5 Learning Advanced Features

This chapter describes the advanced features of the H100 inverter. Check the reference page in the table to see the detailed description for each of the advanced features.

Advanced Tasks	Description	Ref.
Auxiliary frequency operation	Use the main and auxiliary frequencies in the predefined formulas to create various operating conditions. Auxiliary frequency operation is ideal for Draw Operation* as this feature enables fine-tuning of operation speeds.	p.161
Jog operation	Jog operation is a kind of a manual operation. The inverter operates to a set of parameter settings predefined for Jog operation while the Jog command button is pressed.	p.168
Up-down operation	Uses the upper and lower limit value switch output signals (i.e. signals from a flow meter) as Acc/Dec commands to motors.	p.170
3-wire operation	3-wire operation is used to latch an input signal. This configuration is used to operate the inverter by a push button.	p.172
Safety operation mode	This safety feature allows the inverter's operation only after a signal is input to the multi-function terminal designated for the safety operation mode. This feature is useful when extra care is needed in operating the inverter using the multi-purpose terminals.	p.173
Dwell operation	Use this feature for the lift-type loads such as elevators, when the torque needs to be maintained while the brakes are applied or released.	p.175
Slip compensation	This feature ensures that the motor rotates at a constant speed, by compensating for the motor slip as a load increases.	p.177
PID control	PID control provides constant automated control of flow, pressure, and temperature by adjusting the output frequency of the inverter.	p.178
Sleep-wakeup operation	When the inverter operation continues below the PID conditions for a set time period, the PID reference is automatically raised to extend the operation standby time. This keeps the inverter in a standby (sleep) mode when the demand is very low.	p.196

Advanced Tasks	Description	Ref.
Auto-tuning	Used to automatically measure the motor control parameters to optimize the inverter's control mode performance.	p.239
Energy buffering operation	Used to maintain the DC link voltage for as long as possible by controlling the inverter output frequency during power interruptions, thus to delay a low voltage fault trip.	p.215
Energy saving operation	Used to save energy by reducing the voltage supplied to motors during low-load and no-load conditions.	p.261
Speed search operation	Used to prevent fault trips when the inverter voltage is output while the motor is idling or free-running.	p.265
Auto restart operation	Auto restart configuration is used to automatically restart the inverter when a trip condition is released, after the inverter stops operating due to activation of protective devices (fault trips).	p.270
Second motor operation	Used to switch equipment operation by connecting two motors to one inverter. Configure and operate the second motor using the terminal input defined for the second motor operation.	p.274
Commercial power source switch operation	Used to switch the power source to the motor from the inverter output to a commercial power source, or vice versa.	p.276
Cooling fan control	Used to control the cooling fan of the inverter.	p.277
Multi-function output On/Off control	Set standard values and turn On/Off the output relays or multi-function output terminals according to the analog input value.	p.314
Regeneration prevention for press operation.	Used during a press operation to avoid motor regeneration, by increasing the motor operation speed.	p.276
Damper operation	Controls the fan motor optimally when a damper is used in the system.	p.211
Lubrication operation	Supplies lubricant to the machinery before starting the inverter and the mechanical system connected to it.	p.214
Flow compensation	Compensates for pressure loss in a system with long pipelines.	p.212

Advanced Tasks	Description	Ref.
Energy savings display	Displays the amount of energy saved by the use of the inverter, compared to when a commercial power source is used without an inverter.	p.217
Pump clean operation	Cleans the pumps by removing the scales or deposits that are attached to the impeller.	p.219
Inclination setting for operation and stop	Sets the initial operating conditions for a pump by adjusting the acceleration and deceleration times.	p.224
Valve deceleration time setting	Prevents possible pump damage that may be caused by abrupt deceleration.	p.225
Load tuning	Creates load-specific curves for light load operations and the pump clean operation.	p.228
Level detection	Detects and displays the level set by the user.	p.230
Pipe breakage detection	Detects breakages in the pipeline during a PID operation.	p.234
Motor preheating	Prevents motors and pumps from freezing when they are not operated.	p.236
Scheduled operation	Uses the built-in real-time clock (RTC) to operate the inverter according to the desired time schedule.	p.243
Fire mode operation	Operates the inverter in a way to cope with emergency situations, such as fire, by controlling the operation of ventilation (intake and exhaust) fans.	p.262

5.1 Operating with Auxiliary References

Frequency references can be configured with various calculated conditions that use the main and auxiliary frequency references simultaneously. The main frequency reference is used as the operating frequency, while auxiliary references are used to modify and fine-tune the main reference.

Group	Code	LCD Display	LCD Display	Parameter Setting		Setting Range	Unit
DRV	06	Frequency reference	Freq Ref Src	0	Keypad-1	0–9	-

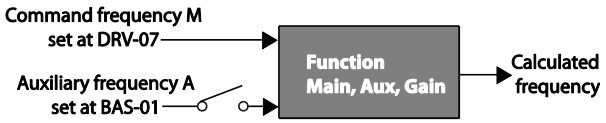
Group	Code	LCD Display	LCD Display	Parameter Setting		Setting Range	Unit
BAS		source					
	01	Auxiliary frequency reference source	Aux Ref Src	1	V1	0–11	-
	02	Auxiliary frequency reference calculation type	Aux Calc Type	0	M+(G*A)	0–7	-
	03	Auxiliary frequency reference gain	Aux Ref Gain	100.0	100.0	-200.0–200.0	%
IN	65–71	Px terminal configuration	Px Define	36	dis Aux Ref	-	-

The table above lists the available calculated conditions for the main and auxiliary frequency references. Refer to the table to see how the calculations apply to an example where the DRV-06 Frq Src code has been set to '0 (Keypad-1)', and the inverter is operating at a main reference frequency of 30.00 Hz. Signals at -10 to +10 V are received at terminal V1, with the reference gain set at 5%. In this example, the resulting frequency reference is fine-tuned within the range of 27.00–33.00 Hz [Codes IN-01–16 must be set to the default values, and IN-06 (V1 Polarity), set to '1 (Bipolar)'].

Auxiliary Reference Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>BAS-01 Aux Ref Src</td><td>Set the input type to be used for the auxiliary frequency reference.
<table>
<tr><td colspan="2">Configuration</td><td>Description</td></tr>
<tr><td>0</td><td>None</td><td>Auxiliary frequency reference is disabled</td></tr>
<tr><td>1</td><td>V1</td><td>Sets the V1 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference.</td></tr>
<tr><td>3</td><td>V2</td><td>Sets the I2 (voltage) terminal at the control terminal block as the source of auxiliary frequency reference (SW4 must be set to 'voltage').</td></tr>
<tr><td>4</td><td>I2</td><td>Sets the I2 (current) terminal at the control terminal block as the source of auxiliary frequency reference (SW4 must be set to 'current').</td></tr>
<tr><td>5</td><td>Pulse</td><td>Sets the TI (pulse) terminal at the control terminal block as the source of auxiliary frequency reference.</td></tr>
</table></td></tr>
<tr><td>BAS-02 Aux Calc Type</td><td>Set the auxiliary reference gain with BAS-03 (Aux Ref Gain) to configure the auxiliary reference and set the percentage to be reflected when calculating the main reference. Note that items 4–7 below may result in either plus (+) or minus (-) references (forward or reverse operation) even when unipolar analog inputs are used.
<table>
<tr><td colspan="2">Configuration</td><td>Formula for frequency reference</td></tr>
<tr><td>0</td><td>M+(G*A)</td><td>Main reference +(BAS-03x BAS-01xIN-01)</td></tr>
<tr><td>1</td><td>M*(G*A)</td><td>Main reference x(BAS-03x BAS-01)</td></tr>
<tr><td>2</td><td>M/(G*A)</td><td>Main reference /(BAS-03x BAS-01)</td></tr>
<tr><td>3</td><td>M+{M*(G*A)}</td><td>Main reference +{ Main reference x(BAS-03x BAS-01)}</td></tr>
<tr><td>4</td><td>M+G*2*(A-50)</td><td>Main reference + BAS-03x2x(BAS-01–50)xIN-01</td></tr>
<tr><td>5</td><td>M*{G*2*(A-50)}</td><td>Main reference x{ BAS-03x2x(BAS-01–50)}</td></tr>
<tr><td>6</td><td>M/{G*2*(A-50)}</td><td>Main reference /{ BAS-03x2x(BAS-01–50)}</td></tr>
<tr><td>7</td><td>M+M*G*2*(A-</td><td>Main reference + Main reference x BAS-</td></tr>
</table></td></tr>
</table>

Code	Description
	50) 03x2x(BAS-01–50) M: Main frequency reference (Hz or rpm) G: Auxiliary reference gain (%) A: Auxiliary frequency reference (Hz or rpm) or gain (%)
BAS-03 Aux Ref Gain	Adjust the size of the input (BAS-01 Aux Ref Src) configured for auxiliary frequency.
IN-65–71 Px Define	Set one of the multi-function input terminals to 36 (dis Aux Ref) and turn it on to disable the auxiliary frequency reference. The inverter will operate using the main frequency reference only.



Auxiliary Reference Operation Ex #1

Keypad Frequency Setting is Main Frequency and V1 Analog Voltage is Auxiliary Frequency

- Main frequency: Keypad (operation frequency 30 Hz)
- Maximum frequency setting (DRV-20): 400 Hz
- Auxiliary frequency setting (BAS-01): V1[Display by percentage(%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (BAS-03): 50%
- IN-01–32: Factory default

Example: an input voltage of 6 V is supplied to V1, and the frequency corresponding to 10 V is 60 Hz. The table below shows the auxiliary frequency A as 36 Hz[=60 Hz X (6 V/10 V)] or 60%[= 100% X (6 V/10 V)].

Setting *		Calculating final command frequency**
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x36 Hz(A))=48 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x60%(A))=9 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x60%(A))=100 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x60%(A))}=39 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(60%(A)–50%)x60 Hz=36 Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])}	30 Hz(M)x{50%(G)x2x(60%(A)–50%)}=3 Hz
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–50%)}=300 Hz
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x(60%(A)–50%)=33 Hz

* M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference (Hz or rpm) or gain (%).

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Auxiliary Reference Operation Ex #2

Keypad Frequency Setting is Main Frequency and I2 Analog Voltage is Auxiliary Frequency

- Main frequency: Keypad (Operation frequency 30 Hz)
- Maximum frequency setting (BAS-20): 400 Hz
- Auxiliary frequency setting (BAS-01): I2 [Display by percentage (%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain setting (BAS-03): 50%
- IN-01–32: Factory default

Example: an input current of 10.4 mA is applied to I2, with the frequency corresponding to 20 mA of 60 Hz. The table below shows auxiliary frequency A as 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*		Calculating final command frequency**
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x24 Hz(A))=42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x40%(A))=6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x40%(A))=150 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(40%(A)–50%)x60 Hz=24 Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])	30 Hz(M)x{50%(G)x2x(40%(A)–50%)} = -3 Hz(Reverse)
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–40%)} = -300 Hz(Reverse)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x (40%(A)–50%)=27 Hz

* M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference Hz or rpm) or gain (%).

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Auxiliary Reference Operation Ex #3

V1 is Main Frequency and I2 is Auxiliary Frequency

- Main frequency: V1 (frequency command setting to 5 V and is set to 30 Hz)
- Maximum frequency setting (DRV-20): 400 Hz
- Auxiliary frequency (BAS-01): I2[Display by percentage (%) or auxiliary frequency (Hz) depending on the operation setting condition]
- Auxiliary reference gain (BAS-03): 50%
- IN-01–32: Factory default

Example: An input current of 10.4 mA is applied to I2, with the frequency corresponding to 20 mA of 60 Hz. The table below shows auxiliary frequency Aas 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*		Calculating final command frequency**
0	M[Hz]+(G[%]*A[Hz])	30 Hz(M)+(50%(G)x24 Hz(A))=42 Hz
1	M[Hz]*(G[%]*A[%])	30 Hz(M)x(50%(G)x40%(A))=6 Hz
2	M[Hz]/(G[%]*A[%])	30 Hz(M)/(50%(G)x40%(A))=150 Hz
3	M[Hz]+{M[Hz]*(G[%]*A[%])}	30 Hz(M)+{30[Hz]x(50%(G)x40%(A))}=36 Hz
4	M[Hz]+G[%]*2*(A[%]-50[%])[Hz]	30 Hz(M)+50%(G)x2x(40%(A)–50%)x60 Hz=24 Hz
5	M[HZ]*{G[%]*2*(A[%]-50[%])}	30 Hz(M)x{50%(G)x2x(40%(A)–50%)}=-3 Hz(Reverse)
6	M[HZ]/{G[%]*2*(A[%]-50[%])}	30 Hz(M)/{50%(G)x2x(60%–40%)}=-300 Hz(Reverse)
7	M[HZ]+M[HZ]*G[%]*2*(A[%]-50[%])	30 Hz(M)+30 Hz(M)x50%(G)x2x(40%(A)–50%)=27 Hz

* M: main frequency reference (Hz or rpm)/G: auxiliary reference gain (%)/A: auxiliary frequency reference (Hz or rpm) or gain (%).

**If the frequency setting is changed to rpm, it is converted to rpm instead of Hz.

Note

When the maximum frequency value is high, output frequency deviation may result due to analog input variation and deviations in the calculations.

5.2 Jog Operation

The jog operation allows for a temporary control of the inverter. You can enter a jog operation command using the multi-function terminals or by using the [ESC] key on the keypad.

The jog operation is the second highest priority operation, after the dwell operation. If a jog operation is requested while operating the multi-step, up-down, or 3-wire operation modes, the jog operation overrides all other operation modes.

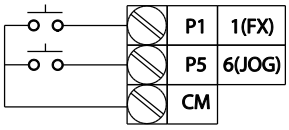
5.2.1 Jog Operation 1-Forward Jog by Multi-function Terminal

The jog operation is available in either forward or reverse direction, using the keypad or multi-function terminal inputs. The table below lists parameter setting for a forward jog operation using the multi-function terminal inputs.

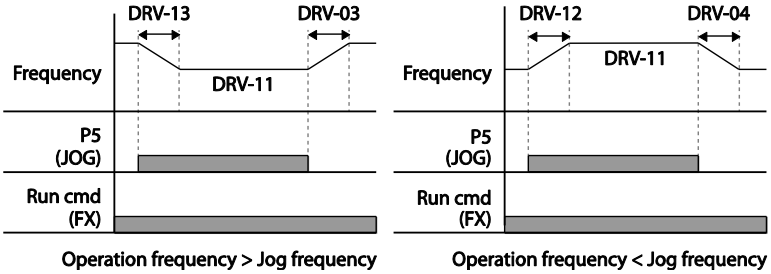
Group	Code	LCD Display	LCD Display	Parameter Setting		Setting Range	Unit
DRV	11	Jog frequency	JOG Frequency	10.00		0.00, Low Freq–High Freq	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00		0.00–600.00	sec
	13	Jog operation deceleration time	JOG Dec Time	30.00		0.00–600.00	sec
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	6	JOG	-	-

Forward Jog Description Details

Code	Description
IN-65–71 Px Define	Select the jog frequency from P1- P7 and then select 6. Jog from IN-65-71.

Code	Description
	 [Terminal settings for jog operation]
DRV-11 JOG Frequency	Set the operation frequency.
DRV-12 JOG Acc Time	Set the acceleration speed.
DRV-13 JOG Dec Time	Set the deceleration speed.

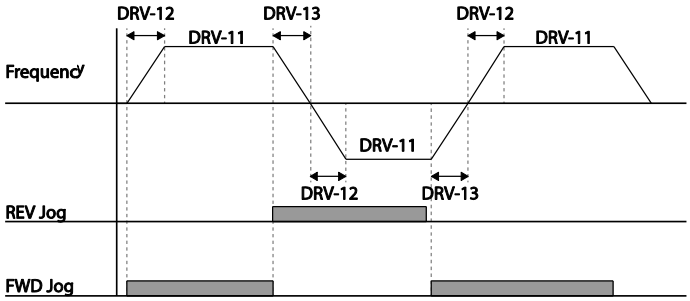
If a signal is entered at the jog terminal while an FX operation command is on, the operation frequency changes to the jog frequency and the jog operation begins.



5.2.2 Jog Operation 2-Forward/Reverse Jog by Multi-function Terminal

For jog operation 1, an operation command must be entered to start operation, but while using jog operation 2, a terminal that is set for a forward or reverse jog also starts an operation. The priorities for frequency, Acc/Dec time and terminal block input during operation in relation to other operating modes (Dwell, 3-wire, up/down, etc.) are identical to jog operation 1. If a different operation command is entered during a jog operation, it is ignored and the operation maintains the jog frequency.

Group	Code	Name	LCD Display	Parameter setting		Setting Range	Unit
DRV	11	Jog frequency	JOG Frequency	10.00		0.00, Low Freq–High Freq	Hz
	12	Jog operation acceleration time	JOG Acc Time	20.00		0.00–600.00	sec
	13	Operation deceleration time	JOG Dec Time	30.00		0.00–600.00	sec
IN	65–71	Px terminal configuration	Px Define (Px: P1–P7)	38	FWD JOG	-	-
				39	REV JOG		



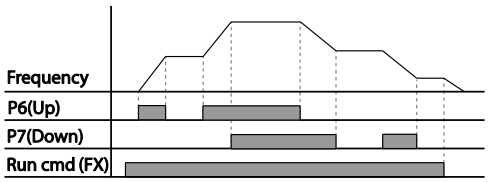
5.3 Up-down Operation

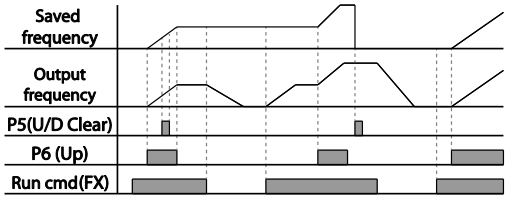
The Acc/Dec time can be controlled through input at the multi-function terminal block. Similar to a flowmeter, the up-down operation can be applied easily to a system that uses the upper-lower limit switch signals for Acc/Dec commands.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV	65	Up-down operation frequency save	U/D Save Mode	1	Yes	0–1	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	19	Up	0–52	-
				20	Down		
				22	U/D Clear		

Up-down Operation Setting Details

Code	Description
IN-65–71 Px Define	Select two terminals for up-down operation and set them to '19 (Up)' and '20 (Down)', respectively. With the operation command input, acceleration begins when the Up terminal signal is on. Acceleration stops and constant speed operation begins when the signal is off. During operation, deceleration begins when the Down signal is on. Deceleration stops and constant speed operation begins when both Up and Down signals are entered at the same time. 
ADV-65 U/D Save Mode	During a constant speed operation, the operating frequency is saved automatically in the following conditions: the operation command (Fx or Rx) is off, a fault trip occurs, or the power is off. When the operation command is turned on again, or when the inverter regains the power source or resumes to a normal operation from a fault trip, it resumes operation at the saved frequency. To delete the saved frequency, use the multi-function terminal block. Set one of the multi-function terminals to 22 (U/D Clear) and apply signals to it during constant speed operation. The saved frequency and the up-down operation configuration will be deleted.

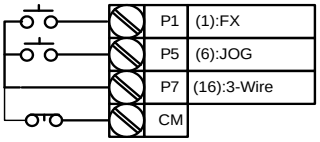
Code	Description
	

5.4 3- Wire Operation

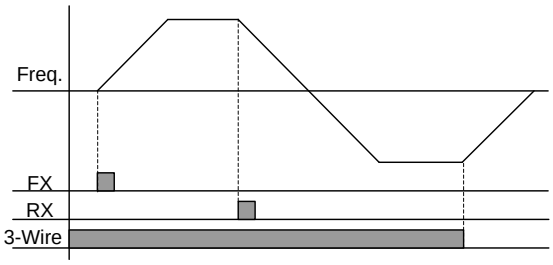
The 3-wire operation latches the signal input (the signal stays on after the button is released), and is used when operating the inverter with a push button.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
DRV	07	Command source	Cmd Source*	1	Fx/Rx - 1	-	-
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	16	3-Wire	-	-

To enable the 3-wire operation, the following circuit sequence is necessary. The minimum input time (t) for 3-wire operation is 2 ms, and the operation stops when both forward and reverse operation commands are entered at the same time.



[Terminal connections for 3-wire operation]



[3- wire operation]

5.5 Safe Operation Mode

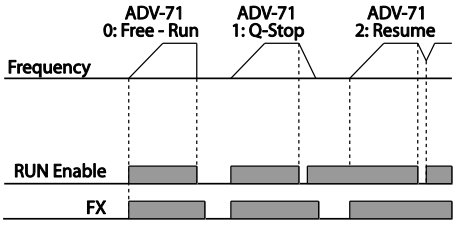
When the multi-function terminals are configured to operate in safe mode, operation commands can be entered in the Safe operation mode only. Safe operation mode is used to safely and carefully control the inverter through the multi-function terminals.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV	70	Safe operation selection	Run En Mode	1	DI Dependent	-	-
	71	Safe operation stop mode	Run Dis Stop	0	Free-Run	0–2	-
	72	Safe operation deceleration time	Q-Stop Time	5.0		0.0–600.0	sec
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	15	RUN Enable	-	-

Safe Operation Mode Setting Details

Code	Description
IN-65–71 Px Define	From the multi-function terminals, select a terminal to operate in safe operation mode and set it to '15 (RUN Enable)'.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>ADV-70 Run En Mode</td><td>
<table>
<tr><td>Setting</td><td></td><td>Function</td></tr>
<tr><td>0</td><td>Always Enable</td><td>Enables safe operation mode</td></tr>
<tr><td>1</td><td>DI Dependent</td><td>Recognizes the operation command from a multi-function input terminal.</td></tr>
</table>
</td></tr>
<tr><td>ADV-71 Run Dis Stop</td><td>Set the operation of the inverter when the multi-function input terminal in safe operation mode is off.
When the safety operation mode terminal signal is given, the inverter decelerates based on the settings at the Q-Stop time. The inverter decelerates and stops based on the deceleration time (Dec Time) settings if the run command is off.
<table>
<tr><td>Setting</td><td></td><td>Function</td></tr>
<tr><td>1</td><td>Free-Run</td><td>Blocks the inverter output when the multi-function terminal is off.</td></tr>
<tr><td>2</td><td>Q-Stop</td><td>The deceleration time (Q-Stop Time) used in safe operation mode. It stops after deceleration and then the operation can resume only when the operation command is entered again. The operation will not begin if only the multi-function terminal is on.</td></tr>
<tr><td>3</td><td>Q-Stop Resume</td><td>The inverter decelerates to the deceleration time (Q-Stop Time) in safe operation mode. It stops after deceleration. Then if the multi-function terminal is on, the operation resumes as soon as the operation command is entered again.</td></tr>
</table>
</td></tr>
<tr><td>ADV-72 Q-Stop Time</td><td>Sets the deceleration time when ADV-71 Run Dis Stop is set to '1 (Q-Stop)' or '2 (Q-Stop Resume)'.</td></tr>
</table>

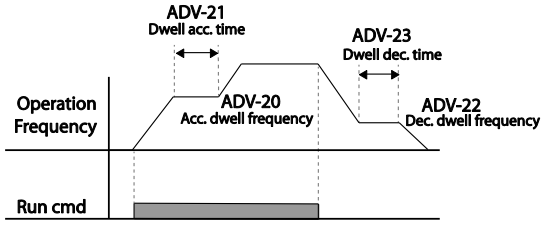


5.6 Dwell Operation

The dwell operation is used to maintain torque during the application and release of the mechanical brakes on lift-type loads. Inverter dwell operation is based on the Acc/Dec dwell frequency and the dwell time set by the user. The following points also affect dwell operation.

- **Acceleration Dwell Operation**: When an operation command runs, acceleration continues until the acceleration dwell frequency and constant speed is reached within the acceleration dwell operation time (Acc Dwell Time). After the Acc Dwell Time has passed, acceleration is carried out based on the acceleration time and the operation speed that was originally set.
- **Deceleration Dwell Operation**: When a stop command is run, deceleration continues until the deceleration dwell frequency and constant speed are reached within the deceleration dwell operation time (Dec Dwell Freq). After the set time has passed, deceleration is carried out based on the deceleration time that was originally set, then the operation stops.

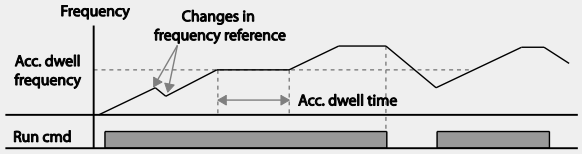
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
ADV	20	Dwell frequency during acceleration	Acc Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	21	Operation time during acceleration	Acc Dwell Time	0.0	0.0–10.0	sec
	22	Dwell frequency during deceleration	Dec Dwell Freq	5.00	Start frequency – Maximum frequency	Hz
	23	Operation time during deceleration	Dec Dwell Time	0.0	0 .0– 60.0	sec



Note

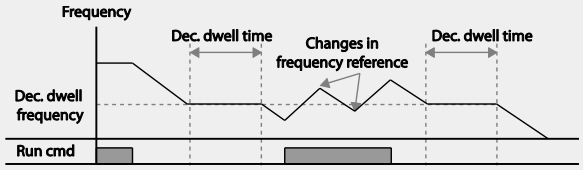
Dwell operation does not work when:

- Dwell operation time is set to 0 sec or dwell frequency is set to 0 Hz.
- Re-acceleration is attempted from stop or during deceleration, as only the first acceleration dwell operation command is valid.



[Acceleration dwell operation]

- Although deceleration dwell operation is carried out whenever stop commands are entered and the deceleration dwell frequency is passed through, it does not work during a deceleration by simple frequency change (which is not a deceleration due to a stop operation), or during external brake control applications.



[Deceleration dwell operation]

5.7 Slip Compensation Operation

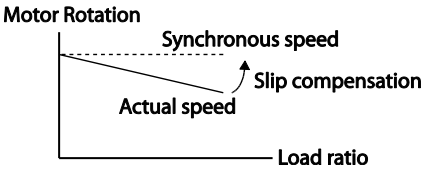
Slip refers to the variation between the setting frequency (synchronous speed) and motor rotation speed. As the load increases there can be variations between the setting frequency and motor rotation speed. Slip compensation is used for loads that require compensation of these speed variations.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
DRV	09	Control Mode	Control Mode	1	Slip Compen	-	-
	14	Motor Capacity	Motor Capacity	2	5.5 kW	0–20	-
BAS	11	Number of motor poles	Pole Number	4		2–48	-
	12	Rated slip speed	Rated Slip	40 (5.5 kW based)		0–3000	Rpm
	13	Rated motor current	Rated Curr	3.6 (5.5 kW based)		1.0–1000.0	A
	14	Motor no-load current	Noload Curr	1.6 (5.5 kW based)		0.5–1000.0	A
	16	Motor efficiency	Efficiency	72 (5.5 kW based)		70–100	%

Slip Compensation Operation Setting Details

Code	Description
DRV-09 Control Mode	Set DRV-09 to '2 (Slip Compen)' to carry out the slip compensation operation.
DRV-14 Motor Capacity	Set the capacity of the motor connected to the inverter.
BAS-11 Pole Number	Enter the number of poles from the motor rating plate.
BAS-12 Rated Slip	Enter the number of rated rotations from the motor rating plate.

Code	Description
	$f_s = f_r - \frac{Rpm \times P}{120}$ f_s = Rated slip frequency f_r = Rated frequency Rpm = Number of the rated motor rotations P = Number of motor poles
BAS-13 Rated Curr	Enter the rated current from the motor rating plate.
BAS-14 Noload Curr	Enter the measured current when the load on the motor axis is removed and when the motor is operated at the rated frequency. If no-load current is difficult to measure, enter a current equivalent to 30-50% of the rated motor current.
BAS-16 Efficiency	Enter the efficiency from the motor rating place.



5.8 PID Control

PID control is one of the most common auto-control methods. It uses a combination of proportional, integral, and differential (PID) controls that provide more effective control for automated systems. The functions of PID control that can be applied to the inverter operation are as follows:

Purpose	Function
Speed Control	Controls speed by monitoring the current speed levels of the equipment or machinery being controlled. Control maintains consistent speed or operates at the target speed.
Pressure Control	Controls pressure by monitoring the current pressure levels of the equipment or machinery being controlled. Control maintains consistent pressure or operates at the target pressure.

Purpose	Function
Flow Control	Controls flow by monitoring the current amount of flow in the equipment or machinery being controlled. Control maintains consistent flow or operates at a target flow.
Temperature Control	Controls temperature by monitoring the current temperature levels of the equipment or machinery to be controlled. Control maintains a consistent temperature or operates at a target temperature.

5.8.1 PID Basic Operation

PID operates by controlling the output frequency of the inverter, through automated system process control to maintain speed, pressure, flow, temperature or tension.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
PID	01	PID Options	PID Sel	0	No	0–1	-
	03	PID output monitor	PID Output	-		-	-
	04	PID reference monitor	PID Ref Value	-		-	-
	05	PID feedback monitor	PID Fdb Value	-		-	-
	06	PID Error Monitor	PID Err Value				
	10	PID reference source	PID Ref Source	0	Keypad	0–9	-
	11	PID reference setting	PID Ref Set	Unit Default		Unit Min–Unit Max	Unit
	12	PID reference 1 auxiliary source selection	PID Ref1AuxSrc	0	None	0–11	-
	13	PID reference 1 auxiliary mode	PID Ref1AuxMod	0	M+(G*A)	0–13	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		selection					
	14	PID reference auxiliary gain	PID Ref 1 Aux G	0.0		-200.0–200.0	Unit
	15	PID reference 2 auxiliary source selection	PID Ref 2 Src	0	Keypad	0–9	-
	16	PID reference 2 keypad setting	PID Ref 2 Set	Unit Default		Unit Min–Unit Max	Unit
	17	PID reference 2 auxiliary source selection	PID Ref2AuxSrc	0	None	0–11	-
	18	PID reference 2 auxiliary mode selection	PID Ref2AuxMod	0	M+(G*A)	0–12	-
	19	PID reference 2 auxiliary gain	PID Ref2 Aux G	0.0		-200.0–200.0	Unit
	20	PID feedback source selection	PID Fdb Src	0	V1	0–9	
	21	PID feedback auxiliary source selection	PID Fdb AuxSrc	0	None	0–11	
	22	PID feedback auxiliary mode selection	PID Fdb AuxMod	0	M+(G+A)	0–13	
	23	PID feedback auxiliary gain	PID Fdb Aux G	0.0		-200.0–200.0	Unit
	24	PID feedback band	PID Fdb Band	0		0–Unit Band	Unit
	25	PID proportional gain 1	PID P-Gain 1	50.0		0.0–300.00	Unit
	26	PID integral time 1	PID I-Time 1	10.0		0.0–200.0	sec

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	27	PID differential time 1	PID D-Time 1	0.00	0–1.00	sec
	28	PID feed forward gain	PID FF-Gain	0.0	0.0–1000.0	Unit
	29	PID output filter	PID Out LPF	0.00	0–10.00	sec
	30	PID output upper limit	PID Limit Hi	100.00	PID Limit Lo–100.00	Unit
	31	PID output lower limit	PID Limit Lo	0.00	-100.00–PID Limit Hi	Unit
	32	PID proportional gain 2	PID P-Gain 2	5.0	0.0–300.00	Unit
	33	PID integral time 2	PID I-Time 2	10.0	0.0–200.0	sec
	34	PID differential time 2	PID D-Time 2	0.00	0–1.00	sec
	35	PID output mode setting	PID Out Mode	0	PID Out	0–3
	36	PID output reverse	PID Out Inv	0	No	0–1
	37	PID output scale	PID Out Scale	100.0	0.1–1000.0	Unit
	40	PID multi-step reference setting 1	PID Step Ref 1	Unit Default	Unit Min–Unit Max	Unit
	41	PID multi-step reference setting 2	PID Step Ref 2	Unit Default	Unit Min–Unit Max	Unit
	42	PID multi-step reference setting 3	PID Step Ref 3	Unit Default	Unit Min–Unit Max	Unit
	43	PID multi-step reference setting 4	PID Step Ref 4	Unit Default	Unit Min–Unit Max	Unit

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
	44	PID multi-step reference setting 5	PID Step Ref 5	Unit Default		Unit Min–Unit Max	Unit
	45	PID multi-step reference setting 6	PID Step Ref 6	Unit Default		Unit Min–Unit Max	Unit
	46	PID multi-step reference setting 7	PID Step Ref 7	Unit Default		Unit Min–Unit Max	Unit
	50	PID controller unit selection	PID Unit Sel	0	%	0–40	-
	51	PID control setting scale	PID Unit Scale	2	X 1	0–4	-
	52	PID control 0% setting figure	PID Unit 0%	0.00		Differ depending on PID-50 setting	
	53	PID control 100% setting figure	PID Unit 100%	100.00		Differ depending on PID-50 setting	
IN	65–71	Px circuit function setting	Px Define(Px: P1–P7)	1	none	0–52-	-

Note

- Normal PID output (PID OUT) is bipolar and is limited by PID-46 (PID Limit Hi) and PID-47 (PID Limit Lo) settings. DRV-20 (MaxFreq) value equals a 100% of PID OUT.
- The following are the variables used in PID operation, and how they are calculated:
  - Unit MAX = PID Unit 100% (PID-68)
  - Unit Min = (2xPID Unit 0% (PID-67)–PID Unit 100%)
  - Unit Default = (PID Unit 100%-PID Unit 0%)/2
  - Unit Band = Unit 100%-Unit 0%
- PID control may be utilized for the following operations:
  Soft fill, auxiliary PID reference compensation, MMC, flow compensation, pipe breakage detection
- During a PID operation, the PID output becomes the frequency reference. The inverter

accelerates or decelerates to the frequency reference based on the Acc/Dec times.

