions

1.1 Product Overview

SV	0008		iS7	-	2	N	O	F	R	W
LS Inverter	Applicable motor capacity		Type	-	Input voltage	Keypad	UL	EMC/ DCL	DBR	Control
	0008	0.75 kW	Universal inverter		2: Three-phase 200 - 230 V 4: Three-phase 380 - 480 V	N: NON S: GLCD (Graphic loader)	O: OPEN E: Enclosed UL Type1 Note 1)	Blank: Non-EMC/ DCL F: EMC D: DCL FD: EMC, DCL	Blank: Non-DB R R: DB R (Braking resistor, built-in) Note 2)	W: Web Control
	0015	1.5 kW								
	0022	2.2 kW								
	0037	3.7 kW								
	0055	5.5 kW								
	0075	7.5 kW								
	0110	11 kW								
	0150	15 kW								
	0185	18.5 kW								
	0220	22 kW								
	0300	30 kW								
	0370	37 kW								
	0450	45 kW								
	0550	55 kW								
	0750	75 kW								
	0900	90 kW								
	1100	110 kW								
	1320	132 kW								
	1600	160 kW								

Note 1) A Type 1 Enclosed product satisfies the requirements for adding a separate conduit option to an iS7 product. This applies to all products with capacities ranging from 0.75 to 75 kW.

Note 2) Only products with capacities below 3.7 kW come equipped with a built-in braking resistor.

1.2 Products with a Built-in Braking Resistor (capacity = less than 3.7 kW)

If you want a high frequency braking resistor, please use a separate braking resistor.

Voltage	Applicable inverter capacity (kW)	Usage (%ED/Continuous operation)	100% braking torque, 2%ED	
			Resistance (Ω)	Watt (W)
200 V product	0.75	2% / 5 sec.	200	100
	1.5	2% / 5 sec.	100	100
	2.2	2% / 5 sec.	60	100
	3.7	2% / 5 sec.	40	100
400 V product	0.75	2% / 5 sec.	900	100
	1.5	2% / 5 sec.	450	100
	2.2	2% / 5 sec.	300	100
	3.7	2% / 5 sec.	200	100

If you use a product with a built-in braking resistor (capacity = less than 3.7 kW), make sure that PRT67 [DB RES SEL] is set to “Inside” and PRT66 [DB Warn %ED] is set to 1 or 2 percent.

If [DB Warn %ED] is 0%, it means that there is no limit on the use of the braking resistor. Continuously using the braking resistor in an environment that requires frequent braking may burn out the braking resistor.

Moreover, for products with a built-in braking resistor, [DB Warn %ED] can be set to 2% to limit capacity and protect the braking resistor. For environments that require frequent braking, please select a product without a built-in braking resistor and use a separate braking resistor.

2% usage means that, if the braking operation conditions are sustained for 100 seconds, braking is activated for 2 seconds only and is deactivated for the remaining 98 seconds even under braking operation conditions.

Products with a built-in braking resistor can continuously operate the braking resistor for 5 seconds. Thus, if the braking operation conditions are maintained, braking is activated for 5 seconds but is deactivated for the next 245 seconds even under braking operation conditions. Therefore, if the braking operation is interrupted, the braking resistor is unavailable for at least 245 seconds (when set at 2%).

2. Winder/Unwinder Operation

2.1 Overview

Winders are also called “spoolers”. These components wind up web material (iron wire, iron plate, steel wire, etc) as they maintain a constant tension in the material. In contrast to this, unwinders unwind web material, as they maintain a constant tension in the material.

Basically, the winder and unwinder in an iS7 inverter use analog feedback from the tension control detectors, such as the dancer or load cell, to activate the PID controller and maintain a constant tension. This way, the winder and unwinder form a closed loop tension control system when winding and unwinding web material. In addition, the characteristics of the PID controller in the closed loop tension control system differ from existing PID controllers. That is why this system is referred to as a “Web PID controller” in this manual.

However, even open loop tension control systems that do not use a Web PID or tension control detectors like dancers and load cells can function using the winder and unwinder from an iS7 inverter.

The tension control operation of an iS7 inverter can be broadly subdivided into the winder/unwinder, closed loop/open loop, and speed/tension command operations.

$$Motor\ \ Speed[rpm] \ = \ \frac{Flux[mpm]}{diameter \times \pi[m]} \qquad - \ Eq.(1.1.1)$$

The actual diameter (m) of the winder increases during operation. As shown in Eq. 1.1.1, the motor speed (rpm) decreases as the diameter of the winder increases to maintain a constant flux (mpm). The motor speed, i.e. output frequency of the inverter, is reduced by activating the Web PID controller. In addition to this, the Web PID controller computes and estimates the increases to the diameter of the winder internally and uses the computed diameter ultimately to decrease the output frequency of the inverter.

In contrast to the winder, the actual diameter (m) of the unwinder decreases during operation. As shown in Eq. 1.1.1, the motor speed (rpm) increases as the diameter of the winder decreases to maintain a constant flux (mpm). In a closed loop tension control system, this motor speed, i.e. the output frequency of the inverter, is increased by activating the Web PID controller. In addition to this, the Web PID controller computes and estimates the decreases to the diameter of the winder internally and uses the computed diameter ultimately to increase the output frequency of the inverter.

This system offers more consistent control over the winder tension than conventional PID controllers. Since the internally computed diameter compensates for the inverter's output frequency once again, the Web PID controller uses significantly less of the inverter's output frequency. Therefore, the

Web PID controller does not risk saturating the output, which is effective in significantly reducing the oscillation of the I controller output.

The Web PID controller also offers the following functions:

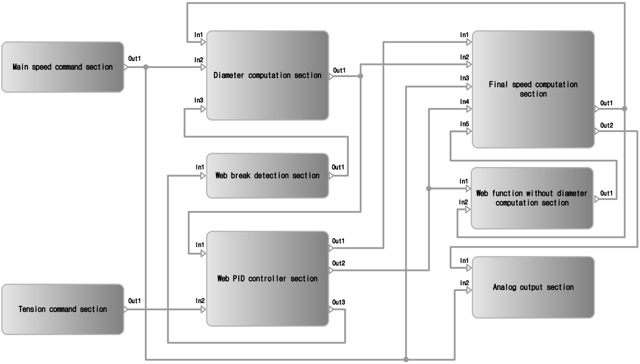
- Eliminates the transient phenomenon that occurs with the dancer or load cell at start up (related code: APP51).
- Compensates for the inertia of the winder (related code: APP56-57).
- Maintains the tension and, if necessary, performs an emergency stop (related code: APP82).
- Detects potential ruptures in the web material in advance (related code: APP76-80).

You must comply with the following settings to ensure that the iS7 properly uses the winder (spooler) or unwinder, or applies them to the closed or open loop system.

Group	Code number	Function	Name	Setting	
APP	01	App Mode	Application selection	5: Tension Ctrl	
APP	02	Tnsn Ctrl Mode	Tension control operation mode selection	0	W_Spd Close
				1	UW_Spd Close
				3	W_Tens Close
				4	UW_Tens Close
				5	W_Spd Open
				6	UW_Spd Open
				7	W_Tens Open
				8	UW_Tens Open

2.2 General Configuration

(1) Closed Loop Speed Control Mode

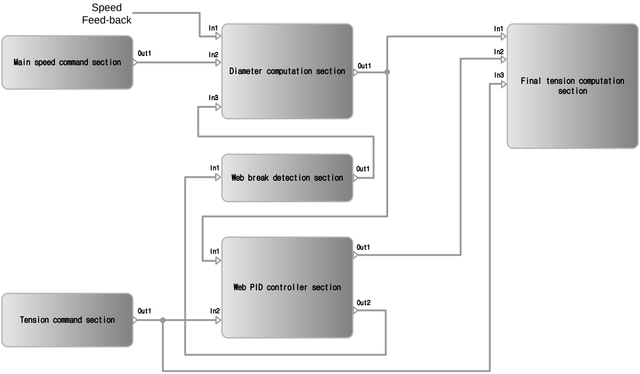


The following table outlines the inputs and outputs for each section.

Functional section	Input		Output	
Main speed command section	-		Out1	Main speed (%)
Tension command section	-		Out1	Tension command (%)
Web PID controller section	In1	Diameter (%)	Out1	Error change compensation frequency (Hz)
			Out2	PID Out (%)
	In2	Tension command (%)	Out3	PID feedback (%)
Diameter computation section	In1	Current output frequency (Hz)	Out1	Diameter (%)
	In2	Main speed (%)		
	In3	Web brake event (0/1)		
Final speed computation	In1	Error change compensation frequency (Hz)	Out1	Final speed command (Hz)

Functional section	Input		Output	
section	In2	Diameter (%)		
	In3	Main speed (%)	Out2	Main speed + PID (%)
	In4	PID output (%)		
	In5	Compensation gain (%)		
Analog output section	In1	Main speed + PID (%)	-	
	In2	Main speed (%)		
Open circuit detection section	In1	PID feedback (%)	Out1	Web brake event (0/1)
Web function without diameter computation section	In1	PID output (%)	Out1	Compensation gain (%)
	In2	Current output frequency (Hz)		

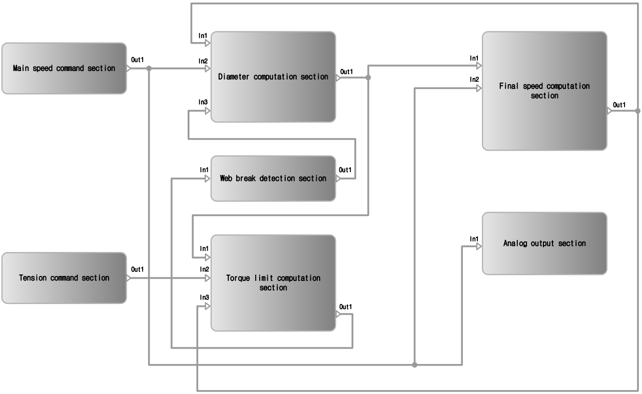
(2) Closed Loop Tension Control Mode



The following table outlines the inputs and outputs for each section.

Functional section	Input		Output	
Main speed command section	-		Out1	Main speed (%)
Tension command section	-		Out1	Tension command (%)
Web PID controller section	In1	Diameter (%)	Out1	PID Out (%)
	In2	Tension command (%)	Out2	PID feedback (%)
Diameter computation section	In1	Current frequency (Hz)	Out1	Diameter (%)
	In2	Main speed (%)		
	In3	Web brake event (0/1)		
Final tension computation section	In1	Diameter (%)	-	
	In2	PID output (%)		
	In3	Tension command (%)		
Open circuit detection section	In1	PID feedback (%)	Out1	Web brake event (0/1)

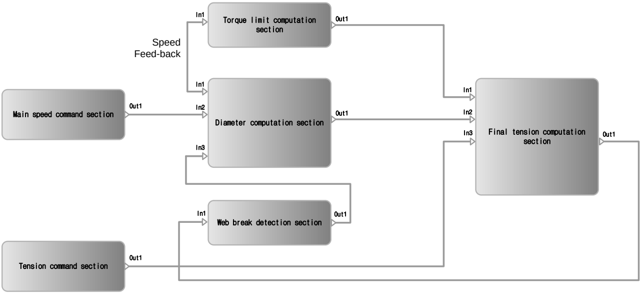
(3) Open Loop Speed Control Mode



The following table outlines the inputs and outputs for each section.

Functional section	Input		Output	
Main speed command section	-		Out1	Main speed (%)
Tension command section	-		Out1	Tension command (%)
Torque limit computation section	In1	Diameter (%)	Out1	Torque limit (%)
	In2	Tension command (%)		
	In3	Current output frequency (Hz)		
Diameter computation section	In1	Current output frequency (Hz)	Out1	Diameter (%)
	In2	Main speed (%)		
	In3	Web brake event (0/1)		
Final speed computation section	In1	Diameter (%)	Out1	Final speed command (Hz)
	In2	Main speed (%)		
Analog output section	In1	Main speed (%)	-	
Open circuit detection section	In1	Torque limit (%)	Out1	Web brake event (0/1)

(4) Open Loop Tension Control Mode

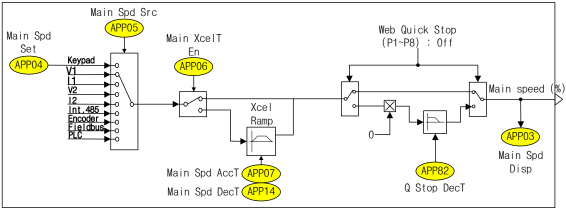


The following table outlines the inputs and outputs for each section.

Functional section	Input		Output	
Main speed command section	-		Out1	Main speed (%)
Tension command section	-		Out1	Tension command (%)
Torque limit computation section	In1	Current frequency (Hz)	Out1	Friction loss (%)
Diameter computation section	In1	Current frequency (Hz)	Out1	Diameter (%)
	In2	Main speed (%)		
	In3	Web brake event (0/1)		
Final tension computation section	In1	Friction loss (%)	Out1	Final torque command (%)
	In2	Diameter (%)		
	In3	Tension command (%)		
Open circuit detection section	In1	Final torque command (%)	Out1	Web brake event (0/1)

2.3 Main Speed Command Section

The main speed command is computed as a percentage (%) and is conceptually identical to the flux (mpm). For example, if you want to reduce the max flux from 800 mpm to 400 mpm, you just need to set the main speed command to 50% (= $400/800 \times 100\,[\%]$). The main speed command may be issued through a keypad, analog input, communication, etc.



(1) Main Speed Command

Group	Code number	Function	Name	Factory default	Range	
APP	03	Main Spd Disp	Main speed command display	Read Only (%)		
APP	04(Note 1)	Main Spd Set	Main speed keypad setting	0.00%	0.00 - 100.00%	
APP	05	Main Spd Src	Main speed command method	V1	0	Keypad
					1	V1
					2	I1
					3	V2
					4	I2
					5	Int.485
					6	Encoder
					7	Fieldbus
					8	PLC
APP	06	Main XcelT En	Main speed accel/decel selection	No	0	No
					1	Yes
APP	07(Note 2)	Main Spd AccT	Main speed accel time	10.0 sec	0.0 - 300.0 sec	

Group	Code number	Function	Name	Factory default	Range
APP	14(Note 2)	Main Spd DecT	Main speed decel time	20.0 sec	0.0 - 300.0 sec

(Note 1): This code appears when “Keypad” is selected in APP05 (Main Spd Src).
(Note 2): This code appears when “Yes” is selected in APP06 (Main XcelT En).

APP03 (Main Spd Disp): Displays the main speed (%). Displays the target main speed (%) when the inverter stops operating. Displays the ramp time for the main speed when the inverter is operating.

APP04 (Main Spd Set): When you select “Keypad” in APP05 (Main Spd Src), the main speed command input in this code activates the inverter.

APP05 (Main Spd Src): You can select how to issue the main speed command. Select “Keypad” to activate the inverter using the main speed (%) input in APP04 (Main Spd Set).

When you select “V1” or “I1,” you can issue the main speed command using the analog input of the basic I/O board. Here, you can adjust the filter, gain, and offset of the analog input in IN07-11 (V1 Filter/Gain/Offset) and IN22 - 26 (I1 Filter/Gain/Offset). When you select “V2” or “I2”, you can issue the main speed command using the analog input of the extended I/O option board. Here, you can adjust the filter, gain, and offset of the analog input in IN37 - 41 (V2 Filter/Gain/Offset) and IN52 - 56 (I2 Filter/Gain/Offset).

If an encoder option board is installed, you can also issue the main speed command using the pulse input of the “Encoder”.

“Int.485” can issue the main speed command via the RS485 communication (Modbus-RTU, LS Inv 485) built in to the basic I/O board. “Fieldbus” and “PLC” can issue the same command via the COM option card and PLC option card, respectively. Here, "Int.485” (RS485 communication built in to the basic I/O board), “Fieldbus” (COM option card), and “PLC” (PLC option card) are valid up to one decimal place for the main speed (%) command. For example, to issue a main speed command of 60.0%, you must enter “600” for the common area address and “0h0396” for the built-in 485 communication, COM option card, or PLC option card.

APP06 (Main XcelT En): This code sets the accel and decel time for the main speed setting. When you select “Yes” in this code, the ramp time for the main speed increases/decreases based on the accel/decel time input in APP07 (Main Spd AccT) and APP14 (Main Spd DecT). The factory default setting for this code is “No”. With this setting, you must ensure that the ramp time for the main speed increases/decreases according to the external upper controller. Otherwise, the main speed command is entered during each step and the system may function unstably.

APP07 (Main Spd AccT), APP14 (Main Spd DecT): These codes appear when “Yes” is selected in APP06 (Main XcelT En). This code sets the accel and decel times for the main speed setting. The accel/decel time is based on the main speed equal to 100%. For example, when APP07 (Main Spd AccT) is set to 10 sec, i.e. the factory default setting, it takes 5 sec (=10 sec * 50% / 100%) to accelerate the main speed from 0% to 50%.

(2) Emergency Stop (Quick Stop)

If an emergency occurs in a closed loop tension control system that uses a dancer or load cell, you can use the Quick Stop to maintain the tension and quickly stop system operation.

This function stops inverter operation for the time specified in APP82 (Q Stop Dec T) when the multi-function input set as “Web Quick Stop” turns ON. The deceleration time remains constant regardless of the current output frequency of the inverter.

For example, if inverter 1, 2, and 3 are interlocked and operating within a system in which their current output frequency is 25 Hz, 40 Hz, and 60 Hz respectively, these inverters all take the same decel time of 3 sec to decelerate, which is the factory default for APP82 (Q Stop Dec T), when the multi-function input “Web Quick Stop” turns ON.

Here, the output of the Web PID controller is effective, so the inverter output remains uninterrupted and the tension remains constant.

Group	Code number	Function	Name	Factory default	Range
In	65 - 72	Px Define	Multi-function input setting	50: Web Quick Stop	-
APP	82	Q Stop Dec T	Emergency stop decel time	3.0 sec	0.1 - 300.0 sec

APP82 (Quick Stop DecT): Maintains a constant tension during inverter operation in a closed loop tension control system that uses a dancer or load cell and specifies the deceleration time for emergency stops.

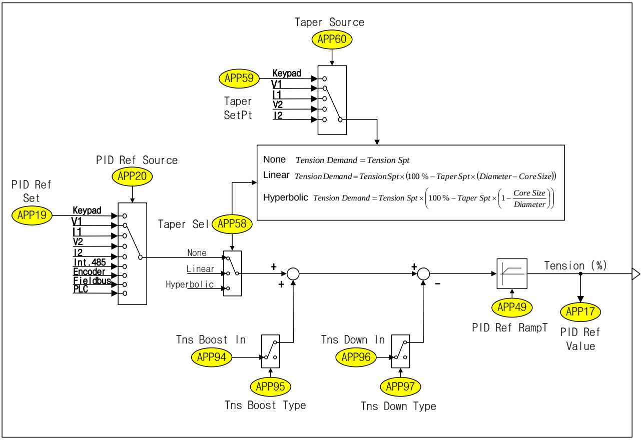
⚠Caution
Even when the “Web Quick Stop” terminal block input turns ON and emergency stop is enabled, the inverter output remains uninterrupted. After an emergency stop, make sure that the inverter operation command turns OFF to ensure that the inverter output is interrupted.

2.4 Tension Command Section

The tension command is computed as a percentage (%) and is conceptually identical to the force (kgf). For example, if you want to maintain a constant force (load) of 10 kgf in a system where the load cell's maximum capacity to measure force (load) is less than 20 kgf, you just need to set the tension command to 50% (=10 / 20 * 100%).

For open loop systems, the tension command is conceptually identical to the torque (%) and is based on the output torque value of the minimum diameter. For example, if an output torque value of 10% is required to maintain the desired tension at the minimum diameter, you should set the tension command to 10% to ensure that the same tension can be maintained at the maximum diameter.

The tension command may be issued through a keypad, analog input, communication, etc.



(1) Tension Command

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>APP</td><td>17</td><td>PID Ref Value</td><td>PID reference monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td>APP</td><td>19 (Note 1)</td><td>PID Ref Set</td><td>PID reference setting (keypad)</td><td>50.00%</td><td colspan="2">-100 - 100%</td></tr>
<tr><td rowspan="9">APP</td><td rowspan="9">20</td><td rowspan="9">PID Ref Src</td><td rowspan="9">PID reference selection</td><td rowspan="9">0: Keypad</td><td>0</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td></tr>
<tr><td>2</td><td>I1</td></tr>
<tr><td>3</td><td>V2</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int.485</td></tr>
<tr><td>6</td><td>Encoder</td></tr>
<tr><td>7</td><td>Fieldbus</td></tr>
<tr><td>8</td><td>PLC</td></tr>
</table>

(Note 1): This code appears when “Keypad” is selected in APP20 (PID Ref Source).

APP17 (PID Ref Value): This code indicates the current PID reference (as a percentage).

APP19 (PID Ref Set): You can set the reference for the PID controller using the keypad. This code appears when “Keypad” is selected in APP20 (PID Ref Src).

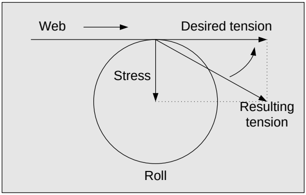
APP20 (PID Ref Src): This code allows you to select from a variety of methods to input the PID controller reference information (keypad, analog, internal COM, external COM, and PLC option).

(2) Tapering

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>58: Web Taper Dis</td><td colspan="2">-</td></tr>
<tr><td rowspan="3">APP</td><td rowspan="3">58</td><td rowspan="3">Taper Sel</td><td rowspan="3">Tapering function selection</td><td rowspan="3">0: None</td><td>0</td><td>None</td></tr>
<tr><td>1</td><td>Linear</td></tr>
<tr><td>2</td><td>Hyperbolic</td></tr>
<tr><td>APP</td><td>59</td><td>Taper SetPt</td><td>Taper keypad setting value</td><td>0.00%</td><td colspan="2">-100.00 - 100.00%</td></tr>
<tr><td rowspan="13">APP</td><td rowspan="13">60</td><td rowspan="13">Taper Source</td><td rowspan="13">Taper value setting method</td><td rowspan="13">0: Keypad</td><td>0</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td></tr>
<tr><td>2</td><td>I1</td></tr>
<tr><td>3</td><td>V2</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>XV1</td></tr>
<tr><td>6</td><td>XI1</td></tr>
<tr><td>7</td><td>XV2</td></tr>
<tr><td>8</td><td>XI2</td></tr>
<tr><td>9</td><td>XV3</td></tr>
<tr><td>10</td><td>XI3</td></tr>
<tr><td>11</td><td>XV4</td></tr>
<tr><td>12</td><td>XI4</td></tr>
<tr><td>APP</td><td>81</td><td>Taper Spt Val</td><td>Taper setting value monitor</td><td colspan="3">Read Only (%)</td></tr>
</table>

In the center wind application, the largest diameter produces the more stress towards the center of the winder. The desired tension is the tension as a tangential direction. This tension is caused by stress, so the sum of these two vectors is the total tension. Thus, tapering can maintain the desired tension. In other words, this function reduces the PID reference by the computed diameter and compensates for the size of the vector caused by stress. Fig. 1.4.1 provides a detailed conceptual diagram and the related equations.

In terms of the tension sensor, tapering is applied based on the load on the load cell (weight sensor) rather than the dancer (position sensor).



Hyperbolic Taper:

$$Tension\ Demand = Tension\ Spt \times \left(100\,\% - Taper\ Spt \times \left(1 - \frac{Core\ Size}{Diameter}\right)\right)$$

Linear Taper:

$$\text{Tension Demand} = \text{Tension Spt} \times (100\,\% - \text{Taper Spt} \times (\text{Diameter} - \text{Core Size}))$$

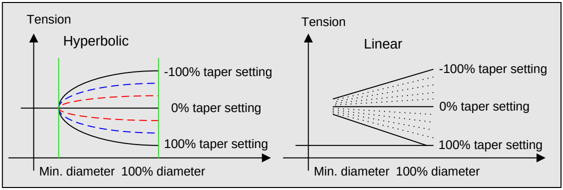


Fig. 1.4.1 Tension variation trend based on the concept and taper setting

(3) Tension Boost/Down

The following table outlines the boost/down setting ranges for the tension (PID Reference).

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>59: Web Boost En</td><td colspan="2">-</td></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>60: Web Down En</td><td colspan="2">-</td></tr>
<tr><td>APP</td><td>94</td><td>Tns Boost In</td><td>Tension boost setting</td><td>0.00%</td><td colspan="2">0.00 - 50.00%</td></tr>
<tr><td rowspan="2">APP</td><td rowspan="2">95</td><td rowspan="2">Tns Boost Type</td><td rowspan="2">Tension boost type</td><td rowspan="2">0: Fixed</td><td>0</td><td>Fixed</td></tr>
<tr><td>1</td><td>Proportional</td></tr>
<tr><td>APP</td><td>96</td><td>Tns Down In</td><td>Tension down setting</td><td>0.00%</td><td colspan="2">0.00 - 50.00%</td></tr>
<tr><td rowspan="2">APP</td><td rowspan="2">97</td><td rowspan="2">Tns Down Type</td><td rowspan="2">Tension down type</td><td rowspan="2">0: Fixed</td><td>0</td><td>Fixed</td></tr>
<tr><td>1</td><td>Proportional</td></tr>
</table>

(4) Tension Command Ramp

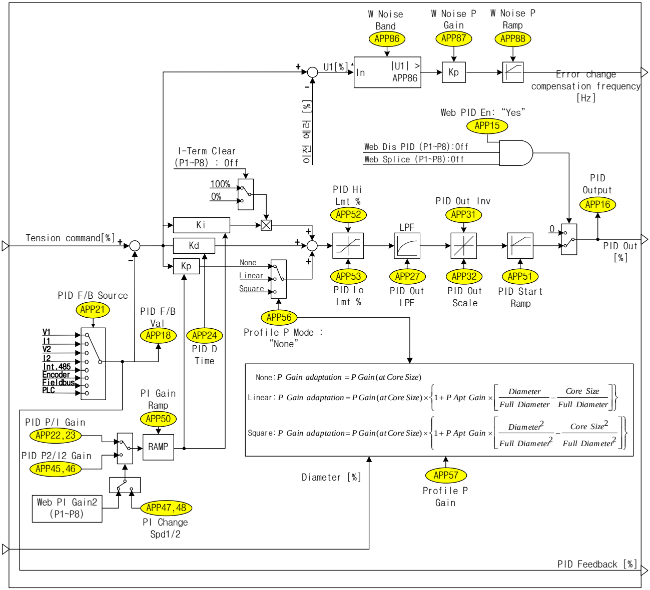
Ramp may increase during the specified time tapering is applied or the final tension command is boosted/downed.

You can send the final tension command, with the tension command ramp applied, to the analog output (AO1: 0 - 10 V voltage, AO2: 0 - 20 mA current). In this case, however, the maximum value for the final tension command is 300.00%. Thus, the AO1 Gain or AO2 Gain must be set to 300.0%.

Group	Code number	Function	Name	Factory default	Range
APP	49	PID Ref RampT	Tension command ramp time	0.0 sec	0.0 - 300.0 sec
OUT	01, 07	AO1, AO2 Mode	Analog output 1, 2	Tension Ref	-

APP49 (PID Ref RampT): You can increase the ramp time when setting the time for the final tension command. Slope of the set time is set based on the 100% tension command. When initial start-up or tension command is changed during operation, it prevent PID output is saturated due to the difference of the command value and feedback value. In the open-loop system, it is used for a gentle start of initial.

2.5 Web PID Controller Section



In a closed loop tension control system, the analog quantity feedback from tension detectors, such as the dancer or load cell, determine the PID controller output. A PID controller optimized for tension control systems is referred to as a Web PID controller.

The Web PID controller also features the following major additional functions.

1) Improves the initial transient phenomenon of the dancer or load cell by increasing the PID output when the inverter starts during ramp up (APP51: PID Start Ramp), 2) Compensates for inertia by using the diameter (%) estimated for that section in the diameter computation to change the P gain of the PID controller (APP56: Profile P Mode, APP57: Profile P Gain), and 3) Compensates for any disturbances (APP86-88) that may occur during operation (APP86-88).

(1) PID Controller

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>49: Web Dis PID</td><td colspan="2">-</td></tr>
<tr><td rowspan="2">APP</td><td rowspan="2">15</td><td rowspan="2">Web PID En</td><td rowspan="2">Tension PID control selection</td><td rowspan="2">1: Yes</td><td>0</td><td>No</td></tr>
<tr><td>1</td><td>Yes</td></tr>
<tr><td>APP</td><td>16</td><td>PID Output</td><td>PID output monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td>APP</td><td>18</td><td>PID Fdb Value</td><td>PID feedback monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td rowspan="8">APP</td><td rowspan="8">21</td><td rowspan="8">PID F/B Src</td><td rowspan="8">PID feedback selection</td><td rowspan="8">1: I1</td><td>0</td><td>V1</td></tr>
<tr><td>1</td><td>I1</td></tr>
<tr><td>2</td><td>V2</td></tr>
<tr><td>3</td><td>I2</td></tr>
<tr><td>4</td><td>Int.485</td></tr>
<tr><td>5</td><td>Encoder</td></tr>
<tr><td>6</td><td>Fieldbus</td></tr>
<tr><td>7</td><td>PLC</td></tr>
<tr><td>APP</td><td>22</td><td>PID P-Gain</td><td>PID controller proportional gain</td><td>50.0%</td><td colspan="2">0.0 - 1000.0%</td></tr>
<tr><td>APP</td><td>23</td><td>PID I-Time</td><td>PID controller integral time</td><td>10.0 s</td><td colspan="2">0.0 - 200.0 s</td></tr>
<tr><td>APP</td><td>24</td><td>PID D-Time</td><td>PID controller differentiation time</td><td>0 ms</td><td colspan="2">0 - 1000 ms</td></tr>
<tr><td>APP</td><td>27</td><td>PID Out LPF</td><td>PID output filter</td><td>0 ms</td><td colspan="2">0 - 10000 ms</td></tr>
<tr><td>APP</td><td>28</td><td>PID I Limit</td><td>PID I controller limit</td><td>100.0%</td><td colspan="2">0.0 - 100.0%</td></tr>
<tr><td rowspan="2">APP</td><td rowspan="2">31</td><td rowspan="2">PID Out Inv</td><td rowspan="2">PID output inverse</td><td rowspan="2">0: No</td><td>0</td><td>No</td></tr>
<tr><td>1</td><td>Yes</td></tr>
<tr><td>APP</td><td>32</td><td>PID Out Scale</td><td>PID output scale</td><td>30.0%</td><td colspan="2">0.0 - 1000.0%</td></tr>
<tr><td>APP</td><td>51</td><td>PID Start Ramp</td><td>PID output at start Ramp time</td><td>5.0 s</td><td colspan="2">0.0 - 300.0 s</td></tr>
<tr><td>APP</td><td>52</td><td>PID Hi Lmt %</td><td>PID output upper limit (%)</td><td>100.0%</td><td colspan="2">APP53-100.0%</td></tr>
<tr><td>APP</td><td>53</td><td>PID Lo Lmt %</td><td>PID output lower limit (%)</td><td>-100.0%</td><td colspan="2">-100 - APP52%</td></tr>
<tr><td>APP</td><td>98</td><td>PID Sample T</td><td>PID controller execution frequency</td><td>1 ms</td><td colspan="2">1-10 ms</td></tr>
</table>

APP15 (Web PID En): Determines whether to use the Web PID controller. This code functions in combination with the multi-function input “Web Dis PID”, as shown in Table 1.5.1.

Table 1.5.1 Selecting whether to use the Web PID controller

APP15 (Web PID En) setting	Status of the multi-function input “Web Dis PID”	Whether to use the Web PID controller
Yes	Off	O
Yes	On	X
No	Off	X
No	On	X

APP16 (PID Output): Indicates the current PID output (%).

APP18 (PID Fdb Value): Indicates the current PID feedback (%).

APP21 (PID F/B Src): This code allows you to select from a variety of methods to input the PID controller feedback (analog, internal COM, external COM, and PLC option).

APP22 (PID P-Gain): Indicates the P1 gain of the PID controller. If the P gain is 100% and the error is 100%, then the P controller output is 100%.

APP23 (PID I-Time): Indicates the I1 gain of the PID controller. If the I gain is 10 sec and the error is 100%, then it takes 10 seconds to saturate the I controller output to 100%.

APP24 (PID D-Time): Indicates the D gain of the PID controller. If the D gain is 10 ms and the error change is 100%, then it takes 10 ms for the D controller output to decrease from 100% to 34%.

APP27 (PID Out LPF): Sets the delay time constant of the PID controller output. In general, this code sets the delay time to 0 ms to shorten the response time of the PID controller. However, a higher value makes the PID controller less responsive but more stable.

APP28 (PID I Limit): Indicates the output limit of the I controller for anti-windup.

APP31 (PID Out Inv): Selects whether to invert the output of the PID controller. Select “Yes” to invert the PID output code before it is output. This code is useful in situations where the tension detectors, such as the dancer or load cell, are oriented oppositely.

APP32 (PID Out Scale): Adjusts the scale of the PID controller output. First, suppose that the PID controller is saturated. In such a situation, if this code is set to 100%, the PID controller output is 100%. When this code is set to 30%, the PID controller output is 30%.

APP51 (PID Start Ramp): Ramp time can be increased during the set time of PID output when the inverter initially starts. This function smoothes the output of the PID controller at initial start up and improves transient phenomena like sloshing when starting the dancer or load cell.

Fig. 1.5.1 (b) shows the output of the P controller at start up when the P gain is 100% and the PID error is 100%. The dotted line in figure (b) shows the output of the P controller when APP51 (PID Start Ramp) is “0 (sec)”. The solid line in figure (b) shows that the output of the PID controller at initial start up tends to increase by the ramp time based on APP51 (PID Start Ramp). In other words, the solid line in (b) is more advantageous than the dotted line in (b) due to the transient phenomena that exists when the inverter initially starts.

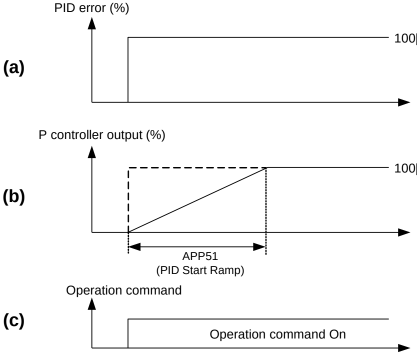


Fig. 1.5.1 Activating APP51 (PID Start Ramp)

Moreover, APP51 (PID Start Ramp) is based on the PID controller output at 100%. For example, when APP51 (PID Start Ramp) is set to 5 sec, it takes 5 sec to fully saturate the output of the PID controller to 100% at initial start up. However, it takes 2.5 sec to saturate the output of the PID controller to 50% at initial start up.

APP52, 53 (PID Hi/Lo Lmt %): Specifies the upper and lower limit of the PID controller output. In addition to this, the cumulative value of the I controller is limited to the upper and lower value specified in this code.

APP98 (PID Sample T): Changes the execution frequency of the Web PID controller.

(2) Inertia Compensation

Group	Code number	Function	Name	Factory default	Range	
APP	56	Profile P Mode	P Gain profile selection	0: None	0	None
					1	Linear
					2	Square
APP	57(Note 1)	Profile P Gain	Profile gain	1.00%	0.01 - 10.00%	

(Note 1): This code appears when you select “Linear” or “Square” in APP56 (Profile P Mode).

The winder develops a larger diameter and produces more inertia over time, so it requires more positive (+) inertia compensation. In contrast to this, the unwinder develops a smaller diameter and produces less inertia over time, so it requires more negative (-) inertia compensation.

For this inertia compensation, P gain should increase as the diameter increases. It is expressed in the following equation. Fig. 1.5.2 shows how the P gain varies depending on the diameter.

“None”:

$$Inertia compensation\ P\ Gain = P\ Gain$$

“Linear”:

$$\text{Innertia compensation } P\ Gain =$$

$$P\ Gain \times \left\{ 1 + \text{Pr}ofile\ P\ \ Gain(APP57)\ \times \left[\frac{Diameter}{Full\ \ Diameter} - \frac{Bobbin\ Diameter}{Full\ \ Diameter} \right] \right\}$$

“Square”:

$$Innertia compensation\ P\ \ Gain =$$

$$P\ Gain \times \left\{ 1 + \ profile\ P\ Gain\ \times \left[\frac{Diameter^2}{Full\ \ Diameter^2} - \frac{Bobbin\ Diameter^2}{Full\ \ Diameter^2} \right] \right\}$$

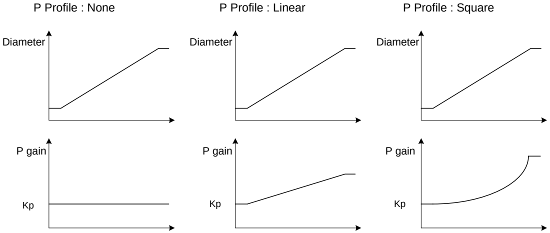


Fig. 1.5.2 The P gain trend varies depending on the APP56 settings (Profile P Mode)

(3) P, I gain Switching (changing the gain during multi-function input and operation)

During inverter operation, system response may become unstable if the P/I gain switches over momentarily without switching the ramp time when the multi-function input “Web PI Gain2” changes. This may also occur if you manually change the APP22 (PID P-Gain) and APP23 (PID I-Time) settings. In order to avoid this risk, make sure the P/I gain switching changes slowly along with the proper setting in APP50 (PI Gain Ramp).

Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	55: Web PI Gain2	-
APP	22	PID P-Gain	PID controller proportional gain	50.0%	0.0 - 1000.0%
APP	23	PID I-Time	PID controller integral time	10.0 s	0.0 - 200.0 s
APP	45	PID P2-Gain	PID controller proportional gain 2	100.0%	0.0 - 1000.0%
APP	46	PID I2-Time	PID controller integral time 2	20.0 s	0.0 - 200.0 s
APP	50	PI Gain Ramp	PI gain switching ramp time	30.0 sec	0.0 - 300.0 sec

APP50 (PI Gain Ramp): This code is the ramp time applicable when P/I gain switching occurs due to a change in the multi-function input “Web PI Gain2” during inverter operation. In addition to this, this code also applies when you use the loader to change the P/I gain during inverter operation. Ramp time switching is based on 1000% for the P gain and 200 sec for the I gain. For example, it takes 3 sec (=30 * 100 / 1000) to change the P gain from 100% to 200% when APP50 (PI Gain Ramp) is set to 30 sec.

Table 1.5.2 Selecting the P/I gain depending on the multi-function input “Web PI Gain2”

Status of the multi-function input “Web PI Gain2”	P/I gain selected
Off	APP22 (PID P-Gain), APP23 (PID I-Time)
On	APP45 (PID P2-Gain), APP46 (PID I2-Time)

(4) P, I gain Switching (switching by speed)

The ramp time can change the PI gain value based on variations in the inverter operation speed, as shown in Fig. 1.5.3.

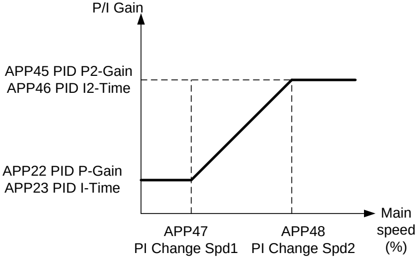


Fig. 1.5.3 Switching the PI gain depending on speed

Group	Code number	Function	Name	Factory default	Range
APP	22	PID P-Gain	PID controller proportional gain	50.0%	0.0 - 1000.0%
APP	23	PID I-Time	PID controller integral time	10.0 s	0.0 - 200.0 s
APP	45	PID P2-Gain	PID controller proportional gain 2	100.0%	0.0 - 1000.0%
APP	46	PID I2-Time	PID controller integral time 2	20.0 s	0.0 - 200.0 s
APP	47	PI Change Spd1	Main speed to start gain switching	0.00%	0.00-PI Change Spd2 (%)
APP	48	PI Change Spd2	Main speed to complete gain switching	0.00%	PI Change Spd1 - 100.00 (%)

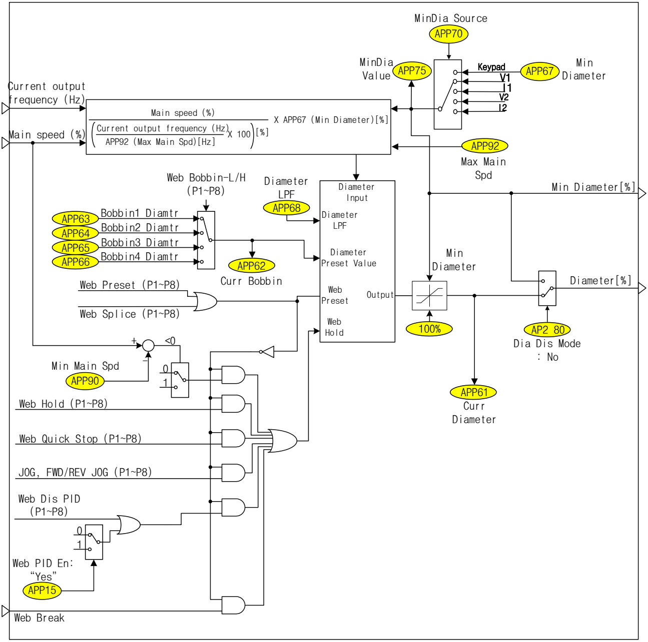
(5) Disturbance Compensation

Group	Code number	Function	Name	Factory default	Range
APP	86	W Noise Band	Disturbance detection band	0.0%	0.0 - 100.0%
APP	87	W Noise P Gain	Disturbance compensation P gain	0.0%	0.0 - 100.0%
APP	88	W Noise P Ramp	Disturbance compensation accel/decel time	0.0 sec	0.0 - 100.0 sec

If an error occurs in the position of the dancer or load cell with an abnormal band set at APP86 (W Noise Band) due to external causes, you can use the P gain set in APP87 (W Noise P Gain) to effectively stabilize the dancer or load cell.

The APP88 (W Noise P Ramp) code sets the time constant for disturbance compensation.

2.6 Diameter Computation Section



In a tension control system, the winder/unwinder flux, motor speed, and diameter are correlated, as shown in Eq. 1.6.1.

$$Flux[mpm] = $$

$$Motor\ speed\,[rpm] \times (diameter \times \pi)[m] = Constant \qquad - Eq(1.6.1)$$

Let's take a look at one example of a winder in a closed loop tension control system. Unless you adjust the flux, the flux (mpm) remains constant as the actual diameter (m) of the winder increases over time. Thus, as shown in Eq. 1.6.1, a flux increase exerts more tension on the dancer or load cell. This causes the output of the Web PID controller to become negative (-) and the actual speed of the motor (rpm) to decrease, which decreases the flux in Eq. 1.6.1 so that it remains constant.

As shown below, Eq. 1.6.2 allows you to use the winder flux (mpm), which is always constant, and the actual speed of the motor (lower rpm) to estimate the diameter computation. This equation assumes that the estimated diameter increases over time.

$$Estimated\ diameter \times \pi\,[m] = \frac{Flux\ [mpm]}{Motor\ speed\,[rpm]} \qquad - Eq.(1.62)$$

Next, let's take a look at an example of an unwinder. With unwinders, unless you adjust the flux, the flux (mpm) remains constant as the actual diameter (m) of the unwinder decreases over time. Thus, like the winder, the unwinder increases the tension on the dancer or load cell as the flux decreases to maintain a constant flux, as shown in Eq. 1.6.1. However, unlike the winder, the unwinder internally inverts the output signals from the Web PID controller internally. Thus, unlike the winder, the output from the Web PID controller becomes positive (+) and the actual speed of the motor (rpm) increases. Once again, the flux in Eq. 1.6.1 increases to maintain its constant speed. As shown above, Eq. 1.6.2 allows you to use the unwinder flux (mpm), which is always constant, and the actual speed of the motor (higher rpm) to estimate the diameter computation. This equation assumes that the estimated diameter decreases over time.

(1) Bobbin Selection and Diameter Initialization

Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	52: Web Preset	-
IN	65 - 72	Px Define	Multi-function input setting	53: Web Bobbin-L	-
IN	65 - 72	Px Define	Multi-function input setting	54: Web Bobbin-H	-
APP	62	Curr Bobbin	Current bobbin display	Read Only	
APP	63	Bobbin1 Diamtr	Bobbin 1 diameter (%)	10.0%	APP67 - 100.0 %
APP	64	Bobbin2 Diamtr	Bobbin 2 diameter (%)	15.0%	APP67 - 100.0 %
APP	65	Bobbin3 Diamtr	Bobbin 3 diameter (%)	20.0%	APP67 - 100.0 %
APP	66	Bobbin4 Diamtr	Bobbin 4 diameter (%)	25.0%	APP67 - 100.0 %

APP62 (Curr Bobbin): Indicates the number of bobbins currently selected (1-4).

APP63 - 66 (Bobbin # Diamtr): As shown below, you must use a combination of multi-function input “Web Bobbin-L” and “Web Bobbin-H" to specify the bobbin diameter. After selecting a bobbin, switch multi-function input “Web Preset” from On➔Off and initialize it to the diameter of the bobbin selected.

Multi-function input “Web Bobbin-H”	Multi-function input “Web Bobbin-L”	Bobbin selected
Off	Off	Bobbin1 (APP63)
Off	On	Bobbin2 (APP64)
On	Off	Bobbin3 (APP65)
On	On	Bobbin4 (APP66)

For example, suppose that there are 4 kinds of bobbin, as shown in the following figure. For these bobbins, you must enter the computed values, i.e. 14.2%, 28.5%, 35.7% and 50.0%, in APP63-66 (Bobbin # Diamtr) respectively. You must also enter 14.2%, i.e. the %diameter of Bobbin1, in APP67 (Min Diameter), since it is the smallest bobbin.

Select the currently installed bobbin using a combination of multi-function input “Web Bobbin-L” and “Web Bobbin-H,” and then switch multi-function input “Web Preset” from On→Off to initialize it.

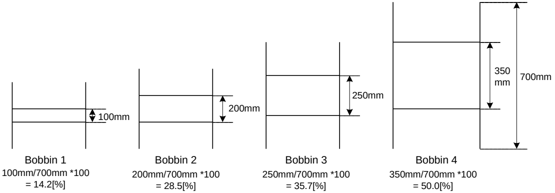


Fig. 1.6.1 Various bobbin sizes

⚠Caution
When you replace a bobbin, always switch multi-function input “Web Preset” from On➔Off. You cannot compute the new diameter if multi-function input “Web Preset” remains ON.

(2) Diameter Computation

Group	Code number	Function	Name	Factory default	Range	
APP	61	Curr Diameter	Current diameter display (%)	Read Only		
APP	67	Min Diameter	Keypad value of minimum bobbin diameter	10.0%	5.0 - 100.0%	
APP	68	Diameter LPF	Diameter computation filter	30.0 sec	0.0 - 300.0 sec	
APP	70	MinDia Source	Selection of the minimum bobbin diameter input	0: Keypad	0	Keypad
					1	V1
					2	I1
					3	V2
					4	I2
					5	XV1
					6	XI1
					7	XV2
					8	XI2
					9	XV3
					10	XI3
					11	XV4
					12	XI4
APP	75	MinDia Value	Minimum bobbin diameter monitor	Read Only (%)		
APP	92	Max Main Spd	Main speed 100% frequency	60.0 Hz	0.0 - DRV20 (Hz)	

You can convert Eq. 1.6.2 to percentages and reorganize it into Eq. 1.6.3.

$$Estimated\ \ diameter\,[\%] =$$

$$\frac{Main\ \ speed[\%]}{\dfrac{Current\ \ output\ \ frequency[Hz]}{APP-92\,(Max\,Main\,Spd)}\times 100\ [\%]} \times APP-67\,(Min\,Diameter) \qquad -Eq\,(1.6.3)$$

The following description of the winder operating mechanism explains Eq. 1.6.3.

