



FRENIC-HVAC

Addendum

This is an update to the standard HVAC Instruction and User's Manuals.

Overview

The HVAC special version (UP) for H-PAQ adds a number of additional functions for pump control. This addendum details this new functionality and the related function code settings. The special version also removes one function code (J198) that is available on the standard HVAC series drives. The function codes that have been added to the HVAC special version are listed in the following tables for reference. Detailed information on the configuration of these function code settings is provided in the subsequent pages. Refer to the FRENIC-HVAC User's Manual for a complete listing of all other available function codes.

■ Related Documentation

- FRENIC-HVAC User's Manual
- FRENIC-HVAC Instruction Manual

These materials are subject to change without notice. You should make sure that you obtain the latest editions for use.

■ Safety Precautions

Read the FRENIC-HVAC Instruction Manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Function Code Tables

E codes: Extension Terminal Functions

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|---|--|---------------------|--------------|-----------------|--------------|
| E82 | Switching Frequency of Accel/Decel Time in Low-Speed Domain | Inherit: Follow the setting of F16 0.1 to 120.0 Hz | Y | Y | Inherit | 6 |
| E83 | Acceleration Time in Low-Speed Domain | Inherit: Follow the current acceleration time 0.01 to 3600.00 s: Acceleration time from 0 Hz to E82 | Y | Y | Inherit | |
| E84 | Deceleration Time in Low-Speed Domain | Inherit: Follow the current deceleration time 0.01 to 3600.00 s: Deceleration time from E82 to 0 Hz | Y | Y | Inherit | |
| E85 | Gradual Deceleration Time Switching Frequency | OFF: Disable 0.1 to 120.0 Hz | Y | Y | OFF | 7 |
| E86 | Gradual Deceleration Time (Check valve protection) | Inherit: Follow the current deceleration time 0.01 to 3600.00 s: Deceleration time from E82 to E85 | Y | Y | Inherit | |

J1 codes: PID Control 1

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|---------------------------------|---|---------------------|--------------|-----------------|--------------|
| J143 | Boost Function (Mode selection) | 0: Disable (disabled at the time of initiation) 1: Enable ("enabled at the time of initiation" plus "only at the time of PID control") 2: Enable (always enabled at the time of initiation) 3: Enable ("only first initiation with power ON" plus "only at the time of PID control") 4: Enable (only at the time of first initiation with power ON) | Y | Y | 0 | 8 |
| J144 | (Operation frequency) | Inherit: Maximum frequency 0.1 to 120.0 Hz | Y | Y | Inherit | |
| J145 | (Acceleration time) | Inherit: Follow the currently effective acceleration time 0.01 to 3600 s * The acceleration time should be from 0 Hz to F _{max} . | Y | Y | Inherit | |
| J146 | (Operation time) | 0.0 to 3600.0 s * Specify the time including acceleration time. * 0.0 Time period while the boost command BST is ON (When BST is not used, this is used as the time until the operation frequency is reached.) | Y | Y | 0.0 | |
| J147 | (Cancel PV level) | OFF: Disable -999.00 to 0.00 to 9990.00 *6 | Y | Y | OFF | |

*6 The upper and lower level values are restricted by the maximum and minimum scales.

J codes: PID Control 1 (cont.)

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|---|---|---------------------|--------------|-----------------|--------------|
| J168 | Control of Maximum Starts Per Hour (Input selection) | 0: Disable 1: Alarm 2: Warning output | Y | Y | 0 | 11 |
| J169 | (Number of slow flowrate stop detections) | 1 to 10 | Y | Y | 1 | |
| J176 | Dry Pump Protection (Input selection) | 0: Disable 1: Alarm 2: Warning output | Y | Y | 0 | 12 |
| J177 | (Detection current) | OFF: Disable 1% to 150% of the inverter rated current | Y | Y | OFF | |
| J178 | (Deviation) | OFF: Disable 0.01 to 9990.00 *6 | Y | Y | OFF | |
| J179 | (Flowrate sensor) | 0: Disable 1: Enable | Y | Y | 0 | |
| J180 | (Detection timer) | 0 to 600s | Y | Y | 0 | |
| J182 | End of Curve Protection (Input selection) | 0: Disable 1: Alarm 2: Warning output | Y | Y | 0 | 14 |
| J183 | (Detection current) | 0.00: Disable 1% to 150% of the inverter rated current | Y | Y | OFF | |
| J184 | (Deviation) | 0.00: Disable 0.01 to 9990.00 *6 | Y | Y | OFF | |
| J185 | (Flowrate sensor) | 0: Disable 1: Enable | Y | Y | 0 | |
| J186 | (Detection timer) | 0 to 600s | Y | Y | 0 | |

J2 codes: PID Control 2

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|---------------------------------------|--|---------------------|--------------|-----------------|--------------|
| J247 | Boost Function (Cancel PV level) | OFF: Disable -999.00 to 0.00 to 9990.00 *6 | Y | Y | OFF | 15 |
| J276 | Dry Pump Protection (Input selection) | 0: Disable 1: Alarm 2: Warning output | Y | Y | 0 | 16 |
| J277 | (Detection current) | OFF: Disable 1% to 150% of the inverter rated current | Y | Y1 | OFF | |
| J278 | (Deviation) | OFF: Disable 0.01 to 9990.00 *6 | Y | Y | OFF | |
| J279 | (Flowrate sensor) | 0: Disable 1: Enable | Y | Y | 0 | |
| J280 | (Detection timer) | 0 to 600s | Y | Y | 0 | |

*6 The upper and lower level values are restricted by the maximum and minimum scales.

J4 codes: Pump APP Functions

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|--|--|---------------------|--------------|-----------------|--------------|
| J401 | Pump Control Mode Selection | 0: Disable 1: Enable (Inverter drive motor fixed system, judged by MV) 2: Enable (Inverter drive motor floating system, judged by MV) 3: Enable (Inverter drive motor floating + commercial power-driven motor system, judged by MV) 11 Enable (Inverter drive motor fixed system, judged by output frequency) 12 Enable (Inverter drive motor floating system, judged by output frequency) 13 Enable (Inverter drive floating + commercial power-driven motor system, judged by output frequency) 52: Enable (Communications-linked inverter drive motor floating system) 54: Enable (Communications-linked all motors simultaneous PID control system) | N | Y | 0 | 37 |
| J402 | Communication Master/Slave Selection | 0: Communication master inverter 1: Communication slave inverter | N | Y | 1 | 39 |
| J403 | Number of Slaves | 1 or 2 units * Set for a master only. | N | Y | 1 | 39 |
| J404 | Master Input Permeation Selection | 0000H to 01FFH (hexadecimal) Bit 0: FWD Bit 1: REV Bit 2: X1 Bit 3: X2 Bit 4: X3 Bit 5: X4 Bit 6: X5 Bit 7: X6 Bit 8: X7 * The inverter sends the master terminal input info to the slave. * The slave stores the received data to S06 after masking. | N | Y | 0 | 39 |
| J411 | Motor 1 Mode Selection | 0: Disable (off at all times) 1: Enable 2: Forced drive ON (forced commercial power drive) | Y | Y | 0 | 40 |
| J412 | Motor 2 Mode Selection | | | | | |
| J413 | Motor 3 Mode Selection | | | | | |
| J414 | Motor 4 Mode Selection | | | | | |
| J415 | Motor 5 Mode Selection | | | | | |
| J416 | Motor 6 Mode Selection | | | | | |
| J417 | Motor 7 Mode Selection | | | | | |
| J418 | Motor 8 Mode Selection | | | | | |
| J425 | Motor Switching Procedure | 0: Fixing procedure 1: Equal operating time (Cumulative run time of each motor is equalized.) 2: Fixing procedure (Switching the motor at slow flowrate stop) 3: Equal operating time (Switching the motor at slow flowrate stop.) | N | Y | 0 | 41 |
| J430 | Stop of Commercial Power-driven Motors | 0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run | Y | Y | 0 | 42 |
| J435 | Motor Regular Switching Mode Selection | 1: Inverter-driven pumps are subject to switching. 2: Commercial power-driven pumps are subject to switching. 3: All pumps (inverter-driven pumps/commercial power-driven pumps) are subject to switching. | Y | Y | 1 | 44 |
| J436 | Motor Regular Switching Time | OFF: Disable 0.1 to 720.0 h: Enable: (Switching time) Test: Enable (Switching time fixed at three minutes) | Y | Y | OFF | |

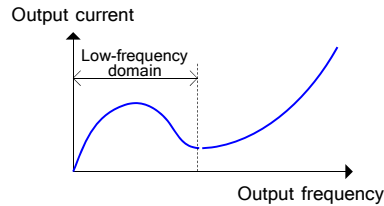
J4 codes: Pump APP Functions (cont.)

| Code | Name | Data setting range | Change when running | Data copying | Default setting | Related page |
|------|--|---|---------------------|--------------|-----------------|--------------|
| J437 | Motor Regular Switching Signal Output Time | 0.00 to 600.00 s Signal output time | Y | Y | 0.10 | 44 |
| J450 | Motor Increase Judgment (Judgment frequency) | Inherit: Depends on J118 0 to 120 Hz | Y | Y | Inherit | 48 |
| J451 | (Duration time) | 0.00 to 3600.00 s | Y | Y | 0.00 | |
| J452 | Motor Decrease Judgment (Judgment frequency) | Inherit: Depends on J119 0 to 120 Hz | Y | Y | Inherit | 49 |
| J453 | (Duration time) | 0.00 to 3600.00 s | Y | Y | 0.00 | |
| J454 | Contacting Restart Time when Switching the Motor | 0.01 to 2.00 s | Y | Y | 0.10 | 49 |
| J455 | Motor Increase Switching Time (Deceleration time) | Inherit: Depends on F08 0.01 to 3600.00 s | Y | Y | Inherit | 50 |
| J456 | Motor Increase Switching Level | 0 to 100% | Y | Y | 0 | |
| J457 | Motor Increase PID Control Start Frequency | Inherit: Depends on J452 0 to 120 Hz | Y | Y | Inherit | |
| J458 | Motor Decrease Switching Time (Acceleration time) | Inherit: Depends on F07 0.01 to 3600.00 s | Y | Y | Inherit | 51 |
| J459 | Motor Decrease Switching Level | Inherit: Depends on J456 0 to 100% | Y | Y | Inherit | |
| J460 | Motor Decrease PID Control Start Frequency | Inherit: Depends on J450 0 to 120 Hz | Y | Y | Inherit | 51 |
| J461 | Motor Increase/Decrease Switching Judgment Non-responsive Area Width | OFF: Disable 0.1 to 50.0% | Y | Y | OFF | 52 |
| J462 | Failure Inverter Judgment Time | OFF, 0.5 to 600.0 s | Y | Y | 5.0 | 52 |
| J465 | Auxiliary Motor (Frequency operation level) | OFF: Disable 0.1 to 120.0 Hz | Y | Y | 60.0 | 53 |
| J466 | (Hysteresis width) | 0.0 to 120.0 Hz | Y | Y | 1.0 | 53 |
| J467 | (PV operation level) | OFF: Disable | Y | Y | OFF | 54 |
| J468 | (Connection timer) | 0.00 to 2.00 s | Y | Y | 0.00 | |
| J469 | (Interrupting timer) | 0.00 to 2.00 s | Y | Y | 0.00 | |
| J480 | Motor Cumulative Run Time (Motor 0) | 0 to 65535 For adjustment at the replacement time | Y | N | 0 | 55 |
| J481 | (Motor 1) | | | | | |
| J482 | (Motor 2) | | | | | |
| J483 | (Motor 3) | | | | | |
| J484 | (Motor 4) | | | | | |
| J485 | (Motor 5) | | | | | |
| J486 | (Motor 6) | | | | | |
| J487 | (Motor 7) | | | | | |
| J488 | (Motor 8) | | | | | |
| J490 | Y Terminal ON Maximum Cumulation Count (Y1 Y2) | 0.000 to 9999 (The display of "1.000" indicates 1000 times.) | Y | N | 0.000 | 56 |
| J491 | (Y3 Y4) | | | | | |
| J492 | Relay ON Maximum Cumulation Count (Y5A 30AB) | | | | | |
| J493 | (Y6RY to Y12RY) | | | | | |

E82,
E83,
E84

**Switching Frequency of Accel/Decel Time in Low-Speed Domain,
Acceleration Time in Low-Speed Domain,
Deceleration Time in Low-Speed Domain**

In low-speed domain, driving a pump motor whose load current is large (e.g., deep well pump) for a long time may damage the motor. Large load current and slow flowrate burn the pump motor. To prevent it, the inverter provides the acceleration/deceleration time exclusive to the low-speed domain and avoids a long run in that domain.



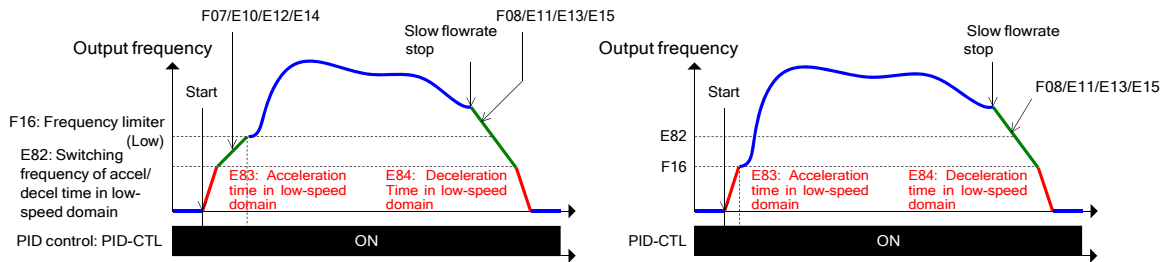
From the start (0 Hz) to the frequency switching point (E82), the acceleration time in low-speed domain (E83) applies. After the output frequency reaches the switching point (E82), the currently selected acceleration time (F07/E10/E12/E14) applies. At the time of stoppage, from the frequency switching point (E82) to 0 Hz, the deceleration time in low-speed domain (E84) applies.

This function works also in reverse operation for anti-jam and during PID control being canceled.

This function does not work in the domain exceeding the low frequency limit specified by F16. The default of F16 is 0.0 Hz so that this function does not work by default independent of the E82 setting. To use this function, therefore, increase the F16 setting to a value greater than E82 setting.

F16 (Frequency limiter (Low)) > E82

F16 (Frequency limiter (Low)) ≤ E82



■ Switching frequency of accel/decel time in low-speed domain (E82)

E82 specifies the switching frequency (frequency switching point).

| Data for E82 | Switching frequency |
|-----------------|---|
| Inherit | Follow the setting of F16 (Frequency limiter (Low)) |
| 0.1 to 120.0 Hz | Arbitrary value within the range of 0.1 to 120.0 Hz |

■ Acceleration time in low-speed domain (E83)

E83 specifies the acceleration time from the start (0 Hz) to the frequency switching point (E82). (When $F16 \leq E82$, from 0 Hz to the F16 setting)

- Data setting range: Inherit (Currently selected acceleration time), 0.01 to 3600.00 (s)

■ Deceleration time in low-speed domain (E84)

E84 specifies the deceleration time from the frequency switching point (E82) to 0 Hz. (When $F16 \leq E82$, from the F16 setting to 0 Hz)

- Data setting range: Inherit (Currently selected deceleration time), 0.01 to 3600.00 (s)

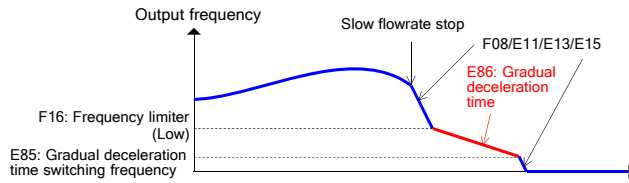
E85, E86**Gradual Deceleration Time Switching Frequency (Check valve protection), Gradual Deceleration Time**

A rapid check valve closure following a pump stop may break check valves (piping, pump and valves) due to a water hammer event. To protect check valves, the inverter provides the gradual deceleration time for gradually decreasing the pump motor speed at the time of check valve closure.

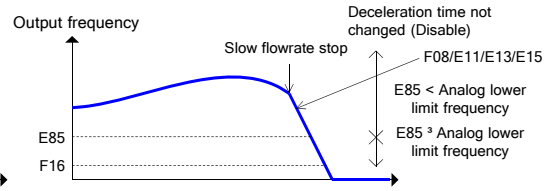
This function works when $E85 \neq \text{OFF}$. Note that when $F16$ (Frequency limiter (Low)) $\leq E85$ (Gradual deceleration time switching frequency), this function does not work.

This function works also during PID control being canceled.

