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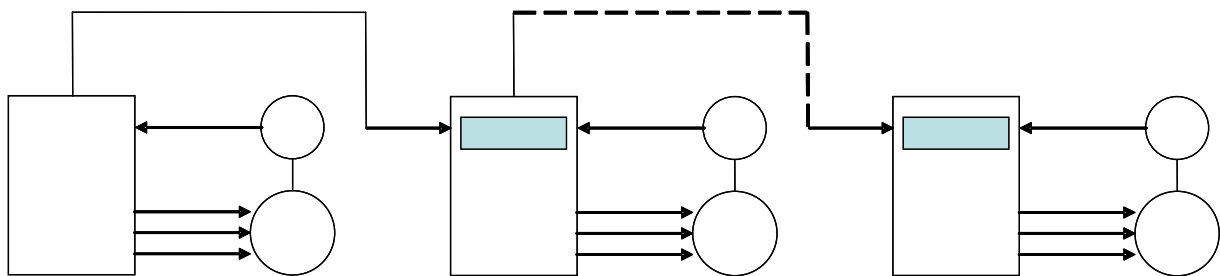
## Sync Operation Control Application

The functions of sync operation control (SYN) group and control terminal in case of using iV5 series vector inverter exclusively for sync operation control inverter are described in this Chapter. Some parts that overlap in common with the usage of universal vector inverter are omitted.

### 1 Introduction & Performance Specification of Sync Option Board

#### 1.1 Introduction

Sync Option Board carries out sync control of speed and position using the Master inverter encoder input and its own motor encoder input signals, used for the interlock control of several inverters.



Example of Sync Option Board Application

#### 1.2 Hardware Specification

Item		Specification	
Type of Installation		Mounted on option connector within inverter control board	
Power Source	Control Power	Supplied from inverter	
	External Power	24V supplied from outside	
Encoder Power Output (Isolated Type)	Master Encoder	Line Drive	5V
		Open Collector	15V
	Slave Encoder	Line Drive	5V
		Open Collector	15V
Range of Encoder Signal Input Frequency		Max. 100kHz	
Encoder Pulse Number	Master Encoder	360 ~ 4096	
	Slave Encoder		
Output Signal Specification	Return Pulse	Open Collector type Master Encoder Return Pulse	
	OT1	Open Collector type Speed Sync completed Signal	
	OT2	Open Collector type Position Sync completed Signal	

#### 1.3 Performance Specification

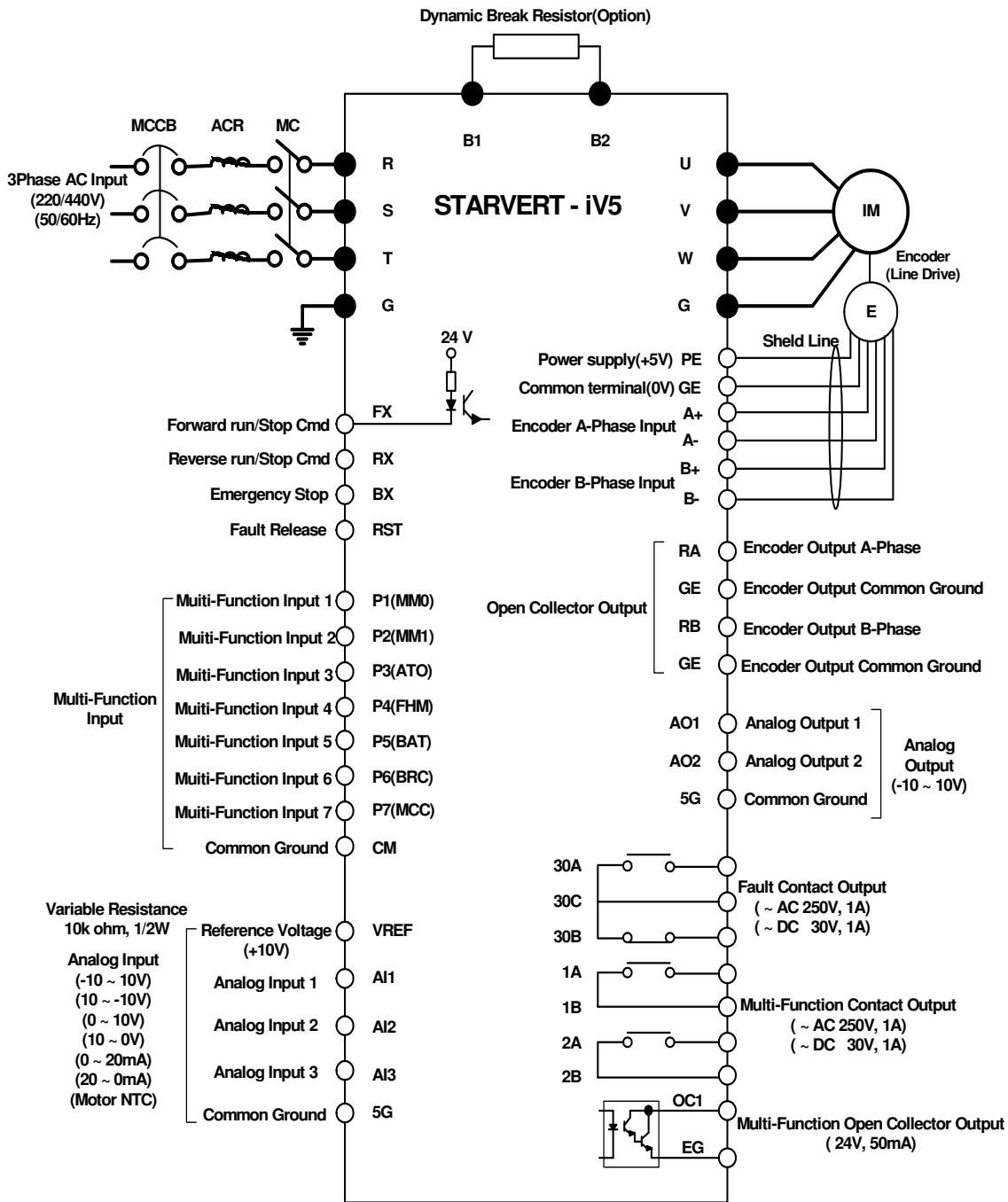
Item	Specification
Speed Sync	0 ~ Speed Limit(Configured in SYN_13)
Position Sync	±5 degrees (In case of constant speed operation at PG Operation 1500 RPM)

## 2 Installation and Wiring

### 2.1 Inverter Terminal Connection Diagram

The power of motor fan, in case it is in 200V series, is directly connected from input power without transformer. In case of 400V series, however, the secondary output voltage of the transformer should be 220V. That is, the voltage ratio of 380: 220 is required for 380V input, while 440: 220 for 440V input.