Unless you change the “main speed (%),” it remains at the constant commanded and the actual diameter of the bobbin for the winder increases over time. At the same time, the tension on the dancer and load cell gradually increases. Thus, the Web PID controller produces a negative (-) output and the “current output frequency (Hz)” of the inverter decreases. Then by Eq. 1.6.3, the “estimated diameter (%)” increases. This “estimated diameter (%)” is internally restricted by the upper limit 100% and lower limit APP67 (Min Diameter). By setting APP68 (Diameter LPF), you can use the time constant of the “estimated diameter (%)” to control the computed speed at that diameter (%).

This “estimated diameter (%)” is crucial in determining the final speed command (Hz) of the inverter. For more details, please see the section 1.7 concerning final speed computations.

APP61 (Curr Diameter): Indicates the diameter of the current bobbin (%). After switching multi-function input “Web Preset” from On→Off, the diameter (%) of the selected bobbin appears. The diameter (%) computed in Eq. 1.6.3 is updated during operation.

APP67 (Min Diameter): When selecting the input value of APP70 with the Keypad, enter the ratio (%) of the empty bobbin diameter to the bobbin diameter when fully wrapped with material. If there are a variety of bobbins available, as shown in Fig. 1.6.1, enter the ratio (%) of the minimum diameter of the smallest bobbin to the maximum diameter of the largest bobbin. In cases such as the one shown in Fig. 1.6.1, enter 14.2% in APP67 (Min Diameter).

APP68 (Diameter LPF): Selects the delay time constant of the diameter (%) computation. Usually set as traverse reciprocating time.

APP70 (MinDia Source): This code allows you to select from a variety of methods to enter the minimum bobbin diameter value (e.g. keypad, analog, extended analog input).

APP75 (MinDia Value): Indicates the minimum bobbin diameter value (%).

APP92 (Max Main Spd): When the main diameter command is 100%, enter the maximum speed (Hz) for the empty diameter of the smallest bobbin. In this example, the empty diameter of the smallest bobbin is 0.1 m (= 100 mm), as shown in Fig. 1.6.1. Suppose that the maximum flux of this system is 350 (mpm) and the belt ratio of the 4-pole motor (faster motor) is 2.3/1. In this situation, you use Eq. 1.6.4 to compute the value to enter in APP92 (Max Main Spd) in the following way.

$$APP-92\,(Max\,Main\,Spd) =$$

$$\frac{350[mpm]}{0.10[m]\times\pi}\times 2.3(Belt\ ratio)\times\frac{4(poles)}{120} = 85.46[Hz] \qquad -Eq\ (1.6.4)$$

(3) Interruption of Diameter Computation

Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	Web Hold	-
APP	69	Web Hold Freq	Interruption frequency of diameter computation	5.00 Hz	0.00 - 30.00 Hz
APP	90	Min Main Spd	Minimum main speed	3.0%	0.0 - 100.0%

Do not compute the diameter when one of the following requirements is met: the multi-function input “Web Hold” is ON, during jog operation, when the Web PID is prohibited, low speeds below the limits of APP69 (Web Hold Freq) and APP90 (Min Main Spd), in Web Break status, and in an emergency stop zone initiated by multi-function input “Web Quick Stop”. Diameter computation is only meaningful under normal operating conditions.

Stop computing the diameter in the following conditions:

- Multi-function input “Web Hold” is On, or
- Main speed command (%) < APP90 (Min Main Spd), or
- Output frequency (Hz) < APP69 (Web Hold Freq), or
- Emergency stop by multi-function input “Web Quick Stop” is On, or
- Web break detected, or
- Multi-function input “Web Dis PID” is On, or
- APP15 (Web PID En) is 'Yes,' or
- During Jog Operation.

(4) Web Function without Diameter Computation

Group	Code number	Function	Name	Factory default	Range	
AP2	80	Dia Dis Mode	Selection of web without diameter computation	0: No	0	No
					1	Yes

Select this option to enable tension control operation without entering a diameter value. If you select “Yes” for AP2 80, the current diameter becomes the minimum diameter regardless of the diameter computation, and the value of diameter has no practical effects on tension control.

For more details on web function without diameter computation, please see section 2.12, "Web Function without Diameter Computation”.

2.7 Final Speed Computation Section

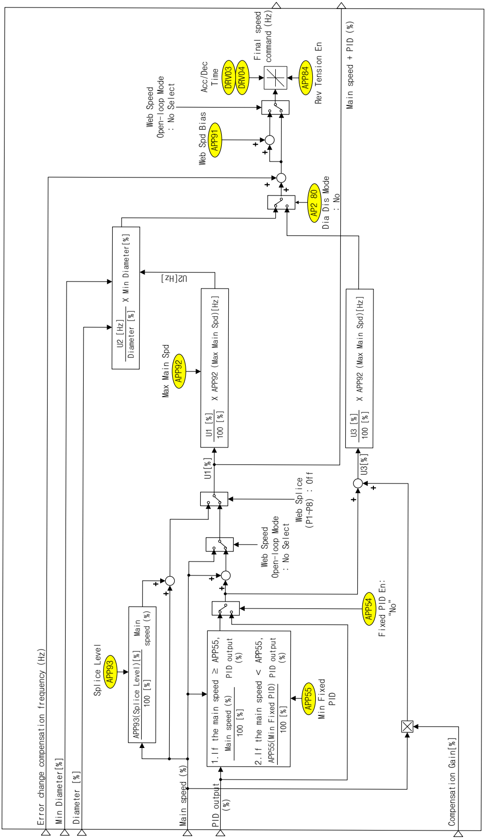


Fig. 1.7.1 Final speed computation section

The final speed computation section determines the final speed command (Hz) of the inverter. It uses the main speed computed in the main speed command section (In3: main speed[%]), the PID output computed in the Web PID controller section (In4: PID output[%]), the error change compensation frequency (In1), and the diameter computed in the diameter computation section (In2: Diameter [%]).

(1) PID Output Method (Fixed/non-fixed PID controller)

Group	Code number	Function	Name	Factory default	Range	
APP	54	Fixed PID En	Fixed PID controller selection	0: No	0	No
					1	Yes
APP	55(Note 1)	Min Fixed PID	Minimum value of the fixed PID controller	10.0%	0.0 - 50.0%	

(Note 1): This code appears when “No” is selected in APP54 (Fixed PID En).

When you select “Yes” in APP54 (Fixed PID En), the PID output(%) - an output of the Web PID controller, as shown in Eq. 1.7.1 - remains constant regardless of the main speed (%).

$$Final\ PID\ output\,[\%] = PID\ output\,[\%] \qquad -Eq\,(1.7.1)$$

When you select “No” as the factory default for APP54 (Fixed PID En), the PID output (%) - an output of the Web PID controller, as shown in Eq. 1.7.2 - is proportional to the main speed (%). In other words, it means that the ratio of the PID output (%) to the main speed remains constant. According to this principle, lower main speeds (%) produce less PID output (%), whereas higher main speeds (%) produce higher PID output (%).

$$Final\ PID\ output[\%] = PID\ output\,[\%] \times \frac{Main\ speed\ command[\%]}{100.0[\%]} \qquad -Eq\,(1.7.2)$$

However, when you select “No” as the factory default in APP54 (Fixed PID En) and receive a command to lower the main speed (%) below the value specified in APP55 (Min Fixed PID), the inverter functions according to the equation shown in Eq. 1.7.3. By functioning according to the equation in Eq. 1.7.3, the inverter prevents the output of the Web PID controller from decreasing the low main speed command (%) below the value specified in APP55 (Min Fixed PID).

$$Final\ PID\ output[\%] = PID\ output\,[\%] \times \frac{APP-55(Min\,Fixed\,PID)[\%]}{100.0[\%]} \qquad -Eq\,(1.7.3)$$

Table 1.7.1 shows the final PID output (%) based on the APP54 (Fixed PID En) setting when you set APP32 (PID Out Scale) to 20% and APP55 (Min Fixed PID) to the factory default 10%. This table assumes that the PID output is now saturated at 20%.

(Note 1) of Table 1.7.1 shows that the main speed is 2% or 8% below the factory default of APP55 (Min Fixed PID), i.e. 10%, so you can determine it using Eq. 1.7.3. (Note 2) shows that main speed is 20% or 80% over the factory default of APP55 (Min Fixed PID), i.e. 10%, so you can determine it using Eq. 1.7.2.

Table 1.7.1 Comparison of PID outputs by PID controller types (APP54: Fixed PID En)

Main speed command (%)	APP54 (Fixed PID En): PID output (%), if Yes	APP54 (Fixed PID En): PID output (%), if No
2.0	20.0	2.0 (Note 1)
8.0	20.0	2.0 (Note 1)
20.0	20.0	4.0 (Note 2)
80.0	20.0	16.0 (Note 2)

(2) Final Speed (Hz) Computation

In Fig. 1.6.1, U1 (%) equals “main speed command (%) + PID output (%),” and is converted to Hertz (Hz) units as shown in Eq. 1.7.4.

$$Main\ speed + PID\ output[Hz] = \frac{Main\ speed + PID\,output[\%]}{100.0[\%]} \times APP92(Max\ Main\ Spd)[Hz] \qquad -Eq\ (1.7.4)$$

Now, you can convert Eq. 1.6.1 of section 1.6 into Eq. 1.7.5. Eq. 1.7.5 allows you to compute the final speed (Hz) of the inverter.

$$Final\ speed[Hz] = \frac{Wire\ speed\ [mpm]}{(Diameter \times \pi)[m]} = \frac{Main\ speed + PID\,output[Hz]}{Estimated\ diameter[\%]} \times APP67(Min\ \ Diameter)[\%] \qquad -Eq\,(1.7.5)$$

Group	Code number	Function	Name	Factory default	Range
APP	89	Compen Xcel %	Rate of compensation reflected by diameter computation in the final speed	20%	0~100[%]

APP89 (Compen Xcel %): As shown in Eq. 1.7.5, the estimated diameter (%) compensates for the final output frequency of the inverter. Here, you can set the rate and response speed where the variations in the output frequency induced by the estimated diameter (%) would otherwise be reflected in the actual output frequency of the inverter.

The lower value of APP89 (Compen Xcel %) values (c.a. 50% or less) leads to the lower rate of output frequency variations due to the estimated diameter of the actual output frequency of the inverter, and also leads to the lower speed of said variations reflected in the actual output frequency.

In order to ensure that the inverter operates reliably at a constant speed, we recommend setting APP89 (Compen Xcel %) to a value of less than ca. 50%.

(3) Web Function without Diameter Computation

Group	Code number	Function	Name	Factory default	Range	
AP2	80	Dia Dis Mode	Selection of web without diameter computation.	0: No	0	No
					1	Yes

Select this option to compute the final speed command without using the diameter value. If you select “Yes” in AP2 80, you can compute the speed command using the main speed, compensation gain, and PID output value. For more details, please see Eq. 1.7.6.

$$\text{Final speed (\%)} = (\text{Main speed} \times \text{compensation gain}) + \text{PID Output [\%]} \quad - \text{Eq. (1.7.6)}$$

The web function without diameter computation is only valid in closed loop speed control mode (APP02: W_Spd Close/U_Spd Close).

For more details on the web function without diameter computation, please see section 2.12, "Web Function without Diameter Computation”.

⚠Caution

The final speed (Hz) is the final value of Eq. 1.7.5, which is regularly computed in the final speed computation section, so acceleration and deceleration occur frequently. Here, the accel and decel time is specified in DRV03 (Acc Time) and DRV04 (Dec Time), respectively.

Moreover, selecting “5: Tension Ctrl” in APP01 (App Mode) automatically sets both DRV03 (Acc Time) and DRV04 (Dec Time) to “0.5 sec”. You can set different values for DRV03 (Acc Time) and DRV04 (Dec Time), but they must be less than 2.0 sec in order to rapidly reflect the final speed.

(4) Reverse Tension

Group	Code number	Function	Name	Factory default	Range	
APP	84	Rev Tension En	Reverse tension selection	0: No	0	No
					1	Yes

APP84 (Rev Tension En): In Fig. 1.7.1, suppose that the sign for U1 (%), i.e. "main speed command (%) + PID output (%)," is negative (-). Under these circumstances, if you select "Yes" for this code and issue a forward (Fwd) operation command, then the inverter can operate in the reverse direction. However, if you select "No" as the factory default for this code and issue a forward (Fwd) operation command, then the inverter cannot operate in reverse and the output frequency is limited to 0 (Hz).

Select "1: Yes" for this function. If the PID output (%) is negative (-) when the main speed command is 0%, operate the inverter in reverse until it reaches the absolute value of the PID output (%) to maintain the tension on the material in the closed loop tension control system.

(5) Splicing

Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	Web Splice	-
APP	93	Splice Level	Splicing level	0.0%	0.0 - 100.0%

A splicing system consists of 2 inverters that can control each motor, which allows you to replace bobbins during operation. When replacing the bobbin, be sure not to change the flux. When the multi-function input specified in "57: Web Splice" of the inverter turns ON, it interrupts the output of the Web PID controller and the final speed command of the inverter is determined only by Eq. 1.7.6 - Eq. 1.7.8, which is a combination of the main speed command (%) and APP93 (Splice Level).

The following explains why we add the second term to the right side of Eq. 1.7.6. As soon as the material is wound onto the new bobbin, you may face abrupt load variations and material deflection. In order to avoid this phenomenon, you must increase the speed to the level of APP93 (Splice Level) when the new bobbin begins to wind material. For example, if you set APP93 (Splice Level) to 20% and the main speed command is 50%, the main speed command (%) becomes 60% (= 50% + 50% x 20% / 100%) when the multi-function input specified in "57: Web Splice" turns ON.

$$Main\ speed\ command[\%] =$$
$$Main\ speed[\%] + Main\ speed[\%] \times \frac{APP-93(Splice\ Level)[\%]}{100[\%]} \quad -Eq(1.7.6)$$

You can use Eq. 1.7.7 to convert this equation into frequency (Hz).

$$Main\ speed\ command[Hz] =$$
$$\frac{Final\ main\ speed\ command\ [\%]}{100.0[\%]} \times APP-92(Max\ Main\ Spd)[Hz] \quad -Eq\ (1.7.7)$$

Finally, Eq. 1.7.7 is processed using Eq. 1.7.8 to output the final speed command of the inverter. As shown in Eq. 1.7.8, “initial diameter (%)” appears in the denominator of the right-hand side, because the diameter of bobbin is initialized to a diameter specified in APP63-66 (Bobbin # Diamtr) when the multi-function input specified in “57: Web Splice” turns ON.

$$Final\ speed\ command[Hz] =$$
$$\frac{Main\ speed\ command[Hz]}{Initial\ diameter[\%]} \times APP-67(Min Diameter)[\%] \quad -Eq(1.7.8)$$

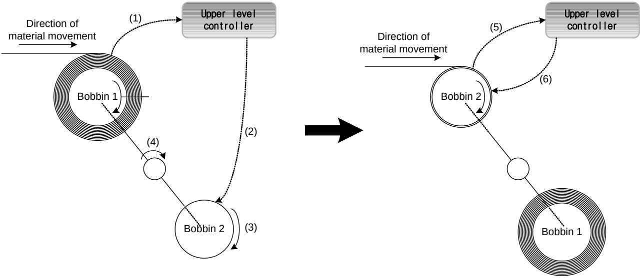


Fig. 1.7.2 Conceptual diagram of splicing

Fig, 1.7.2 illustrates the usual structure of winder splicing systems. The operation sequence of the structure shown in Fig. 1.7.2 is as follows.

When Bobbin 1 is almost completely full, it sends a signal to inform the upper level controller (Fig. 1.7.2 (1)).

The upper level controller then issues an ON signal to the inverter multi-function input specified in “57: Web Splice” that controls empty Bobbin 2 (Fig. 1.7.2 (2)).

The inverter interrupts the output of the Web PID controller. In this situation, the inverter uses a combination of the main speed command (%) and APP93 (Splice Level) as the command value, as shown in Eq. 1.7.6-Eq. 1.7.8, to activate empty Bobbin 2 (Fig. 1.7.2 (3)).

The axis between the bobbins rotates 180 degrees, so Bobbins 1 and 2 switch position (Fig. 1.7.2 (4)).

Bobbin 2 sends a signal to the upper level controller to confirm that the switch is complete (Fig. 1.7.2 (5)).

The upper level controller sends an OFF signal to the inverter's corresponding multi-function input specified in “57: Web Splice” to control Bobbin 2, which interrupts the splicing operation. Then, the Web PID controller resumes operation and diameter computation begins again, so the frequency of inverter is once again determined by Eq. 1.7.5 (Fig. 1.7.2 (6)).

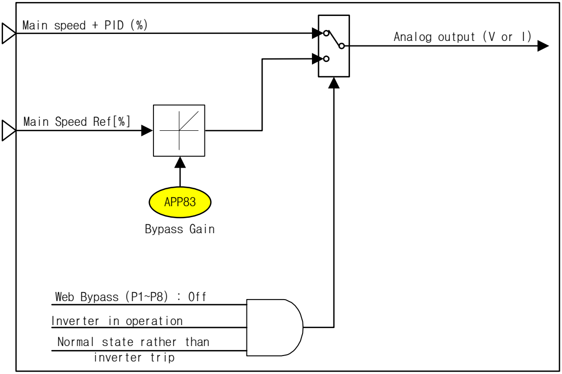
(6) Speed Bias

Group	Code number	Function	Name	Factory default	Range
APP	91	Web Spd Bias	Speed bias setting	1.00 Hz	0.00 - 60.00 Hz

APP91 (Web Spd Bias): Add frequency value, as much as the value specified in APP91 to the command speed to output the final command speed. This value is only effective in open loop speed control mode (APP02: W_Spd Open/U_Spd Open).

Add the speed bias value and saturate speed controller in open loop speed control mode to output the torque limit value and thereby operate inverter.

2.8 Analog Output Section



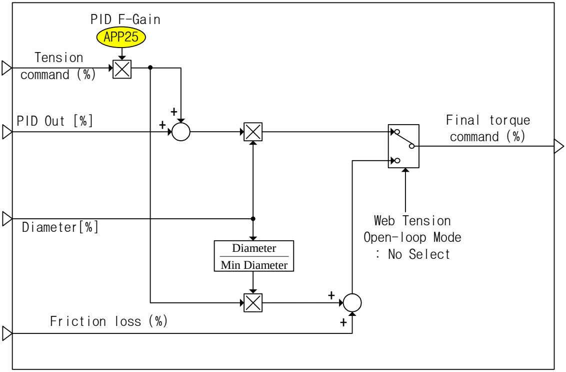
Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	Web Bypass	-
OUT	01, 07	AO1, AO2 Mode	Analog output 1, 2	Web Spd Out	-
APP	83	Bypass Gain	Bypass gain	100.0%	0.0 - 300.0%

During normal inverter operation (multi-function input “Web Bypass” turns OFF, the inverter is operating and works without a trip), you can export the main speed + PID output (%) to an analog output (AO1: 0 - 10 V voltage, AO2: 0 - 20 mA current).

During abnormal inverter operation (multi-function input “Web Bypass” turns ON, the inverter stops operating, or it trips), multiply the main speed (%) by APP83 (Bypass Gain) and export the results to the analog output (AO1: 0 - 10 V voltage, AO2: 0 - 20 mA current).

The PID output is not available in speed control mode of an open loop system, so you can only export the main speed (%) as an analog output.

2.9 Final Tension Computation Section



Final tension computation is available in tension control closed loop/open loop systems.

Closed loop tension systems can use the tension command, Web PID output, and diameter values to output the final torque command.

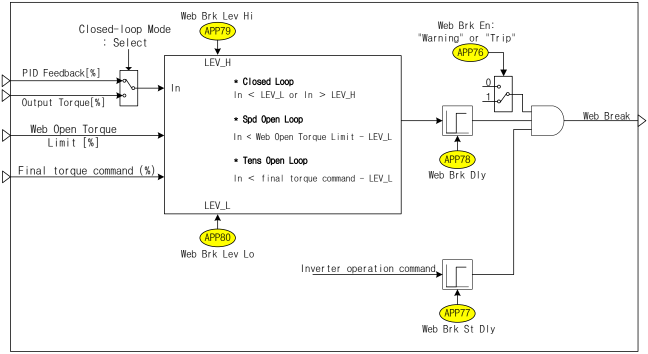
Open loop tension systems do not use the Web PID output, so it uses the tension command, diameter, and friction loss values to output the final torque command.

Group	Code number	Function	Name	Factory default	Range
APP	25	PID F-Gain	Tension scale	100.0%	0.0 - 1000.0%

APP25 (PID F-Gain): This gain controls the scale of the tension command value output from the tension command section.

In a closed loop tension system, you can set this code to favor rapid tension response characteristics. However, you must set this code to default, i.e. 100.0%, in open loop tension systems.

2.10 Web Break Detection Section



Closed loop tension control systems use tension detectors, such as the dancer or load cell. When the feedback from the tension detector is shorter or longer than the time specified, the inverter determines that the web material may be ruptured. It then informs the upper level controller of the potential risk via the multi-function output contact and initiates the proper protective operation based on this setting.

Open loop tension control systems do not use tension detectors. Instead, they use the torque output value to determine web material ruptures. In a speed control open loop tension system, web break detection occurs when the torque output drops below (Web Torque Limit - APP80). The system then initiates the proper protective operation based on this setting.

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>OUT</td><td>31 - 33</td><td>Relay1, 2, Q1</td><td>Multi-function output contact</td><td>Web Break
Web Break Hi
Web Break Lo</td><td colspan="2">-</td></tr>
<tr><td rowspan="3">APP</td><td rowspan="3">76</td><td rowspan="3">Web Brk En</td><td rowspan="3">Web break detection function selection</td><td rowspan="3">1: Warning</td><td>0</td><td>None</td></tr>
<tr><td>1</td><td>Warning</td></tr>
<tr><td>2</td><td>Free-run</td></tr>
<tr><td>APP</td><td>77(Note 1)</td><td>Web Brk St Dly</td><td>Web break detection delay time at initial startup</td><td>10.0 sec</td><td colspan="2">0.0 - 300.0 sec</td></tr>
<tr><td>APP</td><td>78(Note 1)</td><td>Web Brk Dly</td><td>Web break delay time</td><td>5.0 sec</td><td colspan="2">0.0 - 300.0 sec</td></tr>
</table>

Group	Code number	Function	Name	Factory default	Range
APP	79(Note 1)	Web Brk Lev Hi	Web break detection upper limit	80.0%	APP80 - 100.0%
APP	80(Note 1)	Web Brk Lev Lo	Web break detection lower limit	20.0%	0.0 - APP79%

(Note 1): This code appears when you select “Warning” or “Free-run” in APP76 (Web Brk En).

APP76 (Web Brk En): Select “None” to disable web break detection.

When you select “Free-run,” the inverter executes a free-run stop when it detects a web break. If multi-function output contact is set to “29: Trip”, the multi-function output contact turns “ON”.

If you select “Warning” as the factory default and a web break is detected, the inverter does not execute a free-run stop and continues operating normally. The inverter displays a Warning on the digital loader. If the multi-function output contact is set to “36: Web Break,” only the relevant multi-function output contact turns “ON”. When you issue a stop command to the inverter to decelerate and stop it, it releases the Warning displayed on the digital loader, and the multi-function output specified in “36: Web Break” turns OFF.

APP77 (Web Brk St Dly): The Web break detection function does not work until the time period specified in this code has elapsed (from the initial start of the inverter), since web break detection is not significant during initial startup because the dancer and load cell position is unstable.

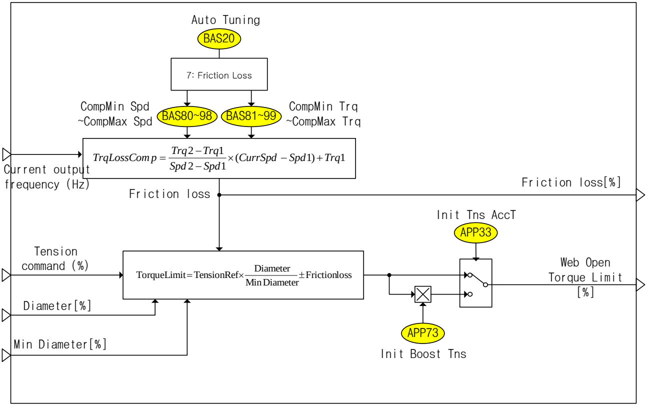
APP78 (Web Brk Dly): If the analog quantity feedback from the dancer or load cell is higher than the web break detection level maximum limit (APP79: Web Brk Lev Hi) or lower than the lower limit (APP79: Web Brk Lev Lo) for longer than the time specified in this code, the inverter considers this situation a Web Break.

APP79 (Web Brk Lev Hi): The system detects a web break when the analog quantity feedback from the dancer or load cell is higher than the value specified in this code.

APP80 (Web Brk Lev Lo): The system detects a web break when the analog quantity feedback from the dancer or load cell drops below the value specified in this code.

In open loop tension systems, the system detects a web break when the torque output falls below the torque limit (speed control) or final torque command (tension control) minus the value specified in this code.

2.11 Torque Limit Computation Section



(1) Torque Limit Computation

This feature is only available in speed control open loop tension systems. You can use the tension command, diameter, and friction loss value to compute the torque limit, as shown in Eq. 1.11.1.

$$\text{Torque Limit [\%]} = \text{Tension command (\%)} \times \frac{\text{Current diameter (\%)}}{\text{Min. diameter (APP67) (\%)}} \pm \text{Friction loss} \qquad - Eq.\,(1.11.1)$$

(2) Friction Loss Measurement

Friction occurs in every mechanical system, and is a factor that can disturb the control performance of the system and result in loss of mechanical energy. When materials are held under tension, such as in a tension control system, the friction loss that occurs on a roll may influence the tension of the material. The Web PID compensates for friction loss in closed loop tension systems, but open loop tension systems do not use a Web PID, so they measure the friction loss on a roll before system operation and compensate for it during the tension control operation.

You can set and measure the friction loss in section 20 (Auto Tuning) of the BAS group.

Group	Code number	Function	Name	Factory default	Range
BAS	20	Auto Tuning	Auto-tuning	7: Friction Loss	-
BAS	80,82, …, 98(Note 1)	FricComp Spd1 - 10	Friction loss measurement frequency	6 (Hz), 12 (Hz), …, 60 (Hz)	0.00 - Max. Freq (Hz)
BAS	81,83, …, 99(Note 1)	FricComp Trq1-10	Friction loss value	0.00%	0.00 - 100.0%

(Note 1): This code appears when you select “Tension Ctrl” in APP01 (App Mode).

APP20 (Auto Tuning): In order to measure friction loss, you must select “Friction Loss” when mounting an empty bobbin without connecting any material to the corresponding roll. When you select a function, the system immediately starts to measure the friction loss.

The system measures friction loss after operating at acceleration and at constant speed for the 10 constant speed zones specified in APP80 to APP98. After the system measures the friction loss, the motor executes a free-run stop. The values measured in each zone are stored in APP81-99 after the system finishes auto-tuning.

General auto-tuning “All” does not include friction loss measurements.

APP80 - 98 (FricComp Spd 1-10): Specifies the friction loss measurement speed.

The default value for the 10 zones is 60 Hz. The possible value range is lower than the “Max Freq” value. You can change the measurement speed at your own discretion.

APP81 - 99 (FricComp Trq 1-10): After the system measures the friction loss, it saves the friction loss value (%) for the specified speed. You can change this value at your own discretion.

The system computes the friction loss and compensates for it with the speed, as shown in the following Fig. 1.11.1.

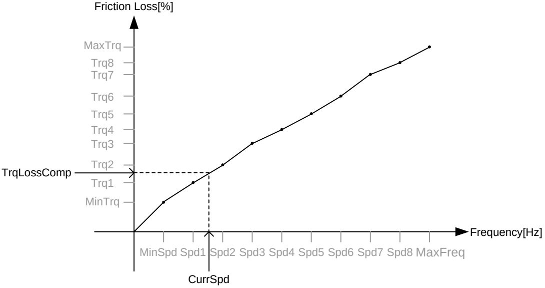


Fig. 1.11.1 Friction loss by speed

(3) Initial Tension Boost

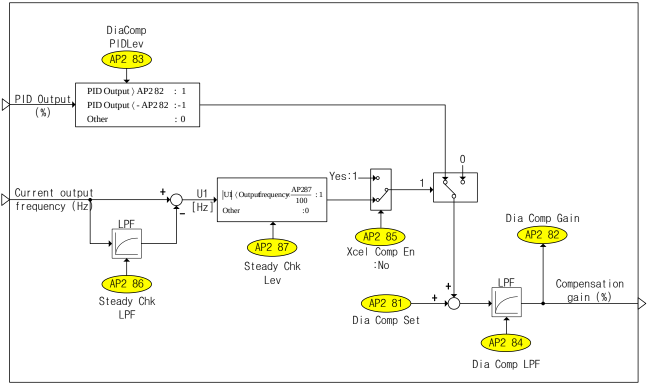
Group	Code number	Function	Name	Factory default	Range
APP	33	Init Tns AccT	Initial tension boost time	1.0 sec	0.1 - 60.0 sec
APP	73	Init Boost Tns	Initial tension boost value	150.0%	100.0 - 500.0%

APP33 (Init Tns AccT): Outputs the value of the initial boosted torque limit for a set period of time. This value is only effective in open loop speed control mode (APP02: W_Spd Open/U_Spd Open).

APP73 (Init Boost Tns): This boosts the tension to the torque limit that is finally computed at initial startup. This value is only effective in open loop speed control mode (APP02: W_Spd Open/U_Spd Open).

You can use this code to boost the initial tension and get fast tension response characteristics at initial startup.

2.12 Web Function without Diameter Computation Section



(1) Compensation Gain Computation

If you do not have information concerning the diameter of the bobbin used for closed loop tension control systems, or you use more bobbins than previously specified, you can control the bobbin without compensating for the diameter computation. If you select “Yes” in AP2 80, you can compute the speed command using the main speed, compensation gain, and PID output value.

The web function without diameter computation is only valid in closed loop speed control mode (APP02: W_Spd Close/UW_Spd Close).

Before operation, you can set the compensation gain (AP2 81). Once the system starts, you can compute the compensation gain (%) by comparing the PID output value with the reference value of AP2 83. The value of the current computed gain in use appears in AP2 82.

When the system stops, the AP2 82 value reverts to the initial AP2 81 compensation gain setting.

Group	Code number	Function	Name	Factory default	Range	
AP2	80(Note 1)	Dia Dis Mode	Selection of web without diameter computation	0: No	0	No
					1	Yes

Group	Code number	Function	Name	Factory default	Range
AP2	81(Note 2)	Dia Comp Set	Initial value of the diameter compensation gain	100.0%	0.0 - 300.0%
AP2	82(Note 2)	Dia Comp Gain	Diameter compensation gain monitor	Read Only (%)	
AP2	83(Note 2)	DiaComp PIDLev	PID output value for the computation	10.00%	0.00 - 100.00%
AP2	84(Note 2)	Dia Comp LPF	Diameter compensation gain filter	50.0 sec	0.0 - 300.0 sec

(Note 1): This code appears when you select “W_Spd Close” or “UW_Spd Close” in APP02 (Tnsn Ctrl Mode).

(Note 2): This code appears when you select “1: Yes” in AP2 80 (Dia Dis Mode).

AP2 80 (Dia Dis Mode): Select this code to control the closed loop tension system without computing the diameter.

This code only appears when you select closed loop speed control mode (APP02: W_Spd Close/UW_Spd Close).

AP2 81 (Dia Comp Set): Sets the value of the initial diameter compensation gain.

When using various bobbins, setting the bobbin diameter to a moderate size allows you to perform the appropriately control for all of the bobbins.

AP2 82 (Dia Comp Gain): This code appears as the AP2-81 value while the system is stopped. When the system starts, the compensation gain computation value appears under the conditions of the compensation gain computation.

AP2 83 (DiaComp PIDLev): Sets the reference of PID output for computing the diameter compensation gain.

The compensation gain value increases when the PID output value exceeds the specified value. On the contrary, the compensation gain decreases when the PID output value falls below the negative (-) value specified.

AP2 84 (Dia Comp LPF): Specifies the time for computing diameter compensation gain.

If you need quicker control specify a small value for AP2-84.

(2) Gain Computation Stop at Accel/Decel

When you compute the compensation gain during accel/decel, the PID output value becomes unstably transient so the system cannot properly compute the gain. On the contrary, unless you compute the compensation gain over a very long accel/decel time, the PID output value may become saturated. Thus, you need to select the appropriate value for each system.

Group	Code number	Function	Name	Factory default	Range	
AP2	85(Note 1)	Xcel Comp En	Selection diameter compensation gain computation for accel/decel	0: No	0	No
					1	Yes
AP2	86(Note 2)	Steady Chk LPF	Speed filter for constant speed judgment	1.0 sec	0.0 - 100.0 sec	
AP2	87(Note 2)	Steady Chk Lev	Speed difference for constant speed judgment	1.00%	0.00 - 50.00%	

(Note 1): This code appears when you select “1: Yes” in AP2 80 (Dia Dis Mode).
(Note 2): This code appears when you select “0: No” in AP2 85 (Xcel Comp En).

AP2 85 (Xcel Comp En): Selects computation of the diameter compensation gain for accel/decel. If you select “No,” the system computes the compensation gain only in zones where constant speed is determined. If you select “Yes,” the system computes the compensation gain in all accel/decel zones.

AP2 86 (Steady Chk LPF): When you only compute the diameter compensation gain in constant speed zones, this code applies the Low Pass Filter to the current output frequency so that you can determine applicable constant speed zones and compare the gain to the current output frequency.

APP87 (Steady Chk Lev): When you only compute the diameter compensation gain in constant speed zones, specify the difference between the current output frequency and the filtered output frequency to determine the constant speed zone. When the difference exceeds the value specify in AP2 87, the system considers it an accel/decel zone and does not compute the compensation gain.

3. Capstan Operation

3.1 Overview

Capstans are devices that wind up and pull heavy objects at a constant speed.

The capstan is positioned between the unwinder and winder in iron making, steel making, and steel casting processes to maintain a constant tension and enable continuous processing.

Like the winder/unwinder, the capstan in an iS7 inverter receives analog quantity feedback from tension control detectors, such as the dancer or load cell, and activates the PID controller to maintain a constant tension.

The characteristics of the PID controller in closed loop tension control systems differ from existing PID controllers. That is why this system is referred to as a 'Web PID Controller' in this manual.

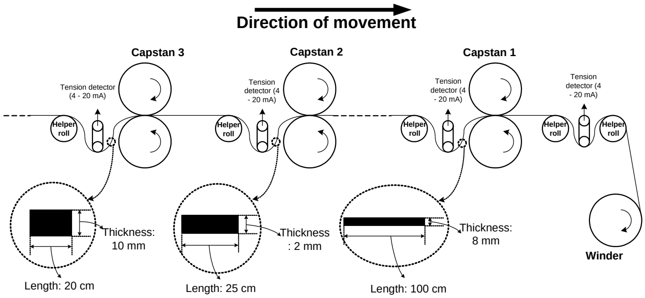


Fig. 2.1.1 Capstan operating mechanisms

As shown in Fig. 2.1.1, thinner web materials in a continuous process require quicker capstan rotations. Because web materials must not bias upward or deflect downward to assure continuous processing, the capstan must handle different thicknesses and lengths of web materials within the same amount of time. Web material thicknesses and lengths vary depending on the process, but, supposing that each process does not lose web materials, the volume of the web materials remains constant. Thus, the thickness (2 mm) of the web material handled by Capstan 1 is 1/4 times more than that (8 mm) of the web material handled by Capstan 2, so the length (100 cm) of the web material handled by Capstan 1 is 4 times more than the length (25 cm) of the web material handled by Capstan 2. Therefore, the rotation speed of Capstan 1 must be 4 times faster than that of Capstan 2 to handle for the different lengths of web materials within the same amount of time.

In the operation of capstans, we can establish Eq. 2.1.1 by this principle. This is similar to Eq. 1.1.1 for the winder/unwinder.

The Web PID controller controls the motor speed, i.e. the output frequency of the inverter. In addition to this, the system computes and estimates “current thickness of the web material” internally and uses the “current thickness of the web material” computed in Eq. 2.1.1 to determine ultimately the output frequency of the inverter.

This system offers more consistent control over the capstan tension than conventional PID controllers. Since the internally computed thickness of the web material compensates for the inverter's output frequency once again, the Web PID controller uses significantly less of the inverter's output frequency. Therefore, the Web PID controller does not risk saturating the output, which significantly reduces the oscillation of the I controller output.

$$Motor\ speed\ [rpm] = \frac{Wire\ speed[mpm]}{Diameter\ of\ capstan \times \pi[m]} \times \frac{Base\ thickness\ of\ materials\ [m]}{Current\ thickness\ of\ materials\ [m]} \quad - Eq(2.1.1)$$

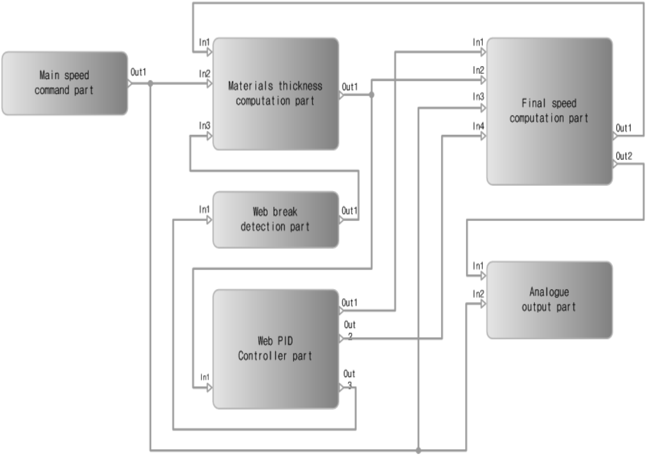
The Web PID controller also offers the following functions.

- Eliminates the transient phenomenon that occurs with the dancer or load cell at start up (related code: APP51).
- Maintains the tension and, if necessary, performs an emergency stop (related code: APP82).
- Detects potential ruptures in the web material in advance (related code: APP76-80).

In order to use the capstan in the iS7 system, you must apply the following settings.

Group	Code number	Function	Name	Setting
APP	01	App Mode	Application selection	5: Tension Ctrl
APP	02	Tnsn Ctrl Mode	Tension control operation mode selection	2: Capstan

3.2 General Configuration



The following table outlines the inputs and outputs for each section.

Functional section	Input		Output	
Main speed command section	-		Out1	Main speed (%)
Web PID Controller Section	In1	Diameter (%)	Out1	Error change compensation frequency (Hz)
			Out2	PID output (%)
			Out3	PID feedback (%)
Material thickness computation section	In1	Current output frequency (Hz)	Out1	Thickness (%)
	In2	Main speed (%)		
	In3	Web break event (0/1)		
Final speed computation section	In1	Error change compensation frequency (Hz)	Out1	Final speed command (Hz)
	In2	Diameter (%)		
	In3	Main speed (%)	Out2	Main speed + PID (%)
	In4	PID output (%)		
Analog output section	In1	Main speed + PID (%)	-	
	In2	Main speed (%)		

Functional section	Input		Output	
Web break detection section	In1	PID feedback (%)	Out1	Web break event (0/1)

3.3 Main Speed Command Section

This is the same as section 2.3 Main Speed Command Section, the main speed command section for the winder/unwinder. See section 2.3 Main Speed Command Section.

3.4 Web PID Controller Section

This is the same as section 2.5 Web PID Controller Section for the winder/unwinder. See section 2.5 Web PID Controller Section .

3.5 Analog Output Section

This is the same as section 2.8 Analog Output Section for the winder/unwinder. See section 2.8 Analog Output Section.

3.6 Web Break Detection Section

This is the same as section 2.10 Web Break Detection Section for the winder/unwinder. See section 2.10 Web Break Detection Section.

3.7 Material Thickness Computation Section

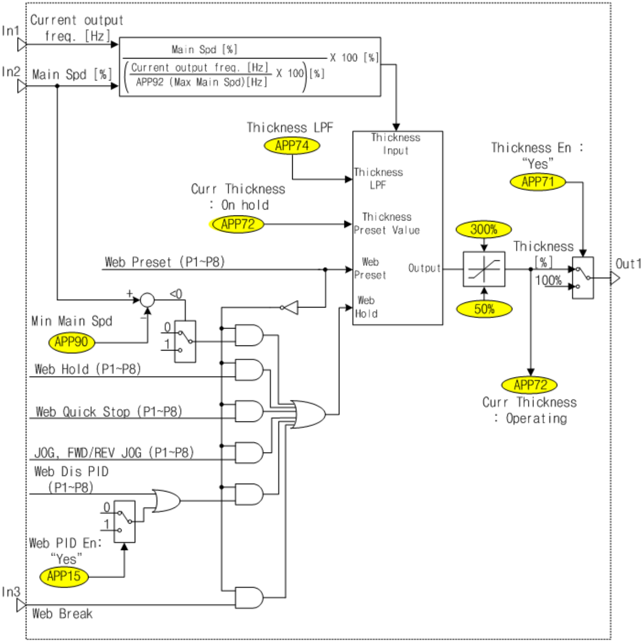


Fig. 2.7.1 illustrates continuous processing in a closed loop tension control system. The web material becomes thinner as the process continues. However, the volume of web material input into each capstan remains constant. Thus, as shown in Fig. 2.7.1, if we suppose that the web material thickness input into Capstan 1, 2, and 3 is 2 mm, 8 mm, and 10 mm, respectively, then we can conclude that the web material length input into Capstan 1, 2, and 3 will be 100 cm, 25 cm, and 20 cm. Therefore, Capstan 1 must rotate faster than Capstan 2 and 3 (Capstan 1 > Capstan 2 > Capstan 3) in order to handle the web material normally in a continuous process without any downward deflection or upper bias.

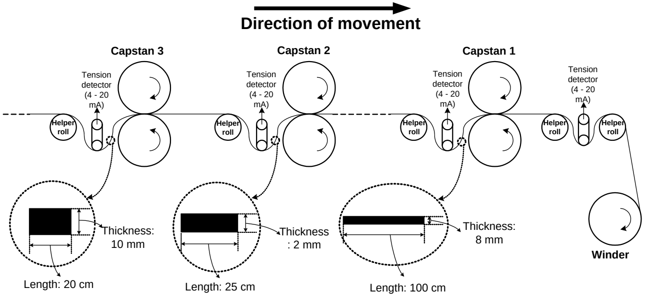


Fig. 2.7.1 Capstan operating mechanism

Thus, in a tension control system, we can draw a correlation between the capstan flux, motor speed, and web material thickness in a continuous process, as shown in Eq. 2.7.1.

$$Motor\ speed\ [rpm] = \frac{Wire\ speed[mpm]}{Diameter\ of\ caps\tan \times \pi[m]} \times \frac{Basethicknes\ of\ materials\,[m]}{Current\ thickness\ of\ materials\,[m]} \quad - Eq(2.7.1)$$

As shown in Eq. 2.7.1, the motor speed (rpm) depends on the flux (mpm) and the current thickness of the web material (m). Therefore, make sure the system computes and estimates the current thickness (m) of web material during inverter operation. Eq. 2.7.1 can be converted into Eq. 2.7.2. You can use Eq. 2.7.2 to estimate the thickness of the web material (m).

$$Estimated\ current\ thickness\ of\ materials[m] = \frac{Wire\ speed[mpm]}{Motor\ speed[rpm] \times (Diameter\ of\ caps\tan \times \pi)[m]} \times Base\ thickness\ of\ materials\,[m] \quad - Eq(2.7.2)$$

(1) Initialization of Web Material Thickness

Group	Code number	Function	Name	Factory default	Range	
IN	65 - 72	Px Define	Multi-function input setting	Web Preset	-	
APP	71	Thickness En	Material thickness computations selection	1: Yes	0	No
					1	Yes
APP	72	Curr Thickness	Specifies the initial thickness of the web material and displays the currently computed thickness of the web material.	100.0%	50.0 - 500.0%	

APP72 (Curr Thickness): Inputs the initial thickness (%) of the web material in stop status. You cannot set this code during operation. During operation, this code displays the computed thickness (%) of the web material.

For example, you can set this code as follows.

When you install the inverter for Capstan 1, Capstan 2, and Capstan 3, as shown in Fig. 2.7.1, you can see the “100.0%” value input in APP72 (Curr Thickness) of each inverter when it stops. When you begin operating the inverter, the APP72 (Curr Thickness) of each inverter displays the estimated thickness that the iS7 computes for the web material. If each capstan correctly determines the main speed and gear ratio and the system computes and inputs the correct value in APP92 (Max Main Spd), then the APP72 (Curr Thickness) code for each inverter slowly changes within the range of about 100% (± 5%).

If the APP72 (Curr Thickness) value falls below 80% during inverter operation, it indicates that the value input in APP92 (Max Main Spd) is excessively low. Moreover, if the APP72 (Curr Thickness) value exceeds 120% during inverter operation, it indicates that the value input in APP92 (Max Main Spd) is excessively high.

If an incorrect value is input in APP92 (Max Main Spd), check the output frequency of the inverter when you input the main speed 100% in this code. Then, enter the output frequency in APP92 (Max Main Spd). Or, use the flux, gear ratio (or belt ratio), measured with a portable tachometer, and capstan diameter (measured with a portable tachometer) in Eq. 2.7.4 to compute the value, and then enter it in APP92 (Max Main Spd).

For details on the test operation, see the Appendices at the end of this document.

⚠Caution
Make sure that multi-function input “Web Preset” turns OFF. If multi-function input “Web Preset” remains ON, you cannot compute the thickness of any web materials.

(2) Material Thickness Computation

Group	Code number	Function	Name	Factory default	Range	
APP	71	Thickness En	Material thickness computation selection	1: Yes	0	No
					1	Yes
APP	72	Curr Thickness	The initial thickness setting (stop status) or current thickness display (during operation)	100.0%	50.0 - 300.0%	
APP	74	Thickness LPF	Material thickness computation filter	30.0 sec	0.0 - 300.0 sec	
APP	92	Max Main Spd	Frequency for main speed 100%	60.0 Hz	DRV19 - DRV20 (Hz)	

You can convert Eq. 2.7.2 to percentages and reorganize it into Eq. 2.7.3.

$$Estimated\ thickness\ of\ \ materials\,[\%]\ =$$
$$\frac{Main\ speed\ input[\%]}{\dfrac{Current\ output\ \ frequency[Hz]}{APP-92\,(Max\,Main\,Freq)}\times 100\ [\%]}\times 100[\%] \qquad -\ Eq\,(2.7.3)$$

The 100% multiplied on the right side of Eq. 2.7.3 is the reference thickness of the web material. This “estimated thickness (%) of the material” is internally limited to the upper limit 300% and lower limit 50%. Adjust the time constant of “the estimated material thickness (%)” using the value of APP74 (Thickness LPF) to control the computed time constant of the material thickness (%).