$F16$ (Frequency limiter (Low)) $> E85$



$F16$ (Frequency limiter (Low)) $\leq E85$ (Disable)



■ Gradual deceleration time switching frequency (E85)

E85 specifies the switching frequency (frequency switching point).

| Data for E85 | Switching frequency |
|-----------------|---|
| OFF | Disable |
| 0.1 to 120.0 Hz | Arbitrary value within the range from 0.1 to 120.0 Hz |

■ Gradual deceleration time (E86)

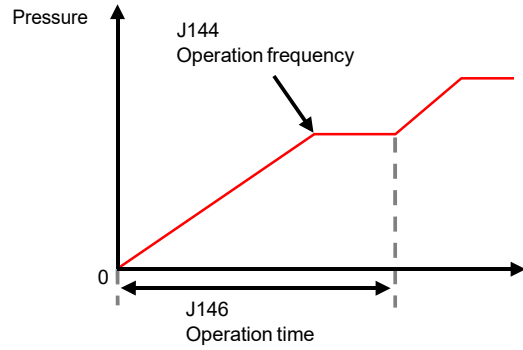
E86 specifies the gradual deceleration time from the F16 setting (Frequency limiter (Low)) to the frequency switching point (E85).

- Data setting range: Inherit (Currently selected deceleration time), 0.01 to 3600.00 (s)

| | |
|---|---|
| J143 J144 J145 J146 J147 | Boost Function (Mode selection) (Operation frequency) (Acceleration time) (Operation time) (Cancel PV level) J247 (Boost Function (Cancel PV level)) |
|---|---|

This can be used for a pump system which needs pressurization for a certain period of time at the time of initiation.

You can set an operation frequency, operation time, and acceleration time to be followed at the time of initiation, so that the optimum operation for pump initiation is resulted.




■ Boost function (Mode selection) (J143)

Select operations conditions for the boost function. The selectable boot conditions include boost command "BST" ON, operation at the time of initiation, and operation at the time of power ON.

- Data setting range: 0 to 4

| Data for J143 | Operation description |
|---------------|--|
| 0 | Disable (disabled at the time of initiation) * When boost command "BST" is ON, the boost function operates. |
| 1 | Enable ("enabled at the time of initiation" plus "only at the time of PID control") |
| 2 | Enable (always enabled at the time of initiation) |
| 3 | Enable ("only first initiation with power ON" plus "only at the time of PID control") |
| 4 | Enable (only at the time of first initiation with power ON) |

 For boost commands, refer to the description about boost command BST (function codes E01 to E07, data = 130)

■ Boost function (operation frequency) (J144)

Select an operation frequency to be used when the boost function is ON.

- Data setting range: 0.1 to 120.0 (Hz)

Inherit: Maximum frequency

■ Boost function (acceleration time) (J145)

You can set acceleration time only for the boost function. As the acceleration time, set time to be taken from 0 to the maximum frequency. (Note that this is not the time to be taken until J144 is reached.)

- Data setting range: 0.01 to 3600.00 (s)

Inherit: The currently effective acceleration time is followed.

■ Boost function (operation time) (J146)

You can set how long the boost function is to be operated.

- Data setting range: 0.1 to 3600.00 (s)

0.0 Time period while the boost command BST is ON

(When BST is not used, this is used as the time until the operation frequency (J144) is reached.)

■ Boost function (cancel PV level) (J147, J247)

Set a PV level (feedback value) for cancelling the boost function during operation. Settable physical quantity conforms to display unit and scale.

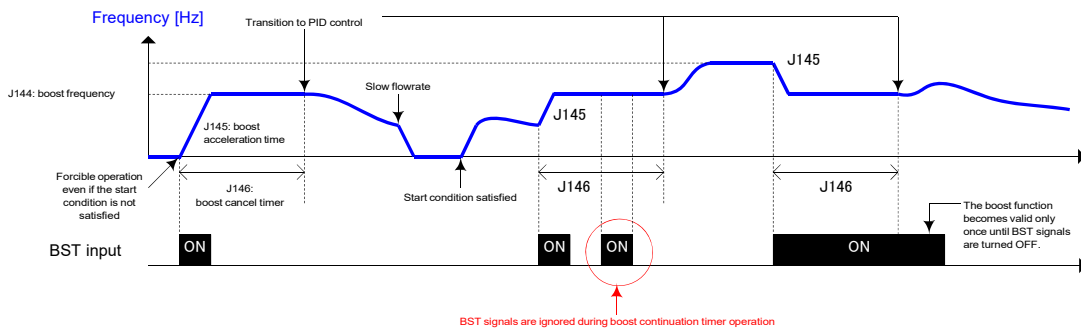
- Data setting range: -999.00 to 0.00 to 9990.00, OFF (Disable)

* The boost function is canceled when the condition in 1) or 2) below is satisfied.

- 1) The set operation time (J146) elapses.
- 2) The cancel PV level (J147, J247) is reached.

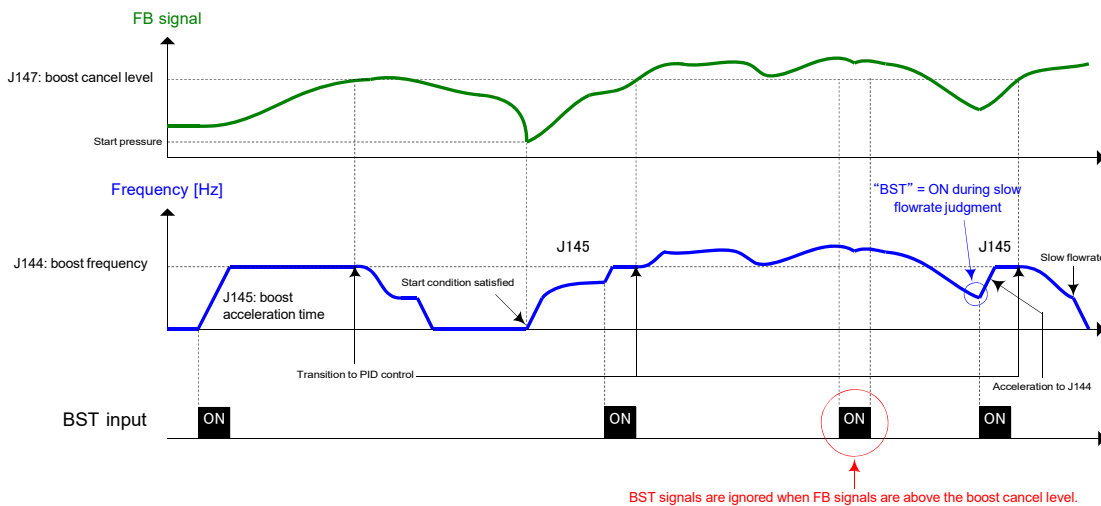
- Note**
- When the run command is OFF (stop), turning BST ON does not cause the boost function to operate.
 - In a case where inverter alarm is generated while the boost function is operating (J143: data 3/4 selection), the boost function operates at the time of re-initiation after cancel of the alarm. Similarly, in a case where the boost function is interrupted for reasons such as run command OFF, free run command ON, and instantaneous power failure, the boost function operates at the time of re-initiation. (The boost function is used for re-initiation because air may still exist in the pipe in a case where avoidance of abnormal pressure increase was intended.)

J146: Boost function cancel example regarding the operation time



Operation time cancel example regarding the boost function with "J1-43 = 1" (BST command is followed) selected

J147: Boost function cancel example regarding the PV level



PV cancel example regarding the boost function with "J1-43 = 1" (BST command is followed) selected

**J168
J169**

**Control of Maximum Starts per Hour (motor)
(Input selection)
(Number of slow flowrate stop detections)**

This detects frequent occurrence of start and slow flowrate stop due to the failure of accumulators or other equipment. As for the inverter, it is possible to select whether operation is to be stopped with alarm or operation is to be continued with warning being output.

If the number of initiations exceeds the number of slow flowrate stop detections (J169) within the number-of-detection clearing time (J170), the control of maximum starts per hour (motor) becomes active in a short period of time.

■ Control of maximum starts per hour (motor) (Input selection) (J168)

J168 specifies the protection mode for control of the maximum starts per hour.

- Data setting range: 0 to 2

| Data for J168 | Operation description |
|---------------|---|
| 0 | Disable |
| 1 | Alarm (inverter stop with roC trip) * After alarm is canceled, Control of maximum starts per hour (motor) is started when the first slow flowrate stop occurs. |
| 2 | Warning output * After warning is canceled, Control of maximum starts per hour (motor) is started when the first slow flowrate stop occurs. |

📖 Operations regarding control of maximum starts per hour can be monitored from external equipment, by assigning **L-ALM** ("Light alarm") to any of [Y1] to [Y4], [Y5A/C] and [30A/B/C]. (E20 to E24 and E27, data = 98)

■ Control of maximum starts per hour (motor) (Number of slow flowrate stop detections) (J169)

Set the number of stops as a detection condition.

- Data setting range: 1 to 10

The number of slow flowrate stop detections (J169) is cleared when one of the following conditions is satisfied.

- When a set period of time has elapsed
- When the run command is OFF (stop)
- When PID control cancel is performed
- When alarm is generated

| | | |
|------|--|--|
| J176 | Dry Pump Protection (Input selection) | J276 (Dry Pump Protection (Input selection)) |
| J177 | (Detection current) | J277 (Dry Pump Protection (Detection current)) |
| J178 | (Deviation) | J278 (Dry Pump Protection (Deviation)) |
| J179 | (Flowrate sensor) | J279 (Dry Pump Protection (Flowrate sensor)) |
| J180 | (Detection timer) | J280 (Dry Pump Protection (Detection timer)) |

The drought status of a water receiving tank, deep well, and others can be detected. Drought status is detected, based on output frequencies, output current, flowrate sensor values, and PID deviation values.

Pressure decrease attributing to factors such as water leakage and impeller damage also can be detected. As for the inverter, it is possible to select whether operation is to be stopped with alarm or operation is to be continued with warning being output.

Dry pump protection becomes active when all of the conditions in (1) to (4) are satisfied and the detection timer (J180, J280) setting time elapses. Set PID control 1 with function codes J176 and J180 and PID control 2 with function codes J276 and J280.

<Detection condition>

- (1) Output frequency detection
 "Output frequency \geq upper limiter"
 (F03, F15, J1/2-18, E61 to E63 = 13: lowest frequency among upper limit frequencies)
 * When drought occurs, the output frequency is kept at the upper limiter during operations because the pressure drops.
- (2) Current detection
 Output current < dry pump protection (detection current) (J177, J277)
 * When drought occurs, decrease of output current is detected due to pump load reduction caused by water volume reduction.
- (3) Deviation detection
 "Feedback value (PV) < PID control command value (SV) - deviation (J178, J278)"
 * When drought occurs, feedback values (PV) decrease because the inlet contacts air.
- (4) Flowrate sensor
 "Flowrate sensor = OFF status"
 * When drought occurs, the flowrate sensor is turned OFF due to water volume reduction.


Note As for the conditions in (1) to (4), those with OFF selected are considered as being satisfied when activation of dry pump protection is judged.
 Note, however, that if all the conditions in (2) to (4) are set to OFF, dry pump protection does not become active when the condition in (1) is satisfied.

■ Dry pump protection (Input selection) (J176, J276)

Set an operation for dry pump protection. Set PID control 1 and PID control 2 with function codes J176 and J276 respectively.

- Data setting range: 0 to 2

| Data for J176, J276 | Operation description |
|---------------------|-------------------------------------|
| 0 | Disable |
| 1 | Alarm (inverter stop with Pdr trip) |
| 2 | Warning output |

 Operations regarding dry pump protection can be monitored from external equipment, by assigning **L-ALM** ("Light alarm") to any of [Y1] to [Y4], [Y5A/C] and [30A/B/C]. (E20 to E24 and E27, data = 98).

■ Dry pump protection (Detection current) (J177, J277)

Set a detection current value at the time of drought, as a detection condition. Set PID control 1 and PID control 2 with function codes J177 and J277 respectively.

(When drought occurs, output current also decreases due to pump load reduction caused by water volume reduction.)

- Data setting range: 1% to 150% of the inverter rated current (allowable continuous current), OFF

■ Dry pump protection (Deviation) (J178, J278)

Set deviation as a detection condition. Set PID control 1 and PID control 2 with function codes J178 and J278 respectively.

(When drought occurs, feedback values (PV) decrease because the inlet contacts air.)

- Data setting range: 0.01 to 9990.00, OFF


(The setting range is limited by the maximum scale and minimum scale.)

■ Dry pump protection (Flowrate sensor) (J179, J279)

Set presence/absence of a flowrate sensor as a detection condition. Set PID control 1 and PID control 2 with function codes J179 and J279 respectively.

(When drought occurs, the flowrate sensor is turned OFF due to water volume reduction.)

- Data setting range: 0 (Disable); 1 (Enable)

 In a case where function codes "J163:0 (analog input selection)" and "E01 to E07:131 (flow switch)" have not been set, the function is disabled even if flowrate sensor (J179, J279) selection is made.

Also, in a case where the ON/OFF level of J164 and J165 is OFF, the function is disabled even if function code J163:0 (analog input selection) is set.

■ Dry pump protection (Detection timer) (J180, J280)

Set detection timer as a detection condition. Set PID control 1 and PID control 2 with function codes J180 and J280 respectively.

- Data setting range: 0 to 600 (s)


| | |
|---|--|
| J182 J183 J184 J185 J186 | End of Curve Protection (Input selection) (Detection current) (Deviation) (Flowrate sensor) (Detection timer) |
|---|--|

Large-water-volume operation status due to factors such as pump capacity selection mistakes can be detected. Large-water-volume status is detected, based on output frequencies, output current, flowrate sensor values, and PID deviation values.

End of curve protection becomes active when all of the conditions in (1) to (4) are satisfied and the detection timer (J186) setting time elapses.

< Detection condition >

- (1) Output frequency detection
 "Output frequency \geq upper limiter"
 (F03, F15, J1/2-18, E61 to E63 = 13: lowest frequency among upper limit frequencies)
 * When in large-water-volume status, the output frequency is kept at the maximum frequency during operations because the pressure is insufficient (the feedback value decreases).
- (2) Current detection
 "Output current > End of curve protection (detection current) (J183)"
 * Because large-water-volume operation is being performed, current according to the maximum load flows.
- (3) Deviation detection
 "Feedback value (PV) < PID control command value (SV) - deviation (J184)"
 * During large-water-volume operation, the feedback value decreases because request of water supply is beyond assumption.
- (4) Flowrate sensor
 "Flowrate sensor = ON status"
 * Because large-water-volume operation is being performed, the flowrate sensor is turned ON like normal operations.


 **Note** As for the conditions in (1) to (4), those with OFF selected are considered as being satisfied when activation of dry pump protection is judged.
 Note, however, that if all the conditions in (2) to (4) are set to OFF, dry pump protection does not become active even when the condition in (1) is satisfied.

■ **End of curve protection (Input selection) (J182)**

Set an operation for End of curve protection.

- Data setting range: 0 to 2

| Data for J182 | Operation description |
|---------------|-------------------------------------|
| 0 | Disable |
| 1 | Alarm (inverter stop with PoL trip) |
| 2 | Warning output |

 Operations regarding End of curve protection can be monitored from external equipment, by assigning *L-ALM* ("Light alarm") to any of [Y1] to [Y4], [Y5A/C] and [30A/B/C]. (E20 to E24 and E27, data = 98).

■ End of curve protection (Detection current) (J183)

Set a detection current value at the time of drought, as a detection condition.

(Because large-water-volume operation is being performed, current according to the maximum load flows.)

- Data setting range: 1% to 150% of the inverter rated current (allowable continuous current), OFF

■ End of curve protection (Deviation) (J184)

Set deviation as a detection condition.

(During large-water-volume operation, the feedback value decreases because request of water supply is beyond assumption.)

Data setting range: 0.01 to 9990.00, OFF


(The setting range is limited by the maximum scale and minimum scale.)

■ End of curve protection (Flowrate sensor) (J185)

Set presence/absence of a flowrate sensor as a detection condition.

(When in large-water-volume status, the flowrate sensor is turned ON.)

- Data setting range: 0 (Disable); 1 (Enable)

 Note Even if the flowrate sensor (J185) is selected, it is disabled if function code J163: 0 (analog input selection), E01 to E07: 131 (flow switch) is not set.

Also, even if function code J163: 0 (analog input selection) is set, it is disabled if the ON/OFF level of J164, J165 is OFF.

■ End of curve protection (Detection timer) (J186)

Set detection timer as a detection condition.