PID Basic Operation Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>PID-01 PID Sel</td><td>Sets the code to '1 (Yes)' to select functions for the process PID.</td></tr>
<tr><td>PID-03 PID Output</td><td>Displays the existing output value of the PID controller. The unit, gain, and scale that were set in the PID group are applied on the display.</td></tr>
<tr><td>PID-04 PID Ref Value</td><td>Displays the existing reference value set for the PID controller. The unit, gain, and scale that were set in the PID group are applied on the display.</td></tr>
<tr><td>PID-05 PID Fdb Value</td><td>Displays the latest feedback value of the PID controller. The unit, gain, and scale that were set in the PID group are applied on the display.</td></tr>
<tr><td>PID-06 PID Err Value</td><td>Displays the differences between the existing reference and the feedback (error value). The unit, gain, and scale that were set in the PID group are applied on the display.</td></tr>
<tr><td>PID-10 PID Ref 1 Src</td><td>Selects the reference input for the PID control. If the V1 terminal is set to a PID feedback source (PID F/B Source), the V1 terminal cannot be set to the PID reference source (PID Ref Source). To set V1 as a reference source, change the feedback source.
<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal
When the analog voltage/current input terminal selection switch (SW4) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V.</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>7</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
<tr><td>8</td><td>Pulse</td><td>TI Pulse input terminal (0-32 kHz Pulse input)</td></tr>
<tr><td>9</td><td>E-PID Output</td><td>External PID output</td></tr>
</table></td></tr>
<tr><td>PID-11 PID Ref Set</td><td>A reference value can be entered if the PID reference type (PID-10) is</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>PID-12 PID Ref1AuxSrc</td><td>set to '0 (Keypad)'.

Selects the external input source to be used as the reference for a PID control. If an external input source is selected, the reference is determined using the input value at the source (set at PID-10) and the value set at PID-13 PID Ref1AuxMod.

<table>
<tr><th colspan="2">Setting</th><th>Function</th></tr>
<tr><td>0</td><td>None</td><td>Not used</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal
[If the analog voltage/current input terminal selection switch (SW4) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V]</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>6</td><td>Pulse</td><td>TI Pulse input terminal (0-32 kHz Pulse input)</td></tr>
<tr><td>7</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>8</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
<tr><td>10</td><td>EPID1 Output</td><td>External PID 1 Output</td></tr>
<tr><td>11</td><td>EPID1 Fdb Val</td><td>External PID 1 feedback value</td></tr>
</table></td></tr>
<tr><td>PID-13 PID Ref1 AuxMod</td><td>PID-13 (PID Ref1) provides formulas to calculate the reference 1 value. If PID-12 (PID RefAuxSrc) is set to any other value than 'None,' the final reference 1 value is calculated using the input value at the source (set at PID-10) and the input value set at PID-12).

<table>
<tr><th colspan="2">Setting</th></tr>
<tr><td>0</td><td>M+(G*A)</td></tr>
<tr><td>1</td><td>M*(G*A)</td></tr>
<tr><td>2</td><td>M/(G*A)</td></tr>
<tr><td>3</td><td>M+(M*(G*A))</td></tr>
<tr><td>4</td><td>M+G*2*(A-50)</td></tr>
<tr><td>5</td><td>M*(G*2*(A-50))</td></tr>
<tr><td>6</td><td>M/(G*2*(A-50))</td></tr>
<tr><td>7</td><td>M+M*G*2*(A-50)</td></tr>
<tr><td>8</td><td>(M-A)^2</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>9</td><td>M^2+A^2</td></tr>
<tr><td>10</td><td>MAX(M,A)</td></tr>
<tr><td>11</td><td>MIN(M,A)</td></tr>
<tr><td>12</td><td>(M+A)/2</td></tr>
<tr><td>13</td><td>Square Root(M+A)</td></tr>
</table>
M= Value by the source set at PID-10
G= Gain value set at PID-14
A= Value input by the source set at PID-12
</td></tr>
<tr><td>PID-14 PID Ref1 Aux G</td><td>Gain value for the formulas provided by PID-13.</td></tr>
<tr><td>PID-20 PID Fdb Src</td><td>Selects feedback input for PID control. If the V1 terminal is set as the PID feedback source (PID F/B Source), the V1 terminal cannot be set as the PID reference source (PID Ref Source). To set V1 as a feedback source, change the reference source.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
<tr><td>2</td><td>V2</td><td rowspan="2">I2 analog input terminal
[If the analog voltage/current input terminal selection switch (SW4) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V]</td></tr>
<tr><td>3</td><td>I2</td></tr>
<tr><td>4</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>5</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
<tr><td>7</td><td>Pulse</td><td>TI Pulse input terminal (0-32 kHz Pulse input)</td></tr>
<tr><td>8</td><td>EPID1 Output</td><td>External PID 1 output</td></tr>
<tr><td>9</td><td>EPID1 Fdb Val</td><td>External PID 1 feedback</td></tr>
</table>
</td></tr>
<tr><td>PID-21 PID Fdb AuxSrc</td><td>Selects the external input source to be used as the reference for a PID control. When the external input source is selected, the reference is determined using the input value at the source (set at PID-10) and the value set at PID-13 PID Ref1AuxMod.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>Not used</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal
[When the analog voltage/current input terminal selection switch (SW4) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V]</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>6</td><td>Pulse</td><td>TI Pulse input terminal (0-32 kHz Pulse input)</td></tr>
<tr><td>7</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>8</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
<tr><td>10</td><td>EPID1 Output</td><td>External PID 1 output</td></tr>
<tr><td>11</td><td>EPID1 Fdb Val</td><td>External PID 1 feedback</td></tr>
</table>
</td></tr>
<tr><td>PID-22 PID FDB AuxMod</td><td>
The PID-30 (PID FDB AuxMod) provides formulas to calculate the final feedback value. If PID-31 (PID RefAuxSrc) is set to any other value than ‘None,’ the final feedback is calculated using the input values at the sources (set at PID-31 and PID-32).
<table>
<tr><th colspan="2">Setting</th></tr>
<tr><td>0</td><td>M+(G*A)</td></tr>
<tr><td>1</td><td>M*(G*A)</td></tr>
<tr><td>2</td><td>M/(G*A)</td></tr>
<tr><td>3</td><td>M+(M*(G*A))</td></tr>
<tr><td>4</td><td>M+G*2*(A-50)</td></tr>
<tr><td>5</td><td>M*(G*2*(A-50))</td></tr>
<tr><td>6</td><td>M/(G*2*(A-50))</td></tr>
<tr><td>7</td><td>M+M*G*2*(A-50)</td></tr>
<tr><td>8</td><td>(M-A)^2</td></tr>
<tr><td>9</td><td>M^2+A^2</td></tr>
<tr><td>10</td><td>MAX(M,A)</td></tr>
<tr><td>11</td><td>MIN(M,A)</td></tr>
<tr><td>12</td><td>(M+A)/2</td></tr>
<tr><td>13</td><td>Square Root(M+A)</td></tr>
</table>
M= Value by the source set at PID-30
G= Gain value set at PID-33
A= Value by the source set at PID-31
</td></tr>
<tr><td>PID-23 PID Fdb Aux G</td><td>Gain value used a formula set at PID-22.</td></tr>
</table>

Code	Description
PID-24 PID Fdb Band	Sets the maximum and minimum value by adding or subtracting the PID Fdb Band value (set at PID-34) from the reference value. When the feedback value is between the maximum and minimum value, this code maintains the PID output.
PID-25 PID P-Gain1 PID-32 PID P-Gain2	Set the output ratio for differences (errors) between the reference and feedback. If the P Gain is set to 50%, then 50% of the error is output.
PID-26 PID I- Time 1 PID-33 PID I- Time 2	Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral time (PID I-Time) is set to 1 second, 100% output occurs after 1 second of the error remaining at 100%. Differences in a normal state can be reduced by PID I Time. When the multi-function terminal block is set to '24 (I-Term Clear)' and is turned on, all of the accumulated errors are deleted. PID output (final frequency reference) is affected by the gains set at PID-26, PID-33, and the Acc/Dec times to achieve the PID output change based on the DRV-03 and DRV-04 settings. Therefore, consider the relationship between these values when configuring the gains and the Acc/Dec times.
PID-27 PID D-Time 1 PID-34 PID D-Time 2	Sets the output volume for the rate of change in errors. If the differential time (PID D-Time) is set to 1 ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10 ms.
PID-28 PID FF-Gain	Sets the ratio that adds the target to the PID output. Adjusting this value leads to a faster response.
PID-29 PID Out LPF	Used when the PID controller output changes too quickly or the entire system is unstable, due to severe oscillation. In general, a lower value (default value=0) is used to speed up response time, but in some cases a higher value increases stability. The higher the value, the more stable the PID controller output is, but the slower the response time.
PID-30 PID Limit Hi, PID-31 PID Limit Lo	Limit the output of the controller.
PID-35 PID Out Mode	Selects one of the PID output modes to modify the PID output. Modifications can be made by adding input values and the main

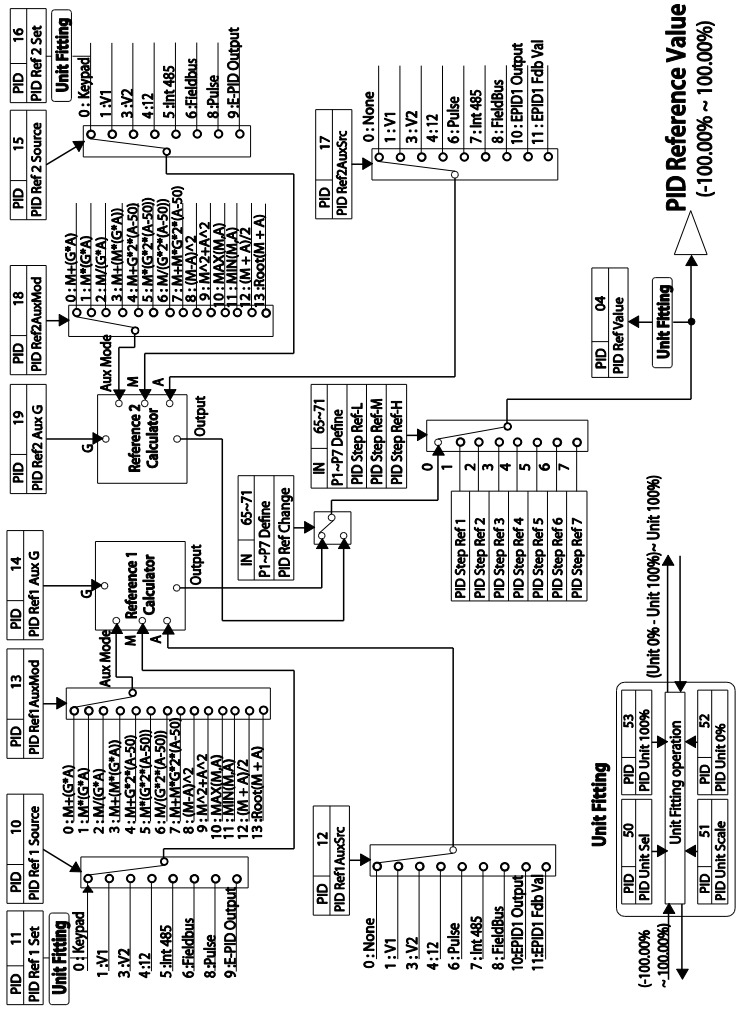
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>operation frequency of the PID output to the final PID output value.
The following table lists the 4 modes that are available.

<table><tr><td colspan="2">Setting</td></tr><tr><td>0</td><td>PID Output</td></tr><tr><td>1</td><td>PID+Main Freq</td></tr><tr><td>2</td><td>PID+EPID1 Out</td></tr><tr><td>3</td><td>PID+EPID1+Main</td></tr></table></td></tr>
<tr><td>PID-36
PID Out Inv</td><td>When PID-36 (PID Out Inv) is set to 'Yes,' the difference (error) between the reference and the feedback is set as the feedback–reference value.</td></tr>
<tr><td>PID-37 PID Out Scale</td><td>Adjusts the volume of the controller output.</td></tr>
<tr><td>PID-40–46 Step Ref 1–7</td><td>Sets the PID reference by multi-function input settings at IN 65–71.</td></tr>
<tr><td>D-50
PID Unit Sel</td><td>Sets the unit for the control variable.
0: CUST is a custom unit defined by the user.

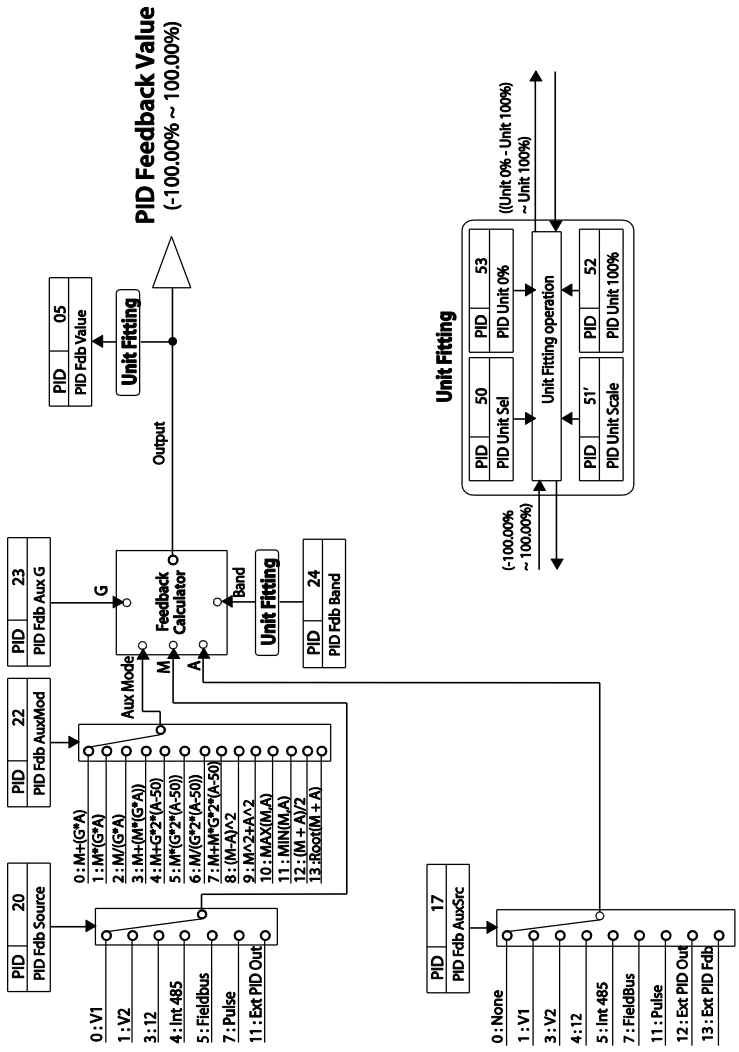
<table><tr><td colspan="4">Setting</td></tr><tr><td>0</td><td>CUST</td><td>21</td><td>m 3/m(m 3/min)</td></tr><tr><td>1</td><td>%</td><td>22</td><td>m 3/h(m 3/h)</td></tr><tr><td>2</td><td>PSI</td><td>23</td><td>l/s</td></tr><tr><td>3</td><td>˚F</td><td>24</td><td>l/m</td></tr><tr><td>4</td><td>˚C</td><td>25</td><td>l/h</td></tr><tr><td>5</td><td>inWC</td><td>26</td><td>kg/s</td></tr><tr><td>6</td><td>inM</td><td>27</td><td>kg/m</td></tr><tr><td>7</td><td>Bar</td><td>28</td><td>kg/h</td></tr><tr><td>8</td><td>mBar</td><td>29</td><td>gl/s</td></tr><tr><td>9</td><td>Pa</td><td>30</td><td>gl/m</td></tr><tr><td>10</td><td>kPa</td><td>31</td><td>gl/h</td></tr><tr><td>11</td><td>Hz</td><td>32</td><td>ft/s</td></tr><tr><td>12</td><td>Rpm</td><td>33</td><td>f3/s(ft3/min)</td></tr><tr><td>13</td><td>V</td><td>34</td><td>f3/h (ft3/h)</td></tr><tr><td>14</td><td>I</td><td>35</td><td>lb/s</td></tr><tr><td>15</td><td>kW</td><td>36</td><td>lb/m</td></tr><tr><td>16</td><td>HP</td><td>37</td><td>lb/m</td></tr><tr><td>17</td><td>mpm</td><td>38</td><td>lb/h</td></tr><tr><td>18</td><td>ft</td><td>39</td><td>ppm</td></tr></table></td></tr>
</table>

Code	Description
	19 m/s 40 pps 20 m3/s(m 3/S)
PID-51 PID Unit Scale	Adjusts the scale to fit the unit selected at PID-65 PID Unit Sel.
PID-52 PID Unit 0 % PID-53 PID Unit 100%	Sets the Unit 0% and Unit 100% values as the minimum and maximum values set at PID-65.

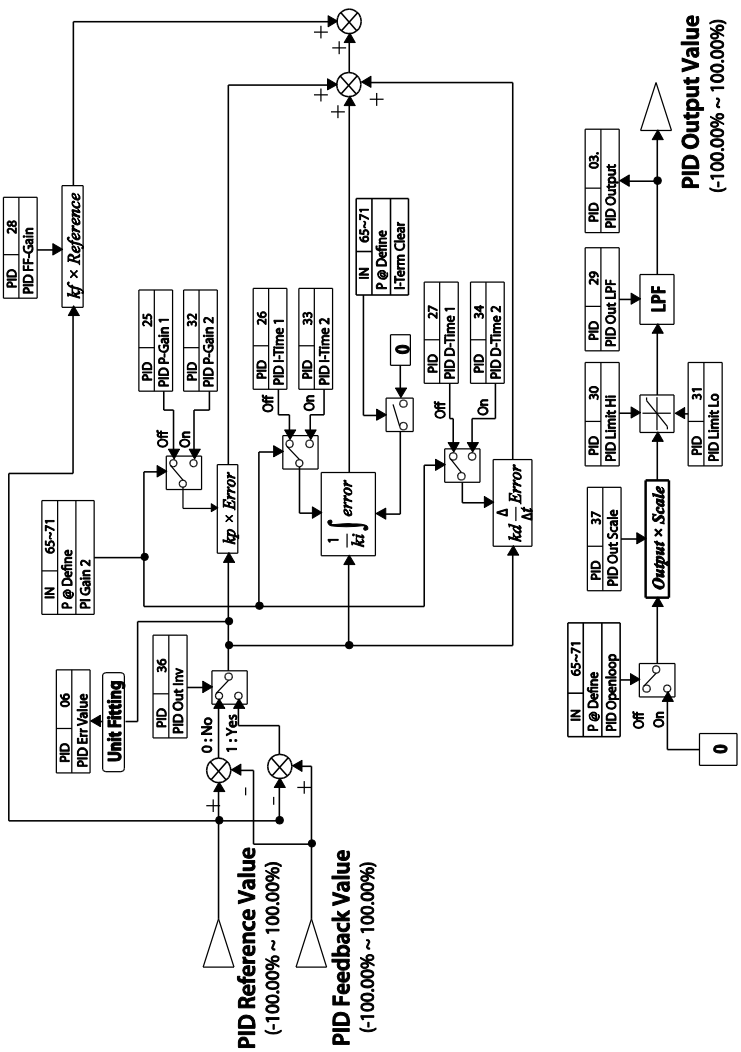
PID Command Block



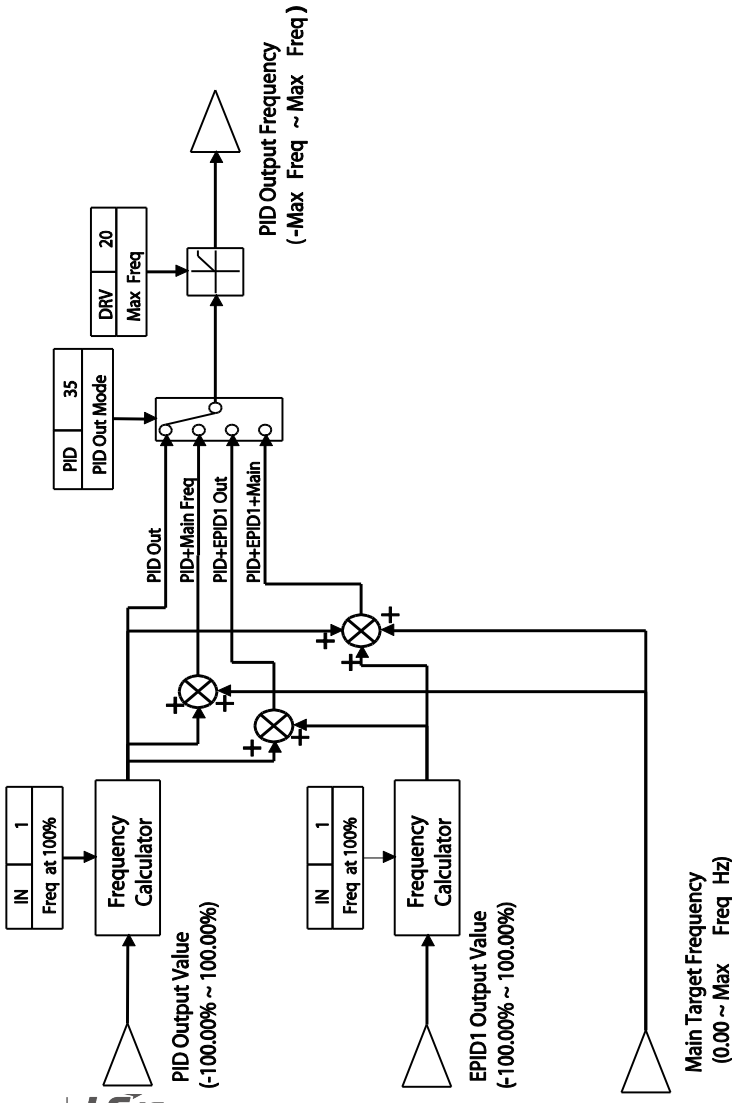
PID Feedback Block



PID Output Block



PID Output Mode Block



5.8.2 Soft Fill Operation

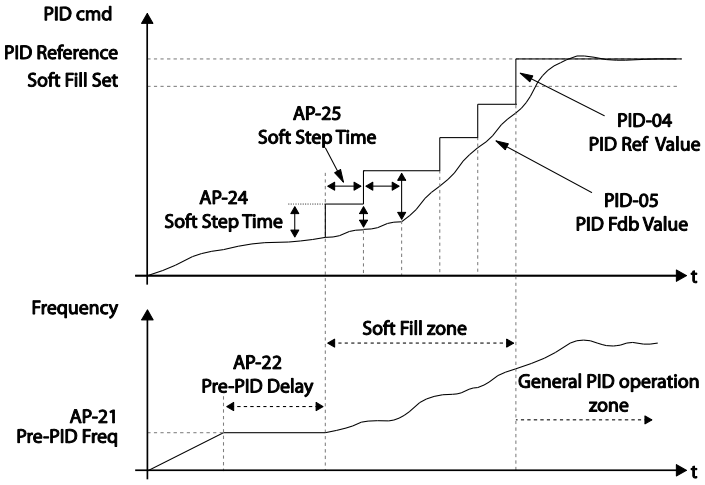
A soft fill operation is used to prevent excessive pressure from building in the pipe system at the initial stage of a pump operation. When the operation command is given, a general acceleration (without PID control) begins and continues until the output reaches the frequency set at AP1-21, for the time set at AP1-22. Then, the soft fill PID operation is performed unless the feedback value has reached the value set at AP1-23 (Soft Fill Set value). The soft fill PID operation continues until the feedback or the soft fill PID reference value reaches the value set at AP1-23 (Soft Fill Set value). When the soft fill operation ends, a normal PID operation starts.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
AP1	20	Soft Fill options	Soft Fill Sel	0	No	0–1	-
	21	Pr- PID operation frequency	Pre-PID Freq	30.00		Low Freq–High Freq	Hz
	22	Pre-PID duration	Pre-PID Delay	60.0		600.0	sec
	23	Soft fill escape value	Soft Fill Set	20.00		Unit Min–Unit Max	%
	24	Soft fill reference increment	Fill Step Set	2.00		0–Unit Band	%
	25	Soft fill reference increment cycle	Fill Step Time	20		0–9999	sec
	26	Soft fill feedback difference	Fill Fdb Diff	0.00		0–Unit Band	%

Soft Fill Operation Setting Details

Code	Description
AP1-20 Soft Fill Sel	Enables or disables the soft fill PID.

Code	Description
AP1-21 Pre-PID Freq	Sets the frequency range for a general acceleration without PID control. If AP1-21 (Pre-PID Freq) is set to 30 Hz, general operation is performed until the PID feedback reaches the value set at AP1-23 (Soft Fill Set). However, if the PID reference or feedback exceeds the value set at AP1-23 during the pre-PID operation, a normal PID operation starts immediately.
AP1-22 Pre-PID Delay AP1-23 Soft Fill Set	In general, a PID operation starts when the feedback volume (controlled variables) of PID controller exceeds the value set at AP1-23. However, if AP1-22 (Pre-PID Delay) is set, the feedback after the set time becomes the default value for the soft fill PID reference, and the inverter starts the soft fill operation. When the feedback or the Soft Fill PID Reference exceeds the Soft Fill Set value, the soft fill operation ends and a normal process PID operation begins.
AP1-24 Fill Step Set AP1-25 Fill Step Time AP1-26 Fill Fdb Diff	The Soft Fill PID Reference increases each time the set time [at AP1-25 (Fill Step Time)] is elapsed, by the amount set at AP1-24 (Fill Step Set). However, note that if the difference between the Soft Fill PID Reference value and the feedback value is greater than the value set at AP1-26 (Fill Fdb Diff value), the Soft Fill PID Reference value does not increase.



When a PID process is performed after the soft fill PID operation, the PID Reference value

becomes the PID-11 PID Ref1 Set value.

5.8.3 PID Sleep Mode

If an operation continues at a frequency lower than the PID operation conditions, a boost operation is performed to extend sleep mode by raising the PID Reference, and then the inverter enters PID sleep mode. In PID sleep mode, the inverter resumes PID operation when the PID feedback falls below the PID Wakeup level and maintains the condition for the time set at AP1-09 (PID WakeUp1 DT) or AP1-13 (PID WakeUp2DT).

Note

PID Wakeup level may be calculated using the following formula:
PID Wakeup Level = PID-04 (PID Ref Value)–AP1-10 (PID WakeUp1Dev) or, PID-04 (PID Ref Value) - AP1-14 PID (WakeUp2Dev).

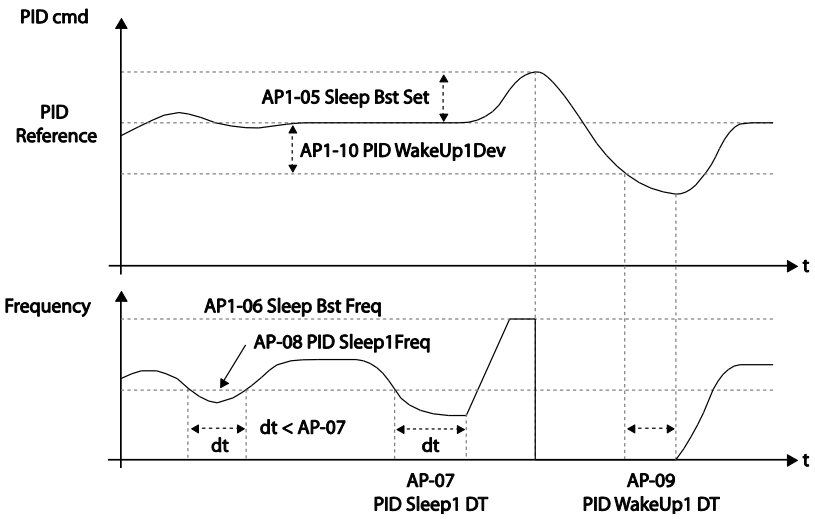
Two sets of configurations are available in PID sleep mode for sleep mode frequency, sleep mode delay time, wakeup variation, and wakeup delay time. One of the two configurations may be selected depending on the multi-function input terminal configuration and input conditions.