We can use Eq. 2.7.3 to explain how to estimate the thickness (%) of the material during inverter operation.

In Fig. 2.7.1, suppose that the APP73 (Thickness Set) value of Capstan 2 changes from the factory default of “100%” to “150%”. Thus, the inverter of Capstan 2 identifies the material thickness as “150%”. This means that the actual thickness of the material handled in Capstan 2 is 8 mm, but the inverter of Capstan 2 identifies it as 8 * 1.5=12 mm internally. Since the inverter operates 1/1.5 times slower than with the material thickness of “100%”, this reduces the scale of the tension exerted on the dancer or load cell. Thus, the Web PID controller output is positive (+) and the “current output frequency (Hz)” in Eq. 2.7.3 increases. In Eq. 2.7.3, the “estimated material thickness (%)” is inversely proportional to the “current output frequency (Hz),” so it decreases and converges on a value of almost 100% of the original thickness of the web material handled by Capstan 2.

This “estimated material diameter (%)” is crucial in determining the final speed command (Hz) of the inverter. For more details, please see the section 2.8 concerning final speed computations.

APP71 (Thickness En): Selects whether to compute the thickness of the web material. When you select “No”, the system does not compute the thickness (%) of the material.

APP72 (Curr Thickness): Inputs the initial thickness (%) of the web material in stop status. You cannot set this code during operation. During operation, this code displays the computed thickness (%) of the web material.

APP74 (Thickness LPF): Selects the delay time constant of the material thickness (%) computation.

APP92 (Max Main Spd): Inputs the output frequency of inverter when the main speed command is 100%. If you know mechanical information, such as the flux, capstan diameter, and belt ratio, you can use Eq. 2.7.4 to compute APP92 (Max Main Spd).

For example, In Fig. 2.7.1, suppose that the thickness of Capstan 1 is 0.4 m, the maximum flux of this system is 900 mpm and the belt ratio of a 4-pole motor (faster motor) is 3.2/1. Here, the value entered in APP92 (Max Main Spd) is computed using Eq. 2.7.4, as follows.

$$APP92\,(Max\,Main\ Spd) =$$

$$\frac{900[mpm]}{0.40[m]\times\pi} \times 3.2(Belt\,ratio) \times \frac{4(poles)}{120} \;=\; 76.43[Hz] \qquad -Eq(2.7.4)$$

(3) Interruption of The Material Thickness Computation

Group	Code number	Function	Name	Factory default	Range
IN	65 - 72	Px Define	Multi-function input setting	Web Hold	-
APP	90	Min Main Spd	Minimum main speed	3.0%	0.0 - 100.0%

You cannot compute the material thickness if any of the following requirements are met: multi-function input “Web Hold” is ON, during jog operation, the Web PID is prohibited, at low speeds below APP90 (Min Main Spd), during Web Break status, and during an emergency stop initiated by the multi-function input “Web Quick Stop”, because the material thickness computation is only meaningful during normal operation.

Stop computing the thickness if the following conditions occur.

- Multi-function input “Web Hold” is On, or
- Main speed command[%] < APP90 (Min Main Spd), or
- Emergency stop by multi-function input “Web Quick Stop” is On, or
- Web break detected, or
- Multi-function input “Web Dis PID” is On, or
- APP15 (Web PID En) is 'Yes,' or
- During Jog Operation.

3.8 Final Speed Computation Section

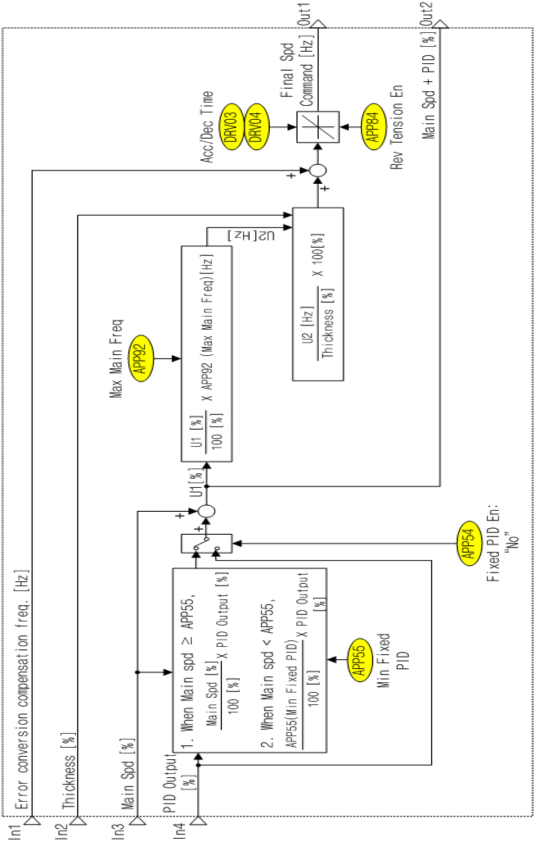


Fig. 2.8.1 Final speed computation section (Capstan)

The final speed computation section determines the final output command (Hz) of the inverter using the main speed computed in the main speed command section (In3: main speed [%]), the PID output computed in the Web PID controller section (In4: PID output [%]), the error change compensation frequency (In1), and the diameter computed in the material thickness computation section (In2: Thickness [%]).

(1) PID Output Method (Fixed/non-fixed PID controller)

This is the same as section 2.7, "(1) PID output method (Fixed/non-fixed PID controller)". See section 2.7.

(2) Final Speed (Hz) Computation

In Fig. 2.8.1, U1 (%) is equal to the "main speed command (%) + PID output (%)" and is converted into (Hz), as shown in Eq. 2.8.1.

$$\text{Main speed} + PID\,output[Hz] = \frac{Main\ speed + PID\,output[\%]}{100.0[\%]} \times APP - 92\left(Max\,Main\,Spd\right)[Hz] \qquad - Eq\ (2.8.1)$$

Now, you can convert Eq. 2.7.1 of section 3.7 into Eq. 2.8.2. The 100% multiplied on the right side of Eq. 2.8.2 is the reference thickness of the web material. This value is fixed.

Eq. 2.8.2 allows you to compute the final speed (Hz) of the inverter.

$$Final\ speed[Hz] = \frac{Main\ speed + PID\,output[Hz]}{Estimated\ thickness\,of\ \ materials[\%]} \times 100\ [\%] \qquad - Eq(2.8.2)$$

Group	Code number	Function	Name	Factory default	Range
APP	89	Compen Xcel %	The compensation rate reflected by the computation of the material thickness at the final speed	20%	0 - 100%

APP89 (Compen Xcel %): As shown in Eq. 2.8.2, the final output frequency of the inverter depends on the estimated material thickness (%). Here, you can set the rate and response speed where the variations in the output frequency induced by the estimated material thickness (%) would otherwise be reflected in the actual output frequency of the inverter.

The lower value of APP89 (Compen Xcel %) values (c.a. 50% or less) leads to the lower rate of output frequency variations due to the estimated material thickness at the actual output frequency of the inverter, and also leads to the lower speed of said variations reflected in the actual output frequency.

In order to ensure that the inverter operates reliably at a constant speed, we recommend setting APP89 (Compen Xcel %) to a value of less than ca. 50%.

⚠Caution
The final speed (Hz) is the final value of Eq. 2.8.2, which is regularly computed in the final speed computation section, so acceleration and deceleration occur frequently. Here, the accel and decel time is specified in DRV03 (Acc Time) and DRV04 (Dec Time), respectively. Moreover, selecting “5: Tension Ctrl” in APP01 (App Mode) automatically sets both DRV03 (Acc Time) and DRV04 (Dec Time) to “0.5 sec”. You can set different values for DRV03 (Acc Time) and DRV04 (Dec Time), but they must be less than 2.0 sec in order to rapidly reflect the final speed.

(3) Reverse Tension

This is the same as paragraph 4 of section 2.7. See paragraph 4 of section 2.7.

(4) Splicing

Capstan operation mode does not support splicing.

4. Other Functions

4.1 Stall Level Control Using the Analog Input

You can control the stall level with the analog input (V1/I1, V2/I2, Pulse) while operating the inverter.

When the web material loosens on an open loop unwinder without a tension control detector, such as a dancer or load cell, you must gradually increase the stall level using the analog input to restore the tension. However, this method does not allow for precise tension control.

Group	Code number	Function	Name	Factory default	Range	
PRT	48	Stall Src Sel	Stall level setting method	0: Keypad	0	Keypad
					1	V1
					2	I1
					3	V2
					4	I2
					5	Pulse
PRT(Note 1)	49	Stall % Disp	Current stall level	Read Only		
PRT	50	Stall Prevent	Stall mode selection	000	000 - 111	
PRT	52	Stall Level 1	Stall level 1	180%	30 - 250%	

(Note 1) PRT49 (Stall % Disp) is enabled when PRT48 (Stall Src Sel) is not “0: Keypad”.

PRT48 (Stall Src Sel): Allows you to select how to set the stall level. If you select “0: Keypad”, you can use a multi-step stall level for PRT51 - 58.

In most cases, the open loop unwinder uses an analog input to set this code and changes the analog input to control the stall level during inverter operation and ultimately maintain the back tension.

PRT50 (Stall Prevent): Determines whether to use the stall function. An open loop unwinder only uses the stall function during acceleration and at constant speeds, so it sets this code to “011”.

PRT52 (Stall Level 1): This stall level enters the maximum value (voltage: 10 V, current: 20 mA) for the analog input. For example, suppose that PRT52 (Stall Level 1) is set to 150% and PRT48 (Stall Src Sel) is set to “1: V1”. If 5 V is input as the current V1, then the stall level of the inverter is 75% (=150%*5V / 10V).

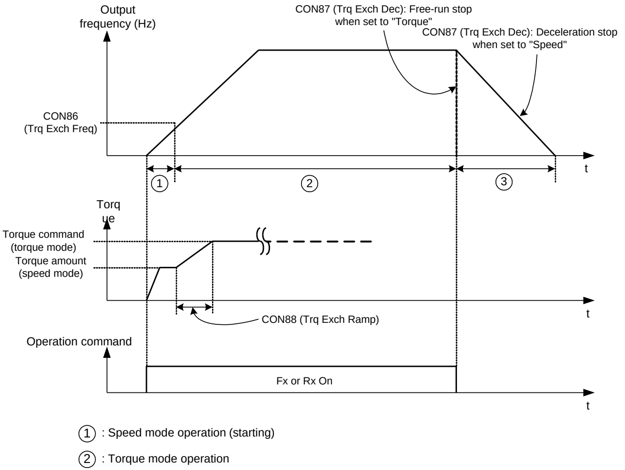
Moreover, PRT49 (Stall % Disp) displays the result of this calculation, which is 75% in this case.

4.2 Automated Speed-torque Switching

The motor automatically starts in speed mode when set to a torque mode that uses a Sensorless-1/Sensorless-2/Sensored vector, but if the set frequency (CON86) is at an abnormal level, it reverts to torque mode.

The motor sometimes fails to start at low torque commands (c.a. less than 10%) under certain load characteristics, particularly in the Sensorless-1/Sensorless-2 torque mode. When this occurs, you can start the motor in speed mode to take advantage of the excellent start characteristics, regardless of the load. Once the motor starts, the motor reverts to torque mode through automatic switching. This allows you to run the motor in a stable torque mode.

This switching function is useful for open loop winders/unwinders without a tension detector, such as a dancer or load cell.



1 : Speed mode operation (starting)

2 : Torque mode operation

3 : Torque mode free-run stop (set CON87 Trq Exch Dec to "Torque": Factory default)
: Speed mode deceleration stop (set CON87 Trq Exch Dec to "Speed")

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>CON</td><td>86</td><td>Trq Exch Freq</td><td>Automated speed-torque switching frequency when operating in torque mode</td><td>0.00 Hz</td><td colspan="2">0 - 30 Hz</td></tr>
<tr><td rowspan="2">CON</td><td rowspan="2">87</td><td rowspan="2">Trq Exch Dec</td><td rowspan="2">Deceleration method when operating in torque mode</td><td rowspan="2">0: Torque</td><td>0</td><td>Torque</td></tr>
<tr><td>1</td><td>Speed</td></tr>
<tr><td>CON</td><td>88</td><td>Trq Exch Ramp</td><td>Torque variation buffer time for automatic switching</td><td>5.0 sec</td><td colspan="2">0 - 300 sec</td></tr>
</table>

CON86 (Trq Exch Freq): When you start the motor in torque mode, this code sets the frequency at which the motor switches from speed mode to torque mode. When set to 0.00 Hz, speed-torque does not automatically switch over so the motor skips speed mode and starts in torque mode and always runs in torque mode.

For example, when you set CON86 (Trq Exch Freq) to 3.00 Hz, the motor runs in speed mode from startup until it reaches 3 Hz, and then automatically switches to torque mode once the frequency rises above 3 Hz.

<table>
<tr><th></th><th>Sensorless-1</th><th>Sensorless-2</th><th colspan="2">Sensored</th></tr>
<tr><td>DRV10 (Torque Control)</td><td>Yes</td><td>Yes</td><td>Yes</td><td>No</td></tr>
<tr><td>IN65 – 75 (P # Define):
Speed/torque input</td><td>-</td><td>-</td><td>Off</td><td>On</td></tr>
<tr><td>Operation mode</td><td>Torque mode</td><td>Torque mode</td><td colspan="2">Torque mode</td></tr>
</table>

CON87 (Trq Exch Dec): Allows you to select how to stop the motor when it receives the stop command while operating in torque mode. The factory default setting is “0: Torque”. Select “0: Torque” to free-run stop the motor in response to a stop command while operating in torque mode.

When you select **“1:** Speed” the motor decelerates until it stops in response to a stop command while operating in torque mode.

CON88 (Trq Exch Ramp): You can issue a torque command in torque mode through the keypad/analog input/communication (RS485, Fieldbus Opt) using the torque command source set in DRV08 (Trq Ref Src). The torque level in speed mode is computed at a very fast sampling cycle inside the inverter, so you cannot change it.

The automated speed-torque switching function causes the motor to start in speed mode and automatically switch to torque mode at a certain frequency (CON86: Trq Exch Freq). When automatically switching from speed to torque mode, you can apply a ramp time to the difference between the torque level computed in speed mode (a value that you cannot change) and the torque command in torque mode (a command you can issue via the keypad/analog input/communication). This provides a buffer against potential impacts on the load at the moment of automated speed-torque switchover.

4.3 External PID Controller

External devices can use the PID controller built in to the inverter (hereinafter called the 'External PID Controller'). In other words, you can export the output of the external PID controller as an analog output (Basic I/O: 0-10 V or 4-20 mA, Extended I/O option: -10 V - 10 V or 4 - 20 mA) or as communication data. This allows external devices to receive the analog output or communication data, so the PID controller can control these external devices.

In order to export the output from the external PID controller as an analog output, set the analog output to “14: PID Output” in the following way.

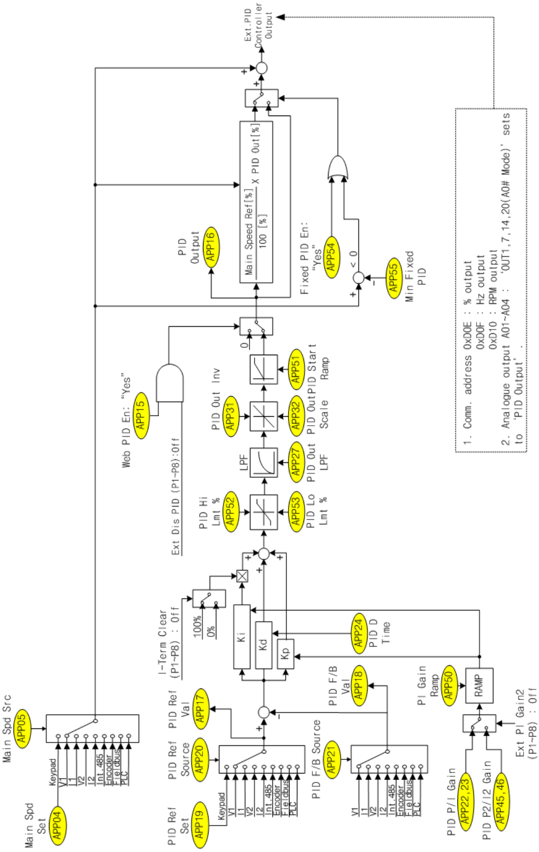
Group	Code number	Function	Name	Setting	Remarks
Out	01	AO1 Mode	Analog output setting	14: PID Output	0 - 10 V (Basic I/O)
Out	07	AO2 Mode	Analog output setting	14: PID Output	4 - 20 mA (Basic I/O)
Out	14	AO3 Mode	Analog output setting	14: PID Output	-10 - 10 V (Extended I/O option)
Out	20	AO4 Mode	Analog output setting	14: PID Output	4 - 20 mA (Extended. I/O option)

The following list of COM addresses corresponds to the main speed input of the external PID controller and the final output of the external PID controller.

COM address	Function	Range	R/W	Remarks
0hD85	Main speed (%) input (Note 1)	0.00 - 100.00%	W	Upper level controller→Inverter
0hD86	Main speed (Hz) input (Note 1)	0.00 - DRV20 Max Freq (x.xx Hz)	W	Upper level controller→Inverter
0hD87	Main speed (RPM) input (Note 1)	0 - DRV20 Max Freq (x RPM)	W	Upper level controller→Inverter

COM address	Function	Range	R/W	Remarks
0hD0E	External PID controller output (%)	-100.00~100.00%	R	Inverter➔Upper level controller
0hD0F	External PID controller output (Hz)	-DRV20 Max Freq - DRV20 Max Freq (x.xx Hz)	R	Inverter➔Upper level controller
0hD10	External PID controller output (RPM)	-DRV20 Max Freq - DRV20 Max Freq (x RPM)	R	Inverter➔Upper level controller

(Note 1): When APP05 (Main Spd Src) is set to Int485, Fieldbus, or PLC, you can receive the main speed command from Int485 or relevant options (Fieldbus, PLC) via the common area (0hD85 - 0hD87).


Main Spd Set
APP04
Main Spd Src
APP05
Keypad
V1
I1
V2
I2
Int.485
Encoder
Fieldbus
PLC
Web PID En: "Yes"
APP15
Ext Dis PID (P1~P8):Off
I-Term Clear
(P1~P8) : Off
100%
0%
PID Ref Set
APP19
PID Ref Source
APP20
PID Ref Val
APP17
Ki
Kd
Kp
PID Hi Lmt %
APP52
LPF
PID Out Inv
APP31
0
PID Output
APP16
Main Speed Ref[%] / 100 [%] X PID Out[%]
Ext.PID Controller Output
APP53
PID Lo Lmt %
APP27
PID Out LPF
APP32
PID Out Scale
APP51
PID Start Ramp
Fixed PID En: "Yes"
APP54
< 0
APP55
Min Fixed PID
PID F/B Source
APP21
PID F/B Val
APP18
APP24
PID D Time
PI Gain Ramp
APP50
RAMP
PID P/I Gain
APP22,23
PID P2/I2 Gain
APP45,46
Ext PI Gain2
(P1~P8) : Off
1. Comm. address 0xD0E : % output
0xD0F : Hz output
0xD10 : RPM output
2. Analogue output AO1~AO4 : 'OUT1,7,14,20(AO# Mode)' sets to 'PID Output'.

⚠Caution

1. The analog output of the basic I/O is 0 - 10 V, 4 - 20 mA, so the external PID controller always exerts a positive (+) output.
2. Extended I/O options have different analog output ranges, such as 0 - 10 V, 4 - 20 mA, or -10 - 10 V. Thus, the external PID controller can exert both positive (+) and negative (-) outputs.
3. As shown in the preceding table, the PID output of the external PID controller has communication addresses, such as 0hD0E (% output), 0hD0F (Hz output), and 0hD10 (RPM output). Moreover, negative (-) outputs are treated as a two's complement value. For example, if the current PID output is -15.23%, “64013” is saved in the COM address of 0hD0E. This is because “64013” is a complement of 2 for “1523” (A value obtained after inverting all of the bits and adding one).

<table>
<tr><th>Group</th><th>Code number</th><th>Function</th><th>Name</th><th>Factory default</th><th colspan="2">Range</th></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>Ext Dis PID</td><td colspan="2">-</td></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>Ext PI Gain2</td><td colspan="2">-</td></tr>
<tr><td>IN</td><td>65 - 72</td><td>Px Define</td><td>Multi-function input setting</td><td>I-Term Clear</td><td colspan="2">-</td></tr>
<tr><td rowspan="7">APP</td><td rowspan="7">01</td><td rowspan="7">App Mode</td><td rowspan="7">Application selection</td><td rowspan="7">None</td><td>0</td><td>None</td></tr>
<tr><td>1</td><td>Traverse</td></tr>
<tr><td>2</td><td>Proc PID</td></tr>
<tr><td>3</td><td>MMC</td></tr>
<tr><td>4</td><td>Auto Seq</td></tr>
<tr><td>5</td><td>Tension Ctrl</td></tr>
<tr><td>6</td><td>Ext PID Ctrl</td></tr>
<tr><td>APP</td><td>16</td><td>PID Output</td><td>PID output monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td>APP</td><td>17</td><td>PID Ref Value</td><td>PID reference monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td>APP</td><td>18</td><td>PID Fdb Value</td><td>PID feedback monitor</td><td colspan="3">Read Only (%)</td></tr>
<tr><td>APP</td><td>19</td><td>PID Ref Set</td><td>PID reference setting (Keypad)</td><td>50.00%</td><td colspan="2">-100 - 100%</td></tr>
<tr><td rowspan="9">APP</td><td rowspan="9">20</td><td rowspan="9">PID Ref Src</td><td rowspan="9">PID reference selection</td><td rowspan="9">0: Keypad</td><td>0</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td></tr>
<tr><td>2</td><td>I1</td></tr>
<tr><td>3</td><td>V2</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int.485</td></tr>
<tr><td>6</td><td>Encoder</td></tr>
<tr><td>7</td><td>Fieldbus</td></tr>
<tr><td>8</td><td>PLC</td></tr>
<tr><td rowspan="6">APP</td><td rowspan="6">21</td><td rowspan="6">PID F/B Src</td><td rowspan="6">PID feedback selection</td><td rowspan="6">1: I1</td><td>0</td><td>V1</td></tr>
<tr><td>1</td><td>I1</td></tr>
<tr><td>2</td><td>V2</td></tr>
<tr><td>3</td><td>I2</td></tr>
<tr><td>4</td><td>Int.485</td></tr>
<tr><td>5</td><td>Encoder</td></tr>
</table>

Group	Code number	Function	Name	Factory default	Range	
					6	Fieldbus
					7	PLC
APP	22	PID P-Gain	PID controller proportional gain	50.0%	0.0 - 1000.0%	
APP	23	PID I-Time	PID controller integral time	10.0 s	0.0 - 200.0 s	
APP	24	PID D-Time	PID controller differentiation time	0 ms	0 - 1000 ms	
APP	27	PID Out LPF	PID output filter	0 ms	0 - 10000 ms	
APP	31	PID Out Inv	PID output inverse	0: No	0	No
					1	Yes
APP	32	PID Out Scale	PID output scale	100.0%	0.0 - 1000.0%	
APP	45	PID P2-Gain	PID controller proportional gain 2	100.0%	0.0 - 1000.0%	
APP	46	PID I2-Time	PID controller integral time 2	20.0 s	0.0 - 200.0 s	
APP	50	PI Gain Ramp	PI gain switchover ramp time	30.0 sec	0.0 - 300.0 sec	
APP	51	PID Start Ramp	PID output at start Ramp time	0.0 s	0.0 - 300.0 s	
APP	52	PID Hi Lmt %	PID output upper limit (%)	100.0%	APP53 - 100.0%	
APP	53	PID Lo Lmt %	PID output lower limit (%)	-100.0%	-100 - APP52 (%)	
APP	85	Ext PID En	External PID control selection	1: Yes	0	No
					1	Yes
APP	98	PID Sample T	PID controller execution frequency	1 ms	1 - 10 ms	

APP01 (App Mode): Selects the Ext PID Ctrl. External devices can use the PID controller built in to the inverter (External PID Controller), regardless of whether the inverter is operating.

APP85 (Ext PID En): Determines whether to use the external PID controller. You can this code in combination with multi-function input “Ext Dis PID,” as shown in Table 3.3.1.

Table 3.3.1 Selecting whether to use the External PID Controller

APP85 (Ext PID En) setting	Status of multi-function input “Ext Dis PID”	Whether to use the Ext PID Controller
Yes (Default)	Off	O
Yes (Default)	On	X
No	Off	X

APP85 (Ext PID En) setting	Status of multi-function input “Ext Dis PID”	Whether to use the Ext PID Controller
No	On	X

APP16 (PID Output): Indicates the current PID output (as a percentage).

APP17 (PID Ref Value): Indicates the current PID reference (as a percentage).

APP18 (PID Fdb Value): Indicates the current PID feedback (as a percentage).

APP19 (PID Ref Set): Sets the reference for the PID controller using the keypad.

APP20 (PID Ref Src): This code allows you to select from a variety of methods to input the PID controller reference information (keypad, analog, internal COM, external COM, and PLC option).

APP21 (PID F/B Src): Selects how to input the PID controller feedback (analog, internal COM, external COM, and PLC option).

APP22 (PID P-Gain): Indicates the P1 gain of the PID controller. If the P gain is 100% and the error is 100%, then the P controller output is 100%.

APP23 (PID I-Time): Indicates the I1 gain of the PID controller. If the I gain is 10 sec and the error is 100%, then it takes 10 seconds to saturate the I controller output to 100%.

APP24 (PID D-Time): Indicates the D gain of the PID controller. If the D gain is 10 ms and the error change is 100%, then it takes 10 ms for the D controller output to decrease from 100% to 34%.

APP27 (PID Out LPF): Sets the delay time constant of the PID controller output. In general, this code sets the delay time to 0 ms to shorten the response time of the PID controller. However, a higher value makes the PID controller less responsive but more stable.

APP31 (PID Out Inv): Selects whether to invert the output of the PID controller. Select “Yes” to invert the PID output code before it is output.

APP32 (PID Out Scale): Adjusts the scale of the PID controller output. First, suppose that the PID controller is saturated. In such a situation, if this code is set to 100%, the PID controller output is 100%. When this code is set to 30%, the PID controller output is 30%.

APP50 (PI Gain Ramp): This code is the ramp time applicable when P/I gain switching occurs due to a change in the multi-function input “Ext PI Gain2” during inverter operation. In addition to this, this code also applies when you use the loader to change the P/I gain during inverter operation. Ramp time switching is based on 1000% for the P gain and 200 sec for the I gain. For example, it takes 3 sec (=30 * 100 / 1000) to change the P gain from 100% to 200% when APP50 (PI Gain Ramp) is set to 30 sec.

Status of multi-function input "Ext PI Gain2"	P/I gain selected
Off	APP22 (PID P-Gain), APP23 (PID I-Time)
On	APP45 (PID P2-Gain), APP46 (PID I2-Time)

APP51 (PID Start Ramp): Increases the ramp time during the set time of PID output when the inverter initially starts. Fig. 3.3.2 (b) shows the output of the P controller at start up when the P gain is 100% and the PID error is 100%. The dotted line in figure (b) shows the output of the P controller when APP51 (PID Start Ramp) is "0 sec". The solid line in figure (b) shows that the output of the PID controller at initial start up tends to increase by the ramp time based on the value of APP51 (PID Start Ramp). In other words, the solid line in (b) is more advantageous than the dotted line in (b) due to the transient phenomena that exists when the inverter initially starts.

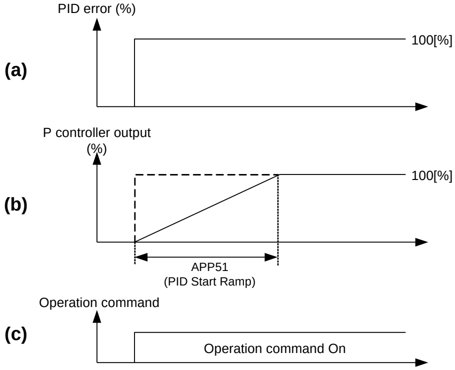


Fig. 3.3.2 Activating APP51 (PID Start Ramp)

Moreover, the APP51 (PID Start Ramp) value is based on the PID controller output at 100%. For example, when APP51 (PID Start Ramp) is set to 5 sec, it takes 5 sec to fully saturate the output of the PID controller to 100% at initial start up. However, it takes 2.5 sec to saturate the output of the PID controller to 50% at initial start up.

APP52, 53 (PID Hi/Lo Lmt %): Specifies the upper and lower limit of the PID controller output. In addition to this, the cumulative value of the I controller is limited to the upper and lower value specified in this code.

APP54 Fixed PID En/APP55 Min Fixed PID:

Group	Code number	Function	Name	Factory default	Range	
APP	54	Fixed PID En	Fixed PID controller selection	0: No	0	No
					1	Yes
APP	55	Min Fixed PID	Minimum value of the fixed PID controller	10.0%	0.0 - 50.0%	

When you select “Yes” for APP54 (Fixed PID En), the PID output (%) - an output of the Ext PID controller, as shown in Eq. 3.3.1 - remains constant regardless of the main speed (%).

$$Final\ PID\,output\,[\%] = PID\ \text{output}\ [\%] \qquad -Eq\ (3.3.1)$$

When you select “No” as the factory default setting for APP54 (Fixed PID En), the PID output (%) - an output of the Ext PID controller, as shown in Eq. 3.3.2 - is proportional to the main speed (%). In other words, it means that the ratio of the PID output (%) to the main speed remains constant. According to this principle, lower main speeds (%) produce less PID output (%), whereas higher main speeds (%) produce more PID output (%).

$$Final\ PID\,output[\%] = PID\,output\ [\%] \times \frac{Main\ speed\ command[\%]}{100.0[\%]} \qquad -Eq\ (3.3.2)$$

However, when you select “No” as the factory default for APP54 (Fixed PID En) and receive a command to lower the main speed (%) below the value specified in APP55 (Min Fixed PID), the inverter functions according to the equation shown in Eq. 3.3.3. By functioning according to the equation in Eq. 3.3.3, the inverter prevents the output of the Web PID controller from decreasing the low main speed command (%) to below the value specified in APP55 (Min Fixed PID).

$$Final\ PID\,output[\%] = PID\,output\ [\%] \times \frac{APP55(Min\,Fixed\ PID)[\%]}{100.0[\%]} \qquad -Eq\ (3.3.3)$$

Table 3.3.1 shows the final PID output (%) based on the APP55 (Fixed PID En) value if APP32 (PID Out Scale) is set to 20% and APP55 (Min Fixed PID) to the factory default setting of 10%. This table assumes that the PID output is now saturated at 20%.

Note 3.3.2 of Table 3.3.1 shows that the main speed is 2% or 8% below the factory default setting of APP55 (Min Fixed PID), i.e. 10%, so you can determine it using Eq. 3.3.3. Note 3.3.2 shows that the main speed is 20% or 80% over the factory default setting of APP55 (Min Fixed PID), i.e. 10%, so you can determine it using Eq. 3.3.2.

Table 3.3.1 Comparison of PID outputs by PID controller types (APP54: Fixed PID En)

Main speed command (%)	APP54 (Fixed PID En): PID output (%), if Yes	APP54 (Fixed PID En): PID output (%), if No
2.0	20.0	2.0(Note 3.3.2)
8.0	20.0	2.0(Note 3.3.2)
20.0	20.0	4.0(Note 3.3.2)
80.0	20.0	16.0(Note 3.3.2)

APP98 (PID Sample T): Changes the execution frequency of the Ext PID Controller.

4.4 Speed Controller P Gain Profile (Inertia Compensation)

The winder develops a larger diameter and produces more inertia over time, so it requires positive (+) inertia compensation. In contrast to this, the unwinder develops a smaller diameter and produces less inertia over time, so it requires negative (-) inertia compensation.

This inertia compensation is applied to the P gain of the Web PID in section 1.5, "Web PID Controller Section". For more effective inertia compensation, you can increase the ASR P gain with a larger diameter. The formulas and figures for inertia compensation are identical to those used for inertia compensation with the P gain of the Web PID. Fig. 3.4.1 shows how the P gain trends and formulas vary depending on the diameter.

Group	Code number	Function	Name	Factory default	Range	
CON	90(Note 1)	ASR P Pro Mode	ASR P Gain profile selection	0: None	0	None
					1	Linear
					2	Square
CON	91(Note 2)	ASR P Pro Gain	ASR profile gain	1.00%	0.01~10.00%	

(Note 1): This code only appears when you set APP-02 (Tnsn Ctrl Mode) to “W_Spd Close,” “UW_Spd Close,” “W_Spd Open,” or “UW_Spd Open”.
(Note 2): This code only appears when CON-90 (ASR P Pro Mode) is set to “Linear” or “Square”.

“None”: $Inetia\ compensation\ \ P\ \ Gain = P\ Gain$

“Linear”:

$$Inetia\ compensation\ P\ Gain = P\ Gain \times \left\{ 1 + Profile\ P\ \ Gain(APP57) \times \left[\frac{Diameter}{Full\ \ Diameter} - \frac{Bobbin\ Diameter}{Full\ \ Diameter} \right] \right\}$$

"Square":

$$Inetia\ compensation\ \ P\ \ Gain = P\,Gain \times \left\{1 + Profile\,P\,Gain \times \left[\frac{Diameter^2}{Full\ \ Diameter^2} - \frac{Bobbin\,Diameter^2}{Full\ \ Diameter^2}\right]\right\}$$

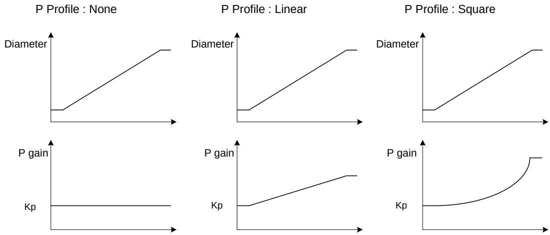


Fig. 1.5.2 The P gain varies depending on the CON90 (ASR P Pro Mode) setting

5. Applied Functions

5.1 Setting the Override Frequency Using the Aux Frequency Command

(If you want to set the frequency for various computing conditions using the main and auxiliary speeds, as for a Draw operation.)

Group	Code number	Function display	Functional settings		Range	Unit
DRV	07	Freq Ref Src	0	Keypad-1	0 - 9	-
BAS	01	AUX Ref Src	1	V1	0 - 4	-
BAS	02	AUX Calc Type	0	M + G * A	0 - 7	-
BAS	03	AUX Ref Gain	-	0.0	200 - 200	%
IN	65 - 75	Px Define	40	Dis Aux Ref	0 - 48	-

You can use two frequency setting methods at the same time to set the operational frequency. You can use the main speed to set the main operational frequency, and you can use the aux speed setting to fine tune the main operation. For example, assume that the settings were made as in the preceding table. If you introduce a -10 to +10 V voltage to the V1 terminal with a gain setting of 5% (variables from IN-01 to LN-16 are the initial values, and the IN-06 V1 polarity is set to Bipolar) while using Keypad-1 as the main speed and operating the inverter at 30.00 Hz, you can fine tune inverter up to 33.00 - 27.00 Hz.

BAS-01 AUX Ref Src: Selects the input type to use for the aux speed.

Setting type		Function
0	None	No aux speed operation
1	V1	Selects the voltage input terminal of the control terminal block as the aux speed command.
2	I1	Selects the current input as the aux speed command.
3	V2	Selects the voltage input of the Ext IO option board as the aux speed command.
4	I2	Selects the current input of the Ext IO option board as the aux speed command.

BAS-02 Aux Calc Type: After determining the size of the aux speed with the gain (BAS-03 Aux Ref Gain), use the four primary functions of arithmetic (addition, subtraction, multiplication, and division) to set the application rate of the main speed.

Setting type		Formula	How to calculate the final frequency command
0	M + (G * A)	M[Hz]+(G[%]*A[Hz])	Main speed command value + (BAS03 x BAS01 x IN01)
1	M * (G * A)	M[Hz]*(G[%]*A[%])	Main speed command value x (BAS03 x BAS01)
2	M/(G * A)	M[Hz]/(G[%]*A[%])	Main speed command value / (BAS03 x BAS01)
3	M+(M*(G*A))	M[Hz]+(M[Hz]*(G[%]*A[%]))	Main speed command value + (Main speed command value x (BAS03 x BAS01))
4	M+G*2*(A-50)	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	Main speed command value + BAS03 x 2 x (BAS01 – 50) x IN01
5	M*(G*2*(A-50))	M[HZ]*(G[%]*2*(A[%]-50[%]))	Main speed command value x (BAS03 x 2 x (BAS01 – 50))
6	M/(G*2*(A-50))	M[HZ]/(G[%]*2*(A[%]-50[%]))	Main speed command value / (BAS03 x 2 x (BAS01 – 50))
7	M+M*G*2*(A-50)	M[HZ]+M[HZ]*G[%]*2*(A[%]-40[%])	Main speed command value + Main speed command value x BAS03 x 2 x (BAS01 – 50)

⚠Caution
If the max frequency is high, an output frequency error may occur due to an analog input error or calculation error.

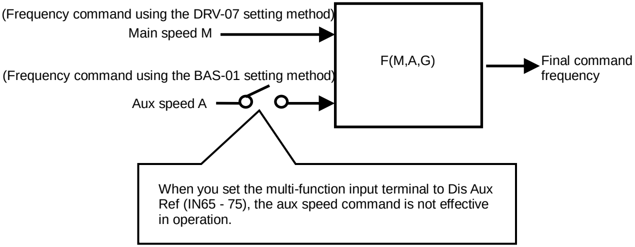
M: Main speed frequency command based on the DRV-07 setting (Hz or RPM),
G: Aux speed gain (%)
A: Aux speed frequency command (Hz or RPM) or gain (%)

In the preceding setting types, the single-direction analog input can allow the (+) or (-) operation at least four times.

BAS-03 Aux Ref Gain: Controls the size of the input (BAS-01 Aux Ref Src) selected as the aux speed.

If you select V1 or I1 as the aux speed and specify the initial values for parameters 01 - 32 of the terminal block input group (IN), then the aux speed frequency operates in the following way.

IN-65 - 75 Px Define: When you input a terminal specified as #40 Dis Aux Ref from the multi-function input terminals, the inverter only operates based on the main speed command and does not activate the aux speed command.



Usage example 1)

If the frequency keypad setting corresponds to the main speed and the V1 analog voltage corresponds to the aux speed.

Conditions

- Main speed (M) setting (DRV-07): Keypad (frequency set as 30 Hz)
- Max frequency (Max Freq) setting (DRV-20): 400Hz
- Aux speed (A) setting (A: BAS-01): V1 (Expressed as an aux speed (Hz) or percentage (%), depending on the computation conditions.)
- Aux speed gain (G) setting (BAS-03): 50%, IN01 - 32: Factory default

If 6 V is inputted to V1, the frequency for 10 V is 60 Hz and therefore aux speed A in the following table is 36 Hz (= 60 Hz x (6 V / 10 V)) or 60% (= 100% x (6 V / 10 V) based on these conditions.

Setting type		Final command frequency
0	M[Hz]+(G[%]*A[Hz])	30 Hz (M) + (50%(G) x 36 Hz(A)) = 48 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz (M) x (50%(G) x 60%(A)) = 9 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz (M)/(50%(G) x 60%(A)) = 100 Hz
3	M[Hz]+(M[Hz]*(G[%]*A[%]))	30 Hz (M)+(30 Hz x (50%(G) x 60%(A))) = 39 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz (M) + 50%(G) x 2 x (60%(A) – 50%) x 60Hz = 36 Hz
5	M[HZ]*(G[%]*2*(A[%]-50[%]))	30 Hz (M) x (50%(G) x 2 x (60%(A) – 50%)) = 3 Hz
6	M[HZ]/(G[%]*2*(A[%]-50[%]))	30 Hz (M) / (50%(G) x 2 x (60% – 50%)) = 300 Hz
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz (M) + 30 Hz (M) x 50%(G) x 2 x (60%(A) – 50%) = 33Hz

* You can change the frequency to RPM, so that RPM will be used in place of Hz.

Usage example 2)

- Main speed (M) setting (DRV-07): Keypad (frequency command set as 30 Hz)
- Max frequency (Max Freq) setting (DRV-20): 400 Hz
- Aux speed (A) setting (BAS-01): I1 (Expressed as an aux speed (Hz) or percentage (%), depending on the conditions.)
- Aux speed gain (G) setting (BAS-03): 50%, IN01 - 32: Factory default

Assuming that 10.4 mA is input to I1, the frequency corresponding to 20 mA is 60 Hz. Therefore, aux speed A in the following table is 24 Hz (= 60 Hz x ((10.4 mA - 4 mA) / (20 mA - 4 mA)), or 40% (=100% x ((10.4 mA -4 mA) / (20 mA - 4 mA)).

Setting type		Final command frequency
0	M[Hz]+(G[%]*A[Hz])	30Hz(M) + (50%(G) x 24Hz(A)) = 42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz (M) x (50%(G) x 40%(A)) = 6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz (M) / (50%(G) x 40%(A)) = 150 Hz
3	M[Hz]+(M[Hz]*(G[%]*A[%]))	30 Hz (M) + (30 Hz x (50%(G) x 40%(A))) = 36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz (M) + 50%(G) x 2 x (40%(A) – 50%) x 60Hz = 24 Hz
5	M[HZ]*(G[%]*2*(A[%]-50[%]))	30 Hz (M) x (50%(G) x 2 x (40%(A) – 50%)) = -3 Hz (Reverse direction)
6	M[HZ]/(G[%]*2*(A[%]-50[%]))	30 Hz (M) / (50%(G) x 2 x (60% – 40%)) = -300 Hz (Reverse direction)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M) + 30Hz(M) x 50%(G) x 2 x (40%(A) – 50%)= 27 Hz

Usage example 3)

- Main speed setting (DRV-07): V1 (If you set the frequency command as 30 Hz at 5 V.)
- Max Freq in Hz (DRV-20): 400 Hz
- Aux speed (BAS-01): I1 (Expressed as an aux speed (Hz) or percentage (%), depending on the conditions.)
- Aux speed gain (BAS-03): 50% (indicates G in the following table. The value is 0.5)
- IN01 - 32: Factory default

Assuming that 10.4 mA is input to I1, the frequency corresponding to 20 mA is 60 Hz. Therefore, aux speed A in the following table is 24 Hz (= 60 Hz x ((10.4 mA - 4 mA) / (20 mA - 4 mA)), or 40% (=100% x ((10.4 mA -4 mA) / (20 mA - 4 mA)).

Setting type		Final command frequency
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M) + (50%(G) x 24 Hz(A)) = 42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz (M) x (50%(G) x 40%(A)) = 6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz (M) / (50%(G) x 40%(A)) = 150 Hz
3	M[Hz]+(M[Hz]*(G[%]*A[%]))	30 Hz (M) + (30 Hz x (50%(G) x 40%(A))) = 36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz (M) + 50%(G) x 2 x (40%(A) – 50%) x 60Hz = 24 Hz
5	M[HZ]*(G[%]*2*(A[%]-50[%]))	30 Hz (M) x (50%(G) x 2 x (40%(A) – 50%)) = -3 Hz (Reverse direction)
6	M[HZ]/(G[%]*2*(A[%]-50[%]))	30 Hz (M) / (50%(G) x 2 x (60% – 40%)) = -300 Hz (Reverse direction)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz (M) + 30 Hz (M) x 50%(G) x 2 x (40%(A) – 50%) = 27 Hz

5.2 Jog Operation (Jog-operating the Inverter)

You can jog-operate the inverter using the terminal block or keypad multi-keys.

(1) Jog Operation 1: Based on the Terminal Block

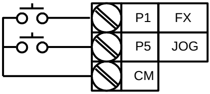
Group	Code number	Function display	Function settings		Range	Unit
DRV	11	JOG Frequency	-	10.00	0.5 - Max. frequency	-
DRV	12	JOG Acc Time	-	20.00	0 - 600	sec
DRV	13	JOG Dec Time	-	30.00	0 - 600	sec
IN	65 - 75	Px Define	6	JOG	-	-

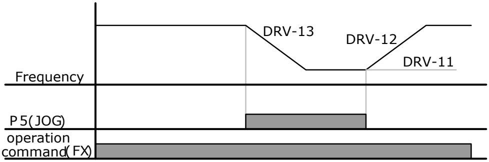
*Px: P1 - P8, P9 - P11 (option)

Select a multi-function terminal block between P1 and P11 to serve as the jog frequency setting terminal, and then select No.6 (JOG) as the function for one of terminal blocks ranging from IN-65 to IN-75. If you input the jog terminal with an operation command input, the operation frequency moves to the jog frequency explained below.

DRV-11 Jog Frequency (Jog frequency): Specifies the frequency for jog operation. The jog operation is assigned top priority except the Dwell operation. Therefore, if you input a jog terminal while operating the inverter at any speed, including multi-step operations, up-down operations, or 3-wire operations, it operates according to the jog frequency.

DRV-12 JOG Acc Time, DRV-13 JOG Dec Time: These are the accel and decel times for moving at the jog frequency.





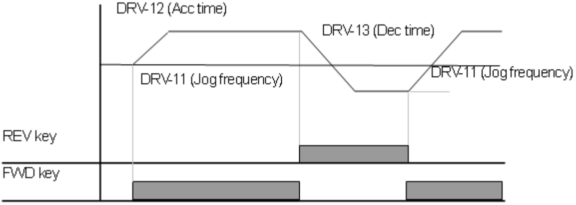
(2) Jog Operation 2: Based on the Terminal Block

Group	Code number	Function display	Function settings		Range	Unit
DRV	11	JOG Frequency	-	10.00	0.5 - Max. frequency	Hz
DRV	12	JOG Acc Time	-	20.00	0 - 600	sec
DRV	13	JOG Dec Time	-	30.00	0 - 600	sec
IN	65 - 75	Px Define	46	FWD JOG	-	-
IN	65 - 75	Px Define	47	REV JOG	-	-

*Px: P1 - P8, P9 - P11 (option)

Jog Operation 1 requires an operation command, but Jog Operation 2 can carry out the jog operation using a terminal set to forward jog (FWD JOG) or reverse jog (REV JOG).

During jog operation, the priority for the Acc/Dec time and terminal block input (Dwell, 3-wire, up/down, etc.) is the same as for Jog Operation 1.Even if you input an operation command during jog operation, the inverter continues to operate at the jog frequency.