- Data setting range: 0 to 600 (s)

| | | |
|-------------|---|-------------------------|
| J247 | Boost Function (Cancel PV level) | (Refer to J147.) |
|-------------|---|-------------------------|

For details about setting the boost function (cancel PV level) setting in PID control 2, refer to function code J147.

| | | | |
|-------------|------------------------------------|-------------------------------------|-------------------------|
| J249 | Slow Flowrate Stop Function | (Mode selection) | (Refer to J149.) |
| J250 | | (Operation level) | (Refer to J150.) |
| J251 | | (Elapsed time) | (Refer to J151.) |
| J256 | | (Initiation inhibition time) | (Refer to J156.) |
| J257 | | (Cancel frequency) | (Refer to J157.) |
| J258 | | (Cancel deviation level 1) | (Refer to J158.) |
| J259 | | (Cancel delay timer) | (Refer to J159.) |
| J260 | | (Cancel deviation level 2) | (Refer to J160.) |

For details about the slow flowrate stop function under PID control 2, refer to the descriptions of J146 to J160.

| | | | |
|------|----------------------------|----------------------------|-------------------------|
| J276 | Dry Pump Protection | (Input selection) | (Refer to J176.) |
| J277 | | (Detection current) | (Refer to J177.) |
| J278 | | (Deviation) | (Refer to J178.) |
| J279 | | (Flowrate sensor) | (Refer to J179.) |
| J280 | | (Detection timer) | (Refer to J180.) |

For details about the dry pump protection, refer to the descriptions of J149 to J160.

J4 codes (Pump APP functions)

Applying the FRENIC-AQUA to a water supply system configured with two or more pumps combined with a header enables the FRENIC-AQUA to control those pumps for operating the water supply system with optimum electric power.

Cascade control and mutual operation control are available for controlling two or more pumps. Understanding the features of each control and selecting the appropriate control allows the FRENIC-AQUA to provide high economic efficiency.

| Control | Features |
|--|---|
| J401 = 1 or 11* Cascade control (Inverter drive motor fixed system) | A single FRENIC-AQUA drives a maximum of 10 pump motors. No. of pumps driven by inverter at variable speed: 1 (fixed) No. of commercial power-driven pumps: 8 max. (fixed) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of commercial power-driven pumps x 1" Pressure fluctuation at the time of adding/subtracting pumps: Large When J401 = 1, adding/subtracting pumps is judged with the ID controller output. When J401 = 11, adding/subtracting pumps is judged with the output frequency. |
| J401 = 2 or 12* Cascade control (Inverter drive motor floating system) | A single FRENIC-AQUA drives a maximum of 5 pump motors. No. of pumps driven by inverter at variable speed: 1 (floating) No. of commercial power-driven pumps: 3 max. (floating) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of inverter drive pumps floating x 2 + 1 (for auxiliary pump)" Pressure fluctuation at the time of adding/subtracting pumps: Small When J401 = 2, adding/subtracting pumps is judged with the ID controller output. When J401 = 12, adding/subtracting pumps is judged with the output frequency. |
| J401 = 3 or 13* Cascade control (Inverter drive motor floating + commercial power-driven motor system) | A single FRENIC-AQUA drives a maximum of 5 pump motors. No. of pumps driven by inverter at variable speed: 1 (floating) No. of commercial power-driven pumps: 3 max. (floating) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of inverter drive pumps floating x 2 + 1 (for auxiliary pump)" Pressure fluctuation at the time of adding/subtracting pumps: Small No. of magnetic contactor ON/OFF times: Small When J401 = 3, adding/subtracting pumps is judged with the ID controller output. When J401 = 13, adding/subtracting pumps is judged with the output frequency. |
| J401 = 52 Mutual operation control (Communications-linked inverter drive motor floating system) | Number of pumps controllable: 3 max. All pumps driven by inverter at variable speed (The same number of inverters is required.) All FRENIC-AQUA units to be linked via RS-485 No magnetic contactor required. Start/stop sequence cycles under PID control. |
| J401 = 54 Mutual operation control (Communications-linked all motors simultaneous PID control system) | Number of pumps controllable: 3 max. All pumps driven by inverter at variable speed (The same number of inverters is required.) All FRENIC-AQUA units to be linked via RS-485 No magnetic contactor required. All pumps operated at the same speed simultaneously. Closed-loop cycling pumps managing not pressure control but flowrate control, which provides large energy saving effect. |

Details of each control are given on the following pages.

* "J401 = 11, 12 or 13" is available in the ROM version 1700 or later. Adding/subtracting pumps is judged with the output frequency so that load fluctuation decreases at that time even if the acceleration/deceleration time is long.

J401 = 1 or 11 Cascade control (Inverter drive motor fixed system)

Configure such a pump drive system that drives a particular pump (M0 in the configuration figure given below) with the FRENIC-AQUA and drives other pumps (M1 to M8) with commercial power by turning magnetic contactors ON with the digital output signals issued by the FRENIC-AQUA.

The FRENIC-AQUA drives the M0 under PID control. If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the FRENIC-AQUA outputs pump start signals to turn the magnetic contactors ON, thereby starting commercial power-driven pumps successively. After starting all pumps, the inverter can further drive a single auxiliary pump (MA).

If the PV signal level rises and the frequency of the inverter-driven pump drops to satisfy the pump subtracting conditions, the FRENIC-AQUA cancels pump start signals to turn the magnetic contactors OFF, thereby stopping commercial power-driven pumps successively.

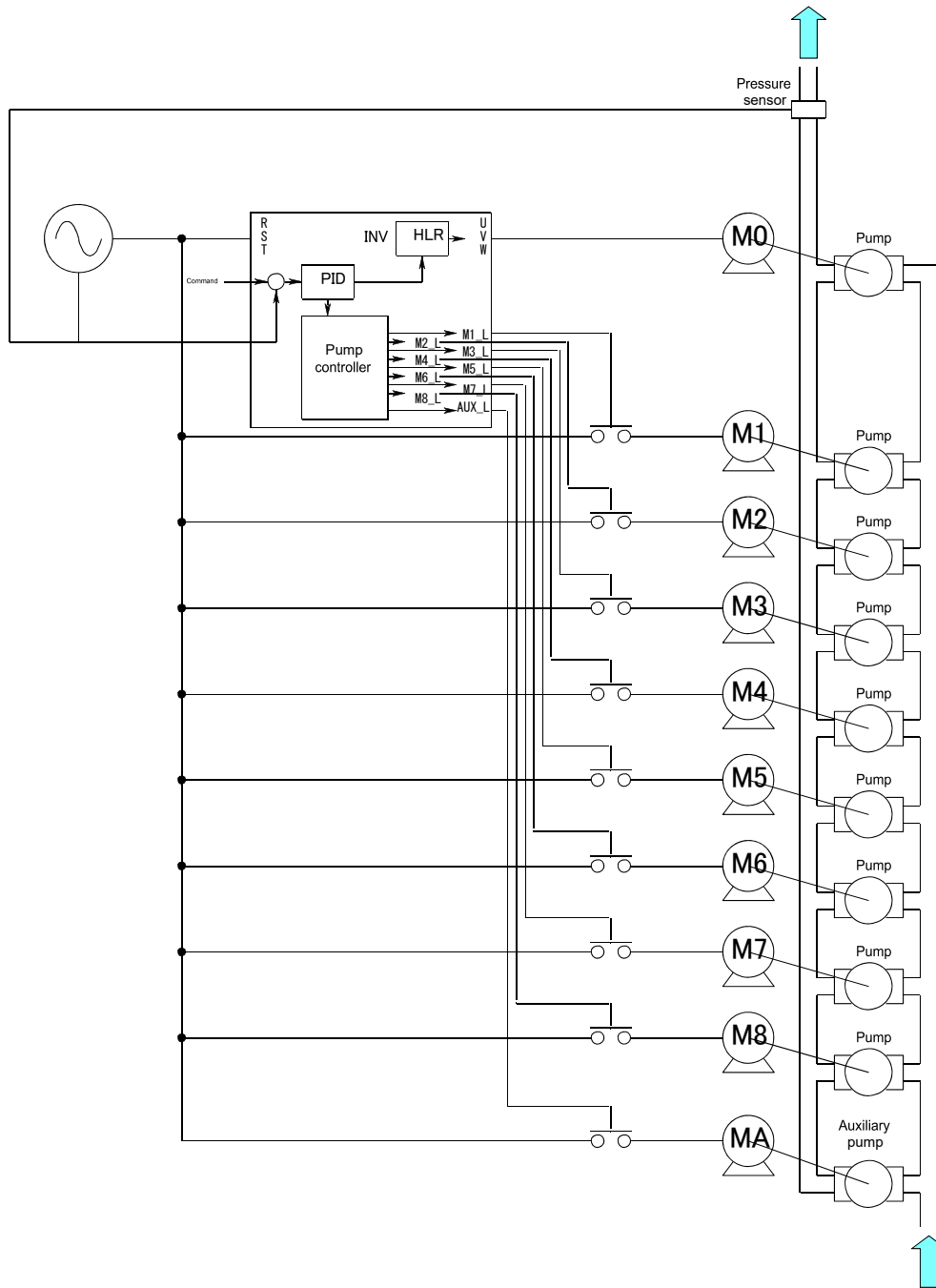
The number of start signal lines available on the FRENIC-AQUA is a total of six--four transistor output lines and two relay output lines in a standard configuration, so the FRENIC-AQUA can control a total of seven pumps (one pump driven by inverter at variable speed and six commercial power-driven pumps) in a standard configuration.

To operate the pump drive system in a maximum configuration, it is necessary to add the optional relay output card (OPC-RY2) to the FRENIC-AQUA. It can add seven relay output lines.

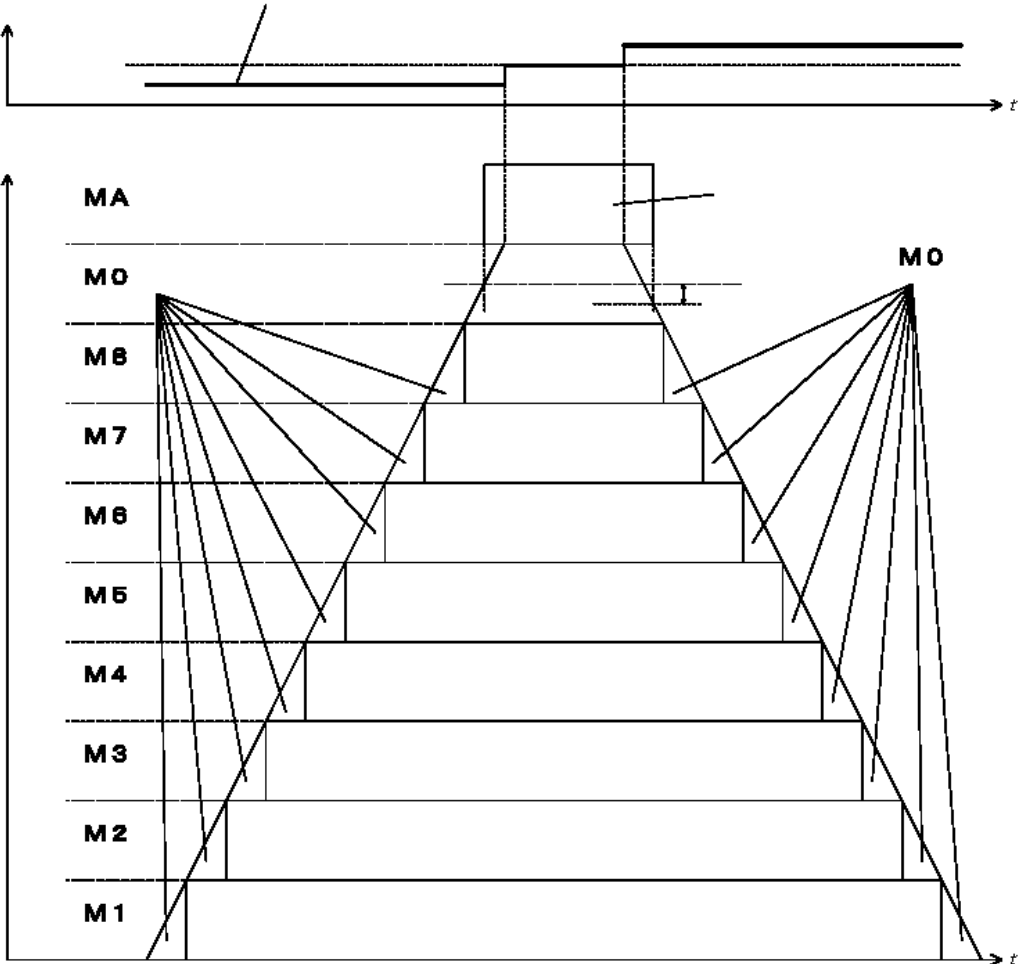
The advantage of this system is low cost since the number of controllable pumps is large and the number of magnetic contactors is one per pump. The disadvantage is large pressure fluctuation since adding/subtracting of pumps targets commercial power-driven pumps.

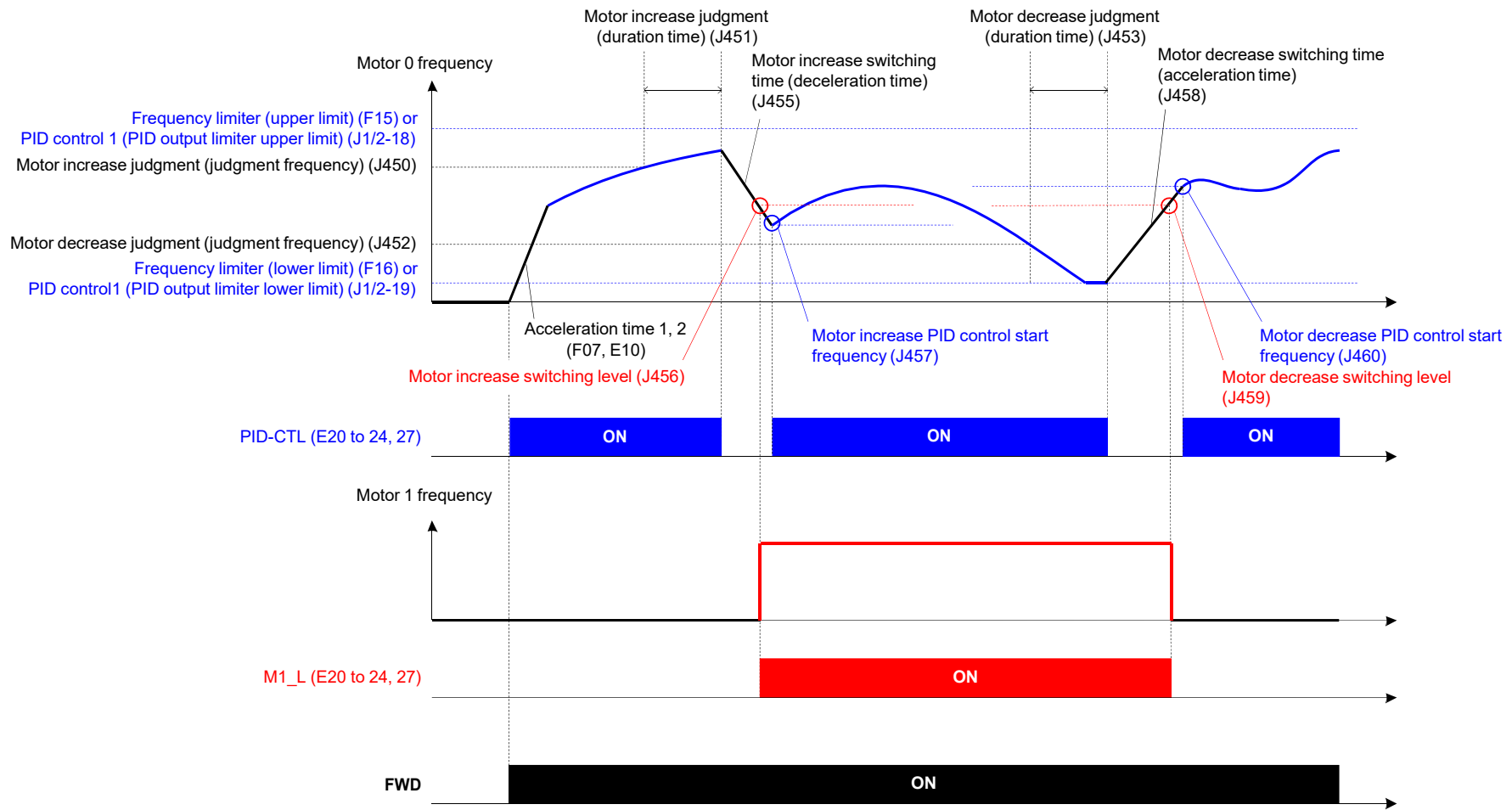
The start/stop sequence of commercial power-driven pumps is changeable so that the operating time of pumps can be averaged.