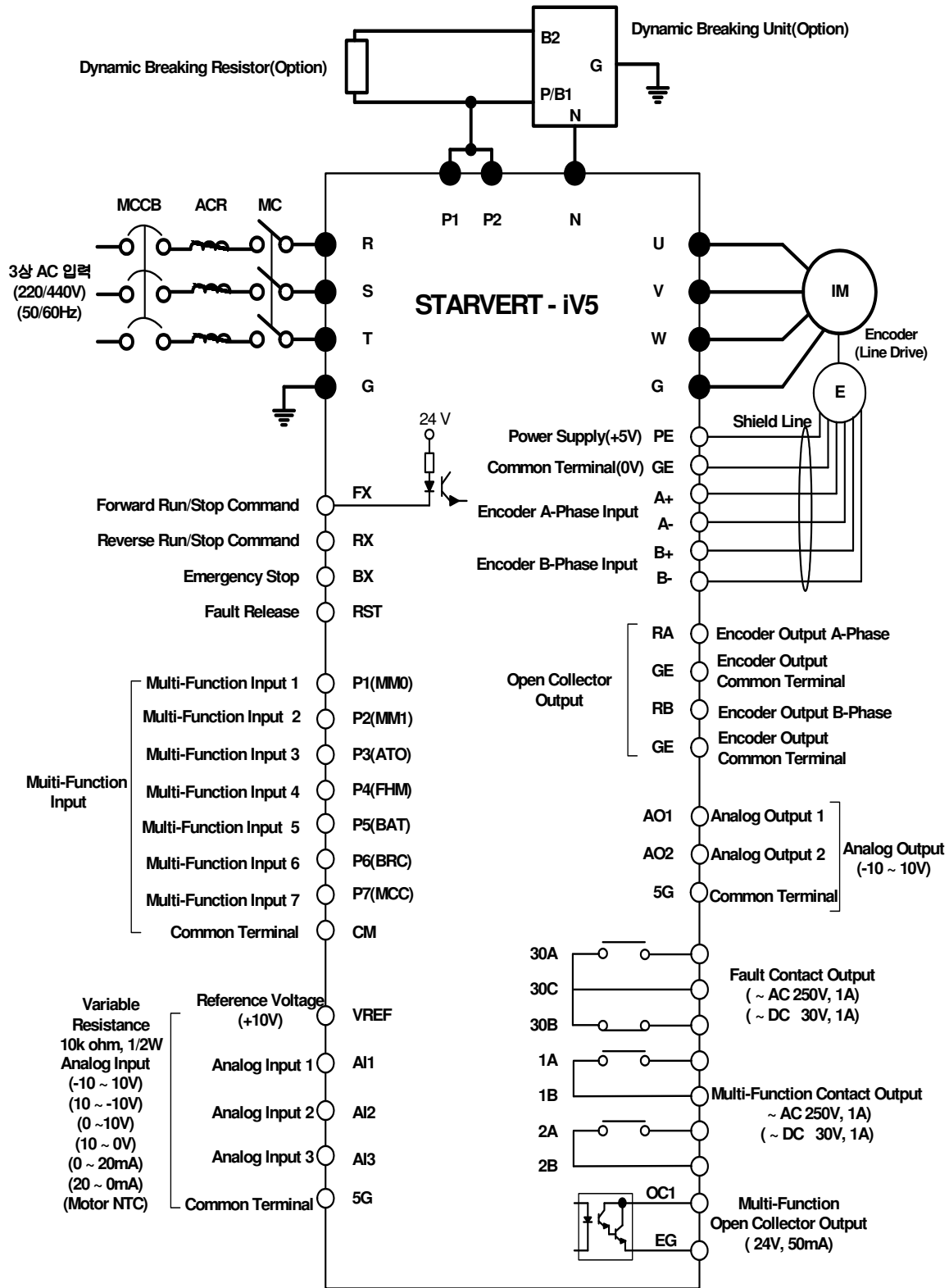
■ SV022iV5-2/4DB ~ SV220iV5-2/4DB



Note) ● : Power Terminal, ○ : Control Terminal

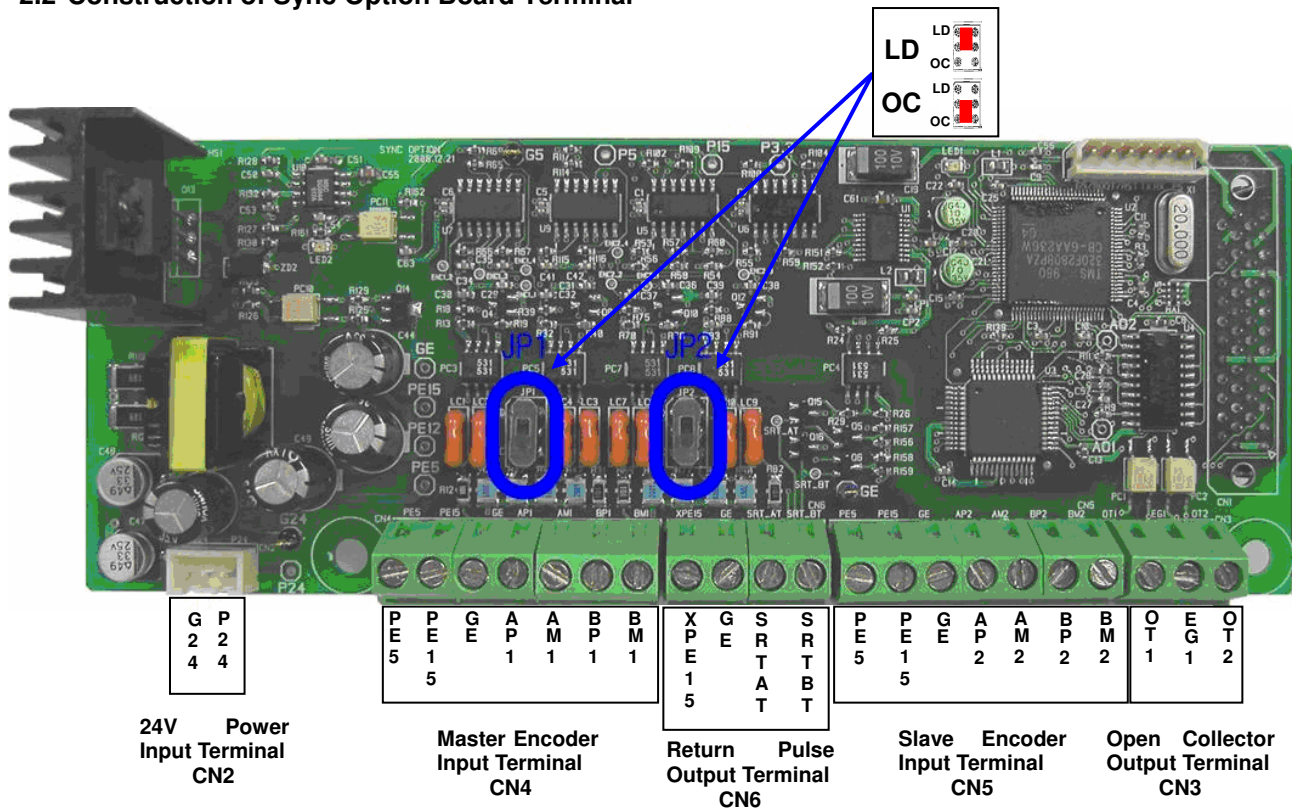
# Sync Operation Application

■ V300/370iV5-2, SV300iV5-4 ~ SV2200iV5-4



Note) ● : Power Terminal, ○ : Control Terminal

## 2.2 Construction of Sync Option Board Terminal



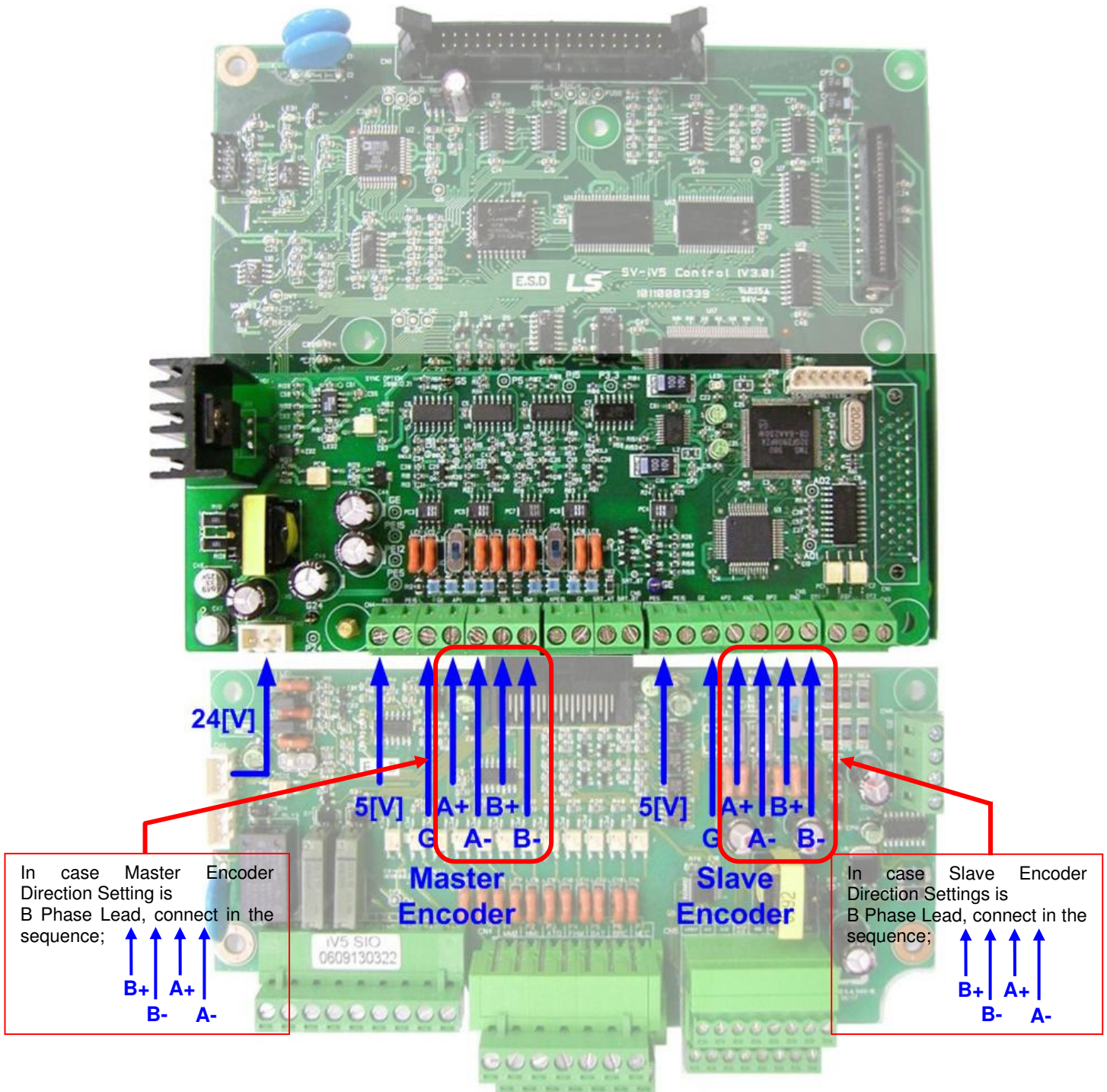
Division	Code	Title	Description		
Encoder Input	C N 4	PE5	Master Encoder Power Supply	5V Line Drive Power Supply	
		PE15		15V Open Collector Power Supply	
		GE		0V	
		AP1	Phase A Input of Master Encoder	Connected to the encoder coupled with main motor or main drive shaft. Please configure Jumper1 (JP1) in conformity with Encoder Type (Open Collector, Complementary, Line Drive)	
		AM1			
		BP1			
	C N 5	PE5	Slave Encoder Power Supply	5V Line Drive Power Supply	
				PE15	15V Open Collector Power Supply
				GE	0V
		AP2	Phase A Input of Slave Encoder	Connected to the encoder coupled with Slave Motor or Slave Drive Shaft. Please configure Jumper2 (JP2) in conformity with Encoder Type (Open Collector, Complementary, Line Drive). <u>In case SIO Board Return Pulse is connected to Slave Encoder Input Terminal, Power of Slave Encoder Input Terminal is not necessary.</u>	
		AM2			
		BP2			
Encoder Output	C N 6	XPE15	External Encoder Power Supply	Used when 15V Encoder Power is supplied from outside.	
		GE	Common Terminal for Encoder Output	Return Output Terminal outputs signals of Master Encoder input terminal. Return Pulse Output Terminal in the type of Open Collector.	
		SRT_AT	Phase A Output of Encoder		
		SRT_BT	Phase B Output of Encoder		
Contact Output	C N 3	OT1	End of Speed Sync Signal	Open Collector Output Terminal outputs signals at the time of sync operation. For further detail, please refer to SYN Groups 18 ~ 21.	
		EG1	Contact Output Common Terminal		
		OT2	End of Sync Position Signal		