Group	Code	Name	LCD Displays	Parameter Setting	Setting Range	Unit
AP1	05	Sleep boost settings	Sleep Bst Set	0.00	0–Unit Max	Unit
	06	Sleep boost speed	Sleep Bst Freq	60.00	0.00, Low Freq–High Freq	Hz
	07	PID sleep mode 1 delay time	PID Sleep 1 DT	20.0	0–6000.0	sec
	08	PID sleep mode 1 frequency	PID Sleep1Freq	0.00	0.00, Low Freq–High Freq	Hz
	09	PID wakeup 1 delay time	PID WakeUp1 DT	20.0	0–6000.0	sec
	10	PID wakeup 1 value	PID WakeUp1Dev	20.00	0–Unit Band	Unit
	11	PID sleep mode 2 delay time	PID Sleep 2 DT	20.0	0–6000.0	sec
	12	PID sleep mode 2	PID	0.00	0.00, Low	Hz

Group	Code	Name	LCD Displays	Parameter Setting		Setting Range	Unit
		frequency	Sleep2Freq			Freq–High Freq	
	13	PID wakeup 2 delay time	PID WakeUp2 DT	20.0		0–6000.0	sec
	14	PID wakeup 2 value	PID WakeUp2Dev	20.00		0–Unit Band	Unit
	20	Soft Fill options	Soft Fill Sel	0	No	0–1	-

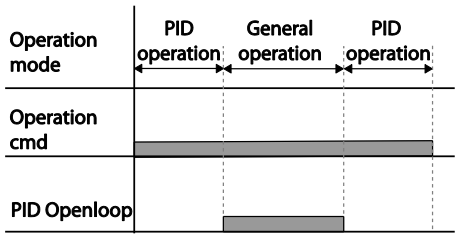
PID Operation Sleep Mode Setting Details

Code	Description
AP1-05 Sleep Bst Set	Sets the sleep boost volume. Feedback must reach the boost level (PID Reference+Sleep Bst Set) for the inverter to enter the Sleep Mode.
AP1-06 Sleep Bst Freq	Sets the inverter operation frequency to reach sleep boost level.
AP1-07 PID Sleep1 DT AP1-11 PID Sleep2 DT AP1-08 PID Sleep1Freq AP1-12 PID Sleep2Freq	If the operating frequency stays below the frequencies set at AP1-08 and AP1-12 for the set times at AP1-07 and AP1-11, the inverter accelerates to the PID sleep boost frequency (PID Sleep Bst Freq). Then, when the feedback reaches the value set at the boost level, the inverter enters standby mode.
AP1-09 PID WakeUp1 DT AP1-13 PID WakeUp2 DT AP1-10 PID WakeUp1Dev AP1-14 PID WakeUp2Dev	Sets the reference for PID operation in PID sleep mode. PID operation resumes when PID feedback variation (from the PID reference) exceeds the values set at AP1-10 and AP1-14, and maintains the condition for times set at AP1-09 or AP1-13.
IN-65–71 P1–7 Define	When the PID Sleep Wake 2 terminal is set and input, PID operation sleep mode is operated based on the parameter settings at AP1-11–14.



5.8.4 PID Switching (PID Openloop)

When one of the multi-function terminals (IN-65–71) is set to '25 (PID Openloop)' and is turned on, the PID operation stops and is switched to general operation. When the terminal turns off, the PID operation starts again.



5.9 External PID

External PID refers to the PID features other than the basic PID features required to control the inverter. The following table shows the areas where external PID controls can be applied.

Purpose	Function
Speed Control	Controls speed by monitoring the current speed levels of the equipment or machinery being controlled. Control maintains consistent speed or operates at the target speed.
Pressure Control	Controls pressure by monitoring the current pressure levels of the equipment or machinery being controlled. Control maintains consistent pressure or operates at the target pressure.
Flow Control	Controls flow by monitoring the amount of flow in the equipment or machinery to be controlled. Control maintains consistent flow or operates at a target flow.
Temperature Control	Controls temperature by monitoring the current temperature levels of the equipment or machinery to be controlled. Control maintains a consistent temperature or operates at a target temperature.

Depending on the PID output mode, the EPID output value can be overlapped to the PID output. External output is also available through the analog output settings at OUT-01 and OUT-07.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
EPI	00	Jump Code	Jump Code	40		1–99	
	01	EPID 1 Mode Selection	EPID1 Mode	0	None	0–3	
	02	EPID1output monitor value	EPID1 Output	0.00		-100.00–100.00%	Unit
	03	EPID1 reference monitor value	EPID1 Ref Val	-		-	-
	04	EPID1 feedback monitor value	EPID1 Fdb Val	-		-	-
	05	EPID1error monitor value	EPID1 Err Val	-		-	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
	06	EPID1 command source selection	EPID1 Ref Src	0	Keypad	0–8	-
	07	EPID1 keypad command value	EPID1 Ref Set	Unit Min		Unit Min–Unit Max	%
	08	EPID1 feedback source selection	EPID1 Fdb Src	0	V1	0–7	-
	09	EPID1 proportional gain	EPID1 P-Gain	50.0		0.0–300.0%	Unit
	10	EPID1 integral time	EPID1 I-Time	10.0		0.0–200.0	Sec
	11	EPID1 differentiation time	EPID1 D-Time	0.00		0–0.00	Sec
	12	EPID1 feed-forward gain	EPID1 FF-Gain	0.0		0.0–1000.0	Unit
	13	EPID1 output filter	EPID1 Out LPF	0		0–10.00	Sec
	14	EPID1 output upper limit	EPID1 Limit Hi	100.00		EPID1 Limit Lo–100.00	-
	15	EPID1 lower limit	EPID1 Limit Lo	0.00		-100.00–EPID1 Limit Hi	-
	16	EPID1 output inverse	EPID1 Out Inv	0	No	0–1	-
	17	EPID1 unit	EPID1 Unit Sel	1: %		Refer to EPID unit details table	-
	18	EEPID1 unit scale	EPID1 Unit Scl	2: X1		0: X100 1: X10 2: X1 3: X0.1 4: X0.01	-
	19	EPID1 unit 0%	EPID1 Unit0%	Differs depending		X100: -32000–	-

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		value		on the unit setting		Unit 100% X10: -3200.0–Unit 100% X1: -320.00–Unit 100% X0.1: -32.000–Unit 100% X0.01: -3.2000–Unit 100%	
	20	EPID1 unit 100% value	EPID1 Unit100%	Differs depending on the unit setting		X100: Unit 0%–32000 X10: Unit 0%–3200.0 X1: Unit 0%–320.00 X0.1: Unit 0%–32.000 X0.01: Unit 0%–3.2000	-
	31	EPID2 Mode selection	EPID2 Mode	0	None	0–3	-
	32	EPID2 output monitor value	EPID2 Output	0.00		-100.00–100.00%	Unit
	33	EPID2 reference monitor value	EPID2 Ref Val	-		-	-
	34	EPID2 feedback monitor value	EPID2 Fdb Val	-		-	-
	35	EPID2 error monitor value	EPID2 Err Val	-		-	-
	36	EPID2 command source selection	EPID2 Ref Src	0	Keypad	0–8	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	37	EPID2 keypad command value	EPID2 Ref Set	Unit Min	Unit Min–Unit Max	Unit
	38	EPID2 feedback source selection	EPID2 Fdb Src	0 V1	0–7	-
	39	EPID2 proportional gain	EPID2 P-Gain	50.0	0.0–300.0	Unit
	40	EPID2 integral time	EPID2 I-Time	10.0	0.0–200.0	Sec
	41	EPID2 differentiation time	EPID2 D-Time	0.00	0–1.00	Sec
	42	EPID2 feed-forward gain	EPID2 FF-Gain	0.0	0.0–1000.0	Unit
	43	EPID2 output filter	EPID2 Out LPF	0	0–10.00	Sec
	44	EPID2 output upper limit	EPID2 Limit Hi	100.00	EPID2 Limit Lo–100.00	-
	45	EPID2 output lower limit	EPID2 Limit Lo	0.00	-100.00–EPID2 Limit Hi	-
	46	EPID2 output inverse	EPID2 Out Inv	0: No	0 No 1 Yes	-
	47	EPID2 unit	EPID2 Unit Sel	0: CUST	Refer to EPID unit details table	-
	48	EPID2 unit scale	EPID2 Unit Scl	2: X1	0: X100 1: X10 2: X1 3: X0.1 4: X0.01	-
	49	EPID2 unit 0% value	EPID2 Unit0%	Differs depending on the unit setting	X100: -32000–Unit 100% X10: -3200.0–	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
					Unit 100% X1: -320.00–Unit 100% X0.1: -32.000–Unit -100% X0.01: -3.2000–Unit 100%	
	50	EPID2 unit 100% value	EPID2 Unit100%	Differs depending on the unit setting	X100: Unit 0%–32000 X10: Unit 0%–3200.0 X1: Unit 0%–320.00 X0.1: Unit 0%–32.000 X0.01: Unit 0%–3.2000	-

Note

- The EPID1–2 output (EPID OUT) is bipolar, and is limited by the EPI-14 (EPID 1 Limit Hi) and EPI-15 (EPID 1 Limit Lo) settings.
- The following are the variables used in PID operation, and how they are calculated:
  - Unit MAX = EPID1 (EPID2) Unit 100% (PID-68)
  - Unit Min = (2xEPID1 (EPID2) Unit0%-EPID1 (EPID2) Unit 100%)
  - Unit Default = (EPID1 (EPID2) Unit 100%-EPID1 (EPID2) Unit 0%)/2

EPID Basic Operation Setting Details

<table>
<tr><th>Code</th><th colspan="3">Description</th></tr>
<tr><td>EPI-01 EPID1 Mode</td><td colspan="3">Sets the EPID1 modes.

<table><tr><td colspan="2">Setting</td><td>Function</td></tr><tr><td>0</td><td>None</td><td>EPID1 is not used.</td></tr><tr><td>1</td><td>Always On</td><td>EPID1 operates at all times.</td></tr><tr><td>2</td><td>During Run</td><td>Operates only when the inverter is running.</td></tr><tr><td>3</td><td>DI Dependent</td><td>Operates when terminal input (EPID1 Run) is on.</td></tr></table></td></tr>
<tr><td>EPI-02 PID Output</td><td colspan="3">Displays the existing output value for the EPID controller. The unit, gain, and scale that were set in the EPID group are applied on the display.</td></tr>
<tr><td>EPI-03 EPID Ref Value</td><td colspan="3">Displays the existing reference value set for the EPID controller. The unit, gain, and scale that were set in the EPID group are applied on the display.</td></tr>
<tr><td>EPI-04 EPID1 Fdb Value</td><td colspan="3">Displays the existing feedback value set for the EPID controller. The unit, gain, and scale that were set in the EPID group are applied on the display.</td></tr>
<tr><td>EPI-05 EPID1 Err Value</td><td colspan="3">Displays the difference between the existing reference and the feedback (error value). The unit, gain, and scale that were set in the PID group are applied on the display.</td></tr>
<tr><td>EPI1-06 EPID1 Ref Src</td><td colspan="3">Selects the reference input for the EPID control. If the V1 terminal is set to an EPID1 feedback source (EPID1 F/B Source), V1 cannot be set as the EPID1 reference source (EPID1 Ref Source). To set V1 as a reference source, change the feedback source.</td></tr>
</table>

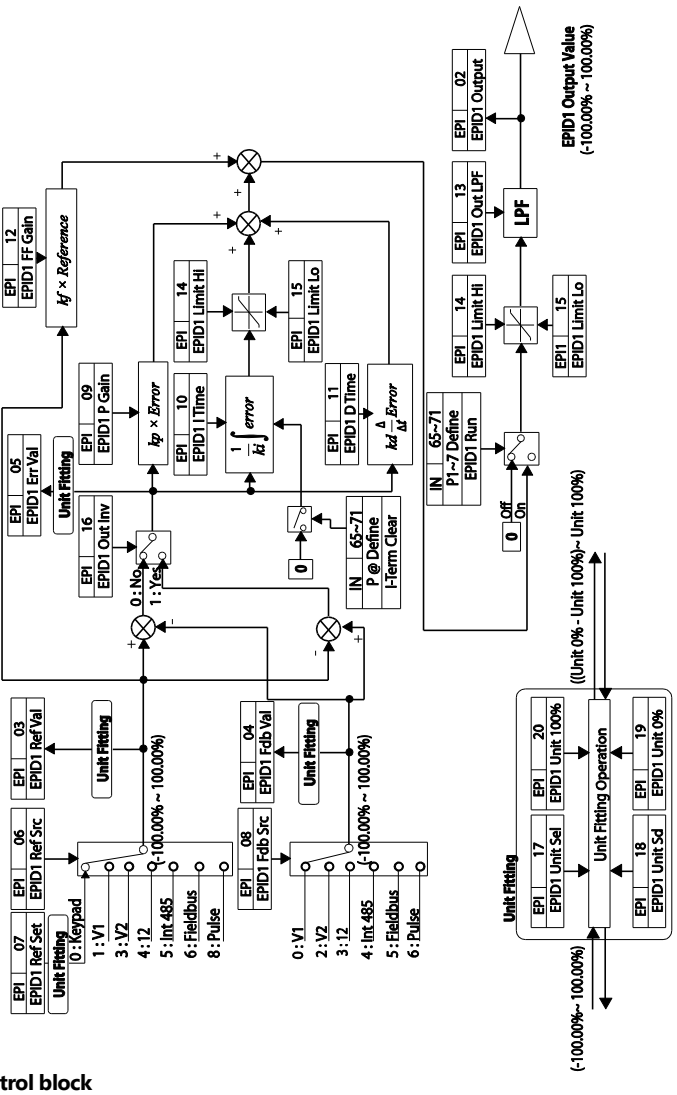
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal [When analog voltage/current input terminal selection switch (SW2) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V]</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>7</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
<tr><td>8</td><td>Pulse</td><td>TI Pulse input terminal (0-32 kHz Pulse input)</td></tr>
</table>
</td></tr>
<tr><td>EPI-07 EPID1 Ref Set</td><td>Set the EPI control reference type (EPI-06) to '0 (Keypad)' to enter the reference value.</td></tr>
<tr><td>EPI-09 EPID1 P-Gain</td><td>Sets the output ratio for differences (errors) between the reference and feedback. If the P-Gain x 2 is set to 50%, then 50% of the error is output. The setting range for P-Gain is 0.0-1,000%.</td></tr>
<tr><td>EPI-08 EDPID1 Fdb Src</td><td>Selects the feedback input for the EPID control. When the V1 terminal is set to an EPID feedback source (PID F/B Source), V1 cannot be set as the PID reference source (PID Ref Source). To set V1 as a reference source, change the feedback source.

<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Keypad</td><td>Keypad</td></tr>
<tr><td>1</td><td>V1</td><td>-10-10 V input voltage terminal</td></tr>
<tr><td>3</td><td>V2</td><td rowspan="2">I2 analog input terminal [When analog voltage/current input terminal selection switch (SW4) at the terminal block is set to I (current), input 0-20 mA current. If it is set to V (voltage), input 0–10 V voltage]</td></tr>
<tr><td>4</td><td>I2</td></tr>
<tr><td>5</td><td>Int. 485</td><td>RS-485 input terminal</td></tr>
<tr><td>7</td><td>FieldBus</td><td>Communication command via a communication option card</td></tr>
</table>
</td></tr>
<tr><td>EPI-10 EPID1 I- Time</td><td>Sets the time to output accumulated errors. When the error is 100%, the time taken for 100% output is set. When the integral time (EPID I-Time) is set to 1 second, 100% output occurs after 1 second of the</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>error remaining at 100%. Differences in a normal state can be reduced by EPID I Time.
All the accumulated errors can be deleted by setting the multi-function terminal block to ‘42 (EPID1 ITerm Clr)’ or ‘48 (EPID2 ITerm Clr)’.</td></tr>
<tr><td>EPI-11
EPI1 D-Time</td><td>Sets the output volume for the rate of change in errors. If the differential time (EPID1 D-Time) is set to 1 ms and the rate of change in errors per sec is 100%, output occurs at 1% per 10 ms.</td></tr>
<tr><td>EPI-12 EPID1 FF-Gain</td><td>Sets the ratio that adds the target to the EPID output. Adjusting this value leads to a faster response.</td></tr>
<tr><td>EPI-13EPID1 Out LPF</td><td>Used when the output of the EPID controller changes too fast or the entire system is unstable, due to severe oscillation. In general, a lower value (default value=0) is used to speed up response time, but in some cases a higher value increases stability. The higher the value, the more stable the EPID controller output is, but the slower the response time.</td></tr>
<tr><td>EPI-14 EPID1 Limit Hi,
EPI-15 EPID1 Limit Lo</td><td>Limits the output of the controller.</td></tr>
<tr><td>EPI-16
EPID1 Out Inv</td><td>If EPID Out Inv is set to ‘Yes,’ the difference (error) value between the reference and the feedback is set as the feedback–reference value.</td></tr>
<tr><td>EPI-17 EPID1 Unit Sel</td><td>Sets the unit for the control variable.
0: CUST is a custom unit defined by the user.

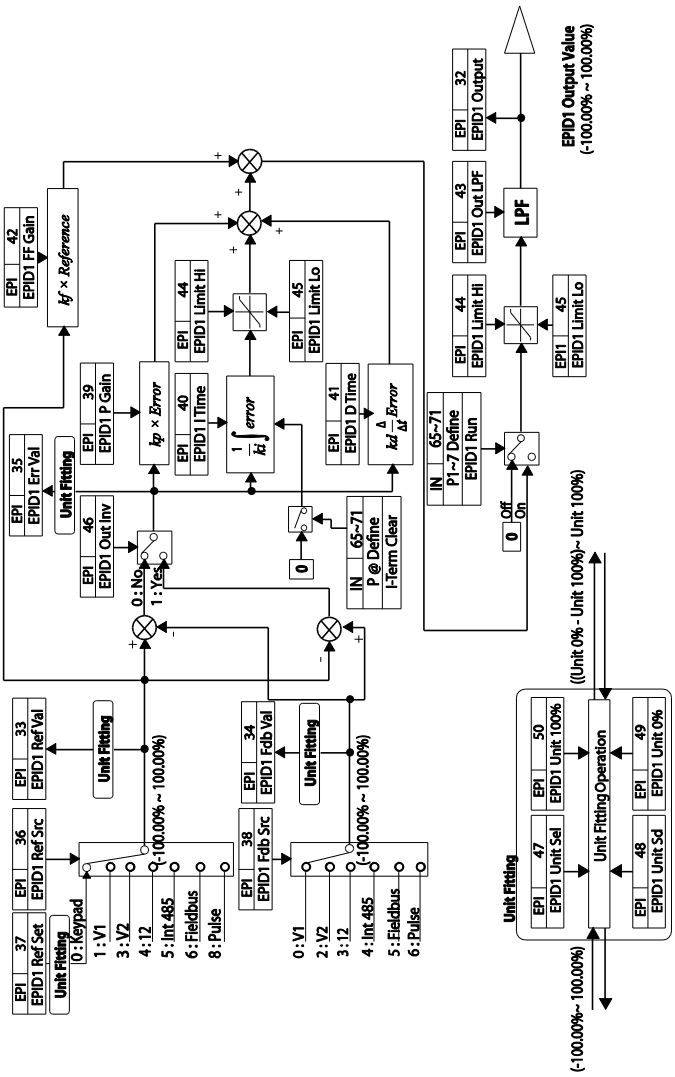
<table>
<tr><td colspan="4">Setting</td></tr>
<tr><td>0</td><td>CUST</td><td>21</td><td>m 3/m(m 3/min)</td></tr>
<tr><td>1</td><td>%</td><td>22</td><td>m 3/h(m 3/h)</td></tr>
<tr><td>2</td><td>PSI</td><td>23</td><td>l/s</td></tr>
<tr><td>3</td><td>˚F</td><td>24</td><td>l/m</td></tr>
<tr><td>4</td><td>˚C</td><td>25</td><td>l/h</td></tr>
<tr><td>5</td><td>inWC</td><td>26</td><td>kg/s</td></tr>
<tr><td>6</td><td>inM</td><td>27</td><td>kg/m</td></tr>
<tr><td>7</td><td>Bar</td><td>28</td><td>kg/h</td></tr>
<tr><td>8</td><td>mBar</td><td>29</td><td>gl/s</td></tr>
<tr><td>9</td><td>Pa</td><td>30</td><td>gl/m</td></tr>
<tr><td>10</td><td>kPa</td><td>31</td><td>gl/h</td></tr>
</table></td></tr>
</table>

Code	Description
	11 Hz 32 ft/s 12 Rpm 33 f3/s(ft3/min) 13 V 34 f3/h (ft3/h) 14 I 35 lb/s 15 kW 36 lb/m 16 HP 37 lb/m 17 mpm 38 lb/h 18 ft 39 ppm 19 m/s 40 pps 20 m3/s(m 3/S)
EPI-18 EPID1 Unit Scl	Adjusts the scale to fit the unit selected at EPI-17 EPI1 Unit Sel.
EPI-19 EPID1 Unit 0 % EPI-20 EPID1 Unit 100%	Sets the EPID1 Unit 0% value and the EPID1 Unit 100% value as the minimum and maximum values set at EPI1-17.



EPID1 Control block

EPID2 Control block



5.10 Damper Operation

A damper is a device that controls the flow in a ventilation system. If a fan and a damper are used together in a system, the inverter may be configured to operate according to the damper's operation status. During a damper operation, one of the relay outputs OUT-31–35 (Relay 1–5) may be set to '33 (Damper Control)' to output a signal based on the damper's operation status. One of the multi-function terminal inputs (IN-65–71) may also be set to '45 (Damper Open)' to receive the damper status input. The inverter starts operating when both the run command and the damper open signal are turned on (relay output setting at OUT-31–35 is not necessary).

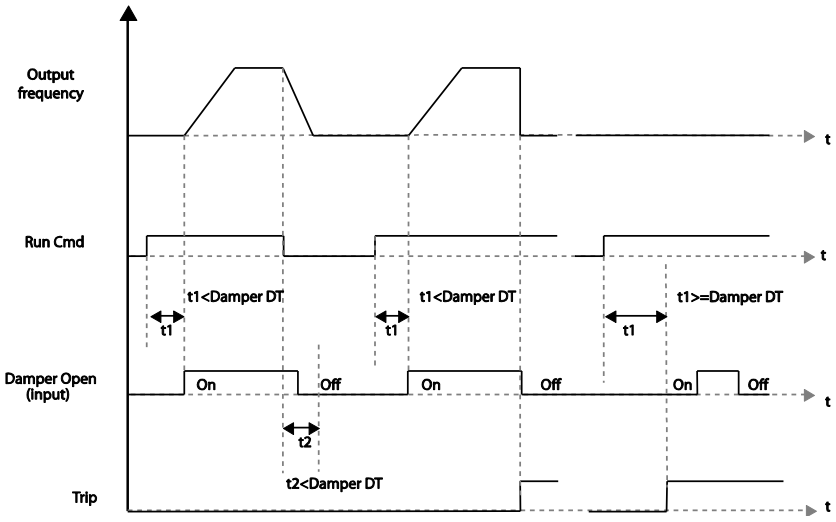
When the time difference between the inverter run command and the damper open signal exceeds the delay time set at AP2-45 (Damper DT), damper error (Damper Err) occurs. If the damper open relay output and damper control input are set at the same time, and if the damper open signal is not received until the time set at AP2-45 (Damper DT) is elapsed (when the inverter is not operating), damper error (Damper Err) occurs.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	45	Damper check time	Damper DT	-	0.1–600.0	(sec)
IN	65-71	P1–7 Px terminal configuration	P1–P7 Define	45 (Damper open)	-	-
OUT	31-35	Multi-function relay 1–5	Relay 1–5	33 (Damper Control)	-	-

Damper Operation Setting Details

Code	Description
AP2-45 Damper DT	Sets the damper open delay time.

Code	Description
	Detects the inverter run command or the damper open signal (whichever is received first) and outputs a damper error (Damper Err) if the other signal is not received until the time set at AP2-45 elapses.
IN-65–71 P1–7 define	Sets one of the multi-functional terminals to '45 (Damper Open)' to enable damper operation.
OUT-31–35 Relay 1–5	Sets one of the relay outputs to '33 (Damper Control)' to provide a relay output when the inverter run command is turned on.



Note

Damper operation is one of the essential system features that are available in both HAND and AUTO modes.

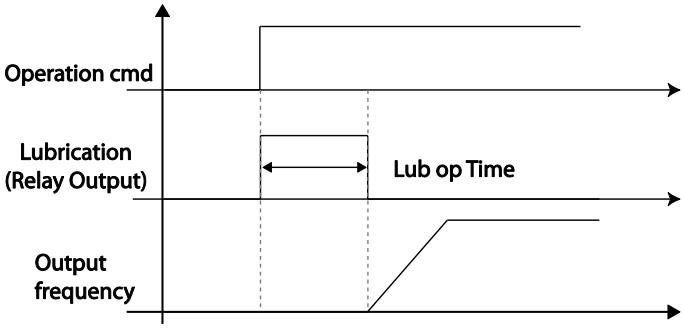
5.11 Lubrication Operation

During a lubrication operation, the inverter outputs the lubrication signal through one of the output relays when the inverter receives a run command. The inverter does not start operating until the time set at AP2-46 (Lub Op Time) has elapsed and the Lubrication signal is turned off.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	46	Lubrication operation time	Lub Op Time		0.1–600.0	(sec)
OUT	31-35	Multi-function relay 1–5	Relay 1–5	33 (Damper Control)	-	-

Lubrication Operation Setting Details

Code	Description
AP2-46 Lub Op Time	Outputs the lubrication signal for a set time when the inverter run command is turned on. The inverter starts operating when the set time has elapsed.
OUT-31–35 Relay 1–5	Sets one of the output relays (OUT-31–35) to '30 (Lubrication)' to enable the Lubrication function.



Note

- The lubrication function can be used to delay inverter operations, depending on the working environment, since the inverter waits for the time set at AP2-46 (Lub Op Time) each time a run command is received.
- Lubrication operation is one of the essential system features that are available in both HAND and AUTO modes.

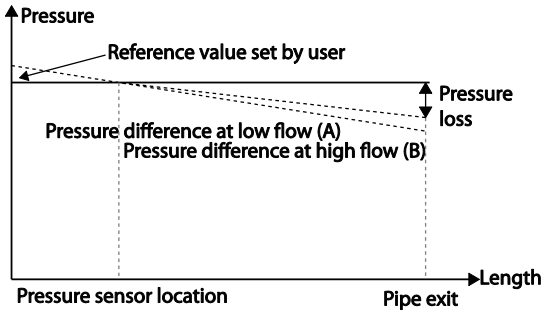
5.12 Flow Compensation

In a system with a pipeline, longer pipes and higher flow rate cause greater pressure loss. A flow compensation operation can compensate for pressure loss by increasing the volume of the PID reference.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
AP1	30	Flow Comp function options	Flow Comp Sel	-	0	No	-
					1	Yes	
	31	Max Comp amount	Max Comp Value	-	0–Unit Band		-

Flow Compensation Setting Details

Code	Description
AP1-30 Flow Comp Sel	Sets the Flow Compensation function options.
AP1-31 Max Comp Value	Sets the maximum compensation volume. This function is based on a PID operation. The volume is given the same unit used for the PID reference.

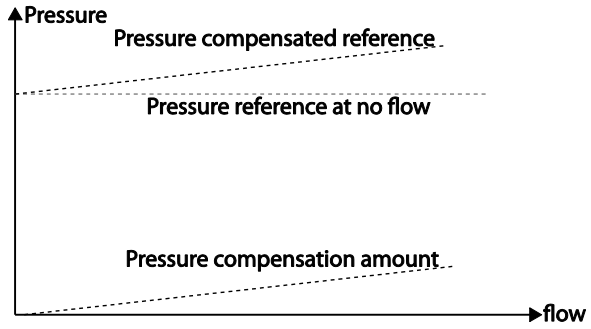


Longer pipes cause the actual pressure to decrease, which in turn increases the difference between the pressure reference and the actual pressure. When the pipe lengths are equal in two different systems, more pressure loss is caused in the system with greater flow. This explains the pressure difference between (A) and (B) in the figure (when the flows are different). To compensate for the pressure loss above, the value of AP1-31 is set to the maximum volume of compensation when the inverter has the maximum frequency, and adds to the PID reference after calculating compensation volume based on the output frequency.

The final PID reference=PID-11+Compensation amount, and compensation amount is shown below.

$$\text{Compensation amount} = \frac{\text{Out Freq} - \text{Start Freq}}{\text{MaxFreq} - \text{Start Freq}} * (\text{PID}-53) * \frac{(\text{AP1} - 31)}{100\%}$$

PID-53: PID Output Maximum value



5.13 Payback Counter

The payback counter displays energy savings information by comparing the average energy efficiency for operations with and without the inverter. The energy savings information is displayed as kWh, saved energy cost, and CO2 emission level.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	87	1st MOTOR average POWER	M1 AVG PWR	Inverter capacity	0.1–90.0	kW
	88	2nd MOTOR average POWER	M2 AVG PWR	Inverter capacity	0.1–90.0	kW
	89	Cost per kWh	Cost per kWh	0	0.0–1000.0	kW
	90	Saved kWh	Saved kWh	0	-999.9–999.9	kWh
	91	Saved MWh	Saved MWh	0	-32000–32000	MWh
	92	Saved Cost below 1000 unit	Saved Cost1	0	-999.9–999.9	-
	93	Saved Cost over 1000 unit	Saved Cost2	0	-32000–32000	-
	94	Reduced CO2 conversion Factor	CO2 Factor	0.5	0.1–5.0	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
	95	Reduced CO2 (Ton)	Saved CO2 - 1	0	-9999–9999		Ton
	96	Reduced CO2 (1000 Ton)	Saved CO2 - 2	0	-160–160		Ton
	97	Reset Energy payback parameter	Reset Energy	0	0	No	-
					1	Yes	

Energy Payback Value Function Setting Details

Code	Description
AP2-87 M1 AVG PWR	Sets the average power value of the #1 motor and calculates the energy savings based on the set value.
AP2-88 M2 AVG PWR	Sets the average power of the #2 motor and calculates energy savings based on the set value.
AP2-89 Cost per kWh	Sets the cost per 1 kWh. Multiply the energy payback counter value with the value set at AP2-89 to calculate the total saved cost. This value is displayed in AP2-92–93.
AP2-90 Saved kWh AP2-91 Saved MWh	Displays the saved energy in kWh (AP2-90) and MWh (AP2-91). When the value reaches 999.9 (kWh) and continues to increase, AP2-91 becomes 1 (MWH), AP2-90 resets to 0.0, and it continues to increase.
AP2-92 Saved Cost1 AP2-93 Saved Cost2	Displays the saved cost to the one-tenth place at AP2-92. When the value reaches 999.9 and continues to increase, AP2-93 becomes 1, AP2-92 resets to 0.0, and it continues to increase.
AP2-94 CO2 Factor	Sets the CO2 reduction rate per 1 MW (default value=0.5). The value is multiplied with AP2-90 and AP2-91, and the resulting values are displayed at AP2-95 and AP2-96.
AP2-95 Saved CO2-1 AP2-96 Saved CO2-2	Displays the CO2 reduction rate in tons (AP2-95) and kilo-tons (AP2-96).
AP2-97 Reset Energy	Resets all the saved energy parameters.

Note

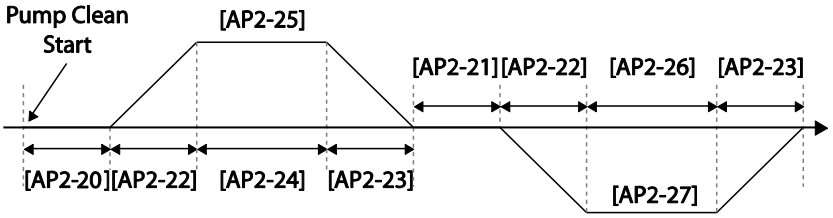
Note that the actual saved energy may differ from the displayed values, since the resulting values are affected by user-defined codes sush as AP2-87 and AP2-88.