< Maximum number connection configuration of inverter drive motor fixed system (J401 = 1) >



< Operation timing scheme of inverter drive motor fixed system (J401 = 1) >





> Pump operation time chart of inverter drive motor fixed system (J401 = 1 or 11) >

< **Function code configuration required for the inverter drive motor fixed system** >

(1) Function codes to be configured

Configuring the following function codes as listed below activates the inverter drive motor fixed system under cascade control.

| Function code | Name | Data | Description |
|------------------------------|--|--|--|
| J401 | Pump control mode selection | 1, 11: Inverter drive motor fixed system | |
| J101 to J138 J201 to J231 | PID control 1 PID control 2 | Depends on each code setting | These function codes configure PID control in accordance with the system design. PID1/PID2 switchable. |
| E20 to E27 o01 to o07 | [Y1] to [Y5] [30A/B/C] [Y6] to [Y12] | 88: <i>AUX_L</i> (Auxiliary motor drive signal) 161, 163, 165, 167, 169, 171, 173, 175: <i>MI_L</i> to <i>M8_L</i> (Motor 1 to 8 being driven by commercial power) | These function codes assign commercial drive start signals to the output terminals according to the number of commercial power-driven pumps. For a maximum configuration, the optional relay output card is required. <i>AUX_L</i> is a drive signal for auxiliary pump. |
| J411 to J418 | Motor 1 to Motor 8 mode selection | 1: Enable | These function codes configure motor modes according to the number of commercial power-driven pumps. Only motors enabled can be control targets. |

(2) Function codes recommended to be configured

| Function code | Name | Data | Description |
|---------------|---------------------------|-------------------------|---|
| J425 | Motor switching procedure | 1: Equal operating time | This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps. |

(3) Function codes for individual adjustments

Configure the following function codes as needed.

| Function code | Name | Data | Description |
|---------------|--|----------------------|--|
| J450 | Motor increase judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. |
| J451 | Motor increase judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J118 (PID upper limiter), the adding conditions are immediately met. |
| J452 | Motor decrease judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. |
| J453 | Motor decrease judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J119 (PID lower limiter), the subtracting conditions are immediately met. |

| Function code | Name | Data | Description |
|---------------|--|---|--|
| J461 | Motor increase/decrease switching judgment non-responsive area width | OFF, 0.1 to 50.0% | If the deviation between SV and PV values is less than the setting of J461, no increase/decrease judgment is made. |
| J455 | Motor increase switching time (Deceleration time) | 0.00 to 3600 s, Inherit | This function code adjusts the sequence to apply at the time of adding motors. If the adding conditions of commercial power-driven pumps are met, the inverter decelerates according to the setting of J455. If the inverter decelerates to the setting of J456, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to decelerate. When it reaches the setting of J457, it restarts PID control. J456 is a percentage within the PID control range (lower to upper limits). The initial speed decelerates according to the deceleration time selected. When it drops to the PID lower limit frequency, the start signal comes ON. |
| J456 | Motor increase switching level | 0 to 100% | |
| J457 | Motor increase PID control start frequency | 0 to 120 Hz, Inherit | |
| J458 | Motor decrease switching time (Acceleration time) | 0.00 to 3600 s, Inherit | This function code adjusts the sequence to apply at the time of motor decrease. If the subtracting conditions of commercial power-driven pumps are met, the inverter accelerates according to the setting of J458. If the inverter accelerates to the setting of J459, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to accelerate. When it reaches the setting of J460, it restarts PID control. J459 is a percentage within the PID control range (lower to upper limits). The initial speed accelerates according to the acceleration time selected. When it rises to the PID upper limit frequency, the start signal comes ON. |
| J459 | Motor decrease switching level | 0 to 100% | |
| J460 | Motor decrease PID control start frequency | 0 to 120 Hz, Inherit | |
| J430 | Stop of commercial power-driven motors | 0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run | This function code specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm. Regardless of this setting, entering a coast-to-stop command BX stops all commercial power-driven pumps. The initial setting is that inverter stop conditions satisfied stops commercial power-driven pumps. |
| J436 | Motor regular switching time | 0.1 to 720.0 h | If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time. |

| Function code | Name | Data | Description |
|---------------|---|---|--|
| E01 to E07 | [X1] to [X7] | 151 to 158: MEM1 to MEM8 Pump control motor 1 to 8 | These function codes individually separate pumps from the inverter drive motor fixed system with external signals. Only pumps whose MEM signals are ON are subject to this system. |
| J465 | Auxiliary motor (Frequency operation level) | OFF, 0.1 to 120 Hz | When all pumps subject to this system are operating and the inverter output exceeds the setting of J465, the auxiliary pump start signal comes ON. If the inverter decelerates from the setting of J465 by the setting of J466, the auxiliary pump start signal goes OFF. |
| J466 | Auxiliary motor (Hysteresis width) | 0.0 to 120 Hz | |

Each function code is detailed separately.

J401 = 2 or 12 Cascade control (Inverter drive motor floating system)

To switch a maximum of four pumps between inverter drive and commercial power drive by a single FRENIC-AQUA, configure two magnetic contactors per pump.

The FRENIC-AQUA drives the first pump at variable speed under PID control. If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the FRENIC-AQUA switches the inverter-driven pump to commercial power drive and drives the newly added pump. After starting all pumps, the inverter can further drive a single auxiliary pump (MA). If the PV signal level rises and the frequency of the inverter-driven pump drops to satisfy the pump subtracting conditions, the FRENIC-AQUA cancels start signals of the pumps being driven by commercial power, thereby stopping them successively. At the time of decreasing pumps, the FRENIC-AQUA continues to drive the last added pump.

In this system, each of pumps to be controlled requires two signal lines for inverter drive and commercial power drive. To operate the pump drive system in a maximum configuration, an auxiliary pump start signal line is further required.

The number of start signal lines available on the FRENIC-AQUA is a total of six--four transistor output lines and two relay output lines in a standard configuration, so the FRENIC-AQUA can control a total of three pumps in a standard configuration.

To operate the pump drive system using four or more pumps, it is necessary to add the optional relay output card (OPC-RY2) to the FRENIC-AQUA. It can add seven relay output lines.

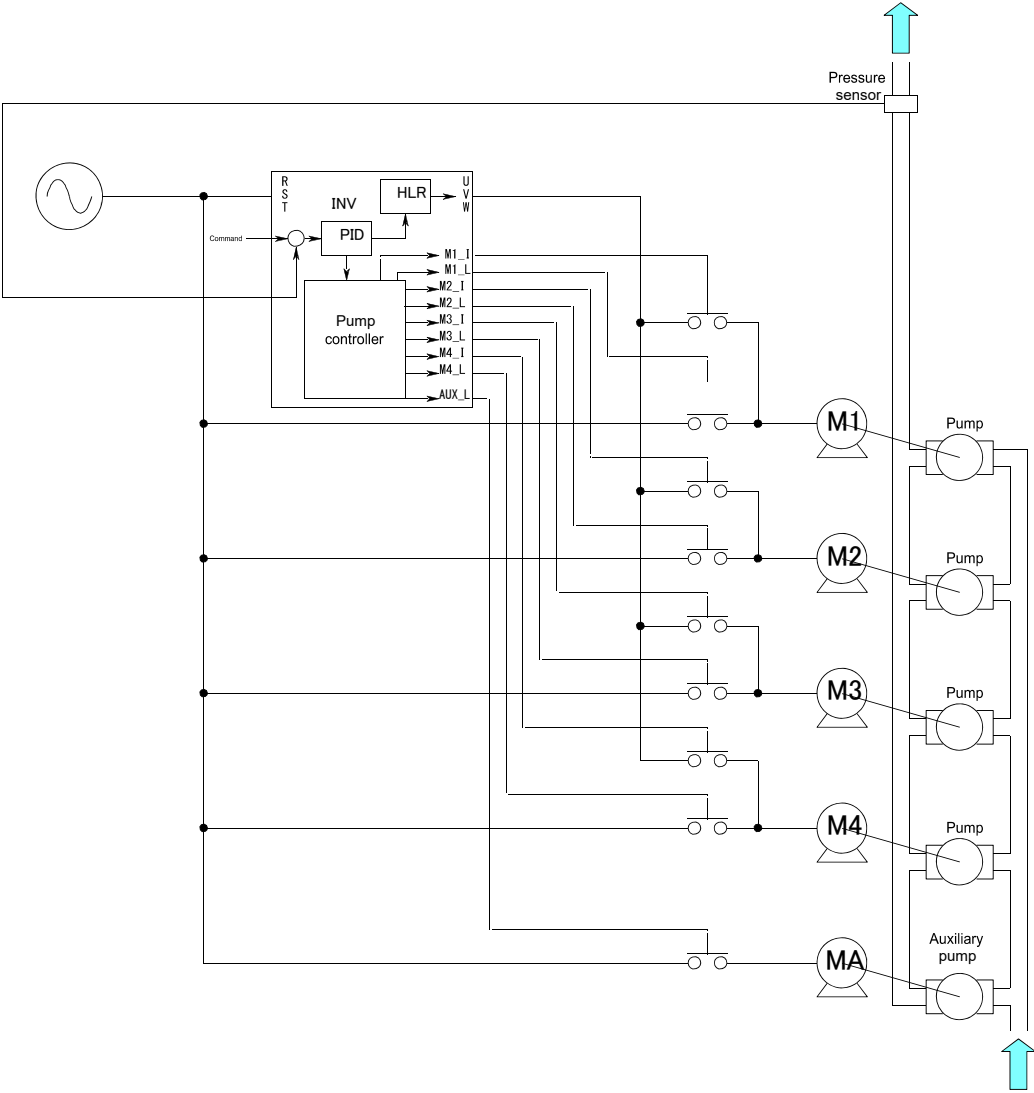
The advantage of this system is that the operating times of pumps can be averaged since the FRENIC-AQUA cycles through pump motors.

J401 = 3 or 13 Cascade control (Inverter drive motor fixed + commercial power-driven motor system)

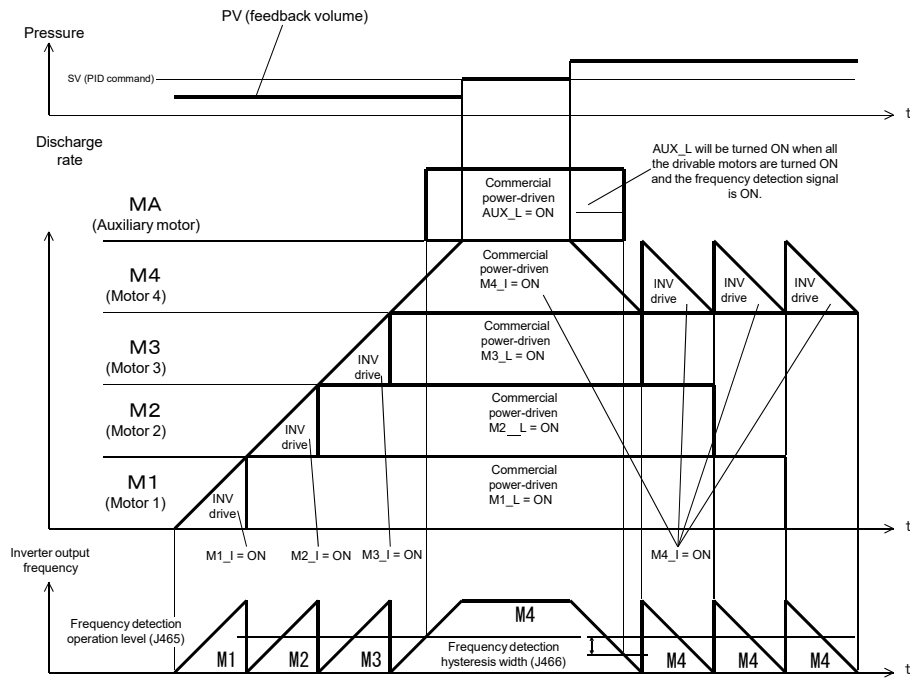
This system is the same as the inverter drive motor floating system in the basic configuration, except that it fixes the inverter drive pump according to the slow flowrate unit and switches the inverter drive pump when the system is started at the next time.

The advantage of this system is that the ON/OFF times of the magnetic contactors can be reduced. Therefore, this system is suitable for clean water supply systems repeating slow flowrate stops frequently.

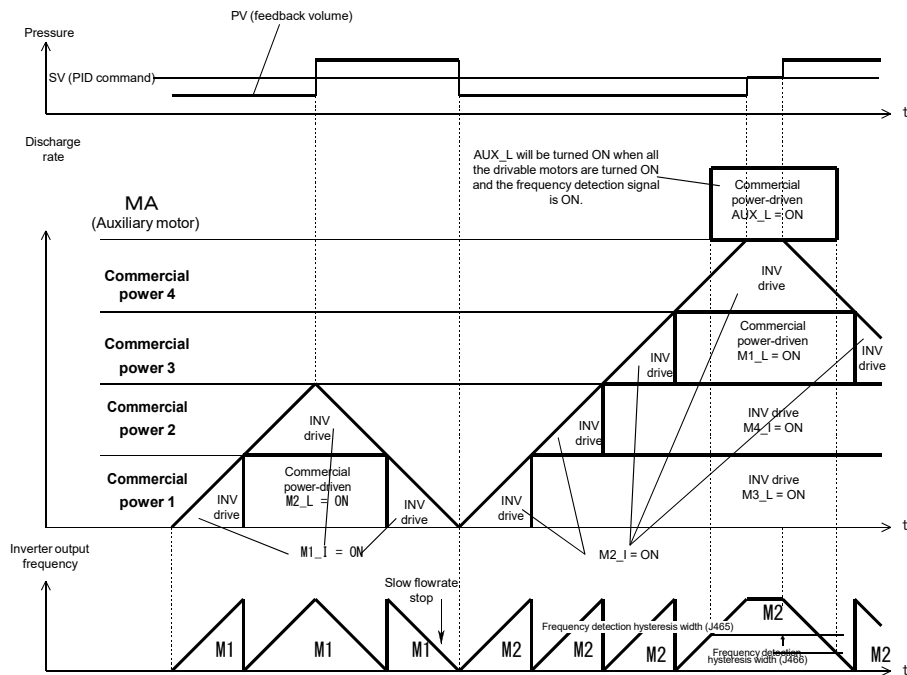
< Maximum number connection configuration of inverter drive motor floating system >