## 2.3 Example of Sync Option Board Connection

### 2.3.1 Example of Connection 1 :

Master Encoder Input Terminal Signal: Line Drive Type

Slave Encoder Input Terminal Signal: Line Drive Type

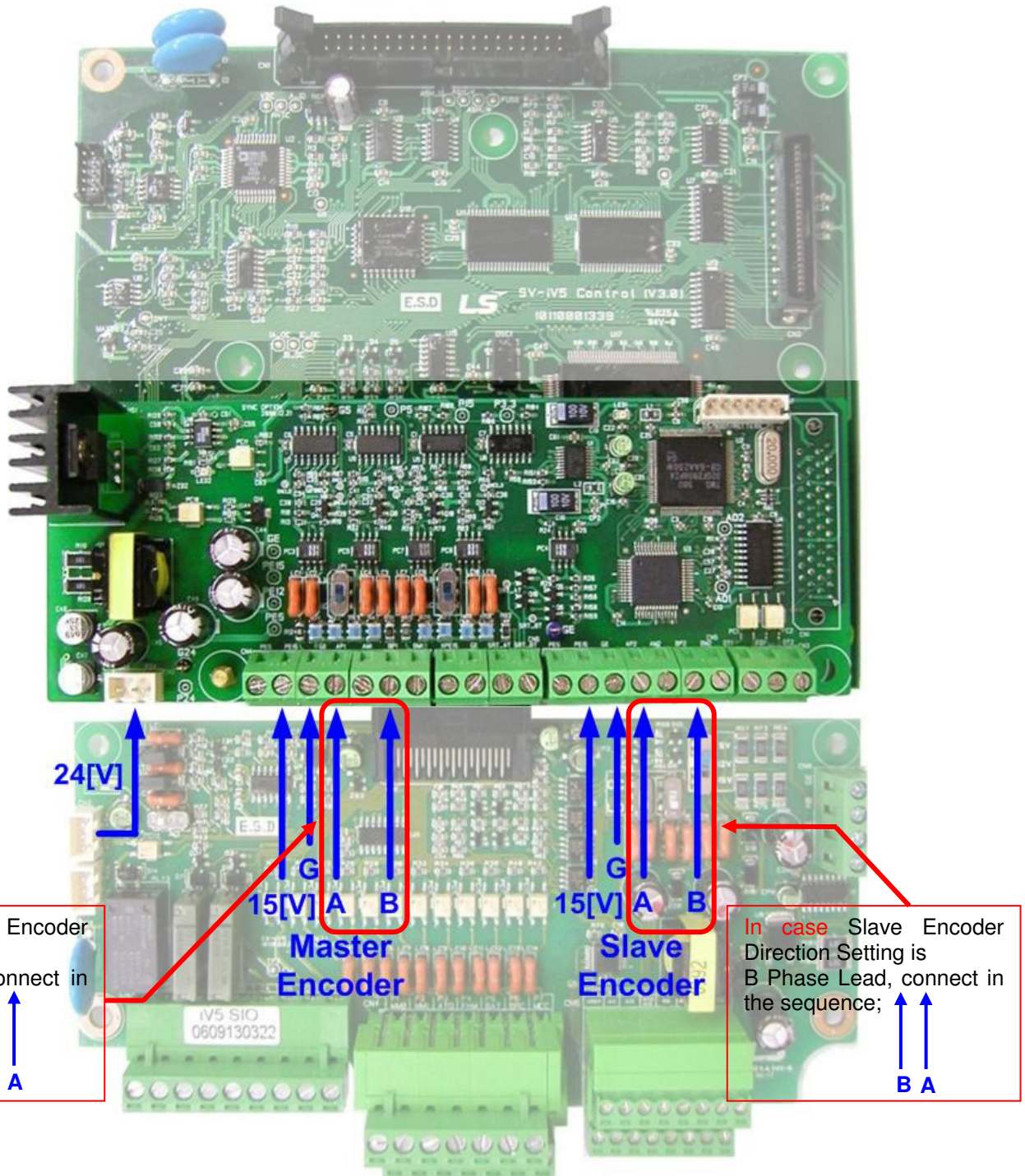


1. Connect the signal lines of Master Encoder and Slave Encoder as above.
2. Configure Jumper1(JP1) and Jumper2(JP2) with LD

### 2.3.2 Example of Connection 2:

Master Encoder Input Terminal Signal: Open Collector Type

Slave Encoder Input Terminal Signal: Open Collector Type



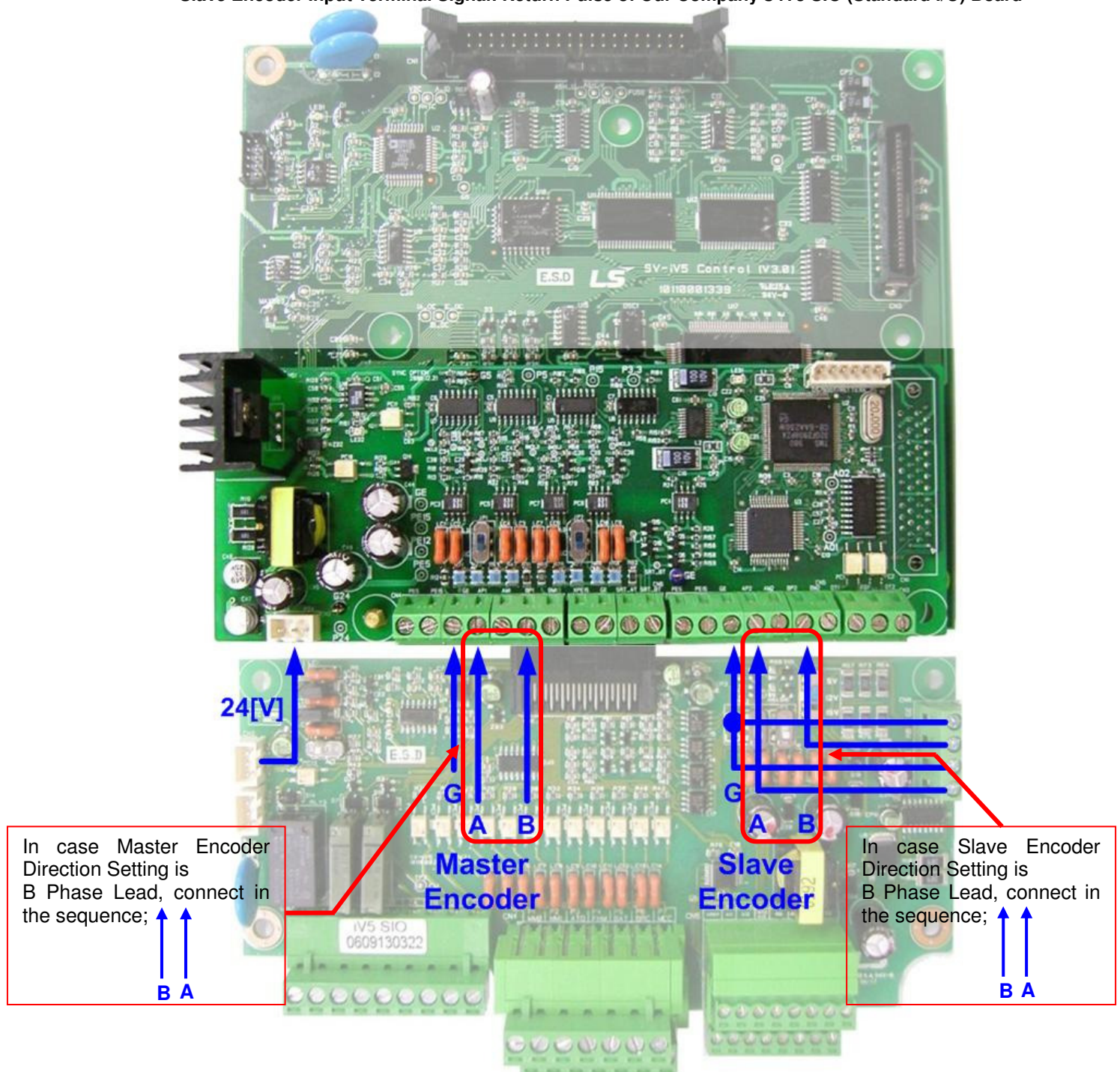
1. Connect the signal lines of Master Encoder and Slave Encoder as above
2. Configure Jumper1 (JP1) and Jumper2 (JP2) with OC.