5.14 Pump Clean Operation

The pump clean operation is used to remove the scales and deposits attached on the impeller inside a pump. This operation keeps the pump clean by performing a repetitive run-and-stop operation of a pump. This prevents loss in pump performance and premature pump failures.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
AP2	15	Pump clean mode 1	Pump Clean Mode1	0: None	0	None	-
					1	DI Defendent	
					2	Output Power	
					3	Output Current	
	16	Pump clean mode 2	Pump Clean Mode2	0: None	0	None	-
					1	Start	
					2	Stop	
					3	Start & Stop	
	17	Pump clean load setting	PC Curve Rate	100.0	100.0–200.0		%
	18	Pump clean reference band	PC Curve Band	5.0	0.0–100.0		%
	19	Pump clean operation delay time	PC Curve DT	60.0	0–6000.0		sec
	20	Pump clean start delay time	PC Start DT	10.0	0–6000.0		Sec
	21	0 speed operating time	PC Step DT	5.0	1.0–6000.0		Sec

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		at Fx/Rx switching				
	22	Pump clean Acc time	PC Acc Time	10.0	0–600.0	Sec
	23	Pump clean Dec time	PC Dec Time	10.0	0–600.0	Sec
	24	Forward step run time	Fwd Steady T	10.0	1.0–6000.0	Sec
	25	Forward step run frequency	Fwd SteadyFreq	30	0.00, Low Freq–High Freq	Hz
	26	Reverse step run time	Rev Steady T	10.0	1.0–6000.0	Sec
	27	Reverse step run frequency	Rev SteadyFreq	30	0.00, Low Freq–High Freq	Hz
	28	Number of Fx/Rx steps for pump clean	PC Num of Steps	5	0–10	-
	29	Pump clean cycle monitoring	Repeat Num Mon	-	-	-
	30	Pump clean repeat number	Repeat Num Set	5	0–10	-
	31	Operation after pump clean	PC End Mode	0	0 Stop 1 Run	-
	32	Pump clean continuous time limit	PC Limit Time	10	6–60	min
	33	Pump clean continuous number limit	PC Limit Num	3	0–10	-



<Basic Pump Clean Operation>

When a pump clean start command is given, the inverter waits until the delay time set at AP2-19 elapses, accelerates by the acceleration time set at AP2-22, and operates at the frequency set at AP2-25. The pump runs for the time set at AP2-24, decelerates by the time set at AP2-23, and then stops. This operation repeats in the forward and reverse directions (one after another) for the number of times set at AP2-28 (PC Num of Step). Each time the steps (Fx/Rx) switch, the inverter waits at a stop state for the time set at AP2-21 before going on with the next step. One step in the forward direction and another step in the reverse direction makes one cycle. The number of pump clean cycles is set at AP2-30. In the figure above, AP2-28 is set to '1', and AP2-30 is set to '1'.

Pump Clean Function Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP2-15 PumpClean Mode</td><td>Sets the pump mode.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>Pump Clean function is not used.</td></tr>
<tr><td>1</td><td>DI defendant</td><td>Set one of the terminal inputs to '46 (Pump Clean Sel)' and performs the pump clean operation by turning on the terminal.</td></tr>
<tr><td>2</td><td>Power</td><td>Performs a pump clean operation when a pump consumes more power than it is supposed to consume in a normal operation.</td></tr>
<tr><td>3</td><td>Current</td><td>Performs a pump clean operation when a pump consumes more current than it is supposed to consume in a normal operation.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP2-16 PumpClean Sel</td><td>Sets the pump clean start mode.

<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>Pump clean is performed only by the function set at AP2-20.</td></tr>
<tr><td>1</td><td>Start</td><td>Pump clean is performed each time the inverter starts operating.</td></tr>
<tr><td>2</td><td>Stop</td><td>Pump clean is performed each time the inverter stops operating.</td></tr>
<tr><td>3</td><td>Start & Stop</td><td>Pump clean is performed each time the inverter starts or stops operating.</td></tr>
</table></td></tr>
<tr><td>AP2-17 PC Curve Rate
AP2-18 PC Curve Band
AP2-19 PC Start DT</td><td>If AP2-15 is set to ‘Power’ or ‘Current,’ multiply the load characteristic curve set at AP2-2–AP2-10 by the value set at AP2-17 (100[%]+AP2-17[%]), and reset the load characteristic curve for the pump clean operation (refer to the load tune features for AP2-2–AP2-10 setting values).
Apply (rated inverter current x AP2-18 setting value) and (rated motor x AP2-18 setting value) to the pump clean load curve calculated by AP2-17 to calculate the final pump clean load curve.
The inverter performs pump clean operation when the inverter continues operating for the time set at AP2-19.</td></tr>
<tr><td>AP2-20 Clean Start DT</td><td>When AP2-15 is set to ‘Power’ or ‘Current’, a pump clean is performed if the inverter operation power or current stays above the pump clean load characteristic curve (defined by AP2-17 and AP2-18) for the time set at AP2-19.</td></tr>
<tr><td>AP2-21 Clean Step DT</td><td>Sets the time for the inverter to maintain 0 speed (stop) before the inverter switches from forward to reverse operation during a pump clean.</td></tr>
<tr><td>AP2-22 PumpClean AccT
AP2-23 PumpClean DecT</td><td>Sets the Acc/Dec times for pump clean operations.</td></tr>
<tr><td>AP2-24 Fwd Steady Time
AP2-26 Rev Steady Time</td><td>Sets the time to maintain forward and reverse operations.</td></tr>
<tr><td>AP2-25 Fwd SteadyFreq
AP2-27 Rev SteadyFreq</td><td>Sets the forward and reverse operation frequencies.</td></tr>
<tr><td>AP2-28 PC Num of Steps</td><td>Determines the number of steps</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>(acceleration/deceleration/stop) in one cycle. Each operation, either in the forward or reverse direction, constitutes one step. If set to '2,' one forward step and one reverse step constitute one cycle.</td></tr>
<tr><td>AP2-31 PC End Mode</td><td>Determines the inverter operation after pump clean operation.

<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Stop</td><td>This stops the inverter after pump cleaning.</td></tr>
<tr><td>1</td><td>Start</td><td>The inverter operates based on the inverter's command status after the pump cleaning. (If a terminal command is received, the inverter performs the operation it was performing before the pump clean operation.)</td></tr>
</table>
</td></tr>
<tr><td>AP2-29 Repeat Num Mon</td><td>Displays the number of the current pump cleaning cycle.</td></tr>
<tr><td>AP2-30 Repeat Num Set</td><td>Sets the number of cycles for one pump clean operation set at AP2-21–AP2-28.</td></tr>
<tr><td>AP2-32 PC Limit Time
AP2-33 PC Limit Num</td><td>Frequent pump clean operations may indicate a serious system problem. To warn the users of potential system problems, an error (CleanRPTErr) occurs if the number of pump clean operation exceeds the number set at AP2-33 within the time period set at AP2-32.</td></tr>
</table>

Note

- When the run prevent feature is active and an operation in the prevented direction is required to perform a pump clean operation, the inverter operates at the 0 speed for the time set at AP2-24 and AP2-26 (Steady Time).
- To stop the pump clean operation, press the OFF key on the keypad or turn it off at the terminal input.
- If the pump clean operation is configured for terminal input and it is turned on, and if ADV-10 (PowerOn Resume) is set to 'Yes', a pump clean operation is performed when the inverter is turned on.
- When performing a pump clean operation via terminal input,
  - if the terminal input is turned off instantly after it is turned on (the operation is triggered), 1 pump clean cycle is operated.

- if ADV-10 (PowerOn Resume) is set to 'Yes', and the terminal input is turned off instantly after it is turned on (the operation is triggered), and if the inverter is turned off during a pump clean then is turned back on again, the pump clean operation is not resumed (because the input terminal is not on when the inverter is turned on).
- if the terminal input is kept on after it is initially turned on, 1 pump clean cycle is operated.

5.15 Start & End Ramp Operation

This function is used to rapidly accelerate the pump to the normal operating level, or to rapidly decelerate the pump and stop it. Start & End ramp operation is performed when ADV-24 (Freq Limit) is set to '1 (Yes).'

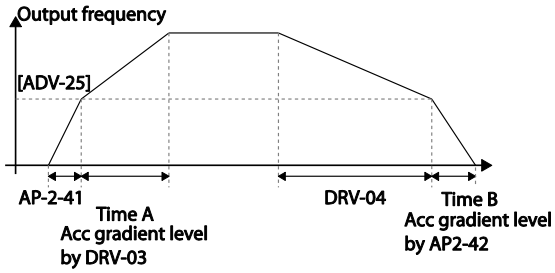
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	40	Start & End Ramp Gradient	Start&End Ramp	0: No	0 No 1 Yes	-
	41	StartRampAcc	StartRampAcc	10.0	0–600.0	Sec
	42	EndRampDec	EndRampDec	10.0	0–600.0	Sec
ADV	24	Frequency limit options	Freq Limit	0: No	0 No 1 Yes	-
	25	Low Freq minimum value	Freq Limit Lo	30.00	Start Freq–Max Freq	Hz
	26	Low Freq maximum value	Freq Limit Hi	60.00	Freq Limit Lo–Max Freq	Hz

Start & End Ramp Operation Setting Details

Code	Description
AP2-40 Start&End Ramp	Sets the pump Start & End Ramp options.

Setting		Function
0	No	The Start & End Ramp operation is not used.

Code	Description		
	1	Yes	Use the Start & End Ramp operation.
AP2-41 Start Ramp Acc	Refers to the time it takes to reach the minimum pump operation frequency for a Start & End Ramp operation (Freq Limit Lo) set at ADV-25 when the inverter starts (it is different from DRV-03 acceleration gradient).		
AP2-42 End Ramp Dec	Refers to the time it takes to reach the 0 step (stop) from the minimum pump operation frequency for a Start & End Ramp operation (Freq Limit Lo) set at ADV-25 (it is different from DRV-03 deceleration gradient).		



< Start&End Ramp Adjustment>

In the figure above, AP2-41 defines the acceleration time to the minimum operation frequency ADV-25 (Freq Limt Lo**)**. AP2-42 defines the deceleration time from the minimum operation frequency to a stopped state. Time A (normal acceleration time set at DRV-03) and Time B (normal deceleration time set at DRV-04) in the figure will change according to the Acc/Dec gradients defined by AP2-41 and AP2-42.

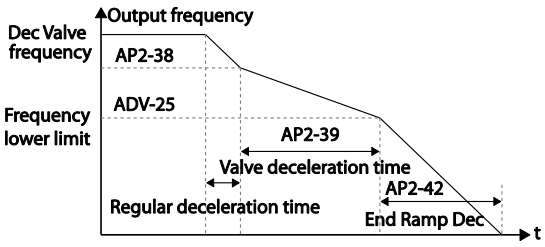
5.16 Decelerating Valve Ramping

This function is used to prevent pump damage due to abrupt deceleration. When the pump operation frequency reaches the valve ramp frequency (AP2-38 Dec Valve Freq) while decelerating rapidly based on the deceleration ramp time (set at AP2-42), it begins to slow down the deceleration based on the deceleration valve ramp time (set at AP2-39 DecValve Time). Decelerating valve ramp operates when ADV-24 (Freq Limit) is set to '1 (Yes)'.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	38	Dec valve ramping start frequency	Dec Valve Freq	40.00	Low Freq–High Freq	Hz
	39	Dec valve ramping time	DecValve Time	0.0	0–6000.0	Sec
ADV	24	Frequency limit options	Limit Mode	0: No	0 No 1 Yes	-
	25	Low Freq minimum value	Freq Limit Lo	30.00	Start Freq–Max Freq	Hz
	26	Low Freq maximum value	Freq Limit Hi	60.00	Freq Limit Lo–Max Freq	Hz

Deceleration Valve Ramping Setting Details

Code	Description
AP2-38 Dec Valve Freq	Sets the start frequency where the slow deceleration begins in order to prevent pump damage when the inverter stops. Decelerating valve ramping is performed from the frequency set at AP2-38 to the frequency limit set at ADV-25 (low frequency limit for pump operation).
AP2-39 DecValve Time	Sets the time it takes to decelerate from the frequency set at AP2-38 to the frequency limit set at ADV-25 (low frequency limit for pump operation).



The time set at AP2-39 refers to the absolute time that it takes for the pump to decelerate from the frequency set at AP2-38 to the frequency limit set at ADV-25.

5.17 Load Tuning

Load tuning refers to an operation that detects the load applied to a specific section of the inverter operation (current and voltage) and creates an ideal load curve for the under load and pump clean operations. The two set points to define the section are user-definable, and are set at 50% and 85% of the base frequency (DRV-18 Base Freq) by default. The load tuning result values are saved at codes AP2-2–AP2-10. These values are user definable as well.

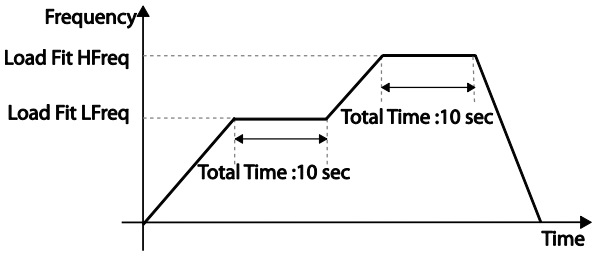
The minimum set point for the load tuning begins at 15% of the base frequency (DRV-18 Base Freq), and the maximum set point can be set up to the base frequency. If the frequency limit is set to '1 (Yes)' at ADV-24 (Freq Limit), the range is limited within the frequencies set at ADV-25 (Freq Limit Lo) and ADV-26 (Freq Limit Hi).

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	01	Load curve Tuning	Load Tune	No	0 No 1 Yes	-
	02	Load curve Low Freq	Load Fit LFreq	30.00	Base Freq*15%–Load Fit HFreq	Hz
	03	Current for Low Freq	Load Fit LCurr	40.0	0.0–200.0	%
	04	Power for Low Freq	Load Fit LPwr	30.0	0.0–200.0	%
	08	Load curve High Freq	Load Fit HFreq	51.00	Load Fit LFreq–High Freq	Hz
	09	Current for High Freq	Load Fit HCurr	80.0	0.0–200.0	%
	10	Power for High Freq	Load Fit HPwr	80.0	0.0–200.0	%
	11	Load current for frequency	Load Curve Cur	-	-	%
	12	Load power for frequency	Load Curve Pwr	-	-	%

Load Tuning Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP2-01 Load Tune</td><td>The inverter performs an automatic tuning to generate an ideal system load curve.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>Load tuning is not used.</td></tr>
<tr><td>1</td><td>Load Tune</td><td>Start load tuning.</td></tr>
</table></td></tr>
<tr><td>AP2-02 Load Fit LFreq</td><td>Defines the first frequency set point for load tuning (user definable).</td></tr>
<tr><td>AP2-03 Load Fit LCurr
AP2-04 Load Fit LPwr</td><td>Displays the current and power measured at the frequency set at AP2-02 as a percentage (%) value, based on motor rated current and rated power. Values for AP2-03 and AP2-04 are user definable.</td></tr>
<tr><td>AP2-08 Load fit HFreq</td><td>Defines the second frequency set point for load tuning (user definable).</td></tr>
<tr><td>AP2-09 Load Fit HCurr
AP2-10 Load Fit HPwr</td><td>Displays the current and power measured at the frequency set at AP2-08 as a percentage (%) value, based on motor rated current and rated power. Values for AP2-09 and AP2-10 are user definable.</td></tr>
<tr><td>AP2-11 Load Curve Cur
AP2-12 Load Curve PWR</td><td>Monitors the load curve value set at AP2-1 (Load Tune) based on the current output frequency.</td></tr>
</table>

When a load tuning is performed, the inverter measures for 10 seconds the motor current and power, at the frequencies set at AP2-02 and AP2-09. The motor current and power values measured here are used to generate an ideal load curve.



Note

Load tuning is not available while the inverter is operating.

Caution

- If the frequencies for AP2-02 (Low Freq) and AP2-08 (High Freq) are set too close to each other, the resulting load curve may not reflect the actual (ideal) load curve. Therefore, it is recommended that you keep the AP2-02 and AP2-08 frequencies as close to the factory defaults as possible.
- If a secondary motor is in use, note that the existing load curve for the main motor will be applied to the secondary motor unless a load tuning has been performed for the secondary motor.

5.18 Level Detection

When the inverter is operating at or above the frequency set at PRT-74 (LDT Level), this function is used to triggers a fault trip or sets a relay output if the source value is out of the range of the user-defined values. If the reset restart feature is turned on, the inverter continues to operate based on the run command after the LDT fault trip is released.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
PRT	70	Level detection mode	LDT Sel	None	None/Warning/Trip	
	71	Level detection range	LDT Area Sel	0: No	0–1	-
	72	Level detection source	LDT Source	0: Output Current	0–11	-
	73	Level detection delay time	LDT Dly Time	2.0	0–9999	Sec
	74	Level detection reference value	LDT Level	Source setting is used	Source setting is used	-
	75	Level detection	LDT Band	Source setting is	Source setting	-

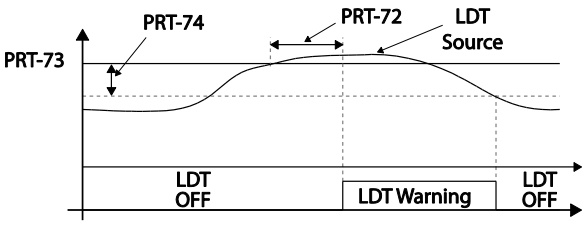
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		bandwidth	width	used	is used	
	76	Level detection frequency	LDT Freq	20.00	0.00–Max Freq (Hz)	Hz
	77	Level detection trip restart time	LDT Restart DT	60.0	0.0–3000.0	Min

Level Detection Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>PRT-70 LDT Sel</td><td>Determines the inverter operation when a level detection trip occurs.
<table>
<tr><td colspan="2">Setting</td><td>Functions</td></tr>
<tr><td>0</td><td>None</td><td>No operation</td></tr>
<tr><td>1</td><td>Warning</td><td>The inverter displays a warning message.</td></tr>
<tr><td>2</td><td>Free-Run</td><td>The inverter free-runs, then stops.</td></tr>
<tr><td>3</td><td>Dec</td><td>The inverter decelerates, then stops.</td></tr>
</table></td></tr>
<tr><td>PRT-71 Level Detect</td><td>Sets the level detection range.
<table>
<tr><td colspan="2">Setting</td><td>Operation</td></tr>
<tr><td>1</td><td>Below</td><td>Triggers a level detect fault trip when the inverter operates below the frequency set by the user.</td></tr>
<tr><td>2</td><td>Above</td><td>Triggers a level detect fault trip when the inverter operates above the frequency set by the user.</td></tr>
</table></td></tr>
<tr><td>PRT-72 LDT Source</td><td>Selects a source for level detection.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Output Current</td><td>Sets the output current as the source.</td></tr>
<tr><td>1</td><td>DC Link Voltage</td><td>Sets the DC link voltage as the source.</td></tr>
<tr><td>2</td><td>Output Voltage</td><td>Sets the output voltage as the source.</td></tr>
<tr><td>3</td><td>kW</td><td>Sets the output power as the source.</td></tr>
<tr><td>4</td><td>V1</td><td>Sets the V1 terminal input as the source.</td></tr>
<tr><td>5</td><td>V2</td><td>Sets the V2 terminal input as the source.</td></tr>
<tr><td>6</td><td>I2</td><td>Sets the I2 terminal input as the source.</td></tr>
<tr><td>7</td><td>PID Ref Value</td><td>Sets the PID reference as the source.</td></tr>
<tr><td>8</td><td>PID Fdb Val</td><td>Sets the PID feedback as the source.</td></tr>
</table></td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>9</td><td>PID Output</td><td>Sets the PID output as the source.</td></tr>
<tr><td>10</td><td>EPID1 Fdb Val</td><td>Sets the external PID feedback 1 as the source.</td></tr>
<tr><td>11</td><td>EPID2 Fdb Val</td><td>Sets the external PID feedback 2 as the source.</td></tr>
</table>
</td></tr>
<tr><td>PRT-73 LDT Dly Time</td><td>Sets the delay time for the operation set at PRT-70.</td></tr>
<tr><td>PRT-74 LDT Level</td><td>Sets the level for the level detection.
The following are the setting ranges and default values by the source.
<table>
<tr><th>Source</th><th>Default Value</th><th>Setting Range</th></tr>
<tr><td>Output Current</td><td>Rated current</td><td>0–150% of the rated current</td></tr>
<tr><td>DC Link Voltage</td><td>350
700</td><td>0–450 V (2 Type)
0–900 V (4 Type)</td></tr>
<tr><td>Output Voltage</td><td>230
460</td><td>0–250 (2 Type)
0–500 (4 Type)</td></tr>
<tr><td>kW</td><td>90% of the Inverter rated power</td><td>0–150% of the Inverter rated power</td></tr>
<tr><td>V1</td><td>9.00 V</td><td>0.00–12.00</td></tr>
<tr><td>V2</td><td>9.00</td><td>-12.00–12.00</td></tr>
<tr><td>I2</td><td>18.00</td><td>0.00–25.00</td></tr>
<tr><td>PID Ref Value</td><td>50</td><td>PID Unit Min–PID Unit Max</td></tr>
<tr><td>PID Fdb Val</td><td>50</td><td>PID Unit Min–PID Unit Max</td></tr>
<tr><td>PID Output</td><td>50</td><td>-100.00%–100.00%</td></tr>
<tr><td>EPID1 Fdb Val</td><td>50</td><td>EPID1 Unit Min–EPID1 Unit Max</td></tr>
<tr><td>EPID2 Fdb Val</td><td>50</td><td>EPID2 Unit Min–EPID2 Unit Max</td></tr>
</table>
</td></tr>
<tr><td>PRT-75 LDT Band Width</td><td>If the source is detected below the set level, it must be adjusted to be above the ‘LDT Level + LDT Band Width’ value to release the level detection fault trip.
If the source is detected above the set level, it must be adjusted to be below the ‘LDT Level - LDT Band Width’ value to release the level detection fault trip.
The level detection trip bandwidth is 10% of the maximum source value.</td></tr>
<tr><td>PRT-76 LDT Freq</td><td>Sets the start frequency for the level detection. When setting the level detection frequency, take into consideration the source type and the LDT level.</td></tr>
</table>

Code	Description
PRT-77 LDT Restart DT	If PRT-08 (RST restart) is set to 'YES,' the inverter restarts after the time set at PRT-76 elapses when an LDT trip is released. The LDT Restart operates each time an LDT trip is released. If PRT-77 is set to any other value than '0' and the inverter is operating in HAND mode, the inverter resets and the LDT trip is released. However, the inverter stays in OFF mode and does not restart the operation instantly.
OUT-31–35 Relay 1–5	Sets one of the output relays to '40 (LDT)' to monitor the level detection status.



<An example of PRT-71 set to (1: Above Level)>

As shown in the figure above, level detection can be carried out (relay output is 'on') as the output frequency is above PRT-76 and the detection value is greater than the value of PRT-74. The LDT operation is released if the value is less than the value subtracted from the value of band of, when the value of the feedback is set from PRT-74 to PRT-75.

ⓘ Caution

- The LDT operation is carried out if the inverter operation is above PRT-74.
- Modify PRT-74 and PRT-75 appropriately when modifying LDT Source of PRT-71.
- PRT-74 and PRT-75 become default value if the LDT Source is modified.
- PRT-77 (Restart DT) and PRT-08 (RST restart) features operate separately.
- The inverter waits until the delay time set at PRT-73 (LDT Dly Time) before it operates based on the setting in LDT-70 when the level detection time condition is met.

5.19 Pipe Break Detection

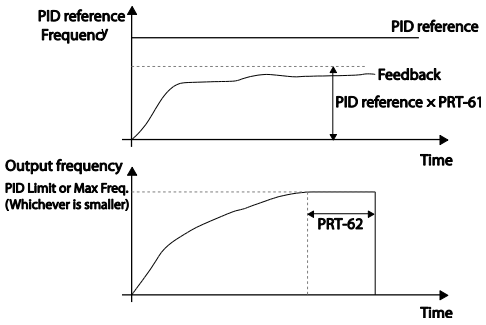
This function detects Pipe Breaks while the PID operation is on. The fault trip or a warning signal will occur if the feedback does not reach the level set by users during the operation with the maximum output (PID maximum output or the maximum speed set).

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
PRT	60	Pipe Break Detection setting	PipeBroken Sel	0	0 None 1 Warning 2 Free-Run 3 Dec	
	61	Pipe Break Detection variation	PipeBroken Dev	97.5	0–100	%
	62	Pipe Break Detection time	PipeBroken DT	10.0	0–6000.0	Sec
OUT	31–36	Relay output 1–5	Relay1–5	28	Pipe Broken	-

Pipe Break Detection Details

Code	Description
PRT-60 PipeBroken Sel	Select the operation while detecting Pipe Breaks Setting: 0 None – No operation; 1 Warning – The inverter displays a warning message.; 2 Free-Run – The inverter free-runs, then stops.; 3 Dec – The inverter decelerates, then stops.
PRT-61 PipeBroken Dev	Sets the Pipe Break Detection level. Set the detect level by multiplying the set value for PRT-61 by PID Reference.
PRT-62 PipeBroken DT	Sets the detect delay time. Pipe Break operates if the Pipe Break situation is maintained for a set amount of time.
OUT31–36	If Pipe Break (28) is set, when a Pipe Break occurs, the inverter sends out

Code	Description
Define	output with Relay.



In the graph above, Pipe Break occurs if the feedback is smaller than the value caculated by multiplying the two values set at PID-04 and PRT-61(PID-04 x PRT-61) at the inverter's maximum output (when PID output is the maximum set value, or the inverter is running at the frequency set at DRV-20).

5.20 Pre-heating Function

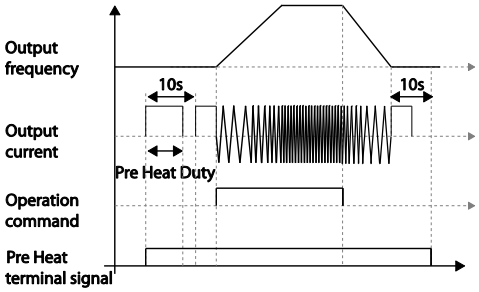
This function uses current to heat up the motor or pump to avoid the motor or the pump freezing when they are not in operation.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP2	48	Initial heating output current	Pre Heat Level	20	1–100	%
	49	Initial heating output duty	Pre Heat Duty	30	1–100	%
	50	DC input delay time	DC Inj Delay T	60.0	0.0–600.0	sec
IN	65–71	Terminal block input 1–7	P1–7 Define	44	Pre Heat	-

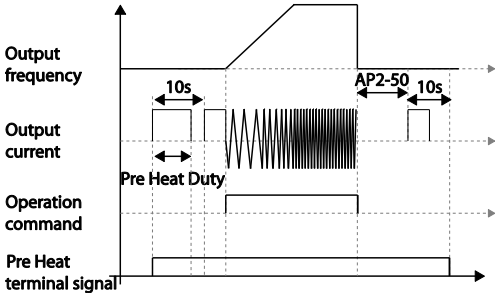
Initial Heating Setting Details

Code	Description
AP2-48 Pre Heat Curr	Sets the current to be used for initial heating. Sets the current to motor no-load current % value.
AP2-49 Pre Heat Duty	Sets the duty (time) for the current to be used for initial heating, from 10 seconds to % value.
AP2-50 DC Inj Delay T	Sets a certain delay time to prevent from an over current trip that may occur when a DC input is performed after the inverter Free-Run stop.
IN-65–71 P1–7 Define	Performs the Pre Heat function if the Pre Heat (44) terminal is set.

The initial heating function continually operates when the set multi-function input terminal is on and until the inverter command is on. If an inverter command is input while the initial heating function is operating, the inverter starts operation immediately.



The initial heating operation starts to run after an inverter operation stops, when the initial heating function's terminal input is on after the inverter operation command is off.



The diagram above shows the operation waveform related to AP2-50 DC Inj Delay T. The Pre Heat function performs when the inverter stop mode is set to Free Run and the Pre Heat signal is supplied. Then, if the inverter operation command is on, the inverter maintains acceleration and a fixed frequency. If the inverter operation command is off, the motor is in Free Run and the Pre Heat operations starts after the time amount set in AP2-50.

Caution

- If the value for AP2-48 Pre Heat Curr is above the rated motor current value, it is limited by the rated motor current value.
- If the value for AP2-48 Pre Heat Curr is too high or the DC current output time is too long, the motor may overheat or be damaged and the Inver IOLT may also malfunction. Reduce the DC output current amount and DC output time to prevent from such damages.

5.21 Auto Tuning

The motor parameters can be measured automatically and can be used for an auto torque boost or sensorless vector control.

Example - Auto Tuning Based on 5.5 kW, 200 V Motor

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
DRV	14	Motor capacity	Motor Capacity	9	5.5 kW	7–20	-
BAS	11	Motor pole number	Pole Number	4		2–48	-
	12	Rated slip speed	Rated Slip	45		0–3000	Rpm
	13	Rated motor current	Rated Curr	21.0		1.0–1000.0	A
	14	Motor no-load current	Noload curr	7.1		0.5–1000.0	A
	15	Motor rated voltage	Rated Volt	220		170–480	V
	16	Motor efficiency	Efficiency	85		70–100	%
	20	Auto tuning	Auto Tuning	0	None	-	-
	21	Stator resistance	Rs	0.314		Depends on the motor setting	Ω
	22	Leakage	Lsigma	3.19		Depends on	mH

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		inductance			the motor setting	

Auto Tuning Default Parameter Setting

Motor Capacity (kW)		Rated Current (A)	No-load Current (A)	Rated Slip Frequency (Hz)	Stator Resistance (Ω)	Leakage Inductance (mH)
200 V	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	0.0676	0.819
400 V	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	0.1266	2.133
	37	74.4	20.1	1.00	0.1014	1.704
	45	90.3	24.4	1.00	0.0843	1.422
	55	106.6	28.8	1.00	0.0693	1.167
	75	141.6	35.4	1.00	0.0507	0.852
	90	167.6	41.9	1.00	0.0399	0.715

Auto Tuning Parameter Setting Details

Code	Description
DRV-14 Motor Capacity	Sets the motor capacity to be used. The maximum motor capacity is limited by the inverter capacity and the keypad only displays the inverter capacity.
BAS-20 Auto Tuning	Select an auto tuning type and run it. Select one of the options and then press the [ENT] key to run the auto tuning.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td>Setting</td><td></td><td>Function</td></tr>
<tr><td>0</td><td>None</td><td>Auto tuning function is disabled. Also, if you select one of the auto tuning options and run it, the parameter value will revert back to '0' when the auto tuning is complete.</td></tr>
<tr><td>1</td><td>All (rotating type)</td><td>Measures all motor parameters while the motor is rotating, including stator resistance (Rs), stator inductance (Lsigma), no-load current (Noload Curr), rotor time constant (Tr), etc. Since the motor is rotating while the parameters are being measured, if the load is connected to the motor spindle, the parameters may not be measured accurately. For accurate measurements, remove the load attached to the motor spindle.
Note that the rotor time constant (Tr) must be measured in a stopped position.</td></tr>
<tr><td>2</td><td>All (static type)</td><td>Measures all parameters while the motor is in the stopped position, including stator resistance (Rs), stator inductance (Lsigma), no-load current (Noload Curr), rotor time constant (Tr), etc. Since the motor is not rotating while the parameters are measured, the measurements are not affected when the load is connected to the motor spindle. However, when measuring parameters, do not rotate the motor spindle on the load side.</td></tr>
</table>
</td></tr>
<tr><td>BAS-14 Noload Curr,
BAS-21 Rs–BAS-24 Tr</td><td>Displays motor parameters measured by auto tuning. For parameters that are not included in the auto tuning measurement list, the default setting will be displayed.</td></tr>
</table>

ⓘ Caution

- Perform auto tuning ONLY after the motor has completely stopped running.
- Auto tuning operates when the inverter's auto mode is off.
- Before you run auto tuning, check the motor pole number, rated slip, rated current, rated voltage, and efficiency on the motor's rating plate and enter the data. The default parameter setting is used for values that are not entered.

