VFD-VJ

User Manual

Delta's high-performance Hybrid servo drive

Power Range :
3-phase 230V series:5.5kW~37kW (7.5~50HP)
3-phase 460V series:5.5kW~75kW (7.5~100HP)

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DELTA

VFD-VJ   User Manual

Delta's high-performance Hybrid servo drive

Preface

Thank you for choosing Delta's high-performance Hybrid servo drive VFD-VJ Series dedicated to plastic injection molding machine. The VFD-VJ series products are made of high quality components and materials that incorporate the latest microcontroller technology.

This manual is to be used for the installation, parameter setting, troubleshooting, and daily maintenance of the Hybrid servo drive. To guarantee safe operation of the equipment, read the following safety guidelines before connecting power to the Hybrid servo drive. Keep this operating manual at hand and distribute to all users for reference.

To ensure the safety of operators and equipment, only qualified personnel familiar with Hybrid servo drive are to do installation, start-up and maintenance. Always read this manual thoroughly before using VFD-VJ series Hybrid Servo Drive, especially the WARNING, DANGER and CAUTION notes. Failure to comply may result in personal injury and equipment damage. If you have any questions, please contact your dealer.

Firmware version: V2.03

PLEASE READ PRIOR TO INSTALLATION FOR SAFETY.

⚠ **DANGER**	☑ AC input power must be disconnected before any wiring to the Hybrid servo drive is made.
	☑ Even if the power has been turned off, a charge may still remain in the DC-link capacitors with hazardous voltages before the POWER LED is OFF. Please do not touch the internal circuit and components. For safe maintenance, use a multimeter to measure the voltage across the +1 and – terminals. The measured value should be lower than 25Vdc for the system to operate normally.
	☑ There are highly sensitive MOS components on the printed circuit boards. These components are especially sensitive to static electricity. Please do not touch these components or the circuit boards before taking anti-static measures. Never reassemble internal components or wiring.
	☑ Ground the Hybrid servo drive using the ground terminal. The grounding method must comply with the laws of the country where the AC motor drive is to be installed.
	☑ This series of products is used to control the three-phase induction motors and permanent magnet synchronous motors. It cannot be used for single-phase motors or for other purposes.
	☑ This series of products cannot be used on occasions that may endanger personal safety.
	☑ Please prevent children or unauthorized personnel from approaching the Hybrid servo drive.

⚠️ **WARNING**	☑ Never connect the Hybrid servo drive output terminals U/T1, V/T2 and W/T3 directly to the AC mains circuit power supply. ☑ DO NOT use Hi-pot test for internal components. The semi-conductor used in Hybrid servo drive easily damage by high-voltage. ☑ Even if the 3-phase AC motor is stop, a charge may still remain in the main circuit terminals of the AC motor drive with hazardous voltages. ☑ Only qualified persons are allowed to install, wire and maintain AC motor drives. ☑ When the Hybrid servo drive uses an external terminal as its source of operation commands, the motor may start running immediately after the power is supplied. In this case, it may be dangerous to any on-site personnel.
⚠️ **CAUTION**	☑ DO NOT install the Hybrid servo drive in a place subjected to high temperature, direct sunlight, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles. ☑ Only use Hybrid servo drives within specification. Failure to comply may result in fire, explosion or electric shock. ☑ When the motor cable between Hybrid servo drive and motor is too long, the layer insulation of the motor may be damaged. Please add an AC output reactor to prevent damage to the motor. Refer to appendix A Reactor for details. ☑ The rated voltage for Hybrid servo drive must be $\leq$ 240V ($\leq$ 480V for 460V models) and the mains supply current capacity must be $\leq$ 5000A RMS ($\leq$10000A RMS for the $\geq$ 40hp (30kW) models).