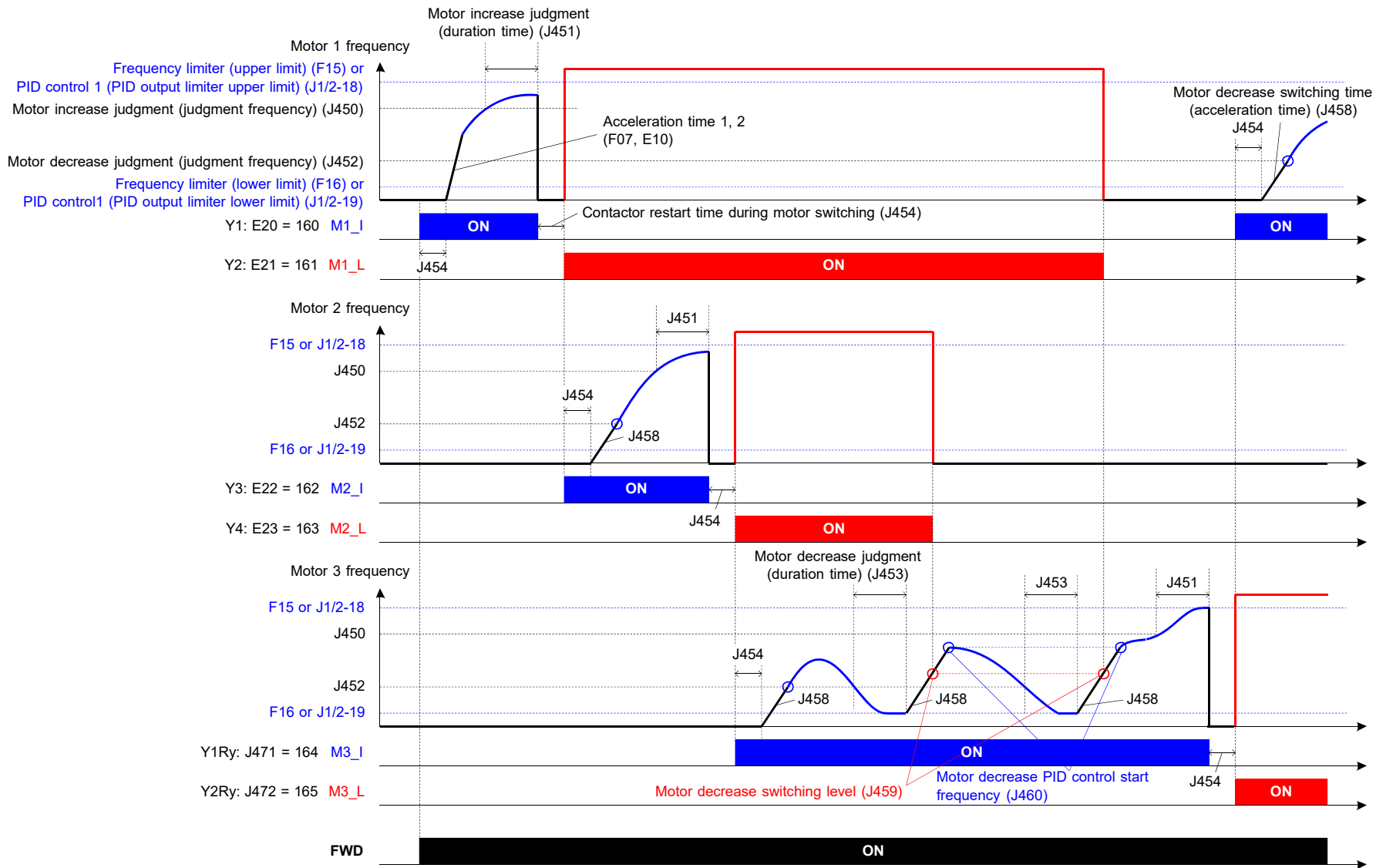


< Operation timing scheme of inverter drive motor floating system (J401 = 2) >

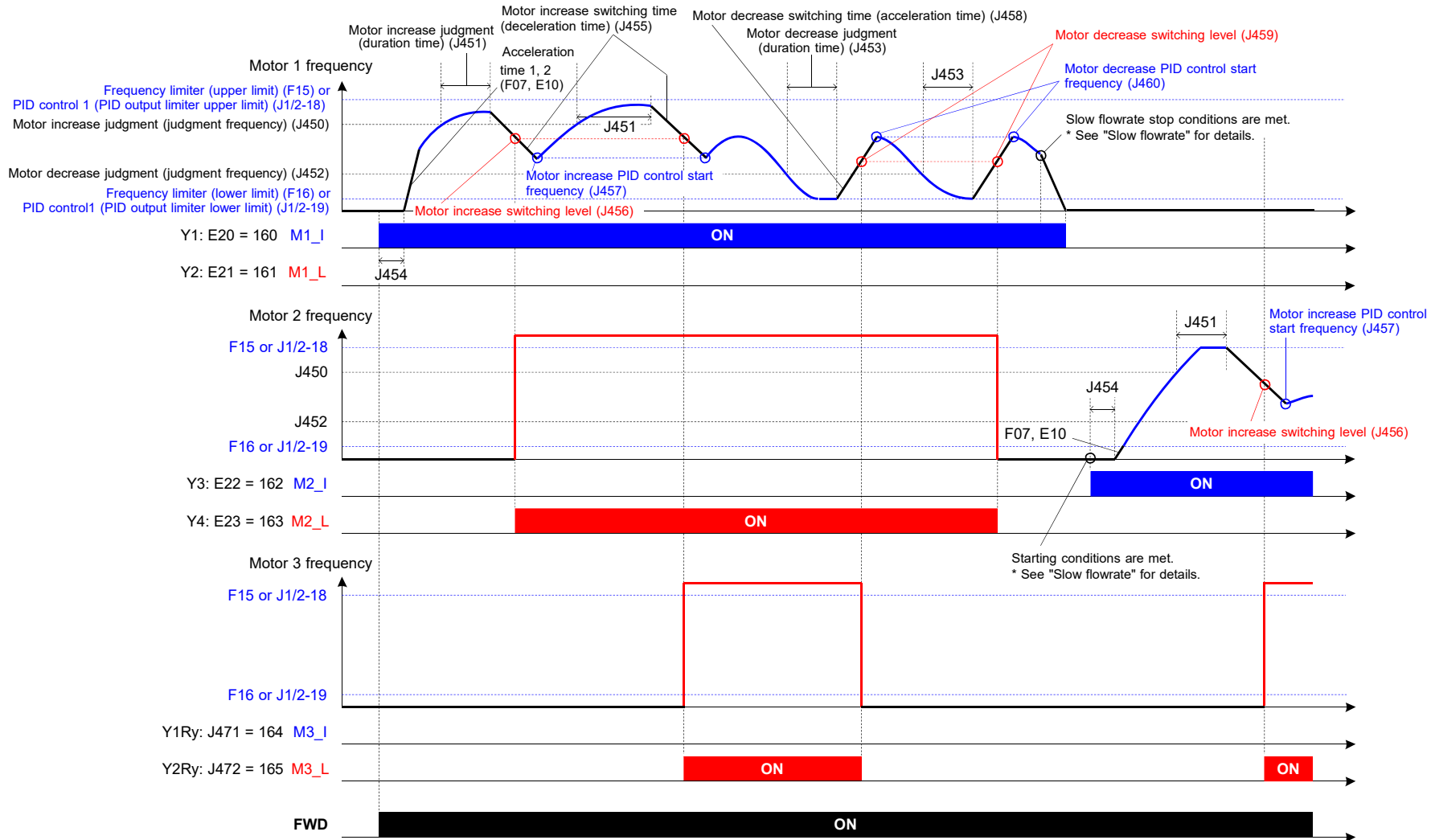


< Operation timing scheme of inverter drive motor floating + commercial power-driven motor system (J401 = 3) >





> Pump operation time chart of inverter drive motor floating system (J401 = 2) >



> Pump operation time chart of inverter drive motor floating + commercial power-driven motor system (J401 = 3) >

< **Function code configuration required for the inverter drive motor floating system and the inverter drive motor floating + commercial power-driven motor system** >

(1) Function codes to be configured

| Function code | Name | Data | Description |
|------------------------------|--|---|---|
| J401 | Pump control mode selection | 2: Inverter drive motor floating system 3: Inverter drive motor floating + commercial power-driven motor system | |
| J101 to J138 J201 to J231 | PID control 1 PID control 2 | Depends on each code setting | These function codes configure PID control in accordance with the system design. PID1/PID2 switchable. |
| E20 to E27 o01 to o07 | [Y1] to [Y5] [30A/B/C] [Y6] to [Y12] | 88: AUX_L (Auxiliary motor drive signal) 160 to 166: MI_I to M4_I (Motor 1 to 4 being driven by inverter) 161 to 167: MI_L to M4_L (Motor 1 to 4 being driven by commercial power) | These function codes assign inverter drive start signals and commercial drive start signals to the output terminals according to the number of pumps. For a maximum configuration, the optional relay output card is required. AUX_L is a drive signal for auxiliary pump. |
| J411 to J414 | Motor 1 to Motor 4 mode selection | 1: Enable | These function codes configure motor modes according to the number of pumps. Only motors enabled can be control targets. |

(2) Function codes recommended to be configured

| Function code | Name | Data | Description |
|---------------|---------------------------|-------------------------|---|
| J425 | Motor switching procedure | 1: Equal operating time | This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps. |

(3) Function codes for individual adjustments

Configure the following function codes as needed.

| Function code | Name | Data | Description |
|---------------|--|----------------------|--|
| J450 | Motor increase judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. |
| J451 | Motor increase judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J118 (PID upper limiter), the adding conditions are immediately met. |

| Function code | Name | Data | Description |
|---------------|--|-------------------------|--|
| J452 | Motor decrease judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. |
| J453 | Motor decrease judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J119 (PID lower limiter), the subtracting conditions are immediately met. |
| J461 | Motor increase/decrease switching judgment non-responsive area width | OFF, 0.1 to 50.0% | If the deviation between SV and PV values is less than the setting of J461, no increase/decrease judgment is made. |
| J454 | Contact restart time when switching the motor | 0.01 to 2.00 s | Taking into account the contactor delay at the time of adding motors, the start of an inverter output can be delayed. Adjust this value when the inverter trips due to a contactor delay. |
| J455 | Motor increase switching time (Deceleration time) | 0.00 to 3600 s, Inherit | This function code adjusts the sequence to apply at the time of adding motors. If the adding conditions of commercial power-driven pumps are met, the inverter decelerates according to the setting of J455. If the inverter decelerates to the setting of J456, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to decelerate. When it reaches the setting of J457, it restarts PID control. J456 is a percentage within the PID control range (lower to upper limits). The initial speed decelerates according to the deceleration time selected. When it drops to the PID lower limit frequency, the start signal comes ON. |
| J456 | Motor increase switching level | 0 to 100% | |
| J457 | Motor increase PID control start frequency | 0 to 120 Hz, Inherit | |
| J458 | Motor decrease switching time (Acceleration time) | 0.00 to 3600 s, Inherit | This function code adjusts the sequence to apply at the time of motor decrease. If the subtracting conditions of commercial power-driven pumps are met, the inverter accelerates according to the setting of J458. If the inverter accelerates to the setting of J459, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to accelerate. When it reaches the setting of J460, it restarts PID control. J459 is a percentage within the PID control range (lower to upper limits). The initial speed accelerates according to the acceleration time selected. When it rises to the PID upper limit frequency, the start signal comes ON. |
| J459 | Motor decrease switching level | 0 to 100% | |
| J460 | Motor decrease PID control start frequency | 0 to 120 Hz, Inherit | |

| Function code | Name | Data | Description |
|----------------------|--|---|---|
| J430 | Stop of commercial power-driven motors | 0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run | This function code specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm. Regardless of this setting, entering a coast-to-stop command BX stops all commercial power-driven pumps. The initial setting is that inverter stop conditions satisfied stops commercial power-driven pumps. |
| J436 | Motor regular switching time | 0.1 to 720.0 h | If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time. |
| E01 to E07 | [X1] to [X7] | 151 to 158: MEM1 to MEM8 Pump control motor 1 to 8 | These function codes individually separate pumps from the inverter drive motor fixed system with external signals. Only pumps whose MEM signals are ON are subject to this system. |
| J465 | Auxiliary motor (Frequency operation level) | OFF, 0.1 to 120 Hz | When all pumps subject to this system are operating and the inverter output exceeds the setting of J465, the auxiliary pump start signal comes ON. If the inverter decelerates from the setting of J465 by the setting of J466, the auxiliary pump start signal goes OFF. |
| J466 | Auxiliary motor (Hysteresis width) | 0.0 to 120 Hz | |
| J467 J468 J469 | Auxiliary motor (PV operation level, Connection timer, Interrupting timer) | 0.00 to 9999.0 0.00 to 2.00 s 0.00 to 2.00 s | When an inverter drive motor is switched in the inverter drive motor floating system, the pressure may decrease. If it happens, run the auxiliary motor to compensate the pressure decrease. For details, refer to the description of function codes given later. |

Each function code is detailed separately.

J401 = 52 Mutual operation control (Communications-linked inverter drive motor floating system)

This system controls up to three pumps which are individually connected with the FRENIC-AQUA units in multidrop connection via RS-485.

The FRENIC-AQUA specified as a master performs PID control and sends run commands and frequency commands to other two slaves.

If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the second inverter is started. After the start of a total of three inverters, the master can output a start signal to drive an auxiliary pump. The start/stop sequence of pumps cycles.

Even if the master stops due to an alarm, the slaves can continue running.

The advantage of this system is very small pressure fluctuation at the time of adding/subtracting pumps and small load to piping since all pumps are driven by inverters. The disadvantage is high cost since each pump requires an inverter.

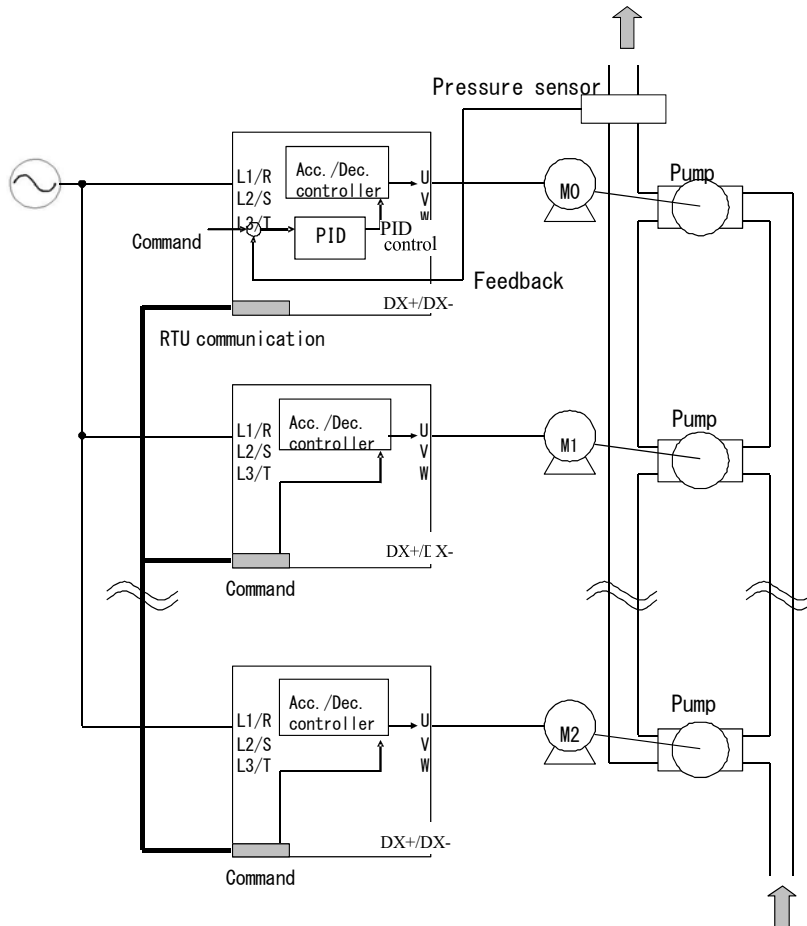
J401 = 54 Mutual operation control (Communications-linked all motors simultaneous PID control system)

This system is configured in the same way as the communications-link inverter drive motor floating system except that all motors are driven under PID control with the same frequency at the same time.

Even if an alarm occurs, the remaining inverters continue to run. If the pressure is insufficient, the inverter outputs a start signal to an auxiliary pump to add one pump.

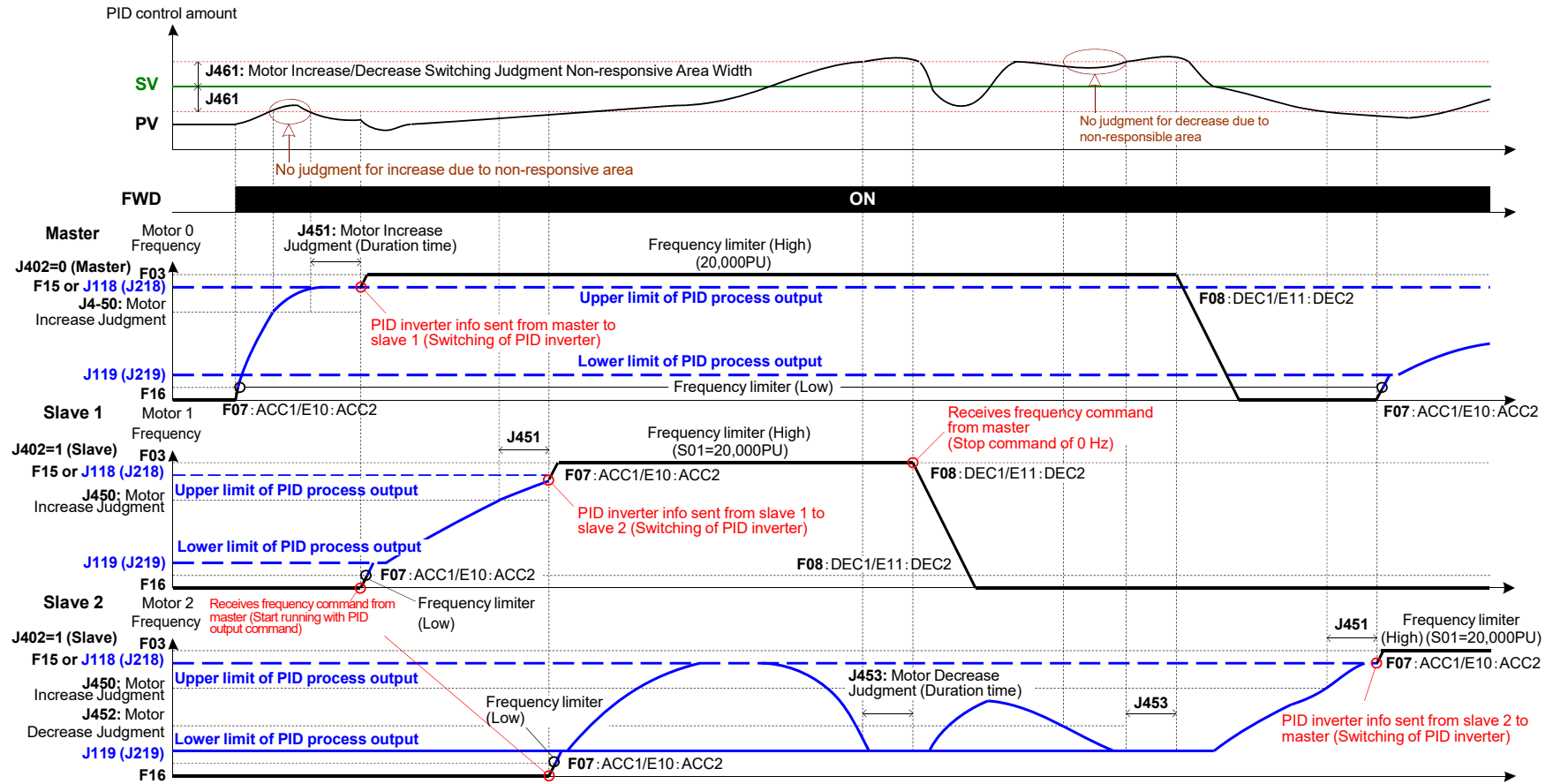
The advantage of this system is that driving two or more pumps under PID control at the same time can deliver water with low power for optimum watt hour in the cooling water cycling system managing the flowrate.