- When measuring all parameters after selecting 2 (All-static type) at BAS-20: compared with rotation type auto tuning where parameters are measured while the motor is rotating, parameter values measured with static auto tuning may be less accurate. Inaccuracy of the measured parameters may degrade the performance of sensorless operations. Therefore, run static-type auto tuning by selecting 2 (All) only when the motor cannot be rotated (when gearing and belts cannot be separated easily, or when the motor cannot be separated mechanically from the load).

5.22 Time Event Scheduling

Time Event function enables the user to operate the inverter using the RTC (Real-Time Clock) feature at certain times that the user would like to set. An RTC battery is installed on the I/O board of the H100 inverter, and it lasts approximately 25,800 hours with the inverter turned off, and 53,300 hours with the inverter turned on.

To use the Time Event, set the current date and time. Three parameters need to be set to configure the Time event feature: Time Period Module, Time Event, and Exception Date.

Time Period	Description
Time Period	Used to set the time of operation.
Time Event	Used to set the time of operation.
Exception Date	Used to specify the exception date. Exception date has the highest priority.

4 Time period Module types, 8 Time Event Module types, and 8 Exception day types can be used to configure time events. The Time Event function works based on a series of configuration using the modules listed in the table above.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP3	01	Current date	Now Date	01/01/2000	01/01/2000 ~ 12/31/2099 (Date)	Hz
	02	Current time	Now Time	0: 00	0: 00–23: 59	Sec
	03	Current day of the week	Now Weekday	0000001	0000000–1111111	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	04	Summer Time Start date	Summer T Start	04/01	01/01 ~ Summer T Stop	Day
	05	Summer Time Finish date	Summer T Stop	11/31	Summer T Start ~ 12/31(Date)	Day
	10	Period connection status	Period Status	-	-	-
	11	Time Period 1 Start time	Period1 StartT	24: 00	00:00 ~ 24:00	Min
	12	Time Period 1 End time	Period1 Stop T	24: 00	Period1 StartT ~ 24:00(Min)	Min
	13	Time Period 1 Day of the week	Period1 Day	0000000	0000000~1111111	-
	14	Time Period 2 Start time	Period2 StartT	24: 00	00:00 ~ 24:00	Min
	15	Time Period 2 End time	Period2 Stop T	24: 00	Period2 StartT ~ 24:00(Min)	Min
	16	Time Period 2 Day of the week	Period2 Day	00000000	0000000~1111111	-
	17	Time Period 3 Start time configuration	Period3 StartT	24: 00	00:00 ~ 24:00	Min
	18	Time Period 3 End time	Period3 Stop T	24: 00	Period3 StartT ~ 24:00(Min)	Min
	19	Time Period 3 Day of the week	Period3 Day	0000000	0000000~1111111	-
	20	Time Period 4 Start time	Period4 StartT	24: 00	00:00 ~ 24:00	Min
	21	Time Period 4 End time	Period4 Stop T	24: 00	Period4 StartT ~ 24:00(Min)	Min

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
	22	Time Period 4 Day of the week	Period4 Day	0000000	0000000~1111111		-
	30	Except1 Date Start time	Except1 StartT	24: 00	00:00 ~ 24:00		Min
	31	Except1 Date End time	Except1 Stop T	24: 00	Except1 StartT ~ 24:00(Min)		Min
	32	Except1 Date	Except1 Date	01/01	01/01–12/31		Day
	33-53	Exception Date 2–Exception Date 8 Parameter (The same condition and setting as Exception Date 1)					
	70	Time Event functions	Time Event En	0: No	0	No	
					1	Yes	
	71	Time Event configuration status	T-Event Status	-	-		
	72	Time Event 1 Connection	T-Event1Period	000000000000	000000000000 ~111111111111		
	73	Time Event 1 functions	T-Event1Define	0: None	0	None	
					1	Fx	
					2	Rx	
					3	Speed-L	
					4	Speed-M	
					5	Speed-H	
					7	Xcel-L	
					8	Xcel-M	
					9	Xcel-H	
					10	Xcel Stop	
					11	Run Enable	
					12	2nd Source	
					13	Exchange	

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
					14	Analog Hold	
					15	I-Term Clear	
					16	PID Openloop	
					17	PID Gain 2	
					18	PID Ref Change	
					19	2nd Motor	
					20	Timer In	
					21	Dias Aux Ref	
					22	EPID1 Run	
					23	EPID1 ITerm Clr	
					24	Pre Heat	
					25	EPID2 Run	
					26	EPID2 iTerm Clr	
					27	Sleep Wake Chg	
					28	PID Step Ref L	
					29	PID Step Ref M	
					30	PID Step Ref H	
	74–87	Time Event 2–Time Event 8 Parameter (The same setting range and initial value as Time Event 1)					

Time Event Function Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP3-01 Now Date
AP3-02 Now Time
AP3-03 Now Weekday</td><td>Sets the current date, time, and day of the week. The Time Event function is based on the setting.</td></tr>
<tr><td>AP3-04 Summer T Start
AP3-05 Summenr T Stop</td><td>Set the Summer time start and finish date.</td></tr>
<tr><td>AP3-06 Date format</td><td>Select the desired date format.
<table><tr><td colspan="2">Configuration</td><td>Function</td></tr><tr><td>0</td><td>YYYY/MM/DD</td><td>Year/Month/Day is displayed.</td></tr><tr><td>1</td><td>MM/DD/YYYY</td><td>Month/Day/Year is displayed (USA).</td></tr><tr><td>2</td><td>DD/MM/YYYY</td><td>The format of Day/Month/Year is displayed (Europe).</td></tr></table></td></tr>
<tr><td>AP3-10 Period Status</td><td>Bits 0–3 are used to indicate the time module that is currently in use among the 4 different time modules set at AP3-11–AP3-22.
Bits 4–11 are used to indicate the exception day that is set at AP3-30–AP3-53.</td></tr>
<tr><td>AP3-11–AP3-20
Period 1–4 Start T</td><td>The start time for the 4 time periods can be set up to 4.</td></tr>
<tr><td>AP3-12–AP3-21
Period 1–4 STop T</td><td>The end time for the 4 time periods can be set up to 4.</td></tr>
<tr><td>AP3-13–AP3-22
Period 1–4 STop T</td><td>The Time period date for the operation can be set up to 4. It can be set on a weekly basis. If the bit is ‘1 (on)’, it indicates the relevant day is selected. If the Bit is ‘0 (off)’, it indicates the relevant day is not selected.
<table><tr><td colspan="7">Bit</td></tr><tr><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr><tr><td>Sunday</td><td>Monday</td><td>Tuesday</td><td>Wednesday</td><td>Thursday</td><td>Friday</td><td>Saturday</td></tr></table></td></tr>
<tr><td>AP3-30–AP3-51
Exception1–8 Start T</td><td>The operation start time for the 8 Exception days can be set.</td></tr>
<tr><td>AP3-31–AP3-52
Exception1–8 Stop T</td><td>The operation end time for the 8 Exception days can be set.</td></tr>
<tr><td>AP3-32–AP3-53
Exception1–8 Date</td><td>The date for the 8 Exception days can be set.</td></tr>
</table>

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP3-70 Time Event En</td><td>Enables or disables the Time Event

<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>No</td><td>Time Event is not used.</td></tr>
<tr><td>1</td><td>Yes</td><td>Time Event is used.</td></tr>
</table></td></tr>
<tr><td>AP3-71 T-Event Status</td><td>It shows which T-Event from 1–8 is being performed.

<table>
<tr><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>T-Event 8</td><td>T-Event 7</td><td>T-Event 6</td><td>T-Event 5</td><td>T-Event 4</td><td>T-Event 3</td><td>T-Event 2</td><td>T-Event 1</td></tr>
</table></td></tr>
<tr><td>AP3-72–86 T-Event1–8 Period</td><td>Select the desired module of the Time Module and Exception Day set in AP3-11–AP3-53 for the relevant events.
If the bit is 1, it indicates the relevant Time Module or Exception Day is selected. If the Bit is 0, it indicates the Time Module or Exception Day is not selected.

<table>
<tr><td colspan="12">bit</td></tr>
<tr><td>11</td><td>10</td><td>9</td><td>8</td><td>7</td><td>6</td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td>0</td></tr>
<tr><td>Exception Date 8</td><td>Exception Date 7</td><td>Exception Date 6</td><td>Exception Date 5</td><td>Exception Date 4</td><td>Exception Date 3</td><td>Exception Date 2</td><td>Exception Date 1</td><td>Period 4</td><td>Period 3</td><td>Period 2</td><td>Period 1</td></tr>
</table></td></tr>
<tr><td>AP3-73–87 T-Event1–8 Define</td><td>Select the desired Event.
<table>
<tr><td colspan="4">Setting</td></tr>
<tr><td>0</td><td>None</td><td>16</td><td>PID Openloop</td></tr>
<tr><td>1</td><td>Fx</td><td>17</td><td>PID Gain 2</td></tr>
<tr><td>2</td><td>Rx</td><td>18</td><td>PID Ref Change</td></tr>
<tr><td>3</td><td>Speed-L</td><td>19</td><td>2nd Motor</td></tr>
<tr><td>4</td><td>Speed-M</td><td>20</td><td>Timer In</td></tr>
<tr><td>5</td><td>Speed-H</td><td>21</td><td>Dias Aux Ref</td></tr>
<tr><td>6</td><td>Xcel-L</td><td>22</td><td>EPID1 Run</td></tr>
<tr><td>7</td><td>Xcel-M</td><td>23</td><td>EPID1 Openloop</td></tr>
<tr><td>8</td><td>Xcel-H</td><td>24</td><td>Pre Heat</td></tr>
<tr><td>9</td><td>Xcel Stop</td><td>25</td><td>EPID2 Run</td></tr>
<tr><td>10</td><td>Run Enable</td><td>26</td><td>EPID2 Openloop</td></tr>
</table></td></tr>
</table>

Code	Description			
	11	2nd Source	27	Sleep Wake Chg
	12	Exchange	28	PID Step Ref L
	13	Analog Hold	29	PID Step Ref M
	14	I-Term Clear	30	PID Step Ref H
	15	None		

Time Period Parameter Setting

There are 4 Time Period Sets in the Time Event. Each Time Period Set has: period 1–4 Start (Start time), Period 1–4 Stop T (End time), and Period 1–4 Day (Operation day) for which they can be set.

The tables below show the parameter values for Time Period 1, Time Period 2, and Time Period 3. When the parameters are set for the Time Periods 1-3 as shown in the tables below, this indicates the Time Event function turns on and off on the following days and time.

Time Period 1

Every Sunday, Monday, Wednesday, Thursday, and Friday at 06: 00 (On) and 18: 00 (Off)

Time Schedule		
Code	Function	Setting
AP3-11	Period1 StartT	06: 00
AP3-12	Period1 StopT	18: 00
AP3-13	Period1 Day	1101110

Time Period 2

Every Sunday and Saturday for 24 hours (On)

Time Schedule		
Code	Function	Setting
AP3-14	Period2 StartT	00: 00
AP3-15	Period2 StopT	24: 00
AP3-16	Period2 Day	1000001

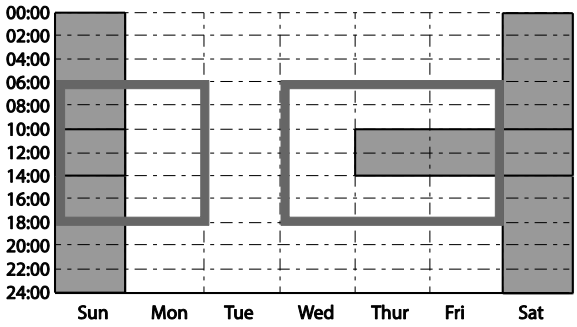
Time Period 3

Every Sunday, Thursday, Friday, and Saturday at 10: 00 (On) and 14: 00 (Off)

Time Schedule

Time Period	Schedule

Code	Function	Setting
AP3-17	Period3 StartT	10: 00
AP3-18	Period3 StopT	14: 00
AP3-19	Period3 Day	1000111



<Time Period settingTime Chart>

Parameters Setting for Exception Date

There are 8 Exception date modules in the Time Event function. They are used to specify the operation on particular days (public holidays, etc.). The settings for the start time and the end time are the same as the settings for the modules and can be set for particular days. The Exception dates can be set redundantly with the Time periods. If the Time Periods and the Exception Dates are set redundantly, the inverter operates on the Exception Dates set.

Title	Setting Range	Description
Except1–8 Start T	00: 00–24: 00	Hour: Minutes (by the minute)
Except1–8 Stop T	00: 00–24: 00	Hour: Minutes
Except1–8 Date	1/1–12/31	Select the particular date (between 1/1 and 12/31)

Time Period	Schedule

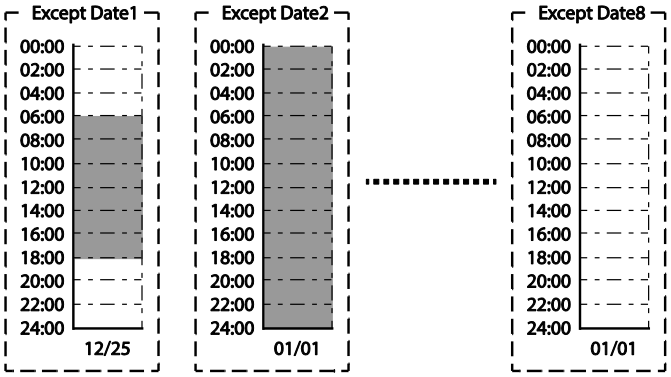
<table>
<tr><th>Time Period</th><th>Schedule</th></tr>
<tr><td>Exception Date 1</td><td>Every Sunday, Monday, Wednesday, Thursday, and Friday at 06: 00 (On) and 18: 00 (Off)

<table>
<tr><td colspan="3">Time Schedule</td></tr>
<tr><td>Code</td><td>Function</td><td>Setting</td></tr>
<tr><td>AP3-30</td><td>Except1 StartT</td><td>06: 00</td></tr>
<tr><td>AP3-31</td><td>Except1 StopT</td><td>18: 00</td></tr>
<tr><td>AP3-32</td><td>Except1 Day</td><td>12/25</td></tr>
</table></td></tr>
<tr><td>Exception Date 2</td><td>Every Sunday and Saturday for 24 hours (On)

<table>
<tr><td colspan="3">Time Schedule</td></tr>
<tr><td>Code</td><td>Function</td><td>Setting</td></tr>
<tr><td>AP3-33</td><td>Except2 StartT</td><td>00: 00</td></tr>
<tr><td>AP3-34</td><td>Except2 StopT</td><td>24: 00</td></tr>
<tr><td>AP3-35</td><td>Except2 Day</td><td>01/01</td></tr>
</table></td></tr>
<tr><td>Exception Date 3</td><td>Every Sunday, Thursday, Friday, and Saturday at 10: 00 (On) and 14: 00 (Off)

<table>
<tr><td colspan="3">Time Schedule</td></tr>
<tr><td>Code</td><td>Function</td><td>Setting</td></tr>
<tr><td>AP3-36</td><td>Except3 StartT</td><td>10: 00</td></tr>
<tr><td>AP3-37</td><td>Except3 StopT</td><td>14: 00</td></tr>
<tr><td>AP3-38</td><td>Except3 Day</td><td>01/01</td></tr>
</table></td></tr>
</table>

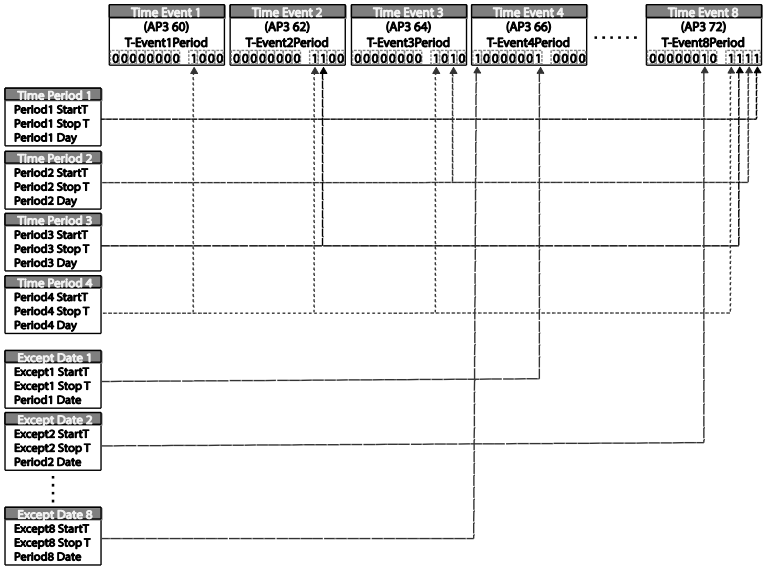
Title	Setting Range	Remarks
Except1–8 StartT	00: 00–24: 00	Hour: Minutes (by the minute)
Except1–8 Stop T	00: 00–24: 00	Hour: Minutes
Except1–8 Date	1/1–12/31	Select the particular date (between 1/1 and 12/31)



<The Time Chart for the Exception Day>

The connection settings for Time Period and Time Event

There are 8 Time event modules in the Time Event function. The parameters for T-Events 1–8 are used to set the connections to each module for the Time Period and the Exception Date. The parameters for T-Event 1–8 are used to specify the operation on particular days. Each Time event module can be set for the connections to 4 Time period modules and 8 Exception days. Time event modules are set as a bit unit in the parameters for Events 1–8. The diagram below shows the connections between the Time event modules and the time period modules. The Time Event 1 is connected to Time Period 4. The Time Event 8 is connected to Time Periods 1–4 and the Exception Dates 2.



Time Event Module Function Settings

The functions to be performed in the Time Event for T-Events 1–8 can be set. 30 functions can be set (refer to page *248*). There are 8 Time event modules in the Time Event. The parameters for T-Events 1–8 are used to set the connections to each module for the Time Period and the Exception Date. The parameters for T-Events 1–8 are used to specify the operation on particular days.

Example of the Time Event operations

If the Time events are set as the parameters below, the inverter operates as illustrated.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
DRV	06	Command Source	Cmd Ref Src	5: Time Event	0–9		-
	07	Frequency command source	Freq Ref Src	0: KeyPad	0–5		-
	11	Time Period 1 Start time	Period1 StartT	10: 00	00: 00–24: 00		Min
	12	Time Period 1 End time	Period1 Stop T	20: 00	00: 00–24: 00		Min
	13	Time Period 1 Day of the week	Period1 Day	0110000	0000000–1111111		
	14	Time Period 2 Start time	Period2 StartT	12: 00	00: 00–24: 00		Min
	15	Time Period 2 End time	Period2 Stop T	17: 00	00: 00–24: 00		Min
	16	Time Period 2 Day of the week	Period2 Day	00100000	0000000–1111111		-
	70	Time Event configuration	Time Event En	1: YES	0	No	-
					1	Yes	
AP3	72	Time Event 1 connection configuration	T-Event1Period	00000000001	000000000001–111111111111		
	73	Time Event 1 functions	T-Event1Define	1: Fx	0	None	
					1	Fx	

					2	Rx	
					3	Speed-L	
					4	Speed-M	
					5	Speed-H	
					7	Xcel-L	
					8	Xcel-M	
					9	Xcel-H	
					10	Xcel Stop	
					11	Run Enable	
					12	2nd Source	
					13	Exchange	
					14	Analog Hold	
					15	I-Term Clear	
					16	PID Openloop	
					17	PID Gain 2	
					18	PID Ref Change	
					19	2nd Motor	
					20	Timer In	
					21	Dias Aux Ref	
					22	EPID1 Run	
					23	EPID1 ITerm Clr	
					24	Pre Heat	
					25	EPID2 RUn	
					26	EPID2 ITerm Clr	
					27	Sleep Wake Chg	
					28	PID Step Ref L	
					29	PID Step Ref M	

					30	PID Step Ref H	
	74	Time Event 2 connection	T-Event1Period	00000000010	000000000001–111111111111		
	75	Time Event 2 functions	T-Event2Define	3: Speed-L	Refer to AP3-73		

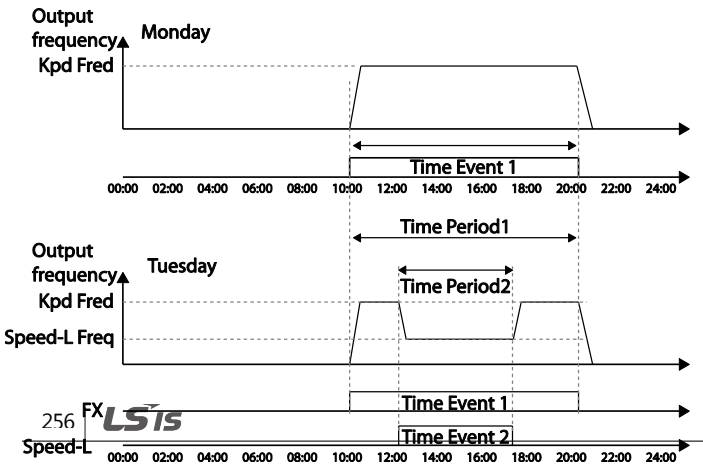
The parameters in the table above shows the frequency command sources for the keypad and the operation command sources for the Time Event.

The following is an example of an inverter operation utilizing the Time Period modules 1 and 2 with Time Events 1 and 2:

Time Period 1 is used to operate the inverter on Mondays and Tuesdays from 10AM to 8PM. Time Period 2 is used to operate the inverter on Tuesday from 12PM to 5PM.

Time Event 1 triggers forward operations based on the frequency input on the keypad and continues the operation for the time set at Time Period module 1. Time Event 2 operates the inverter at Speed-L for the time set at Time Period module 2.

On Mondays, the inverter operates in the forward direction based on the frequency input on the keypad from 10AM to 8PM (Time Event 1). On Tuesdays, it operates again in the forward direction based on the keypad frequency input from 10AM to 12PM (Time Event 1), and then operates at Speed-L from 12PM to 5PM (Time Event 2). When the operation assigned by Time Event 2 is complete, the inverter resumes its Time Event 1 operation (the inverter operates based on the keypad frequency input from 5PM to 8PM).



<An example of Time Event>

Note

When repetitive frequency commands related to the frequency input command occur while the Time Event function is performing, Time Event performs its function in the order of the frequency command sources set in Freq Ref Src for DRV-07 (followed by Jog operation and multi-step acc/dec).

Caution

If a fault trip occurs during a time event operation, the inverter stops the operation and stays in a trip state. When this happens, there are two options to resume the stopped operation:

- Set PRT-07 (RST Restart) to 'YES' to allow the inverter to automatically restart after the trip condition is released.
- Refresh the setting at AP3-70 (Time Event En). Set AP3-70 to 'Yes' from 'No'. If one of the input terminals (IN-65–71 Px Define) is assigned to it, turn the swtich off then turn it back on to resume the time event operation.

5.23 Kinetic Energy Buffering

When the input power supply is disconnected, the inverter's DC link voltage decreases, and a low voltage trip occurs blocking the output. A kinetic energy buffering operation uses regenerative energy generated by the motor during the blackout to maintain the DC link voltage. This extends the time for a low voltage trip to occur, after an instantaneous power interruption.

Group	Code	Name	LCD Display	Parameter Setting		Setting range	Unit
CON	77	Kinetic energy buffering selection	KEB Select	1	Yes	0–1	-
	78	Kinetic energy buffering start level	KEB Start Lev	130		110–140	%

Group	Code	Name	LCD Display	Parameter Setting	Setting range	Unit
	79	Kinetic energy buffering stop level	KEB Stop Lev	135	125–145	%
	80	Kinetic energy buffering slip gain	KEB Slip Gain	300	1–20000	-
	81	Kinetic energy buffering P-Gain	KEB P Gain	1000	1–20000	-
	82	Kinetic energy buffering I gain	KEB I Gain	500	1–20000	-
	83	Kinetic energy buffering acceleration time	KEB Acc Time	10.0	0.0–600.0	Sec

Kinetic Energy Buffering Operation Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CON-77
KEB Select</td><td>Select the kinetic energy buffering operation when the input power is disconnected.

<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>No</td><td>General deceleration is carried out until a low voltage trip occurs.</td></tr>
<tr><td>1</td><td>Yes</td><td>The inverter power frequency is controlled and the regeneration energy from the motor is charged by the inverter.</td></tr>
</table></td></tr>
<tr><td>CON-78
KEB Start Lev,
CON-79
KEB Stop Lev</td><td>Sets the start and stop points of the kinetic energy buffering operation. The set values must be based on the low voltage trip level at 100%, and the stop level (CON-79) must be set higher than the start level (CON-78).</td></tr>
<tr><td>CON-80
KEB Slip Gain</td><td>Used to prevent malfunctions caused by low voltage from initial kinetic energy buffering occurring due to power interruptions.</td></tr>
<tr><td>CON-81
KEB P Gain</td><td>Used to maintain the voltage during the kinetic energy buffering operation. It operates the inverter by modifying the set value to prevent malfunctions caused by low voltage after power interruptions.</td></tr>
<tr><td>CON-82
KEB I Gain</td><td>Used to maintain the voltage during the kinetic energy buffering operation. Sets the gain value to maintain the operation until the frequency stops during the kinetic energy buffering operation.</td></tr>
<tr><td>CON-83
KEB Acc Time</td><td>Sets the acceleration time for the frequency reference when the inverter's operation becomes normal after the kinetic energy buffering operation.</td></tr>
</table>

Note

- The KEB functions may perform differently depending on the size of the loads. The KEB Gains can be set for a better performance.
- If a low voltage trip occurs after a power interruption, it indicates the load inertia and level are high. In such cases, the KEB functions can be performed better by increasing the KEB I Gain and the KEB Slip Gain.
- If motor vibration or torque variation occurs during the KEB function operation after power interruptions, the KEB functions can be performed better by increasing the KEB P Gain or decreasing the KEB I Gain.

Caution

Depending on the duration of instantaneous power interruptions and the amount of load inertia, a low voltage trip may occur even during a kinetic energy buffering operation. Motors may vibrate during kinetic energy buffering operation for some loads, except for variable torque loads (for example, fan or pump loads).

5.24 Anti-hunting Regulation (Resonance Prevention)

This function is used to prevent the hunting of a V/F controlled fan or motor caused by current distortion or oscillation, due to mechanical resonance or other reasons.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range		Unit
CON	13	Enable or disable anti-hunting regulation (resonance prevention)	AHR Sel	1	Yes	0 1	No Yes	-
	14	Anti-hunting regulation P-Gain	AHR P-Gain	1000		0–32767		-
	15	Anti-hunting regulation start frequency	AHR Low Freq	0		0–AHR High Freq		Hz
	16	Anti-hunting regulation end frequency	AHR High Freq	400.00		AHR Low Freq–400.00		Hz
	17	Anti-hunting regulation compensation voltage limit	AHR Limit	2		0–20		%

Anti-hunting Regulation Setting Details

Code	Description
CON-13 AHR Sel	Selects the Anti-hunting regulator operation. Setting: 0 No — Disable anti-hunting regulation. Setting: 1 Yes — Enable anti-hunting regulation.
CON-14 AHR P-Gain	Increasing AHR proportional gain improves responsiveness of the anti-hunting regulation. However, current oscillation may result if AHR proportional gain is set too high.
CON-15 AHR Low Freq CON-16 AHR High Freq	Sets the lower limit frequency (CON-15) and the maxim limit frequency (CON-16) for anti-hunting regulation.

5.25 Fire Mode Operation

This function is used to allow the inverter to ignore minor faults during emergency situations, such as fire, and provides continuous operation to protect other systems, such as ventilating fans. In Fire mode, the inverter continues to operate based on the Fire mode run direction and frequency set at PRT-46 and PRT-47.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
PRT	44	Fire mode password	Fire Mode PW	3473	-		-
	45	Fire mode setting	Fire Mode Sel	0: None	0	None	-
					1	Fire Mode	
					2	Test Mode	
	46	Fire mode run direction	Fire Mode Dir	0: Forward	0	Forward	-
					1	Reverse	
	47	Fire mode run frequency	Fire Mode Freq	60.00	0–max Freq		Hz
	48	Fire mode	Fire Mode Cnt	0	-		-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
		operation count				
IN	65–75	Digital input configuration	Px Define	40: Fire Mode	-	-
OUT	31–35	Digital output configuration	Relay1,2 / Q1	27: Fire Mode	-	-
	36	TR output configuration	Q1 define	27: Fire Mode		-

When the multi-function terminal configured for Fire mode is turned on, the inverter ignores all other commands and operates in the direction set at PRT-46 (Fire mode run direction) at the speed set at PRT-47 (Fire mode run frequency). In Fire mode, the inverter ignores any faults, other than 'ASHT,' 'Over Current 1,' 'Over Voltage,' 'Ground F,' and continues to operate. If any of the faults that can stop inverter operation occur, the inverter automatically performs a reset restart to continue the operation.

Fire Mode Function Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>PRT-44 Fire Mode PW</td><td>Fire mode password is 3473.
A password must be created to enable Fire mode. PRT-45 (Fire Mode Sel) can be modified only after the password is entered.</td></tr>
<tr><td>PRT-45 Fire Mode Sel</td><td>Sets the Fire Mode.
<table><tr><td colspan="2">Setting</td><td>Function</td></tr><tr><td>0</td><td>None</td><td>Fire mode is not used.</td></tr><tr><td>1</td><td>Fire Mode</td><td>Normal Fire mode</td></tr><tr><td>2</td><td>Test Mode</td><td>Fire mode test mode
In Fire test mode, faults are normally processed.
Using Fire test mode does not increase the count value at PRT-48 (Fire Mode Cnt).</td></tr></table></td></tr>
<tr><td>PRT-46 Fire Mode Dir</td><td>Sets the run direction for Fire mode operation.</td></tr>
</table>

Code	Description
PRT-47 Fire Mode Freq	Sets the operation frequency for Fire mode.
PRT-48 Fire Mode Cnt	Counts the number of the Fire mode operations. The number increases only when PRT-45 (Fire Mode Sel) is set to 'Normal'. The count increases up to 99, then it does not increase any more.

Caution

- If damper or lubrication operations are set for the inverter, Fire mode operation is performed after the delay times set in the relevant operations.
- Note that Fire mode operation voids the product warranty.
- In Fire mode test mode, the inverter does not ignore the fault trips or perform a reset restart. All the fault trips will be processed normally. Fire mode test mode does not increase the Fire mode count (PRT-48).
- When the Fire mode operation is complete, the inverter stops operating and is turned off.