DRV-12 (Acc time)
DRV-13 (Dec time)
DRV-11 (Jog frequency)
DRV-11 (Jog frequency)
REV key
FWD key

(3) Keypad-based Jog Operation

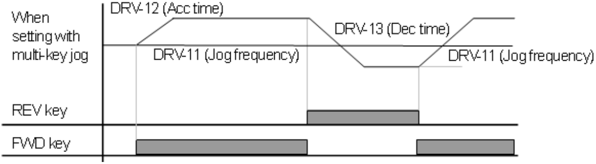
Mode	Group	Code number	Function display	Function settings		Range	Unit
CNF	-	42	Multi-Key Sel	1	JOG Key	-	-
PAR	DRV	06	Cmd Source	0	Keypad	0 - 5	sec

*Px: P1 - P8, P9 - P11 (option)

Set the #42 code of Config (CNF) mode using the #1 JOG Key. Set the DRV-06 code of Parameter (PAR) mode using the #0 Keypad. When you press the Multi key, the J icon on the upper portion of the display screen inverts ( ). This indicates that you can perform jog operation using the keypad. You can press and hold the forward (FWD) or reverse (REV) operation key on the keypad to operate the inverter at the jog frequency setting (DRV-11 JOG Frequency).

The inverter stops operating if you do not press the FWD or REV key.

DRV-12 and DRV-13 set the accel/decel ramp time to the jog operation frequency.



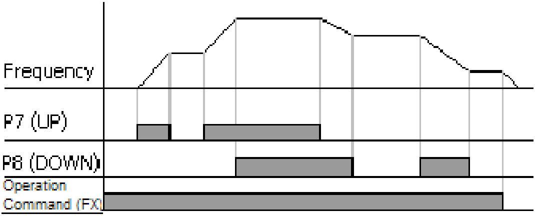
5.3 Up – Down Operation

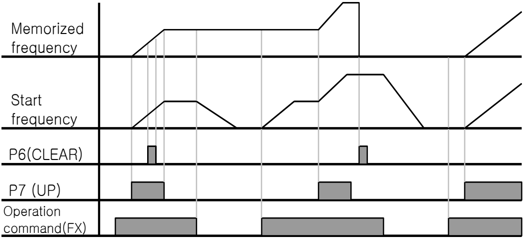
Group	Code number	Function display	Function settings		Range	Unit
ADV	65	U/D Save Mode	1	Yes	0 - 1	-
IN	65 - 75	Px Define	17	Up	0 - 48	-
IN	65 - 75	Px Define	18	Down	0 - 48	-
IN	65 - 75	Px Define	20	U/D Clear	0 - 48	-

*Px: P1 - P8, P9 - P11 (option)

You can use the multi-function terminal block to control acceleration and deceleration. You can use this in systems where the upper-lower limit switch signal functions as the deceleration command.

Group	Code number	Function display	Code description
ADV	65	U/D Save Mode	▪ If the operation command (FX or RX terminal) is off or trips or a power failure occurs during the constant speed operation, the frequency used for the operation is stored in the memory. ▪ The inverter uses the saved frequency when the operation command turns on again or returns to its normal status. Use the multi-function terminal block to delete the saved frequency. Set a multi-function terminal to #20 U/D Clear, and then input the terminal during a stop or at a constant speed to delete the frequency stored for the up-down operation.
IN	65 - 75	Px Define	▪ Select the terminal to use for the up-down operation, and then set the relevant terminal functions in #17 up and #18 down. ▪ If the UP terminal signal is ON when an operation command is input, then the speed increases. If this signal is OFF, then the inverter stops accelerating and operates at a constant speed. ▪ If the DOWN terminal signal is ON during operation, the inverter begins to decelerate. If this signal is OFF, the inverter stops decelerating and operates at a constant speed. ▪ If both the UP and DOWN signals are ON at the same time, both acceleration and deceleration stop.


Frequency
P7 (UP)
P8 (DOWN)
Operation
Command (FX)


Memorized
frequency
Start
frequency
P6(CLEAR)
P7 (UP)
Operation
command(FX)

5.4 Wire Operation (Operating the Inverter with the Push Button or Equivalent)

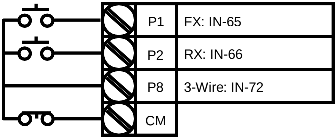
Group	Code number	Function display	Function settings		Range	Unit
DRV	06	Cmd Source	1	Fx/Rx - 1	0 - 5	-
IN	65 - 75	Px Define	14	3-Wire	0 - 48	-

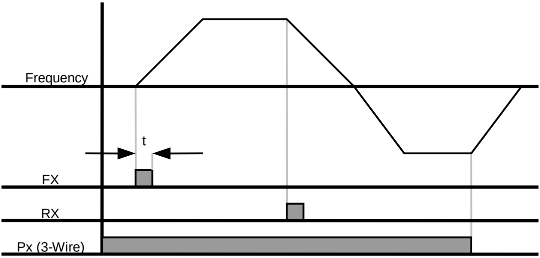
*Px: P1 - P8, P9 - P11 (option)

This refers to a function that latches the input signals and carries out the operation shown in the following figure.

Therefore, you can use the Push button switch to configure a simple sequence circuit, as shown in the following figure. The minimum input time (t) for the input terminal should be 1 msec or longer to properly operate the inverter.

The inverter stops operating if forward and reverse operation commands are input at the same time.



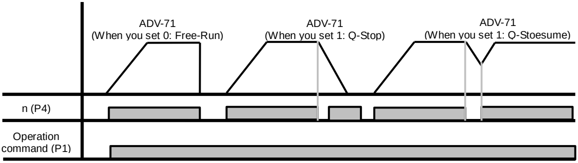


5.5 Safe Operation Mode (Using the Terminal Input to Limit Operation)

Group	Code number	Function display	Function settings		Range	Unit
ADV	70	Run En Mode	1	DI Dependent	-	-
ADV	71	Run Dis Stop	0	Free-Run	0 - 2	-
ADV	72	Q-Stop Time	-	5.0	0 - 600	sec
IN	65 - 75	Px Define	13	Run Enable	0 - 48	

A function that uses the multi-function input terminal to make the operation command effective by software.

Group	Code number	Function display	Code description
IN	65 - 75	Px Define	▪ Selects a multi-function input terminal for No.13 safe operation mode (RUN Enable). (The safe operation function does not work if you only set the multi-function terminal block to RUN Enable.)
ADV	70	Run En Mode	▪ When you set this code to #1 DI Dependent, the multi-function input terminals can recognize this operation command. ▪ Safe operation mode cannot function if you set this code to #0 Always Enable.
ADV	71	Run Dis Stop	▪ Sets the inverter operation when the multi-function input terminal for safe operation mode is OFF. ▪ 0: Free-Run Cuts off the power to the inverter when the multi-function terminal is OFF. ▪ 1: Q-Stop Uses the deceleration time (Q-Stop Time) in safe operation mode to decelerate inverter. You must input the operation command again to enable this operation even if the multi-function terminal is ON. ▪ 2: Q-Stop Resume Uses the safe operation mode deceleration time (Q-Stop Time) to decelerate. With the operation command ON, the operation starts normally when the multi-function terminal receives an input.
ADV	72	Q-Stop Time	▪ Sets the deceleration time if you set ADV-71 (Run Dis Stop) to #1 Q-Stop or #2 Q-Stop Resume.


ADV-71
(When you set 0: Free-Run)
ADV-71
(When you set 1: Q-Stop)
ADV-71
(When you set 1: Q-Stoesume)
n (P4)
Operation
command (P1)

5.6 Dwell Operation (Operating the Inverter in Dwell Mode)

Group	Code number	Function display	Initial value		Range	Unit
ADV	20	Acc Dwell Freq	-	5.00	Start frequency - Max. frequency	Hz
ADV	21	Acc Dwell Time	-	0.0	0 - 10	sec
ADV	22	Dec Dwell Freq	-	5.00	Start frequency - Max. frequency	Hz
ADV	23	Dec Dwell Time	-	0.0	0 - 10	sec

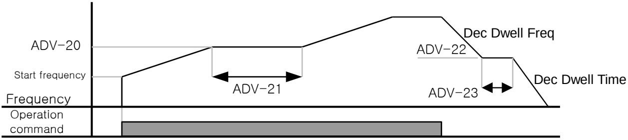
When an operation command is input, you can operate the inverter at a constant speed with the preset acceleration dwell frequency during the acceleration dwell time, and then the inverter begins to accelerate.

When a stop command is input, you can operate the inverter at a constant speed with the preset deceleration dwell frequency during the deceleration dwell time before the inverter stops.

When you use the control mode (DRV-09 Control Mode) as the V/F mode, you can use it to operate the inverter at the dwell frequency before opening the mechanical brake under the elevator load, and then open the brake.

⚠ Caution

If you perform a dwell operation at a frequency higher than the motor's rated slip under similar loads, as shown in the previous examples, bear in mind that the overcurrent flowing through the motor may damage it or adversely affect its lifespan.



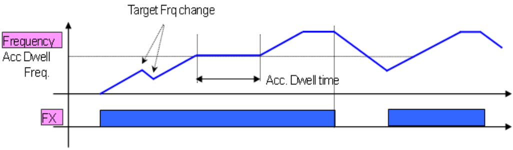
Detailed Description of Dwell Operations

You can use Dwell operations to assure a certain level of torque for opening and activating the brake under a lift load. When an operation command is input, you can accelerate inverter in Dwell operation mode up to the Dwell frequency during the preset acceleration time. You can operate the inverter using the speed setting after the Accel Dwell Time set for the Dwell operation frequency. If a stop command is input during operation, you can use the Dwell operation frequency to operate the inverter at a lower speed. After the Dec Dwell Time, you can stop the inverter according to the previous deceleration time. If the Dwell operation time or Dwell frequency is set to 0, then the Dwell operation does not work.

The acceleration Dwell operation command is only effective when you issue the first command. This operation does not work if the inverter returns to the previous acceleration path following the Dwell frequency acceleration. The deceleration Dwell functions when you input a stop command and the inverter goes through the deceleration Dwell frequency. It does not function during normal frequency deceleration which is not the result of a stop deceleration. The Dwell operation does not function if the outside brake control is ON.

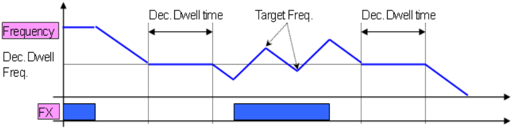
Acceleration Dwell

The acceleration Dwell operation command is only effective when you issue the first command. This operation does not work if the inverter returns to the previous acceleration path following the Dwell frequency acceleration.



Deceleration Dwell

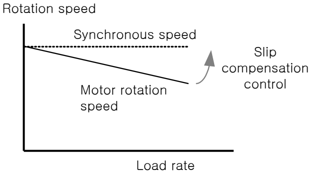
The deceleration Dwell functions when you input a stop command and the inverter goes through the deceleration Dwell frequency. It does not function during normal frequency deceleration which is not the result of a stop deceleration.



5.7 Slip Compensation Operation

In induction motors, the difference between the motor rotation speed and the frequency (synchronous speed) increases depending on the load factor.

You can adjust the speed difference (slip) to compensate for the load if this occurs. If the control mode is set to Sensorless or Vector and V/F PG, the system automatically compensates for the speed difference.



Group	Code number	Function display	Function setting display		Unit
DRV	09	Control Mode	2	Slip Compen	-
DRV	14	Motor Capacity	2	0.75 (Based on 0.75 kW)	kW
BAS	11	Pole Number	-	4	-
BAS	12	Rated Slip	-	90 (Based on 0.75 kW)	rpm
BAS	13	Rated Curr	-	3.6 (Based on 0.75 kW)	A
BAS	14	Noload Curr	-	1.6 (Based on 0.75 kW)	A
BAS	16	Efficiency	-	72 (Based on 0.75 kW)	%
BAS	17	Inertia Rate	-	0 (Based on 0.75 kW)	-

DRV-09 Control Mode (Control mode): Ensure that the control mode is set to #2 Slip Compen.

DRV-14 Motor Capacity (Motor capacity): Set the capacity of motor connected to the inverter output.

BAS-11 Pole Number (No. of motor poles): Input the number of poles stated on the motor nameplate.

BAS-12 Rated Slip (Rated slip): Use the RPM rating on the motor nameplate to input the rated slip.

BAS-13 Rated Curr (Rated current): Input the rated current shown on the motor nameplate.

BAS-14 Noload Curr (No-load current): Input the current reading obtained when operating the motor at the rated frequency after removing load devices connected to the motor shaft. If it is difficult to measure the no-load current, input a current level equivalent to 30 - 50% of the rated motor current.

BAS-16 Efficiency (Motor efficiency): Input the efficiency rating stated on the motor nameplate.

BAS-17 Inertia Rate (Load inertia ratio): Select the load inertia based on motor inertia.

(0: Less than 10 times the motor inertia, 1: 10 times the motor inertia, 2-8: More than 10 times the motor inertia)

$$f_s = f_r - \left(\frac{rpm \times P}{120} \right)$$

Here,

f_s = Rated slip frequency, f_r = Rated frequency, rpm = Motor rated RPM, P = Number of motor poles

Ex) Rated frequency: 60 Hz, Rated RPM: 1740 rpm, No. of poles: 4.

$$f_s = 60 - \left(\frac{1740 \times 4}{120} \right) = 2Hz$$

5.8 PID Control

(1) Basic PID Operation

This is the most common type of automatic control. The P in PID stands for proportional, the I stands for integral, and the D stands for differential. Combining these three elements provides flexible control for the system.

Group	Code number	Function display	Setting display		Setting range	Unit
APP	01	App Mode	2	Proc PID	0 - 4	-
APP	16	PID Output	-	-	-	-
APP	17	PID Ref Value	-	-	-	-
APP	18	PID Fdb Value	-	-	-	-
APP	19	PID Ref Set	-	50.00	-100 - 100	%
APP	20	PID Ref Source	0	Keypad	0 - 10	-
APP	21	PID F/B Source	0	V1	0 - 10	-
APP	22	PID P-Gain	-	50.0	0 - 1000	%
APP	23	PID I-Time	-	10.0	0 - 32.0	Sec
APP	24	PID D-Time	-	0	0 - 1000	msec
APP	25	PID F-Gain	-	0.0	0 - 1000	%
APP	26	P Gain Scale	-	100.0	0 - 100	%
APP	27	PID Out LPF	-	0	0 - 10000	msec
APP	29	PID Limit Hi	-	60.00	0 - 300	Hz
APP	30	PID Limit Lo	-	0.5	0 - 300	Hz
APP	31	PID Out Inv	-	No	0 - 1	-
APP	32	PID Out Scale	-	100.0	0.1 - 1000	%
APP	34	Pre-PID Freq	-	0.00	0 - Max. frequency	Hz
APP	35	Pre-PID Exit	-	0.0	0 - 100	%
APP	36	Pre-PID Delay	-	600	0 - 9999	Sec
APP	37	PID Sleep DT	-	60.0	0 - 999.9	Sec
APP	38	PID Sleep Freq	-	0.00	0 - Max. frequency	Hz
APP	39	PID WakeUp Lev	-	35	0 - 100	%

Group	Code number	Function display	Setting display		Setting range	Unit
APP	40	PID WakeUp Mod	0	Below Level	0 - 2	-
APP	42	PID Unit Sel	0	Hz	0 - 12	-
APP	43	PID Unit Gain	-	100.0	0 - 650	%
APP	44	PID Unit Scale	2	X 1	0 - 2	-
APP	45	PID P2-Gain	-	100.0	0 - 1000	%
IN	65 – 75	Px Define	22	I-Term Clear	0 - 48	-
IN	65 - 75	Px Define	23	PID Openloop	0 - 48	-
IN	65 - 75	Px Define	24	P Gain2	0 - 48	-

The PID manipulates the output frequency of the inverter to control the flux, temperature, tension, and other system processes.

APP-01 App Mode (Application mode): When set to No.2 Proc PID, this code sets the functions for the PID process.

APP-16 PID Output: Displays the current output value of the PID controller. The unit, gain, and scale specified in APP-42, APP-43, and APP-44 are applied to the values before they are displayed.

APP-17 PID Ref Value: Displays the reference currently set in the PID controller. The unit, gain, and scale specified in APP-42, APP-43, and APP-44 are applied to the values before they are displayed.

APP-18 PID Fdb Value: Displays the current feedback input for the PID controller. The unit, gain, and scale specified in APP-42, APP-43, and APP-44 are applied to the values before they are displayed.

APP-19 PID Ref Set: If the reference for PID control (APP-20) is set to Keypad (0: Keypad), you can input the reference value in this code. If the reference is any value besides Keypad, it ignores the value specified in APP-19.

APP-20 PID Ref Source: Selects the reference input for PID control (the items in gray will be provided as options in the future). If the V1 terminal is set to PID F/B Source, you cannot set V1 to PID Ref Source. You can change the F/B Source to another item to set V1 to Ref Source.

Setting type		Function	PID F/B Source Availability
0	Keypad	Inputs the PID reference from the inverter keypad.	X
1	V1	The -10 - 10 V voltage input terminal of terminal block	O
2	I1	The 0 - 20 mA current input terminal	O

Setting type		Function	PID F/B Source Availability
		of terminal block	
3	V2	The voltage input terminal of the Ext I/O option card	O
4	I2	The current input terminal of the Ext I/O option card	O
5	Int. 485	The RS485 input terminal of the terminal block	O
6	Encoder	The pulse input of the encoder option card	O
7	FieldBus	The communication command from the communication option card	O
8	PLC	The command from the PLC option card	O
9	Synchro	The command from the synchronous operation option card	O
10	Binary Type	The command from the BCD option card	X

You can display the PID reference in monitor mode and APP-17. You can monitor it using the item defined as No. 17 PID Ref Value in CNF-06 - 08 under Config Mode (CNF).

APP-21 PID F/B Source: Selects the feedback input in PID control. You can select any reference input type except keypad input (Keypad-1, Keypad-2). You cannot set the feedback with the same input as the reference input.

For instance, if you select the No. 1 V1 terminal as the APP-20 Ref Source, then you cannot select V1 as the APP-21 PID F/B Source. You can monitor the feedback flow by selecting No.18 PID Fbk Value in CNF-06 - 08.

APP-22 PID P-Gain, APP-26 P Gain Scale: Defines the output rate for the difference (error) between the reference and the feedback.

If the P gain is set to 50%, then the system outputs 50% of the errors. You can set the P gain within the 0.0 to 1000.0% range. If you need a value lower than 0.1%, then use the P Gain Scale in APP-26.

APP-23 PID I-Time: Sets the time for outputting the accumulated error volume. If the error setting is 100%, set the time for when it reaches a 100% output. If the integral time (PID I-Time) is 1 second, then 100% is outputted 1 second after the error reaches 100%. You can use the integral time to reduce normal errors. Set the function of the multi-function terminal block to No. 21 I-Term Clear, and then turn ON the terminal block. This allows you to delete the accumulated integral volume.

APP-24 PID D-Time: Sets the output volume for the error change rate. If the differential time (PID D-Time) is 1 msec and the rate of change per second is 100%, then 1% is outputted every 10 msec.

APP-25 PID F-Gain: Sets the target volume to the PID output and sets its rate. This can improve response time.

APP-27 PID Out LPF: You can use this code when the PID controller output changes too quickly or the entire system becomes unstable due to severe oscillations. Usually, small values (the default value is 0) increase the response time, but larger values increase the stability. Larger values make the PID controller output more stable, but the response time may increase.

APP-29 PID Limit Hi, APP30 PID Limit Lo: The output limits for the PID controller.

APP-32 PID Out Scale: Adjusts the output of the controller.

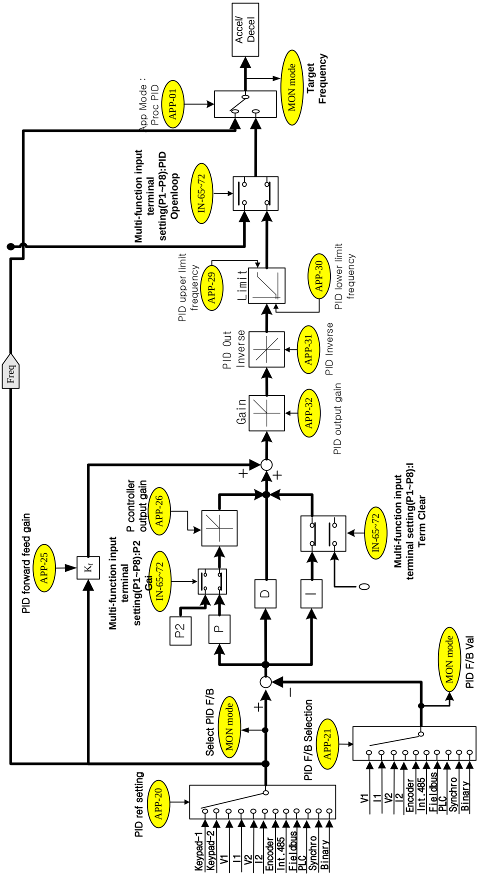
APP-42 PID Unit Sel: Specifies the units for the control volume.

Setting type			Function
0	%	-	Indicates the value as a percentage without a physical quantity.
1	Bar	Pressure	You can select various units of pressure.
2	mBar		
3	Pa		
4	kPa		
5	Hz	Speed	Indicates the inverter output frequency or motor rotation speed.
6	rpm		
7	V	Voltage	Indicates the value in voltage, current, wattage, or horse power.
8	I	Current	
9	kW	Wattage	
10	HP	Horse power	
11	°C	Temperature	Indicates the value in Celsius or Fahrenheit.
12	°F		

APP-43 PID Unit Gain, APP44 PID Unit Scale: Adjust the size to suit the unit selected in APP-42 PID Unit Sel.

APP-45 PID P2-Gain: You can use the multi-function terminal to change the PID controller gain. Setting the function of the terminal block selected in the IN-65 to IN-75 range to No.23 P Gain2 and inputting the selected terminal switches to the gain set in APP-45 instead of the gain set in APP-22 and APP-23.

(2) PID Control Block Diagram



Note
▪ When the PID switching operation (switching from PID operation to general operation) is inputted to the multi-function input (P1 - P11), the percentage values are converted to hertz values before they are outputted. ▪ The polarity of the normal PID output (PID OUT) is unidirectional and limited by APP-29 (PID Limit Hi) and APP-30 (PID Limit Lo). ▪ 100.0% is based on the DRV-20 (maxFreq) value.

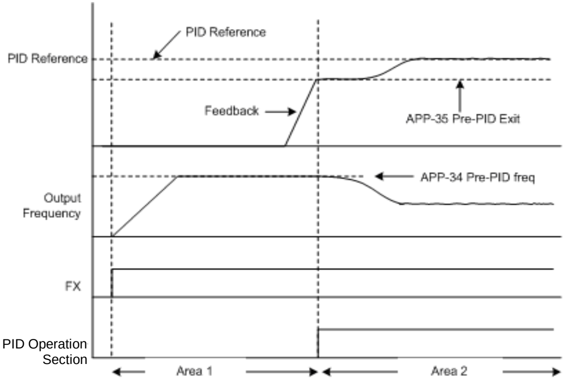
(3) Pre-PID Operation

You can use this function when an operation command is inputted to activate the inverter in general acceleration to set the frequency without starting a PID operation. You can start the PID operation once the control volume increases to a certain level.

APP-34 Pre-PID Freq: This code allows you to input a frequency up to the general acceleration, if you need general acceleration without PID control.

For instance, if you set the Pre-PID Freq to 30 Hz, then you can continue to carry out general operation at 30 Hz until the control volume (PID feedback volume) exceeds the value specified in APP-35.

APP-35 Pre-PID Exit, APP36 Pre-PID Delay: You can start the PID control operation when the feedback volume (control volume) of the PID controller exceeds the value specified in APP-35. If the feedback volume is less than the value specified in APP-35 for the time period specified in APP-36, then a 'Pre-PID Fail' trip occurs and the power is cut off.



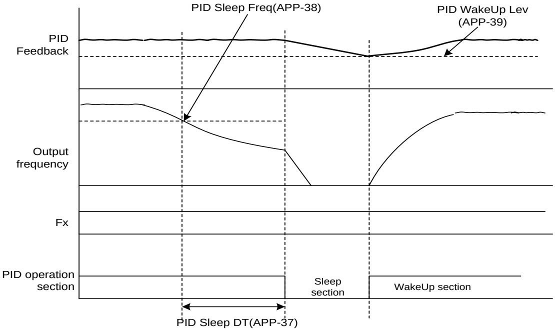
(4) PID Sleep Mode

APP-37 PID Sleep DT, APP-38 PID Sleep Freq: If the inverter operates at a frequency lower than the APP-38 Sleep Frequency for the time period set in APP-37 PID Sleep DT, then the inverter stops operating and enters PID sleep mode. For details about the criteria for switching to PID operation mode from PID sleep mode, refer to the APP-39 PID WakeUp Lev.

APP-39 PID WakeUp Lev, APP40 PID WakeUp Mod: Specifies the criteria for starting PID operation from PID sleep mode, as previously explained.

If you select #0 (Below Level) in APP-40, you can restart PID operation when the feedback volume is less than the value specified in APP-39 (PID WakeUp Lev). If you select #1 (Above Level), you can start the inverter when the volume is more than the value specified in APP-39.

If you select #2 (Beyond Level), you can restart the inverter when the difference between the reference and feedback is more than the value specified in APP-39.



(5) PID Operation Switching (PID Openloop)

When you input a terminal set to No.22 PID Openloop in IN-65 - 75 (Px Define) of the multi-function terminal block, this function stops the PID operation and switches to general operation. If the terminal is OFF, you can restart the PID operation.

5.9 Auto-tuning

You can measure the motor parameters automatically. Moreover, you can connect the encoder option card to the inverter body to test the operating conditions of the encoder. You can use motor parameters (measured by auto-tuning) for auto torque boost, sensorless vector control, vector control, etc.

Ex) Based on a 0.75 kW, 220 V motor

Group	Code number	Function display	Initial settings display		Unit
DRV	14	Motor Capacity	1	0.75	kW
BAS	11	Pole Number	-	4	-
BAS	12	Rated Slip	-	40	rpm
BAS	13	Rated Curr	-	3.6	A
BAS	14	Noload curr	-	1.6	A
BAS	15	Rated Volt	-	220	V
BAS	16	Efficiency	-	72	%
BAS	20	Auto Tuning	0	None	-
BAS	21	Rs	-	26.00	Ω
BAS	22	Lsigma	-	179.4	mH
BAS	23	Ls	-	1544	mH
BAS	24	Tr	-	145	msec
APO	04	Enc Opt Mode	0	None	-

⚠ Caution

Be sure to perform auto-tuning after the motor stops.

Before auto-tuning, input the number of motor poles, rated slip, rated current, rated voltage, and efficiency stated on the motor nameplate. You can use items you do not input as automatic default settings.

Input voltage	Motor capacity (kW)	Rated current (A)	No-load current (A)	Rated slip frequency (Hz)	Stator resistor (Ω)	Leakage inductance (mH)
200	0.2	1.1	0.8	3.33	14.0	40.4
	0.4	2.4	1.4	3.33	6.70	26.9
	0.75	3.4	1.7	3.00	2.600	17.94
	1.5	6.4	2.6	2.67	1.170	9.29
	2.2	8.6	3.3	2.33	0.840	6.63
	3.7	13.8	5.0	2.33	0.500	4.48
	5.5	21.0	7.1	1.50	0.314	3.19
	7.5	28.2	9.3	1.33	0.169	2.844
	11	40.0	12.4	1.00	0.120	1.488
	15	53.6	15.5	1.00	0.084	1.118
	18.5	65.6	19.0	1.00	0.068	0.819
	22	76.8	21.5	1.00	0.056	0.948
	30	104.6	29.3	1.00	0.042	0.711
400	0.2	0.7	0.5	3.33	28.00	121.2
	0.4	1.4	0.8	3.33	14.0	80.8
	0.75	2.0	1.0	3.00	7.81	53.9
	1.5	3.7	1.5	2.67	3.52	27.9
	2.2	5.0	1.9	2.33	2.520	19.95
	3.7	8.0	2.9	2.33	1.500	13.45
	5.5	12.1	4.1	1.50	0.940	9.62
	7.5	16.3	5.4	1.33	0.520	8.53
	11	23.2	7.2	1.00	0.360	4.48
	15	31.0	9.0	1.00	0.250	3.38
	18.5	38.0	11.0	1.00	0.168	2.457
	22	44.5	12.5	1.00	0.168	2.844
	30	60.5	16.9	1.00	0.126	2.133
	37	74.4	20.1	1.00	0.101	1.704
	45	90.3	24.4	1.00	0.084	1.422
	55	106.6	28.8	1.00	0.069	1.167
	75	141.6	35.4	1.00	0.050	0.852
	90	167.6	41.9	1.00	0.039	0.715
	110	203.5	48.8	1.00	0.032	0.585
	132	242.3	58.1	1.00	0.027	0.488
	160	290.5	69.7	1.00	0.022	0.403
	185	335.0	77.0	1.00	0.021	0.380

(1) Motor Parameter Tuning (Rs, Lsigma, Ls, Tr, Noload curr)

BAS-20 Auto Tuning: Selects the type of auto-tuning and performs. Select one of the following items and press the Prog key to immediately perform auto-tuning.

- **0: None**

  Displays the initial auto-tuning items. Indicates when auto-tuning is in progress and when it is complete.

- **1: ALL**

  Select this item to measure the motor parameters as the motor rotates. You can measure parameters such as the stator resistance (Rs), leakage inductance (Lsigma), stator inductance (Ls), no-load current (Noload Curr), rotor time constant (Tr), etc. If the inverter is equipped with an encoder option card, you can also measure the status of the encoder. Make sure that you set the correct functions related to the encoder to measure the status of the encoder.

  If you select vector control as the control mode, then select #1 ALL auto-tuning item. Since the parameters are measured as the motor rotates, connecting a load to the motor shaft may cause the parameters to be incorrectly measured. Therefore, remove any loads on the motor to correctly measure the parameters.

  However, if the Control Mode (DRV-09) is set to Sensorless-2, then the rotor time constant (Tr) is tuned while the motor is stopped.

- **2: ALL (Stdstl)**

  Measures the parameters when the motor is stopped. Select this mode to measure the stator resistance (Rs), leakage inductance (Lsigma), and rotor time constant (Tr) at the same time. You can use this mode when the Control Mode (DRV-09) is Sensorless-2.

- **3: Rs+Lsigma**

  Measures parameters when the motor is stopped. You can use the values measured in auto torque boost and sensorless vector control. Since the motor is not rotating, loads on the motor do not affect the accuracy of the parameter measurement. However, you must ensure that the load does not cause the motor shaft to rotate.

- **4: Enc. Test**

  Connect the encoder option card to the body of the inverter, and then properly connect the encoder lead (attached to the motor) to the option card. As the motor rotates, ensure that the wiring is correct and check the A and B pulses for incorrect wiring. Be sure to properly set the functions related to encoder when measuring the status of the encoder.

- **5: Tr**

  When the Control Mode (DRV-09) is Vector, measure the rotor time constant (Tr) as the motor rotates.

  When the Control Mode (DRV-09) is Sensorless-2, measure the rotor time constant (Tr) when the motor is stopped.

  You must tune the rotor time constant (Tr) again if you change the Control Mode (DRV-09) from Sensorless-2 to Vector.

  BAS-21 Rs - BAS-24 Tr, BAS-14 Noload Curr: Indicates the motor parameters measured during auto-tuning.

  The default auto-tuning settings appear for parameters that are not included in the measurement list.

(2) Measuring the Encoder Connection Status (When Using V/F PG, SENSORED VECTOR)

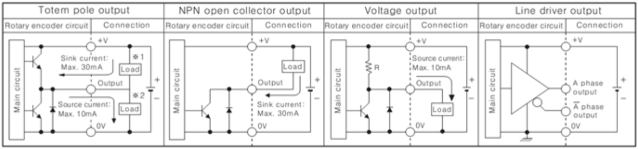
Group	Code number	Function display	Setting display		Setting range	Unit
BAS	20	Auto Tuning	3	Enc Test	0 - 4	-
APO	01	Enc Opt Mode	1	Feed-back	0 - 2	-
APO	04	Enc Type Sel	0	Line Driver	0 - 2	-
APO	05	Enc Pulse Sel	0	(A+B)	0 - 2	-
APO	06	Enc Pulse Num	-	1024	10 - 4096	-
APO	08	Enc Monitor	-	-	-	-

APO-01 Enc Opt Mode: Set this mode to #1 Feedback.

APO-04 Enc Type Sel: Selects how to transmit encoder signals. Set this option according to the specifications included in the Encoder User Manual.

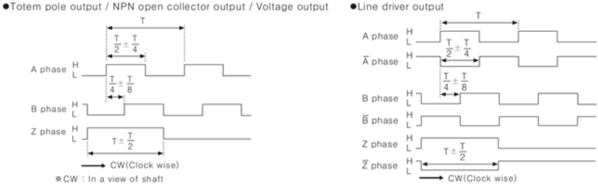
Select Line Driver (0), Totem or Com (1), or Open Collect (2), depending on the specification of the encoder.

■Control output diagram



☞ Totem pole output type can be used for NPN open collector output type(※1) or Voltage output type(※2).
☞ All output circuits are the same A, B, Z phase(Line driver output is A, $\overline{A}$, B, $\overline{B}$, Z, $\overline{Z}$)

■Output waveform



APO-05 Enc Pulse Sel: Sets the direction of the encoder output pulse. You can select #0 (A+B) for the forward operation (FWD) and #2 –(A+B) for the reverse operation (REV). Select #1 to use the encoder output pulse as a reference for the frequency setting.

APO-06 Enc Pulse Num: Specifies the number of output pulses for each revolution.

APO-08 Enc Monitor: Converts the encoder output into motor revolutions and represent it in Hz or rpm.

BAS-20 Auto Tuning: Select the encoder-related options and set #3 Enc Test in auto-tuning to operate the inverter up to 20 Hz in the forward direction. Operate the inverter in the forward direction, and then decelerate it before accelerating it up to 20 Hz in the reverse direction. If the encoder functions properly, the auto-tuning item changes to None. The "Enc reversed" icon appears when there is a fault in the encoder wiring. If this occurs, change the APO-05 Enc Pulse Sel setting or reverse two of the inverter output wires connected to the motor.

5.10 V/F Operation Using the Speed Sensor

Group	Code number	Function display		Setting display	Setting range	Unit
DRV	09	Control Mode	1	V/F PG	0 - 5	-
CON	45	PG P-Gain	-	3000	0 - 9999	-
CON	46	PG I-Gain	-	50	0 - 9999	-
CON	47	PG Slip Max %	-	100	0 - 200	%
APO	01	Enc Opt Mode	1	Feedback	0 - 2	-

Install an encoder option card to improve the speed control precision of the V/F controller. Ensure that the encoder is properly connected before operating the inverter.

DRV-09 Control Mode: Selects the control mode for the #2 V/F PG. #0 V/F control mode adds speed control to inverter operation. The reference for the speed controller becomes the set frequency, and the feedback becomes an encoder input.

CON-45 PG P-Gain, CON-46 PG I-Gain: Specifies the proportional gain (PG P-Gain) and integral gain (PG I-Gain) of the speed controller. A higher proportional gain reduces the response time. However, setting the proportional gain too high may cause the speed controller to function unstably. In contrast to this, a lower integral gain reduces the response time. However, an excessively low integral gain setting may cause the speed controller to function unstably.

CON-47 PG Slip Max %: This code is the reference value (as a percentage) of the rated slip (BAS12: Rated Slip). You can use the value of this code as the maximum compensation slip value. For example, if this function code is 90% and the rated slip (BAS12: Rated Slip) is 30 rpm, then the maximum compensation slip is equal to 30 * 0.9 = 27 rpm.

5.11 Sensorless (I) Vector Control

Group	Code number	Function display	Setting display		Unit
DRV	09	Control Mode	3	Sensorless-1	-
DRV	10	Torque Control	0	No	-
DRV	14	Motor Capacity	x	x.xx	kW
BAS	11	Pole Number	-	4	-
BAS	12	Rated Slip	-	2.00	Hz
BAS	13	Rated Curr	-	3.6	A
BAS	14	Noload curr	-	0.7	A
BAS	15	Rated Volt	-	220	V
BAS	16	Efficiency	-	83	%
BAS	20	Auto Tuning	2	Rs+Lsigma	-
CON	21	ASR-SL P Gain1	-	100.0	%
CON	22	ASR-SL I Gain1	-	200	msec

⚠ **Caution**

For high performance operation, you should measure the parameters of the motor connected to the inverter output.

Use auto-tuning (BAS-20 Auto Tuning) to measure the parameters before initiating Sensorless (I) Vector operation.

The inverter and motor should have the same capacity to achieve high performance in Sensorless (I) Vector control mode.

A motor with a capacity that is two or more levels smaller than the inverter capacity could adversely affect the control characteristics. If this is the case, change the control mode to V/F control mode. Moreover, DO NOT connect multiple motors to the inverter output when operating the inverter in Sensorless (I) Vector control mode.

Before auto-tuning, input the following items as stated on the motor nameplate.

- DRV-14 Motor Capacity (Motor capacity)
- BAS-11 Pole Number (No. of poles)
- BAS-12 Rated Slip (Rated slip)
- BAS-13 Rated Curr (Rated current)
- BAS-15 Rated Volt (Rated voltage)
- BAS-16 Efficiency (Efficiency)

Auto-tuning when the motor is stopped: If it is difficult to remove the load connected to the motor shaft, select #2 Rs+Lsigma as the auto-tuning item (BAS-20 Auto Tuning). Measure the motor parameters when the motor stops. Use the motor no-load current as the basic setting. After performing auto-tuning, the motor stator resistance (Rs) and leakage inductance (Lsigma) values are saved in BAS-21 and BAS-22.

Auto-tuning as the motor rotates: Disconnect the load connected to the motor shaft, and then select #1 All as the auto-tuning item. Selecting this item measures the parameters while the motor rotates. When auto-tuning is complete, you can save the motor stator resistance (Rs), leakage inductance (Lsigma), stator inductance (Ls), and no-load current (Noload Curr) values.

CON-21 ASR-SL P Gain1, CON-22 ASR-SL I Gain1: These codes change the speed controller gain of Sensorless (I) Vector control.

Set the controller gain to meet the default motor parameters and accel/decel time.

⚠ Caution
You can adjust the controller gain to meet the load characteristics. However, the motor may overheat or the system may become unstable due to the controller gain settings.

DRV-10 Torque Control: You can select which speed and torque control modes to use for Sensorless (I) Vector control. Set torque control (DRV-10) to Yes to operate the inverter in torque control mode. For more details on torque control mode, see section 5.14 Torque Control.

⚠ Caution
Select Control. In torque control mode, DO NOT switch the forward rotation command to a reverse rotation command or vice versa while operating the inverter. This can cause an overcurrent trip or reverse deceleration error. Select Speed Search for sensorless vector control if the inverter starts during a motor free-run. (CON-71 Speed Search = Speed search setting during acceleration (0001))

5.12 Sensorless (II) Vector Control

Group	Code number	Function display	Setting display		Unit
DRV	09	Control Mode	3	Sensorless-2	-
DRV	10	Torque Control	0	No	-
DRV	14	Motor Capacity	x	Varies depending on the motor capacity.	kW
BAS	11	Pole Number	-	4	-
BAS	12	Rated Slip	-	Varies depending on the motor capacity.	Hz
BAS	13	Rated Curr	-	Varies depending on the motor capacity.	A
BAS	14	Noload curr	-	Varies depending on the motor capacity.	A
BAS	15	Rated Volt	-	220/380/440/480	V
BAS	16	Efficiency	-	Varies depending on the motor capacity.	%
BAS	20	Auto Tuning	2	Rs+Lsigma	-
CON	20	SL2 G View Sel	1	Yes	-
CON	21	ASR-SL P Gain1	-	Varies depending on the motor capacity.	%
CON	22	ASR-SL I Gain1	-	Varies depending on the motor capacity.	msec
CON	23	ASR-SL P Gain2	-	Varies depending on the motor capacity.	%
CON	24	ASR-SL I Gain2	-	Varies depending on the motor capacity.	%
CON	26	Observer Gain1	-	10500	-
CON	27	Observer Gain2	-	100.0	%
CON	28	Observer Gain3	-	13000	-
CON	29	S-Est P Gain 1	-	Varies depending on the motor capacity.	-
CON	30	S-Est I Gain 1	-	Varies depending on the motor capacity.	-
CON	31	S-Est P Gain 2	-	Varies depending on the motor capacity.	%
CON	32	S-Est I Gain 2	-	Varies depending on the motor capacity.	%
CON	48	ACR P-Gain	-	1200	-
CON	49	ACR I-Gain	-	120	-

⚠ Caution

For high performance operation, you should measure the parameters of the motor connected to the inverter output.

Use auto-tuning (BAS-20 Auto Tuning) to measure the parameters before initiating Sensorless (II) Vector operation.

The inverter and motor must have the same capacity to achieve high performance in Sensorless (II) Vector control mode. A motor with a capacity that is two or more levels smaller than the inverter capacity could adversely affect the control characteristics. If this is the case, change the control mode to V/F control mode. Moreover, DO NOT connect multiple motors to the inverter output when operating the inverter in Sensorless (II) Vector control mode.

Before performing auto-tuning, input the following items as stated on the motor nameplate.

- DRV-14 Motor Capacity (Motor capacity)
- BAS-11 Pole Number (No. of poles)
- BAS-12 Rated Slip (Rated slip)
- BAS-13 Rated Curr (Rated current)
- BAS-15 Rated Volt (Rated voltage)
- BAS-16 Efficiency (Efficiency)

Disconnect the load connected to the motor shaft, and then select #1 All as the auto-tuning item. Selecting this item measures the parameters as the motor rotates. When auto-tuning is complete, ensure that the stator resistance (Rs), leakage inductance (Lsigma), stator inductance (Ls), no-load current (Noload Curr), and rotor time constant (Tr) values of the motor are automatically saved in BAS-21, BAS-22, BAS-23, BAS-14, and BAS-24, respectively.

CON-20 SL2 G View Sel: Select Yes for #1 to set the various gains (e.g. CON-23 ASR-SL P Gain2, CON-24 ASR-SL I Gain2, CON-27 Observer Gain2, CON-28 Observer Gain3, CON-31 S-Est P Gain2, CON-32 S-Est I Gain2, etc) that are applied when the motor rotates at moderate or high speeds (ca. 1/2 of base frequency) under Sensorless (II) Vector control. These parameters do not appear if you select #0.

(1) Speed Controller Gain

CON-21 ASR-SL P Gain1, CON-22 ASR-SL I Gain1: These codes change the speed PI controller gain in Sensorless (II) Vector control. For the PI speed controller, the speed controller P gain is the proportional gain for speed errors. As the speed error becomes larger, the torque output command become larger. Therefore, the larger the value is, the faster the speed deviation decreases.

The speed controller I gain is the integral gain for speed errors. It is the time (in msec) until the gain becomes the rated torque output command when the constant speed error continues. The smaller the value is, the faster the speed deviation decreases. The speed controller gain can improve the speed control waveform while monitoring the changes in the speed. If the speed deviation does not decrease quickly, increase the speed controller P gain or decrease the I gain (time in msec). However, setting the P gain too high or the I gain too low can cause severe vibrations. If oscillations occurs in the speed waveform, try to increase the I gain (time in msec) or P gain.

CON-23 ASR-SL P Gain2, CON-24 ASR-SL I Gain2: These only appear when you select No.1 Yes for SL2 G View Sel (CON-20). They change the gain of the speed controller at moderate or high speeds (ca. 1/2 of base frequency) when controlling the Sensorless (II) Vector.

You can set CON-23 ASR-SL P Gain2, as a percentage, to the low speed gain CON-23 ASR-SL P Gain1. This causes the responsiveness to decrease if P Gain 2 falls below 100.0%. For example, if CON-23 ASR-SL P Gain1 is 50.0% and CON-23 ASR-SL P Gain2 is 50.0%, then the speed controller P gain for moderate or high speeds is 25.0%.

You can also set CON-24 ASR-SL I Gain2 as a percentage of CON-24 ASR-SL I Gain1. For I gain, the smaller I gain 2 is, the slower the response time is. For example, if CON-23 ASR-SL I Gain1 is 100 msec and CON-23 ASR-SL I Gain2 is 50.0%, then the speed controller I gain for moderate or high speeds is 200 msec. Set the controller gain to meet the default motor parameters and accel/decel time.

(2) Observer Controller Gain of the Magnetic Flux

CON-26 Observer Gain1, CON27 Observer Gain2, CON-28 Observer Gain3: For Sensorless (II) Vector control, you must use an observer to estimate the stator current and rotor magnetic flux of the motor. Observer Gain1 (CON-26) applies to the low-middle speed zone. Observer Gain2 (CON-27) and Observer Gain3 (CON-28) apply to the middle-high speed zone and torque mode, respectively. DO NOT change the default settings for the observer gains unless otherwise authorized.

Observer Gain2 (CON-27) and Observer Gain3 (CON-28) only appear when you select #1 Yes in SL2 G View Sel (CON-20).

(3) Speed Estimator Controller Gain

CON-29 S-Est P Gain1, CON30 S-Est I Gain1: These change the speed estimator gain for Sensorless (II) Vector control. When the speed indication does not fit the target value for the normal status, you can increase or decrease the speed estimator P gain or I gain. Moreover, you can adjust these gains if severe vibrations or current ripples occur in the motor when a load is applied. Test the effects of reducing the speed estimator P gain or I gain. The speed estimator gain setting is set to meet the default motor parameters and accel/decel time.

CON-31 S-Est P Gain2, CON-32 S-Est I Gain2: These only appear when you select No.1 Yes for SL2 G View Sel (CON-20). They change the gain of the speed estimator at moderate or high speeds (ca. 1/2 of base frequency) when controlling the Sensorless (II) Vector.

You can set CON-31 S-Est P Gain2 and CON32 S-Est I Gain2 as a percentage (%) of low speed gains CON-29 S-Est P Gain1 and CON-30 S-Est I Gain1, respectively. For example, when CON-29 S-Est P Gain1 is 300 and CON-31 S-Est P Gain2 is 40.0%, the speed estimator P gain at middle or high speeds is equal to 120. You can set this P Gain1 in the same manner as the low-middle speed gain. The speed estimator gain setting must meet the default motor parameters and accel/decel time.

CON-34 SL2 OVM Perc: The overmodulation zone does not appear when the ratio of the output voltage to the input voltage is less than 100%, so the output voltage has a linear relation to the input voltage. CON34 (SL2 OVM Perc) sets the voltage range. This range is limited by the overmodulation zone of Sensorless-2.

The factory default setting of this code is 120%, but you can specify a higher value for CON34 (SL2 OVM Perc) if you use a mechanical unit that operates with a very high level of reverse load (torque limit < load level) or strikes and retracts, like an impact load (press, etc), to operate the inverter with load applied without causing a trip.

Moreover, areas with poor input voltages primarily have lower input voltages than the nominal voltage, so an OC1 trip occurs more frequently when you apply a very high reverse load (torque limit < load level), such as an impact load. This can also occur due to insufficient output voltages. You can operate the inverter without a trip at very high loads by setting CON34 (SL2 OVM Perc) to as high as 140-150%.

CON-48 ACR P-Gain, CON49 ACR I Gain: Adjusts the P gain and I gain of current PI controller.

DRV-10 Torque Control: You can select which speed and torque control modes to use in Sensorless (II) Vector control mode. Set torque control (DRV-10) to Yes to switch to operate the inverter in torque control mode. For more details on torque control mode, see section 5.14 Torque Control.

⚠ Caution
You can adjust the controller gain to meet the load characteristics. However, the motor may overheat or the system may become unstable due to the controller gain settings.