< Maximum number connection configuration of mutual operation (J401 = 52 or 54) >



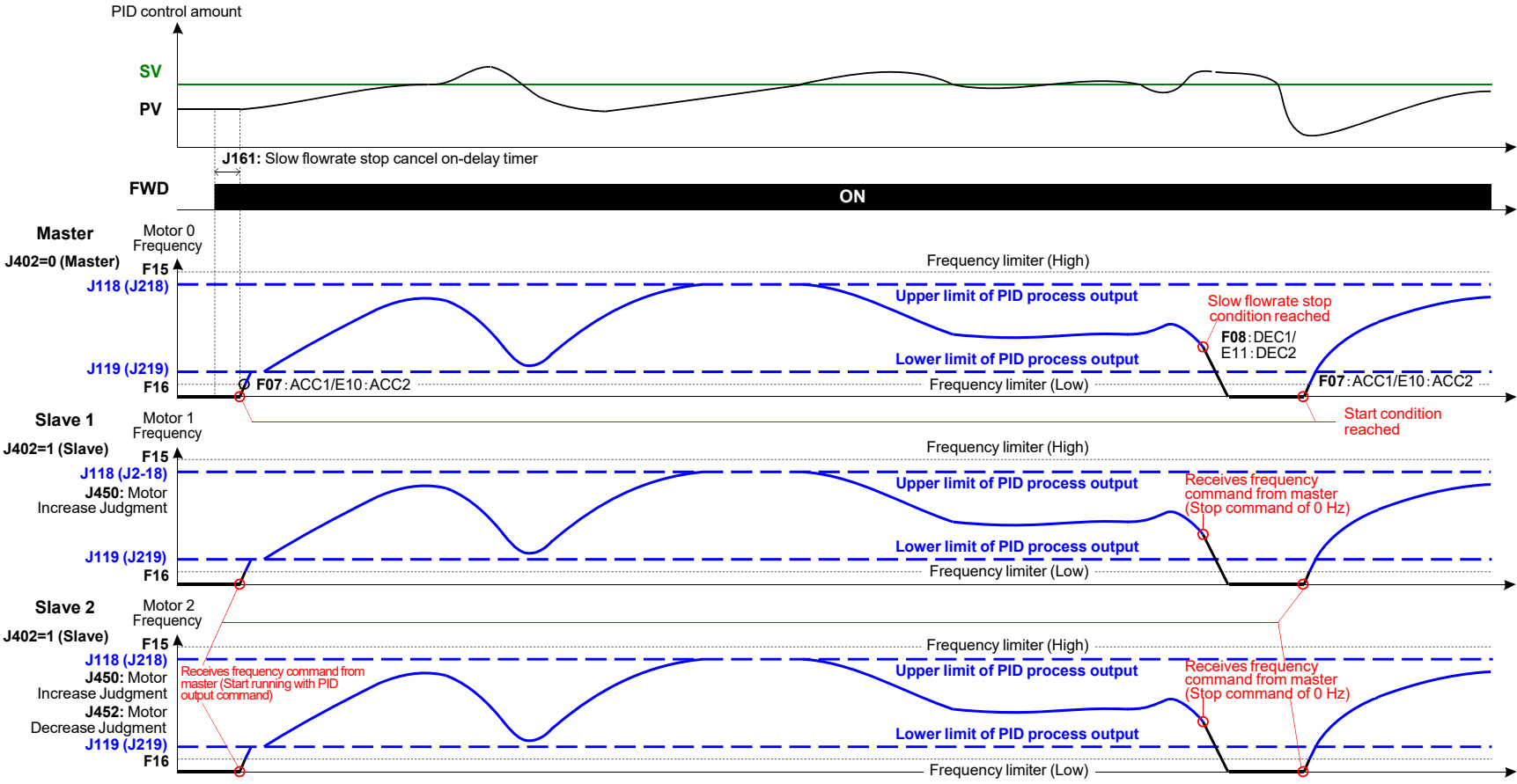
Communications-linked inverter-driven motor floating system (J401 = 52)

When F15 > J118 (J218):



< Operation timing scheme of communications-linked inverter-drive motor floating system >

Communications-linked all motors simultaneous PID control system (J401 = 54)



< Function code configuration required for the communications-linked inverter drive motor floating system and communications-linked all motors simultaneous PID control system >

(1) Function codes to be configured (Different between master and slaves)

For master

| Function code | Name | Data | Description |
|------------------------------|--------------------------------|--|---|
| J401 | Pump control mode selection | 52: Communications-linked inverter drive motor floating system 54: Communications-linked all motors simultaneous PID control system | |
| J101 to J138 J201 to J231 | PID control 1 PID control 2 | Depends on each code setting | These function codes configure PID control in accordance with the system design. PID1/PID2 switchable. |
| J403 | Number of slaves | 1 or 2 | |
| y20 | RS-485 communication 2 | 50: Communications link pump control protocol | |

For slaves

| Function code | Name | Data | Description |
|---------------|--------------------------------------|--|--|
| J401 | Pump control mode selection | 52: Communications-linked inverter drive motor floating system 54: Communications-linked all motors simultaneous PID control system | |
| H30 | Communication s link function | 8: Frequency command (RS-485) and run command (RS-485) | Ready to receive run commands and frequency command. |
| J402 | Communication master/slave selection | 1: Communication slave inverter | |
| y11 | Station address | 1 or 2 | 1 for the 1st motor, 2 for the 2nd motor |
| y20 | RS-485 communication 2 | 50: Communications link pump control protocol | |

(2) Function codes recommended to be configured

| Function code | Name | Data | Description |
|---------------|---------------------------|-------------------------|---|
| J425 | Motor switching procedure | 1: Equal operating time | This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps. |

(3) Function codes for individual adjustments

Configure the following function codes as needed. No configuration is required for all motors simultaneous PID control system.

| Function code | Name | Data | Description |
|---------------|--|---|---|
| J450 | Motor increase judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. |
| J451 | Motor increase judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J118 (PID upper limiter), the adding conditions are immediately met. |
| J452 | Motor decrease judgment (Judgment frequency) | 0 to 120 Hz, Inherit | This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. |
| J453 | Motor decrease judgment (Duration time) | 0.00 to 3600 s | The default is that if the frequency reaches the setting of J119 (PID lower limiter), the subtracting conditions are immediately met. |
| J461 | Motor increase/decrease switching judgment non-responsive area width | OFF, 0.1 to 50.0% | If the deviation between SV and PV values is less than the setting of J461, no increase/decrease judgment is made. |
| J430 | Stop of commercial power-driven motors | 0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run | This function code specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm. Regardless of this setting, entering a coast-to-stop command BX stops all commercial power-driven pumps. The initial setting is that inverter stop conditions satisfied stops commercial power-driven pumps. |
| J436 | Motor regular switching time | 0.1 to 720.0 h | If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time. |


Each function code is detailed separately.

| | |
|-------------|---|
| J401 | Pump Control Mode Selection E01 to E07 Terminals X1 to X7 (Function selection) E20 to 24 Terminals Y1 to Y5 (Function selection) E27 Terminal 30A/B/C (Ry output) H13 Restart Mode after Momentary Power Failure (Restart time) J101/J201 PID Control (Mode selection) |
|-------------|---|

J401 selects the pump control mode.

- Data setting range: 0 to 54

| Data for J401 | Function | Description |
|---------------|--|---|
| 0 | Disable | Pump quantity control (switching motor) is not performed. |
| 1 | Enable (Inverter drive motor fixed system) | Perform cascade control in the inverter drive motor fixed system. Adding/subtracting pumps is judged with the PID processor output. |
| 2 | Enable (Inverter drive motor floating system) | Perform cascade control in the inverter drive motor floating system. Adding/subtracting pumps is judged with the PID processor output. |
| 3 | Enable (Inverter drive motor floating + commercial power-driven motor system) | Perform cascade control in the inverter drive motor floating + commercial power-driven system. Adding/subtracting pumps is judged with the PID processor output. |
| 11 | Enable (Inverter drive motor fixed system) | Perform cascade control in the inverter drive motor fixed system. Adding/subtracting pumps is judged with the output frequency. |
| 12 | Enable (Inverter drive motor floating system) | Perform cascade control in the inverter drive motor floating system. Adding/subtracting pumps is judged with the output frequency. |
| 13 | Enable (Inverter drive motor floating + commercial power-driven motor system) | Perform cascade control in the inverter drive motor floating + commercial power-driven system. Adding/subtracting pumps is judged with the output frequency. |
| 52 | Enable (Communications-linked inverter drive motor floating system) | Perform mutual operation control in the communications-linked inverter drive motor floating system. |
| 54 | Enable (Communications-linked all motors simultaneous PID control system) | Perform mutual operation control in the communications-linked all motors simultaneous PID control system. |

-  **Note**
- The default setting cannot be modified during operation.
 - When performing pump control, specify the pump control mode selection (J401), PID control 1 (mode selection) (J101), and PID control 2 (mode selection) (J201).
 - During mutual operation, if the slave unit generates an alarm (SLA: slave alarm), the master unit generates a "light alarm."

Functions for different J401 operating formats

Some functions are disabled, depending on the J401 operating format. The chart below indicates whether functions are enabled or disabled.

| Function code | J401: | | | | |
|--|---------------------------------------|-------|-------|----|----|
| | Pump control operation mode selection | | | | |
| | 1, 11 | 2, 12 | 3, 13 | 52 | 54 |
| J101 to J138/J201 to J231 | Y | | | | |
| Boost function (J143 to J147) | Y | | | | |
| Slow flow rate stop (J149 to J154, J156 to J160/J249 to J251, J256 to J260) | Y | | | | |
| Flowrate sensor input selection (J163 to J166) | Y | | | | |
| High frequency operation protection (J168, J169) | Y | | | | |
| Dry pump protection (J176 to J180/J276 to J280) | Y | | N | | |
| End of curve protection (J182 to J186) | Y | | N | | |
| Filter clogging/ anti-jam (J188 to J195) | N | | | | |
| Communication master/slave selection (J402) | N | | Y | | |
| Number of slave units (J403) | N | | Y | | |
| Master input transmission selection (J404) | N | | Y | | |
| Motors 1 to 8 drive selection (J411 to J418) | Y | | N | | |
| Motor switching sequence (J425) | Y | | | N | |
| Stop of commercial power-driven motors (J430) | Y | | N | | |
| Motor fixed-period switch (J435 to J437) | Y | | | N | |
| Motor increase judgment (J450, J451) | Y | | | N | |
| Motor decrease judgment (J452, J453) | Y | | | N | |
| Motor switching time contact wait period (J454) | N | Y | | N | |
| Motor increase switching time (deceleration time) (J455) | Y | N | N | N | |
| Motor increase switching level (J456) | Y | N | N | N | |
| Motor increase PID control start frequency (J457) | Y | N | N | N | |
| Motor decrease switching time (acceleration time) (J458) | Y | N | N | N | |
| Motor decrease switching level (J459) | Y | N | N | N | |
| Motor decrease PID control start frequency (J460) | Y | N | N | N | |
| Motor increase/decrease judgment dead zone (J461) | Y | | | N | |
| Abnormal unit judgment time (J462) | N | | N | | N |
| Auxiliary motor (J465 to J467) | Y | | | | |
| Auxiliary motor (J468, J469) | N | Y | | N | |

Y: Enabled, N: Disabled

J402**Communication Master/Slave Selection**

J402 defines inverters as a master or slave in mutual operation. This function code only needs to be set during mutual operation. Set the inverter used as the master unit to “0,” and the inverter used as the slave unit to “1.”

- Data setting range: 0, 1
- 0: Master inverter
- 1: Slave inverter

J403**Number of slaves**

J403 specifies the number of slave inverters in mutual operation. This function code only needs to be set during mutual operation. (This is required only for master, not for slave.)

- Data setting range: 1, 2

J404**Master Input Permeation Selection**

During mutual operation, the input terminals for making these settings on the slave units (X1 to X7, FWD, REV), the master unit terminal input information is reflected via the master unit operation command (S06). As a result, terminal input on the master unit allows simultaneous terminal input on the slave unit. As terminal input on the master unit is also input on the slave unit, the same settings are applied to the master and slave for terminals **X1** to **X7**, **FWD**, **REV** (function selection) (E01 to E07, E98, E99).

- Data setting range: 0 to 01FF (hexadecimal display)


| | | | | | | | | |
|----|----|----|----|----|----|----|-----|-----|
| 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| X7 | X6 | X5 | X4 | X3 | X2 | X1 | REV | FWD |

(All bits are 1, and master unit input information reflection is enabled.)

(Example)

If master units X1, X2 and X4 are reflected in slave unit 1 and master units X4, X5 and X7 are reflected in slave unit 2

The setting for slave unit 1 is 0 0010 1100 (binary) = 02C (hexadecimal), so J404 = 002C, and the setting for slave unit 2 is 1 0110 0000 (binary) = 160 (hexadecimal), to J404 = 0160.

-  **Note**
- When **FWD** and **REV** are set on J404, do not set function codes: E98 and E99 for terminals **FWD** and **REV** for both the master and slave to **FWD**, **REV**, **FWD2** and **REV2**. While number of terminals in operation for the master unit is (F02 = 1) and the run command is entered, the run command remains entered on the slave unit, so the slave unit will not operate as commanded by the master unit pump control commands.

J411 to J418

Motor 1 Mode Selection to Motor 8 Mode Selection

For motor mode selection, select the motor operation subject to pump control. When specifying "2" with forced drive (forced commercial power drive) ON, the pump commercial power driving signal can be output regardless of run command. This function code only needs to be set during cascade operation.

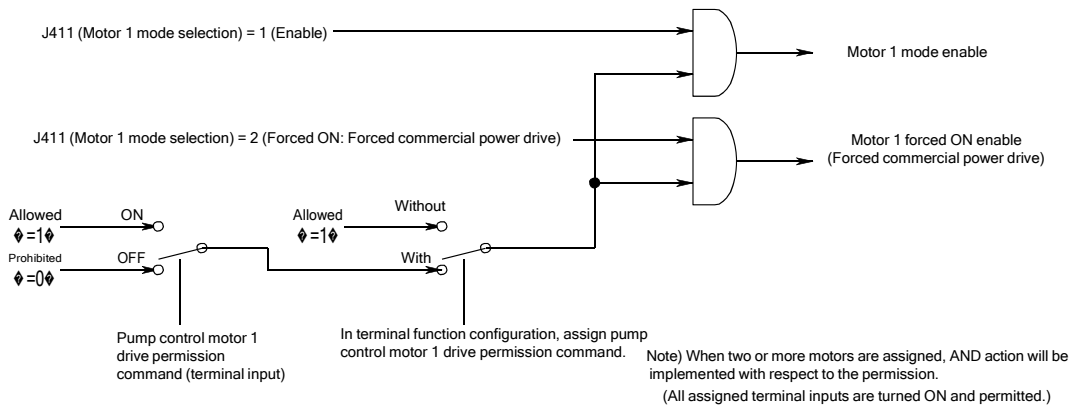
| Data for J411 to J418 | Function |
|-----------------------|---|
| 0 | Disable (off at all times) |
| 1 | Enable |
| 2 | Forced drive ON (forced commercial power drive) |

Note • Forced drive ON (forced commercial power drive) is a function to turn on the relay output forcibly to connect the motor to the commercial power supply. Thus, even if the run command is off, turn on the relay output to drive the motor by commercial power.

[1] Pump control drive motor permission commands 1 to 8 of pump control motor ("MEN1" to "MEN8")

As mode selection of pump control motors, there are pump control drive motor permission commands 1 to 8 ("MEN1" to "MEN8") by terminal input. A combination of the pump control drive motor permission command and the motor mode selection enables motor degradation. Degradation is a state in which the system is under operation continually with only the corresponding motor stopped.