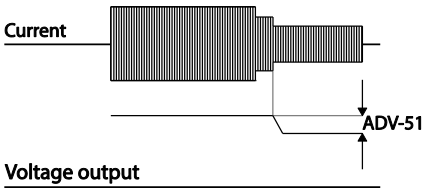
5.26 Energy Saving Operation

5.26.1 Manual Energy Saving Operation

If the inverter output current is lower than the current set at BAS-14 (Noload Curr), the output voltage must be reduced as low as the level set at ADV-51 (Energy Save). The voltage before the energy saving operation starts will become the base value of the percentage. Manual energy saving operation will not be carried out during acceleration and deceleration.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range		Unit
ADV	50	Energy saving operation	E-Save Mode	1	Manual	0	None	-
						1	Manual	
						2	Auto	

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	51	Energy saving amount	Energy Save	30	0–30	%



5.26.2 Automatic Energy Saving Operation

The inverter finds the optimal energy saving point for the time set at ADV-52 based on the rated motor current and the voltage output. The Energy saving operation is effective for the normal duty operations. It does operate when the load level is more than 80% of the rated motor current.

Group	Code	Name	LCD Display	Setting		Setting Range	Unit
ADV	50	Energy saving operation	E-Save Mode	2	Auto	0–2	-
	52	Energy saving point search time	E-Save Det T	20.0 (Sec)		0.0–100.0	Sec

Caution

If the operation frequency is changed, or acceleration or deceleration is carried out during an energy saving operation, the actual Acc/Dec time may take longer than the set time due to the time required to return to general operations from the energy saving operation.

5.27 Speed Search Operation

Speed search operation is used to prevent fault trips that can occur when the inverter

voltage output is disconnected and the motor is idling. Since this feature estimates the motor rotation speed based on the inverter output current, it does not give the exact speed.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CON	70	Speed search mode selection	SS Mode	0	Flying Start-1	-	-
	71	Speed search operation selection	Speed Search	0000		-	bit
	72	Speed search reference current	SS Sup-Current	90%		50–120	%
	73	Speed search proportional gain	SS P-Gain	100		0–9999	-
	74	Speed search integral gain	SS I-Gain	200		0–9999	-
	75	Output block time before speed search	SS Block Time	1.0		0–60	sec
OUT	31	Multi-function relay 1 item	Relay 1	19	Speed Search	-	-
	33	Multi-function output 1 item	Q1 Define				

Speed Search Operation Setting Details

Code	Description
CON-70 SS Mode	Select a speed search type. 0 Flying Start-1: The speed search is carried out as it controls the inverter output current during idling below the CON-72 (SS Sup-Current) parameter setting. If the direction of the idling motor and the direction of operation command at restart are the same, a stable speed search function can be performed at about 10 Hz or lower. However, if the direction of

Code	Description
CON-71 Speed Search	

		the idling motor and the direction of operation command at restart are different, the speed search does not produce a satisfactory result because the direction of idling cannot be established.
1	Flying Start-2	The speed search is carried out as it PI controls the ripple current which is generated by the counter electromotive force during no-load rotation. Because this mode establishes the direction of the idling motor (forward/reverse), the speed search function is stable regardless of the direction of the idling motor and direction of operation command. However because the ripple current is used which is generated by the counter electromotive force at idle (the counter electromotive force is proportional to the idle speed), the idle frequency is not determined accurately and re-acceleration may start from zero speed when the speed search is performed for the idling motor at low speed (about 10 - 15 Hz, though it depends on motor characteristics).

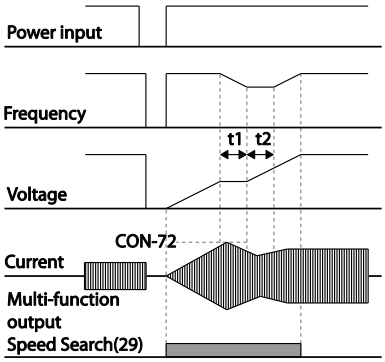
Speed search can be selected from the following 4 options. If the top display segment is on, it is enabled (On). If the bottom segment is on, it is disabled (Off).

Item	Bit Setting On Status	Bit setting Off Status
Keypad		

Type and Functions of Speed Search Setting

Setting				Function
bit4	bit3	bit2	bit1	
			✓	Speed search for general acceleration
		✓		Initialization after a fault trip
	✓			Restart after instantaneous power interruption
✓				Starting with power-on

Code	Description
	Speed search for general acceleration: If bit 1 is set to '1' and the inverter operation command runs, acceleration starts with the speed search operation. When the motor is rotating under load, a fault trip may occur if the operation command is run for the inverter to provide voltage output. The speed search function prevents such fault trips from occurring. **Initialization after a fault trip other than an LV trip:** If bit 2 is set to '1' and PRT-08 (RST Restart) is set to '1 (Yes)', the speed search operation automatically accelerates the motor to the operation frequency used before the fault trip when the [Reset] key is pressed (or the terminal block is initialized) after a fault trip. **Automatic restart after a power interruption:** If bit 3 is set to '1,' and if a low voltage trip occurs due to a power interruption but the power is restored before the internal power shuts down, the speed search operation accelerates the motor back to its frequency reference before the low voltage trip. If an instantaneous power interruption occurs and the input power is disconnected, the inverter generates a low voltage trip and blocks the output. When the input power returns, the operation frequency before the low voltage trip and the voltage is increased by the inverter's inner PI control. If the current increases above the value set at CON-72, the voltage stops increasing and the frequency decreases (t1 zone). If the current decreases below the value set at CON-27, the voltage increases again and the frequency stops decelerating (t2 zone). When the normal frequency and voltage are resumed, the speed search operation accelerates the motor back to its frequency reference before the fault trip.

Code	Description
	 **Starting with power-on:** Set bit 4 to '1' and ADV-10 (Power-on Run) to '1 (Yes)'. If inverter input power is supplied while the inverter operation command is on, the speed search operation will accelerate the motor up to the frequency reference.
CON-72 SS Sup-Current	The amount of current flow is controlled during speed search operation based on the motor's rated current. If CON-70 (SS mode) is set to '1 (Flying Start-2)', this code is not visible.
CON-73 SS P-Gain, CON-74 SS I-Gain	The P/I gain of the speed search controller can be adjusted. If CON-70 (SS Mode) is set to '1(Flying Start-2)', different factory defaults, based on motor capacity, are used and defined in DRV-14 (Motor Capacity).
CON-75 SS Block Time	The block time parameter prevents overvoltage trips due to counter electromotive force.

Note

If operated within the rated output, the H100 series inverter is designed to withstand instantaneous power interruptions within 8 ms and maintain normal operation. The DC voltage inside the inverter may vary depending on the output load. If the power interruption time is longer than 8 ms, a low voltage trip may occur.

Caution

Select the Speed search function (normal acceleration) for a proper re-operation during a free-run.
If the speed search function (normal acceleration) is not selected during the acceleration, an over current trip or an overload trip may occur.

5.28 Auto Restart Settings

When inverter operation stops due to a fault and a fault trip is activated, the inverter automatically restarts based on the parameter settings.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
PRT	08	Select start at trip reset	RST Restart	11	-	-
	09	Auto restart count	Retry Number	6	0–10	-
	10	Auto restart delay time	Retry Delay	1.0	0.1–60.0	sec
CON	71	Select speed search operation	Speed Search	-	0000–1111	bit
	72	Speed search startup current	SS Sup-Current	90	70–120	%
	73	Speed search proportional gain	SS P-Gain	100	0–9999	
	74	Speed search integral gain	SS I-Gain	200	0–9999	
	75	Output block time before speed search	SS Block Time	1.0	0.0–60.0	sec

Auto Restart Setting Details

Code	Description

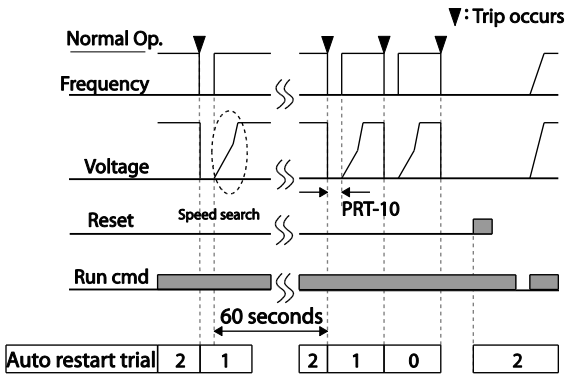
<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>PRT-08
RST Restart</td><td>The Reset restart function can be performed by one of the two different types.
If the top segment is turned on, it indicates the function is on. If the bottom segment is turned on, it indicates the function is off.

<table>
<tr><td>Type</td><td>Bit On</td><td>Bit Off</td></tr>
<tr><td>LCD Display</td><td>  </td><td>  </td></tr>
</table>

Reset Restart function
<table>
<tr><td colspan="2">Setting</td><td rowspan="2">Function</td></tr>
<tr><td>Bit1</td><td>Bit 0</td></tr>
<tr><td></td><td>✓</td><td>For fault trips other than LV</td></tr>
<tr><td>✓</td><td></td><td>For LV fault trips</td></tr>
</table>

For fault trips other than LV: If the Bit 0 is turned on, the inverter restarts after a trip occurs and triggers a reset.
For LV fault trips: If the Bit 1 is turned on, the inverter restarts after a trip occurs and triggers a reset.</td></tr>
<tr><td>PRT-09
Retry Number,
PRT-10
Retry Delay</td><td>The number of available auto restarts can be set at PRT-09. If a fault trip occurs during an operation, the inverter restarts after the time set at PRT-10 (Retry Delay). At each restart, the inverter counts the number of tries and subtracts it from the number set at PRT-09 until the retry number count reaches 0. After an auto restart, if a fault trip does not occur within 60 sec, it will increase the restart count number. The maximum count number is limited by the number set at PRT-09.

If the inverter stops due to over current or hardware diagnosis, an auto restart is not activated. At auto restart, the acceleration options are identical to those of speed search operation. Codes CON-72–75 can be set based on the load. Information about the speed search function can be found at 5.27 Speed Search Operation on page 265.</td></tr>
</table>



[Example of auto restart with a setting of 2]

Caution

- If the auto restart number is set, be careful when the inverter resets from a fault trip. The motor may automatically start to rotate.
- In HAND mode, auto restart resets the trip condition but it does not restart the inverter operation.
- In AUTO mode,
  - if the auto restart is configured, the inverter restarts after a trip condition is released (command via digital input is used to restart the operation).
  - if the auto restart is not configured and the trip condition is released using the OFF key, or the switches at the terminal input, the inverter stays in the OFF state. Because the command information is reset along with the trip condition, a new command is required to operate the inverter.

5.29 Operational Noise Settings (Carrier Frequency Settings)

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CON	04	Carrier	Carrier Freq	3.0	1.0–15.0	kHz

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		Frequency					
	05	Switching Mode	PWM* Mode	0	Normal PWM	0–1	-

* PWM: Pulse width modulation

Operational Noise Setting Details

Code	Description
CON-04 Carrier Freq	Adjusts motor operational noise by changing carrier frequency settings. Power transistors (IGBT) in the inverter generate and supply high frequency switching voltage to the motor. The switching speed in this process refers to the carrier frequency. If the carrier frequency is set high, it reduces operational noise from the motor. If the carrier frequency is set low, it increases operational noise from the motor.
CON-05 PWM Mode	The heat loss and leakage current from the inverter can be reduced by changing the load rate option at CON-05 (PWM Mode). Selecting '1 (LowLeakage PWM)' reduces heat loss and leakage current, compared to when '0 (Normal PWM)' is selected. However, it increases the motor noise. Low leakage PWM uses a 2 phase PWM modulation mode, which helps minimize degradation and reduces switching loss by approximately 30%.

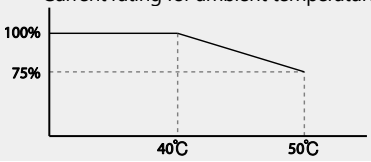
Item	Carrier Frequency	
	1.0 kHz	15 kHz
	LowLeakage PWM	Normal PWM
Motor noise	↑	↓
Heat generation	↓	↑
Leakage current	↓	↑
Leakage current	↓	↑

Note

- **Carrier Frequency at Factory Default Settings:** 3 kHz
- **H100 Series Inverter Derating Standard (Derating):** The over load rate represents an

acceptable load amount that exceeds rated load, and is expressed as a ratio based on the rated load and the duration. The overload capacity on the H100 series inverter is 120%/1 min for normal loads. The current rating differs from the load rating, as it also has an ambient temperature limit. For derating specifications refer to *11.8 Inverter Continuous Rated Current Derating* on page *591*.

- Current rating for ambient temperature at normal load operation.



5.30 2nd Motor Operation

The 2nd motor operation is used when a single inverter switch operates two motors. Using the 2nd motor operation, a parameter for the 2nd motor is set. The 2nd motor is operated when a multi-function terminal input, defined as a 2nd motor function, is turned on.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	28	2nd Motor	-	-

2nd Motor Operation Setting Details

Code	Description
IN-65–71 Px Define	Set one of the multi-function input terminals (P1–P5) to 26 (2nd Motor) to display the M2 (2nd motor group) group. An input signal to a multi-function terminal set to 2nd motor will operate the motor according to the code settings listed below. However, if the inverter is in operation, input signals to the multi-function terminals will not read as a 2nd motor parameter. PRT-50 (Stall Prevent) must be set first, before M2-28 (M2-Stall Lev) settings can be used. Also, PRT-40 (ETH Trip Sel) must be set first, before M2-29 (M2-ETH 1 min) and M2-30 (M2-ETH Cont) settings.

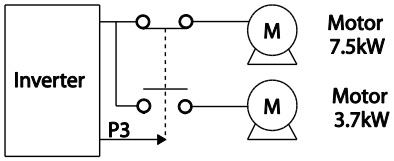
Parameter Setting at Multi-function Terminal Input on a 2nd Motor

Code	Description	Code	Description
M2-04 Acc Time	Acceleration time	M2-15 M2-Efficiency	Motor efficiency
M2-05 M2-Dec Time	Deceleration time	M2-17 M2-Rs	Stator resistance
M2-06 M2-Capacity	Motor capacity	M2-18 M2-Lsigma	Leakage inductance
M2-07 M2-Base Freq	Motor base frequency	M2-25 M2-V/F Patt	V/F pattern
M2-08 M2-Ctrl Mode	Control mode	M2-26 M2-Fwd Boost	Forward torque boost
M2-10 M2-Pole Num	Pole number	M2-27 M2-Rev Boost	Reverse torque boost
M2-11 M2-Rate Slip	Rated slip	M2-28 M2-Stall Lev	Stall prevention level
M2-12 M2-Rated Curr	Rated current	M2-29 M2-ETH 1 min	Motor heat protection 1 min rating
M2-13 M2-Noload Curr	No-load current	M2-30 M2-ETH Cont	Motor heat protection continuous rating
M2-14 M2-Rated Volt	Motor rated voltage		

Example - 2nd Motor Operation

Use the 2nd motor operation when switching operation between a 7.5 kW motor and a secondary 3.7 kW motor connected to terminal P3. Refer to the following settings.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
IN	67	Terminal P3 configuration	P3 Define	26	2nd Motor	-	-
M2	06	Motor capacity	M2-Capacity	-	3.7 kW	-	-
	08	Control mode	M2-Ctrl Mode	0	V/F	-	-

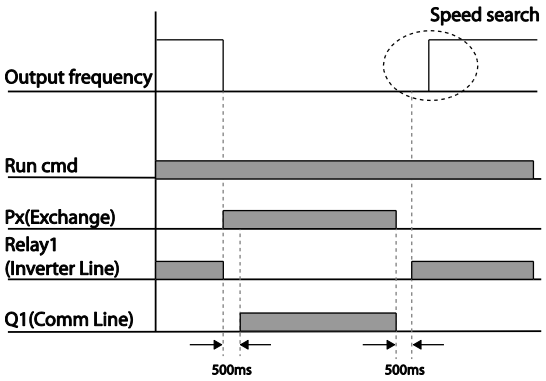


5.31 Supply Power Transition

A supply power transition is used to switch the power source for the motor connected to the inverter from the inverter output power to the main supply power source (commercial power source), or vice versa.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
IN	65–71	Px terminal configuration	Px Define(Px: P1–P7)	18	Exchange	-	-
OUT	31	Multi-function relay 1 items	Relay1	17	Inverter Line	-	-
	33	Multi-function output 1 items	Q1 Define	18	Comm Line	-	-

Supply Power Transition Setting Details

Code	Description
IN-65–71 Px Define	When the motor power source changes from inverter output to main supply power, select a terminal to use and set the code value to '18 (Exchange)'. Power will be switched when the selected terminal is on. To reverse the transition, switch off the terminal.
OUT-31 Relay 1– OUT-36 Q1 Define	Set multi-function relay or multi-function output to '17 (Inverter Line)' or '18 (Comm Line)'. The relay operation sequence is as follows. 

5.32 Cooling Fan Control

This function turns the inverter's heat-sink cooling fan on and off. It is used in situations where the load stops and starts frequently or a noise-free environment is required. The correct use of cooling fan controls can extend the cooling fan's life.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV	64	Cooling fan control	Fan Control	0	During Run	0–2	-

Cooling Fan Control Detail Settings

Code	Description		
ADV-64 Fan Control	Settings		Description
	0	During Run	The cooling fan runs when the power is supplied to the inverter and the operation command is on. The cooling fan stops when the power is supplied to the inverter and the operation command is off. When the inverter heat sink temperature is higher than its set value, the cooling fan operates automatically regardless of its operation status.
	1	Always On	Cooling fan runs constantly if the power is supplied to the inverter.
	2	Temp Control	With power connected and the run operation command on: if the setting is in Temp Control, the cooling fan will not operate unless the temperature in the heat sink reaches the set temperature.

Note

Despite setting ADV-64 to '0 (During Run)', if the heat sink temperature reaches a set level by current input harmonic wave or noise, the cooling fan may run as a protective function.

5.33 Input Power Frequency and Voltage Settings

Select the frequency for inverter input power. If the frequency changes from 60 Hz to 50 Hz, all other frequency (or RPM) settings, including the maximum frequency, base frequency, etc., will change to 50 Hz. Likewise, changing the input power frequency setting from 50 Hz to 60 Hz will change all related function item settings from 50 Hz to 60 Hz.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
BAS	10	Input power frequency	60/50 Hz Sel	0	60 Hz	0–1	-

Set Inverter input power voltage. Low voltage fault trip level changes automatically to the set voltage standard.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
BAS	19	Input power voltage	AC Input Volt	200 Type	220	170–240	V
				400 Type	380	320–480	

5.34 Read, Write, and Save Parameters

Use read, write, and save function parameters on the inverter to copy parameters from the inverter to the keypad or from the keypad to the inverter.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	46	Parameter read	Parameter Read	1	Yes	-	-
	47	Parameter write	Parameter Write	1	Yes	-	-
	48	Parameter save	Parameter Save	1	Yes	-	-

Read, Write, and Save Parameter Setting Details

Code	Description
CNF-46 Parameter Read	Copies saved parameters from the inverter to the keypad. Saved parameters on the keypad will be deleted and replaced with the copied parameters.
CNF-47 Parameter Write	Copies saved parameters from the keypad to the inverter. Saved parameters on the inverter will be deleted and replaced with the copied parameters. If an error occurs during parameter writing, the previously saved data will be used. If there is no saved data on the Keypad, 'EEP Rom Empty' will be displayed.
CNF-48 Parameter Save	As parameters set during communication transmission are saved to RAM, the setting values will be lost if the power goes off and on. When setting parameters during communication transmission, select '1 (Yes)' at CNF-48 to save the set parameter.

5.35 Parameter Initialization

User changes to parameters can be initialized (reset) to factory default settings on all or selected groups. However, during a fault trip situation or operation, parameters cannot be reset.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	40	Parameter initialization	Parameter Init	0	No	0–15	

Parameter Initialization Setting Details

Code	Description			
CNF-40 Parameter Init	Setting		LCD Display	Function
	0	No	No	-
	1	Initialize all groups	All Grp	Initialize all data. Select '1 (All Grp)' and press the [PROG/ENT] key to start initialization. On completion, '0 (No)' will be displayed.
	2	Initialize DRV group	DRV Grp	Initialize data by groups. Select initialize group and press the [PROG/ENT] key to start initialization. On completion, '0 (No)' will be displayed.
	3	Initialize BAS group	BAS Grp	
	4	Initialize ADV group	ADV Grp	
	5	Initialize CON group	CON Grp	
	6	Initialize IN group	IN Grp	
	7	Initialize OUT group	OUT Grp	
	8	Initialize COM group	COM Grp	
	9	Initialize PID group	PID Grp	
	1	Initialize EPI	EPI Grp	

Code	Description
	0 group 11 Initialize AP1 group (AP1 Grp) 12 Initialize AP2 group (AP2 Grp) 13 Initialize AP3 group (AP3 Grp) 14 Initialize PRT group (PRT Grp) 15 Initialize M2 group (M2 Grp)

5.36 Parameter View Lock

Use parameter view lock to hide parameters after registering and entering a user password.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF	50	Parameter view lock	View Lock Set	Un-locked	0–9999	
	51	Parameter view lock password	View Lock Pw	Password	0–9999	

Parameter View Lock Setting Details

Code	Description
CNF-51 View Lock Pw	Register a password to allow access to parameter view lock. Follow the steps below to register a password. No: Procedure 1: [PROG/ENT] key on CNF-51 code will show the previous password input window. If registration is made for the first time, enter '0.' It is the factory default. 2: If a password had been set, enter the saved password. 3: If the entered password matches the saved password, a new window prompting the user to enter a new password will be

Code	Description
	displayed (the process will not progress to the next stage until the user enters a valid password).
	4 Register a new password.
	5 After registration, code CNF-51 will be displayed.
CNF-50 View Lock Set	To enable parameter view lock, enter a registered password. The [Locked] sign will be displayed on the screen to indicate that parameter view lock is enabled. To disable parameter view lock, re-enter the password. The [locked] sign will disappear.

5.37 Parameter Lock

Use parameter lock to prevent unauthorized modification of parameter settings. To enable parameter lock, register and enter a user password first.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF	52	Parameter lock	Key Lock Set	Un-locked	0–9999	-
	53	Parameter lock password	Key Lock Pw	Password	0–9999	-

Parameter Lock Setting Details

Code	Description
CNF-53 Key Lock PW	Register a password to prohibit parameter modifications. Follow the procedures below to register a password.

No	Procedures
1	Press the [PROG/ENT] key on CNF-53 code and the saved password input window will be displayed. If password registration is being made for the first time, enter '0'. It is the factory default.
2	If a saved password has been set, enter the saved password.
3	If the entered password matches the saved password, then a new window to enter a new password will be displayed. (The process will not move to next stage until the user enters a valid password).

Code	Description
	4 Register a new password. 5 After registration, Code CNF-53 will be displayed.
CNF-52 Key Lock Set	To enable parameter lock, enter the registered password. The [Locked] sign will be displayed on the screen to indicate that prohibition is enabled. Once enabled, pressing the [PROG/ENT] key aton function code will not allow the display edit mode to run. To disable parameter modification prohibition, re-enter the password. The [Locked] sign will disappear.

Caution

If parameter view lock and parameter lock functions are enabled, no inverter operation related function changes can be made. It is very important that you memorize the password.

5.38 Changed Parameter Display

This feature displays all the parameters that are different from the factory defaults. Use this feature to track changed parameters.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	41	Changed parameter display	Changed Para	0	View All	-	-

Changed Parameter Display Setting Details

Code	Description		
CNF-41 Changed Para	Setting		Function
	0	View All	Display all parameters
	1	View Changed	Display changed parameters only

5.39 User Group

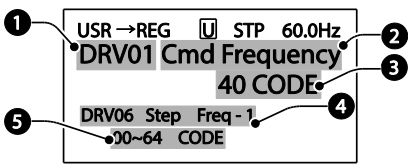
Create a user defined group and register user-selected parameters from the existing function groups. The user group can carry up to a maximum of 64 parameter registrations.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	42	Multi-function key settings	Multi Key Sel	3	UserGrp SelKey	-	-
	45	Delete all user registered codes	UserGrp AllDel	0	No	-	-

User Group Setting Details

Code	Description
CNF-42 Multi Key Sel	Select 3 (UserGrp SelKey) from the multi-function key setting options. If user group parameters are not registered, setting the multi-function key to the user group select key (UserGrp SelKey) will not display user group (USR Grp) items on the Keypad. Follow the procedures below to register parameters to a user group.

No	Procedure
1	Set CNF- 42 to '3 (UserGrp SelKey)'. A U icon will be displayed at the top of the LCD display.
2	In the parameter mode (PAR Mode), move to the parameter you need to register and press the [MULTI] key. For example, if the [MULTI] key is pressed in the frequency reference in DRV-01 (Cmd Frequency), the screen below will be displayed.



❶Group name and code number of the parameter

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td>❷Name of the parameter
❸Code number to be used in the user group. Pressing the [PROG/ENT] key on the code number (40 Code) will register DRV-01 as code 40 in the user group.
❹Existing parameter registered as the user group code 40
❺Setting range of the user group code. Entering '0' cancels the settings.</td></tr>
<tr><td>3</td><td>❸Set a code number to use to register the parameter in the user group. Select the code number and press the [PROG/ENT] key.</td></tr>
<tr><td>4</td><td>Changing the value in ❸will also change the value in ❶If no code is registered, 'Empty Code' will be displayed. Entering '0' cancels the settings.</td></tr>
<tr><td>5</td><td>The registered parameters are listed in the user group in U&M mode. You can register one parameter multiple times if necessary. For example, a parameter can be registered as code 2, code 11, and more in the user group.</td></tr>
</table>

Follow the procedures below to delete parameters in the user group.
<table>
<tr><th>No.</th><th>Settings</th></tr>
<tr><td>1</td><td>Set CNF- 42 to '3 (UserGrp SelKey)'. A U icon will be displayed at the top of the LCD display.</td></tr>
<tr><td>2</td><td>In the USR group in U&M mode, move the cursor to the code that is to be deleted.</td></tr>
<tr><td>3</td><td>Press the [MULTI] key.</td></tr>
<tr><td>4</td><td>Move to 'YES' on the deletion confirmation screen, and press the [PROG/ENT] key.</td></tr>
<tr><td>5</td><td>Deletion completed.</td></tr>
</table>
</td></tr>
<tr><td>CNF-25 UserGrp AllDel</td><td>Set to '1 (Yes)' to delete all registered parameters in the user group.</td></tr>
</table>

5.40 Easy Start On

Run Easy Start On to easily setup the basic motor parameters required to operate a motor in a batch. Set CNF-61 (Easy Start On) to '1 (Yes)' to activate the feature, initialize all parameters by setting CNF-40 (Parameter Init) to '1 (All Grp)', and restart the inverter to activate Easy Start On.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	61	Parameter easy start settings	Easy Start On	1	Yes	-	-

Easy Start On Setting Details

Code	Description
CNF-61 Easy Start On	Follow the procedures listed below to set the easy start on parameters. No: Procedures 1: Set CNF-61 (Easy Start On) to '1(Yes)'. 2: Select '1 (All Grp)' in CNF-40 (Parameter Init) to initialize all parameters in the inverter. 3: Restarting the inverter will activate Easy Start On. Set the values in the following screens on the Keypad. To escape from Easy Start On, press the [ESC] key. Start Easy Set: Select 'Yes'. CNF-99: Select a macro. BAS-10 60/50 Hz Sel: Set motor rated frequency. DRV-14 Motor Capacity: Set motor capacity. BAS-13 Rated Curr: Set motor rated current. BAS-15 Rated Volt: Set motor rated voltage. BAS-11 Pole Number: Set motor pole number. BAS-19 AC Input Volt: Set input voltage. PRT-08 Reset Restart: Sets the restart voltage when performing a trip reset. PRT-09 Retry Number: Sets the number of restart trial when performing a trip reset. COM-96 PowerOn Resume: Sets the serial communication

Code	Description
	restart function. CON-71 SpeedSearch: Set SpeedSearch. DRV-06 Cmd Source: Set command source. DRV-07 Freq Ref Src: Set Frequency Reference source. When the settings are complete, the minimum parameter settings on the motor have been made. The Keypad will return to a monitoring display. Now the motor can be operated with the command source set at DRV-06.

Caution

Use caution when turning on the inverter after Easy Start On configuration. If codes such as PRT-08 (Reset Restart), COM-96 (PowerOn Resume), or CON-71 (SpeedSearch) are configured in Easy Start On, the inverter may start operating as soon as it is powered on.

5.41 Config (CNF) Mode

The config mode parameters are used to configure keypad related features.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
CNF*	2	LCD brightness/contrast adjustment	LCD Contrast	-	-	
	10	Inverter S/W version	Inv S/W Ver	x.xx	-	
	11	Keypad S/W version	Keypad S/W Ver	x.xx	-	-
	12	Keypad title version	KPD Title Ver	x.xx	-	-
	30–32	Power slot type	Option-x Type	None	-	-
	44	Erase trip history	Erase All Trip	No	-	-
	60	Add title update	Add Title Up	No	-	-
	62	Initialize accumulated electric energy	WH Count Reset	No	-	-

Config Mode Parameter Setting Details

Code	Description
CNF-2 LCD Contrast	Adjusts LCD brightness/contrast on the keypad.
CNF-10 Inv S/W Ver, CNF-11 Keypad S/W Ver	Checks the OS version in the inverter and on the keypad.
CNF-12 KPD Title Ver	Checks the title version on the keypad.
CNF-30–32 Option-x Type	Checks the type of option board installed in the option slot. The H100 inverters use type-1 option boards only (CNF-30 Option-1 Type). CNF-31 and CNF-32 are not used.
CNF-44 Erase All Trip	Deletes the stored trip history.
CNF-60 Add Title Up	When inverter SW version is updated and more code is added, CNF-60 settings will add, display, and operate the added codes. Set CNF-60 to '1 (Yes)' and disconnect the keypad from the inverter. Reconnecting the keypad to the inverter updates titles.
CNF-62 WH Count Reset	Initialize the accumulated electric energy consumption count.

5.42 Macro Selection

The Macro selection function is used to put various application functions together in a group. For applications with the H100 series inverters, 7 basic Macro configurations are currently available. Macro functions cannot be added by the user, but the data can be modified.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	43	Macro selection	Macro Select	0	Basic	0–7	-
				1	Compressor		
				2	Supply Fan		
				3	Exhaust Fan		
				4	Cooling		

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
					Tower		
				5	Circul. Pump		
				6	Vacuum Pump		
				7	Constant Torq		

Macro Selection Details

Code	Description
CNF-43 Macro Select	A list of Macro settings is displayed for user selection. When a Macro function is selected, all the related parameters are automatically changed based on the inverter's Macro settings. If '0 (Basic)' is selected, all the inverter parameters, including the parameters controlled by the Macro function, are initialized. For other macro application settings (settings 1–7), refer to *5.42 Macro Selection* on page *290*.

5.43 Timer Settings

Set a multi-function input terminal to a timer. Sets the On/Off controls to the multi-function outputs and relays according to the timer settings.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
IN	65–71	Px terminal configuration	Px Define (Px: P1–P7)	35	Timer In	-	-
OUT	31	Multi-function relay 1	Relay 1	22	Timer Out	-	-
	33	Multi-function output 1	Q1 Define				

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	55	Timer on delay	TimerOn Delay	3.00	0.00–100.00	sec
	56	Timer off delay	TimerOff Delay	1.00	0.00–100.00	sec

Timer Setting Details

Code	Description
IN-65–71 Px Define	Choose one of the multi-function input terminals and change it to a timer terminal by setting it to '35(Timer In)'.
OUT-31 Relay 1, OUT-36 Q1 Define	Set the multi-function output terminal or relay to be used as a timer to '22 (Timer out)'.
OUT-55 TimerOn Delay, OUT-56 TimerOff Delay	Input a signal (On) to the timer terminal to operate a timer output (Timer out) after the time set at OUT-55 has passed. When the multi-function input terminal is off, the multi-function output or relay turns off after the time set at OUT-56.

