## 8.1.12 Sensorless(II) vector control

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

**⚠ Caution**

**The parameter of the motor connected to the output terminal of the inverter should be measured for high-performance operation. Measure the parameter using auto tuning(BAS-20 Auto Tuning) before vector operation. For high-performance control of sensorless(I) vector control, the inverter capacity should be equal to that of the motor. If the motor capacity is lower than the inverter capacity by more than 2 phases, there might be a problem with the control characteristic, so change the control mode to V/F control. In addition, in case of sensorless(I) vector control operation, do not connect more than one motor to the inverter output.**

Before auto tuning, enter the items on the motor plate first.

DRV-14 Motor Capacity (motor capacity)
BAS-11 Pole Number (number of poles)
BAS-12 Rated Slip (rated slip)
BAS-13 Rated Curr (rated current)
BAS-15 Rated Volt (rated voltage)
BAS-16 Efficiency (efficiency)

Separate the load connected to the motor shaft and set the auto tuning item at No. 1 All. The motor measures the parameter while rotating. When auto tuning finishes, the measured values of the motor stator resistance(Rs), leak inductance(Lsigma), stator inductance(Ls), no-load current(Noload Curr) and rotor time constant(Tr) are saved in BAS-21, BAS-22, BAS-23, BAS-14 and BAS-24 respectively.

**CON-20 SL2 G View Sel :** If you select No. 1 Yes, the user can set various gains(CON-23 ASR-SL P Gain2, CON-24 ASR-SL I Gain2, CON-27 Observer Gain2, CON-28 Observer Gain3, CON-31 S-Est P Gain2, CON-32 S-Est I Gain2) applied to rotation at higher than medium speed(about 1/2 of the base frequency). If you select No. 0 No, the related parameter is not displayed.

1) Speed Controller Gain

**CON-21 ASR-SL P Gain1, CON-22 ASR-SL I Gain1 :** The speed PI controller gain of the sensorless(II) vector control can be changed. In PI speed controller, the speed controller PI gain is the proportional gain of the speed error and has a characteristic of having higher torque output command as the speed error rises. That is why the higher the speed error is, the faster speed variance decreases. The speed controller I gain is the integral gain of the speed error. When a constant speed error continues, the speed controller I gain is the time(msec) it takes until the rated torque output command. The lower the value is, the faster the speed variance decreases.

The wave form of the speed controller gain can be improved after observing the tendency of the speed change. If the speed variance is not rapidly reduced, the speed controller P gain can be increased or I gain(time in terms of msec) can be decreased. However, if P gain is increased or I gain is decreased too much, a lot of vibration might occur. In addition, in case of oscillation of the speed wave form, it can be adjusted by increasing I gain or P gain.

**CON-23 ASR-SL P Gain2, CON-24 ASR-SL I Gain2 :** Can be seen only when SL2 G View Sel(CON-20) is set as No. 1 Yes. The speed controller gain at higher than the medium speed of sensorless(II) vector control(about 1/2 of the base frequency).

CON-23 ASR-SL P Gain2 is set as the percentage of the low speed gain CON-23 ASR-SL P Gain1. That is, the lower P Gain2 is than 100.0%, the lower the responsiveness is. For example, if CON-23 ASR-SL P Gain1 is 50.0% and CON-23 ASR-SL P Gain2 is 50.0%, the speed controller P gain at higher than the actual medium speed is 25.0%.

CON-24 ASR-SL I Gain2 is also set in percentage of the CON-24 ASR-SL I Gain1. For I gain, as well, the lower I Gain2 is, the lower the responsiveness is. For example, if CON-23 ASR-SL I Gain1 is 100msec and CON-23 ASR-SL I Gain2 is 50.0%, the speed controller I gain at higher than the actual medium speed is 200msec. The controller gain is set according to the default motor parameter and Acc/Dec time.