## Sync Operation Application

### 2.3.3 Example of Connection 3:

Master Encoder Input Terminal Signal: Return Pulse of Our Company's iV5 SIO (Standard I/O) Board

Slave Encoder Input Terminal Signal: Return Pulse of Our Company's iV5 SIO (Standard I/O) Board



1. Connect the signal lines of Master Encoder and Slave Encoder as above.
2. Configure Jumper1 (JP1) and Jumper2 (JP2) with OC.
3. **When using the return pulse of our Company's iV5 SIO (Standard I/O), don't connect it to the power supply.**

## 3 Preparations and Operation

### 3.1 Change into Sync Operation Control Mode

LCD loader display can be indicated up to 32 digits in English letters and Arabic numerals, allowing you to directly check a variety of settings on screen.

Shown below are the appearance of LCD loader and the functions of each part. In case of setting control (CON) group CON\_02 (Application) to “Synchro” after installing sync option board, LCD loader home screen is changed into sync operation control mode as shown in the following figure. For the function of each key of the loader, please refer to ‘Loader’ in 4.1, Chapter 4.

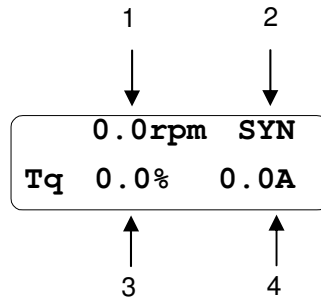


#### 3.1.1 Method of Changing into Sync Operation Control Mode

CON ▶ Application 02 General Vect	Move to Application Mode of Control (CON) Group
CON ▶ Application 02 General Vect ■	Press [PROG] key. Universal Vector Application Mode – Cursor appears (■)
CON ▶ Application 02 Synchro ■	Change into sync operation control mode using [▲(Up)] key.
CON ▶ Application 02 Synchro	Set to sync operation control mode pressing [ENT] key.

## 3.2 Loader Display in Sync Operation Control Mode

### 3.2.1 Home Screen



The status of the screen as above is called “Home Screen of Display Group” or “Home Screen”, and you can return to this home screen by pressing SHIFT/ESC key. Each item on the screen shows the associated information as shown in the table below.

Item No.	Title	Function
1	Motor Speed	Indicate actual rotating speed of the motor in rpm
2	Motor Control Mode	SPD : Speed Control Mode TRQ : Torque Control Mode <b>SYN : Sync Operation Control Mode</b> BX : Indication of Emergency Stop State
3	Torque	Indicate detent torque occurred against 100% rating output of the motor
4	Inverter Output Current	Indicate effective value for the inverter’s actual output current

### 3.2.2 Faults Detected in Sync Operation Control Mode

Faults detected in the exclusive mode for sync operation are as follow, which are displayed in DIS\_05.

Barrier Function	LCD DISPLAY	Fault
Error of Exclusive Sync Board Power Supply	SynPower Err	When 24V power is not supplied to exclusive sync board, LED2 is turned off, indicating the failure of power supply.
Detecting Error from Master Encoder	Master Enc Err	When the cable of master encoder is short-circuited or wrongly connected where Sync_07 M_Enc ErrChk is set to ‘Yes’, it detects encoder error generating fault of encoder. In case of open collector typed encoder, however, it cannot detect encoder error. In this case, set Sync_07 M_Enc ErrChk to ‘No’.
Detecting Error from Slave Encoder	Slave Enc Err	When the cable of master encoder is short-circuited or wrongly connected where Sync_09 S_Enc ErrChk is set to ‘Yes’, it detects encoder error generating fault of encoder. In case of open collector typed encoder, however, it cannot detect encoder error. In this case, set Sync_09 S_Enc ErrChk to ‘No’.

## 3.3 Parameter Group Change

When selecting sync operation control application mode, sync operation control group (SYN) is added following the user group, provided that sync option board is installed on the control board.

Name of Group	LCD loader (Left upper corner of LCD)	Major Description
Display Group	DIS	Motor Speed, Motor Control Mode, Detent Torque, Inverter Output Current, User Selection Display, Process PID Output / Ref / Fdb, Current Failure State, User Group Display Setting
Digital I/O Group	DIO	Digital Input Parameter, Digital Output Parameter, etc.
Parameter Group	PAR	Parameter Initialization, Parameter READ / WRITE / LOCK / PASSWORD, Motor-related Constant, Auto-Tuning, etc.
Function Group	FUN	Operation Frequency, Operation Method, Stop Method, Acceleration/Deceleration Time and Pattern,

## Sync Operation Application

		Carrier Frequency, Electronic Thermal Selection, etc.
Control Group	CON	Control Mode, ASR PI Gain, Process PID Gain, Draw Control Setting, Droop Control-Related Constant, Torque Control-Related Constant, etc.
External Group	EXT	Parameter Setting for Communication Option Mode, etc.
Analog I/O Group	AIO	Analog Input Parameter, Analog Output Parameter, etc.
User Group	USR	User Macro Definition, User Macro Storage, User Macro Recall, etc.
<b>Sync Operation Group</b>	<b>SYN</b>	<b>Parameter Settings for the Control of Speed Sync and Position Sync at the time of Sync Operation</b>

- For further details by groups except sync operation group, please refer to Function in Sector 6 of Main Manual.

### 3.4 Motor Parameter Input

Superior characteristics of the motor can be acquired if you input the motor parameters in the following order and conduct the tuning of each parameter using auto-tuning function.


Loader Display	Description
PAR ▶ Motor select 07 kW	Input the capacity of the motor to be used. The basic capacity is same as that of the inverter. If motor capacity is not shown on the list, select "User Define", and then input it directly in PAR_08
PAR ▶ UserMotorSel 08 kW	In case selecting "User Define" in PAR_07, directly input the motor capacity in PAR_08. <small>☞ (PAR_08 is shown only when you set PAR_07 as "User Define")</small>
PAR ▶ Enc Pulse 10	Input the pulse number of encoder attached to the motor.
PAR ▶ Base Speed 17 rpm	Input the based speed of the motor. <small>☞ Caution: Not the rating speed described on the name plate.</small>
PAR ▶ Rated Volt 18 V	Input the base voltage of the motor. (Rated voltage of the motor described on the name plate)
PAR ▶ Pole number 19 []	Input the pole number of the motor.
PAR ▶ Efficiency 20	Input the efficiency of the motor. <u>In case the efficiency is not described on the name plate of the motor, don't change it, but just leave it in the initial value.</u>
PAR ▶ Rated-Slip 21 rpm	Input the rated slip of the motor. (Motor rated slip = Motor base Speed – Motor rated speed)
PAR ▶ Rated-Curr 22 A	Input the rated current of the motor

### 3.5 Auto-Tuning

Out of the parameters of the motor, it automatically detects stator resistance, stator inductance, magnetizing current, secondary time constant of the motor playing important roles in the vector control, allowing it to obtain exact characteristics. Auto-tuning method consists of measuring with the motor rotated (Rotary Auto-Tuning) and stopped (Static Auto-Tuning).