5.44 Multiple Motor Control (MMC)

The MMC (Multiple Motor Control) function is used to control multiple motors for a pump system. The main motor connected with the inverter output is controlled by the PID controller. The auxiliary motors are connected with the supply power and turned on and off by the relay within the inverter.

Group	Code	Name	LCD Display	Setting	Setting Range		Unit
AP1	40	MMC function selection	MMC Sel	0: No	0	No	-
					1	Yes	
	41	Bypass selection	Regul Bypass	0: No	0	No	-
					1	Yes	
	42	Number of auxiliary motors	Num of Aux	0	0–5		-

Group	Code	Name	LCD Display	Setting	Setting Range		Unit
	43	Auxiliary starting motor selection	Starting Aux	1	1–5		-
	44	Number of operating auxiliary motors	Aux Motor Run	-	-		-
	45	Auxiliary motor (#1– 4) priority	Aux Priority 1	-	-		-
	46	Auxiliary motor (#5– 8) priority	Aux Priority 2	-	-		-
	48	Auxiliary motor operation at stop	Aux All Stop	0: No	0	No	-
					1	Yes	
	49	Stop order for auxiliary motors	FIFO/FILO	0: FILO	0	FILO	-
					1	FIFO	
	50	Auxiliary motor pressure difference	Actual Pr Diff	2	0–100		Unit
	51	Main motor acceleration time when auxiliary motor # is reduced	Aux Acc Time	2	0–600.0		Sec
	52	Main motor deceleration time when auxiliary motor is added	Aux Dec Time	2	0–600.0		Sec
	53	Auxiliary motor start delay time	Aux Start DT	5	0.0–999.9		Sec
	54	Auxiliary motor stop delay time	Aux Stop DT	5	0.0–999.9		Sec
	55	Auto change mode selection	Auto Ch Mode	0: None	0	None	-
					1	AUX	
					2	MAIN	
	56	Auto change time	Auto Ch Time	72: 00	00: 00–99: 00		Min

Group	Code	Name	LCD Display	Setting	Setting Range	Unit
	57	Auto change frequency	Auto Ch Level	20.00	Low Freq–High Freq	Hz
	58	Auto change operation time	Auto Op Time	-	-	-
	60	#1 auxiliary motor start frequency	Start Freq 1	45	Low Freq–High Freq	Hz
	61	#2 auxiliary motor start frequency	Start Freq 2	45	Low Freq–High Freq	Hz
	62	#3 auxiliary motor start frequency	Start Freq 3	45	Low Freq–High Freq	Hz
	63	#4 auxiliary motor start frequency	Start Freq 4	45	Low Freq–High Freq	Hz
	64	#5 auxiliary motor start frequency	Start Freq 5	45	Low Freq–High Freq	Hz
	70	#1 auxiliary motor stop frequency	Stop Freq 1	20	Low Freq–High Freq	Hz
	71	#2 auxiliary motor stop frequency	Stop Freq 2	20	Low Freq–High Freq	Hz
	72	#3 auxiliary motor stop frequency	Stop Freq 3	20	Low Freq–High Freq	Hz
	73	#4 auxiliary motor stop frequency	Stop Freq 4	20	Low Freq–High Freq	Hz
	74	#5 auxiliary motor stop frequency	Stop Freq 5	20	Low Freq–High Freq	Hz
	80	#1 auxiliary motor reference compensation	Aux1 Ref Comp	0	0–Unit Band	Unit
	81	#2 auxiliary motor reference compensation	Aux2 Ref Comp	0	0–Unit Band	Unit
	82	#3 auxiliary motor reference	Aux3 Ref Comp	0	0–Unit Band	Unit

Group	Code	Name	LCD Display	Setting	Setting Range		Unit
		compensation					
	83	#4 auxiliary motor reference compensation	Aux4 Ref Comp	0	0–Unit Band		Unit
	84	#5 auxiliary motor reference compensation	Aux5 Ref Comp	0	0–Unit Band		Unit
	90	Interlock selection	Interlock	0: No	0	No	-
					1	Yes	
	91	Delay time before an operation for the next motor when an interlock or an auto change on the main motor occur.	Interlock DT	5.0	0–360.0		Sec

MMC Setting Details

Code	Description
AP1-40 MMC Sel	Selects the MMC operation settings.
AP1-42 Num of Aux	Decides the number of auxiliary motors to use. Set OUT31–36 to '21 (MMC)' to use the out terminal for auxiliary motor operation. The number of the configured output terminals determines the total number of auxiliary motors to be used.
AP1-43 Starting Aux	Sets the start auxiliary motor.
AP1-44 Aux Motor Run	Indicates the number of the operating auxiliary motors.
AP1-45–46 Aux Priority1–2	Indicates auxiliary motor priority. The priority can be modified at AP1-49 (FIFO/FILO).
AP1-48 Aux All Stop	Selects a stop mode for when the relay output to auxiliary motors are turned off due to the inverter stop. 0 (No): turns off all the relays at once. 1 (Yes): turns off the relay sequentially based on the time set at AP1-54 (Aux Stop DT).
AP1-49 FIFO/FILO	Decides the stopping order for the auxiliary motors. Set the auxiliary motors to stop in the order, or the reverse order, that they were turned on.
AP1-50 Actual Pr Diff	Sets the difference between the reference and the feedback. The auxiliary motors are turned on when the difference between the current reference and the feedback is greater than a set value.
AP1-51 Acc Time AP1-52 Dec Time	When an auxiliary motor starts or stops, the main motor stops the PID control, and performs general acceleration and deceleration. When an auxiliary motor starts, the main motor decelerates to the auxiliary motor deceleration frequency set at AP1-70–74 (Stop Freq 1–5) based on the deceleration time set at AP1-52 (Dec Time).

Code	Description
	When the auxiliary motor stops, the main motor accelerates up to the auxiliary motor restart frequency set at AP1-61–65 (Start Freq 1–5) based on the acceleration time set at AP1-51 (Acc Time).
AP1-53 Aux Start DT AP1-54 Aux Stop DT	The auxiliary motors turns on or off after the auxiliary motor stop delay time or the auxiliary motor restart delay time elapses, or if the difference between the current reference and the feedback is greater than the value set at AP1-50 (Actual Pr Diff).
AP1-60–64 Start Freq1–5	Sets the auxiliary motor start frequency.
AP1-70–74 Stop Freq 1–5	Sets the auxiliary motor stop frequency.
OUT-31–35 Relay 1–5 OUT-36 Q1 Define	Configure the output terminals to '21 (MMC)' to use the terminals to control the auxiliary motors. The number of the configured output terminals determines the total number of auxiliary motors to be used.

5.44.1 Multiple Motor Control (MMC) Basic Sequence

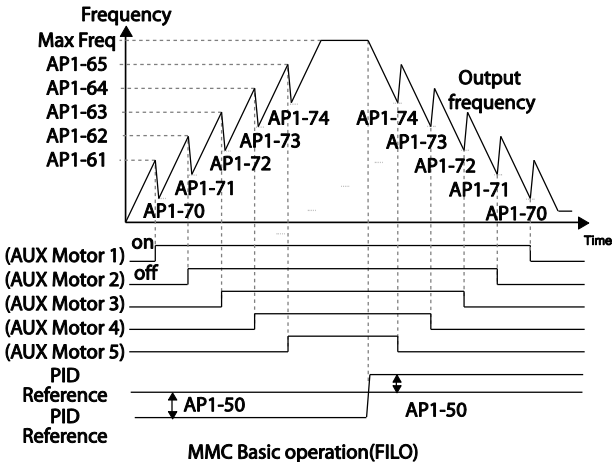
Multiple motor control (MMC) is an operation based on PID control. During an MMC operation, the main and auxiliary motors organically operate together.

During a PID operation, the auxiliary motors are turned on when the inverter frequency reaches the start frequencies set at AP1-61–65 (Start freq), and the difference between the PID reference and feedback is smaller than the value set at AP1-50. Then, the auxiliary motors stop operating when the operation frequency reach the stop frequency set at AP1-70–74 (Stop Freq 1–5) and the difference between the PID reference and feedback becomes greater than the value set at AP1-50.

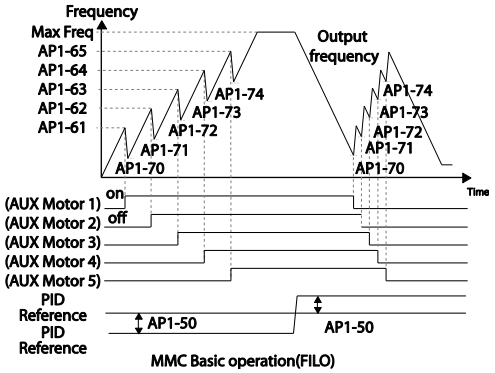
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
AP1	61–65	#2–5 auxiliary motor start frequency	Start Freq 2–5	Frequency value within the range	Low Freq–High Freq	Hz

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	50	Auxiliary motors pressure difference	Actual Pr Diff	Percentage value within the range	0–100 (%)	%
	70–74	#1–5 auxiliary motor stop frequency	Stop Freq 1–5	Frequency value within the range	Low Freq– High Freq	Hz

The following diagram describes the MMC basic sequence based on FILO and FIFO settings.

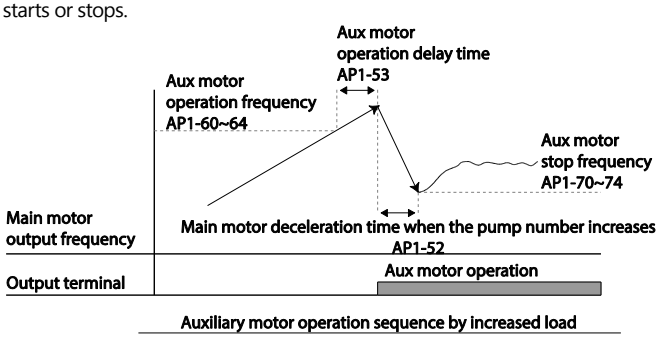


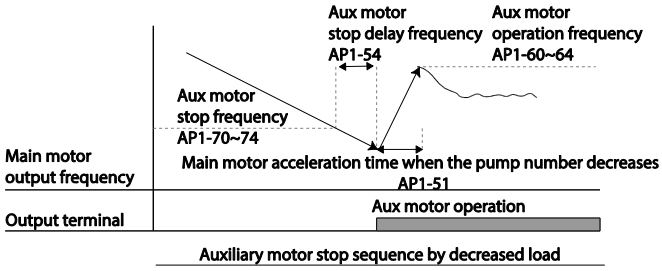
MMC Basic operation(FILO)



MMC Basic operation(FILO)

The following diagram is an operation graph based on the start and stop delay times set at AP1-53 (Aux start DT) and AP1-54 (Aux stop DT). When the start or stop frequencies are reached, the auxiliary motor waits for the time set at AP1-53 (Aux start DT) or AP1-54 (Aux stop DT) before it starts or stops.





5.44.2 Auto Change

The auto change function enables the inverter to automatically switch operations between main and auxiliary motors. Prolonged continuous operation of a motor deteriorates motor capabilities. The auto change function switches the motors automatically when certain conditions are met to avoid biased use of certain motors and protect them from deterioration.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range		Unit
AP1	55	Auto change mode	Auto Ch Mode	0	None	0	None	-
				1	Aux motor	1	AUX	

Group	Code	Name	LCD Display	Parameter Setting		Setting Range		Unit
		selection					Exchange	
				2	Main motor	2	Main Exchange	
	56	Auto change time	Auto Ch Mode	Time value within the range		00: 00–99: 00		Sec.
	57	Auto change frequency	Auto Ch Level	Frequency value within the range		Low Freq–High Freq		Hz
	58	Auto change operation time	Auto Op Time	Time value within the range		-		Sec.

Auto Change Setting Details

Code	Description
AP1-55 Auto Ch Mode	Select the motors to apply the auto change function. Setting: 0 – None; 1 – Aux motor; 2 – Main motor Refer to Examples of Auto Change Sequences below for details.
AP1-56 Auto Ch Time	Sets the auto change intervals.
AP1-57 Auto Ch Level	Sets the reference frequency for auto change. Auto change function is activated when certain conditions are met, and the main motor output frequency is below the frequency set at AP1-57.
AP1-58 Auto Op Time	Sets the elapsed time since the last auto change. Since auto change is not activated if certain conditions are not met, even when the auto change interval set at AP1-56 is elapsed. Therefore, the times indicated at AP1-58 may be longer than the time interval set at AP1-56.

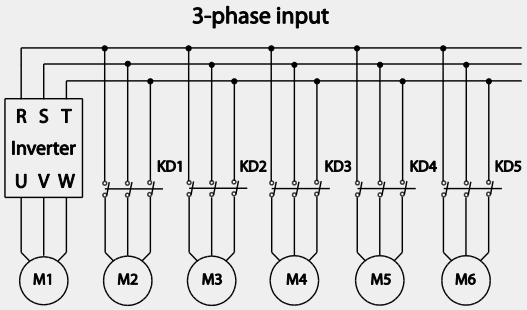
When AP1-55 (Auto Ch Mode) is set to '0 (None),' the auxiliary motors operates based on the order (sequence) set at AP1-43 (Starting Aux). Auto Change functionality is disabled.

When AP1-55 (Auto Ch Mode) is set to '1 (Aux)', the auxiliary motors operate based on the order (sequence) set at AP1-43 (Starting Aux). During the operation, auto change is activated if the inverter operation time has exceeded the time set at AP1-56 (Auto Ch Time) and if the main motor operation frequency is below the frequency set at AP1-57 (Auto Ch Level).

Once the auto change is operated, the auxiliary motor that started first is given the lowest priority and all the other auxiliary motors' priority level increases by 1. Then, general MMC operation continues.

NOTE

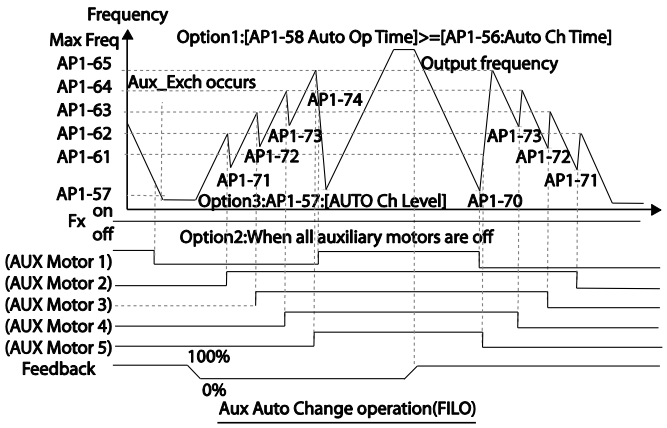
Auto change does not work while the auxiliary motors are operating. Auto change is operated only when all the auxiliary motors are stopped and if all the conditions set for the auto change are met. When the inverter stops, all motors stop operating, and the auxiliary motor with the highest priority becomes the starting auxiliary motor. If the inverter power is turned off then turned back on, the auxiliary motor set at AP1-43 (Starting Aux) becomes the starting auxiliary motor.

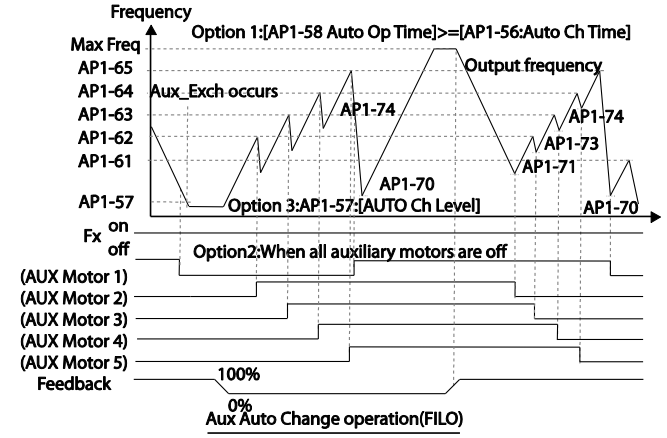


Start order and stop order of the auxiliary motors are based on the order set at AP1-49 (FIFO/FILO).

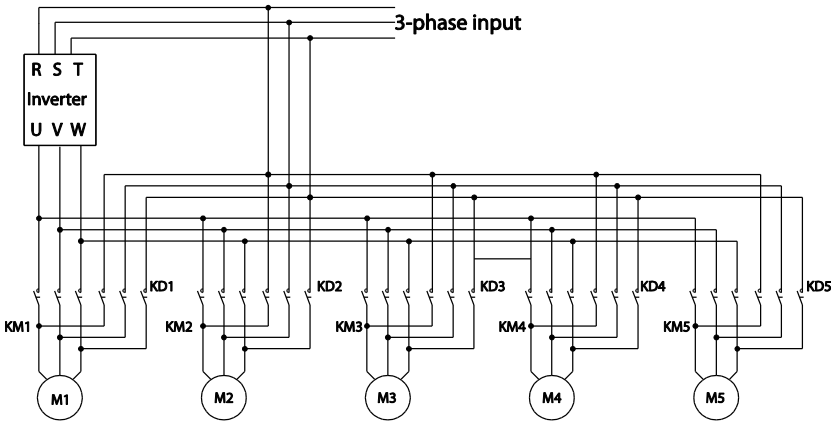
The following diagrams depict the auxiliary motor start and stop sequence, based on a FIFO configuration, when the inverter operation time exceeds the auto change interval set at AP1-58. If all the auxiliary motors are turned off and the inverter operation frequency is below the frequency set at AP1-58 (Auto Op Time), auto change is operated. Then, when the inverter frequency increases due to decrease in the feedback, auxiliary motor #2 starts instead of auxiliary motor #1 due to this auto change (auxiliary motor #1 starts last, for it has the lowest priority).

Later on during the operation, when the feedback increases and the auxiliary motors begin to stop, the FILO setting is applied to control the order for the auxiliary motors to stop.





When AP1-55 (Auto Ch Mode) is set to '2 (Main),' the system uses all the motors (main and auxiliary motors) regardless of the types. The auxiliary motor with the highest priority is operated first and used as the main motor. Then, when the auto change conditions are met, this motor is stopped and the motor priorities are re-arranged. This way, the system always operates the motor with the highest priority and uses it as the main motor of the MMC operation. In this case, before auto change is operated for the main motor, the interlock delay time set at AP1-91 (Interlock DT) is applied.

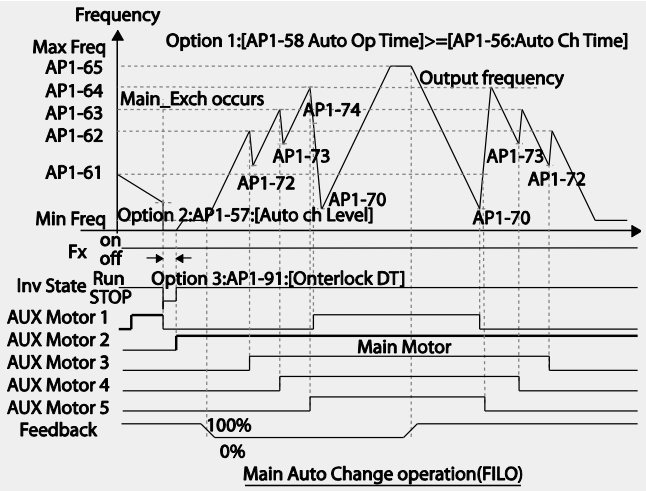


NOTE

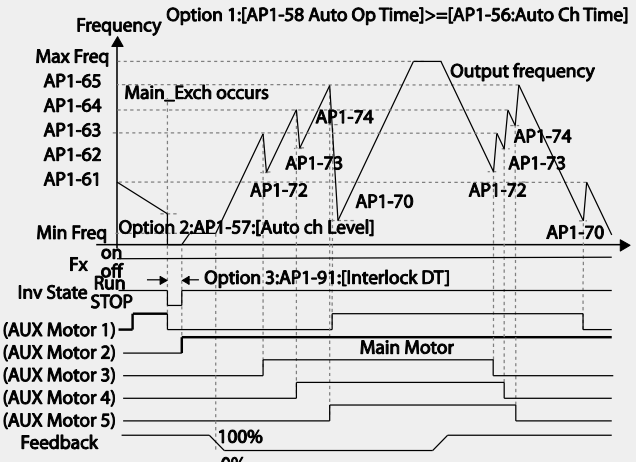
Auto change does not work while the auxiliary motors are operating. Auto change is operated only when all the auxiliary motors are stopped and if all the conditions set for the auto change are met. When the inverter stops, all motors stop operating, and the auxiliary motor with the highest priority becomes the starting auxiliary motor. If the inverter power is turned off then turned back on, the auxiliary motor set at AP1-43 (Starting Aux) becomes the starting auxiliary motor.

The following diagrams depict the auto change operation when AP1-55 (Auto Ch Mode) is set to '2 (Main),' when the inverter operation time exceeds the auto change interval set at AP1-58. If the inverter operation frequency is below the frequency set at AP1-57, all the auxiliary motors including the start auxiliary motor are turned off. After the delay time set at AP1-91 (Interlock DT) elapses, the 'Main' auto change is operated. After the 'Main' auto change, the auxiliary motor that was turned on after the starting auxiliary motor becomes the main motor.

In the following diagrams, because auxiliary motor #1 is the starting auxiliary motor. Auxiliary motor #2 becomes the main motor after the auto change. The auxiliary motor on/off operation is identical to that of Aux Exchange, and the 'off' conditions differ based on the FIFO/FILO configuration.



Main Auto Change operation(FILO)



Main Auto Change operation(FIFO)

5.44.3 Interlock

When there is motor trouble, the interlock feature is used to stop the affected motor and replace it with another that is not currently operating (off state). To activate the interlock feature, connect the cables for abnormal motor signal to the inverter input terminal and configure the terminals as interlock 1–5 inputs. Then, the inverter decides the motor's availability based on the signal inputs. The order in which the alternative motor is selected is decided based on the auto change mode selection options set at AP1-55.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range		Unit
AP1	90	Interlock selection	Interlock	1	0	NO	-
					1	YES	

After configuring the IN-65–71 multi-purpose input terminals as Interlock input 1–5, if an interlock signal is received from an auxiliary motor, the output contacts are turned off for the motor and the motor is excluded from the MMC operation. This causes the priority level of the auxiliary motors with lower priority level than the interlocked motor to be increased by 1.

The interlock is released when the input terminals (IN-65–71) are turned off, and the relevant auxiliary motor is included in the MMC operation again, with lowest priority.

When the inverter stops, all motors stop operating, and the auxiliary motor with the highest priority becomes the starting auxiliary motor.

When the multi-purpose input terminals (IN-65–71, P1–7 Define) are set for the interlock feature, an interlock is 'Off' when the contacts are valid, and 'On' when they are invalid.

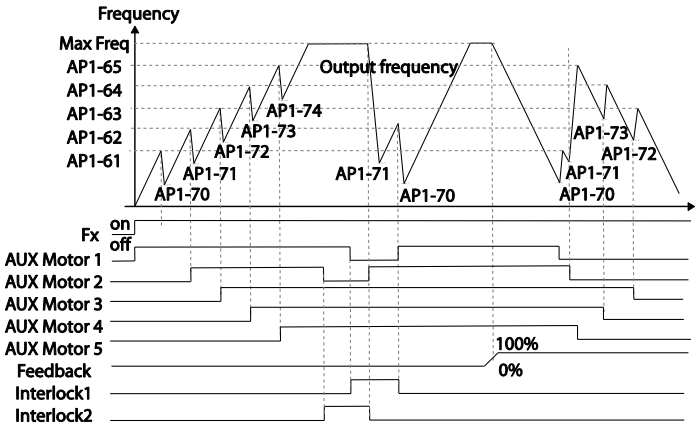
InterLock Setting Details

Code	Description
AP1-90 InterLock	Enables or disables the Interlock.
AP1-91 Interlock DT	Sets the delay time before the Interlock occurs.

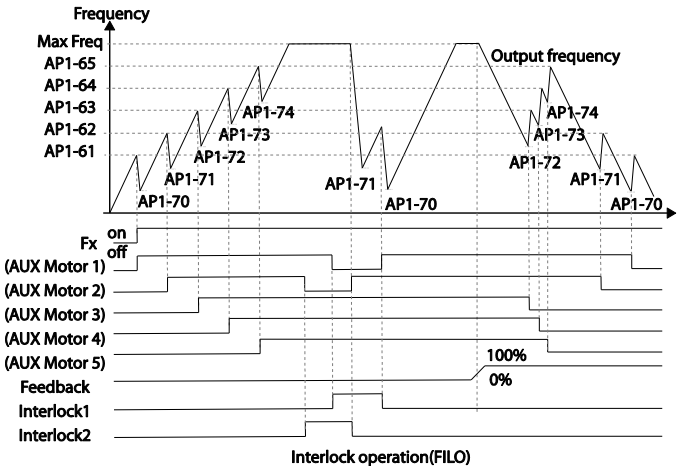
Note

IN-65–71 PxDefine: Select the terminal from the input terminal function group (IN-65–71) and set Interlock 1-5 respectively with the correct motor order. When auto change mode selection (AP1–55) is set to '0 (None)' or '1 (Aux)', and if 5 motors are operated, including the main motor, the interlock numbers 1,2,3,4,5 refer to the montors connected to Relay 1,2,3,4,5 (If interlock numbers 1,2,3,4,5 are connected to Relay 1,2,3,4,5 at the inverter output terminal).
However, if auto change mode selection (AP1-55) is set to '2 (Main)', and the main and auxiliary motors are connected to the inverter output terminal Relay 1,2,3,4, Interlock 1,2,3,4 are the monitors connected to Relay 1,2,3,4.

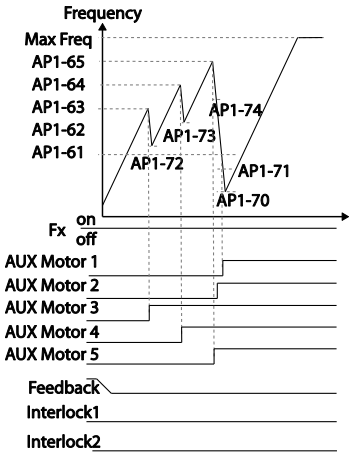
The figure below shows the motor operating as a sequence by FILO. The motor turns on from the starting auxiliary motor (Starting Aux) by order, and turns off depending on the rise of PID feedback. At this point, the interlock occurs at auxiliary motor #2 by multi-function input, the auxiliary motor turns off. The output frequency falls to the frequency set at AP1-71, and rises again. Then, the interlock occurs at auxiliary motor #1. The auxiliary motor stops and falls to the frequency set at AP1-71, and then rises again. Interlock #2 should be released first, then release interlock #1 to let the auxiliary motor operate (When interlocks are released, they will have the lowest priority of the operating motors). If the auxiliary motor turns off by a rise of Feedback, the auxiliary motors turns off in order from 1 to 5, because auxiliary motor #1 turned on last. The interlocked auxiliary motor will have the lowest priority.



Interlock operation(FILO)



When interlock is released, the auxiliary motor's priority becomes different. When Interlock occurs at auxiliary motor #2, the priority is number 1>3>4>5>2. When it occurs at auxiliary motor #1, the priority is number 3>4>5>2>1. The figure below shows the order of the auxiliary motors activating depending on the priority (of Interlock occurring and releasing). In the figure, the order is the same for FILO/FIFO, because the auxiliary motor turns on.



Regular Bypass

This function controls the motor speed based on the feedback amount instead of using the PID. Auxiliary motors may be controlled with this feature based on the feedback amount.

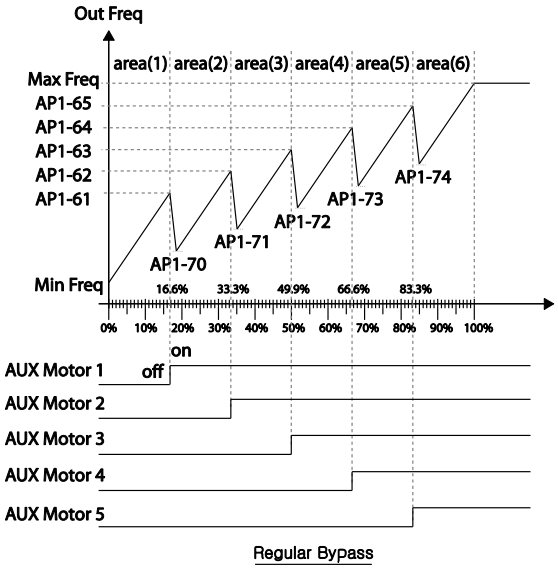
Group	Code	Name	LCD Display	Parameter Setting			Setting Range	Unit
AP1	41	Bypass selection	Regul Bypass	1	0	No	-	-
					1	Yes		
	60–64	#1–5 auxiliary motor start frequency	Start Freq 1–5	Frequency value within the range			Freq Low Limit–Freq High limit	Hz
	70–74	#1–5 auxiliary motor stop frequency	Stop Freq 1–5	Frequency value within the range			Low Freq–High Freq	Hz
OUT	31–35	Multi-function relay1–5	Relay 1–5	21	Multiple motor control (MMC)		-	-
	36	Multi-function 1 item	Q1 Define	40	KEB Operation		-	-

Regular Bypass Detail Settings

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>AP1-41 Regular Bypass</td><td>Sets the regular bypass mode.
<table><tr><td>Mode</td><td>Setting</td></tr><tr><td>0</td><td>No</td></tr><tr><td>1</td><td>Yes</td></tr></table></td></tr>
<tr><td>AP1-60–64 Start Freq 1–5</td><td>Sets the auxiliary motor start frequency.</td></tr>
<tr><td>AP1-70–74 Stop Freq 1–5</td><td>Sets the auxiliary motor stop frequency.</td></tr>
<tr><td>OUT-31–35 Relay 1–5
OUT-36 Q1 Define</td><td>Set OUT31–35 to '21 (MMC)' to use the out terminal for auxiliary motor operation. The number of configured output terminals determines the total number of auxiliary motors to be used.</td></tr>
</table>

When an input set by the PID feedback of the analog input terminal (I or V1 or Pulse) is 100%, divide the area by the number of motors being used (including the main motor). Each auxiliary motor turns on when feedback reaches the relevant level and turns off when feedback goes below the relevant level. The primary motor increases its speed based on the feedback and when it reaches the start frequency of the relevant auxiliary motor and decelerates to the stop frequency. The primary motor reaccelerates when the frequency increases, depending on the feedback increase. If the relevant auxiliary motor is turned off because of the feedback decrease, the primary motor accelerates from the stop frequency to the start frequency.

To use the regular bypass function, '1 (Yes)' has to be selected in the MMC and PID functions. Only FILO operates between the AP1-49 (FIFO/FILO) in a regular bypass function.