Adjusting the various gains in Sensorless (II) Vector control mode: The motor and load characteristics greatly affect Sensorless (II) Vector control, so you need to adjust the gains of the controller to suit the application. Suppose that Sensorless (II) Vector control operates in speed mode (DRV-10 torque control is set to #0 No).

First, if the inverter operates unstably at extremely low speeds (below 2-3 Hz) or speed shakes occur at startup, double the factory default setting of CON-22 ASR-SL I Gain1 and adjust the gain value to the proper level.

Secondly, sites that primarily use a regenerative load may produce torque ripples in the motor when the regenerative load is applied. If this occurs, reduce CON-21 ASR-SL P Gain1 to as low as 50% of the factory default setting and adjust the gain value to the proper level.

If the torque ripple does not disappear, restore CON-21 ASR-SL P Gain1 to its factory default settings and reduce CON-30 S-Est I Gain 1 to as much as 50% of its factory default setting and adjust the gain value to the proper level.

5.13 Vector Control

Install the encoder option card in the inverter body and operate the motor at a highly accurate speed and in a vector control mode where you can control the torque.

Group	Code number	Function display	Initial settings display		Unit
DRV	09	Control Mode	4	Vector	-
DRV	21	Hz / rpm Sel	1	Rpm Display	-
BAS	20	Auto Tuning	1	Yes	-
CON	09	PreExTime	-	1.0	Sec
CON	10	Flux Force	-	100.0	%
CON	11	Hold Time	-	1.0	Sec
CON	12	ASR P Gain 1	-	50.0	%
CON	13	ASR I Gain 1	-	300	msec
CON	15	ASR P Gain 2	-	50.0	%
CON	16	ASR I Gain 2	-	300	msec
CON	18	Gain Sw Freq	-	0.00	Hz
CON	19	Gain Sw Delay	-	0.10	Sec
CON	51	ASR Ref LPF	-	0	msec
CON	52	Torque Out LPF	-	0	msec
CON	53	Torque Lmt Src	0	Keypad-1	-
CON	54	FWD +Trq Lmt	-	180	%
CON	55	FWD –Trq Lmt	-	180	%
CON	56	REV +Trq Lmt	-	180	%
CON	57	REV –Trq Lmt	-	180	%
CON	58	Trq Bias Src	0	Keypad-1	-
CON	59	Torque Bias	-	0.0	%
CON	60	Trq BiasFF	-	0.0	%
IN	65 - 75	Px Define	36	Asr Gain 2	-
IN	65 - 75	Px Define	37	ASR P/PI	-

⚠ Caution

For high performance operation in vector control mode, you must input the correct data for the related functions, such as the motor parameter measurements and the encoder. Perform the following setting procedure before starting operation in vector control mode. The inverter and motor must have the same capacity to achieve high performance in vector control mode. A motor with a capacity that is two or more levels smaller than the inverter capacity could adversely affect the control characteristics. If this is the case, change the control mode to V/F control mode. Moreover, DO NOT connect multiple motors to the inverter output when operating the inverter in vector control mode.

(1) Items to Check Before Operation

Disconnect any loads connected to the motor shaft. Input the motor parameters: Input the values for the following items stated on the motor nameplate:

- DRV-14 Motor Capacity (Motor capacity)
- BAS-11 Pole Number (No. of poles)
- BAS-12 Rated Slip (Rated slip)
- BAS-13 Rated Curr (Rated current)
- BAS-15 Rated Volt (Rated voltage)
- BAS-16 Efficiency (Efficiency)

(2) Encoder Option Card Checklist

Set the encoder option mode (APO-01) to No. 1 Feedback. Then, provide the following information to meet the specifications of the encoder.

APO-04 Enc Type Sel: Selects how to transmit encoder signals. Set this option according to the specifications included in the Encoder User Manual. Select Line Driver (0), Totem or Com (1), or Open Collect (2), depending on the specification of the encoder.

APO-05 Enc Pulse Sel: Sets the direction of the encoder output pulse. You can select #0 (A+B) for the forward operation (FWD) and #2 –(A+B) for the reverse operation (REV). Select #1 to use the encoder output pulse as a reference for the frequency setting.

APO-06 Enc Pulse Num: Inputs the number of output pulses for each revolution.

Group	Code number	Function display	Setting display		Setting range	Unit
BAS	20	Auto Tuning	3	Enc Test	0 - 4	-
APO	01	Enc Opt Mode	1	Feed-back	0 - 2	-
APO	04	Enc Type Sel	0	Line Driver	0 - 2	-
APO	05	Enc Pulse Sel	0	(A+B)	0 - 2	-

Group	Code number	Function display	Setting display		Setting range	Unit
APO	06	Enc Pulse Num	-	1024	10 - 4096	-
APO	08	Enc Monitor	-	-	-	-

APO-01 Enc Opt Mode: Set this mode to #1 Feedback.

APO-04 Enc Type Sel: Selects how to transmit encoder signals. Set this option according to the specifications included in the Encoder User Manual. Select an option, such as Line Driver (0), Totem or Com (1) and Open Collect (2).

APO-05 Enc Pulse Sel: Sets the direction of the encoder output pulse. You can select #0 (A+B) for the forward operation (FWD) and #2 –(A+B) for the reverse operation (REV). Select #1 to use the encoder output pulse as a reference for the frequency setting.

APO-06 Enc Pulse Num: Specifies the number of output pulses for each revolution.

APO-08 Enc Monitor: Converts the encoder output into motor revolutions and represent it in Hz or rpm.

BAS-20 Auto Tuning: Select the encoder-related options and set #3 Enc Test in auto-tuning to operate the inverter up to 20 Hz in the forward direction. Operate the inverter in the forward direction, and then decelerate it before accelerating it up to 20 Hz in the reverse direction. If the encoder functions properly, the auto-tuning item changes to None. The "Enc reversed" icon appears if there is a fault in the encoder wiring. If this occurs, change the APO-05 Enc Pulse Sel setting or reverse two of the inverter output wires connected to the motor.

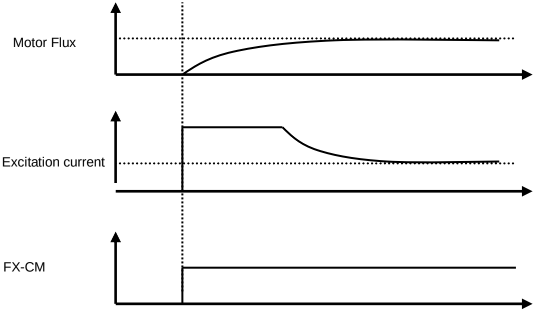
(3) Auto-Tuning

Select No. 1 ALL in auto-tuning (BAS-20).

(4) Initial Excitation

CON-09 PreExTime: Sets the initial excitation time. You can start operation after performing excitation up to the rated flux of the motor.

CON-10 Flux Force: You can reduce the initial excitation time. The motor flux increases up to the rated flux and the time remains constant, as in the following figure. Therefore, in order to reduce the time that it takes to reach the rated flux, apply a higher motor flux base value than the rated flux and reduce the applied motor flux base value when the magnetic flux reaches the rated flux.



(5) Gain Setting

CON-12 ASR P Gain 1, CON-13 ASR I Gain 1: Sets the proportional gain and integral gain of the speed controller (ASR).

A higher proportional gain increases the response rate of the controller, so it is applied to large loads. However, an excessively high gain may cause the motor to oscillate at speed. A lower integral gain setting increases the response rate. However, an excessively low gain may cause the motor to oscillate at speed.

CON-15 ASR P Gain 2, CON-16 ASR I Gain 2: You can use a separate control gain, depending on the motor RPM, to meet the requirements of the load system. The gain of the speed controller varies depending on the gain switching frequency (CON-18) and switching time (CON-19) settings.

CON-51 ASR Ref LPF: Available in vector speed mode. This adjusts the filter time constant of the speed controller reference input.

CON-52 Torque Out LPF: Available in vector speed mode or vector torque mode. In vector speed mode, you can use this code to adjust the filter time constant of the speed controller output. In vector torque mode, you can use this code to adjust the filter time constant of the torque command.

CON-48 ACR P-Gain, CON-49 ACR I Gain: Available in sensorless speed/torque, vector speed/torque mode. Adjusts the P gain and I gain of the current PI controller.

IN-65 - 75 Px Define

36: ASR Gain2

When the preset terminal is inputted, you can switch gains after the switching time (CON-19).

37: ASR P/PI

Operates while the inverter is stopped. The integral controller does not operate when the preset terminal is inputted.

(6) Torque Limit

Limit the speed controller power to adjust the size of torque reference. You can set the reverse and regeneration limits for positive/negative direction operations, as shown in the following figure.

CON-53 Torque Lmt Src: Selects the input type for the torque limit. You can use the keypad, terminal block analog input (V1 and I1), or communication options to set the torque limit.

- **0: Keypad-1, 1: Keypad-2**

  Use the keypad to set torque limits. You can set the limit to be up to 200%, depending on the rated torque of the motor. The following codes set the direction of rotation and reverse/regeneration limits.

  CON-33 FWD +Trq Lmt: Positive direction reverse (motoring) operation torque limit

  CON-34 FWD –Trq Lmt: Positive regeneration operation torque limit

  CON-35 REV +Trq Lmt: Negative direction reverse operation torque limit

  CON-36 REV –Trq Lmt: Negative direction regeneration operation torque limit

- **2: V1, 3: I1**

  Use the inverter terminal block's analog input terminal to set the torque limit. Use IN-02 Torque at 100% of the item to set the max. torque. For example, if IN-02 is 200% and you use the voltage input (V1), then the torque limit is 200% when 10 V is inputted.

  However, when using the factory default settings for the V1 terminal, check the settings in monitor mode if the torque limit setting uses a method other than the keypad. In Config Mode CNF-06 - 08, select No.20 Torque Limit.

- **3: Int 485**

  Use the terminal block's communication terminal to set the torque limit.

(7) Setting the Torque Bias

CON-58 Trq Bias Src: Selects the offset value to add to the torque reference.

- **0: Keypad-1, 1: Keypad-2**

  Input the keypad-aided setting in CON-38 Torque Bias. You can set this code to be up to 120%, depending on the rated current of the motor.

- **2: V1, 3: I1, 6: Int 485**

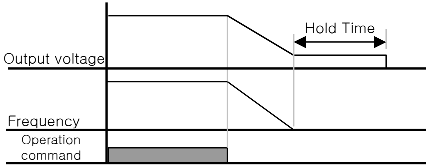
  You can set this code in the same manner as the torque reference setting previously described. You can see the setting in monitor (MON) mode. Select #21 Torque Bias in CFG06 - 08, which are the Config (CFG) mode items.

IN-65 - 75 Px Define: If the multi-function input is set to #48 Trq Bias and the multi-function input is not ON, then the system ignores any Torque Bias value entered via the keypad, analog, or communication inputs.

CON-60 Trq BiasFF: Depending on the rotational direction of the motor, you can add this code to the torque bias level to compensate for any losses. When you input a negative (-) value, the torque bias level decreases by the set amount.

Zero-speed control when the inverter stops: Hold Time

CON-11 Hold Time: Performs a zero-speed operation for the amount of time specified after a stop command decelerates and stops the motor. This cuts off the output flow after the time elapses.



5.14 Torque Control (Controlling the Torque)

Torque control refers to controlling the motor to ensure that the torque output matches the torque command. The motor RPM remains constant when the motor output torque is balanced with the motor load torque. Thus the motor RPM depends on the load for torque control.

To control the torque, the motor RPM increases when the output torque of the motor exceeds the amount required for the load on the motor.In order to avoid this, you must set the speed limit to prevent the motor RPM from increasing excessively. (Speed control is enabled during speed limit operation, so you cannot control the motor torque.)

(1) Setting Torque Control

Ensure that the DRV-09 Control Mode is set to Sensorless 1, 2, or Vector to activate torque control.

- **DRV-09 Control Mode:** Set the control mode to No. 3, 4 Sensorless 1, 2, or No. 5 Vector.
- **DRV-10 Torque Control:** Set the torque control to No. 1 Yes.

Group	Code number	Function display	Setting display		Unit
DRV	02	Cmd Torque	-	0.0	%
DRV	08	Trq Ref Src	0	Keypad-1	-
DRV	09	Control Mode	5	Vector	-
DRV	10	Torque Control	1	Yes	-
BAS	20	Auto Tuning	1	Yes	-
CON	62	Speed Lmt Src	0	Keypad-1	-
CON	63	FWD Speed Lmt	-	60.00	Hz
CON	64	REV Speed Lmt	-	60.00	Hz
CON	65	Speed Lmt Gain	-	100	%
IN	65 - 75	Px Define	35	Speed/Torque	-
OUT	31 - 33	Relay x or Q1	27	Torque Dect	-
OUT	59	TD Level	-	100	%
OUT	60	TD Band	-	5.0	%

⚠ **Caution**

In order to operate inverter in torque control mode, you must make sure that the basic operating conditions are set as explained in the Sensorless Vector mode or Vector Control mode sections.You cannot control the motor torque in the slow speed regeneration zone or at slow speeds with a small load. Select the Vector Control mode.

In torque control mode, DO NOT switch the forward rotation command to a reverse rotation command or vice versa while operating the inverter. This can cause an

⚠ Caution
overcurrent trip or reverse deceleration error. Select Speed Search for sensorless vector control if you want the inverter to start during a motor free-run. (CON-71 Speed Search = Speed search setting during acceleration (0001))

(2) Setting the Torque Reference

You can set the torque reference in the same manner as the frequency reference. Selecting torque control mode deactivates the frequency reference.

DRV-08 Trq Ref Src: Selects the torque reference type.

- **0: Keypad-1, 1: keypad-2**

  Use the keypad to input the torque reference value. CON-02 Cmd Torque sets the torque command. Depending on the rated torque of the motor, you can set it up to 180%.

- **2: V1, 3: I1**

  You can use the voltage (V1) or current (I1) terminal block of the inverter to input the torque reference. Use the IN-02 Torque at 100% item to set the maximum torque. For example, if you set IN-02 to 200% and use the current input (V1) to set the torque reference, then the torque limit is 200% at a 20 mA input current (when the function of the I1 terminal is set to the factory default setting). You can see the setting in monitor (MON) mode. Select #19 Torque Ref in CFG codes 06 - 08, which are the codes that set Config (CFG) mode options.

- **6: Int 485**

  Use the inverter terminal block's communication terminal to set the torque limit.

(3) Speed Limit

When operating the inverter in torque control mode, different load conditions may cause it to operate faster than the maximum speed. Therefore, you must use the speed limit function to avoid such speed divergences.

CON-62 Speed Lmt Src: Selects the method for setting the speed limit value.

0: Keypad-1, 1: keypad-2

Use the keypad to set the speed limit value. Set the forward speed limit value in CON-41 FWD Speed Lmt and set the reverse speed limit value in CON-42 REV Speed Lmt.

2: V1, 3: I1, 6: Int 485

Operates in the same way as the frequency command setting. You can see the setting in monitor (MON) mode. Select #21 Torque Bias in CFG codes 06 - 08, which are the codes that set the Config (CFG) mode option.

CON-65 Speed Lmt Gain: If the motor speed exceeds the set speed limit, set the reduction ratio of the torque reference.

Select No. 35 Speed/Torque as the function of the multi-function input terminal, and then input it while the inverter is stopped. This allows you to shift from torque control mode to vector control (speed control) mode to operate the inverter.

5.15 Droop Control

When you use multiple motors to drive a single load, you can use Droop Control to balance the load or prevent speed controller saturation in vector control or equivalent modes.

Group	Code number	Function display	Initial settings display		Unit
CON	66	Droop Perc	-	0.0	%
CON	67	Droop St Torque	-	100.0	%

CON-66 Droop Perc: Sets the ratio of the speed command to the rated torque of motor.

CON-67 Droop St Torque: Specifies the torque at which to start the Droop Control function. These values allow you to control the motor speed based on the load torque. This function uses the following equation.

$$Droop\ speed = Maximum\ frequency \times DroopPerc \times \frac{Torque\ reference - DroopStTorque}{100\%\ torque - DroopStTorque}$$

5.16 Speed/Torque Switchover

This function only operates in Vector Control mode. You can use this function to shift from speed mode to torque mode or vice versa with the multi-function input while operating the inverter.

Group	Code number	Function display	Initial settings display		Unit
CON	68	SPD/TRQ Acc T	-	20.0	Sec
CON	69	SPD/TRQ Dec T	-	30.0	Sec
IN	65 - 75	Px Define	35	Speed/Torque	-

While operating the inverter in vector torque mode (DRV09: Vector, DRV10: Yes), turn ON the multi-function input set to Speed/Torque. This switches from the current mode to vector speed mode. The mode changes based on the accel/decel time set in CON codes 50 and 51.

While operating the inverter in vector speed mode (DRV09: Vector, DRV10: No), turn ON the multi-function input set to Speed/Torque. This switches from the current mode to vector torque mode.

5.17 Kinetic Energy Buffering

If the input power fails, the voltage of the inverter DC power decreases and the low voltage trip cuts off the power output. During a power failure, the system controls the inverter power frequency and maintains the voltage level in the DC power unit. Therefore, the system can keep functioning during momentary power interruptions because they do not cause a low voltage trip.

Group	Code number	Function display	Setting display		Unit
CON	77	KEB Select	1	Yes	-
CON	78	KEB Start Lev	-	130	%
CON	79	KEB Stop Lev	-	135	%
CON	80	KEB Gain	-	1000	-

CON-77 KEB Select: Selects the energy buffering operation for when the input power is cut off. If you select No.0 Continue, the system performs a general deceleration operation until a low voltage failure occurs. If you select No.1 KEB Select, the system controls the inverter power frequency and sends the regeneration energy from the motor to charge the DC unit of the inverter.

CON-78 KEB Start Lev, CON-79 KEB Stop Lev: These set the start and stop point for the energy buffering operation. Set the low voltage level based on 100% so that the stop level (CON-79) is higher than the start level (CON-78).

CON-80 KEB Gain: Specifies the gain that uses the load-side moment of inertia quantity to control the energy buffering operation. If the load inertia is large, use the lower gain value. Use a higher gain value for smaller load inertia values.

If the motor vibrates severely when the input power cuts off and the KEB function operates, set the gain (CON-80: KEB Gain) to half of its previous value. But lowering the gain too much can cause a low voltage trip during the energy buffering operation (KEB).

⚠ Caution

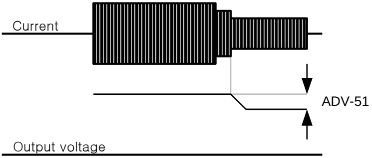
- A low voltage trip may occur during the deceleration phase of the energy buffering operation due to a momentary power interruption or the load inertia.
- During the energy buffering operation, the motor may vibrate under loads other than the variable torque load (load from the fans and pumps).

5.18 Energy Saving Operation

■ Manual Energy Saving Operation

Group	Code number	Function display	Setting display		Unit
ADV	50	E-Save Mode	1	Manual	-
ADV	51	Energy Save	-	30	%

If the inverter output current is less than the current set in BAS-14 Noload Curr (motor no-load current), then the output voltage is reduced by the amount set in ADV-51. The voltage before the energy saving operation starts becomes the base value, as a percentage. The energy saving operation does not work during acceleration and deceleration.



■ Automatic Energy Saving Operation

Group	Code number	Function display	Setting display		Unit
ADV	50	E-Save Mode	2	Auto	-

The system automatically calculates the amount of energy savings based on the rated current of the motor (BAS-13) and the no-load current (BAS-14), and then it adjust the output voltage accordingly.

⚠ Caution
If the operation frequency changes or acceleration/deceleration is initiated by a stop command or other command during the energy saving operation, the Acc/Dec time may be longer than the specified Acc/Dec time due to the time required to return to normal operation from the energy saving operation.

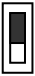
5.19 Speed Search Operation

This function prevents situations that could happen when the inverter is provided with the output voltage while the inverter output voltage is cut off and the motor is idling. This determines the rotation speed of motor based on the output current of the inverter, without measuring the actual speed.

Group	Code number	Function display	Initial settings display			Unit
CON	71	Speed Search	-	0000		Bit
CON	72	SS Sup-Current	-	Less than 75 kW	150	%
				More than 90 kW	100	
CON	73	SS P-Gain	-	100		-
CON	74	SS I-Gain	-	200		-
CON	75	SS Block Time	-	1.0		Sec
OUT	31~32	Relay 1, 2	19	Speed Search		-
OUT	33	Q1 Define				

CON-71 Speed Search: Selects one of the following types of speed searches. If the point of the switch appears at the top, the bit is set. If the point appears at the bottom, no bit is set.

Bit setting status (On):



Bit setting off state (Off):

Setting type				Function
Bit 4	Bit 3	Bit 2	Bit 1	The right side of the display is bit 1.
			✓	Select speed search for acceleration
		✓		When starting on a reset after a trip occurs.
	✓			When restarting after a momentary power interruption.
✓				When starting at the same time as the power is input.

(1) Select Speed Search for Acceleration

If bit 1 is set to 1 and an inverter operation command is inputted, then the acceleration starts with the speed search operation. A trip can occur if the motor is rotating due to the load when the operation command is input into the inverter for voltage output. This can also cause stress on the motor. If this is the case, you can use the search function to accelerate the inverter without causing a trip.

⚠ Caution
When operating the inverter in Sensorless II mode for the starting load during a free run cycle, select speed search for acceleration to assure good operation. Failure to do so may cause an overcurrent trip or overload trip.

(2) Starting on Reset after a Trip Occurs

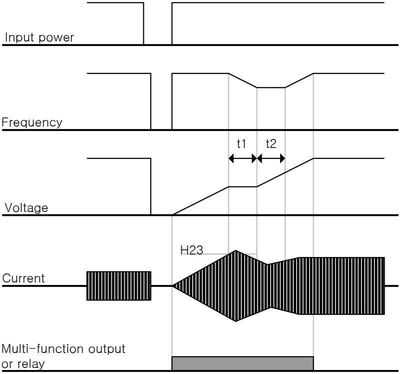
If you set Bit 2 to 1 and set PRT-08 RST Restart to Yes, then you can use the speed search operation to accelerate the inverter up to a certain frequency before a trip occurs when you input the reset key (or terminal block reset) after a trip occurs.

(3) Restarting after a Momentary Power Interruption

If the power returns before the power in the inverter runs out after the inverter input power is cut off and a low voltage trip occurs, then the system accelerates up to the frequency before the trip using the speed search operation.

Set Start Bit 4 to 1 at the same time as the power is input and set ADV-10 Power-on Run to Yes. If the inverter operation command is on and the inverter input power is inputted, then the system accelerates up to the target frequency using the speed search operation.

Ex) A speed search operation after the power returns from a momentary power interruption



Note

- If a momentary power interruption occurs and the input power is cut off, then the inverter generates a low voltage trip (Lvt) to block the output.
- When the input power returns, the inverter inner PI control outputs the frequency before the low voltage trip to increase the voltage.
- t1: If the current increases above the amount specified in ADV-61, then the voltage stops increasing and the frequency decreases.
- t2: If the current falls below the amount specified in ADV-61, then the voltage increases again and the frequency stops the deceleration.
- If the normal frequency and voltage are recovered, acceleration is carried out with the frequency before trip.

ADV-61 SS Sup-Current: Controls the current during the speed search operation based on the rated current of the motor.

You can set the gain of the controller in ADV-62 and 63.

ADV-64 SS Block Time: Starts operation after the output is cut off for a preset amount of time and before starting the speed search operation. The speed search operation is meant mainly for large-inertia loads. We recommend restarting after stopping for a load with high frictional force.

The iS7 series inverter is designed to operate normally in power interruptions of 15 msec or less, if used within the rated output. If the voltage input to the inverter is 200 - 230 Vac for an inverter with a 200 V level input voltage or 380 - 460 Vac for an inverter with a 400 V level input voltage, then the system is protected against momentary power interruption and the current is based on the constant torque load current (CT load).

The DC voltage inside the inverter may change based on the output load. Therefore, a low voltage trip may occur if the momentary power interruption time is 15 msec or more or the output exceeds the rated voltage.

5.20 Automatic Restart Operation

■ Automatic Restart Operation

Group	Code number	Function display	Initial setting range	Initial value	Unit
PRT	08	RST Restart	0: No/Yes(1)	0: NO	-
PRT	09	Retry Number	0 - 10	0	-
PRT	10	Retry Delay	0 - 60.0	1.0	Sec
CON	71 - 75	SS-related function	-	-	-

You can use this function to prevent the system from stopping when the inverter's protection function is activated due to noise or a similar cause.

PRT-08 RST Restart, PRT-09 Retry Number, PRT-10 Retry Delay: Operates only when PRT-08 RST Restart is set to YES. PRT-09 sets the number of automatic restarts. If a trip occurs during operation, the inverter performs the automatic restart operation after the time set in PRT-10 Retry Delay. The number of restarts decreases by 1 every time an automatic restart is executed. When it becomes zero, the system cannot execute an automatic restart if a trip occurs.

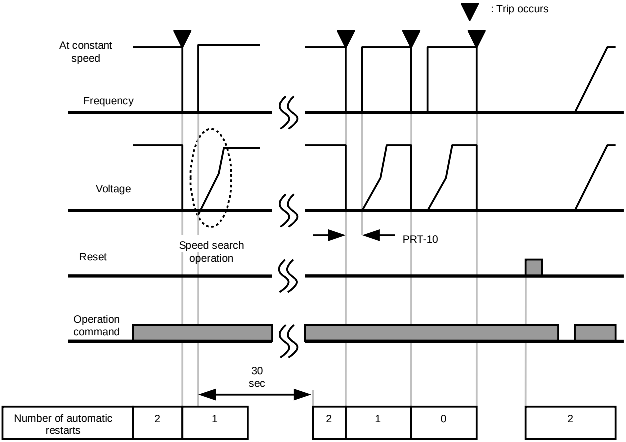
If a trip does not occur within 60 seconds of the automatic restart, then the number of automatic restarts returns to the previous level set in the inverter. The maximum number is limited to the number of restarts.

An automatic restart is not executed if the inverter stops due to a low voltage, emergency stop (Bx), inverter overheat, or hardware error (HW Diag).

The acceleration operation at automatic restart has the same characteristics as the speed search operation. Therefore, you can set the functions of CON 72-75 based on the load. For more details on the speed search function, refer to page 8-36.

⚠ Caution
If the number of automatic restart is set, the inverter reset function is disabled and the motor rotates freely after a trip occurs.

The following figure shows a case when the number of automatic restarts is set to 2.



5.21 Operation Sound Selection

Group	Code number	Function display	Setting display		Range	Unit
CON	04	Carrier Freq	-	5.0	0.7 - 15 kHz	kHz
CON	05	PWM Mode	1	Normal PWM	Normal PWM /Low Leakage PWM	-

CON-04 Carrier Freq: Selects the operation sound generated by the motor. The power device (IGBT) in the inverter generates the high frequency switching voltage and applies it to the motor. This high frequency is also called the 'carrier frequency.' If the carrier frequency is high, the operation sound decreases. If it is low, the motor operation sound increases.

CON-05 PWM Mode: Reduces the heat loss and leakage current generated in the inverter based on the load. When you select Low Leakage PWM, the heat loss and leakage current is less than those in Normal PWM, however, the noise generated by the motor increases.

The following table lists the advantages and disadvantages of selecting the various carrier frequency sizes and load rates.

	Carrier frequency (Carrier Freq)	
	0.7 kHz	15 kHz
	LowLeakage PWM	Normal PWM
Motor noise	↑ (Increasement)	↓ (Decreasement)
Heat generated	↓ (Decreasement)	↑ (Increasement)
Noise generated	↓ (Decreasement)	↑ (Increasement)
Leakage current	↓ (Decreasement)	↑ (Increasement)

The following table lists the factory default carrier frequencies for each inverter capacity.

0.75 - 22 kW	30 - 45 kW	55 - 75 kW	90 - 110 kW	132 - 160 kW
5 kHz (Max. 15 kHz)	5 kHz (Max. 10 kHz)	5 kHz (Max. 7 kHz)	3 kHz (Max. 6 kHz)	3 kHz (Max. 5 kHz)

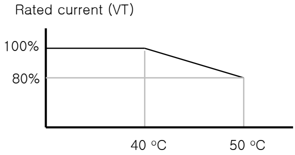
⚠ Caution

The default carrier frequency for 90 - 160 kW products is 3 kHz. However, as shown in the following figure, the value displayed on the bottom left of the keypad is D: 5.0 and this value indicates the default for products with a capacity of 75 kW or lower.

The iS7 Inverter supports two types of load rates. The overload rate is 150%/1 min for heavy duty and 110%/1 min for normal duty. Therefore, the current rating varies depending on the load rate and is limited depending on the ambient temperature.

Rated Current Derating Specifications by Temperature

The following is the rated current derating limit at various ambient temperatures when operating inverter at a general load rate (VT: Variable Torque):



Frame 1,2

Rated Current Derating Specifications by Carrier:

The following is the guaranteed rated current at various carrier frequencies based on the load.

Inverter capacity		0.75 - 7.5 kW	11 - 22 kW	30 - 75 kW
CT load	Normal temperature (25℃)	10 kHz	10 kHz	5 kHz
	High temperature (40℃)	7 kHz	7 kHz	4 kHz
	High temperature (50℃)	5 kHz	5 kHz	4 kHz
VT load	Normal temperature (25℃)	7 kHz	7 kHz	3 kHz
	High temperature (40℃)	2 kHz	2 kHz	2 kHz

5.22 Second Motor Operation (with One Inverter)

You can connect an inverter to two motors for the switching operation. This allows you to operate the second motor when the input of the terminal defined as the second function is 1 as a parameter of the second motor.

Group	Code number	Function display	Setting display		Unit
IN	65 – 75	Px Define	26	2nd Motor	-
M2	04	M2-Acc Time	-	5.0	Sec

IN65 - 75 Px Define: Set the function option of the multi-function input terminal to No.26 2nd motor to display the PAR➔M2 group (2nd motor group) in parameter mode.

Set the multi-function terminal as the second motor input to operate the motor using the following code. During operation, the multi-function terminal does not work as the second motor parameter even when inputted.

M2-08 (M2-Ctrl Mode) does not support V/F PG and Vector as operation modes.

In order to use M2-28 (M2-Stall Lev), make sure that PRT50 (Stall Prevent) is set to the desired value.

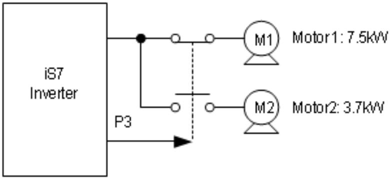
In order to use M2-29 (M2-ETH 1min) and M2-30 (M2-ETH Cont), make sure that PRT40 (ETH Trip Sel) is set to the desired value.

Code Number	Function	Details
04	M2-Acc Time	Acceleration time
05	M2-Dec Time	Deceleration time
06	M2-Capacity	Motor capacity
07	M2-Base Freq	Rated frequency of the motor
08	M2-Ctrl Mode	Control mode
10	M2-Pole Num	Number of poles
11	M2-Rate Slip	Rated slip
12	M2-Rated Curr	Rated current
13	M2-Noload Curr	No-load current
14	M2-Rated Volt	Rated voltage of the motor
15	M2-Efficiency	Motor efficiency
16	M2-Inertia Rt	Load inertia rate
17	M2-Rs	Stator resistor
18	M2-Lsigma	Leakage inductance

Code Number	Function	Details
19	M2-Ls	Stator inductance
20	M2-Tr	Rotor time constant
25	M2-V/F Patt	Output voltage pattern
26	M2-Fwd Boost	Positive direction torque boost
27	M2-Rev Boost	Negative direction torque boost
28	M2-Stall Lev	Stall level
29	M2-ETH 1min	One minute continuous rated level of the electronic thermal
30	M2-ETH Cont	Electronic thermal operation level
40	M2-LoadSpdGain	Adjust load speed display gain
41	M2-LoadSpdScal	Adjust load speed display scale
42	M2-LoadSpdUnit	Adjust load speed display unit

Use: Apply the following settings to use the second motor operation function of the P3 terminal in an existing 7.5 kW motor for a 3.7 kW switching operation.

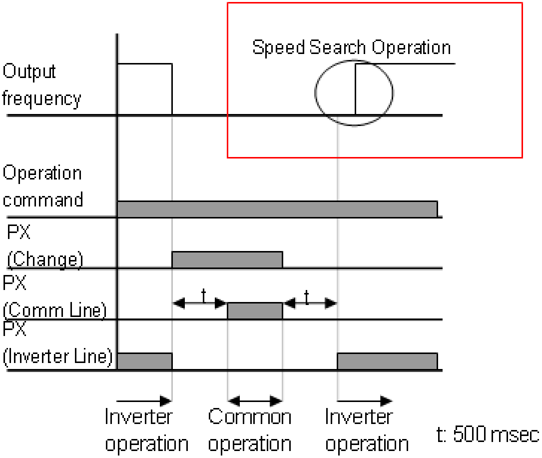
Group	Code number	Function display	Setting display		Unit
IN	67	P3 Define	26	2^{nd} Motor	-
M2	06	M2-Capacity		3.7 kW	kW
M2	08	Ctrl Mode	0	V/F	-



5.23 Bypass Operation

Group	Code number	Function display	Setting display		Unit
IN	65 - 75	Px Define	16	Exchange	-
OUT	31 - 32	Relay1,2	17	Inverter Line	-
OUT	33	Q1 Define	18	Comm Line	-

You can switch the load operated by the inverter to the commercial power or vice versa.



IN-65 - 75 Px Define: Sets the No.15 Exchange and switches the motor from inverter power to commercial power. Turn OFF the preset terminal to switch the motor from commercial power to the inverter output terminal.

OUT-30 Relay 1 - OUT-32 MO1 Define: Set the multi-function relay or output to No.16 Inverter Line and No.17 Comm Line. For details on the relay operation sequence, refer to the following figure.

5.24 Cooling Fan Control

Group	Code number	Function display	Setting display		Unit
IN	65 - 75	Px Define	16	Exchange	-
OUT	31 - 32	Relay1,2	17	Inverter Line	-
OUT	33	Q1 Define	18	Comm Line	-

Turn the fans installed to cool the heat sink of the inverter body On or Off. Use this when the motor stops and starts frequently or in areas that must remain quiet. This function helps extend the life of the cooling fan.

No.0 During Run (only activated during operation): Operates the cooling fan whenever power is applied to the inverter and an operation command is inputted. The cooling fan stops when the operation command turns OFF or the inverter output is cut off. If the heat sink temperature rises above a certain level, the cooling fan is activated regardless of the operation command.

No.1 Always On (always activated): Operates the cooling fan when power is applied to the inverter.

No.2 Temp Control (Temperature monitoring): Operates the cooling fan when the heat sink reaches a certain temperature, regardless of whether power is applied to the inverter or an operation command is input.

⚠ Caution
In products with a capacity of 11 - 75 kW, even if ADV-64 is set to “During Run,” the cooling fan may activate as a protective measure if the heat sink reaches a certain temperature due to harmonic waves or noise in the input current.

5.25 Input Power Frequency Selection

Group	Code number	Function display	Initial settings display		Unit
BAS	10	60/50 Hz Sel	0	60	Hz

Select the input power frequency.

When you change this setting from 60 Hz to 50 Hz, all the items related to the frequency (or rpm) set to 60 Hz or higher change to 50 Hz.

In contrast to this, changing this setting from 50 Hz to 60 Hz causes all the function items set to 50 Hz to change to 60 Hz.

5.26 Inverter Input Voltage Selection

Set the inverter input power voltage. The Low Voltage failure level changes automatically based on the voltage setting.

Group	Code number	Function display	Initial settings display		Unit
BAS	19	AC Input Volt	-	220	V

5.27 Reading, Writing, and Saving Parameters

Mode	Code number	Function display	Setting display		Unit
CNF	46	Parameter Read	1	Yes	-
CNF	47	Parameter Write	1	Yes	-
CNF	48	Parameter Save	1	Yes	-

This function copies the parameters saved in the inverter body to the keypad or the parameters saved in the keypad to the inverter body.

CNF-46 Parameter Read: Copies the parameters saved in the inverter body to the keypad. This deletes all of the existing parameters saved in the keypad.

CNF-47 Parameter Write: Copies the parameters saved in the keypad to the inverter body. This deletes all of the existing parameters saved in the keypad. If an error occurs while writing the parameters, you can use the existing data saved as they are. An “EEP Rom Empty” message appears if there is no data saved in the keypad.

CNF-48 Parameter Save: Since the parameters set via communication are saved in the RAM, they are all deleted when you turn the inverter On or Off. If you set the parameters via communication and select Yes in CNF-48 Parameter Save, then the parameters remain even if you turn the inverter On or Off.

5.28 Parameter Initialization

Mode	Code number	Function display	Initial settings display		Unit
CNF	40	Parameter Init	0	No	-

You can initialize the parameters changed by the user to the factory default settings. You can initialize the data en bloc for all groups or for individual groups.

You cannot initialize the parameters if a trip occurs or while the inverter is operating.

1: All Groups

Initializes all data. If you select No.1 All Groups and press the PROG key, the initialization starts. No. 0 appears when it is complete.

2: DRV - 13: M2

You can initialize parameters for individual groups. If you select a group and press the PROG key, the initialization starts. When completed, No.0 No is displayed.

5.29 Hide Parameter Mode and Prohibit Parameter Changes

Hide Parameter Mode Function

Mode	Code number	Function display	Setting display		Unit
CNF	50	View Lock Set	-	Unlocked	-
CNF	51	View Lock PW	-	Password	-

You can set a password and make parameter (PAR) mode invisible on the keypad. All other modes (CNF mode, user mode, macro mode, trip mode) remain visible, except for parameter (PAR) mode.

CNF-51 View Lock PW: Registers the password you want to use for hide parameter mode function. Perform the following procedure to register the password.

Order	Description
1	▪ Press the PROG key in the CNF-51 code to display the previous password registration window. The factory default setting is No.0. For the first registration, enter No.0. ▪ If there is a previous password, enter it. ▪ If the entered password matches the previous password, a display window appears for you to register new password. ▪ If the password entered differs from the previous password, the previous password registration window reappears.
2	▪ Register the new password.
3	▪ The CNF-51 View Lock PW appears again once the password is registered.

CNF-50 View Lock Set: If you enter the registered password with the hide parameter mode function disabled, 'Locked' appears and no parameter groups are visible in the keypad. When you enter the password again, 'Unlocked' appears. When using the mode key to move to the next step, parameter mode appears.

⚠ Caution
When the hide parameter group function is active, you cannot change the functions related to inverter operation. Therefore, be sure to remember the registered password.

Prohibit Parameter Change

Mode	Code number	Function display	Setting display		Unit
CNF	52	Key Lock Set	-	Unlocked	-
CNF	53	Key Lock PW	-	Password	-

You can use the password registered by the user to prohibit parameter changes.

CNF-53 Key Lock PW: Registers the password you want to use to prohibit parameter changes. Perform the following steps to register the password.

Order	Description
1	▪ Press the PROG key in CNF-52 code to display the previous password registration window. The factory default setting is No.0. For the first registration, enter No.0. ▪ If there is a previous password, enter it. ▪ If the entered password matches the previous password, a display window appears for you to register new password. ▪ If the password entered differs from the previous password, the previous password registration window reappears.
2	▪ Register the new password.
3	▪ The CNF-53 Key Lock PW appears again once the password is registered.

CNF-52 Key Lock Set: If you enter the registered password with the prohibit change function disabled, 'Locked' appears and you cannot switch to the Editor mode even if you press the PROG key in the function code you want to edit. If you enter the password again, the Unlocked icon disappears and the prohibit change function is disabled.

⚠ Caution
When the hide parameter group function is active, you cannot change the functions related to inverter operation. Therefore, be sure to remember the registered password.

Displaying the Changed Parameters Function

Mode	Code number	Function display	Initial settings display		Unit
CNF	41	Changed Para	0	View All	-
			1	View Changed	

This function only shows the parameters that differ from the factory default settings. Use it to track modified parameters.

Select No1 View Changed to only display the changed parameters. Select No.0 View All to display all of the existing parameters.

5.30 Add User Group (USR Grp)

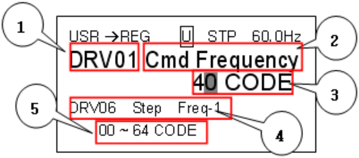
Mode	Code number	Function display	Initial settings display		Unit
CNF	42	Multi-Key Sel	3	UserGrp SelKey	-
CNF	45	UserGrp AllDel	0	No	-

You can put together only the selected parameters from the data available for the groups in the parameter mode to carry out data modification. You can register up to 64 parameters for each user group.

CNF-42 Multi-Key Sel: Select No.3 UserGrp SelKey from the multi-function key functions.

Even if the aforementioned multi-function key is set to UserGrp SelKey, the user group (USR Grp) does not appear unless you register the user group parameter.

■ Registering Parameters in User Group (USR Grp)

Order	Description
1	First select Multi-Key in CNF Mode Code 42 and then the No.3.UserGrp SelKey.  icon appears at the top of the screen.
2	In PAR mode, go to the parameter you want to register and press MULTI Key. For example, press MULTI Key in Cmd Frequency (DRV Group Code No.1) to open the following screen.  Screen description 1: Parameter group and code number to register 2: Name of the parameter to register 3: Code number to register in the user group (if you press PROG/ENT Key at 40, it is registered in the user group code No.40.) 4: Information about the parameter previously registered in user group code No.40 5: User group's code setting range (0 means cancellation of code setting)

Order	Description
3	You can set No.3 in the display screen shown above. And then select the code number you want and press the PROG/ENT key.
4	When a value changes in No.3, the values shown in No.4 also change. No.4 shows the information of the parameters previously registered and if none is registered in the code number, 'Empty Code' is displayed. 0 is cancellation of code setting.
5	These parameters are registered in U&M Mode's user group. (If required, you can register parameters multiple times. For example, you can register a parameter in user group code No.2, code No.11, etc.)

■ Deleting Parameters Registered in User Groups

Order	Description
1	First select Multi-Key in CNF Mode Code 42 and then the 3.UserGrp SelKey.  icon appears at the top of the screen.
2	In U&M Mode USR Group, move the cursor to the code you want to delete.
3	Press the MULTI Key.
4	A message prompt appears asking you if you want to delete the parameter.
5	Select YES and press the PROG/ENT key.
6	Deletion is completed.

CNF-25 UserGrp AllDel: Select No.1 Yes to delete all of the parameters registered in the user group.

5.31 Add Macro Group

Mode	Code number	Function display	Initial settings display		Unit
CNF	43	Macro Select	0	None	-

If you select an applied load, the inverter selects the related functions so that you can apply the changes to the macro group.

CNF-43 Macro Select: You can use this function to put various application functions into a group for easy setup. This causes the macro group called MC1 (DRAW function) or MC2 (Traverse function) to appear in the User & Macro (U&M) mode connected to the two functions, i.e. DRAW and Traverse.

This function is available from inverter. You cannot add or delete a function item included in the macro, but you can change the data in the macro group.

For details on the Traverse function, please see Chapter 8, Section 8.1.37, "Traverse Operation”.

The Draw function is a type of open loop tension control. It uses the speed difference between the motors for the main speed command rate to maintain the tension of the materials between the motors.

For more details, refer to section 8.1.1, "Setting the Override Frequency Using the Aux Frequency Command”.

5.32 Easy Start

Mode	Code number	Function display	Initial settings display		Unit
CNF	61	Easy Start On	1	Yes	-

CNF-61 Easy Start On: Set this code to Yes and select All in CNF-40 Parameter Init to initialize all of the inverter parameters. Easy Start begins working when you turn the inverter Off and then On.

■ Starting Easy Start

Order	Description
1	Set CNF-61 Easy Start On to Yes.
2	Select All in CNF-40 Parameter Init to initialize all of the inverter parameters.
3	Easy Start starts when the inverter power is turned off/on the first time. If the parameters appear on the digital loader in the following sequence, set them using the appropriate values. (Press the ESC key on the digital loader to immediately exit Easy Start.) ▪ Start Easy Set: Select Yes. ▪ CNF-01 Language Sel: Select the desired language. ▪ DRV-14 Motor Capacity: Specify the capacity of the motor. ▪ BAS-11 Pole Number: Specify the number of motor poles. ▪ BAS-15 Rated Volt: Specify the rated voltage of the motor. ▪ BAS-10 60/50Hz Sel: Specify the rated frequency of the motor. ▪ BAS-19 AC Input Volt: Specify the input voltage. ▪ DRV-06 Cmd Source: Select how to issue an operation command. ▪ DRV-01 Cmd Frequency: Specify the operation frequency. Now, exit to the monitoring screen. Now that minimal parameters are set to operate the motor, use the operation command method set in DRV-06 to operate the motor.

5.33 Other Config (CNF) Mode Parameters

Mode	Code number	Function display	Initial settings display		Unit
CNF	2	LCD Contrast	-	-	-
CNF	10	Inv S/W Ver	-	x.xx	-
CNF	11	Keypad S/W Ver	-	x.xx	-
CNF	12	KPD Title Ver	-	x.xx	-
CNF	30~32	Option-x Type	-	None	-
CNF	42	Changed Para	0	View ALL	
CNF	44	Erase All Trip	0	No	-
CNF	60	Add Title Del	0	No	-
CNF	62	WH Count Reset	0	No	-
CNF	74	Fan Time	-	0000DAY:00:00	-
CNF	75	Fan Time Rst	0	No	-

CNF-2 LCD Contrast: Controls the LCD contrast of the digital loader.

CNF-10 Inv S/W Ver, CNF-11 Keypad S/W Ver: These codes display the OS versions of the inverter body and digital loader.

CNF-12 KPD Title Ver: Displays the title version of the digital loader.

CNF-30 - 32 Option-x Type: Displays the types of option boards inserted in slots 1 - 3.

CNF-42 Changed Para: Displays only parameters that differ from the factory default settings when set to View Changed.

CNF-44 Erase All Tip: Deletes the saved fault history.

CNF-60 Add Title Del: When you upgrade the software version of inverter body and add new codes, you can use this function to display any codes added to the previous version of the keypad and activate any extra functions. Set this code to Yes and remove the keypad from the inverter body and insert it again to update the digital keypad title.

CNF-62 WH Count Reset: Clears accumulated power consumption.

CNF-74 Fan Time, CNF75 Fan Time Rst: Indicates the cumulative time of cooling fan operation. Select Yes in CNF-75 Fan Time Rst to clear CNF-74 Fan Time.

5.34 Timer Function

Group	Code number	Function display	Initial settings display		Unit
IN	65 - 75	Px Define	38	Timer In	-
OUT	31 - 33	Relay1,2 / Q1	27	Timer Out	-
OUT	55	TimerOn Delay	-	3.00	Sec
OUT	56	TimerOff Delay	-	1.00	Sec

This is the timer function for the multi-function input terminal. You can turn the multi-function output (including relay) On or Off using the timer.

IN-65 - 75 Px Define: Sets the terminal for the timer from the multi-function input terminals to the No.38 Timer In. When you input the set terminal, the output set to the Timer Out activates after the time period set in OUT-55 TimerOn Delay has elapsed. When the multi-function input terminal is OFF, the multi-function output (or relay) turns OFF after the time period set in OUT-56 TimerOff Delay has elapsed.