#### 3.5.1 Rotary Auto-Tuning Method

##### 1) Preparatory Work

 <b>Caution</b>
<ul style="list-style-type: none"> <li>Be sure to leave the motor in unloaded state by removing the mechanical part connected with the motor shaft. Otherwise, it may cause personal injury and/or damage to the machine. Furthermore, it requires sudden acceleration/deceleration several times to find the secondary time constant of the motor, and therefore you have to conduct auto-tuning with the damping resistance connected.</li> </ul>

##### 2) Sequence of Auto-Tuning

Loader Display	Description	Tuning Time
PAR ▶ AutoTuneType 23 Rotational	Be sure to set auto-tuning method to <b>‘Rotational’</b> .	-
PAR ▶ Auto tuning 24 ALL1	Upon setting auto-tuning mode to <b>‘ALL1’</b> , auto-tuning starts immediately	-
PAR ▶ Auto tuning 24 Enc Testing	Rotate the motor in Forward Direction at 1500(rpm) to check the cable connection of encoder and any defect of encoder.	30 ~ 35 (Sec)
PAR ▶ Auto tuning 24 Rs Tuning	Obtain the stator resistance value of the motor without rotating the motor	10 ~ 20 (Sec)
PAR ▶ Auto tuning 24 sL Tuning	Obtain the leakage coefficient value without rotating the motor	5 ~ 20 (Sec)
PAR ▶ Auto tuning 24 IF Tuning	Obtain the magnetizing current value of the motor by rotating it at 1500(rpm)	30~60 (Sec)
PAR ▶ Auto tuning 24 Ls Tuning	Obtain the stator inductance value of the motor by rotating it at 1500(rpm).	50~ 60 (Sec)
PAR ▶ Auto tuning 24 Tr Tuning	Obtain the secondary time constant of the motor by conducting accel/decel continuously dozens of times. As it requires sudden accel/decel, be sure to tune it with damping resistance connected. Otherwise, <b>‘Over Voltage’ trip may occur.</b>	20~ 60 (Sec)

## Sync Operation Application

PAR ▶ Auto tuning 24           None	When the proper parameters are found through the processes as above, change the data into <b>'None'</b> . Otherwise, it outputs the message of <b>'[] Error'</b> . In this case, <u>check if the motor and encoder setting parameters are correct</u> and then perform the above steps once again. In the event it outputs <b>'[] Error'</b> <b>again</b> , please enquire our Technical Team.	Total Time Required 3 ~ 5 (Min)
PAR ▶ Auto tuning 24           [] Error		

- During auto-tuning process, FWD/REV LED of the loader flash at the same time.
- When PAR\_23 (Auto tuning) is set to "ALL2", encoder is not tested, and the remaining parameters are same with "ALL1" as above.
- Individual auto-tuning can be performed by motor constants.  
(Encoder Test, Rs Tuning, Lsigma, Flux Curr, Ls Tuning, Tr Tuning)
- If encoder (A,B) or inverter output (U,V,W) wiring has been changed, it shows 'Enc AB Chgd' message on the screen during auto-tuning. In this case, don't change the line connection but change the encoder direction setting of PAR\_11(Enc Dir Set) from 'B Phase Lead' to 'A Phase Lead', or from 'A Phase Lead' to 'B Phase Lead' to operate it without changing the wiring.

### 3.5.2 Static Auto-Tuning Method

#### 1) Preparatory Work

You may obtain the exact parameters only when starting tuning with the motor shaft bound.

#### 2) Sequence of Auto-Tuning

Loader Display	Description	Tuning Time
PAR ▶ AutoTuneType 23           StandStill	Be sure to set auto-tuning method to <b>'Standstill'</b>	-
PAR ▶ Auto tuning 24           ALL1	Upon setting the type of auto-tuning to <b>"ALL1"</b> , auto-tuning starts immediately	-
PAR ▶ Auto tuning 24           Rs Tuning	Obtain the stator resistance value of the motor without rotating the motor.	20 ~ 30(Sec)
PAR ▶ Auto tuning 24           sL Tuning	Obtain the leakage coefficient value without rotating the motor	90 ~ 150(Sec)
PAR ▶ Auto tuning 24           If/Tr/Ls Tuning	Obtain magnetizing current, secondary time constant of the motor and primary inductance simultaneously without rotating the motor but by energizing direct current pulse.	40 ~ 70(Sec)
PAR ▶ Auto tuning 24           None	When the proper parameters are found through the processes as above, change the data into <b>'None'</b> . Otherwise, it outputs the message of <b>'[] Error'</b> . In this case, <u>check if the motor and encoder setting parameters are correct</u> and then perform the above steps once again. In the event it outputs <b>'[] Error'</b> <b>again</b> , please enquire our Technical Team.	<b>Total Time Required 3 ~ 5 (Min)</b>
PAR ▶ Auto tuning 24           [] Error		

- During auto-tuning process, FWD/REV LED of the loader flash at the same time.
- Individual auto-tuning is available by motor constants.  
(Rs Tuning, Lsigma, If/Tr/Ls Tune)

## 3.6 Parameter Setting required for Sync Operation Control

At the time of sync operation control, be sure to set the inverter parameter in the following sequence.

For further detail of the function, see SYN Group Function.

### 3.6.1 SYN Control Mode Setting (Compulsory)

In order to use exclusively for sync operation control, be sure to set the setting of CON\_02 Application to **'Synchro'**. Upon setting it to **'Synchro'** SYN group is displayed. In this case, sync control exclusive option board should have been installed in the control board. When set to **'General Vect'**, **SYN group is not displayed where sync operation cannot be used.**

CON ▶ Application
02        Synchro

### 3.6.2 Sync Operation Disable Signal Setting (Option)

Sync operation control can be divided into either sync operation upon the start-up of the master motor or sync operation during the operation of master motor. The former is called start-up sync operation, while the latter called following sync operation. In this case, the following sync operation can be done by setting one of multi-function Input terminals (DIO\_01 ~ DIO\_07) to **'Synch Disable'**. When the multi-function Input terminal is powered On, it is changed from sync operation to general operation. Then the motor is operated with the speed command set in the general operation state. It conducts sync operation unless the preset multi-function input terminal is Off or set to **'Synch Disable'**.

DIO ▶ P1 Define
01    Synch Disable

### 3.6.3 Sync Operation Hold Signal Setting (Option)

In the event of slave inverter is not under sync operation but operates at a certain speed (hold operation) during sync operation control, you may use it after setting one of multi-function inputs (DIO\_01 ~ DIO\_07) to **'Synch Hold'**. In this case, it is operated with Hold Speed as set at SYN\_22 SynHold Spd. In case the preset multi-function input during sync operation is powered On, Slave Motor Speed is operated at the preset hold speed regardless of sync operation. It conducts sync operation if the preset multi-function input is Off. **In this case, however, please be noted that it is operated following the speed of the master motor in speed sync operation, but changed at the initial position in position sync.**

DIO ▶ P2 Define
02        Synch Hold

SYN ▶ SynHold Spd
22        100.0 rpm

### 3.6.4 Sync Operation Mode Selection (Compulsory)

In sync operation control, it can be divided into speed sync operation and position sync operation. Speed sync operation means the slave motor being operated following the speed of the master motor, while position sync operation means the slave motor following the position of the master motor. In order to conduct speed sync or position sync, you may use it after setting SYN\_03 SynOptMode to **‘Speed’** or **‘Position’**.

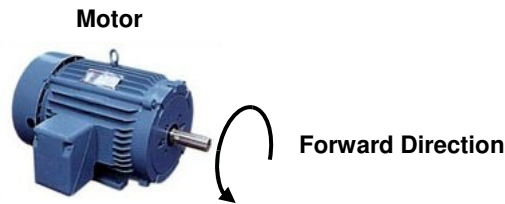


### 3.6.5 Acceleration/Deceleration Time Setting for Sync Operation (Compulsory)

In case of the acceleration/deceleration time for sync operation control, the time set at FUN\_40 Acc Time-1 and FUN\_41 Dec Time-1 is applied. At the time of sync operation control, please set acceleration/deceleration time to 0.00 sec. If a certain time is set, time delay occurs at the time of sync operation control, and then sync operation may be delayed in transient state. In case of using sync operation Disable signal (Synch Disable) or sync operation Hold signal (Synch Hold) by means of multi-function input terminal, the main acceleration/deceleration time set when it was converted from sync operation to general operation or Hold operation is applied. Therefore, keep in mind that there could exist sudden acceleration/deceleration when set to 0.00 sec. In order to prevent this problem, set to Xcel-L or Xcel-H in the multi-function input terminal, and then use the acceleration/deceleration time excepting the main acceleration/deceleration time.

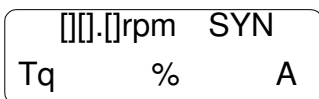
### 3.6.6 Master and Slave Motor Direction Setting (Compulsory)

When the motor is seen from the load side, define it Forward direction rotating CCW direction as be seen below.

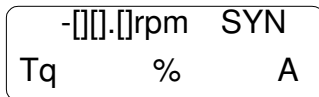


#### 1) Encoder Direction on Inverter SIO Board

- ① Check Forward Rotation : When rotating the motor shaft in forward direction with the inverter power-supplied, check that the speed on the display group home screen is shown “+” (positive) direction.

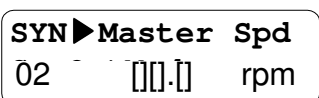


- ② Check Reverse Rotation : When rotating the motor shaft in reverse direction in the same method as above, check that the speed on the display group home screen is shown “-” (negative) direction.

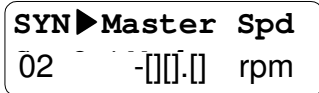


#### 2) Encoder Direction on Sync Control Exclusive Option Board (Master and Slave Speeds being Equal)

- ① Check Forward Rotation: When rotating the motor or drive shaft in forward direction with the inverter power-supplied, check that the speed of SYN\_02 Master Spd is shown “+” (Positive) direction.