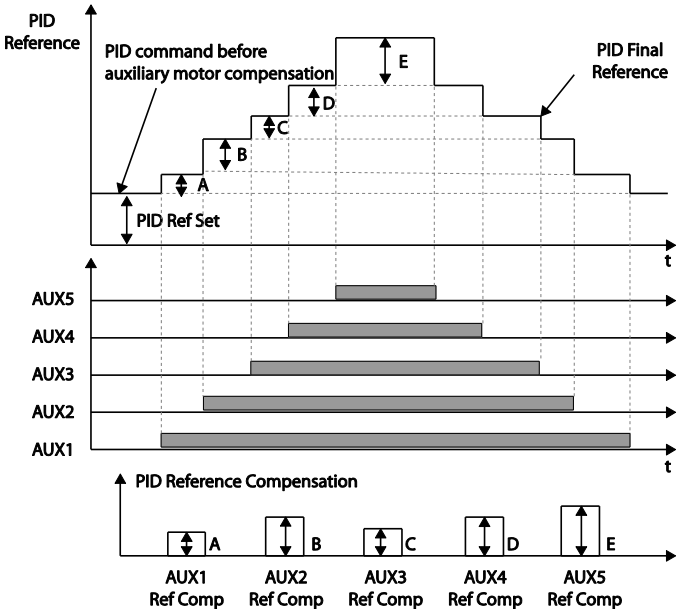


5.44.4 Aux Motor PID Compensation

When the number of operating auxiliary motors increases, the flow rate of the pipe also increases and the pressure of the pipe line decreases. Aux motor PID compensation compensates for this pressure when the number of the auxiliary motor increases. By adding the additional PID reference value (relevant to the auxiliary motor) to the current reference, the loss of pressure can be compensated for.

Auxiliary PID Compensation Detailed Settings

Code	Description
AP1-81–85 Aux 1–5 Ref Comp	Set the relevant PID reference compensation rate whenever the auxiliary motor is turned on. The PID reference can be set over 100%, but when it exceeds 100%, the maximum value of the PID reference is limited to 100%. Unit band value is the value between unit 100%–0%.



< Auxiliary motor PID compensation>

NOTE

When the aux reference value is set to 100%, the final PID reference becomes 100%. In this case, output frequency of the inverter does not decelerate because the PID output does not decelerate even if the input feedback value is 100%.

5.45 Multi-function Output On/Off Control

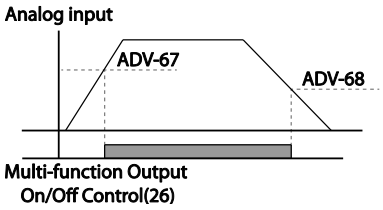
Set reference values (on/off level) for analog input and control output relay or multi-function output terminal on/off status accordingly.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV	66	Output terminal on/off control mode	On/Off Ctrl Src	1	V1	0–6	-
	67	Output terminal on level	On-C Level	90.00		Output terminal off level–100.00%	%
	68	Output terminal off level	Off-C Level	10.00		0.00–Output terminal on level	%
OUT	31	Multi-function relay 1 item	Relay 1	26	On/Off	-	-
	33	Multi-function output 1 item	Q1 Define				

Multi-function Output On/Off Control Setting Details

Code	Description
ADV-66 OnOff Ctrl Src	Select analog input On/Off control.
ADV-67 On Ctrl Level , ADV-68 Off Ctrl Level	Set On/Off level at the output terminal.



5.46 Press Regeneration Prevention

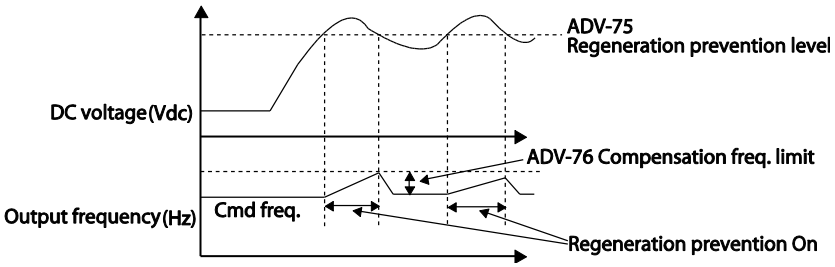
Press regeneration prevention is used during press operations to prevent braking during the regeneration process. If motor regeneration occurs during a press operation, motor operation speed automatically goes up to avoid the regeneration zone.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
ADV	74	Select press regeneration prevention for press	RegenAvd Sel	0	No	0–1	-
	75	Press regeneration prevention operation voltage level	RegenAvd Level	350 V		200 V class: 300–400 V	V
				700 V		400 V class: 600–800 V	
	76	Press regeneration prevention compensation frequency limit	CompFreq Limit	1.00 (Hz)		0.00–10.00 Hz	Hz
	77	Press regeneration prevention P-Gain	RegenAvd Pgain	50.0 (%)		0 .0–100.0%	%
	78	Press regeneration prevention I gain	RegenAvd Igain	500 (ms)		20–30000 ms	ms

Press Regeneration Prevention Setting Details

Code	Description
ADV-74 RegenAvd Sel	Frequent regeneration voltage from a press load during a constant speed motor operation may force excessive stress on the brake unit, which may damage or shorten brake life. To prevent this, select ADV-74 (RegenAvd Sel) to control DC link voltage and disable the brake unit operation.
ADV-75 RegenAvd Level	Set brake operation prevention level voltage when the DC link voltage goes up due to regeneration.
ADV-76 CompFreq Limit	Set an alternative frequency width that can replace actual operation frequency during regeneration prevention.
ADV-77 RegenAvd	To prevent regeneration zone, set P-Gain/I gain in the DC link voltage

Code	Description
Pgain, ADV-78 RegenAvd Igain	suppress PI controller.



Note

Press regeneration prevention does not operate during accelerations or decelerations; it only operates during constant speed motor operation. When regeneration prevention is activated, output frequency may change within the range set at ADV-76 (CompFreq Limit).

5.47 Analog Output

An analog output terminal provides an output of 0–10 V voltage, 4–20 mA current, or 0–32 kHz pulse.

5.47.1 Voltage and Current Analog Output

An output size can be adjusted by selecting an output option at the AO (Analog Output) terminal. Set the analog voltage/current output terminal setting switch (SW5) to change the output type (voltage/current).

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OUT	01	Analog output1	AO1 Mode	0 Frequency	0–15	-
	02	Analog output1 gain	AO1 Gain	100.0	-1000.0–1000.0	%
	03	Analog output1 bias	AO1 Bias	0.0	-100.0–100.0	%
	04	Analog output1 filter	AO1 Filter	5	0–10000	ms
	05	Analog constant output1	AO1 Const %	0.0	0.0–100.0	%
	06	Analog output1 monitor	AO1 Monitor	0.0	0.0–1000.0	%

Voltage and Current Analog Output Setting Details

Code	Description
OUT-01 AO1 Mode	Select a constant value for output. The following example for output voltage setting.

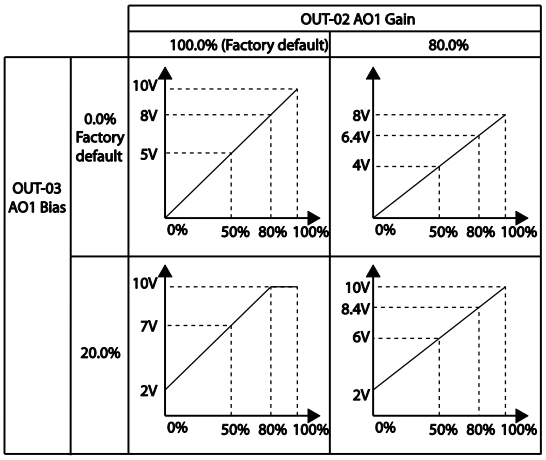
Setting		Function
0	Frequency	Outputs operation frequency as a standard. 10 V output is made from the frequency set at DRV-20 (Max Freq).
1	Output Current	10 V output is made from 150% of inverter rated current.
2	Output Voltage	Sets the outputs based on the inverter output voltage. 10 V output is made from a set voltage in BAS-15 (Rated V). If 0 V is set in BAS-15, 200 V/400 V models output 10 V based on the actual input voltages (240 V and 480 V respectively).
3	DC Link Volt	Outputs inverter DC link voltage as a standard. Outputs 10 V when the DC link voltage is 410 V DC for 200 V models, and 820 V DC for 400 V models.
4	Output Power	Monitors output wattage. 150% of rated output

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td></td><td>
<table>
<tr><td></td><td></td><td>is the maximum display voltage (10 V).</td></tr>
<tr><td>7</td><td>Target Freq</td><td>Outputs set frequency as a standard. Outputs 10 V at the maximum frequency (DRV-20).</td></tr>
<tr><td>8</td><td>Ramp Freq</td><td>Outputs frequency calculated with Acc/Dec function as a standard. May vary with actual output frequency. Outputs 10 V.</td></tr>
<tr><td>9</td><td>PID Ref Value</td><td>Outputs command value of a PID controller as a standard. Outputs approximately 6.6 V at 100%.</td></tr>
<tr><td>10</td><td>PID Fdk Value</td><td>Outputs feedback volume of a PID controller as a standard. Outputs approximately 6.6 V at 100%.</td></tr>
<tr><td>11</td><td>PID Output</td><td>Outputs output value of a PID controller as a standard. Outputs approximately 10 V at 100%.</td></tr>
<tr><td>12</td><td>Constant</td><td>Outputs OUT-05 (AO1 Const %) value as a standard.</td></tr>
<tr><td>13</td><td>EPID1 Output</td><td>Output is based on the output value of the external PID1 controller. Outputs 10 V in 100%.</td></tr>
<tr><td>14</td><td>EPID Ref Val</td><td>Output is based on the reference value of the external PID1 controller. Outputs 6.6 V in 100%.</td></tr>
<tr><td>15</td><td>EPID Fdb Val</td><td>Output is based on the feedback amount of the external PID1 controller. Outputs 6.6 V in 100%.</td></tr>
</table>
</td></tr>
<tr><td>OUT-02 AO1 Gain,
OUT-03 AO1 Bias</td><td>Adjusts output value and offset. If frequency is selected as an output item, it will operate as shown below.

$$AO1 = \frac{Frequency}{MaxFreq} \times AO1\ Gain + AO1\ Bias$$

The graph below illustrates how the analog voltage output (AO1) changes depending on OUT-02 (AO1 Gain) and OUT-3 (AO1 Bias) values. The Y-axis is analog output voltage (0–10 V), and the X-axis is a % value of the output item.

Example, if the maximum frequency set at DRV-20 (Max Freq) is 60 Hz and the present output frequency is 30 Hz, then the x-axis value on the next graph is 50%.</td></tr>
</table>

Code	Description
	
OUT-04 AO1 Filter	Set filter time constant on analog output.
OUT-05 A01 Const %	If the analog output at OUT-01 (AO1 Mode) is set to '12 (Constant)', the analog voltage output is dependent on the set parameter values (0–100%).
OUT-06 AO1 Monitor	Monitors the analog output value. Displays the maximum output voltage as a percentage (%) with 10 V as the standard.

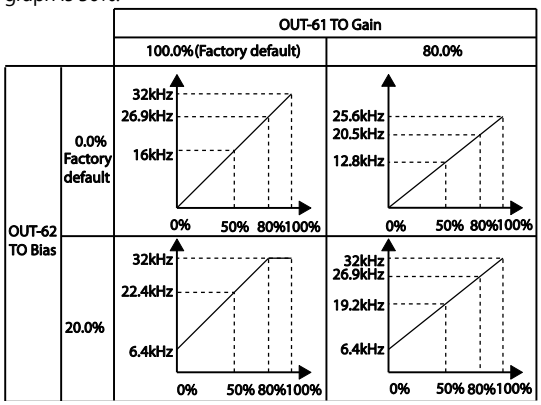
5.47.2 Analog Pulse Output

Output item selection and pulse size adjustment can be made for the TO (Pulse Output) terminal.

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OUT	61	Pulse output setting	TO Mode	0 Frequency	0–15	-
	62	Pulse output gain	TO Gain	100.0	-1000.0–1000.0	-
	63	Pulse output bias	TO Bias	1000.0	-100.0–100.0	-
	64	Pulse output filter	TO Filter	5	0–10000	-

Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
	65	Pulse output constant output2	TO Const %	0.0	0.0–100.0	%
	66	Pulse output monitor	TO Monitor	0.0	0–1000.0	%

Analog Pulse Output Setting Details

Code	Description
OUT-62 TO Gain, OUT-63 TO Bias	Adjusts output value and offset. If frequency is selected as an output, it will operate as shown below. $$TO = \frac{Frequency}{MaxFreq} \times TO\ Gain + TO\ Bias$$ The following graph illustrates that the pulse output (TO) changes depend on OUT-62 (TO Gain) and OUT-63 (TO Bias) values. The Y-axis is an analog output current (0–32 kHz), and X-axis is a % value of the output item. For example, if the maximum frequency set at DRV-20 (Max Freq) is 60 Hz and present output frequency is 30 Hz, then the x-axis value on the next graph is 50%. 
OUT-64 TO Filter	Sets filter time constant on analog output.

Code	Description
OUT-65 TO Const %	If the analog output item is set to constant, the analog pulse output is dependent on the set parameter values.
OUT-66 TO Monitor	Monitors the analog output value. It displays the maximum output pulse (32 kHz). as a percentage (%) of the standard.

NOTE

OUT-08 AO2 Gain and OUT-09 AO2 Bias Tuning Mode on 0–20 mA output

1 Set OUT-07 (AO2 Mode) to 'constant' and set OUT-11 (AO2 Const %) to 0.0 %.

2 Set OUT-09 (AO2 Bias) to 20.0% and then check the current output. 4 mA output should be displayed.

- If the value is less than 4 mA, gradually increase OUT-09 (AO2 Bias) until 4 mA is measured.
- If the value is more than 4 mA, gradually decrease OUT-09 (AO2 Bias) until 4 mA is measured.

3 Set OUT-11 (AO2 Const %) to 100.0%.

4 Set OUT-08 (AO2 Gain) to 80.0% and measure the current output at 20 mA.

- If the value is less than 20 mA, gradually increase OUT-08 (AO2 Gain) until 20 mA is measured.
- If the value is more than 20 mA, gradually decrease OUT-08 (AO2 Gain) until 20 mA is measured.

The functions for each code are identical to the descriptions for the 0–10 V voltage outputs with an output range 4–20 mA.

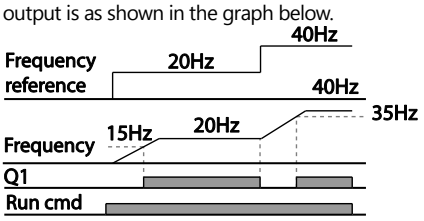
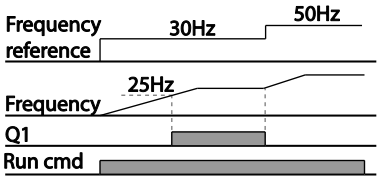
5.48 Digital Output

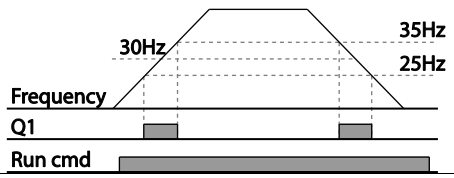
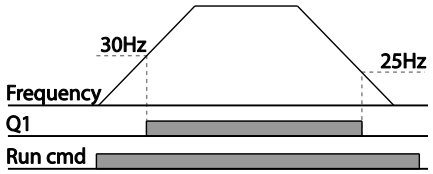
5.48.1 Multi-function Output Terminal and Relay Settings

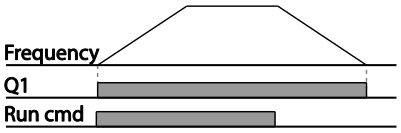
Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OUT	31	Multi-function relay 1 setting	Relay 1	23	Trip	-	-
	32	Multi-function relay 2 setting	Relay 2	14	Run	-	-
	33	Multi-function relay 3 setting	Relay 3	0	None	-	-
	34	Multi-function relay 4 setting	Relay 4	0	None	-	-
	35	Multi-function relay 5 setting	Relay 5	0	None	-	-
	36	Multi-function output setting	Q1 define	0	None	-	-
	41	Multi-function output monitor	DO Status	-		00–11	bit
	57	Detection frequency	FDT Frequency	30.00		0.00–Maximum frequency	Hz
	58	Detection frequency band	FDT Band	10.00			
IN	65–71	Px terminal configuration	Px Define	18	Exchange	-	-

Multi-function Output Terminal and Relay Setting Details

Code	Description
OUT-31–35 Relay1–5	Set relay (Relay 1–5) output options.

Code	Description		
	Setting		Function
	0	None	No output signal
	1	FDT-1	Detects inverter output frequency reaching the user set frequency. Outputs a signal when the absolute value (set frequency–output frequency) < detected frequency width/2. When the detected frequency width is 10 Hz, FDT-1 output is as shown in the graph below. 
	2	FDT-2	Outputs a signal when the user-set frequency and detected frequency (FDT Frequency) are equal, and fulfills FDT-1 condition at the same time. [Absolute value (set frequency-detected frequency) < detected frequency width/2 & FDT-1] Detected frequency width is 10 Hz. When the detected frequency is set to 30 Hz, FDT-2 output is as shown in the graph below. 
	3	FDT-3	Outputs a signal when the Absolute value (output frequency–operation frequency) < detected frequency width/2. Detected frequency width is 10 Hz. When the detected frequency is set to 30 Hz, FDT-3 output is as shown in

Code	Description		
			the graph below. 
	4	FDT-4	The output signal can be separately set for acceleration and deceleration conditions. • **In acceleration:** Operation frequency ≧ Detected frequency • **In deceleration:** Operation frequency > (Detected frequency–Detected frequency width/2) Detected frequency width is 10 Hz. When the detected frequency is set to 30 Hz, FDT-4 output is as shown in the graph below. 
	5	Over Load	Outputs a signal at motor overload.
	6	IOL	Outputs a signal when the inverter input current exceeds the rated current and a protective function is activated to prevent damage to the inverter, based on inverse proportional characteristics.
	7	Under Load	Outputs a signal at load fault warning.
	8	Fan Warning	Outputs a signal at fan fault warning.
	9	Stall	Outputs a signal when a motor is overloaded and stalled.
	10	Over Voltage	Outputs a signal when the inverter DC link voltage rises above the protective operation voltage.

Code	Description		
	11	Low Voltage	Outputs a signal when the inverter DC link voltage drops below the low voltage protective level.
	12	Over Heat	Outputs signal when the inverter overheats.
	13	Lost Command	Outputs a signal when there is a loss of analog input terminal and RS-485 communication command at the terminal block. Outputs a signal when communication power is present and an I/O expansion card is installed. It also outputs a signal when losing analog input and communication power commands.
	14	RUN	Outputs a signal when an operation command is entered and the inverter outputs voltage. No signal output during DC braking. 
	15	Stop	Outputs a signal at operation command off, and when there is no inverter output voltage.
	16	Steady	Outputs a signal in steady operation.
	17	Inverter Line	Outputs a signal while the motor is driven by the inverter line.
	18	Comm Line	Outputs a signal when multi-function input terminal (switching) is entered. For details, refer to *5.31Supply Power Transition* page on *276.*
	19	Speed Search	Outputs a signal during inverter speed search operation. For details, refer to *5.27Speed Search Operation* on page *265.*
	20	Ready	Outputs a signal when the inverter is in stand by mode and ready to receive external operation commands.
	21	MMC	Used as a multi-motor control function. By configuring the relay output and the multi-function output to MMC and configuring the AP1-40–AP1-92, it can conduct the necessary operations for multi-motor control function.
	22	Timer Out	A timer function to operate terminal output after a

Code	Description		
			certain time by using multi-function terminal block input. For details, refer to 5.43*Timer* Settings on page 291.
	23	Trip	Outputs a signal after a fault trip. Refer to *5.45 Multi-function Output On/Off Control* on page *314* .
	25	DB Warn %ED	Refer to 0_ Dynamic Braking (DB) Resistor Configuration on page 358.
	26	On/Off Control	Outputs a signal using an analog input value as a standard. Refer to *5.45 Multi-function Output On/Off Control* on page *314* .
	27	Fire Mode	Outputs a signal when Fire mode is in operation.
	28	Pipe Break	Outputs a signal when a pipe is broken.
	29	Damper Err	Outputs a signal when damper open signal is not entered. For more details, refer to *0 Damper* Operation on page *211.*
	30	Lubrication	Outputs a signal when a lubrication function is in operation.
	31	PumpClean Sel	Outputs a signal when a pump cleaning function is in operation.
	32	LDT Trip	Outputs a signal when an LDT trip occurs.
	33	Damper Control	Outputs a signal when a damper open signal is set at IN-65–71 multi-function terminals and run command is on.
	34	CAP.Warning	Outputs a signal when value of the PRT-85 is lower than the value of the PRT-86 (CAP life cycle examination do not operate properly).
	35	Fan Exchange	Outputs a signal when fan needs to be replaced.
	36	AUTO State	Outputs a signal in AUTO mode.
	37	HAND State	Outputs a signal in HAND mode.
	38	TO	Outputs a signal at pulse output.
	39	Except Date	Outputs a signal when operating the exception day schedule.
	40	KEB Operating	Outputs a signal at KEB operation.

Code	Description
OUT-36 Q1 Define	Select an output item for the multi-function output terminal (Q1) of the terminal block. Q1 stands for the open collector TR output.
OUT-41 DO State	Used to check On/Off state of the D0 by each bit.

ⓘ Caution

- FDT-1 and FDT-2 functions are related to the frequency setting of the inverter. If the inverter enters standby mode by pressing the off key during auto mode operation, FDT-1 and FDT-2 function operation may be different because the set frequency of the inverter is different compared to the set frequency of the auto mode.
- If monitoring signals such as 'Under load' or' LDT' are configured at multi-function output terminals, signal outpouts are maintained unless certain conditions defined for signal cutoff are met.

5.48.2 Fault Trip Output using Multi-function Output Terminal and Relay

The inverter can output a fault trip state using the multi-function output terminal (Q1) and relay (Relay 1).

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
OUT	30	Fault trip output mode	Trip Out Mode	010		-	bit
	31	Multi-function relay 1	Relay 1	23	Trip	-	-
	32	Multi-function relay 2	Relay 2	14	Run	-	-
	33	Multi-function relay 3	Relay 3	0	none	-	
	34	Multi-function relay 4	Relay 4	0	none	-	
	35	Multi-function relay 5	Relay 5	0	none	-	
	36	Multi-function output1	Q1 Define	0	none	-	-
	53	Fault trip output on delay	TripOut OnDly	0.00		0.00–100.00	sec
	54	Fault trip output off delay	TripOut OffDly	0.00		0.00–100.00	sec

Fault Trip Output by Multi-function Output Terminal and Relay - Setting Details

Code	Description
OUT-30 Trip Out Mode	Fault trip relay operates based on the fault trip output settings. Item: Keypad display — bit on:  — bit off:  Select a fault trip output terminal/relay and select '29' (Trip Mode) at codes OUT- 31–33. When a fault trip occurs in the inverter, the relevant terminal and relay will operate. Depending on the fault trip type, terminal and relay operation can be configured as shown in the table below. Setting | Function

Code	Description			
	bit3	bit2	bit1	
			✓	Operates when low voltage fault trips occur
		✓		Operates when fault trips other than low voltage occur
	✓			Operates when auto restart fails (PRT-08–09)
OUT-31–35 Relay1–5	Set relay output (Relay 1–5).			
OUT-36 Q1 Define	Select output for multi-function output terminal (Q1). Q1 is open collector TR output.			

5.48.3 Multi-function Output Terminal Delay Time Settings

Set on-delay and off-delay times separately to control the output terminal and relay operation times. The delay time set at codes OUT-50–51 applies to multi-function output terminal (Q1) and relay, except when the multi-function output function is in fault trip mode.

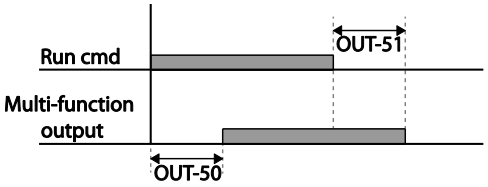
Group	Code	Name	LCD Display	Parameter Setting	Setting Range	Unit
OUT	50	Multi-function output On delay	DO On Delay	0.00	0.00–100.00	sec
	51	Multi-function output Off delay	DO Off Delay	0.00	0.00–100.00	sec
	52	Select multi-function output terminal	DO NC/NO Sel	000000*	00–11	bit

*Multi-function output terminals are numbered. Starting from the right (number 1), the number increases to the left.

Output Terminal Delay Time Setting Details

Code	Description
OUT-50 DO On Delay	When a relay operation signal (operation set in OUT 31–35, 36) occurs, the relay turns on or the multi-function output operates after the time delay set at OUT-50.

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>OUT-51 DO Off Delay</td><td>When relay or multi-function output is initialized (off signal occurs), the relay turns off or multi-function output turns off after the time delay set at OUT-54.</td></tr>
<tr><td>OUT-52 DO NC/NO Sel</td><td>Select the terminal type for the relay and multi-function output terminal. By setting the relevant bit to '0,' it will operate A terminal (Normally Open). Setting it to '1' will operate B terminal (Normally Closed). Shown below in the table are Relay 1–5 and Q1 settings starting from the right bit.
<table>
<tr><td>Item</td><td>bit on</td><td>bit off</td></tr>
<tr><td>Keypad display</td><td></td><td></td></tr>
</table>
</td></tr>
</table>



5.49 Operation State Monitor

The inverter's operation condition can be monitored using the keypad. If the monitoring option is selected in config (CNF) mode, a maximum of four items can be monitored simultaneously. Monitoring mode displays three different items on the keypad, but only one item can be displayed in the status window at a time.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	20	Display item condition display window	AnyTime Para	0	Frequency	-	-
	21	Monitor mode display 1	Monitor Line-1	0	Frequency	-	Hz
	22	Monitor mode	Monitor Line-	2	Output	-	A

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
		display 2	2		Current		
	23	Monitor mode display 3	Monitor Line-3	3	Output Voltage	-	V
	24	Monitor mode initialize	Mon Mode Init	0	No	-	-

Operation State Monitor Setting Details

<table>
<tr><th>Code</th><th>Description</th></tr>
<tr><td>CNF-20 AnyTime Para</td><td>Select items to display on the top-right side of the keypad screen. Choose the parameter settings based on the information to be displayed. Codes CNF-20–23 share the same setting options as listed below.
<table>
<tr><td colspan="2">Setting</td><td>Function</td></tr>
<tr><td>0</td><td>Frequency</td><td>On stop, displays the set frequency. During operation, displays the actual output frequency (Hz).</td></tr>
<tr><td>1</td><td>Speed</td><td>On stop, displays the set speed (rpm). During operation, displays the actual operating speed (rpm).</td></tr>
<tr><td>2</td><td>Output Current</td><td>Displays output current.</td></tr>
<tr><td>3</td><td>Output Voltage</td><td>Displays output voltage.</td></tr>
<tr><td>4</td><td>Output Power</td><td>Displays output power.</td></tr>
<tr><td>5</td><td>WHour Counter</td><td>Displays inverter power consumption.</td></tr>
<tr><td>6</td><td>DCLink Voltage</td><td>Displays DC link voltage within the inverter.</td></tr>
<tr><td>7</td><td>DI Status</td><td>Displays input terminal status of the terminal block. Starting from the right, displays P1–P8.</td></tr>
<tr><td>8</td><td>DO Status</td><td>Displays output terminal status of the terminal block. Starting from the right: Relay1, Relay2, and Q1.</td></tr>
<tr><td>9</td><td>V1 Monitor[V]</td><td>Displays the input voltage value at terminal V1 (V).</td></tr>
<tr><td>10</td><td>V1 Monitor[%]</td><td>Displays input voltage terminal V1 value as a percentage. If -10 V, 0 V, +10 V is measured, -100%, 0%, 100% will be displayed.</td></tr>
<tr><td>13</td><td>V2 Monitor[V]</td><td>Displays input voltage terminal V2 value (V).</td></tr>
<tr><td>14</td><td>V2 Monitor[%]</td><td>Displays input voltage terminal V2 value as a percentage.</td></tr>
</table></td></tr>
</table>

Code	Description		
	15	I2 Monitor[mA]	Displays input current terminal I2 value (A).
	16	I2 Monitor[%]	Displays input current terminal I2 value as a percentage.
	17	PID Output	Displays the PID controller output.
	18	PID Ref Value	Displays the PID controller reference value.
	19	PID Fdb Value	Displays the PID controller feedback volume.
	20	EPID1 Mode	Displays the External PID1 mode.
	21	EPID1 Output	Displays the External PID1output value.
	23	EPID1 Ref Val	Displays the External PID1 reference value.
CNF-21–23 Monitor Line-x	Select the items to be displayed in monitor mode. Monitor mode is the first mode displayed when the inverter is powered on. A total of three items, from monitor line-1 to monitor line- 3, can be displayed simultaneously.		
CNF-24 Mon Mode Init	Selecting '1 (Yes)' initializes CNF-20–23.		

Note

Inverter power consumption

Values are calculated using voltage and current. Electric power is calculated every second and the results are accumulated. Setting CNF-62 (WH Count Reset) value to '1 (Yes)' will reset cumulated electric energy consumption. Power consumption is displayed as shown below:

- Less than 1,000 kW: Units are in kW, displayed in 999.9 kW format.
- 1–99 MW: Units are in MW, displayed in 99.99 MWh format.
- 100–999 MW: Units are in MW, displayed in 999.9 MWh format.
- More than 1,000 MW: Units are in MW, displayed in 9,999 MWh format and can be displayed up to 65,535 MW. (Values exceeding 65,535 MW will reset the value to 0, and units will return to kW. It will be displayed in 999.9 kW format).

5.50 Operation Time Monitor

This feature is used to monitor the inverter and fan operation times.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
CNF	70	Cumulated inverter power-on time	On-time	0/00/00 00: 00		-	min
	71	Cumulated inverter operation time	Run-time	0/00/00 00: 00		-	min
	72	Inverter operation accumulated time initialization	Time Reset	0	No	0–1	-
	74	Cooling fan operation accumulated time	Fan time	0/00/00 00: 00		-	min
	75	Cooling fan operation accumulated time initialization	Fan Time Reset	0	No	0–1	-

Operation Time Monitor Setting Details

Code	Description
CNF-70 On-time	Displays accumulated power supply time. Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-71 Run-time	Displays accumulated time of voltage output by operation command input. Information is displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-72 Time Reset	Setting '1 (Yes)' will delete the power supply accumulated time (On-time) and operation accumulated time (Run-time) and is displayed as 0/00/00 00: 00 format.
CNF-74 Fan time	Displays accumulated time of the inverter cooling fan operation. Information will be displayed in [YY/MM/DD Hr: Min (0/00/00 00: 00)] format.
CNF-75 Fan Time Reset	Setting '1 (Yes)' will delete the cooling fan operation accumulated time (on-time) and operation accumulated time (Run-time) and will display it in 0/00/00 00: 00 format.

5.51 PowerOn Resume Using the Serial Communication

If there is a run command when recovering the power after instantaneous power interruption using serial communication (Serial Communication [BAC net, LonWorks, Modbus RTU]), the inverter carries out the run command which was set before the instantaneous power interruption.

Group	Code	Name	LCD Display	Parameter Setting		Setting Range	Unit
COM	96	Automatic restart of the communication restart	PowerOn Resume	0	No	0–1	-

Caution

- If proper communication is unavailable after the instantaneous power interruption, even if the COM-96 PowerOn Resume function is set to 'Yes,' do not operate the inverter.
- The Power-on Run function operates separately (Power-on Run function and PowerOn Resume function is set to 'Yes' and power turns off and turns on, inverter maintains for the time set in Power-on run function and then, by the Power On Resume function, if the inverter is in operation by the communication command before the power interruptions, the inverter is in operation after the power recovery.)