5.35 Traverse Operation Function

Group	Code number	Function display	Initial settings display		Unit
APP	01	App Mode	1	Traverse	-
APP	08	Trv Amplit %	-	0.0	%
APP	09	Trv Scramb %	-	0.0	%
APP	10	Trv Acc Time	-	2.0	Sec
APP	11	Trv Dec Time	-	3.0	Sec
APP	12	Trv Offset Hi	-	0.0	%
APP	13	Trv Offset Lo	-	0.0	%
IN	65 - 75	Px Define	27	Trv Offset Lo	-
IN	65 - 75	Px Define	28	Trv Offset Hi	-

APP-01 App Mode: Selects the Application Function Mode (App Mode) to No. 1 Traverse. Displays the functions necessary for the traverse operation.

APP-08 Trv Amplit %: Selects the magnitude of the traverse operation frequency. Set as a percentage of the operation frequency.

$$Trv.Amp\ Frequency = \frac{Operation\ frequency * TrvAmplit\%}{100}$$

APP-09 Trv Scramb %: Selects the magnitude of the scramble operation frequency. Sets the magnitude of the frequency jump at the start of deceleration, as shown in the following figure.

$$Trv.Scr\ \ frequency = Trv.Amp\ \ frequency - \frac{Trv.Amp\ \ frequency * (100 - TrvScramb\%)}{100}$$

APP-10 Trv Acc Time, APP11 Trv Dec Time: Specifies the accel/decel time of the traverse operation.

APP-12 Trv Offset Hi: Selecting and entering the No. 28 Trv Offset Hi functions in the multi-function input terminal causes the system to operate with the frequency pattern increased by the value specified in APP-12.

$$Trv.OffsetHi\ frequency = \frac{Operation\ frequency * TrvOffsetHi}{100}$$

APP-13 Trv Offset Lo: Selecting and entering the No. 27 Trv Offset Lo functions in the multi-function input terminal causes the system to operate with the frequency pattern decreased by the value specified in APP-13.

$$Trv.OffsetLo\ frequency = \frac{Operation\ frequency * TrvOffsetLo}{100}$$

5.36 Brake Control

Group	Code number	Function display	Setting display		Setting range	Unit
DRV	09	Control Mode	0	V/F		
ADV	41	BR Rls Curr	-	50.0	0 - 180%	%
ADV	42	BR Rls Dly	-	1.00	0 - 10.0	Sec
ADV	44	BR Rls Fwd Fr	-	1.00	0 - Maximum frequency	Hz
ADV	45	BR Rls Rev Fr	-	1.00	0 - Maximum frequency	Hz
ADV	46	BR Eng Dly	-	1.00	0 - 10	Sec
ADV	47	BR Eng Fr	-	2.00	0 - Maximum frequency	Hz
OUT	31 - 33	Relay x or Q1	35	BR Control		-

This controls the on/off operation of the brake in a load system that uses an electronic brake. The activation sequence differs depending on the control mode (DRV-09) settings. Please check the control mode before configuring the sequence.

If the brake control is working, the DC brake at start (ADV-12) and dwell operation (ADV-20 - 23) do not operate. If the torque control (DRV-10) is set, brake control does not work.

■ Non-vector Control Modes

Brake release sequence: If you issue an operation command while the motor is stopped, the motor accelerates up to the brake release frequency (ADV-44 and 45) according to the forward or reverse direction. When the brake release frequency is reached and the current flowing in the motor reaches the brake release current (BR Rls Curr), then the brake release signal is outputted to the output relay defined for brake control or the multi-function output terminal. Maintain the frequency during the brake release delay time (BR Rls Dly) and then accelerate

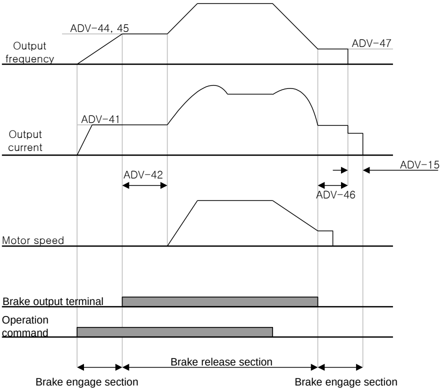
Brake engage sequence: The motor decelerates if the stop command is inputted during operation. If the output frequency reaches the brake engage frequency (BR Eng Fr), the deceleration stops and the brake engage signal is issued to the output terminal. After maintaining the frequency during the brake engage delay period (BR Eng Dly), the output frequency becomes "0". If the DC brake time (ADV-15) and DC braking quantity (ADV-16) are defined, cut off the inverter power after DC braking.

■ Vector Control Modes

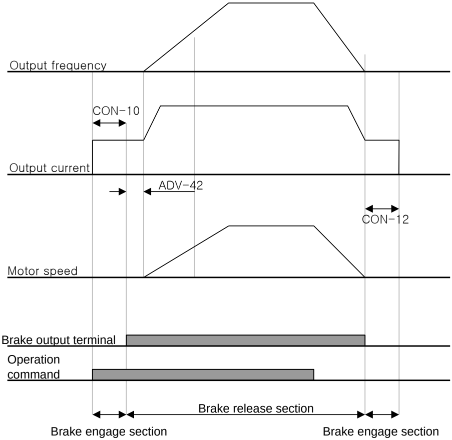
Brake release sequence: If you enter an operation command, the brake release signal is output to the output terminal after the initial excitation period. Start acceleration after the brake release delay period (BR Rly Dly).

Brake engage sequence: If you enter the stop command, the system decelerates to the zero ("0") speed and outputs the brake engage signal. After the brake engage delay period (BR Eng Dly) elapses, the system blocks the output.

This does not function in Torque Control mode.



For non-vector control mode settings



For vector control mode settings

5.37 Multi-Function Output On/Off Control Function

Group	Code number	Function display	Setting display		Setting range	Unit
ADV	66	On/Off Ctrl Src	1	V1	-	-
ADV	67	On-C Level	-	90.00	10 - 100%	%
ADV	68	Off-C Level	-	10.00	0 - Output contact on level	%
OUT	31 - 33	Relay x or Q1	34	On/Off Control	-	-

You can turn the output relay or multi-function output terminal on or off if the analog input value is above the set value.

Select the analog input to use for the on/off input in ADV-66, and then define the level, in ADV-67 and 68, at which the output terminals turn on and off, respectively. If the analog input exceeds the value defined in ADV-67, the output terminal turns on. If it is below the value in ADV-68, it turns off.

5.38 Regeneration Evasion Function for Press

(Used to avoid braking in the regeneration condition during press operation)

While operating the press, this function prevents the regeneration area by automatically increasing the motor operation speed in the motor regeneration status.

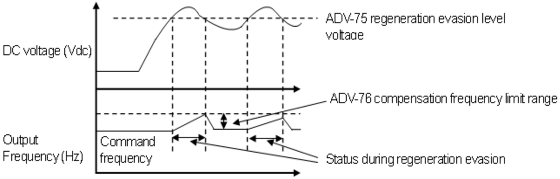
Group	Code number	Function display	Setting indication and range		Initial value	Unit
ADV	74	RegenAvd Sel	0	No	0: No	-
			1	Yes		
ADV	75	RegenAvd Level	200 V product: 300 - 400 V		350 V	V
			400 V product: 600 - 800 V		700 V	
ADV	76	CompFreq Limit	0 - 10.00 Hz		1.00 Hz	Hz
ADV	77	RegenAvd Pgain	0 - 100.0%		50.0%	%
ADV	78	RegenAvd Igain	20 – 30000 msec		500 msec	msec

ADV-74 RegenAvd Sel (Selection of regeneration evasion function for press): If a regeneration voltage, such as a press load, occurs frequently when operating the motor at a constant speed, select this function to suppress the DC link voltage and avoid activating the braking unit. Excessive operation of the DB unit can burn it out or reduce its lifespan.

ADV-75 RegenAvd Level (Setting the level for regeneration evasion for press): Specifies the voltage level for DB operation evasion if the DC link voltage increases due to the regeneration voltage.

ADV-76 CompFreq Limit (Compensation frequency limit of regeneration evasion for press): Specifies the variable frequency width for the actual command frequency during regeneration operation area evasion.

ADV-77 RegenAvd Pgain (Compensation controller P gain setting for regeneration evasion for press), ADV-77 RegenAvd Igain (Compensation controller I gain setting for regeneration evasion for press): These set the P and I gains for DC Link voltage suppression PI controller to avoid the regeneration operation area.



⚠ Caution
The regeneration evasion for press only works when the motor is operating at a constant speed zone (no operation during accel/decel zone). Even operating at a constant speed during the regeneration evasion, the output frequency can change as much as the frequency specified in the ADV-76 CompFreq Limit.

6. Table of Functions

6.1 Parameter Mode – Drive Group (➔DRV)

Please refer to iS7 user manual for the parameter which a page is not indicated in the table.

No.	Communication address	Function display	Name	Setting range		Initial value		Change during operation	Reference page	Note 1)Control mode				
										V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0~99		9		O	-	O	O	O	O	O
01	0h1101	Cmd Frequency	Target frequency	0 - Max. frequency (Hz)		0.0		O	-	O	O	O	X	X
02	0h1102	Cmd Torque	Torque command	-180 – 180%		0.0		O	5-45	X	X	X	O	O
03	0h1103	Acc Time	Acceleration time	0 - 600 sec		75 kW or less	20.0	O	-	O	O	O	O	O
						90 kW or more	60.0							
04	0h1104	Dec Time	Deceleration time	0 - 600 sec		75 kW or less	30.0	O	-	O	O	O	O	O
						90 kW or more	90.0							
06	0h1106	Cmd Source	Operation Command Methods	0	Keypad	1: Fx/Rx-1		X	5-8	O	O	O	O	O
				1	Fx/Rx-1									
				2	Fx/Rx-2									
				3	Int 485									
				4	Field Bus				Option					
				5	PLC				Option					
07	0h1107	Freq Ref Src	Frequency Setting Methods	0	Keypad-1	0: Keypad-1		X	5-1	O	O	O	X	X
08	0h1108	Trq Ref Src	Torque Command Methods	1	Keypad-2	0: Keypad-1		X	5-45	X	X	X	O	O
				2	V1									
				3	I1									
				4	V2									
				5	I2									
				6	Int 485									
				7	Encoder									
				8	Fied Bus									
				9	PLC									
09 Note 1)	0h1109	Control Mode	Control mode	0	V/F	0: V/F		X	5-73	O	O	O	O	O
				1	V/F PG				5-31					
				2	Slip Compen				5-16					
				3	Sensorless-1				5-32					

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Note 1) Control mode				
				4	Sensorless-2			5-38					
				5	Vector			5-45					

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 1) This indicates the effectiveness of each code depending on the control mode setting:
V/F: V/F mode (including PG), SL: Sensorless-1 and 2 modes, VC: Vector mode, SLT: Sensorless-1 and 2 Torque modes,
VCT: Vector Torque mode
Please refer to the Options Manual provided separately for more information on the various options.

Drive Group (PAR → DRV)

No.	Communication address	Function display	Name	Setting range		Initial value		Change during operation	Reference page	Control mode				
										V/F	SL	VC	SLT	VCT
10	0h110A	Torque Control	Torque Control	0	No	0: No		X	5-32, 5-34,5-45	X	X	X	O	O
				1	Yes									
11	0h110B	Jog Frequency	Jog frequency	0.5 - Max. frequency (Hz)		10.00		O	5-5, 5-6	O	O	O	O	O
12	0h110C	Jog Acc Time	Jog Operation Acceleration time	0 - 600 sec		20.0		O	5-5, 5-6	O	O	O	O	O
13	0h110D	Jog Dec Time	Jog Operation Deceleration time	0 - 600 sec		30.0		O	5-5, 5-6	O	O	O	X	X
14	0h110E	Motor Capacity	Motor Capacity	0: 0.2 kW, 1: 0.4 kW 2: 75 kW, 3: 1.5 kW 4: 2.2 kW, 5: 3.7 kW 6: 5.5 kW, 7: 7.5 kW 8: 11 kW, 9: 15 kW 10:18.5 kW,11:22 kW 12: 30 kW,13: 37 kW 14: 45 kW,15: 55 kW 16: 75 kW, 17: 90 kW 18: 110 kW 19: 132 kW 20: 160 kW 21: 185 kW		Changes depending on the inverter capacity		X	5-16, 5-25, 5-32	O	O	O	O	O
15	0h110F	Torque Boost	Torque Boost Action	0	Manual	0: Manual		X	-	O	X	X	X	X
				1	Auto									
				2	Advanced Auto									
16 Note 2)	0h1110	Fwd Boost	Forward torque boost	0 – 15%		75 kW or less	2.0	X	-	O	X	X	X	X
						90 kW or more	1.0							
17	0h1111	Rev Boost	Reverse torque boost	0 – 15%		75 kW or less	2.0	X	-	O	X	X	X	X
						90 kW or more	1.0							
18	0h1112	Base Freq	Base frequency	30 - 400 Hz		60.00		X	-	O	O	O	O	O
19	0h1113	Start Freq	Start frequency	0.01 – 10 Hz		0.50		X	-	O	X	X	X	X
20	0h1114	Max Freq	Maximum frequency	40~400		60.00		X	-	O	O	O	O	O
21	0h1115	Hz/Rpm Sel	Speed Unit Selection	0	Hz Display	0: Hz		O	5-38	O	O	O	O	O
				1	Rpm Display									

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
26 Note 3)	0h111A	Adv ATB Filter	ATB Torque boost Filter		1~1000 msec	100	O	7.28	O	X	X	X	X
27	0h111B	Adv ATB M Gain	Reverse Torque boost Gain		0~300 %	50	O	7-28	O	X	X	X	X
28	0h111C	Adv ATB G Gain	Regeneration Torque boost Gain		0~300 %	50	O	7-28	O	X	X	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 2) DRV-16 - 17 only appear when the value of the DRV-15 (Torque Boost) code is "Manual”.
Note 3) DRV-26 - 28 only appear when the value of the DRV-15 (Torque Boost) code is "Advanced Auto”.

6.2 Parameter Mode – Basic Function Group (→BAS)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99		20	O	-	O	O	O	O	O
01	0h1201	Aux Ref Src	Aux speed command setting method	0 1 2 3 4	None V1 I1 V2 I2	0: None	X	5-1, 5-32	O	O	O	X	X
02 Note 3)	0h1202	Aux Calc Type	Aux speed command motion selection	0 1 2 3 4 5 6 7	M+(G*A) M*(G*A) M/(G*A) M+(M*(G*A)) M+G*(A-50%) M*(G*(A-50%)) M/(G*(A-50%)) M+M*G*(A-50%)	0: M+(G*A)	X	5-1	O	O	O	X	X
03	0h1203	Aux Ref Gain	Aux speed command gain	-200.0 - 200.0%		100.0	O	5-1	O	O	O	X	X
04	0h1204	Cmd 2nd Src	Second operation command method	0 1 2 3 4 5	Keypad Fx/Rx-1 Fx/Rx-2 Int 485 FieldBus PLC	1: Fx/Rx-1	O	-	O	O	O	O	O
05	0h1205	Freq 2nd Src	Second frequency setting method	0	Keypad-1	0:Keypad-1	O	-	O	O	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 3) The BAS-02 and 03 codes cannot be displayed if the value of the BAS-01 (Aux Ref Src) code is "NONE".

Basic Function Group (PAR → BAS)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
21	-	Rs	Stator resistor	Depends on the motor setting.	-	X	5-25	X	O	O	O	O
22	-	Lsigma	Leakage inductance	Depends on the motor setting.	-	X	5-25	X	O	O	O	O
23	-	Ls	Stator inductance	Depends on the motor setting.	-	X	5-25	X	O	O	O	O
24 Note 4)	-	Tr	Rotor time constant	25 - 5000 msec	-	X	5-25	X	O	O	O	O
41 Note 5)	0h1229	User Freq 1	User frequency 1	0 - Max. frequency (Hz)	15.00	X	-	O	X	X	X	X
42	0h122A	User Volt 1	User voltage 1	0 – 100%	25	X	-	O	X	X	X	X
43	0h122B	User Freq 2	User frequency 2	0 - Max. frequency (Hz)	30.00	X	-	O	X	X	X	X
44	0h122C	User Volt 2	User voltage 2	0 - 100%	50	X	-	O	X	X	X	X
45	0h122D	User Freq 3	User frequency 3	0 - Max. frequency (Hz)	45.00	X	-	O	X	X	X	X
46	0h122E	User Volt 3	User voltage 3	0 - 100%	75	X	-	O	X	X	X	X
47	0h122F	User Freq 4	User frequency 4	0 - Max. frequency (Hz)	60.00	X	-	O	X	X	X	X
48	0h1230	User Volt 4	User voltage 4	0 – 100%	100	X	-	O	X	X	X	X
50 Note 6)	0h1232	Step Freq-1	Multi-step speed frequency 1	0 - Max. frequency (Hz)	10.00	O	-	O	O	O	X	X
51	0h1233	Step Freq-2	Multi-step speed frequency 2	0 - Max. frequency (Hz)	20.00	O	-	O	O	O	X	X
52	0h1234	Step Freq-3	Multi-step speed frequency 3	0 - Max. frequency (Hz)	30.00	O	-	O	O	O	X	X
53	0h1235	Step Freq-4	Multi-step speed frequency 4	0 - Max. frequency (Hz)	40.00	O	-	O	O	O	X	X
54	0h1236	Step Freq-5	Multi-step speed frequency 5	0 - Max. frequency (Hz)	50.00	O	-	O	O	O	X	X
55	0h1237	Step Freq-6	Multi-step speed frequency 6	0 - Max. frequency (Hz)	60.00	O	-	O	O	O	X	X
56	0h1238	Step Freq-7	Multi-step speed frequency 7	0 - Max. frequency (Hz)	60.00	O	-	O	O	O	X	X
57	0h1239	Step Freq-8	Multi-step speed frequency 8	0 - Max. frequency (Hz)	55.00	O	-	O	O	O	X	X
58	0h123A	Step Freq-9	Multi-step speed frequency 9	0 - Max. frequency (Hz)	50.00	O	-	O	O	O	X	X

No.	Communication	Function	Name	Setting range	Initial	Change	Reference	Control mode				
59	0h123B	Step Freq-10	Multi-step speed frequency 10	0 - Max. frequency (Hz)	45.00	O	-	O	O	O	X	X
60	0h123C	Step Freq-11	Multi-step speed frequency 11	0 - Max. frequency (Hz)	40.00	O	-	O	O	O	X	X
61	0h123D	Step Freq-12	Multi-step speed frequency 12	0 - Max. frequency (Hz)	35.00	O	-	O	O	O	X	X
62	0h123E	Step Freq-13	Multi-step speed frequency 13	0 - Max. frequency (Hz)	25.00	O	-	O	O	O	X	X
63	0h123F	Step Freq-14	Multi-step speed frequency 14	0 - Max. frequency (Hz)	15.00	O	-	O	O	O	X	X
64	0h1240	Step Freq-15	Multi-step speed frequency 15	0 - Max. frequency (Hz)	5.00	O	-	O	O	O	X	X
70	0h1246	Acc Time-1	Multi-step acceleration time 1	0 - 600 sec	20.0	O	-	O	O	O	X	X
71	0h1247	Dec Time-1	Multi-step deceleration time 1	0 - 600 sec	20.0	O	-	O	O	O	X	X
72 [Note 7)]	0h1248	Acc Time-2	Multi-step acceleration time 2	0 - 600 sec	30.0	O	-	O	O	O	X	X
73	0h1249	Dec Time-2	Multi-step deceleration time 2	0 - 600 sec	30.0	O	2-46	O	O	O	X	X
74	0h124A	Acc Time-3	Multi-step acceleration time 3	0 - 600 sec	40.0	O	-	O	O	O	X	X
75	0h124B	Dec Time-3	Multi-step deceleration time 3	0 - 600 sec	40.0	O	-	O	O	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 4) The BAS-24 only appears when the DRV-09 control mode is "Sensorless-2" or "Vector”.
Note 5) BAS-41 - 48 only appears when BAS-07 or M2-25 (M2-V/F Patt) is set to "User V/F”.
Note 6) BAS-50 - 64 only appears when one or more of the IN-65 - 72 multi-function inputs are set to "Multi-step speed" (Speed–L.M.H,X).
Note 7) It only appears when one or more of the IN-72 - 75 multi-function inputs are set to "Multi-step Accel/Decel" (Xcel-L,M,H).

Basic Function Group (PAR → BAS)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	S L	V C	S L T	V C T
80 Note 8)	0h1250	FricComp Spd 1	Friction loss measuring frequency 1	0 - Max. frequency (Hz)	6.00	O	2-45	X	X	O	X	X
81	0h1251	FricComp Trq 1	Friction loss value 1	0 - 100%	0.00	O	2-45	X	X	O	X	X
82	0h1252	FricComp Spd 2	Friction loss measuring frequency 2	0 - Max. frequency (Hz)	12.00	O	2-45	X	X	O	X	X
83	0h1253	FricComp Trq 2	Friction loss value 2	0 - 100%	0.00	O	2-45	X	X	O	X	X
84	0h1254	FricComp Spd 3	Friction loss measuring frequency 3	0 - Max. frequency (Hz)	18.00	O	2-45	X	X	O	X	X
85	0h1255	FricComp Trq 3	Friction loss value 3	0 – 100%	0.00	O	2-45	X	X	O	X	X
86	0h1256	FricComp Spd 4	Friction loss measuring frequency 4	0 - Max. frequency (Hz)	24.00	O	2-45	X	X	O	X	X
87	0h1257	FricComp Trq 4	Friction loss value 4	0 - 100%	0.00	O	2-45	X	X	O	X	X
88	0h1258	FricComp Spd 5	Friction loss measuring frequency 5	0 – 100%	30.00	O	2-45	X	X	O	X	X
89	0h1259	FricComp Trq 5	Friction loss value 5	0 – 100%	0.00	O	2-45	X	X	O	X	X
90	0h125A	FricComp Spd 6	Friction loss measuring frequency 6	0 - Max. frequency (Hz)	36.00	O	2-45	X	X	O	X	X
91	0h125B	FricComp Trq 6	Friction loss value 6	0 – 100%	0.00	O	2-45	X	X	O	X	X
92	0h125C	FricComp Spd 7	Friction loss measuring frequency 7	0 - Max. frequency (Hz)	42.00	O	2-45	X	X	O	X	X
93	0h125D	FricComp Trq 7	Friction loss value 7	0 - 100%	0.00	O	2-45	X	X	O	X	X
94	0h125E	FricComp Spd 8	Friction loss measuring frequency 8	0 - Max. frequency (Hz])	48.00	O	2-45	X	X	O	X	X
95	0h125F	FricComp Trq 8	Friction loss value 8	0 - 100%	0.00	O	2-45	X	X	O	X	X
96	0h1260	FricComp Spd 9	Friction loss measuring frequency 9	0 - Max. frequency (Hz)	54.00	O	2-45	X	X	O	X	X
97	0h1261	FricComp Trq 9	Friction loss value 9	0 – 100%	0.00	O	2-45	X	X	O	X	X
98	0h1262	FricComp Spd10	Friction loss measuring frequency 10	0 - Max. frequency (Hz)	60.00	O	2-45	X	X	O	X	X
99	0h1263	FricComp Trq10	Friction loss value 10	0 – 100%	0.00	O	2-45	X	X	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 8) BAS-80 to 99 only appears when the APP-01 (App Mode) is "Tension Ctrl".

6.3 Parameter Mode – Expanded Function Group (PAR→ADV)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99		24	O	-	O	O	O	O	O
01	0h1301	Acc Pattern	Accelerating pattern	0	Linear	0: Linear	X	-	O	O	O	X	X
02	0h1302	Dec Pattern	Decelerating pattern	1	S-curve		X	-	O	O	O	X	X
03	0h1303	Acc S Start	S-curve acceleration start point gradient	1 – 100%		40	X	-	O	O	O	X	X
04	0h1304	Acc S End	S-curve acceleration end point gradient	1 – 100%		40	X	-	O	O	O	X	X
05	0h1305	Dec S Start	S-curve deceleration start point gradient	1 – 100%		40	X	-	O	O	O	X	X
06	0h1306	Dec S End	S-curve deceleration end point gradient	1 – 100%		40	X	-	O	O	O	X	X
07	0h1307	Start Mode	Start mode	0 1	Acc Dc-Start	0: Acc	X	-	O	O	O	X	X
08	0h1308	Stop Mode	Stop mode	0 1 2 3 4	Dec Dc-Brake Free-Run Reserved Power Braking	0: Dec	X	-	O	O	O	X	X
09	0h1309	Run Prevent	Selection of prohibited rotation direction	0 1 2	None Forward Prev Reverse Prev	0: None	X	-	O	O	O	X	X
10	0h130A	Power-on Run	Starting with the power on	0 1	No Yes	0: No	O	-	O	O	O	X	X
12 Note 9)	0h130C	Dc-Start Time	DC braking time at startup	0 - 60 sec		0.00	X	-	O	O	O	X	X
13	0h130D	Dc Inj Level	Amount of applied DC	0 – 200 %		50	X	-	O	O	O	X	X
14 Note 10)	0h130E	Dc-Block Time	Output blocking time before DC braking	0 - 60 sec		0.10	X	-	O	O	O	X	X
15	0h130F	Dc-Brake Time	DC braking time	0 - 60 sec		1.00	X	-	O	O	O	X	X
16	0h1310	Dc-Brake Level	DC braking quantity	0 – 200%		50	X	-	O	O	O	X	X
17	0h1311	Dc-Brake Freq	DC braking frequency	Start frequency - 60 (Hz)		5.00	X	-	O	O	O	X	X
20	0h1314	Acc Dwell Freq	Dwell frequency on acceleration	Start frequency - Max. frequency (Hz)		5.00	X	5-14	O	O	O	X	X
21	0h1315	Acc Dwell Time	Dwell operation time on acceleration	0 - 60.0 sec		0.00	X	5-14	O	O	O	X	X
22	0h1316	Dec Dwell Freq	Dwell frequency on deceleration	Start frequency - Max. frequency (Hz)		5.00	X	5-14	O	O	O	X	X
23	0h1317	Dec Dwell Time	Dwell operation time on	60.0 sec		0.00	X	5-14	O	O	O	X	X

No.	Communication	Function	Name	Setting	Initial	Change	Reference	Control mode				
			deceleration									

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 9) ADV-12 only appears when the ADV-07 "Start Mode" is set to "Dc-Start".
Note 10) ADV-14 - 17 only appears when the ADV-08 "Stop Mode" is set to "DC-Brake".

Expanded Function Group (PAR → ADV)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
24	0h1318	Freq Limit	Frequency limit	0	No	0: No	X	-	O	O	O	X	X
				1	Yes								
25 Note 11)	0h1319	Freq Limit Lo	Lower limit frequency	0 - upper limit (Hz)		0.50	O	-	O	O	O	X	X
26	0h131A	Freq Limit Hi	Upper limit frequency	0.5 - Max. frequency (Hz)		60.00	X	-	O	O	O	X	X
27	0h131B	Jump Freq	Frequency jump	0	No	0: No	X	-	O	O	O	X	X
				1	Yes								
28 Note 12)	0h131C	Jump Lo 1	Lower limit 1 of jump frequency	0 - jump frequency upper limit 1 (Hz)		10.00	O	-	O	O	O	X	X
29	0h131D	Jump Hi 1	Upper limit 1 of jump frequency	Lower limit 1 of jump frequency 1 - Max. frequency (Hz)		15.00	O	-	O	O	O	X	X
30	0h131E	Jump Lo 2	Lower limit 2 of jump frequency	0 - Jump frequency Upper limit 2 (Hz)		20.00	O	-	O	O	O	X	X
31	0h131F	Jump Hi 2	Upper limit 2 of jump frequency	Lower limit 2 of jump frequency 1 - Max. frequency (Hz)		25.00	O	-	O	O	O	X	X
32	0h1320	Jump Lo 3	Lower limit 3 of jump frequency	0 - Jump frequency Upper limit 3 (Hz)		30.00	O	-	O	O	O	X	X
33	0h1321	Jump Hi 3	Upper limit 3 of jump frequency	Lower limit 3 of jump frequency 1 - Max. frequency (Hz)		35.00	O	-	O	O	O	X	X
41 Note 13)	0h1329	BR Rls Curr	Brake release current	0 - 180.0 (%)		50.0	O	5-73	O	O	O	X	X
42	0h132A	BR Rls Dly	Brake release delay time	0 - 10.00 sec		1.00	X	5-73	O	O	O	X	X
44	0h132C	BR Rls Fwd Fr	Brake release forward frequency	0 400 (Hz)		1.00	X	5-73	O	O	O	X	X

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
45	0h132D	BR Rls Rev Fr	Brake release reverse frequency	0 - 400 (Hz)		1.00	X	5-73	O	O	O	X	X
46	0h132E	BR Eng Dly	Brake engage delay time	0 - 10 sec		1.00	X	5-73	O	O	O	X	X
47	0h132F	BR Eng Fr	Brake engage frequency	0 - 400 (Hz)		2.00	X	5-73	O	O	O	X	X
50	0h1332	E-Save Mode	Energy saving operation	0	None	0: None	X	5-49	O	O	X	X	X
				1	Manual								
				2	Auto								
51Note 14)	0h1333	Energy Save	Energy saving level	0 – 30 (%)		0	O	5-49	O	O	O	X	X
60	0h133C	Xcel Change Fr	Change Acc/Dec Time Frequency	0 - Max. frequency (Hz)		0.00	X		O	O	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 11) ADV-25 - 26 only appear when ADV-24 (Freq Limit) is set to "Freq Limit”.
Note 12) ADV-28 - 33 only appear when ADV-27 (Jump Freq) is set to "Yes”.
Note 13) ADV-41 - 47 only appear when a code value of OUT-31 - 33 is set to "BR Control”.
Note 14) ADV-51 only appears when ADV-50 (E-Save Mode) is set to a value other than "None”.

Expanded Function Group (PAR → ADV)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
61	-	Load Spd Gain	Revolution display gain	1 - 6000.0%		100.00	O	-	O	O	O	X	X
62	-	Load Spd Scale	Revolution display scale	0	x 1	0: x 1	O	-	O	O	O	X	X
				1	x 0.1								
				2	x 0.01								
				3	x 0.001								
				4	x 0.0001								
63	0h133F	Load Spd Unit	Revolution display unit	0	rpm	0: rpm	O	-	O	O	O	O	O
				1	mpm								
64	0h1340	FAN Control	Cooling fan control	0	During Run	0: During Run	O	-	O	O	O	X	X
				1	Always ON								
				2	Temp Control								
65	0h1341	U/D Save Mode	Up/down operation frequency save	0	No	0: No	O	5-9	O	O	O	X	X
				1	Yes								
66	0h1342	On/Off Ctrl Src	-	0	None	0: None	X	5-76	O	O	O	O	O
				1	V1								
				2	I1								
				3	V2								
				4	I2								
67	0h1343	On-C Level	Output contact On level	10 – 100%		90.00	X	5-76	O	O	O	O	O
68	0h1344	Off-C Level	Output contact Off level	-100.00 - Output contact On level (%)		10.00	X	5-76	O	O	O	O	O
70	0h1346	Run En Mode	Safe operation selection	0	Always Enable	0: Always Enable	X	5-12	O	O	O	O	O
				1	DI Dependent								
71 Note 15)	0h1347	Run Dis Stop	Safe operation stop method	0	Free-Run	0: Free-Run	X	5-12	O	O	O	O	O
				1	Q-Stop								
				2	Q-Stop Resume								
72	0h1348	Q-Stop Time	Safe operation deceleration time	0 - 600.0 sec		5.0	O	5-12	O	O	O	O	O
74	0h134A	RegenAvd Sel	Selection of regeneration evasion function for the press.	0	No	No	X	5-77	O	O	O	O	O
				1	Yes								
75	0h134B	RegenAvd Level	Voltage level of regeneration evasion motion for press	200 V: 300 - 400		350V	X	5-77	O	O	O	X	X
				400 V: 600 - 800		700V							
76 Note 16)	0h134C	CompFreq Limit	Compensation frequency limit of regeneration evasion for the press	0 - 10.00 Hz		1.00 (Hz)	X	5-77	O	O	O	X	X
77	0h134D	RegenAvd Pgain	Regeneration evasion for	0 - 100.0%		50.0%	O	5-77	O	O	O	X	X

No.	Communication address	Function display	Name	Setting range	Initial value	Change during	Reference page	Control mode				
			press P gain									
78	0h134E	RegenAvd Igain	Regeneration evasion for press I gain	20 - 30000 msec	500 msec	O	5-77	O	O	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 15) ADV-71 - 72 only appear when ADV-70 (Run En Mode) is set to "DI Dependent”.
Note 16) ADV-76 - 78 only appear when ADV-74 (RegenAvd Sel) is set to "Yes”.

6.4 Parameter Mode – Control Function Group (➔CON)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Note 1)Control mode V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99		51	O	-	O	O	O	O	O
04	0h1404	Carrier Freq	Carrier frequency	75 kW or less	0.7 - 15 kHz	5.0	O	5-56	O	O	O	O	O
				90 - 110 kW	0.7 - 6 kHz	3.0							
				132 - 160 kW	0.7 - 5 kHz	3.0							
05	0h1405	PWM Mode	Switching mode	0	Normal PWM	0: Normal PWM	X	5-56	O	O	O	O	O
				1	Low leakage PWM								
09	0h140A	PreExTime	Initial excitation time	0 - 60 sec		1.00	X	5-38	X	X	O	O	O
10	0h140B	Flux Force	Initial excitation amount	100 – 500%		100.0	X	5-38	X	X	O	O	O
11	0h140C	Hold Time	Continued operation duration	0 - 60 sec		1.00	X	5-38	X	X	O	X	X
12	0h140D	ASR P Gain 1	Speed controller proportional gain 1	0.10 – 500%		50.0	O	5-38	X	X	O	X	X
13	0h140E	ASR I Gain 1	Speed controller integral gain 1	10 - 9999 msec		300	O	5-38	X	X	O	X	X
15	0h140F	ASR P Gain 2	Speed controller proportional gain 2	10 – 500%		50.0	O	5-38	X	X	O	X	X
16	0h1410	ASR I Gain 2	Speed controller integral gain 2	10 - 9999 msec		300	O	5-38	X	X	O	X	X
18	0h1412	Gain SW Freq	Gain switching frequency	0 - 120 Hz		0.00	X	5-38	X	X	O	X	X
19	0h1413	Gain Sw Delay	Gain switching time	0 - 100 sec		0.10	X	5-38	X	X	O	X	X
20	0h1414	SL2 G View Sel	Sensorless-2 2nd gain display setting	0	No	0: No	O	5-34	X	X	X	X	X
				1	Yes								
21	0h1415	ASR-SL P Gain1	Sensorless 1, 2 speed controller proportional gain 1	0 – 5000%		Variable depending on the motor capacity	O	5-32, 5-34	X	O	X	X	X
22	0h1416	ASR-SL I Gain1	Sensorless 1, 2 speed controller integral gain 1	10 - 9999 msec		Dependent on motor capacity	O	5-32	X	O	X	X	X
23Note 17)	0h1417	ASR-SL P Gain2	Sensorless-2 speed controller proportional gain 2	1.0 – 1000.0%		Variable depending on the motor capacity	O	5-34	X	X	X	X	X
24	0h1418	ASR-SL I Gain2	Sensorless-2 speed controller integral gain 2	1.0 – 1000.0%		Variable depending on the motor capacity	O	5-34	X	X	X	X	X
26	0h141A	Observer Gain1	Sensorless-2 observer gain 1	0 - 30000		10500	O	5-34	X	X	X	X	X
27	0h141B	Observer Gain2	Sensorless-2 observer gain 2	1 – 1000%		100.0	O	5-34	X	X	X	X	X
28	0h141C	Observer	Sensorless-2	0 - 30000		13000	O	5-34	X	X	X	X	X

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Note 1)Control mode				
		Gain3	observer gain 3									
29	0h141D	S-Est P Gain1	Sensorless-2 speed estimator proportional gain 1	0 - 30000	Variable depending on the motor capacity	O	5-34	X	X	X	X	X
30	0h141E	S-Est I Gain1	Sensorless-2 speed estimator integral gain 1	0 - 30000	Variable depending on the motor capacity	O	5-34	X	X	X	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 17) CON-23 - 28 and 31 - 32 only appear when DRV-09 (Control Mode) is set to "Sensorless-2" and CON-20 (SL2 G View Sel) is set to "YES".

Control Function Group (PAR → CON)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	Control mode SL	Control mode VC	Control mode SLT	Control mode VCT
31	0h141F	S-Est P Gain2	Sensorless-2 speed estimator proportional gain 2	1.0 – 1000.0%	Varies according to the motor capacity	O	5-34	X	X	X	X	X
32	0h1420	S-Est I Gain2	Sensorless-2 speed estimator integral gain 2	1.0 – 1000.0%	Varies according to the motor capacity	O	5-34	X	X	X	X	X
34	0h1422	SL2 OVM Perc	Sensorless-2 overmodulation range adjustment	100 – 180%	120.00	O	-	X	O	X	X	X
45 Note 18)	0h142D	PG P Gain	PG operation proportional gain	0 - 9999	3000	O	5-31	O	X	X	X	X
46	0h142E	PG I Gain	PG operation integral gain	0 - 9999	50	O	5-31	O	X	X	X	X
47	0h142F	PG Slip Max%	Max. slip during PG operation	0 - 200	100	X	5-31	O	X	X	X	X
48	-	ACR P Gain	Current controller P gain	0 - 10000	1200	O	5-34	X	O	O	O	O
49	-	ACR I Gain	Current controller I gain	0 - 10000	120	O	5-34	X	O	O	O	O
51	0h1433	ASR Ref LPF	Speed controller reference filter	0 - 20000 msec	0	X	-	X	O	O	X	X
52	0h1434	Torque Out LPF	Torque controller output filter	0 - 2000 msec	0	X	5-38	X	X	X	O	O
53	0h1435	Torque Lmt Src	Setting torque limit	0 Keypad-1 1 Keypad-2 2 V1 3 I1 4 V2 5 I2 6 Int 485 7 Encoder 8 FieldBus 9 PLC 10 Synchro 11 Binary Type	0: Keypad-1	X	5-38	X	X	X	O	O
54 Note 19)	0h1436	FWD +Trq Lmt	Positive-direction reverse Torque limit	0 – 200%	180.0	O	5-38	X	X	X	O	O
55	0h1437	FWD –Trq Lmt	Positive-direction regeneration Torque limit	0 – 200%	180.0	O	5-38	X	X	X	O	O
56	0h1438	REV +Trq Lmt	Negative-direction reverse Torque limit	0 – 200%	180.0	O	5-38	X	X	X	O	O
57	0h1439	REV –Trq Lmt	Negative-direction regeneration Torque limit	0 – 200%	180.0	O	5-38	X	X	X	O	O

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 18) CON-45 - 47 only appear if an encoder board is inserted.
Note 19) CON-54 - 57 only appear when DRV-09 (Control Mode) is set to "Sensorless-1, 2" or "Vector".

Control Function Group (PAR → CON)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Note 1) Control mode V/F	SL	VC	SLT	VCT
58	0h143A	Trq Bias Src	Torque bias setting method	0 Keypad-1 1 Keypad-2 2 V1 3 I1 4 V2 5 I2 6 Int 485 7 FieldBus 8 PLC	0: Keypad-1	X	5-38	X	X	O	X	X
59	0h143B	Torque Bias	Torque bias amount	-120 – 120%	0.0	O	5-38	X	X	O	X	X
60	0h143C	Torque Bias FF	Torque bias compensation	0 – 100%	0.0	O	5-38	X	X	O	X	X
62	0h143E	Speed Lmt Src	Speed limit setting method	0 Keypad-1 1 Keypad-2 2 V1 3 I1 4 V2 5 I2 6 Int 485 7 FieldBus 8 PLC	0:Keypad-1	O	5-45	X	X	X	X	O
63	0h143F	FWD Speed Lmt	Forward speed limit	0 - Max. frequency (Hz)	60.00	O	5-45	X	X	X	X	O
64	0h1440	REV Speed Lmt	Reverse speed limit	0 - Max. frequency (Hz)	60.00	O	5-45	X	X	X	X	O
65	0h1441	Speed Lmt Gain	Speed limit operation gain	100 – 5000%	500	O	5-45	X	X	X	X	O
66	0h1442	Droop Perc	Droop operation amount	0 – 100%	0.0	O	-	X	X	X	X	O
67	0h1443	Droop St Trq	Droop start torque	0 – 100%	100.0	O	-	X	X	X	X	O
68	0h1444	SPD/TRQAcc T	Torque mode →speed mode switching acceleration time	0 - 600 sec	20.0	O	-	X	X	X	X	O
69	0h1445	SPD/TRQAcc T	Torque mode →speed mode switching deceleration time	0 - 600 sec	30.0	O	-	X	X	X	X	O
70	0h1446	SS Mode	Selection of speed search mode	0 Flying Start-1 1 Flying Start-2	0: Flying Start-1	X	-	O	O	O	X	X

Control Function Group (PAR → CON)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	V/F	SL	VC	SLT	VCT
71	0h1447	Speed Search	Selection of speed search operation	Bit: 0000 - 1111 1: Selection of speed by acceleration 2: When starting from reset after tripping the switch 3: When restarting after an interruption in instantaneous power 4: When starting with the power on	0000	X	5-50	O	O	O	X	X
72[Note 20)]	0h1448	SS Sup-Current	Speed search reference current	80 – 200%	75 kW or less: 150 90 kW or more: 100	O	5-50	O	O	X	X	X
73	0h1449	SS P-Gain	Speed search proportional gain	0 – 9999	100	O	5-50	O	O	X	X	X
74	0h144A	SS I-Gain	Speed search integral gain	0 – 9999	200	O	5-50	O	O	X	X	X
75	0h144B	SS Block Time	Output blocking time before the speed search	0 - 60.0 sec	1.0	X	5-50	O	O	X	X	X
77	0h144D	KEB Select	Energy buffering selection	0: No 1: Yes	0: No	X	5-48	O	O	O	X	X
78[Note 21)]	0h144E	KEB Start Lev	Energy buffering start level	110 – 140%	125.0	X	5-48	O	O	O	X	X
79	0h144F	KEB Stop Lev	Energy buffering stop level	130 – 145%	130.0	X	5-48	O	O	O	X	X
80	0h1450	KEB Gain	Energy buffering gain	1 – 1000	1000	O	5-48	O	O	O	X	X
82[Note 22)]	0h1452	ZSD Frequency	zero-speed detected frequency	0 - 10 Hz	2.00	O	-	X	X	O	X	O
83	0h1453	ZSD Band	zero-speed detected frequency band	0 - 2 Hz	1.00	O	-	X	X	O	X	O

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.

Note 20) CON-72 - 75 only appear when CON-71 (Speed Search) is set to '1' or higher.
Note 21) CON-78 - 80 only appear when CON-77 (KEB Select) is set to "Yes”.
Note 22) CON-82 - 83 only appear when DRV-09 (Control Mode) is set to "Vector”.

Control Function Group (PAR → CON)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Note 1) Control mode				
									V/F	SL	VC	SLT	VCT
86 Note 23)	0h1456	Trq Exch Freq	Torque switching frequency	0 - 30.00 Hz		0.00	X	4-3	X	X	X	O	O
87	0h1457	Trq Exch Dec	Torque mode deceleration method	0	Torque	0: Torque	X	4-3	X	X	X	O	O
				1	Speed								
88	0h1456	Trq Exch Ramp	Torque switching lamp	0 - 300.0 sec		5.0	X	4-3	X	X	X	O	O
90 Note 24)	0h145A	ASR P Pro Mode	ASR P Gain profile selection	0	None	0: None	O	4-13	X	X	O	X	X
				1	Linear								
				2	Square								
91 Note 25)	0h145B	ASR P Pro Gain	ASR profile gain	0.01 – 10%		1.00	O	4-13	X	X	O	X	X

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 23) CON-86 - 88 codes appear when DRV10 (Torque Control) is set to "1" and DRV-09 (Control Mode) is set to "Sensorless-1" or "Sensorless-2". Alternatively, it also appears when DRV09 (Control Mode) is set to "Vector;" DRV10 (Torque Control) is set to "1" and the "Speed/Torque" terminal has not been entered; or DRV10 (Torque Control) is set to "0" and the "Speed/Torque" terminal has been entered with the terminal set in IN65 - 75. Under the conditions previously mentioned, however, CON-87 and 88 only appear if CON-86 has a value other than "0".
Note 24) CON-90 only appears when APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close," "UW_Spd Close," "W_Spd Open," or "UW_Spd Open”.
Note 25) CON-91 only appears when CON90 (ASR P Pro Mode) is set to "Linear" or "Square”.

6.5 Parameter Mode – Input Terminal Block Function Group (➔IN)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode				
								V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99	65	O	-	O	O	O	O	O
01	0h1501	Freq at 100%	Frequency at maximum analog input	Start frequency - Max. frequency (Hz)	60.00	O	-	O	O	O	X	X
02	0h1502	Torque at100%	Torque at maximum analog input	0 – 200%	100.0	O	-	X	X	O	O	O
05	0h1505	V1 Monitor (V)	V1 input amount display	0 - 10 V	0.00	O	-	O	O	O	O	O
06	0h1506	V1 Polarity	Selects the V1 input polarity.	0 Unipolar 1 Bipolar	0: Unipolar	X	-	O	O	O	O	O
07	0h1507	V1 Filter	Time constant of V1 input filter	0 - 10000 msec	10	O	-	O	O	O	O	O
08	0h1508	V1 Volt x1	Minimum input voltage of V1	0 - 10 V	0.00	O	-	O	O	O	O	O
09	0h1509	V1 Perc y1	Output at V1 minimum voltage (%)	0 – 100%	0.00	O	-	O	O	O	O	O
10	0h150A	V1 Volt x2	Maximum input voltage for V1	0 - 10 V	10.00	O	-	O	O	O	O	O
11	0h150B	V1 Perc y2	Output at V1 maximum voltage (%)	0 – 100%	100.00	O	-	O	O	O	O	O
12 Note 26)	0h150C	V1 –Volt x1’	V1 –minimum input voltage	-10 - 0 V	0.00	O	-	O	O	O	O	O
13	0h150D	V1 –Perc y1’	Output at V1 minimum voltage (%)	-100 – 0%	0.00	O	-	O	O	O	O	O
14	0h150E	V1 –Volt x2’	V1 – maximum input voltage	-10 - 0 V	-10.00	O	-	O	O	O	O	O
15	0h150F	V1 –Perc y2’	Output at V1 maximum voltage (%)	-100 – 0%	-100.00	O	-	O	O	O	O	O
16	0h1510	V1 Inverting	Changing rotation direction	0 No 1 Yes	0: No	O	-	O	O	O	O	O
17	0h1511	V1 Quantizing	V1 quantization level	0.04 – 10%	0.04	O	-	O	O	O	O	O
20	0h1514	I1 Monitor (mA)	I1 input amount display	0 - 20 mA	0.00	O	-	O	O	O	O	O
22	0h1516	I1 Filter	I1 input filter time constant	0 - 10000 msec	10	O	-	O	O	O	O	O
23	0h1517	I1 Curr x1	I1 minimum input current	0 - 20 mA	4.00	O	-	O	O	O	O	O
24	0h1518	I1 Perc y1	Output (%) at the I1 min. current	0 – 100%	0.00	O	-	O	O	O	O	O
25	0h1519	I1 Curr x2	I1 maximum input current	0 - 20 mA	20.00	O	-	O	O	O	O	O
26	0h151A	I1 Perc y2	Output (%) at the I1 max. current	0 – 100%	100.00	O	-	O	O	O	O	O
31	0h151F	I1 Inverting	I1 rotation direction change	0 No 1 Yes	0: No	O	-	O	O	O	O	O
32	0h1520	I1 Quantizing	I1 quantization level	0.04 – 10%	0.04	O	-	O	O	O	O	O

Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 26) IN-12 - 15 only appear when IN-06 (V1 Polarity) is set to "Bipolar".