- ② Check Reverse Rotation: When rotating the motor or drive shaft in reverse direction with the inverter power-supplied, check that the speed of SYN\_02 Master Spd is shown “-” (Negative) direction.



- ③ Check the speed of the slave motor in the same way as above.  
 ④ The speeds displayed in SYN 02 Master Spd and SYN 03 Slave Spd show the value read through the sync option board, and therefore they could be different from the speeds displayd on the initail screen.

## 4 DIO Group (DIO\_□□)

### 4.1 DIO\_01 ~ DIO\_07 (Definition of Multi-Function Input P1~7)

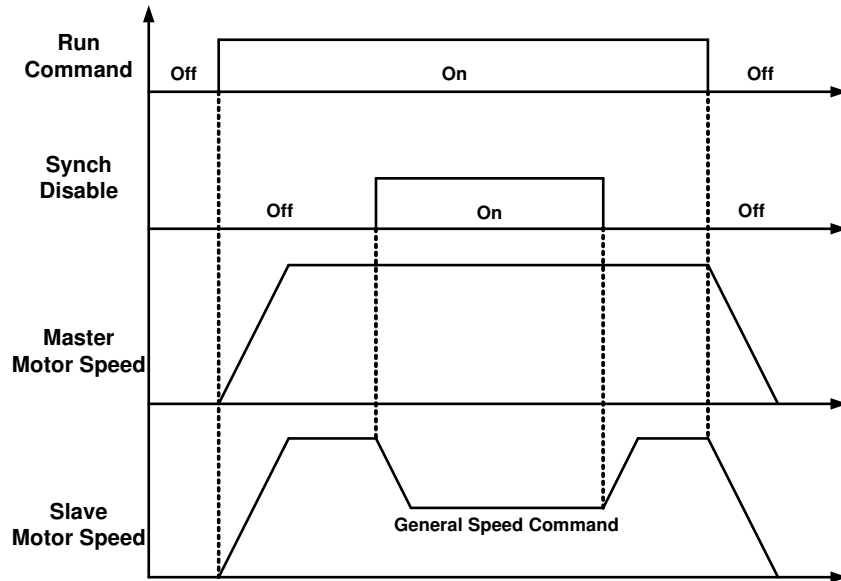
If you select “Synchro” in CON\_02 Application of Control (CON) Group, you can select following functions in addition, provided that **exclusive sync operation option board is installed on the control board**. For the basic function, see the main Manual. Only the functions necessary in sync operation mode are described in this Chapter.

Function Code	Loader Display	Name of Function	function
DIO_01 ~ DIO_07	39 (Synch Disable)	Sync Operation Disable Command Signal	Changed into general operation mode if the preset multi-function input terminal is On, while into sync operation control mode if the same is Off
	40 (Synch Hold)	Sync Hold Operation Command Signal	Hold operation at the speed set in SYN_22 if the preset multi-function input terminal is On

#### 4.1.1 Synch Disable Function

It comes to sync operation mode if the multi-function input terminal set to “Synch Disable” becomes Off, while general operation mode by the preset speed command if the same becomes On. The operation condition is as follow;

- ① If the multi-function input terminal set to “Synch Disable” is Off where the operation commands of master inverter and slave inverter are powered, speed command of slave inverter follows the speed of master motor in case of speed sync operation, while follows the position of master motor in case of position sync operation.
- ② If the multi-function input terminal set to “Synch Disable” is On where the operation commands of master inverter and slave inverter are powered, the motor of slave inverter is operated by the speed command set in the general operation.
- ③ If the multi-function input terminal set to “Synch Disable” is changed from On to Off where the operation commands of master inverter and slave inverter are powered, it follows the speed of master motor immediately after the multi-function input terminal becomes Off in case of speed sync operation, while follows the position of master motor immediately after the multi-function input terminal becomes Off in case of position sync operation.
- ④ To use the sync operation control mode, the multi-function input terminal set to “Synch Disable” should be Off without fail. If powered On, the slave motor is operated by the speed command set in general operation mode.
- ⑤ **In sync operation control mode general operation mode is not conducted unless multi-function input terminal is set to ‘Synch Disable’. That is, otherwise, sync operation is conducted only.**
- ⑥ If converted from sync operation to general operation or from general operation to sync operation, it is operated by main acceleration/deceleration time (FUN\_40, 41). In this case, keep in mind that sudden acceleration/deceleration may occur if it is set to 0.00 sec.

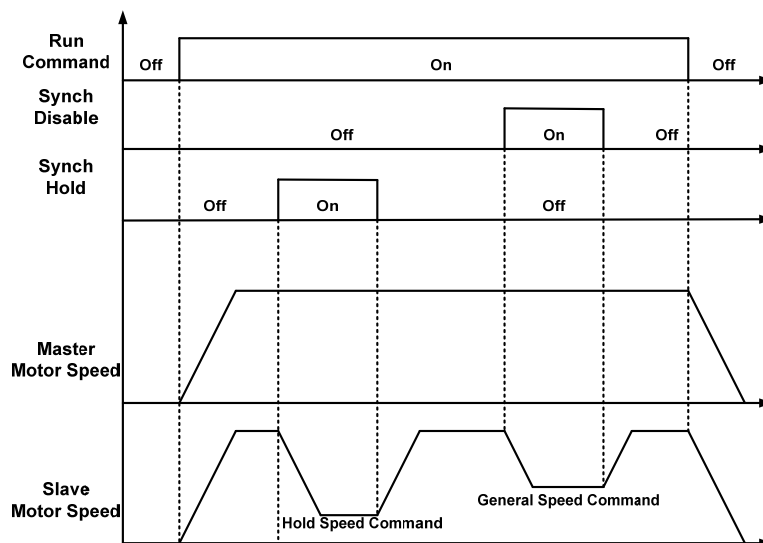


**Figure 1. Synch Disable Waveform**

### 4.1.2 Synch Hold function

When it falls under any of the following cases where the multi-function input terminal set to 'Synch Hold' is On, it is operated at the Hold Speed set in SYN\_22. In this case, sync operation is not conducted.

- ① If the multi-function input terminal set to 'Synch Hold' is changed from Off to On where the Multi-Function input terminal set to 'Synch Disable' is Off, the speed of slave motor is operated by the Hold Speed command set in SYN\_22.
- ② If the multi-function input terminal set to 'Synch Hold' is changed from On to Off where the Multi-Function input terminal set to 'Synch Disable' is Off, the slave motor conducts sync operation.
- ③ Where the Multi-Function input terminal set to 'Synch Disable' is On, it conducts general speed command operation regardless On/Off of the multi-function input terminal set to "Synch Hold".
- ④ **If converted from sync operation to hold operation or from hold operation to sync operation, it is operated by main acceleration/deceleration time (FUN\_40, 41). In this case, keep in mind that sudden acceleration/deceleration may occur if it is set to 0.00 sec.**



**Figure 2. Synch Hold Waveform**

## Sync Operation Application

### 5. SYN Group

#### 5.1 Function Code of SYN Group (SYN □□)

Function Code	Comm Address	Name of Function	Loader Display	Data to be set			Setting Availability during Operation	Page
				Range	Unit	Factory Default		
SYN_00		Selection of Function Code	Jump Code	1 ~ 15				18
SYN_01		Sync S/W Version	Syn Version	Display only			No	18
SYN_02		Master Motor Speed	Master Spd	Display only	rpm		No	18
SYN_03		Slave Motor Speed	Slave Spd	Display only	rpm		No	18
SYN_04	7B04	Selection of Speed/Position Sync	SynOptMode	0 (Speed) 1 (Position)		0 (Speed)	No	18
SYN_05	7B05	Direction of Slave Motor Operation	Slave Dir	0 (Forward) 1 (Reverse)		0 (Forward)	No	18
SYN_06	7B06	Master Encoder Pulse Input	M_Enc Pulse	360 ~ 4096		1024	No	19
SYN_07	7B07	Detection of Master Encoder Error	M_Enc ErrChk	0 (No) 1 (Yes)		0 (No)	No	19
SYN_08	7B08	Slave Encoder Pulse input	S_Enc Pulse	360 ~ 4096		1024	No	19
SYN_09	7B09	Detection of Slave Encoder Error	S_Enc ErrChk	0 (No) 1 (Yes)		0 (No)	No	19
SYN_10	7B0A	Speed Feed-Forward Compensation Gain	Spd FF Gain	0.0 ~ 150.0	%	100.0	No	19
SYN_11	7B0B	Speed LPF Gain	Spd LPFGain	5 ~ 500	ms	5	Yes	19
SYN_12	7B0C	Position Controller P Gain	Pos P Gain	0.1 ~ 300.0	%	100.0	Yes	19
SYN_13	7B0D	Speed Limit	Spd Limit	100.0 ~ FUN_04	rpm	1800.0	No	20
SYN_14	7B0E	Master Speed/Position Calibration Coefficient1	Master Multi	1 ~ 10000		1	No	20
SYN_15	7B0F	Master Speed/Position Calibration Coefficient 2	Master Div	1 ~ 10000		1	No	20
SYN_16	7B10	Slave Position Calibration Coefficient1	Slave Multi	1 ~ 10000		1	No	20
SYN_17	7B11	Slave position Calibration Coefficient2	Slave Div	1 ~ 10000		1	No	20
SYN_18	7B12	Level of Speed Sync completion	Syn_S Comp	0.0 ~ 1000.0	rpm	20.0	No	20
SYN_19	7B13	Time Delayed in Detecting completion of Speed Sync	Syn_S DelayT	0.00~10.00	sec	1.00	Yes	21
SYN_20	7B14	Level of Position Sync Completion	Syn_P Comp	0 ~ 65535	pulse	100	Yes	21
SYN_21	7B15	Time Delayed in Detecting Completion of Position Sync	Syn_P DelayT	0.00~10.00	sec	1.00	Yes	21
SYN_22	7B16	Sync Hold Speed	SynHold Spd	0.0 ~ FUN_04	rpm	100.0	Yes	21

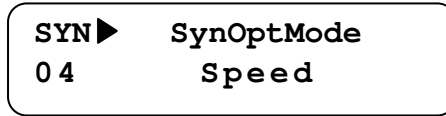
### 5.2 SYN Group Function

#### 5.2.1 Jump Function (SYN\_00)

You may jump directly to the code you desire using SYN\_00.