2) Magnetic Flux Observer Controller Gain

**CON-26 Observer Gain1, CON-27 Observer Gain2, CON-28 Observer Gain3 :** For sensorless(II) vector control, the observer for estimating the stator current and rotor magnetic flux of the motor is essential. Observer Gain1(CON-26) applies at low and medium speed and Observer Gain2(CON-27) applies at medium and high speed and Observer Gain3(CON-28) applies in the torque mode. It is recommended that you do not change the observer gain from its default value.

Observer Gain2(CON-27) and Observer Gain3(CON-28) can be see only when SL2 G View Sel(CON-20) is set at No. 1 Yes.

3) Speed Estimator Gain

**CON-29 S-Est P Gain1, CON-30 S-Est I Gain1 :** The speed estimator gain of sensorless(II) vector control can be changed. The speed estimator P gain or I gain can be increased or decreased by a small amount for adjustment when the displayed value of speed is not equal to the goal value in a normal state. These gains can be also adjusted when there is great vibration in the motor or high current ripple with power ON. In such a case, you can conduct a test mostly by decreasing the P gain or I gain of the speed estimator. The speed estimator gain is set according to the default motor parameter and Acc/Dec time.

**CON-31 S-Est P Gain2, CON-32 S-Est I Gain1 :** Can be see only when SL2 G View Sel(CON-20) is set at No. 1 Yes. The speed estimator gain can be changed at higher than the medium speed(above a half of the base frequency) in sensorless(II) vector control.

CON-31 S-Est P Gain2 and CON-32 S-Est I Gain1 are respectively set as the percentage of low speed gain CON-29 S-Est P Gain1 and CON-30 S-Est I Gain1. For example, if CON-29 S-Est P Gain1 is 300 and CON-31 S-Est P Gain2 is 40.0%, the speed estimator P gain at higher than the actual medium speed is 120. The setting method is the same as the low and medium speed gain setting method. The speed estimator gain is set according to the default motor parameter and Acc/Dec time.

**CON-34 SL2 OVM Perc :** Output Voltage have a linearity for Input Voltage at non-overmodulation area which the ratio of Output Voltage /Input Voltage is below 100%. At CON-34 (SL2 OVM Perc) can set the voltage range which is limited at Sensorless-2 overmodulation area. In a application such as impact load (Press etc.; Torque limit<load), Tripless operation can be possible by increasing the value of CON34 (SL2 OVM Perc) when load is applied. (Default value: 120 [%])

Also, Input Voltage is lower than nominal voltage at the area where supply a unstable input voltage so OC1 Trip is occurred frequently when heavy reverse load such as impact load (Torque Limit<Load) is applied. The Trip caused by lower Output Voltage. In this case, set the CON-34 (SL2 OVM Perc) to 140~150% and you can operate Tripless operation in case heavy load is applied.

**CON-48 ACR P-Gain, CON-49 ACR I Gain :** Adjusts the P gain and I gain of the current PI controller.

**DRV-10 Torque Control :** The speed control mode and torque control mode are selected from the sensorless(II) vector control mode and used. If the torque control(DRV-10) is set as Yes, operation is carried out in the torque control mode. For details on the torque control mode, see 8.1.14 Torque control.

**⚠ Caution**

**The controller gain can be adjusted according to the load characteristic. However, motor overheat of system instability might occur according to the controller gain setting.**

**Guide on Various Gain Adjustment of Sensorless (II) Vector Control :** Because the sensorless(II) vector control is greatly influenced by the characteristics of the motor and load, it is sometimes necessary to adjust the controller gain. Let's assume that the sensorless(II) vector control is carried out in speed mode (DRV-10 torque control set at No. 0 No).

Firstly, if instable operation is observed at extremely low speed below 2~3Hz) or the speed bounds during starting, adjust the gain properly increasing CON-22 ASR-SL I Gain1 until it is twice the default value.

Secondly, where regenerative load is usually used, torque ripple might occur frequently in the motor with regenerative load supplied. In such a case, try increasing CON-21 ASR-SL P Gain1 to 50% of the default value to adjust the gain properly. If it does not work, increase CON-21 ASR-SL P Gain1 back to the default value and adjust the gain value decreasing CON-30 S-Est I Gain 1 to 50% of the default value.