📝 **NOTE**

■ The content of this manual may be revised without prior notice. Please consult our distributors or download the most updated version at http://www.delta.com.tw/industrialautomation

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7. *Recommended Operations for Customers and Troubleshooting*

Appendix A Optional Accessories

1. Description of Hybrid Servo Drives

The Hybrid servo drive should be kept in the shipping carton or crate before installation. In order to retain the warranty coverage, the Hybrid servo drive should be stored properly when it is not to be used for an extended period of time. Storage conditions are:

⚠ **CAUTION**	☑ Store in a clean and dry location free from direct sunlight or corrosive fumes.
	☑ Store within an ambient temperature range of -20 °C to +60 °C.
	☑ Store within a relative humidity range of 0% to 90% and non-condensing environment.
	☑ Avoid storing the product in an environment containing corrosive gases and liquids.
	☑ DO NOT place on the ground directly. It should be stored properly. Moreover, if the surrounding environment is humid, you should put exsiccator in the package.
	☑ DO NOT store in an area with rapid changes in temperature. It may cause condensation and frost.
	☑ If the Hybrid servo drive is stored for more than 3 months, the temperature should not be higher than 30 °C. Storage longer than one year is not recommended, it could result in the degradation of the electrolytic capacitors.
	☑ When the Hybrid servo drive is not used for longer time after installation on building sites or places with humidity and dust, it's best to move the Hybrid servo drive to an environment as stated above.

1-1 Receiving and Inspection
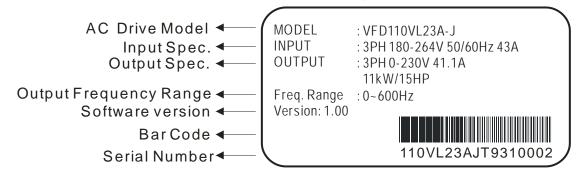
This VFD-VJ Hybrid servo drive has gone through rigorous quality control tests at the factory before shipment. After receiving the Hybrid servo drive, please check for the following:

☑ Inspect the unit to assure it was not damaged during shipment.
☑ Make sure that the part number indicated on the nameplate corresponds with the part number of your order.
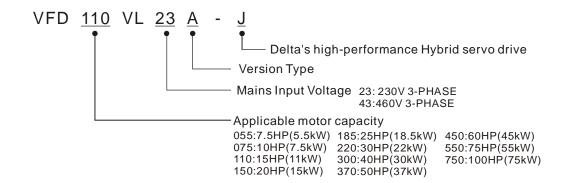
If the registered information does not match your purchase order, or if the product has any problem, please contact the dealer or distributor.

Nameplate Information
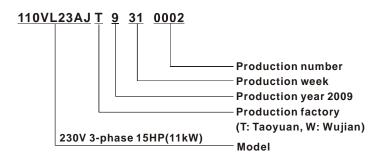
Let us take the 15HP/11kW 230V 3-Phase model as an example.

AC Drive Model ◄	MODEL : VFD110VL23A-J
Input Spec. ◄	INPUT : 3PH 180-264V 50/60Hz 43A
Output Spec. ◄	OUTPUT : 3PH 0-230V 41.1A
	11kW/15HP
Output Frequency Range ◄	Freq. Range : 0~600Hz
Software version ◄	Version: 1.00
Bar Code ◄	
Serial Number ◄	110VL23AJT9310002

Model Explanation

VFD 110 VL 23 A - J

- Delta's high-performance Hybrid servo drive
- Version Type
- Mains Input Voltage 23: 230V 3-PHASE
  43: 460V 3-PHASE
- Applicable motor capacity
  055:7.5HP(5.5kW) 185:25HP(18.5kW) 450:60HP(45kW)
  075:10HP(7.5kW) 220:30HP(22kW) 550:75HP(55kW)
  110:15HP(11kW) 300:40HP(30kW) 750:100HP(75kW)
  150:20HP(15kW) 370:50HP(37kW)

Series Number Explanation

110VL23AJ T 9 31 0002

- Production number
- Production week
- Production year 2009
- Production factory (T: Taoyuan, W: Wujian)
- Model
- 230V 3-phase 15HP(11kW)