**(Example) In case of moving to SYN\_04;**

Press [PROG] Key, setting 4 after you press [SHIFT/ESC] / [▲UP] / [▼DOWN] Key, and then press [ENT] Key. Next you can move to following



After Jump Movement, you may move to the other code using [▲UP] / [▼DOWN] Key.

#### 5.2.2 SYN\_01 Syn Version : Display of Sync Program Version

Display the sync program version of the sync option board.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_01	Syn Version	Sync S/W Version	Display Only		

#### 5.2.3 SYN\_02 Master Spd : Display of Master Motor Speed

Display the speed of encoder mounted on the master motor or master drive shaft.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_02	Master Spd	Master Motor Speed	Display Only	rpm	

#### 5.2.4 SYN\_03 Slave Spd : Display of Slave Motor Speed

It displays the speed of the encoder mounted on the slave motor. Slave motor speed is equal to that displayed on the keypad home screen. The motor speed appeared on the home screen, however, indicates the value directly read from the encoder. As the motor speed displayed on SYN\_03 Slave Spd indicates the value read through the sync option board, it could be deviated from that displayed on the home screen.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_03	Slave Spd	Slave Motor Speed	Display Only	rpm	

#### 5.2.5 SYN\_04 SynOptMode : Selection of Speed/Position Sync

Sync Operation Control Mode can be set to speed sync operation and position sync operation.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_04	SynOptMode	Selection of Speed/Position Sync	Speed Position		Speed

#### 5.2.6 SYN\_05 Slave Dir : Slave Motor Operation Direction

Set the slave motor operation direction. Slave motor operation direction is determined by master motor operation direction, slave motor operation command and the slave motor operation direction configured thereafter.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_05	Slave Dir	Slave Motor Operation Direction	Forward Reverse		Forward

Master Operation Command	Slave Operation Command	Slave Motor Operation Direction	Slave Motor Final Operation Direction
Forward Direction	Forward Direction	Forward Direction	Forward Direction
Forward Direction	Forward Direction	Reverse Direction	Reverse Direction
Forward Direction	Reverse Direction	Forward Direction	Reverse Direction
Forward Direction	Reverse Direction	Reverse Direction	Forward Direction
Reverse Direction	Forward Direction	Forward Direction	Reverse Direction
Reverse Direction	Forward Direction	Reverse Direction	Forward Direction
Reverse Direction	Reverse Direction	Forward Direction	Forward Direction
Reverse Direction	Reverse Direction	Reverse Direction	Reverse Direction

### 5.2.7 SYN\_06 M\_Enc Pulse : Input of Master Encoder Pulse Number

Input the pulse number of the encoder mounted on master motor or master drive shaft. In case of the pulse number of master encoder, the speed is calculated from the readout of master motor or drive shaft encoder on the sync option board that is mounted on the master inverter. Therefore it is required to input exact pulse number of the encoder.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_06	M_Enc Pulse	Master Encoder Pulse Input	360 ~ 4096		1024

### 5.2.8 SYN\_07 M\_Enc ErrChk : Detection of Master Encoder Error

Detect the error of the encoder mounted on the master motor or master drive shaft. In case the encoder cable is short-circuited or wrongly connected where set to "Yes", it detects the error of from encoder, generating Master Encoder Fault. **In case of open collector typed encoder, however, it cannot detect the encoder error. Please set it to "No"**

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_07	M_Enc ErrChk	Detection of Master Encoder Error	No Yes		No

### 5.2.9 SYN\_08 S\_Enc Pulse : Input of Slave Encoder Pulse Number

Input the pulse number of the encoder mounted on slave motor or slave drive shaft. In case of the pulse number of Slave Encoder, the speed is calculated from the readout of slave motor or drive shaft encoder on the sync option board that is mounted on the slave inverter. Therefore your are required to input exact pulse number of the encoder

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_08	S_Enc Pulse	Slave Encoder Pulse Input	360 ~ 4096		1024

### 5.2.10 SYN\_09 S\_Enc ErrChk : Detection of Slave Encoder Error

Detect the error of the encoder mounted on the slave motor or slave drive shaft. In case the encoder cable is short-circuited or wrongly connected where set to "Yes", it detects the error of from encoder, generating Slave Encoder Fault. **In case of open collector typed encoder, however, it cannot detect the encoder error. Please set it to "No"**

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_09	S_Enc ErrChk	Detection of Slave Encoder Error	No Yes		No

### 5.2.11 SYN\_10 Spd FF Gain : Speed Feed-Forward Compensation Gain

When treating the pure P Controller only in position sync operation mode, the position could be deviated. In this case, the position deviation could be reduced by converting the readout of the master encoder into speed and compensating it feed forward. If configured with 100[%], the deviation in normal condition will be at minimum. For further detail, please refer to the control block diagram.

※ Activated only where SYN\_04 SynOptMode is Position

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_10	Spd FF Gain	Speed Feed-Forward Compensation Gain	0.0 ~ 150.0	%	100.0

### 5.2.12 SYN\_11 Spd LPFGain : Speed Low-Pass Filter Gain

When noise is mixed in the input waveform of master and slave encoder, speed deviation could exist. Such influence can be reduced by setting low-pass gain.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_11	Spd LPFGain	Speed LPF Gain	5 ~ 500	Ms	5

### 5.2.13 SYN\_12 Pos P Gain : Position Controller P Gain

Set P gain of position controller when conducting the position sync operation.

※ Activated only where SYN\_04 SynOptMode is Position.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_12	Pos P Gain	Position Controller P Gain	0.1 ~ 300.0	%	100.0

### 5.2.14 SYN\_13 Spd Limit : Speed Limit Setting

It means the slave speed limit under the speed sync operation, while the speed output limit under the position sync operation. Motor is not operated exceeding the configured speed. **If configured lower than the master operation speed under the position sync operation, the output deviation of the position controller may cause reverse rotation. So be sure to configure it at higher than the master operation speed**

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_13	Spd Limit	Speed Limit	100. ~ FUN_04	rpm	1800.0

### 5.2.15 SYN\_14 Master Multi: Master Speed/Position Calibration Coefficient1

### 5.2.16 SYN\_15 Master Div: Master Speed/Position Calibration Coefficient 2

### 5.2.17 SYN\_16 Slave Multi: Slave Position Calibration Coefficient1 (Activated only when SYN\_04 SynOptMode is Position)

### 5.2.18 SYN\_17 Slave Div: Slave Position Calibration Coefficient2 (Activated only when SYN\_04 SynOptMode is Position)

SYN\_14 ~ SYN\_17 are the multiplying/dividing to correct the speed/position of master motor or drive shaft and slave motor or drive shaft. Master speed/position Calibration Coefficient (SYN\_14 ~ SYN\_15) can be used in speed sync operation mode, while master speed/position Calibration Coefficient (SYN\_14 ~ SYN\_15) and slave position Calibration Coefficient (SYN\_16 ~ SYN\_17) can be used in the position sync.

#### (Example) Using Master Speed/Position Calibration Coefficient in Speed Sync Operation Mode

In the speed sync operation mode, as it is necessary for the slave motor to follow the speed of master motor or drive shaft, the speed of the slave motor can be calibrated using the calibration coefficient of the master speed/position. For example, when you want to run the slave motor in the speed of 250 [rpm] where the present operation speeds of the master is 500 [rpm], you can use the following formula adjusting the ratio of master speed/position Calibration Coefficient.

$$\begin{aligned}
 \text{Slave Motor Speed} &= \text{Master Motor Speed} \times \frac{\text{Master Speed / Position calibration coefficient 1}}{\text{Master Speed / Position calibration coefficient 2}} \\
 &= 500 \times \frac{1}{2} = 250 \text{ [rpm]}
 \end{aligned}$$

As shown in the above formula. The master speed/position calibration coefficient 1 being assessed by multiplying the master operation speed that takes effect of raising the slave motor speed, while the master speed/position calibration coefficient 2 being assessed by dividing the master operation speed that takes effect of dropping the slave motor speed. In this regard, when the position of master encoder is installed on the motor shaft the master speed/position calibration coefficient set to 1 can be used. But it is necessary when the rate adjustment is required as it is not installed on motor but on drive shaft.