Input Terminal Block Function Group (PAR → IN)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
35 Note 27)	0h1523	V2 Monitor (V)	V2 input amount display	0 - 10 V		0.00	O	-	O	O	O	O	O
36	0h1524	V2 Polarity	V1 input polarity selection	0	Unipolar	1: Bipolar	O	-	O	O	O	O	O
				1	Bipolar								
37	0h1525	V2 Filter	V2 input filter time constant	0 - 10000 msec		10	O	-	O	O	O	O	O
38	0h1526	V2 Volt x1	Minimum input voltage of V2	0 - 10 V		0.00	O	-	X	X	O	O	O
39	0h1527	V2 Perc y1	Output (%) at the V2–min. voltage	0 – 100%		0.00	O	-	O	O	O	O	O
40	0h1528	V2 Volt x2	Maximum input voltage of V2	0 - 10 V		0.00	O	-	X	X	O	O	O
41	0h1529	V2 Perc y2	Output (%) at the V2 max. voltage	0 – 100%		100.00	O	-	O	O	O	O	O
42	0h152A	V2 –Volt x1’	V2 - Output at the min. voltage	-10 - 0 V		0.00	O	-	O	O	O	O	O
43	0h152B	V2–Perc y1’	V2 - Output (%) at the min. voltage	-100 – 0%		0.00	O	-	O	O	O	O	O
44	0h152C	V2 –Volt x2’	V2 – Maximum input voltage	-10 - 0 V		-10.00	O	-	O	O	O	O	O
45	0h152D	V2 – Perc y2’	V2 - Output (%) at the max. voltage	-100 – 0%		-100.00	O	-	O	O	O	O	O
46	0h152E	V2 Inverting	V2 rotation direction change	0	No	0: No	O	-	O	O	O	O	O
				1	Yes								
47	0h152F	V2 Quantizing	V2 quantization level	0.04 – 10%		0.04	O	-	O	O	O	O	O
50	0h1532	I2 Monitor (mA)	I2 input amount display	0 - 20 mA		0.00	O	-	O	O	O	O	O
52	0h1534	I2 Filter	I2 input filter time constant	0 - 10000 Msec		10	O	-	O	O	O	O	O
53	0h1535	I2 Curr x1	I2 minimum input current	0 - 20 mA		4.00	O	-	O	O	O	O	O
54	0h1536	I2 Perc y1	Output (%) at the I2 min. current	0 – 100%		0.00	O	-	O	O	O	O	O
55	0h1537	I2 Curr x2	I2 maximum input current	0 - 20 mA		10.00	O	-	O	O	O	O	O
56	0h1538	I2 Perc y2	Output (%) at the I2 max. current	0 – 100%		100.00	O	-	O	O	O	O	O
61	0h153D	I2 Inverting	Changing rotation	0	No	0: No	O	-	O	O	O	O	O
				1	Yes								

No.	Communication	Function	Name	Setting		Initial	Change	Reference	Control mode				
			direction										
62	0h153E	I2 Quantizing	I2 quantization level	0.04 – 10%		0.17	O	-	O	O	O	O	O

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* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 27) IN-35 - 62 only appear when an expansion IO board is installed.

Input Terminal Block Function Group (PAR → IN)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
65	0h1541	P1 Define	P1 terminal function setting	0	NONE	1: FX	X	-	O	O	O	O	O
				1	FX								
66	0h1542	P2 Define	P2 terminal function setting	2	RX	2: RX	X	-	X	X	O	O	O
67	0h1543	P3 Define	P3 terminal function setting	3	RST	5: BX	X	-	O	O	O	O	O
68	0h1544	P4 Define	P4 terminal function setting	4	External Trip	4: Ex.t	X	-	O	O	O	O	O
69	0h1545	P5 Define	P5 terminal function setting	5	BX	7: Sp-L	X	-	O	O	O	O	O
70	0h1546	P6 Define	P6 terminal function setting	6	JOG	8: Sp-M	X	5-5	O	O	O	O	O
71	0h1547	P7 Define	P7 terminal function setting	7	Speed-L	9: Sp-H	X	-	O	O	O	O	O
72	0h1548	P8 Define	P8 terminal function setting	8	Speed-M	6: JOG	X	-	O	O	O	O	O
73 Note 28)	0h1549	P9 Define	P9 terminal function setting	9	Speed-H	0: NONE	X	-	O	O	O	O	O
74	0h154A	P10 Define	P10 terminal function setting	10	Speed-X	0: NONE	X	-	O	O	O	O	O
75	0h154B	P11 Define	P11 terminal function setting	11	XCEL-L	0: NONE	X	-					
				12	XCEL-M			-					
				13	RUN Enable			5-11					
				14	3-Wire			5-11					
				15	2nd Source			-					
				16	Exchange			5-60,5-61					
				17	Up			5-9					
				18	Down			5-9					
				19	- reserved -			-					
				20	U/D Clear			5-9					
				21	Analog Hold			-					
				22	I-Term			5-19					

No.	Communication	Function	Name	Setting		Initial	Change	Reference	Control mode				
					Clear								
				23	PID Openloop			5-19					
				24	P Gain2			-					
				25	XCEL Stop			-					
				26	2nd Motor			5-58					
				27	Trv Offset Lo			5-72					
				28	Trv Offset Hi			5-72					
				29	Interlock 1			-					
				30	Interlock 2			-					
				31	Interlock 3			-					
				32	Interlock 4			-					

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 28) IN73 - 75 only appear when an expansion IO board is installed.

Input Terminal Block Function Group (PAR → IN)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
				33	- Reserved -			-					
				34	Pre Excite			-					
				35	Speed/Torque			5-45,5-47					
				36	ASR Gain 2			5-38					
				37	ASR P/PI			5-38					
				38	Timer In			5-71					
				39	Thermal In			-					
				40	Dis Aux Ref			5-1					
				41	SEQ-1								
				42	SEQ-2								
				43	Manual								
				44	Go Step								
				45	Hold Step								
				46	FWD JOG			5-6					
				47	REV JOG			5-6					
				48	Trq Bias			-					
				49	Web Dis PID			2-17					
				50	Web Quik Stop			2-10					
				51	Web Hold			-					
				52	Web Preset			2-27					
				53	Web Bobbin-L			2-27					
				54	Web Bobbin-H			2-27					
				55	Web PI Gain2			2-22					
				56	Web Bypass			-					
				57	Web Splice			-					
				58	Web Taper Dis			2-13					
				59	Web Boost En			2-15					
				60	Web Down En			2-15					
				61	Ext Dis PID			-					

No.	Communication	Function	Name	Setting range		Initial	Change	Reference	Control mode				
				62	Ext PI Gain2			-					

Input Terminal Block Function Group (PAR → IN)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode: V/F	SL	VC	SLT	VCT
85	0h1555	DI On Delay	Multi-function input terminal on filter	0 - 10000 msec	10	O	-	O	O	O	O	O
86	0h1556	DI Off Delay	Multi-function input terminal off filter	0 - 10000 msec	3	O	-	O	O	O	O	O
87	0h1557	DINC/NO Sel	Multi-function input contact selection	P8 – P1 0: A contact (NO) 1: B contact (NC)	0000 0000	X	-	O	O	O	O	O
88	0h1558	RunOn Delay	Operation command delay time	0 - 100 sec	0.00	X	-	O	O	O	O	O
89	0h1559	InCheck Time	Multi-step command delay time	1 - 5000 msec	1	X	-	O	O	O	O	O
90	0h155A	DI Status	State of the multi-function input terminal	P8 – P1 0: Connection (On) 1: Open (OFF)	0000 0000	O	-	O	O	O	O	O

6.6 Parameter Mode – Output Terminal Block Function Group (→OUT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
00	-	JumpCode	Jump code	0 - 99		30	O	-	O	O	O	O	O
01	0h1601	AO1 Mode	Analog output 1 item	0	Frequency	0: Frequency	O	-	O	O	O	O	O
				1	Current								
				2	Voltage								
				3	DC Link Volt								
				4	Torque								
				5	Watt								
				6	Idss								
				7	Iqss								
				8	Target Freq								
				9	Ramp Freq								
				10	Speed Fbd								
				11	Speed Dev								
				12	PIDRef Value								
				13	PIDFbk Value								
				14	PID Output			4-4					
				15	Constant			-					
				16	Web Spd Out								
				17	Tension Ref								
02	0h1602	AO1 Gain	Analog output 1 gain	-1000 – 1000%		100.0	O	-	O	O	O	O	O
03	0h1603	AO1 Bias	Analog output 1 bias	-100 – 100%		0.0	O	-	O	O	O	O	O
04	0h1604	AO1 Filter	Analog output 1 filter	0 - 10000 msec		5	O	-	O	O	O	O	O
05	0h1605	AO1 Const %	Analog constant output 1	0 – 1000%		0.0	O	-	O	O	O	O	O
06	0h1606	AO1 Monitor	Analog output 1 monitor	0 – 1000%		0.0	-	-	O	O	O	O	O

Input Terminal Block Function Group (PAR → OUT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
07	0h1607	AO2 Mode	Analog output 2 item	0	Frequency	0: Frequency	O	-	O	O	O	O	O
				1	Current								
				2	Voltage								
				3	DC Link Volt								
				4	Torque								
				5	Watt								
				6	Idss								
				7	Iqss								
				8	Target Freq								
				9	Ramp Freq								
				10	Speed Fbd								
				11	Speed Dev								
				12	PIDRef Value								
				13	PIDFbk Value								
				14	PID Output			4-4					
				15	Constant			-					
				16	Web Spd Out								
				17	Tension Ref								
08	0h1608	AO2 Gain	Analog output 2 gain	-1000 – 1000%		80.0	O	-	O	O	O	O	O
09	0h1609	AO2 Bias	Analog output 2 bias	-100 – 100%		20.0	O	-	O	O	O	O	O
10	0h160A	AO2 Filter	Analog output 2 filter	0 - 10000 msec		5	O	-	O	O	O	O	O
11	0h160B	AO2Const %	Analog constant output 2	0 – 100%		0.0	O	-	O	O	O	O	O
12	0h160C	AO2 Monitor	Analog output 2 monitor	0 – 1000%		0.0	O	-	O	O	O	O	O
14[Note 29)]	0h160E	AO3 Mode	Analog output 3 item	0	Frequency	0: Frequency	O	-	O	O	O	O	O
				1	Current								
				2	Voltage								
				3	DC Link Volt								
				4	Torque								
				5	Watt								
				6	Idss								
				7	Iqss								
				8	Target Freq								
				9	Ramp Freq								
				10	Speed Fbd								
				11	Speed Dev								
				12	PID Ref								

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
					Value								
				13	PID Fbk Value								
				14	PID Output								
				15	Constant								

Input Terminal Block Function Group (PAR → OUT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	V/F	SL	VC	SLT	VCT
15	0h160F	AO3 Gain	Analog output 3 gain	-1000 – 1000%		100.0	O	-	O	O	O	O	O
16	0h1610	AO3 Bias	Analog output 3 bias	-100 – 100%		0.0	O	-	O	O	O	O	O
17	0h1611	AO3 Filter	Analog output 3 filter	0 - 10000 msec		5	O	-	O	O	O	O	O
18	-	AO3 Const %	Analog constant output 3	0 – 100%		0.0	O	-	O	O	O	O	O
19	0h1613	AO3 Monitor	Analog output 3 monitor	-1000 – 1000%		0.0	O	-	O	O	O	O	O
20	0h1614	AO4 Mode	Analog output 4 item	0	Frequency	0: Frequency		-	O	O	O	O	O
				1	Current								
				2	Voltage								
				3	DC Link Volt								
				4	Torque								
				5	Watt								
				6	Idss								
				7	Iqss								
				8	Target Freq								
				9	Ramp Freq								
				10	Speed Fbd								
				11	Speed Dev								
				12	PID Ref Value								
				13	PID Fbk Value								
				14	PID Output			4-4					
				15	Constant			-					
21	0h1615	AO4 Gain	Analog output 2 gain	-1000 – 1000%		80.0	-	-	O	O	O	O	O
22	0h1616	AO4 Bias	Analog output 2 bias	-100 – 100%		20.0	O	-	O	O	O	O	O

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
23	0h1617	AO4 Filter	Analog output 2 filter	0 - 10000 msec		5	O	-	O	O	O	O	O
24	-	AO4 Const %	Analog constant output 4	0 – 100%		0.0	O	-	O	O	O	O	O
25	0h1619	AO4 Monitor	Analog output 2 monitor	0 – 1000%		0.0	O	-	O	O	O	O	O
30	0h161E	Trip Out Mode	Fault output item	Bit	000 - 111	010	O	-	O	O	O	O	O
				1	Low voltage								
				2	Any faults other than low voltage								
				3	Automatic restart final failure								

Input Terminal Block Function Group (PAR → OUT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
31	0h161F	Relay 1	Multi-function relay 1 item	0	NONE	28: Trip	O		O	O	O	O	O
32	0h1620	Relay 2	Multi-function relay 2 item	1	FDT-1	13:Run	O		O	O	O	O	O
33	0h1621	Q1 Define	Multi-function output 1 item	2	FDT-2	0: FDT-1	O		O	O	O	O	O
34 Note 31)	0h1622	Q2 Define	Multi-function output 2 item	3	FDT-3	0: FDT-2	O		O	O	O	O	O
35	0h1623	Q3 Define	Multi-function output 3 item	4	FDT-4	0: FDT-3	O		O	O	O	O	O
36	0h1624	Q4 Define	Multi-function output 4 item	5	Over Load	0: FDT-4	O		O	O	O	O	O
				6	IOL								
				7	Under Load								
				8	Fan Lock								
				9	Stall								
				10	Over Voltage								
				11	Low Voltage			-					
				12	Over Heat								
				13	Lost Command								
				14	Run								
				15	Stop								

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
				16	Steady								
				17	Inverter Line								
				18	Comm Line								
				19	Speed Search								
				20	Step Pulse								
				21	Seq Pulse								
				22	Ready			-					
				23	Trv Acc								
				24	Trv Dec								
				25	MMC			-					
				26	Zspd Dect								
				27	Torque Dect			5-45,5-71					
				28	Timer Out			-					
				29	Trip								
				30	Lost Keypad								
				31	DB Warn%ED								
				32	ENC Tune								
				33	ENC Dir								
				34	On/Off Control			5-76					
				35	BR Control			5-73					
				36	Web Break			-					
				37	Web Break Hi								
				38	Web Break Lo								

Input Terminal Block Function Group (PAR → OUT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
41	0h1629	DI Status	State of the multi-function output	-		-	-	-	O	O	O	O	O
50	0h1632	DO On Delay	Multi-function output On delay	0 - 100 sec		0.00	O	-	O	O	O	O	O
51	0h1633	DO Off Delay	Multi-function output Off delay	0 - 100 sec		0.00	O	-	O	O	O	O	O
52	0h1634	DO NC/NO Sel	Multi-function output contact selection.	Q1,Relay2,Relay1		000	X	-	O	O	O	O	O
				0	A contact (NO)								
				1	B contact (NC)								
53	0h1635	TripOut OnDly	Fault output On delay	0 - 100 sec		0.00	O	-	O	O	O	O	O

No.	Communication address	Function display	Name	Setting range	Initial value	Change during	Reference page	Control mode				
54	0h1636	TripOut OffDly	Fault output Off delay	0 - 100.00 sec	0.00	O	-	O	O	O	O	O
55	0h1637	TimerOn Delay	Timer On Delay	0 - 100.00 sec	0.00	O	5-71	O	O	O	O	O
56	0h1638	TimerOff Delay	Timer Off Delay	0 - 100.00 sec	0.00	O	5-71	O	O	O	O	O
57	0h1639	FDT Frequency	Detected frequency	0 - Max. frequency (Hz)	30.00	O	-	O	O	O	O	O
58	0h163A	FDT Band	Detected frequency band	0 - Max. frequency (Hz)	10.00	O	-	O	O	O	O	O
59	0h163B	TD Level	Detected torque amount	0 – 150%	100.0	O	-	X	X	O	X	O
60	0h163C	TD Band	Detected torque width	0 – 10%	5.0	O	5-71	X	X	O	X	O

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 29) OUT-14 - 25 only appear when an expansion IO board is installed.
Note 30) OUT-34 - 36 only appear when an expansion IO board is installed.

6.7 Parameter Mode – Communication Function Group (➔COM)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	Control mode SL	Control mode VC	Control mode SLT	Control mode VCT
00	-	Jump Code	Jump code	0 - 99	20	O	-	O	O	O	O	O
01	0h1701	Int485 St ID	Built-in communication inverter ID	0 - 250	1	O	-	O	O	O	O	O
02	0h1702	Int485 Proto	Built-in communication protocol	0 ModBus RTU 1 Reserved 2 LS Inv 485 3 Serial Debug	0: ModBus RTU	O	-	O	O	O	O	O
03	0h1703	Int485 BaudR	Built-in communication speed	0 1200 bps 1 2400 bps 2 4800 bps 3 9600 bps 4 19200 bps 5 38400 bps	3: 9600 bps	O	-	O	O	O	O	O
04	0h1704	Int485 Mode	Built-in communication frame setting	0 D8/PN/S1 1 D8/PN/S2 2 D8/PE/S1 3 D8/PO/S1	0: D8/PN/S1		-	O	O	O	O	O
05	0h1705	Resp Delay	Transmission delay after reception	0 - 1000 ms	5ms	O	-	O	O	O	O	O
06[Note 31)]	-	FBus S/W Ver	Communication option S/W version		0.00	O	Option	O	O	O	O	O
07	0h171B	FBus ID	Communication option inverter ID	0 - 255	1	O	Option	O	O	O	O	O
08	0h1711	FBUS BaudRate	FIELD BUS communication speed	-	12Mbps		Option	O	O	O	O	O
09	0h171C	FieldBus LED	Communication option LED status	-	-	O	Option	O	O	O	O	O
30	0h171E	ParaStatus Num		0 - 8	3	O	-	O	O	O	O	O
31	0h171F	Para Stauts-1	Communications address 1	0000 - FFFF Hex	000A	O	-	O	O	O	O	O
32	0h1720	Para Stauts-2	Communications address 2	0000 - FFFF Hex	000E	O	-	O	O	O	O	O
33	0h1721	Para Stauts-3	Communications address 3	0000 - FFFF Hex	000F	O	-	O	O	O	O	O
34	0h1722	Para Stauts-4	Communications address 4	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
35	0h1723	Para Stauts-5	Communications address 5	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
36	0h1724	Para Stauts-6	Communications address 6	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
37	0h1725	Para Stauts-7	Communications address 7	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
38	0h1726	Para Stauts-8	Communications address 8	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
39	0h1727	Para Stauts-9	Communications address 9	0000 - FFFF Hex	0000	O	-	O	O	O	O	O

No.	Communication address	Function display	Name	Setting range	Initial value	Change during	Reference page	Control mode				
40	0h1728	Para Stauts-10	Communications address 10	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
41	0h1729	Para Stauts-11	Communications address 11	0000 - FFFF Hex	000F	O	-	O	O	O	O	O

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode				
								V/F	SL	VC	SLT	VCT
42	0h172A	Para Stauts-12	Communications address 12	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
43	0h172B	Para Stauts-13	Communications address 13	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
44	0h172C	Para Stauts-14	Communications address 14	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
45	0h172D	Para Stauts-15	Communications address 15	0000 - FFFF Hex	0000	O	-	O	O	O	O	O
46	0h172E	Para Stauts-16	Communications address 16	0000 - FFFF Hex	0000	O	-	O	O	O	O	O

Communication Function Group (PAR → COM)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
50	0h1732	Para Ctrl Num		0 - 8		2	O	-	O	O	O	O	O
51	0h1733	Para Control-1	Input address 1	0000 - FFFF Hex		0005	X	-	O	O	O	O	O
52	0h1734	Para Control-2	Input address 2	0000 - FFFF Hex		0006	X	-	O	O	O	O	O
53	0h1735	Para Control-3	Input address 3	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
54	0h1736	Para Control-4	Input address 4	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
55	0h1737	Para Control-5	Input address 5	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
56	0h1738	Para Control-6	Input address 6	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
57	0h1739	Para Control-7	Input address 7	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
58	0h173A	Para Control-8	Input address 8	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
59	0h173B	Para Control-9	Input address 9	0000 - FFFF Hex		0005	X	-	O	O	O	O	O
60	0h173C	Para Control-10	Input address 10	0000 - FFFF Hex		0006	X	-	O	O	O	O	O
61	0h173D	Para Control-11	Input address 11	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
62	0h173E	Para Control-12	Input address 12	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
63	0h173F	Para Control-13	Input address 13	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
64	0h1740	Para Control-14	Input address 14	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
65	0h1741	Para Control-15	Input address 15	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
66	0h1742	Para Control-16	Input address 16	0000 - FFFF Hex		0000	X	-	O	O	O	O	O
70	0h1746	Virtual DI 1	Communication multi-function input 1	0	None	0: None	O	-	O	O	O	O	O
71	0h1747	Virtual DI 2	Communication multi-function input 2	1	FX	0: None	O	-	O	O	O	O	O
72	0h1748	Virtual DI 3	Communication multi-function input 3	2	RX	0: None	O	-	O	O	O	O	O
73	0h1749	Virtual DI 4	Communication multi-function input 4	3	RST	0: None	O	-	O	O	O	O	O
74	0h174A	Virtual DI 5	Communication multi-function input 5	4	External Trip	0: None	O	-	O	O	O	O	O
75	0h174B	Virtual DI 6	Communication multi-function input 6	5	BX	0: None	O	-	O	O	O	O	O
76	0h174C	Virtual DI 7	Communication multi-function input 7	6	JOG	0: None	O	-	O	O	O	O	O
77	0h174D	Virtual DI 8	Communication multi-function input 8	7	Speed-L	0: None	O	-	O	O	O	O	O
78	0h174E	Virtual DI 9	Communication multi-function input 9	8	Speed-M	0: None	O	-	O	O	O	O	O
79	0h174F	Virtual DI 10	Communication multi-function input 10	9	Speed-H	0: None	O	-	O	O	O	O	O
80	0h1750	Virtual DI 11	Communication multi-function input 11	10	Speed-X	0: None	O	-	O	O	O	O	O

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
81	0h1751	Virtual DI 12	Communication multi-function input 12	11	XCEL-L	0: None	O	-	O	O	O	O	O
82	0h1752	Virtual DI 13	Communication multi-function input 13	12	XCEL-M	0: None	O	-	O	O	O	O	O
83	0h1753	Virtual DI 14	Communication multi-function input 14	13	RUN Enable	0: None	O	-	O	O	O	O	O
84	0h1754	Virtual DI 15	Communication multi-function input 15	14	3-Wire	0: None	O	-	O	O	O	O	O
85	0h1755	Virtual DI 16	Communication multi-function input 16	15	2nd Source	0: None	O	-	O	O	O	O	O
				16	Exchange								
				17/18	Up/Down								
				19	Reserved								
				20	U/D Clear								
				21	Analog Hold								
				22	I-Term Clear			-					
				23	PID Openloop								
				24	P Gain2								
				25	XCEL Stop								
				26	2nd Motor								

Communication Function Group (PAR → COM)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
				27	Trv Offset Lo								
				28	Trv Offset Hi								
				29	Interlock 1								
				30	Interlock 2								
-	-	-	-	31	Interlock 3	0:None	O	-	O	O	O	O	O
				32	Interlock 4								
				33	Reserved								
				34	Pre Excite								
				35	Speed/Torque								

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
				36	ASR Gain 2								
				37	ASR P/PI								
				38	Timer In								
				39	Thermal In								
				40	Dis Aux Ref								
				41	SEQ-1								
				42	SEQ-2								
				43	Manual								
				44	Go Step								
				45	Hold Step								
				46	FWD JOG								
				47	REV JOG								
				48	Trq Bias								
				49	Web Dis PID								
				50	Web Quik Stop								
				51	Web Hold								
				52	Web Preset								
				53	Web Bobbin-L								
				54	Web Bobbin-H								
				55	Web PI Gain2								
				56	Web Bypass								
				57	Web Splice								
86	0h1756	Virt DI Status	Virtual multi-function state	-		-	-	-					
90	175A	Comm Mon Sel	Monitor type selection	0	Int 485	0: Int 485	O	-	O	O	O	O	O
				1	Keypad								
				2	Field Bus								
91	175B	RcvFrame Num	Number of received frames	-		0	-	-	O	O	O	O	O
92	175C	Err Frame Num	Number of error frames	-		0	-	-	O	O	O	O	O
93	175D	Nak Frame Num	Number of write error frames	-		0	-	-	O	O	O	O	O
94 Note 31)	-	Comm Update	-	0	No	0	-	-	O	O	O	O	O
				1	Yes								

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 31) COM-06 - 17 and 94 only appear after you install the communication option card.
Please refer to the Options Manual for more information about the various options.

6.8 Parameter Mode – Application Function Group (→APP)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	S L	V C	S L T	V C T
00	-	Jump Code	Jump code	0 - 99		20	O	-	O	O	O	O	O
01[Note 32)]	0h1801	App Mode	Application function selection	0	None	0: None	X	-	O	O	O	X	X
				1	Traverse			3-2					
				2	Proc PID			4-8					
				3	Reserved			5-18					
				4	Reserved			오류! 책갈피가 정의되어 있지 않습니다.					
				5	Tension Ctrl			-					
				6	Ext PID Ctrl			-					
02	0h1802	Tnsn Ctrl Mode	Selection of tension control operation mode	0	W_Spd Close	0: W_Spd Close	X	2-2, 3-2	O	O	O	X	X
				1	UW_Spd Close				O	O			
				2	Capstan				O	O			
				3	W_Tens Close				X	X			
				4	UW_Tens Close				X	X			
				5	W_Spd Open				X	X			
				6	UW_Spd Open				X	X			
				7	W_Tens Open				X	X			
				8	UW_Tens Open				X	X			
03	0h1803	Main Spd Disp	Main speed display	Read Only (%)				2-8	O	O	O	X	X
04[Note 33)]	0h1804	Main Spd Set	Main speed command (keypad)	-100.00 - 100.00 (%)		0.00	O	2-8	O	O	O	X	X
05	0h1805	Main Spd Src	Selection of the main speed command method	0	Keypad	1: V1	X	2-8	O	O	O	X	X
				1	V1								
				2	I1								
				3	V2								
				4	I2								
				5	Int 485								
				6	Encoder								
				7	FieldBus								
				8	PLC								
06	0h1806	Main XcelT En	Selection of the main speed accel/decel	0	No	0: No	O	2-8	O	O	O	X	X
				1	Yes								
07[Note 34)]	0h1807	Main Spd AccT	Main speed acceleration time	0.0 - 300.0 sec		10.0	O	2-8	O	O	O	X	X
14[Note 34)]	0h180E	Main Spd DecT	Main speed deceleration time	0.0 - 300.0 sec		20.0	O	-	O	O	O	X	X
15[Note 41)]	0h180F	Web PID En	Tension PID control selection	0	No	1: Yes	O	2-17	O	O	O	X	X
				1	Yes								
16[Note 41)]	0h1810	PID Output	PID output monitor	Read Only (%)				2-17,4-8,5-18	O	O	O	X	X
17	0h1811	PID Ref Value	PID reference monitor	Read Only (%)				2-12,4-8,5-18	O	O	O	X	X
18[Note 41)]	0h1812	PID Fbk Value	PID feedback monitor	Read Only (%)				2-17,4-8,5-18	O	O	O	X	X
19	0h1813	PID Ref Set	PID reference setting	-100 – 100%		50%	O	2-12,4-8,5-18	O	O	O	X	X

Note 32) APP-02 - 99 only appear when APP-01 (App Mode) is set to "Tension Ctrl”.
Note 33) APP-04 only appears when APP-05 (Main Spd Src) is set to "Keypad”.
Note 34) APP-07 and 14 only appear when APP06 (Main XcelT En) is set to "Yes”.
Note 41) It only appears when the APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close," "UW_Spd Close," "W_Tens Close," "UW_Tens Close," and "Capstan”.

Application Function Group (PAR → APP)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode				
								V/F	SL	VC	SLT	VCT
20	0h1814	PID Ref Source	PID reference selection	0 Keypad 1 V1 2 I1 3 V2 4 I2 5 Int 485 6 Encoder 7 FieldBus 8 PLC	0: Keypad	X	2-12,4-8, 5-18	O	O	O	X	X
21[Note 41)]	0h1815	PID F/B Source	PID feedback selection	0 V1 1 I1 2 V2 3 I2 4 Int 485 5 Encoder 6 FieldBus 7 PLC	1: I1	X	2-17,4-8, 5-18	O	O	O	X	X
22[Note 41)]	0h1816	PID P-Gain	PID controller proportional gain	0 – 1000%	50.0	O	2-17	O	O	O	X	X
23[Note 41)]	0h1817	PID I-Time	PID controller integral time	0 - 200.0 sec	10.0	O	2-17	O	O	O	X	X
24[Note 41)]	0h1818	PID D-Time	PID controller differentiation time	0 - 1000 msec	0	O	2-17	O	O	O	X	X
25	0h1819	PID F-Gain	Tension scale	0 - 1000.0%	100.0	O	2-41	X	X	O	X	X
27[Note 41)]	0h181B	PID Out LPF	PID output filter	0 - 10000 ms	0	O	2-17	O	O	O	X	X
28[Note 41)]	0h181C	PID I Limit	PID I controller limit	0 – 100%	100.0	O	2-17	O	O	O	X	X
31[Note 41)]	0h181F	PID Out Inv	PID output inverse	0 No 1 Yes	0: No	X	2-17	O	O	O	X	X
32[Note 41)]	0h1820	PID Out Scale	PID output scale	0.0 - 1000.0%	30.0	O	2-17	O	O	O	X	X
33	0h1821	Init Tns AccT	Initial tension increase time	0.1 - 60.0 sec	1.0	O	2-46	X	X	O	X	X
42[Note 41)]	0h182A	PID Unit Sel	PID controller unit selection	0 % 1 Bar 2 mBar 3 Pa 4 KPa 5 Hz 6 rpm	0: %	O	5-19	O	O	O	X	X

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
				7	V								
				8	I								
				9	kW								
				10	HP								
				11	℃								
				12	°F								

Note 41) It only appears when the APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close," "UW_Spd Close," "W_Tens Close," "UW_Tens Close," and "Capstan”.

Application Function Group (PAR → APP)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
43 (Note 41)	0h182B	PID Unit Gain	PID unit gain	0 - 300[%]		100.0	O	5-19	O	O	O	X	X
44 Note 41)	0h182C	PID Unit Scale	PID unit scale	0	X 100	2: x 1	O	5-19	O	O	O	X	X
				1	X 10								
				2	X 1								
				3	X 0.1								
				4	X 0.01								
45 Note 41)	0h182D	PID P2-Gain	PID 2nd proportional gain	0 – 1000%		100.0	O	2-22	O	O	O	X	X
46 Note 41)	0h182E	PID I2-Time	PID 2nd integral gain	0 - 200.0 sec		20.0	O	2-22	O	O	O	X	X
47 Note 41)	0h182F	PI Change Spd1	Starting main speed for gain switching	0 - PI Change Spd2 (%)		0.00	O	2-23	O	O	O	X	X
48 Note 41)	0h1830	PI Change Spd2	Completing main speed for gain switching.	PI Change Spd1 - 100%		0.00	O	2-23	O	O	O	X	X
49	0h1831	PID Ref RampT	Tension command ramp time	0 - 300.0 sec		0.0	O	2-15	O	O	O	X	X
50 Note 41)	0h1832	PI Gain Ramp	PI gain switching ramp time	0.0 - 300.0 sec		30.0	O	2-22	O	O	O	X	X
51 Note 41)	0h1833	PID Start Ramp	PID output ramp time at startup	0.0 - 300.0 sec		5.0	O	2-17	O	O	O	X	X
52 Note 41)	0h1834	PID Hi Lmt %	PID output upper limit (%)	APP53 - 100.0%		100.0	O	2-17	O	O	O	X	X
53 Note 41)	0h1835	PID Lo Lmt %	PID output lower limit (%)	-100.0 to APP52 (%)		-100.0	O	2-17	O	O	O	X	X
54 Note 41)	0h1836	Fixed PID En	Fixed PID controller selection	0	No	0: No	O	2-34	O	O	O	X	X
				1	Yes								
55 Note 35)	0h1837	Min Fixed PID	Minimum value of the fixed PID	0.0 - 100.0%		10.0	O	2-34	O	O	O	X	X

No.	Communication address	Function display	Name	Setting range	Initial value	Change during	Reference page	Control mode				
			controller									
56	0h1838	Profile P Mode	P Gain profiler selection	0 None 1 Linear 2 Square	0: None	O	2-20	O	O	O	X	X
57 Note 36)	0h1839	Profile P Gain	Profiler gain	0.01 - 10.00%	1.00	O	2-20	O	O	O	X	X
58	0h183A	Taper Sel	Tapering function selection	0 None 1 Linear 2 Hyperbolic	0: None	X	2-13	O	O	O	X	X
59	0h183B	Taper SetPt	Taper setting value (keypad)	-100 – 100%	0.00	O	2-13	O	O	O	X	X
60	0h183C	Taper Source	Taper setting selection	0 Keypad 1 V1 2 I1 3 V2 4 I2	0: Keypad	X	2-13	O	O	O	X	X

Note 35) APP-55 only appears when APP54 (Fixed PID En) is set to "No".
Note 36) APP-57 only appears when APP56 (Profile P Mode) is set to "Linear" or "Square".
Note 41) It only appears when the APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close," "UW_Spd Close," "W_Tens Close," "UW_Tens Close," and "Capstan".

Application Function Group (PAR → APP)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
61 Note 37)	0h183D	Curr Diameter	Current diameter display (%)	APP67 - 100.0%	Current diameter	X	2-29	O	O	O	X	X
62 Note 37)	0h183E	Curr Bobbin	Current bobbin display	Read Only (1 - 4)			2-27	O	O	O	X	X
63 Note 37)	0h183F	Bobbin1 Diamtr	Bobbin 1 diameter (%)	APP67 - 100.0%	10.0	O	2-27	O	O	O	X	X
64 Note 37)	0h1840	Bobbin2 Diamtr	Bobbin 2 diameter (%)	APP67 - 100.0%	15.0	O	2-27	O	O	O	X	X
65 Note 37)	0h1841	Bobbin3 Diamtr	Bobbin 3 diameter (%)	APP67 - 100.0%	20.0	O	2-27	O	O	O	X	X
66 Note 37)	0h1842	Bobbin4 Diamtr	Bobbin 4 diameter (%)	APP67 - 100.0%	25.0	O	2-27	O	O	O	X	X
67 Note 37)	0h1843	Min Diameter	Min. bobbin diameter (%)	5.0 - 100.0%	10.0	X	2-29	O	O	O	X	X
68 Note 37)	0h1844	Diameter LPF	Diameter calculation filter	0.0 - 300.0 sec	50.0	O	2-29	O	O	O	X	X
69	0h1845	Web Hold Freq	Diameter calculation stop filter	0 - 30.00 Hz	5.00	O	2-31	O	O	O	X	X
70	0h1846	MinDia Source	Selection of min. bobbin diameter entry	0 Keypad 1 V1 2 I1 3 V2 4 I2	0: Keypad	X	2-29	O	O	O	X	X
71 Note 38)	0h1847	Thickness En	Material thickness computation selection	0 No 1 Yes	1: Yes	X	3-7	O	O	O	X	X
72 Note 38)	0h1848	Curr Thickness	Current thickness display (%)	10.0 - 100.0%	100.0	X	3-7	O	O	O	X	X

No.	Communication	Function	Name	Setting		Initial	Change	Reference	Control mode				
73	0h1849	Init Boost Tns	The initial tension increase value	100.0 - 500.0%		150.0	O	-	X	X	O	X	X
74 Note 38)	0h184A	Thickness LPF	Material thickness computation filter	0.0 - 300.0 sec		30.0	O	3-8	O	O	O	X	X
75	0h184B	MinDia Value	Min. bobbin diameter monitor	Read Only (%)				2-29	O	O	O	X	X
76	0h184C	Web Brk En	Selection of web break detection function	0	None	1: Warning	O	2-42	O	O	O	X	X
				1	Warning								
				2	Free-run								
77 Note 39)	0h184D	Web Brk St Dly	Web function detection delay time at initial startup	0.0 - 300.0 sec		10.0	O	2-42	O	O	O	X	X
78 Note 39)	0h184E	Web Brk Dly	Web function detection delay time	0.0 - 300.0 sec		5.0	O	2-42	O	O	O	X	X
79 Note 39)	0h184F	Web Brk Lev Hi	Web function detection upper limit	APP80 - 100.0%		80.0	O	2-43	O	O	O	X	X
80 Note 39)	0h1850	Web Brk Lev Lo	Web function detection lower limit	0.0 - APP79%		20.0	O	2-43	O	O	O	X	X

Note 37) APP-61 - 68 only appear when APP02 (Tnsn Ctrl Mode) is set to a mode other than "Capstan".
Note 38) APP-71 - 74 only appear when APP02 (Tnsn Ctrl Mode) is set to "Capstan".
Note 39) APP-77 - 80 only appear when APP76 (Web Brk En) is set to "Warning" or "Free-run".

Application Function Group (PAR → APP)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
81	0h1851	Taper Spt Val	Taper setting value monitor	Read Only (%)				2-13	O	O	O	X	X
82	0h1852	Q Stop Dec T	Emergency stop deceleration time	0.1 - 300.0 sec		3.0	O	2-10	O	O	O	X	X
83	0h1853	Bypass Gain	Bypass gain	0.0 - 300.0%		100.0	O	2-40	O	O	O	X	X
84	0h1854	Rev Tension En	Reverse crawling function selection	0	No	0: No	O	2-37	O	O	O	X	X
				1	Yes								
85	0h1855	Ext PID En	External PID selection	0	No	1: Yes	O	4-9	O	O	O	X	X
				1	Yes								
86 Note 41)	0h1856	W Noise Band	Disturbance detection band	0.0 - 100.0%		0.0	O	2-24	O	O	O	X	X
87 Note 41)	0h1857	W Noise P Gain	Disturbance compensation for P gain	0.0 - 100.0%		0.0	O	2-24	O	O	O	X	X
88 Note 41)	0h1858	W Noise Ramp	Accel/decel time to compensate for disturbances	0.0 - 100.0 sec		0.0	O	2-24	O	O	O	X	X
89	0h1859	Compen Xcel %	Diameter/thickness compensation ratio	0 – 100%		70	O	2-35,3-12	O	O	O	X	X
90	0h185A	Min Main	Min. main speed	0.0 - 100.0%		3.0	O	2-31,3-10	O	O	O	X	X

No.	Communication address	Function display	Name	Setting range	Initial value	Change during	Reference page	Control mode				
		Spd										
91	0h185B	Web Spd Bias	Speed bypass setting	0 - 60.00 (Hz)	1.00	O	2-39	X	X	O	X	X
92	0h185C	Max Main Spd	Frequency for main speed command 100%	DRV19 - DRV20 (Hz)	60.00	O	2-29,3-8	O	O	O	X	X
93[Note 40)]	0h185D	Splice Level	Splice level	0.0 - 100.0%	0.0	O	2-37	O	O	O	X	X
94	0h185E	Tns Boost In	Tension boost setting	0 - 50.00%	0.00	O	2-15	O	O	O	X	X
95	0h185F	Tns Boost Type	Tension boost type	0 Fixed 1 Proportional	0: Fixed	X	2-15	O	O	O	X	X
96	0h1860	Tns Down In	Tension down setting	0 - 50.00%	0.00	O	2-15	O	O	O	X	X
97	0h1861	Tns Down Type	Tension down type	0 Fixed 1 Proportional	0: Fixed	X	2-15	O	O	O	X	X
98	0h1862	PID Sample T	PID calculation cycle	1 - 10 ms	1	X	2-17,4-9	O	O	O	X	X
99	0h1863	Web S/W Ver	Dedicated S/W version	Read Only (1.xx)			-	O	O	O	X	X

Note 40) APP-93 only appears when APP02 (Tnsn Ctrl Mode) is set to a mode other than "Capstan”.
Note 41) It only appears when the APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close," "UW_Spd Close," "W_Tens Close," "UW_Tens Close," and "Capstan”.

6.9 Parameter Mode – Application Function Group 2 (➔AP2)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode				
								V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 – 99	10	O	-	O	O	O	O	O
80[Note 42)]	0h1950	Dia Dis Mode	Selection of web without the diameter calculation	0 No 1 Yes	0: No	X	2-32,2-36, 2-47	O	O	O	X	X
8[Note 43)]	0h1951	Dia Comp Set	Initial value of the diameter compensation gain	0 - 300.0%	100.0	O	2-48	O	O	O	X	X
82	0h1952	Dia Comp Gain	Diameter compensation gain monitor	Read Only (%)			2-48	O	O	O	X	X
83	0h1953	DiaComp PIDLev	PID output value for calculation basis	0 - 100.00%]	10.00	O	2-48	O	O	O	X	X
84	0h1954	Dia Comp LPF	Diameter compensation gain filter	0 - 300.0 sec	50.0	O	2-48	O	O	O	X	X
85	0h1955	Xcel Comp En	Selection of diameter compensation gain computation during accel/decel	0 No 1 Yes	0: No	O	2-49	O	O	O	X	X
86[Note 44)]	0h1956	Steady Chk LPF	Speed filter for determining constant speed	0 - 100.0 sec	1.0	O	2-49	O	O	O	X	X
87	0h1957	Steady Chk Lev	Speed difference for determining constant speed	0 - 50.00%	1.00	O	2-49	O	O	O	X	X

Note 42) AP2-80 only appears when APP-02 (Tnsn Ctrl Mode) is set to "W_Spd Close" and "UW_Spd Close”.
Note 43) AP2-81 - 85 only appear when AP2-80 (Dia Dis Mode) is set to "Yes”.
Note 44) AP2-86 - 87 only appear when AP2-85 (Xcel Comp En) is set to "No”.

6.10 Parameter Mode – Option Card Function Group (➔APO)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	Control mode SL	Control mode VC	Control mode SLT	Control mode VCT
00	-	Jump Code	Jump code	0 - 99	20	O	-	O	O	O	O	O
01[Note 45)]	0h1A01	Enc Opt Mode	Encoder function item	0 None 1 Feedback 2 Reference	0:None	O	5-29,5-31, 5-39	O	O	O	O	O
04	0h1A04	Enc Type Sel	Encoder type selection	0 Line Driver 1 Totem or Com 2 Open Collector	0: Line Driver	X	5-25,5-29, 5-39	O	O	O	O	O
05	0h1A05	Enc Pulse Sel	Encoder pulse direction	0 (A+B) 1 -(A+B) 2 A	0: (A+B)	X	5-29, 5-39	O	O	O	O	O
06	0h1A06	Enc Pulse Num	Number of encoder pulses	10 - 5000	1024	X	5-29, 5-40	O	O	O	O	O
08	0h1A08	Enc Monitor	Feedback monitor	-	-	O	5-29, 5-40	O	O	O	O	O
09	0h1A09	Pulse Monitor	Reference monitor	-	-	O	-	O	O	O	O	O
10	0h1A0A	Enc Filter	Encoder input filter	0 - 10000 msec	3	O	-	O	O	O	O	O
11	0h1A0B	Enc Pulse x1	Min. pulse of the Enc input	0 - 100 kHz	0.00	O	-	O	X	O	X	O
12	0h1A0C	Enc Perc y1	Output (%) at the Enc min. pulse	0 - 100%	0.00	O	-	O	X	O	X	O
13	0h1A0D	Enc Pulse x2	Max. pulse of the Enc input	0 - 200 kHz	100	O	-	O	X	O	X	O
14	0h1A0E	Enc Perc y2	Output (%) at the Enc max. pulse	0 – 100%	100	O	-	O	X	O	X	O
58[Note 46)]	0h1A3A	PLC LED Status	PLC option LED status	-	-	O	Option	O	O	O	O	O
59	0h1A3B	PLC S/W Ver	PLC option card S/W version	-	1.X	O	Option	O	O	O	O	O
60	0h1A3C	PLC Wr Data 1	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
61	0h1A3D	PLC Wr Data 2	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
62	0h1A3E	PLC Wr Data 3	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
63	0h1A3F	PLC Wr Data 4	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
64	0h1A40	PLC Wr Data 5	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
65	0h1A41	PLC Wr Data 6	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
66	0h1A42	PLC Wr Data 7	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
67	0h1A43	PLC Wr Data 8	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 45) APO-01 - 14 only appear when an encoder board is installed.
Note 46) APO-58 - 83 only appear when the PLC option board is installed.

Option Card Function Group (PAR → APO)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode				
								V/F	SL	VC	SLT	VCT
76	0h1A44	PLD Rd Data 1	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
77	0h1A45	PLD Rd Data 2	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
78	0h1A41	PLD Rd Data 3	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
79	0h1A42	PLD Rd Data 4	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
80	0h1A43	PLD Rd Data 5	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
81	0h1A44	PLD Rd Data 6	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
82	0h1A45	PLD Rd Data 7	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O
83	0h1A45	PLD Rd Data 8	-	0 - FFFF [Hex]	0000	O	Option	O	O	O	O	O

6.11 Parameter Mode – Protection Function Group (→PRT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99		40	O	-	O	O	O	O	O
04	0h1B04	Load Duty	Load level setting	0 1	Normal Duty Heavy Duty	1:Heavy Duty	X	-	O	O	O	O	O
05	0h1B05	Phase Loss Chk	Input/output open-phase protection	Bit 1 2	00 - 11 Open-phase of output Open-phase of input	00	X	-	O	O	O	O	O
06	0h1B06	IPO V Band	Open-phase of input voltage band	1 - 100 V		40	X	-	O	O	O	O	O
07	0h1B07	Trip Dec Time	deceleration time at fault	0 - 600 sec		3.0	O	-	O	O	O	O	O
08	0h1B08	RST Restart	Selection of startup on trip reset	0 1	No Yes	0: No	O	5-54	O	O	O	O	O
09	0h1B09	Retry Number	Number of automatic restarts	0 - 10		0	O	5-54	O	O	O	O	O
10[Note 47)]	0h1B0A	Retry Delay	Automatic restart delay time	0 - 60.0 sec		1.0	O	5-54	O	O	O	O	O
11	0h1B0B	Lost KPD Mode	Motion at keypad command loss	0 1 2 3	None Warning Free-Run Dec	0: None	O	-	O	O	O	O	O
12	0h1B0C	Lost Cmd Mode	Motion at speed command loss	0 1 2 3 4 5	None Free-Run Dec Hold Input Hold Output Lost Preset	0: None	O	-	O	O	O	O	O
13[Note 48)]	0h1B0D	Lost Cmd Time	Time to judge speed command loss	0.1 - 120 sec		1.0	O	-	O	O	O	O	O
14	0h1B0E	Lost Preset F	Operation frequency at speed command loss	Start frequency - Max. frequency (Hz)		0.00	O	-	O	O	O	O	O
15	0h1B0F	AI Lost Level	Analog input loss judgment level	0 1	Half of x1 Below x1	0: Half of x1	O	-	O	O	O	O	O
17	0h1B11	OL Warn Select	Overload warning selection	0 1	No Yes	0: No	O	-	O	O	O	O	O
18	0h1B12	OL Warn Level	Overload alarm level	30 – 180%		150	O	-	O	O	O	O	O
19	0h1B13	OL Warn Time	Overload warning time	0 - 30.0 sec		10.0	O	-	O	O	O	O	O
20	0h1B14	OL Trip Select	Motion at overload fault	0 1 2	None Free-Run Dec	1: Free-Run	O	-	O	O	O	O	O
21	0h1B15	OL Trip Level	Overload fault	30 – 200%		180	O	-	O	O	O	O	O

No.	Communication	Function	Name	Setting	Initial	Change	Reference	Control mode				
			level									

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 47) PRT-10 only appears when PRT-09 (Retry Number) is set to "0" or more.
Note 48) PRT-13 - 15 only appear when PRT-12 (Lost Cmd Mode) is a value other than "NONE".