1-2 Product Specifications

Specifications of 230V Series

Frame No.		C			D			E2	
Model No. VFD-_ _VL_ _A-J		055	075	110	150	185	220	300	370
Power (KW)		5.5	7.5	11	15	18.5	22	30	37
Horse Power (HP)		7.5	10	15	20	25	30	40	50
Output	Output Current for Continuous Operation Over 60 sec (A)	33	46	62	90	119	119	180	248
	Output Current for Continuous Operation Over 20 sec (A)	37	54	70	106	140	140	204	292
Power Supply	Input Current (A)	25	31	47	60	80	90	106	126
	Tolerable Input Voltage Variation	Three-phase 200~240V 50/60Hz							
	Tolerable Supply Voltage Variation	±10% (180~264V)							
	Tolerable Supply Frequency Variation	±5% (47~63Hz)							
Weight (kg)		8	10	10	13	13	13	36	36

Specifications of 460V Series
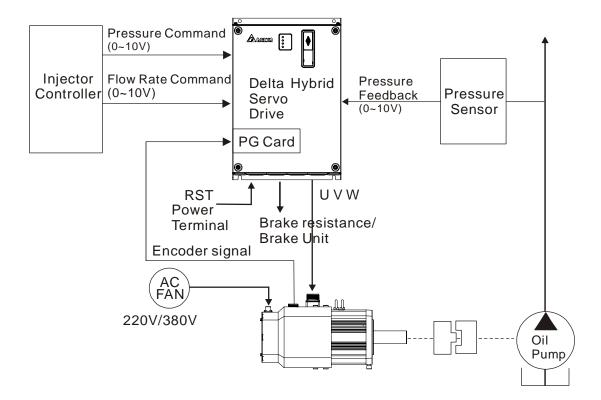
Frame No.		C			D			E1			E2	
Model No. VFD-_ _VL_ _A-J		055	075	110	150	185	220	300	370	450	550	750
Power (KW)		5.5	7.5	11	15	18.5	22	30	37	45	55	75
Horse Power (HP)		7.5	10	15	20	25	30	40	50	60	75	100
Output	Output Current for Continuous Operation Over 60 sec (A)	21	27	36	46	58	62	102	124	155	187	255
	Output Current for Continuous Operation Over 20 sec (A)	25	32	42	54	68	78	120	146	182	220	300
Power Supply	Input Current (A)	14	18	24	31	39	47	56	67	87	101	122
	Tolerable Input Voltage Variation	Three-phase 380~480V, 50/60Hz										
	Tolerable Supply Voltage Variation	±10% (342~528V)										
	Tolerable Supply Frequency Variation	±5% (47~63Hz)										
Weight (kg)		8	10	10	13	13	13	36	36	36	50	50

Common Features

Control method		SVPWM
Speed Detector		Resolver / Incremental Encoder
Speed Command Input		DC 0~10V, 3-point calibration of analog input is supported
Pressure Command Input		DC 0~10V, 3-point calibration of analog input is supported
Pressure Feedback Input		DC 0~10V
General Purpose Input Signal		5 ch DC24V 8mA
General Purpose Output Signal		2 ch DC24V 50mA, 1 ch Relay output
Analog Output Voltage		1 ch dc 0~10V
Optional Peripheral	Speed Feedback PG Card	Mandatory (Refer to Appendix A-5)

Accessories	Braking Resistor	Mandatory (Refer to Appendix A-1)		
	Pressure Sensor	Mandatory (It must has an output signal ranging within 0~10V, which can be configured by Parameters 03-10~03-11; The maximum pressure can be configured by Parameter 00-08)		
	EMI Filter	Optional (Refer to Appendix A-7)		
Protection Feature	Motor Protection	Electronic thermal relay protection		
	Over Current Protection	Over current protection is activated at 300% of the rated current		
	Ground Leakage Current Protection	Activated when the leakage current is higher than 50% of the drive's rated current		
	Voltage Protection	Over Voltage Level: Vdc>400/800 V; Low Voltage Level: Vdc<200/400 V		
	Input Power Supply Over Voltage Protection	Metal Oxide Varistor (MOV)		
	Over Temperature Protection	Built-in temperature sensor		
Environment	Protection Level	NEMA 1/IP20		
	Operation Temperature	-10°C~45°C		
	Storage Temperature	-20°C~60°C		
	Humidity	Below 90% RH (non-condensing)		
	Vibration	1.0G below 20Hz, 0,6G at 20~60 Hz		
	Cooling System	Forced air cooling		
	Installation Altitude	Altitude below 1,000m, keep from corrosive gasses, liquid and dust		
International Certification		CE		

1-3 Overview of Hybrid Servo Systems

1-3-1 Selection of Hybrid Servo Drives and Motors

Due to the differences in the hydraulic system in practical applications, the following choice of drives and motors is provided as a reference.