< Action block diagram of pump control drive motor permission command >



[2] PID control action

In the inverter-driven motor floating system (J401 = 2), the following state (1) or (2) is developed depending on the setting of motor mode selection (J411 to J418).

(1) Driving of all motors are not permitted

When driving of all motors is not permitted (pump control drive motor permission commands 1 to 8 = OFF ("MEN1" to "MEN8") or the motors are set to disable with motor mode selection (J411 to J418), PID control will not start because no motors can control the pump.

(2) All motors are driven by commercial power forcibly

On changing all motors from forced commercial power drive state to enable state ("2 ⇒ 1" for J411 to J418) with the run command turned ON, motor increase/decrease judgment will be performed immediately based on the PID control.

J425

Motor Switching Procedure

In pump control, two or more motors are operated while switching them. When increasing or decreasing the number of operating motors, specify the motors to be driven and the motors to be stopped in the motor switching procedure (J425). This allows cumulative run time for each motor to be equalized.

- Data setting range: 0 to 3

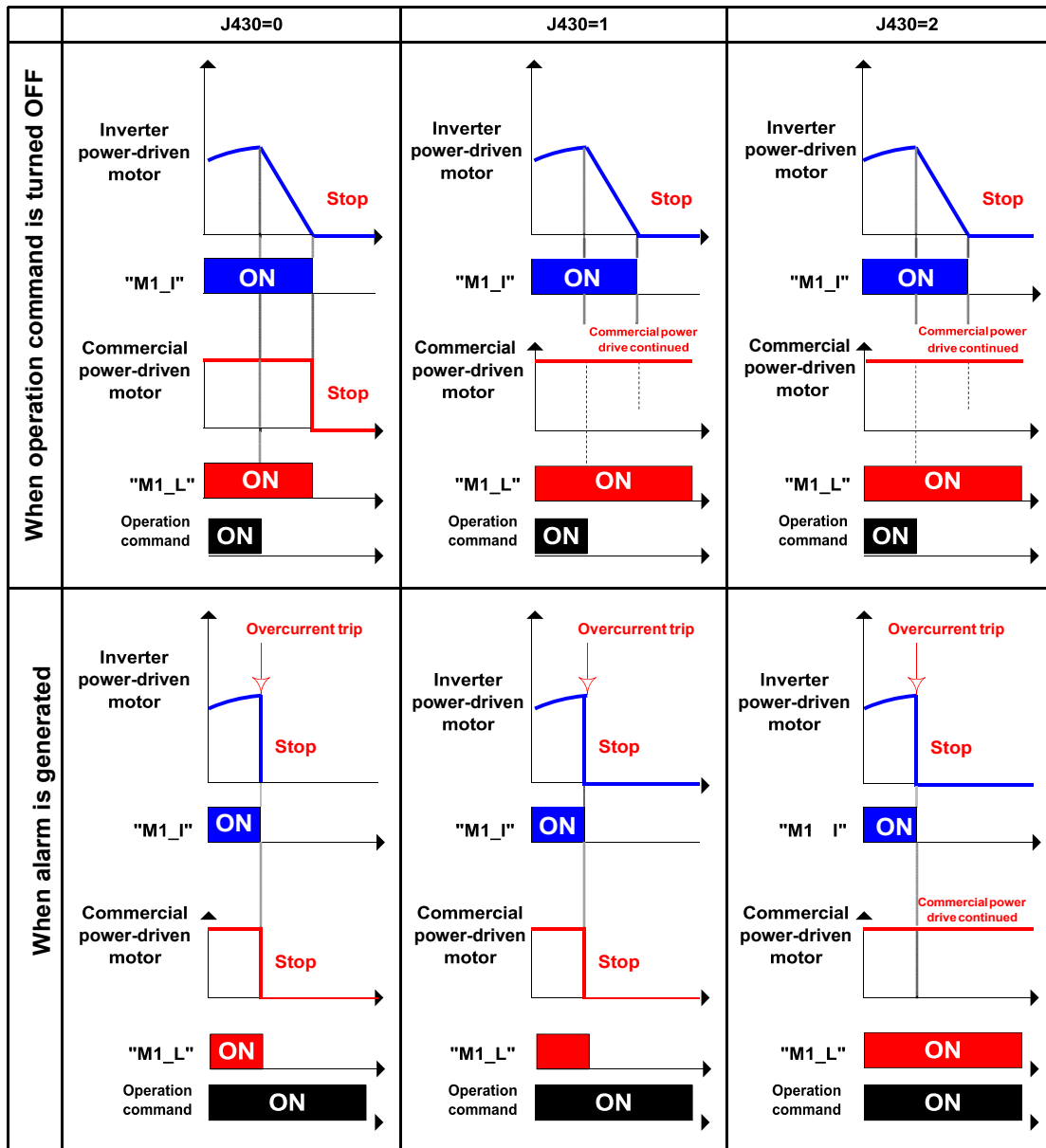
| Data for J425 | Function |
|---------------|--|
| 0 | Fixing procedure <When the number of motors increases> The number increases successively in order of increasing the motor number. (motor 1 ⇒ motor 2, motor 3...) <When the number of motors decreases> The number decreases successively in order of decreasing the motor number. (motor 3 ⇒ motor 2, motor 1...) |
| 1 | Equal operating time (Cumulative run time of each motor is equalized.) <When the number of motors increases> Of the motors that are not running, turn on the motor having the shortest operating time. <When the number of motors decreases> Of the motors that are running, turn off the motor having the longest operating time. |
| 2 | Fixing procedure (Switching the motor at slow flowrate stop) Mode selection is the same when J425 is configured to 0. However, the drive motor switches to the subsequent motor not only when motors are increased, but also during slow flowrate stop. |
| 3 | Equal operating time (Switching the motor at slow flowrate stop) The operation is the same as when J425 =1 is selected. However, the drive motor switches to the motor with least operating time not only when motors are increased, but also during slow flowrate stop. |

J430**Stop of Commercial Power-driven Motors J411 to J418 (Motor mode selection)**

J430 specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm under cascade control.

- Data setting range: 0 to 2

| Data for J430 | Type of stop | Description | |
|---------------|--------------------------------|--|--|
| | | Inverter-driven motor | Commercial power-driven motor |
| 0 | When run command is turned off | The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M4_I") are turned off in concurrence with inverter output stop. | Motor commercial power driving signals ("M1_L" to "M8_L") are turned off at a time as soon as the inverter stops the output. |
| | When alarm is generated | Output to the motor is stopped and motor inverter drive signals ("M1_I" to "M4_I") are turned off. | Motor commercial power driving signals ("M1_L" to "M8_L") are turned off at a time as soon as the inverter stops the output. |
| 1 | When run command is turned off | The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M4_I") are turned off in concurrence with inverter output stop. | Operation is continued. |
| | When alarm is generated | Output to the motor is stopped and motor inverter drive signals ("M1_I" to "M4_I") are turned off. | Motor commercial power driving signals ("M1_L" to "M8_L") are turned off at a time as soon as the inverter stops the output. |
| 2 | When run command is turned off | The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M4_I") are turned off in concurrence with inverter output stop. | Operation is continued. |
| | When alarm is generated | Output to the motor is stopped and inverter drive motor signals ("M1_I" to "M4_I") are turned off. | Operation is continued. |



Commercial power-driven motors (including forced on motor) can be stopped in the following methods.

- ① When turning off commercial power-driven motors individually
 - Set motor mode selection to disable (J411 to J418 = 0).
 - Turn off the pump control motor drive permission command ("MEN1" to "MEN8").
- ② When turning off commercial power-driven motors at a time
 - Set pump control to disable (J401 = 0 or J101/J201 = 0).
 - Perform BX input.

The above-mentioned function codes (J401 J101/J201) cannot be changed during operation.

| | |
|---|--|
| J435 J436 J437 | Motor Regular Switching Mode Selection Motor Regular Switching Time Motor Regular Switching Signal Output Time J401 (Pump Control Mode Selection) J411 to J418 (Motor Mode Selection) J425 (Motor Operating Time Procedure) J454 (Contactor Restart Time during Motor Switching) J458 (Motor Decrease Switching Time (Acceleration time)) J480 to J488 (Operating Time Cumulative Run Time) |
|---|--|

When the number of motors under operation remains unchanged for a period of the motor regular switching time (J436), switch one motor under operation to another motor under suspension. This allows to equalize the operating time of the pump connected to each motor.

■ **Motor regular switching mode selection (J435)**

When the inverter drive motor floating system (J401 = 2) or inverter drive motor floating + commercial power-driven motor system (J401 = 3), communication link inverter floating method (J401 = 52) is specified in pump control mode selection, if the number of motors under operation remains unchanged switching, specifies the motor.

When the inverter drive motor fixed system (J401 = 1) is specified in pump control mode selection, commercial drive motors will be subject to switching. (Same as when J435 is configured to 2.)

- Data setting range: 1, 2, 3

| Data for J435 | Description |
|---------------|--|
| 1 | Inverter-driven motors are subject to switching during cascade operation. During mutual operation, PID controlled units are subject to switching. |
| 2 | During cascade operation, commercial drive motors are subject to switching. During mutual operation, units in highest frequency operation are subject to switching. |
| 3 | During cascade operation, all motors (inverter-driven motors /commercial power-driven motors) are subject to switching. During mutual operation, all motors (PID controlled units/units in highest frequency operation) are subject to switching. |

■ **Motor regular switching time (J436)**

The time for judging the regular switching operation of the motor is specified on a 0.1-hour basis. If the period specified for regular motor switching (J436) elapses without any change in the number of motors in operation, regular motor switching is performed.

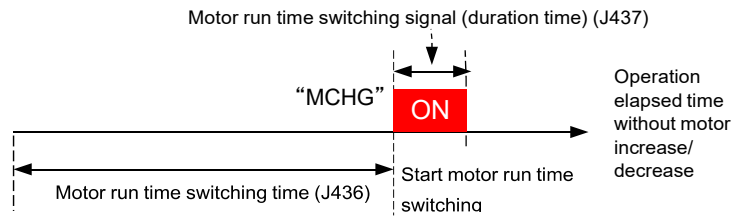
- Data setting range: OFF, 0.1 to 720.0 h, Test

| Data for J436 | Description |
|----------------|---|
| OFF | Disabled |
| 0.1 to 720.0 h | Enable: Switching time |
| Test | Enable: Switching time fixed to three minutes |

■ Motor regular switching signal output time (J437)

Motor regular switching signal output time (duration time) is specified. After a lapse of motor regular switching time (J436), switching forecast signal "MCHG" is output and switching operation is implemented.

- Data setting range: 0.00 to 600.00 second



Furthermore, the motors in which forced on (forced commercial power drive) (J411 to J418 = 2) is selected in motor mode selection shall not be subject to motor operating time switching.


[1] Motors subject to motor operating time switching

After the number of motors remains unchanged for motor operating time switching time (J436), switching operation will be implemented on the following motors.

| Motor regular switching time (J436) | Description | | |
|--|--|--|--|
| OFF | Motor regular switching operation is not implemented. | | |
| 0.1 to 720.0 h | <p>After the number of motors under operation remains unchanged for a period specified in the motor regular switching time (J436), motor regular switching operation will be implemented.</p> <p>The motor under operation with the maximum cumulative run time is stopped and then the motor under suspension with the minimum cumulative run time is driven.</p> <p>However, when the motor subject to stop has a shorter (or the same) cumulative run time than the motor subject to operation, no switching will be implemented.</p> <p>When there are two or more motors in which the maximum cumulative run time is the same with the minimum cumulative run time, the motor with smaller motor number will be subject to switching.</p> | | |
| | Pump control mode selection (J401) | Motor regular switching mode selection (J435) | Motor subject to switching during operation |
| | 1: Fixed system | - | Commercial drive motor |
| | 2: Floating system 3: Floating + commercial power-driven motor system | 1: Subject to commercial power-driven pump | Commercial drive motor |
| | | 2: Subject to inverter-driven pump | Inverter drive motor |
| | | 3: Subject to all pumps | Inverter drive motor Commercial drive motor |
| | 52: Communication link inverter floating method | 1. Subject to commercial drive pumps | Unit in highest-frequency operation |
| | | 2. Subject to inverter drive pumps | PID-controlled unit |
| 3. Subject to all pumps | | PID-controlled unit Unit in highest-frequency operation | |
| 54: Method in which all communication links simultaneously controlled by PID | Regular motor switching not performed. | | |
| Test | Switching operation is implemented as in the case with motor regular time switching function operation (J436 = 0.1 to 720.0 h) However, operating motor switching operation will be implemented after the number of motors under operation remains unchanged for three minutes. This setting is a function used for operation check upon start-up of the inverter. | | |

[2] Cancel regular switching operation

Operating time is counted during which there are no changes in the number of motors. When this count reaches the specified motor operation switching time (J436), regular switching occurs. Clearing this count by changing the regular switching time clearing command "MCLR" from ON to OFF cancels this regular switching. While the switching warning signal "MCHG" is being output, the regular switching time clearing command "MCLR" can be turned from ON to OFF to cancel regular switching.

-  **Note** • When the motor regular switching time clearing command "MCLR" remains turned on continually, the time in which the number of operating motors remains unchanged is always cleared, which prevents motor regular switching from running.

[3] Regular switching via input terminal

Even if there are no changes in the number of motors and the specified motor operation switching time (J436) is not reached, changing the pump control switching command "PCHG" from ON to OFF allows regular switching to be performed. In this case, the count of the time during which the number of motors in operation remains unchanged is cleared.

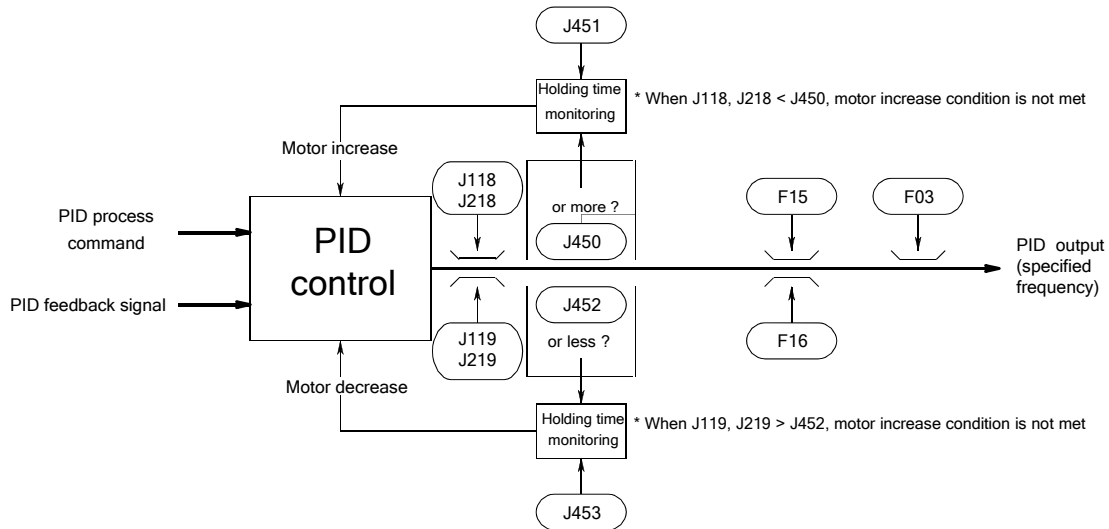
| | |
|--|--|
| J450 J451 J452 J453 | Motor Increase Judgment (Judgment frequency) (Duration time) Motor Decrease Judgment (Judgment frequency) (Duration time) |
|--|--|

During cascade operation (J401 = 1, 2, 3) or during communication link inverter floating method (J401 = 52) in mutual operation, changes in the number of motors are implemented when the motor increase/decrease judgment (duration time) (J451/J453) has elapsed over the inverter operation frequency (PID output (MV)) higher or lower the motor increase/decrease judgment (judgment frequency) (J450/J452).

When J401 = 11, 12 or 13, the judgment uses the actual output frequency instead of MV.

- Note**
- When the deviation between the PID command value (SV value) and the PID feedback value is within the non-responsive area, switching operations are not performed based on the motor change judgment.
 - When the deviation between the PID command value (SV value) and the PID feedback value is negative, the number of motors is not increased based on the motor increase judgment. When the deviation between the PID command value (SV value) and the PID feedback value is positive, the number of motors is not decreased based on the motor decrease judgment.

< Action block diagram of upper and lower limiters >



■ Motor increase judgment (Judgment frequency) (J450)

Motor increase judgment frequency is specified.

- Data setting range: 0 to 120 Hz, Inherit

| Data for J450 | Description |
|---------------|--|
| 0 to 120 Hz | Motor increase judgment frequency |
| Inherit | Depends on the PID control (PID output limiter upper limit) (J118, J218) |

■ Motor increase judgment (Duration time) (J451)

The duration time of motor increase judgment frequency is specified.