#### (Example) Position sync operation using Master and Slave speed/position Calibration Coefficient

In position sync operation mode, it requires the calibration of slave motor position as well as master motor or drive shaft position. In this calibration is available using master speed/position calibration coefficient and slave position calibration coefficient. Master speed/position calibration coefficient can be used in the same way as in the speed sync operation mode. But in case of the value other than '0' as **SYN\_10 Spd FF Gain**, it is applied to the speed using Feed-Forward Compensation. Slave position calibration coefficient compensates the position of slave, but as the value of slave position calibration coefficient 1 is set in large scale, the position of slave is highly assessed, where the speed of slave motor is operated at low level. On the contrary, as the value of slave position calibration coefficient 2 is set in large scale, the position of slave is assessed lower, where the speed of slave motor is operated at high level. For example, when setting the value of master speed/position calibration coefficient 1 to 4, and the value of master speed/position calibration coefficient 2 to 2, slave position calibration coefficient 1 to 2, and slave position calibration coefficient 2 to 4, assuming the operation speed of master to be 200 [rpm], the operation of slave motor will be as follow.

## Sync Operation Application

$$\text{Slave Motor speed} = \text{Master Motor speed} \times \frac{\text{Master Speed / Position calibration coefficient 1}}{\text{Master Speed / Position calibration coefficient 2}} \times \frac{\text{Slave Position calibration coefficient 2}}{\text{Slave Position calibration coefficient 1}} = 200 \times \frac{4}{2} \times \frac{4}{2} = 800 [\text{rpm}]$$

As shown in the above formula, the output of slave inverter position controller is reflected on the speed command. In this case, as the position is calculated using the master and slave encoder pulse, the master and slave position calibration coefficients during position sync operation mode calibrates with the coefficient against each position, and it is reflected in inverter speed command with the position controller operated using calibrated position.

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Factory Default
SYN_14	Master Multi	Master Speed/Position calibration coefficient 1	1 ~ 10000	1
SYN_15	Master Div	Master Speed/Position calibration coefficient 2	1 ~ 10000	1
SYN_16	Slave Multi	Slave Position calibration coefficient 1	1 ~ 10000	1
SYN_17	Slave Div	Slave Position calibration coefficient 2	1 ~ 10000	1

### 5.2.19 SYN\_18 Syn\_S Comp : Level of Speed Sync completion

### 5.2.20 SYN\_19 Syn\_S DelayT : Time Delayed in Detection of Speed Sync completion

### 5.2.21 SYN\_20 Syn\_P Comp : Level of Position Sync completion

### 5.2.22 SYN\_21 Syn\_P DelayT : Time Delayed in Detection of Position Sync completion

Level of Speed Sync completion(SYN\_18 Syn\_S Comp) and Time Delayed in Detection of Speed Sync completion (SYN\_19 Syn\_S DelayT) continue outputs in case the speed deviation during the time set in SYN\_19 Syn\_S DelayT after the Open Collector 1 (OT1) of the sync option board is less than setting where the deviation between master and slave operation speeds calibrated in speed sync operation mode is less than the setting, but otherwise it interrupts the output (High).

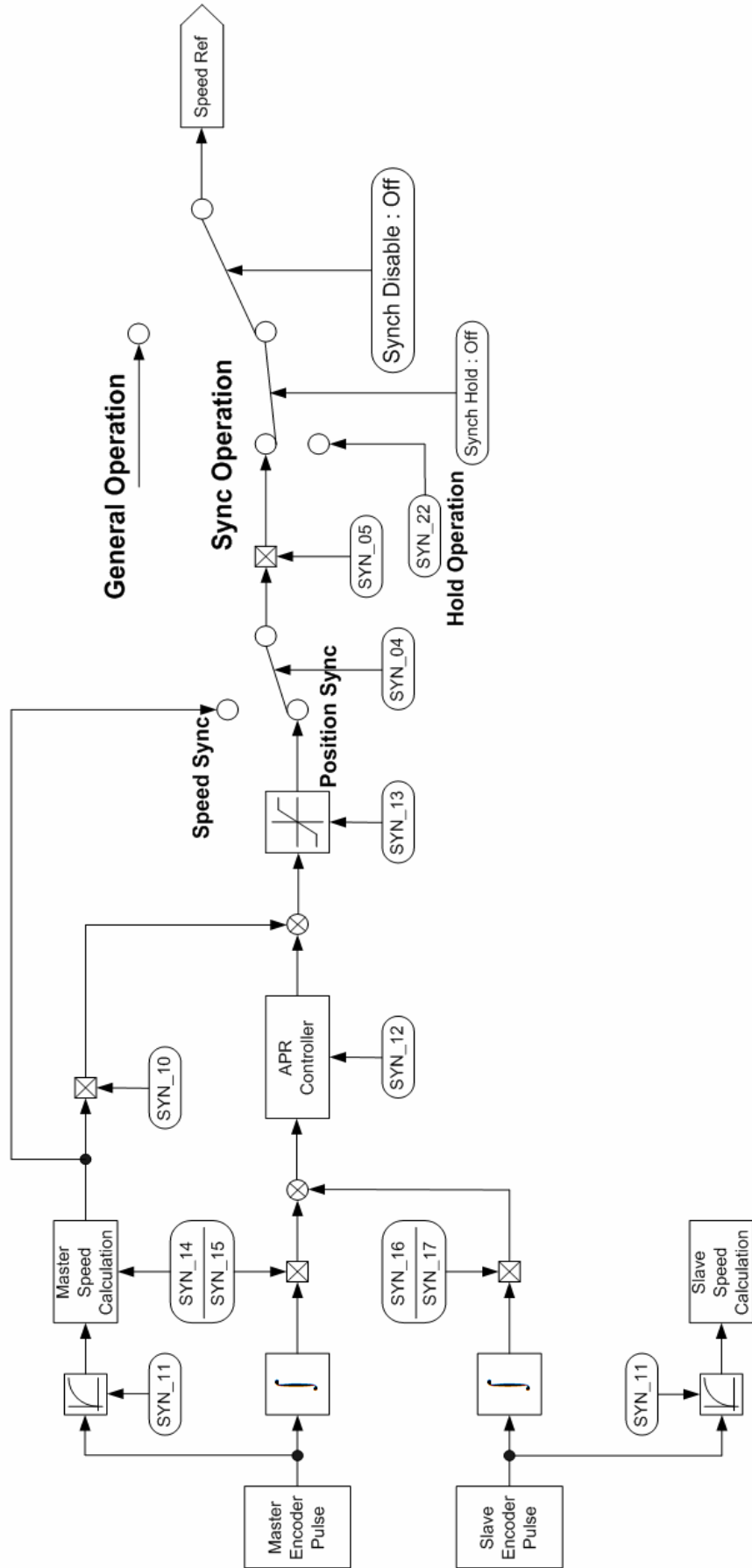
In the meantime, Level of Position Sync completion(SYN\_20 Syn\_P Comp) and Time Delayed in Detection of Position Sync completion(SYN\_21 Syn\_P DelayT) continue outputs in case the position deviation during the time set in SYN\_21 Syn\_P DelayT after it is output through the Open Collector 2 (OT2) of the sync option board (Active Low) is less than setting where the deviation between master encoder value and the slave encoder value position of which is calibrated in position sync operation mode is less than the setting, but otherwise it interrupts the output (High)

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_18	Syn_S Comp	Level of Speed Sync completion	0.0 ~ 1000.0	rpm	20.0
SYN_19	Syn_S DelayT	Time Delayed in Detection of Speed Sync completion	0.00 ~ 10.00	sec	1.00
SYN_20	Syn_P Comp	Level of Position Sync completion	0 ~ 65535	pulse	100
SYN_21	Syn_P DelayT	Time Delayed in Detection of Position Sync completion	0.00 ~ 10.00	sec	1.00

### 5.2.23 SYN\_22 SynHold Spd : Sync Hold Speed

In Sync Hold Speed, hold operation activates at the speed of "Synch Hold" set in Multi-Function input terminal (DIO\_01~DIO\_07) during speed/position sync operation mode is On. Operation activates in hold speed which is set regardless of sync operation mode, which conducts with sync operation again if multi-function input terminal is Off. In **speed sync operation mode, operation activates in master operation speed, but special attention should be paid to the fact that initial position is lost in the position sync operation mode.** Hold speed operation is not conducted if sync disable signal "Synch Disable" set in Multi-Function input terminal (DIO\_01~DIO\_07) is On. This is valid only if **sync disable signal "Synch Disable" is Off. Furthermore, motor operation direction is determined in accordance with the operation command given to the inverter regardless of motor operation direction in sync operation mode.**

Function Code	LCD DISPLAY	Name of Function	Range of Setting	Unit	Factory Default
SYN_16	SynHold Spd	Sync Hold Speed	0.0 ~ FUN_04	rpm	100.0



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