In the following example, a flow of 64L/min and maximum holding pressure of 175Bar are used.

1. Pump Displacement per Revolution

    Based on the maximum flow of the system (L/min), the pump displacement per revolution (cc/rev) can be calculated.

    Example: If the maximum flow of the system is 64L/min and the highest rotation speed of the motor is 2000rpm, the displacement per revolution is 64/2000*1000 = 32 cc/rev.

2. Maximum Torque of the Motor

    Based on the maximum pressure (Mpa) and pump displacement per revolution (cc/rev), the maximum torque can be calculated.

    Example: For the required maximum pressure of 17.5 Mpa and pump displacement per revolution of 32cc/rev

    Torque = 17.5*32*1.3/(2*pi) = 116 N-m, where the factor 1.3 is used to compensate the total loss in the system.

3. Rated Torque and Rated Power of the Motor

    At the maximum pressure for the holding pressure, the required torque should be 1.5 times of the motor's rated torque or less (depending on the data provided by the motor's

manufacturer). Over such an operating condition, the over-temperature of the motor may easily occur. Let us take the factor 1.5 as an example, if the rated torque of the motor is 77 N-m, the motor with a power of 12kW* and a rated speed of 1500 rpm can be chosen.

*The power of the motor is calculated by using $P(W) = T(N-m) \times \omega(rpm \times 2\pi / 60)$

4. Maximum Current of the Motor

   Example: Check the parameter kt (Torque/A) in the motor's specifications, if kt = 3.37, the maximum current is approximately 116/3.37 = 34A at the maximum torque of 116 N-m.

5. Selection of Matched Hybrid Servo Drive

   Example: Look up the over-load capability for each Hybrid servo drive in the product specification chart

   If the holding pressure is at the maximum pressure of 17.5 Mpa, and a pump of 32cc/rev is used, the required motor current is approximately 34A

   For such a current value, the following models can be chosen

   VFD075VL43A-J, the overload may occur within 20 sec.

   VFD110VL43A-J, the overload may occur approximately after 60 sec.

NOTE

If there is no suitable motor that meets the specifications, a motor with a higher rated value can be used instead.

For any information about the Hybrid servo drives or any assistance in detailed configuration of your company's products, please contact the manufacturer.

1-3-2 Selection of Pump for Hybrid Servo Motor

Select a pump with a suitable displacement based on the required flow rate and motor speed;

- If low noise is required, you can choose the screw pump or internal gear type.If a high volumetric efficiency is required, you can choose the piston pump or dual displacement piston pump.
- Comparison of Commonly Used Pump (This may vary for different pump manufacturers).

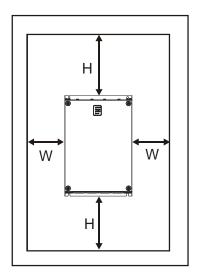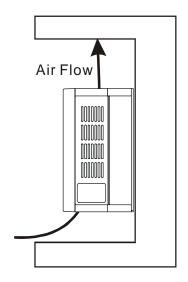| Type of Oil Pump	Volumetric Efficiency	Flow Pulsation	Rotation Speed	Noise
Internal Gear Pump	Low	Medium	Medium	Low
Piston Pump	High	Low	Low	High
Screw Pump	Medium	High	High	Medium

1-4 Product Installation

Please install the Hybrid servo drive under the following environmental conditions to ensure safety of use:

Environmental Condition for Operation	Ambient temperature	-10°C~ +45°C
	Relative Humidity	<90% (non-condensing)
	Pressure	86 ~ 106 kPa
	Installation Altitude	<1000m
	Vibration	<20Hz: 9.80 m/s^2 (1G) max; 20~50H:5.88 m/s^2 (0.6G) max
Environmental Condition for Storage and Transportation	Ambient temperature	-20°C~ +60°C (-4°F ~ 140°F)
	Relative Humidity	<90% (non-condensing)
	Pressure	86 ~ 106 kPa
	Vibration	<20Hz: 9.80 m/s^2 (1G) max; 20 ~ 50Hz: 5.88 m/s^2 (0.6G) max
Contamination Protection Level	Level 2: Applicable to factory environment with low-to-medium contamination	

Space for Installation

HP	W mm (inch)	H mm (inch)
7.5-20HP	75 (3)	175 (7)
25-75HP	75 (3)	200 (8)
100HP	75 (3)	250 (10)
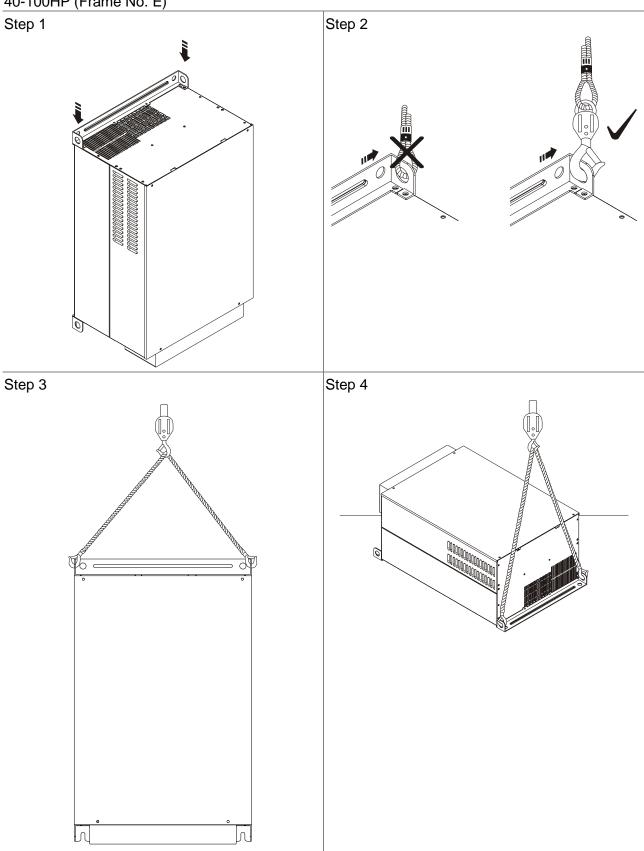
1. Mount the Hybrid servo drive vertically on a flat vertical surface object by screws. Other directions are not allowed.
2. The Hybrid servo drive will generate heat during operation. Allow sufficient space around the unit for heat dissipation.

3. The heat sink temperature may rise to 90°C when running. The material on which the Hybrid servo drive is mounted must be noncombustible and be able to withstand this high temperature.

4. When Hybrid servo drive is installed in a confined space (e.g. cabinet), the surrounding temperature must be within -10 ~ 40°C with good ventilation. DO NOT install the Hybrid servo drive in a space with bad ventilation.

5. When installing multiple Hybrid servo drives in the same cabinet, they should be adjacent in a row with enough space in-between. When installing one Hybrid servo drive below another one, use a metal separation between the Hybrid servo drives to prevent mutual heating.

☑ Prevent fiber particles, scraps of paper, saw dust, metal particles, etc. from adhering to the heat sink.

Lifting

Please carry only fully assembled Hybrid servo drives as shown in the following. Lift the Hybrid servo drive by hooking the lifting hole.

40-100HP (Frame No. E)

Step 1	Step 2

Step 3	Step 4
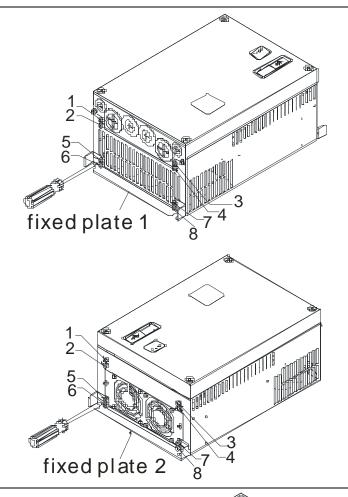
Flange Mounting

Step 1:

Please take out the 16 screws (8 screws for each top and bottom side of the drive) and remove the fixed plate 1 and fixed plate 2) as shown in the following figures.

fixed plate 1

fixed plate 2

Step 2:

place the 8 screws back in to secure the fixed plate 1 and fixed plate 2 (as shown in the following figures) with the following torque.