- Data setting range: 0.00 to 3600 s

■ Motor decrease judgment (Judgment frequency) (J452)

Motor decrease judgment frequency is specified.

- Data setting range: 0 to 120 Hz, Inherit

| Data for J450 | Description |
|---------------|--|
| 0 to 120 Hz | Motor decrease judgment frequency |
| Inherit | Depends on the PID control (PID output limiter upper limit) (J118, J218) |

■ Motor decrease judgment (Duration time) (J453)

The duration time of motor decrease judgment frequency is specified.

- Data setting range: 0.00 to 3600.00 s

J454

Contactor Restart Time when Switching the Motor

■ Contactor restart time during motor switching (J454)

In the inverter drive motor floating system (J401 = 2, 12) and inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the motors are operated by delaying starting inverter-driven motors or commercial power-driven motors when the number of motors is increased or regular switching is implemented. The delay time (relay or contactor activation delay time) is specified.

- Data setting range: 0.01 to 2.00 s

J455
J456
J457

Motor Increase Switching Time (Deceleration time)
Motor Increase Switching Level
Motor Increase PID Control Start Frequency

■ **Motor increase switching time (Deceleration time) (J455)**

In the inverter drive motor fixed system (J401 = 1, 11), when the number of motors increases in the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the inverter-driven motor is slowed down during the motor increase switching time (deceleration time) (J455), and after the commercial power-driven motor is driven the output frequency reaches the motor increase PID start frequency (J457), and deceleration stops. At this point, PID control recommences, and the inverter-driven motor operates with the PID control MV frequency.

- Data setting range: Inherit, 0.01 to 3600.00 s

| Data for J455 | Description |
|-------------------|---|
| 0.01 to 3600.00 s | The deceleration time of the inverter-driven motor before commercial power-driven motor is driven with motor increase judgment. |
| Inherit | Depend on F08 (Deceleration time 1). When RT1 is ON, the time depends on E11 (Deceleration time 2) |

■ **Motor increase switching level (J456)**

In the inverter drive motor fixed system (J40 = 1, 11), when the number of motors increases in the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), if the output frequency of the inverter driven motor is below the motor increase switching level (J456), the contactors for the increased units is turned ON.

- Data setting range: 0 to 100%

$$\text{Switching frequency [Hz]} = (\text{J456}/100\%) \times ((\text{J118}, \text{J218}) - (\text{J119}, \text{J219})) + (\text{J19}, \text{J219})$$

Note: J118: PID control 1 (PID output limiter upper limit), J119: PID control 1 (PID output limiter lower limit)

Note: J218: PID control 2 (PID output limiter upper limit), J219: PID control 2 (PID output limiter lower limit)

■ **Motor increase PID control start frequency (J457)**

In the inverter drive motor fixed system (J401 = 1, 11), when the number of motors increases in the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the frequency is set to create PID control.

- Data setting range: 0 to 120 Hz, Inherit

| Data for J457 | Description |
|---------------|--|
| 0 to 120 Hz | PID control start frequency after driving the commercial power-driven motor with motor increase judgment |
| Inherit | The motor decrease judgment (judgment frequency) (J452) depends on the motor increase PID control start frequency. |

| | |
|---|--|
| J458 J459 J460 | Motor Decrease Switching Time (Acceleration time) Motor Decrease Switching Level Motor Decrease PID Control Start Frequency |
|---|--|

■ Motor decrease switching time (Acceleration time) (J458)

During motor decrease during cascade operation, the inverter-driven motor is accelerated at motor deceleration switching time (acceleration time) (J458). After the commercial driven motor is interrupted, acceleration stops when output frequency reaches the motor decrease PID start frequency (J460). At this point, PID control recommences, and the inverter-driven motor operates with the PID control MV frequency.

- Data setting range: Inherit, 0.01 to 3600.00 s

| Data for J458 | Description |
|-------------------|--|
| 0.01 to 3600.00 s | The acceleration time of inverter-driven motor before stopping the commercial power-driven motor with motor decrease judgment. |
| Inherit | F07: Depends on acceleration time 1 (When RT1 is turned ON, E10: acceleration time 2) |

■ Motor decrease switching level (J459)

When motors are decreased during cascade operation, if the output frequency of the inverter-driven motor is above that of the motor decrease switching level (J459), the contacts for the decreased units are turned OFF.

- Data setting range: 0 to 100%, Inherit

| Data for J459 | Description |
|---------------|---|
| 0 to 100% | The inverter-driven motor frequency level when the commercial power-driven motor is stopped with motor decrease judgment. |
| Inherit | The motor increase switching level (J456) depends on the motor decrease switching level (J459). |

$$\text{Switching frequency [Hz]} = (\text{J459}/100\%) \times ((\text{J119}/219) - (\text{J118}/219)) + \text{J19}$$

■ Motor decrease PID control start frequency (J460)

When motors are decreased during cascade operation, the PID control start frequency is specified.

- Data setting range: 0 to 120 Hz, Inherit

| Data for J460 | Description |
|---------------|--|
| 0 to 120 Hz | The PID control start frequency after the commercial power-driven motor is stopped with motor decrease judgment. |
| Inherit | Depends on the motor increase judgment (judgment frequency) (J450) |

J461**Motor Increase/Decrease Switching Judgment Non-responsive Area Width**

■ Motor increase/decrease switching judgment non-responsive area width (J461)

In the PID control, no motor increase/decrease judgment will be performed as long as the deviation between the PID command value (SV value) and the PID feedback value is less than the specified value.

- Data setting range: OFF, 0.1 to 50.0%

| Data for J461 | Description |
|---------------|--|
| 0.1 to 50.0% | Deviation between PID command value (SV value) and PID feedback value, assuming 100% of PID feedback full scale. |
| OFF | Disable (Always perform motor increase/decrease judgment) |

J462**Failure Inverter Judgment Time**

In the communications-linked inverter drive motor floating system (J401 = 52), if PID control comes to be at the hold state in the inverter running under PID control due to the limiter (e.g., current limit), then it is judged whether to exclude the PID control inverter.

If any other ready-to-run inverter exists in the system and the failure inverter judgment time (J462) has elapsed, the current PID control inverter will be switched to the other one.

This switching does not involve increase/decrease of inverters or regular switching even if their conditions are met.

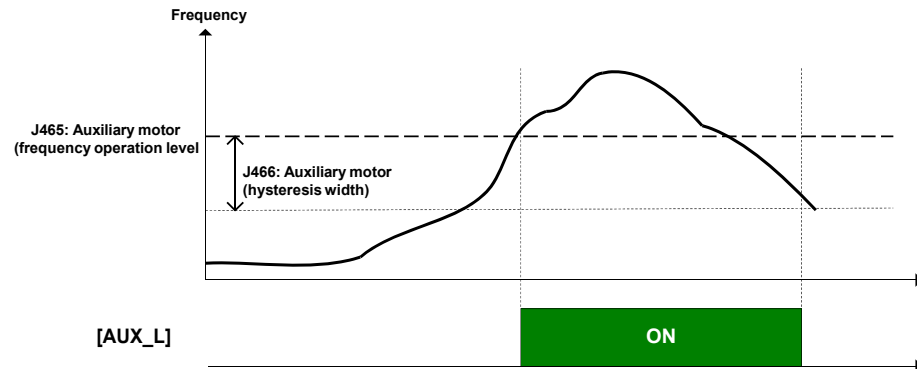
If J462 = OFF, no switching occurs. During auto search for idling motor speed, no PID control inverter will be switched even if PID control comes to be at the hold state.

- Data setting range: OFF, 0.5 to 600.0 s

**J465
J466**

**Auxiliary Motor (Frequency operation level)
(Hysteresis width)**

When all the set motors are under operation, the output frequency (for cascade operation: inverter-driven motor output frequency; for mutual operation: output frequency of units during PID control) reaches the auxiliary motor (frequency operation level) (J465), the auxiliary motor drive signal "AUX_L" is turned on and output. When the frequency is lowered below the auxiliary motor (frequency operation level) by more than the auxiliary motor (hysteresis width) (J466), the auxiliary motor drive signal "AUX_L" is turned OFF. However, when the configuration is set to disable (J101/J201 = 0) in PID mode selection, or the configuration is set to disable (J401 = 0) in the pump control mode selection, the auxiliary motor drive signal "AUX_L" is turned OFF at all time.



■ Auxiliary motor (frequency operation level) (J465)

The frequency for determining the auxiliary motor drive is specified. When the frequency of the inverter-driven motor exceeds this value, the auxiliary motor is driven.

When the configuration is set to 0.0, the frequency at the frequency detection operation level (E31) is specified.

- Data setting range: OFF, 0.1 to 120.0 Hz

■ Auxiliary motor (hysteresis width) (J466)

The frequency width for determining the auxiliary motor stop is specified. When the frequency is lowered below the auxiliary motor (frequency operation level) (J465) by more than this value, the auxiliary motor is stopped.

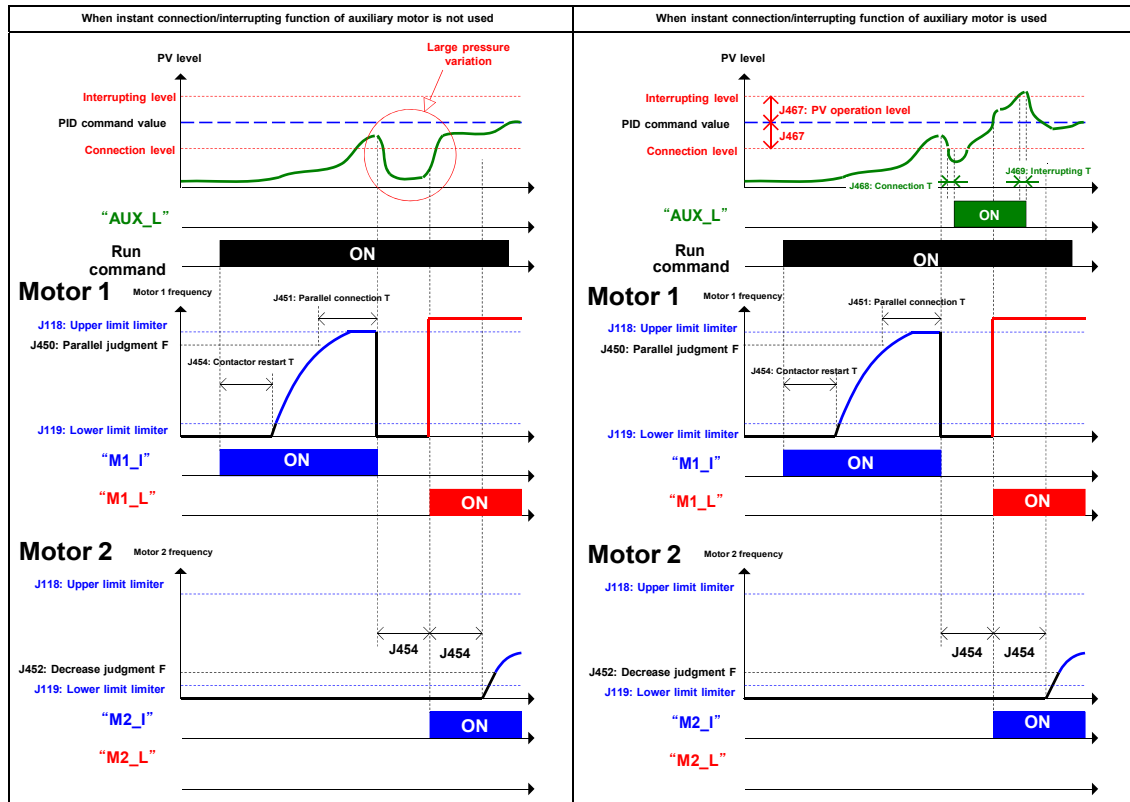
When the configuration is set to 0.0, the frequency detection hysteresis width (E32) is specified.

- Data setting range: 0.0 to 120.0 Hz

J467
J468
J469

**Auxiliary Motor (PV operation level)
(Connection timer)
(Interrupting timer)**

For the inverter drive motor floating system (J401 = 2, 12) in the pump control mode selection, the inverter-driven motor is allowed to free-run before increasing the number of motors. The auxiliary motor is driven to control the pressure variation during a time period until the motor is commercial power-driven (contactor restart time during motor switching (J454)). Furthermore, when the number of motors is decreased, the auxiliary motor is not driven. The timing to drive and stop the auxiliary motor is determined by the connection level and the interrupting level. This judgment is implemented continually for a given period of time after allowing the inverter-driven motor to free-run. This period of time is ten times the larger value of the contactor restart time during motor switching (J454) or the auxiliary motor (connection timer) (J468).



In the pump control, each motor cumulative run time (J480 to J488) is cumulated. The motor cumulative run time can be used for maintenance plan.

The motor cumulative run time is counted when the gate is turned ON and the dew condensation prevention function is not operated.

This is counted even during commercial operation due to the output signal, “M□_L” from the inverter.

The cumulative run time is cumulated in the range from 0 to 65,535 hours and reset to zero as it exceeds 65,535 hours, and then the time is cumulated continually. For the display of cumulative run time, 1 hour is displayed as 1 hours in the keypad.


The cumulative run time can be specified to any value from the keypad. The initial time of replacing machine parts or inverter can be specified to any value.

The chart below indicates cumulative operating times and corresponding motor numbers for each pump control mode selection (J401) setting.

| Function code | | Pump control mode selection (J401) | | |
|---------------|-------------------------------------|------------------------------------|----------------------|--------------|
| | | 1, 11 | 2, 3, 12, 13 | 52, 54 |
| J480 | Cumulative operating time (Motor 0) | Inverter drive motor | - | Master unit |
| J481 | Cumulative operating time (Motor 1) | M1_L motor | M1_I and M1_L motors | Slave unit 1 |
| J482 | Cumulative operating time (Motor 2) | M2_L motor | M2_I and M2_L motors | Slave unit 2 |
| J483 | Cumulative operating time (Motor 3) | M3_L motor | M3_I and M3_L motors | - |
| J484 | Cumulative operating time (Motor 4) | M4_L motor | M4_I and M4_L motors | - |
| J485 | Cumulative operating time (Motor 5) | M5_L motor | - | - |
| J486 | Cumulative operating time (Motor 6) | M6_L motor | - | - |
| J487 | Cumulative operating time (Motor 7) | M7_L motor | - | - |
| J488 | Cumulative operating time (Motor 8) | M8_L motor | - | - |

| | |
|--|--|
| J490 J491 J492 J493 | Y terminal ON Maximum Cumulation Count (Y1 Y2) (Y3 Y4) (Y5A 30AB) (Y6RY to Y12RY) |
|--|--|

Y terminal output and relay output option ON/OFF cumulation count can be monitored. This serves as a guide for the operating life of each relay. The cumulation count stops when 1 million is reached. Furthermore, the relay time can be reset by the user by clearing the relay ON cumulation count and using the keypad. This is operational only when cascade operation is enabled (J401 = 1, 2, 3, 11, 12, 13). The count is stored in units of 16 when the power is off, so the maximum deviation is 16 each time the power is turned off.

 • The relay ON maximum cumulation count (J490 to J493) is resettable by keypad operation.

■ Y terminal ON maximum cumulation count (Y1 Y2) (J490)

The larger of the cumulation counts of Y terminal outputs (E20, E21) ON of inverter main body is displayed. The display of "1.000" indicates 1000 times.

■ Y terminal ON maximum cumulation count (Y3 Y4) (J491)

The larger of the cumulation counts of Y terminal outputs (E22, E23) ON of inverter main body is displayed. The display of "1.000" indicates 1000 times.

■ Relay ON maximum cumulation count (Y5A 30AB) (J492)

The larger of the cumulation counts of relay outputs (E24, E27) ON of inverter main body is displayed. The display of "1.000" indicates 1000 times.

■ Relay ON maximum cumulation count (Y6RY to Y12RY) (J493)

The larger of the relay ON cumulation counts on the relay output option (OPC-RY2) is displayed. The display of "1.000" indicates 1000 times.

| Output terminals | Lifetime of contacts | Capacity of contacts |
|-------------------------------------|---|-----------------------------|
| Transistor outputs (Y1, Y2, Y3, Y4) | Depends upon the specifications of the relay to be connected. | - |
| Contact outputs (Y5, 30A/B/C) | 200000 times (when turned ON/OFF at one-second intervals) | 250 VAC 0.3A 48 VDC 0.5A |
| Relay output option OPC-RY | 200000 times (when turned ON/OFF at one-second intervals) | 250 VAC 0.3A 48 VDC 0.5A |
| Relay output option OPC-RY2 | 200000 times (when turned ON/OFF at one-second intervals) | 250 VAC 0.3A 48 VDC 0.5A |