Protection Function Group (PAR → PRT)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
22	0h1B16	OL Trip Time	Overload fault time	0 - 60 sec	60.0	O	-	O	O	O	O	O
25	0h1B19	UL Warn Sel	Underload warning selection	0 No 1 Yes	0: No	O	-	O	O	O	O	O
26	0h1B1A	UL Warn Time	Underload warning time	0 - 600.0 sec	10.0	O	-	O	O	O	O	O
27	0h1B1B	UL Trip Sel	Underload fault selection	0 None 1 Free-Run 2 Dec	0: None	O	-	O	O	O	O	O
28	0h1B1C	UL Trip Time	Underload fault time	0 - 600 sec	30.0	O	-	O	O	O	O	O
29	0h1B1D	UL LF Level	Underload lower limit level	10 – 30%	30	O	-	O	O	O	O	O
30	0h1B1E	UL BF Level	Underload upper limit level	10 – 100%	30	O	-	O	O	O	O	O
31	0h1B1F	No Motor Trip	Motion under no motor detection	0 None 1 Free-Run	0: None	O	-	O	O	O	O	O
32	0h1B20	No Motor Level	No motor detection current level	1 – 100%	5	O	-	O	O	O	O	O
33	0h1B21	No Motor Time	No motor detection delay	0.1 - 10.0 sec	3.0	O	-	O	O	O	O	O
34	0h1B22	Thermal-T Sel	Selection of motion after motor detects overheating motor	0 None 1 Free-Run 2 Dec	0: None	O	-	O	O	O	O	O
35	0h1B23	Thermal In Src	Input selection of the sensor detecting overheating motor	0 None 1 V1 2 I1 3 V2 4 I2	0: None	X	-	O	O	O	O	O
36	0h1B24	Thermal-T Lev	Fault level of the sensor detecting overheating motors	0 – 100%	50.0	O	-					
37	0h1B25	Thermal-T Area	Fault area of the sensor detecting overheating motor	0 Low 1 High	0: Low	O	-	O	O	O	O	O
40	0h1B28	ETH Trip Sel	Electronic thermal fault level selection	0 None 1 Free-Run 2 Dec	0: None	O	-	O	O	O	O	O
41	0h1B29	Motor Cooling	Motor cooling	0 Self-cool	0: Self-cool	O	-	O	O	O	O	O

No.	Communication	Function	Name	Setting		Initial	Change	Reference	Control mode				
			fan type	1	Forced-cool								
42	0h1B2A	ETH 1min	Electronic thermal 1 minute rating	120 – 200%		150	O	-	O	O	O	O	O
43	0h1B2B	ETH Cont	Electronic thermal continuous rating	50 – 200%		120	O	-	O	O	O	O	O
48	0h1B30	Stall Src Sel	Stall level setting method	0	Keypad	0: Keypad	X	4-1	O	O	O	X	X
				1	V1								
				2	I1								
				3	V2								
				4	I2								
				5	Pulse								

Protection Function Group (PAR → PRT)

No.	Communication address	Function display	Name	Setting range		Initial value	Change during operation	Reference page	Control mode				
									V/F	SL	VC	SLT	VCT
49[Note 49)]	0h1B31	Stall % Disp	Stall level display	Read Only		Read Only	X	4-1	O	O	O	X	X
50	0h1B32	Stall Prevent	Stall prevention motion	Bit	000 – 111	000	X	4-1	O	O	X	O	X
				1	Accelerating								
				2	At constant speed								
				3	At deceleration								
51	0h1B33	Stall Freq 1	Stall frequency 1	DRV19 - PRT53 (Hz)		60.00	O	-	O	O	X	O	X
52	0h1B34	Stall Level 1	Stall level 1	30 – 250%		180	X	4-1-	O	O	X	O	X
53	0h1B35	Stall Freq 2	Stall frequency 2	PRT51 - PRT55 (Hz)		60.00	O	-	O	O	X	O	X
54	0h1B36	Stall Level 2	Stall level 2	30 - 250%		180	X	-	O	O	X	O	X
55	0h1B37	Stall Freq 3	Stall frequency 3	PRT53 - PRT57 (Hz)		60.00	O	-	O	O	X	O	X
56	0h1B38	Stall Level 3	Stall level 3	30 – 250%		180	X	-	O	O	X	O	X
57	0h1B39	Stall Freq 4	Stall frequency 4	PRT55 - DRV20 (Hz)		60.00	O	-	O	O	X	O	X
58	0h1B3A	Stall Level 4	Stall level 4	30 – 250%		180	X	-	O	O	X	O	X
66	0h1B42	DB Warn %ED	DB resistor warning level	0 – 30%		0	O	-	O	O	O	O	O
70	0h1B46	OverSPD Freq	Overspeed judgment frequency	20 – 130%		120.0	O	-	X	X	O	X	O
72	0h1B48	OverSPD Time	Overspeed judgment time	0.01 - 10.00 sec		0.01	O	-	X	X	O	X	O
73	0h1B49	Speed Dev Trip	Speed error fault	0	No	0: No	O	-	X	X	O	X	X
				1	Yes								
74	0h1B4A	Speed Dev Band	Speed error width	2 - Max. frequency (Hz)		20.00	O	-	X	X	O	X	X
75	0h1B4B	Speed	Speed error	0.1 - 1000.0 sec		1.0	O	-	X	X	O	X	X

No.	Communication address	Function display	Name	Setting range		Initial value	Change during	Reference page	Control mode				
		DevTime	judgment time										
77	0h1B4D	Enc Wire Check	Encoder option connection check	0 1	No Yes	0: No	O	-	X	X	O	X	O
78	0h1B4E	Enc Check Time	Encoder connection check time	0.1 - 1000.0 sec		1.0	O	-	X	X	O	X	O
79	0h1B4F	FAN Trip Mode	Cooling fan fault selection	0 1	Trip Warning	0: Trip	O	-	O	O	O	O	O
80	0h1B50	Opt Trip Mode	Motion selection at option trip	0 1 2	None Free-Run Dec	1: Free-Run	O	-	O	O	O	O	O
81	0h1B51	LVT Delay	Low voltage fault judgment delay time	0 - 60.0 sec		0.0	X	-	O	O	O	O	O

* Codes in shaded rows are hidden codes that only appear when setting corresponding codes.
Note 49) PRT-49 only appears when PR-48 (Stall Src Sel) is set to "1" or more.

6.12 Parameter Mode – 2nd Motor Function Group (➔M2) Note 50)

No.	Communication address	Function display	Name	Setting range	Initial value	Change during operation	Reference page	Control mode V/F	SL	VC	SLT	VCT
00	-	Jump Code	Jump code	0 - 99	1	O	-	O	O	X	O	X
04	0h1C04	M2-Acc Time	Acceleration time	0 - 600 sec	75 kW or less: 20.0 90 kW or more: 60.0	O	-	O	O	X	O	X
05	0h1C05	M2-Dec Time	Deceleration time	0 - 600 sec	75 kW or less: 30.0 90 kW or more: 90.0	O	-	O	O	X	O	X
06	0h1C06	M2-Capacity	Motor capacity	0 - 0.2 kW 21 185 kW	-	X	-	O	O	X	O	X
07	0h1C07	M2-Base Freq	Base frequency	30 - 400 Hz	60.00	X	-	O	O	X	O	X
08	0h1C08	M2-Ctrl Mode	Control mode	0 V/F 1 V/F PG 2 Slip Compen 3 Sensorless-1 4 Sensorless-2	0: V/F	X	-	O	O	X	O	X
10	0h1C0A	M2-Pole Num	Number of motor poles	2 - 12	4	X	-	O	O	X	O	X
11	0h1C0B	M2-Rated Slip	Rated slip speed	0 - 3000 rpm	-	X	-	O	O	X	O	X
12	0h1C0C	M2-Rated Curr	Motor rated current	1.0 - 1000.0 A	-	X	-	O	O	X	O	X
13	0h1C0D	M2-Noload Curr	Motor no-load current	0.5 - 1000.0 A	-	X	-	O	O	X	O	X
14	0h1C0E	M2-Rated Volt	Motor rated voltage	180 - 480 V	0	X	-	O	O	X	O	X
15	0h1C0F	M2-Efficiency	Motor efficiency	70 – 100 (%)	-	X	-	O	O	X	O	X
16	0h1C10	M2-Inertia Rt	Load inertia rate	0 - 8	0	X	-					
17	-	M2-Rs	Stator resistor	0 - 9.999 (Ω)	-	X	-					
18	-	M2-Lsigma	Leakage inductance	0 - 99.99 mH	-	X	-					
19	-	M2-Ls	Stator inductance	0 - 999.9 mH	-	X	-	O	O	X	O	X
20	-	M2-Tr	Rotor time constant	25 - 5000 msec	-	X	-	O	O	X	O	X
25	0h1C19	M2-V/F Patt	V/F pattern	0 Linear 1 Square 2 User V/F	0: Linear	X	-	O	O	X	O	X
26	0h1C1A	M2-Fwd Boost	Forward torque boost	0 – 15%	75 kW or less: 2.0	X	-	O	O	X	O	X
27	0h1C1B	M2-Rev Boost	Reverse torque boost	0 – 15%	90 kW or more: 1.0	X	-	O	O	X	O	X
28	0h1C1C	M2-Stall Lev	Stall prevention level	30 – 150%	150	X	-	O	O	X	O	X
29	0h1C1D	M2-ETH 1min	Electronic thermal 1 minute rating	100 – 200%	150	X	-	O	O	X	O	X
30	0h1C1E	M2-ETH Cont	Electronic thermal continuous rating	50 – 150%	100	X	-	O	O	X	O	X

<table>
<tr><th>No.</th><th>Communication address</th><th>Function display</th><th>Name</th><th colspan="2">Setting range</th><th>Initial value</th><th>Change during</th><th>Reference page</th><th colspan="5">Control mode</th></tr>
<tr><td>40</td><td>0h1C28</td><td>M2-LoadSpdGain</td><td>Revolution display gain</td><td colspan="2">0.1 - 6000.0%</td><td>100.0</td><td>O</td><td>-</td><td>O</td><td>O</td><td>O</td><td>O</td><td>O</td></tr>
<tr><td rowspan="5">41</td><td rowspan="5">0h1C29</td><td rowspan="5">M2-LoadSpdScal</td><td rowspan="5">Revolution display scale</td><td>0</td><td>x 1</td><td rowspan="5">0: x 1</td><td rowspan="5">O</td><td rowspan="5">-</td><td rowspan="5">O</td><td rowspan="5">O</td><td rowspan="5">O</td><td rowspan="5">O</td><td rowspan="5">O</td></tr>
<tr><td>1</td><td>x 0.1</td></tr>
<tr><td>2</td><td>x 0.01</td></tr>
<tr><td>3</td><td>x 0.001</td></tr>
<tr><td>4</td><td>x 0.0001</td></tr>
<tr><td rowspan="2">42</td><td rowspan="2">0h1C2A</td><td rowspan="2">M2-LoadSpdUnit</td><td rowspan="2">Revolution display unit</td><td>0</td><td>rpm</td><td rowspan="2">0: rpm</td><td rowspan="2">O</td><td rowspan="2">-</td><td rowspan="2">O</td><td rowspan="2">O</td><td rowspan="2">O</td><td rowspan="2">O</td><td rowspan="2">O</td></tr>
<tr><td>1</td><td>mpm</td></tr>
</table>

Note 50) The M2 group only appear when the "2nd Motor" is specified in IN65 - 75.

6.13 Trip mode (TRP Current (or Last-x))

<table>
<tr><th>No.</th><th>Function display</th><th>Name</th><th colspan="2">Setting range</th><th>Initial value</th></tr>
<tr><td>00</td><td>Trip Name (x)</td><td>Fault type display</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>01</td><td>Output Freq</td><td>Operation frequency at fault</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>02</td><td>Output Current</td><td>Output current at fault</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>03</td><td>Inverter State</td><td>Accel/Decel status at fault</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>04</td><td>DCLink Voltage</td><td>DC voltage</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>05</td><td>Temperature</td><td>NTC temperature</td><td colspan="2">-</td><td>-</td></tr>
<tr><td>06</td><td>DI State</td><td>Input terminal block status</td><td colspan="2">-</td><td>0000 0000</td></tr>
<tr><td>07</td><td>DO State</td><td>Output terminal block status</td><td colspan="2">-</td><td>000</td></tr>
<tr><td>08</td><td>Trip On Time</td><td>Fault time after power on</td><td colspan="2">-</td><td>0000DAY 00:00</td></tr>
<tr><td>09</td><td>Trip Run Time</td><td>Fault time after starting operation</td><td colspan="2">-</td><td>0000DAY 00:00</td></tr>
<tr><td rowspan="2">10</td><td rowspan="2">Trip Delete?</td><td rowspan="2">Fault history deletion</td><td>0</td><td>No</td><td rowspan="2">0: No</td></tr>
<tr><td>1</td><td>Yes</td></tr>
</table>

6.14 Config Mode (CNF)

No.	Function display	Name	Setting range		Initial value	Reference page
00	Jump Code	Jump code	0 - 99		40	-
01	Language Sel	Keypad language selection	English		English	-
02	LCD Contrast	LCD contrast adjustment	-		-	5-70
10	Inv S/W Ver	Main body S/W version	-		1.XX	5-70
11	Keypad S/W Ver	Keypad S/W version	-		1.XX	5-70
12	KPD Title Ver	Keypad title version	-		1.XX	5-70
20 Note 51)	Anytime Para	Status window display item	0	Frequency	0: Frequency	-
21	Monitor Line-1	Monitor mode display item 1	1	Speed	0: Frequency	-
22	Monitor Line-2	Monitor mode display item 2	2	Output Current	2: Output Current	-
23	Monitor Line-3	Monitor mode display item 3	3	Output Voltage	3: Output Voltage	-
			4	Output Power		
			5	WHour Counter		
			6	DCLink Voltage		
			7	DI State		
			8	DO State		
			9	V1 Monitor (V)		
			10	V1 Monitor (%)		
			11	I1 Monitor (mA)		
			12	I1 Monitor (%)		
			13	V2 Monitor (V)		
			14	V2 Monitor (%)		
			15	I2 Monitor (mA)		
			16	I2 Monitor (%)		
			17	PID Output		
			18	PID Ref Value		
			19	PID Fbk Value		
			20	Torque		
			21	Torque Limit		
			22	Trq Bias Ref		
			23	Speed Limit		
			24	Load Speed		
			25	XV1Monitor (V)		
			26	XV1Monitor (%)		

Note 51) Items no. 7 and 8 do not appear in the Anytime Parameters.

Config Mode (CNF)

No.	Function display	Name	Setting range		Initial value	Reference page
			27	XI1Monitor (mA)		-
			28	XI1Monitor (%)		
			29	XV2Monitor (V)		
			30	XV2Monitor (%)		
			31	XI2Monitor (mA)		
			32	XI2Monitor (%)		
			33	XV3Monitor (V)		
			34	XV3Monitor (%)		
			35	XI3Monitor (mA)		
			36	XI3Monitor (%)		
			37	XV4Monitor (V)		
			38	XV4Monitor (%)		
			39	XI4Monitor (mA)		
			40	XI4Monitor (%)		
			41	Main Spd Disp		
			42	Curr Diameter		
			43	Curr Thickness		
			44	Temperature		
24	Mon Mode Init	Monitor mode initialization	0	No	0: No	-
			1	Yes		
30	Option-1 Type	Option slot 1 type display	0	None	0: None	Option
31	Option-2 Type	Option slot 2 type display	1	PLC	0: None	Option
32	Option-3 Type	Option slot 3 type display	2	Profi	0: None	Option
			3	Ext. I/O		
			4	Encoder		
40	Parameter Init	Parameter initialization	0	No		5-63
			1	All Grp		
			2	DRV Grp		
			3	BAS Grp		
			4	ADV Grp		
			5	CON Grp		
			6	IN Grp		
			7	OUT Grp		
			8	COM Grp		
			9	APP Grp		
			10	AUT Grp		
			11	APO Grp		
			12	PRT Grp		
			13	M2 Grp		
41	Changed Para	Changed parameter Sign	0	View All	0: View All	5-65
			1	View Changed		

Config Mode (CNF)

No.	Function display	Name	Setting range		Initial value	Reference page
42	Multi Key Sel	Multi-function key item	0	None	0: None	5-66,5-70
			1	JOG Key		
			2	Local/Remote		
			3	UserGrp SelKey		
43	Macro Select	Macro function item	0	None	0: None	5-68
			1	Draw App		
			2	Traverse		
44	Erase All Trip	Fault history deletion	0	No	0: No	5-70
			1	Yes		
45	UserGrp AllDel	User registration code deletion	0	No	0: No	5-66
			1	Yes		
46	Parameter Read	Read parameters	0	No	0: No	5-62
			1	Yes		
47	Parameter Write	Write parameters	0	No	0: No	5-62
			1	Yes		
48	Parameter Save	Saves communication parameters	0	No	0: No	5-62
			1	Yes		
50	View Lock Set	Hide parameter mode	0 - 9999		Un-locked	5-64
51	View Lock Pw	Password to hide parameter mode	0 - 9999		Password	5-64
52	Key Lock Set	Lock parameter edit	0 - 9999		Un-locked	5-65
53	Key Lock Pw	Password to lock parameter editing	0 - 9999		Password	5-65
60	Add Title Up	Additional keypad title update	0	No	0: No	5-70
			1	Yes		
61	Easy Start On	Simple parameter setting	0	No	0: Yes	5-69
			1	Yes		
62	WHCount Reset	Initializing power consumption	0	No	0: No	5-70
			1	Yes		
70	On-time	Accumulated time of inverter motion	0000DAY hh:mm		-	-
71	Run-time	Accumulated time of inverter operation	0000DAY hh:mm		-	-
72	Time Reset	Initializing the accumulative time of inverter operation	0	No	0: No	-
			1	Yes		
73	Real Time	Clock display	0000DAY hh:mm		-	-
74	Fan Time	Accumulated time of cooling fan operation	0000DAY hh:mm		-	5-70
75	Fan Time Rst	Initializes the accumulated time of cooling fan operation.	0000DAY hh:mm		-	5-70

7. iS7 Communication Common Areas

7.1 iS7 Monitoring Common Areas

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0300	Inverter model	-	-	iS7: 000Bh	
0h0301	Inverter capacity	-	-	0.75 kW: 3200h	
				1.5 kW: 4015h	2.2 kW: 4022h
				3.7 kW: 4037h	5.5 kW: 4055h
				7.5 kW: 4075h	11 kW: 40B0h
				15 kW: 40F0h	18.5 kW: 4125h
				22 kW: 4160h	30 kW: 41E0h
				37 kW: 4250h	45 kW: 42D0h
				55 kW: 4370h	75 kW: 44B0h
				90 kW: 45A0h	110 kW: 46E0h
				132 kW: 4840h	160 kW: 4A00h
				185 kW: 4B90h	
0h0302	Inverter voltage/power input types (single-phase, 3-phase) /Cooling method	-	-	200 V single-phase self-cooling: 0220h	
				200 V 3-phase self-cooling: 0230h	
				200 V single-phase forced cooling: 0221h	
				200 V 3-phase forced cooling: 0231h	
				400 V single phase self cooling: 0420h	
				400 V 3-phase self cooling: 0430h	
				400 V single phase forced cooling: 0421h	
				400 V 3-phase forced cooling: 0431h	
0h0303	Inverter S/W version	-	-	(Example) 0h0100: Version 1.00	
				0h0101: Version 1.01	
0h0304	Reserved	-	-	-	
0h0305	Inverter operation state	-	-	B15	0000(0): Normal state 0100(4): Warning occurred 1000(8): Fault occurred (Operates according to the value specified in PRT-30 "Trip Mode".)
				B14	
				B13	
				B12	
				B11	-
				B10	
				B9	
				B8	
				B7	0001(1): During speed search 0010(2): Accelerating 0011(3): Driving at a constant speed 0100(4): Decelerating 0101(5): Decelerating to a stop 0110(6): H/W OCS 0111(7): S/W OCS 1000(8): Dwell during operation
				B6	
				B5	
				B4	
				B3	0000(0): Stop 0001(1): Forward during operation 0010(2): Reverse during operation 0011(3): DC during operation (zero-speed control)
				B2	
				B1	
				B0	

<table>
<tr><th>Communication Address</th><th>Parameter</th><th>Scale</th><th>Unit</th><th colspan="2">Assigned content by bit</th></tr>
<tr><td rowspan="16">0h0306</td><td rowspan="16">Inverter operation, Frequency command source</td><td rowspan="16">-</td><td rowspan="16">-</td><td>B15</td><td rowspan="8">Operation command source
00000000(0): Keypad 00000001(1): Communication option
00000010(2): App/PLC 00000011(3): Built-in 485
00000100(4): Terminal block
00000101(5): Reserved
00000110(6): Auto 1
00000111(7): Auto 2</td></tr>
<tr><td>B14</td></tr>
<tr><td>B13</td></tr>
<tr><td>B12</td></tr>
<tr><td>B11</td></tr>
<tr><td>B10</td></tr>
<tr><td>B9</td></tr>
<tr><td>B8</td></tr>
<tr><td>B7</td><td rowspan="8">Frequency command source
00000000(0): Keypad speed
00000001(1): Keypad torque
00000010~00000100(2 – 4): Up/Down operation speed
00000101(5): V1 00000110(6): I1
00000111(7): V2 00001000(8): I2
00001001(9): Pulse 00001010(10): Built-in 485
00001011(11): Communication option
00001100(12): App (PLC)
00001101(13): Jog 00001110(14): PID
00001111~00010110(15 – 22): Auto Step
00011001~00100111(25 – 39): Multi-step speed frequency</td></tr>
<tr><td>B6</td></tr>
<tr><td>B5</td></tr>
<tr><td>B4</td></tr>
<tr><td>B3</td></tr>
<tr><td>B2</td></tr>
<tr><td>B1</td></tr>
<tr><td>B0</td></tr>
<tr><td>0h0307</td><td>Keypad S/W version</td><td></td><td></td><td colspan="2">(Example) 0h0100: Version 1.00</td></tr>
<tr><td>0h0308</td><td>Keypad title version</td><td></td><td></td><td colspan="2">0h0101: Version 1.01</td></tr>
<tr><td>0h0309 - 0h30F</td><td>Reserved</td><td></td><td></td><td colspan="2"></td></tr>
<tr><td>0h0310</td><td>Output current</td><td>0.1</td><td>A</td><td colspan="2">-</td></tr>
<tr><td>0h0311</td><td>Output frequency</td><td>0.01</td><td>Hz</td><td colspan="2">-</td></tr>
<tr><td>0h0312</td><td>Output RPM</td><td>0</td><td>RPM</td><td colspan="2">-</td></tr>
<tr><td>0h0313</td><td>Motor feedback speed</td><td>0</td><td>RPM</td><td colspan="2">- 32768 rpm - 32767 rpm (with directionality)</td></tr>
<tr><td>0h0314</td><td>Output voltage</td><td>1</td><td>V</td><td colspan="2">-</td></tr>
<tr><td>0h0315</td><td>DC Link Voltage</td><td>1</td><td>V</td><td colspan="2">-</td></tr>
<tr><td>0h0316</td><td>Output power</td><td>0.1</td><td>kW</td><td colspan="2">-</td></tr>
<tr><td>0h0317</td><td>Output torque</td><td>0.1</td><td>%</td><td colspan="2">-</td></tr>
<tr><td>0h0318</td><td>PID reference</td><td>0.1</td><td>%</td><td colspan="2">-</td></tr>
<tr><td>0h0319</td><td>PID feedback</td><td>0.1</td><td>%</td><td colspan="2">-</td></tr>
<tr><td>0h031A</td><td>Display the number of poles for the 1st motor</td><td>-</td><td>-</td><td colspan="2">Display the number of poles for the 1st motor</td></tr>
<tr><td>0h031B</td><td>Display the number of poles for the 2nd motor</td><td>-</td><td>-</td><td colspan="2">Display the number of poles for the 2nd motor</td></tr>
<tr><td>0h031C</td><td>Display the number of poles for the selected motor</td><td>-</td><td>-</td><td colspan="2">Display the number of poles for the selected motor</td></tr>
<tr><td>0h031D</td><td>Select Hz/rpm</td><td>-</td><td>-</td><td colspan="2">0: Hz unit
1: rpm unit</td></tr>
<tr><td>0h031E - 0h031F</td><td>Reserved</td><td>-</td><td>-</td><td colspan="2">-</td></tr>
</table>

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0320	Digital input information			BI5	Reserved
				BI4	Reserved
				BI3	Reserved
				BI2	Reserved
				BI1	Reserved
				BI0	P11 (Expansion I/O)
				B9	P10 (Expansion I/O)
				B8	P9 (Expansion I/O)
				B7	P8 (Basic I/O)
				B6	P7 (Basic I/O)
				B5	P6 (Basic I/O)
				B4	P5 (Basic I/O)
				B3	P4 (Basic I/O)
				B2	P3 (Basic I/O)
				B1	P2 (Basic I/O)
				B0	P1 (Basic I/O)
0h0321	Digital Output information	-	-	BI5	Reserved
				BI4	Reserved
				BI3	Reserved
				BI2	Reserved
				BI1	Reserved
				BI0	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Q4 (Expansion I/O)
				B4	Q3 (Expansion I/O)
				B3	Q2 (Expansion I/O)
				B2	Q1 (Basic I/O)
				B1	Relay2 (Basic I/O)
				B0	Relay1 (Basic I/O)

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0322	Virtual digital Input information	-	-	B15	Virtual DI 16 (COM85)
				B14	Virtual DI 15 (COM84)
				B13	Virtual DI 14 (COM83)
				B12	Virtual DI 13 (COM82)
				B11	Virtual DI 12 (COM81)
				BI0	Virtual DI 11 (COM80)
				B9	Virtual DI 10 (COM79)
				B8	Virtual DI 9 (COM78)
				B7	Virtual DI 8 (COM77)
				B6	Virtual DI 7 (COM76)
				B5	Virtual DI 6 (COM75)
				B4	Virtual DI 5 (COM74)
				B3	Virtual DI 4 (COM73)
				B2	Virtual DI 3 (COM72)
				B1	Virtual DI 2 (COM71)
				B0	Virtual DI 1 (COM70)
0h0323	Display the selected motor	-	-	0: The 1st motor/1: The 2nd motor	
0h0324	AI1	0.01	%	Analog input 1 (Basic I/O)	
0h0325	AI2	0.01	%	Analog input 2 (Basic I/O)	
0h0326	AI3	0.01	%	Analog input 3 (Expansion I/O)	
0h0327	AI4	0.01	%	Analog input 4 (Expansion I/O)	
0h0328	AO1	0.01	%	Analog output 1 (basic I/O)	
0h0329	AO2	0.01	%	Analog output 2 (basic I/O)	
0h032A	AO3	0.01	%	Analog output 3 (extended I/O)	
0h032B	AO4	0.01	%	Analog output 4 (extended I/O)	
0h032C	Reserved	-	-	-	
0h032D	Temperature	1	℃	-	
0h032E	Reserved	-	-	-	
0h032F	Reserved	-	-	-	

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0330	Latch type trip information-1	-	-	BI5	Fuse Open Trip
				BI4	Overheat Trip
				BI3	Arm Short
				BI2	External Trip
				BI1	Overvoltage Trip
				BI0	Overcurrent Trip
				B9	NTC Trip
				B8	Overspeed Deviation
				B7	Overspeed
				B6	Input open-phase trip
				B5	Output open-phase trip
				B4	Ground Fault Trip
				B3	E-Thermal Trip
				B2	Inverter Overload Trip
				B1	Underload Trip
				B0	Overload Trip
0h0331	Latch type trip information-2	-	-	BI5	Reserved
				BI4	Reserved
				BI3	The safety option on the terminal block input blocks the inverter output (only for products with a rated power of 90 kW or higher).
				BI2	Bad contact of Slot3 option card
				BI1	Bad contact of Slot2 option card
				BI0	Bad contact of Slot1 option card
				B9	No Motor trip
				B8	External brake trip
				B7	Bad contact of basic IO board
				B6	Pre PID Fail
				B5	Error while writing parameters
				B4	Reserved
				B3	FAN Trip
				B2	PTC (thermal sensor) trip
				B1	Encoder Error Trip
				B0	MC Fail Trip

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0332	Level type trip information	-	-	B15	Reserved
				B14	Reserved
				B13	Reserved
				B12	Reserved
				B11	Reserved
				B10	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	Keypad lost command
				B2	Lost Command
				B1	LV
				B0	BX
0h0333	H/W diagnosis trip information	-	-	B15	Reserved
				B14	Reserved
				B13	Reserved
				B12	Reserved
				B11	Reserved
				B10	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Gate Drive Power Loss
				B3	Watchdog-2 error
				B2	Watchdog-1 error
				B1	EEPROM error
				B0	ADC error

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0334	Warning information	-	-	B15	Reserved
				B14	Reserved
				B13	Reserved
				B12	Reserved
				B11	Reserved
				B10	Reserved
				B9	Auto-tuning failed
				B8	Keypad lost
				B7	Encoder misconnection
				B6	Wrong installation of encoder
				B5	DB
				B4	FAN running
				B3	Lost command
				B2	Inverter Overload
				B1	Underload
				B0	Overload
0h0335 - 0h033F	Reserved	-	-	-	
0h0340	On Time date	0	Day	Total number of days when the inverter is powered on	
0h0341	On Time minute	0	Min	Total number of minutes excluding the total number of On Time days	
0h0342	Run Time date	0	Day	Total number of days when the inverter drives the motor	
0h0343	Run Time minute	0	Min	Total number of minutes excluding the total number of Run Time days	
0h0344	Fan Time date	0	Day	Total number of days when the heat sink fan has run	
0h0345	Fan Time minute	0	Min	Total number of minutes excluding the total number of Fan Time days	
0h0346	Reserved	-	-	-	
0h0347	Reserved	-	-	-	
0h0348	Reserved	-	-	-	
0h0349	Reserved	-	-	-	
0h034A	Option 1	-	-	0: NO 2: Reserved 4: Reserved 6: Reserved 8: Reserved 10: PLC 23: Encoder	1: Reserved 3: Profibus, 5: Reserved 7: RNet, 9: Reserved 20: External IO-1
0h034B	Option 2	-	-		
0h034C	Option 3				

7.2 Common Areas for iS7 Control

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0380	Frequency command	0.01	Hz	Command frequency setting	
0h0381	RPM command	1	rpm	Command RPM setting	
0h0382	Operation command	-	-	B7	Reserved
				B6	Reserved
				B5	Reserved
				B4	Reserved
				B3	0➔1: Free-run stop
				B2	0➔1: Reset trip
				B1	0: Reverse command 1: Forward command
				B0	0: Stop command 1: Run command
				Ex) Forward operation command: 0003h, Reverse operation command: 0001h	
0h0383	Acceleration time	0.1	sec	Acceleration time setting	
0h0384	Deceleration time	0.1	sec	Deceleration time setting	
0h0385	Virtual digital input control (0: Off, 1: On)	-	-	BI5	Virtual DI 16 (COM85)
				BI4	Virtual DI 15 (COM84)
				BI3	Virtual DI 14 (COM83)
				BI2	Virtual DI 13 (COM82)
				BI1	Virtual DI 12 (COM81)
				BI0	Virtual DI 11 (COM80)
				B9	Virtual DI 10 (COM79)
				B8	Virtual DI 9 (COM78)
				B7	Virtual DI 8 (COM77)
				B6	Virtual DI 7 (COM76)
				B5	Virtual DI 6 (COM75)
				B4	Virtual DI 5 (COM74)
				B3	Virtual DI 4 (COM73)
				B2	Virtual DI 3 (COM72)
				B1	Virtual DI 2 (COM71)
				B0	Virtual DI 1 (COM70)

Communication Address	Parameter	Scale	Unit	Assigned content by bit	
0h0386	Digital Output Control (0: Off, 1: On)	-	-	BI5	Reserved
				BI4	Reserved
				BI3	Reserved
				BI2	Reserved
				BI1	Reserved
				BI0	Reserved
				B9	Reserved
				B8	Reserved
				B7	Reserved
				B6	Reserved
				B5	Q4 (Expansion I/O, OUT36: None)
				B4	Q3 (Expansion I/O, OUT35: None)
				B3	Q2 (Expansion I/O, OUT34: None)
				B2	Q1 (Basic I/O, OUT33: None)
				B1	Relay2 (Basic I/O, OUT32: None)
				B0	Relay1 (Basic I/O, OUT31: None)
0h0387	Reserved	-	-	Reserved	
0h0388	PID reference	0.1	%	Give the PID reference command	
0h0389	PID feedback value	0.1	%	PID feedback value	
0h038A - 0h038F	Reserved	-	-	-	
0h0390	Torque Ref	0.1	%	Torque command	
0h0391	Fwd Pos Torque Limit	0.1	%	Forward motoring torque limit	
0h0392	Fwd Neg Torque Limit	0.1	%	Forward regenerative torque limit	
0h0393	Rev Pos Torque Limit	0.1	%	Reverse motoring torque limit	
0h0394	Rev Neg Torque Limit	0.1	%	Reverse regenerative torque limit	
0h0395	Torque Bias	0.1	%	Torque bias	
0h0396	Web Main Speed	0.1	%	Main speed command	
0h0397 - 0h399	Reserved	-	-	-	
0h039A	Anytime Para	-	-	Sets the CNF-20 value.	
0h039B	Monitor Line-1	-	-	Sets the CNF-21 value.	
0h039C	Monitor Line-2	-	-	Sets the CNF-22 value.	
0h039D	Monitor Line-3	-	-	Sets the CNF-23 value.	

7.3 Common Areas for iS7 Dedicated Product Monitoring

Communication Address	Parameter	Scale	Unit	Assigned content by bit
0h0D00	Input of expansion I/O-2 V1	0.01	%	Input of expansion I/O-2 voltage (V1)
0h0D01	Input of expansion I/O-2 V2	0.01	%	Input of expansion I/O-2 voltage (V2)
0h0D02	Input of expansion I/O-2 V3	0.01	%	Input of expansion I/O-2 voltage (V3)
0h0D03	Input of expansion I/O-2 V4	0.01	%	Input of expansion I/O-2 voltage (V4)
0h0D04	Reserved	-	-	-
0h0D05	Input of expansion I/O-2 I1	0.01	%	Input of expansion I/O-2 current (I1)
0h0D06	Input of expansion I/O-2 I2	0.01	%	Input of expansion I/O-2 current (I2)
0h0D07	Input of expansion I/O-2 I3	0.01	%	Input of expansion I/O-2 current (I3)
0h0D08	Input of expansion I/O-2 I4	0.01	%	Input of expansion I/O-2 current (I4)
0h0D09	Reserved	-	-	-
0h0D0A	Expansion I/O-2 AO1	0.01	%	Expansion I/O-2 analog output 1 (AO1)
0h0D0B	Expansion I/O-2 AO2	0.01	%	Expansion I/O-2 analog output 2 (AO2)
0h0D0C	Expansion I/O-2 AO3	0.01	%	Expansion I/O-2 analog output 3 (AO3)
0h0D0D	Expansion I/O-2 AO4	0.01	%	Expansion I/O-2 analog output 4 (AO4)
0h0D0E	External PID controller output	0.01	%	External PID controller (APP01 App Mode: Ext PID Ctrl) output (%)
0h0D0F	External PID controller output	0.01	Hz	External PID controller (APP01 App Mode: Ext PID Ctrl) output (Hz)
0h0D10	External PID controller output	0	RPM	External PID controller (APP01 App Mode: Ext PID Ctrl) output (RPM)
0h0D11 - 0h0D7F	Reserved	-	-	-

7.4 Common Areas for iS7 Dedicated product control

Communication Address	Parameter	Scale	Unit	Assigned content by bit
0h0D80	Web Main Spd	0.1	%	Main speed command
0h0D81	Reserved	-	-	-
0h0D82	Reserved	-	-	-
0h0D83	Reserved	-	-	-
0h0D84	Reserved	-	-	-
0h0D85	External PID controller main speed input	0.01	%	External PID controller (APP01 App Mode: Ext PID Ctrl) main speed input (%)
0h0D86	External PID controller main speed input	0.01	Hz	External PID controller (APP01 App Mode: Ext PID Ctrl) main speed input (Hz)
0h0D87	External PID controller main speed input	0	RPM	External PID controller (APP01 App Mode: Ext PID Ctrl) main speed input (RPM)
0h0D88 - 0h0DFF	Reserved	-	-	-

Appendix A Sample Web-only Parameter Settings

A.1 Overview

This appendix uses an imaginary tension control system and the basic mechanical information from the winder, unwinder, and capstan to describe how to set the parameters for each inverter and perform a test drive.

Fig. A1.1 provides an outline of this imaginary tension control system.

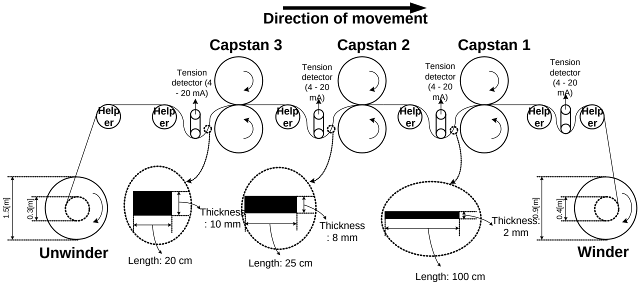

Fig. A1.1 An imaginary tension control system

Table A1.1 lists mechanical information for each inverter depicted in Fig. A1.1. Generally, the manufacturer of the machine provides this information.

Table A1.1 An imaginary tension control system

	Unwinder	Capstan 3	Capstan 2	Capstan 1	Winder
Number of poles	4	4	4	4	4
Min. diameter (m)	0.3	0.6	0.6	0.6	0.4
Belt ratio (gear ratio)	1:6.5	1:13.4	1:9.7	1:7.3	1:4.1
Max. linear speed (mpm)	250 (Note 1)	250 (Note 1)	340 (Note 2)	450 (Note 3)	600 (Note 4)

(Note 1): Max. linear speed measured between the unwinder and capstan 3.
(Note 2): Max. linear speed measured between capstan 3 and capstan 2.
(Note 3): Max. linear speed measured between capstan 2 and capstan 1.
(Note 4): Max. linear speed measured between capstan 1 and the winder.

Appendix B Setting the Parameters

B.1 Setting Winder Parameters

1. Use the mechanical information about the winder from Table A1.1 to enter the APP92 (Max Main Spd) setting. The APP92 (Max Main Spd) setting determines the maximum rotation speed of the motor (Hz or RPM) at the minimum diameter and maximum linear speed. Use the following formula to calculate the APP92 setting.

$$APP-92\,(Max\,Main\,Spd) = \frac{600[mpm]}{0.4[m]\times\pi} \times 4.1(Beltratio) \times \frac{4(pole)}{120} = 65.29[Hz]$$

   Release the DRV20 (Max Freq) limit to set the APP92 (Max Main Spd) setting. To account for the frequency added from the PID controller, enter approx. 1.2 times the APP92 (Max Main Spd) to the DRV20 (Max Freq).

2. Now, enter the bobbin diameter. The following formula uses the minimum diameter of 0.4 m and the maximum diameter of 0.9 m from Fig. A1.1 to calculate the ratio of the maximum diameter to the min. diameter as a percentage.

$$Minimum\ Diameter[\%] = \frac{0.4[m]}{0.9[m]} \times 100[\%] = 44.4[\%]$$

   Enter the calculated 44.4% as the APP63 (Bobbin 1 Diameter) and the APP67 (Min Diameter) settings.

3. Be sure to reset the bobbin diameter when replacing a bobbin. To do this, you must assign a function that resets the bobbin diameter to one of the multi-function inputs. Select an IN code between IN65 - 72 (P# Define), and then set it to "52: Web Preset”.

4. Finally, set the operation command method in DRV06 (Cmd Source); the parameters related to the main speed command in APP03 - 14 codes and the PID controller in APP15 - 57 codes; or any other additional functions (web brake detection, emergency stop, bypass, reverse crawling, etc.), if necessary.

B.2 Setting Unwinder Parameters

1. Use the mechanical information about the unwinder from Table A1.1 to enter the APP92 (Max Main Spd) setting. The APP92 (Max Main Spd) setting determines the maximum rotation speed of the motor (Hz or RPM) at the minimum diameter and maximum linear speed. Use the following formula to calculate the APP92 setting.

$$APP-92\,(Max\,Main\,Spd) = \frac{250[mpm]}{0.3[m]\times\pi} \times 6.5(Belt\ \ ratio) \times \frac{4(Poles)}{120} \ = \ 57.50[Hz]$$

Release the DRV20 (Max Freq) limit to set the APP92 (Max Main Spd). To account for the frequency added from the PID controller, enter approx 1.2 times the APP92 (Max Main Spd) setting to the DRV20 (Max Freq).

2. Now, enter the bobbin diameter. The following formula uses the minimum diameter of 0.3 m and the maximum diameter of 1.5 m from Fig. A1.1 to calculate the ratio of the maximum diameter to the min. diameter as a percentage.

$$Minimum\ \ Diameter[\%] = \frac{0.3[m]}{1.5[m]} \times 100[\%] \ = \ 20.0[\%]$$

Enter the calculated 20.0% as the APP67 (Min Diameter) setting.

Enter 100.0% as the APP63 (Bobbin 1 Diameter) setting, since this is the maximum diameter.

3. Like the winder, be sure to reset the bobbin diameter when replacing a bobbin. To do this, you must assign a function that resets the bobbin diameter to one of the multi-function inputs. Select an IN code between IN65 - 72 (P# Define), and then set it to "52: Web Preset”.

4. Finally, set the operation command method in DRV06 (Cmd Source); the parameters related to the main speed command in APP03 - 14 and the PID controller in APP15 - 57; or any other additional functions (web brake detection, emergency stop, bypass, reverse crawling, etc.), if necessary.

B.3 Setting Capstan Parameters

1. Use the mechanical information about Capstan 1, 2, and 3 from Table A1.1 to enter the APP92 (Max Main Spd) setting. The APP92 (Max Main Spd) setting determines the maximum rotation speed of the motor (Hz or RPM) at the reference thickness of the material (100%) and at the maximum linear speed. Use the following formula to calculate the APP92 setting.

$$\text{Capstan 1 } APP-92\,(Max\,Main\,Spd) = \frac{450[mpm]}{0.6[m]\times\pi} \times 7.3(Belt\ ratio) \times \frac{4(Poles)}{120} = 58.12[Hz]$$

$$\text{Capstan 2 } APP-92\,(Max\,Main\,Spd) = \frac{340[mpm]}{0.6[m]\times\pi} \times 9.7(Belt\ ratio) \times \frac{4(Poles)}{120} = 58.35[Hz]$$

$$\text{Capstan 3 } APP-92\,(Max\,Main\,Spd) = \frac{250[mpm]}{0.6[m]\times\pi} \times 13.4(Belt\ ratio) \times \frac{4(Poles)}{120} = 59.27[Hz]$$

Release the DRV20 (Max Freq) limit for each inverter to set the APP92 (Max Main Spd) setting for each inverter. To account for the frequency added from the PID controller, enter approx. 1.2 times the APP92 (Max Main Spd) to the DRV20 (Max Freq).

2. Finally, set the operation command method in DRV06 (Cmd Source); the parameters related to the main speed command in APP03 - 14 and the PID controller in APP15 - 57; or any other additional functions (web brake detection, emergency stop, bypass, reverse crawling, etc.), if necessary.

Warranty

Product Name	AC Variable Speed Drive	Date of Installation	
Model Name	Web Control Manual	Warranty Period	
Customer	Name		
	Address		
	Phone Number		
Sales Agency	Name		
	Address		
	Phone Number		

Notes
This inverter has been manufactured by LS ELECTRIC using strict quality control and inspection processes. The warranty period is 18 months from the date of installation. A period of 18 months from the date of manufacture will be applied if the date of installation has not been entered. However, the warranty period may vary according to the terms of the contract.

Free after-sales servicing
If the drive fails as a result of normal usage during the warranty period, contact our agency or designated service center. We will repair the drive free of charge.

Paid Servicing
In the following instances, repair services are provided for a fee: ▪ If the damage is the result of deliberate action or negligence. ▪ If the damage is the result of power supply problems or an improper connecting device. ▪ If the damage is the result of a natural disaster (for example, fire, flood, gas, earthquake, etc.). ▪ If the inverter has been modified or repaired somewhere other than our agency or service center. ▪ If there is no LS ELECTRIC name plate attached. ▪ If the warranty period is over.

Please visit the LS ELECTRIC homepage (http://www.lselectric.co.kr) for more useful information and services:

Manual Revision History

No.	Date of Publication	Contents Changed	Version Number	Remarks
1	20080430	-	0.01	1
2	20080718	-	0.02	2
3	20080721	-	1.00	3
4	20080813	Modified the content of 3.(2), "Automated Speed-Torque Switching".	1.01	4
5	20091104	Added content on 3.(3), "External PID Controller".	1.02	5
6	20091117	Modified web-only common area	1.03	6
7	20100309	Modified content concerning the external PID control (section 3.3) and dedicated common areas.	1.04	7
8	20100512	-	1.05	8
9	20110128	Added content concerning braking resistance.	1.07	9
10	20120426	Added content concerning the Open-loop Winder and Tension Control Mode. Added Web PID improvement (web without diameter calculation).	1.10	10
11	20140709	Correct the parameter of 'Chap 6. Table of Function'	1.11	11
12	20150423	2015 S/W version contents update	1.12	12
13	20200608	New LS ELECTRIC CI update	1.13	13

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