Frame No. C: 14-17kgf-cm [12.2-14.8in-lbf]
Frame No. D: 20-25kgf-cm [17.4-21.7in-lbf]
Frame No. E: 20-25kgf-cm [17.4-21.7in-lbf]
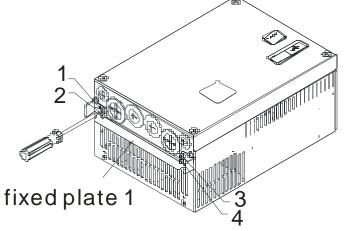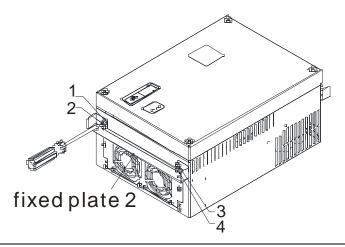
fixed plate 1

fixed plate 2
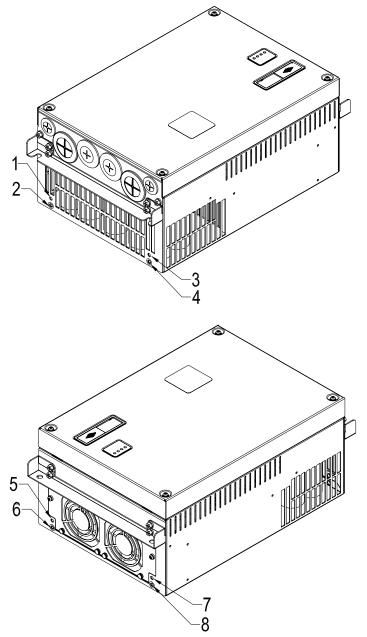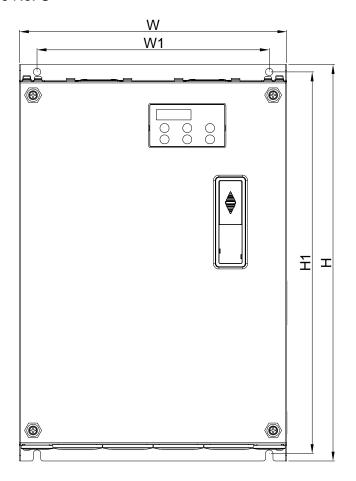
Step 3:
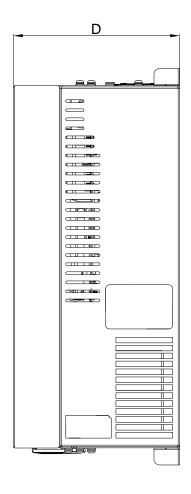
Please notice that it doesn't need to put those 8 screws shown in the following figures back to the drive. Moreover, please make sure that these 2 different fixed plates are put in the correct side as shown in the figures.
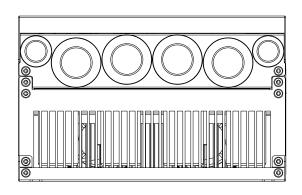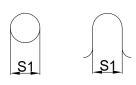
1-5 Product Dimensions

Frame No. C
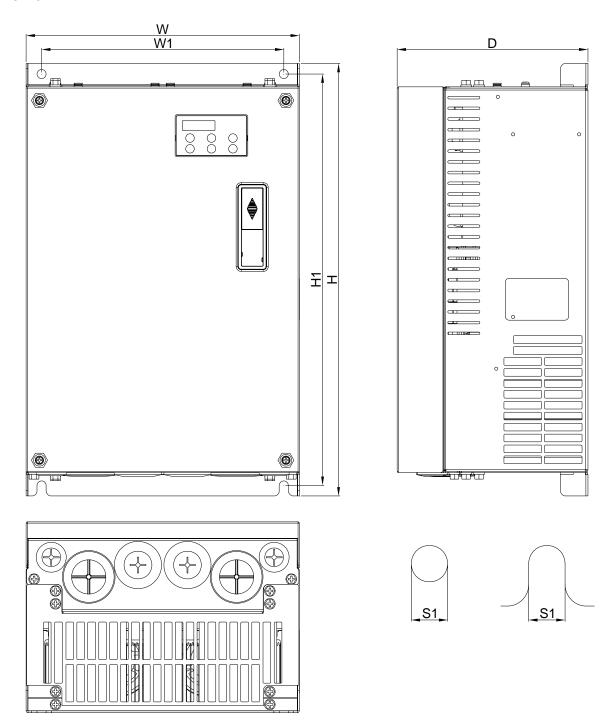
Unit: mm [inch]

Frame No.	W	W1	H	H1	H2	H3	D	Ø	Ø1	Ø2	Ø3
C	235 [9.25]	204 [8.03]	350 [13.78]	337 [13.27]	320 [12.60]	-	136 [5.35]	6.5 [0.26]	-	34 [1.34]	22 [0.87]

NOTE

Frame No. C: VFD055VL23A/43A-J, VFD075VL23A/43A-J, VFD110VL23A/43A-J,

Frame No. D
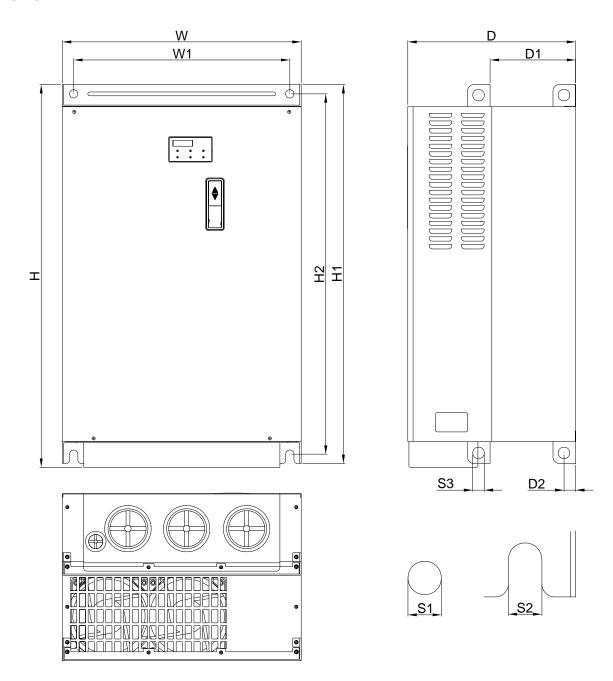
Unit: mm [inch]

Frame No.	W	W1	H	H1	H2	H3	D	Ø	Ø1	Ø2	Ø3
D	255.0 [10.04]	226.0 [8.90]	403.8 [15.90]	384.0 [15.12]	360.0 [14.17]	21.9 [0.86]	168.0 [6.61]	8.5 [0.33]	44 [1.73]	34 [1.34]	22 [0.87]

NOTE

Frame No. D: VFD150VL23A/43A-J, VFD185VL23A/43A-J, VFD220VL23A/43A-J,

Frame No. E

Unit: mm [inch]

Frame No.	W	W1	H	H1	H2	D	D1:	D2:	S1	S2	S3
E1	370.0 [14.57]	335.0 [13.19]	-	589.0 [23.19]	560.0 [22.05]	260.0 [10.24]	132.5 [5.22]	18.0 [0.71]	13.0 [0.51]	13.0 [0.51]	18.0 [0.71]
E2	370.0 [14.57]	335.0 [13.19]	595.0 [23.43]	589.0 [23.19]	560.0 [22.05]	260.0 [10.24]	132.5 [5.22]	18.0 [0.71]	13.0 [0.51]	13.0 [0.51]	18.0 [0.71]

NOTE

Frame No. E1: VFD300VL43A-J, VFD370VL43A-J, VFD450VL43A-J,

Frame No. E2: VFD300VL23A-J, VFD370VL23A-J, VFD550VL43A-J, VFD750VL43A-J,

2. Wiring

After removing the front cover , check if the power and control terminals are clear. Be sure to observe the following precautions when wiring.

☑ Make sure that power is only applied to the R/L1, S/L2, T/L3 terminals. Failure to comply may result in damage to the equipments. The voltage and current should lie within the range as indicated on the nameplate

☑ All the units must be grounded directly to a common ground terminal to prevent lightning strike or electric shock.

☑ Please make sure to fasten the screw of the main circuit terminals to prevent sparks which is made by the loose screws due to vibration
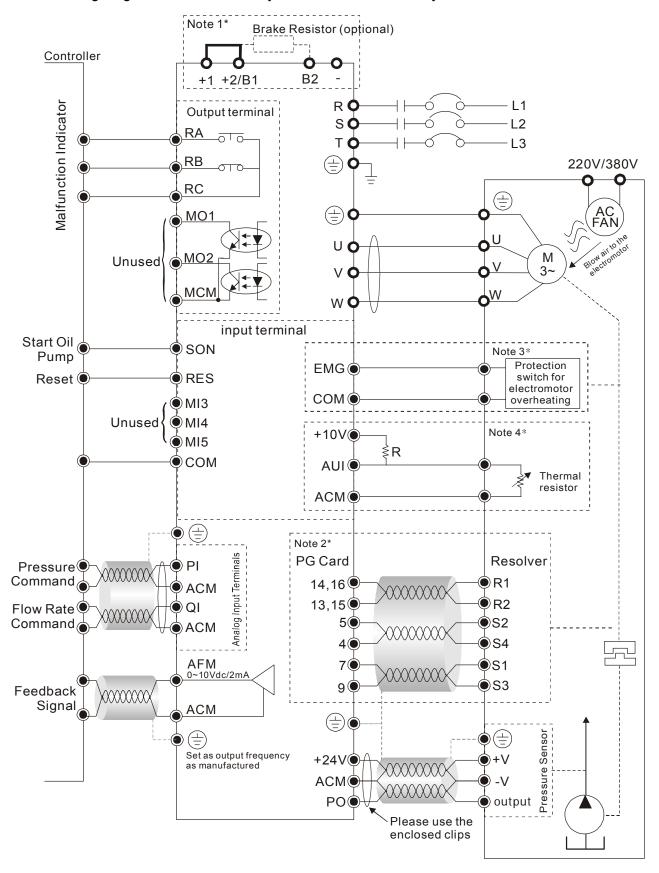
⚠ DANGER	☑ It is crucial to turn off the Hybrid servo drive power before any wiring installation are made. A charge may still remain in the DC bus capacitors with hazardous voltages even if the power has been turned off therefore it is suggested for users to measure the remaining voltage before wiring. For your personnel safety, please do not perform any wiring before the voltage drops to a safe level < 25 Vdc. Wiring installation with remaining voltage condition may cause sparks and short circuit. ☑ Only qualified personnel familiar with Hybrid servo drives is allowed to perform installation, wiring and commissioning. Make sure the power is turned off before wiring to prevent electric shock.
⚠ CAUTION	☑ Make sure that power is only applied to the R/L1, S/L2, T/L3 terminals. Failure to comply may result in damage to the equipment. The voltage and current should lie within the range as indicated on the nameplate. ☑ Check following items after finishing the wiring: 1. Are all connections correct? 2. No loose wires? 3. No short-circuits between terminals or to ground?
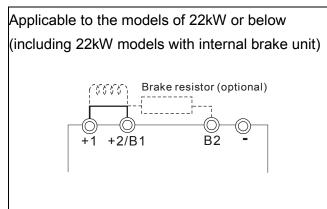
2-1 Description of Wiring
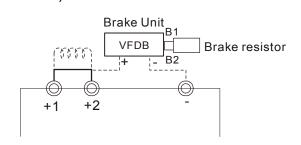
Users must connect wires according to the circuit diagrams on the following pages.

Standard wiring diagram of the VFD-VJ Hybrid servo drive in factory

Note 1*
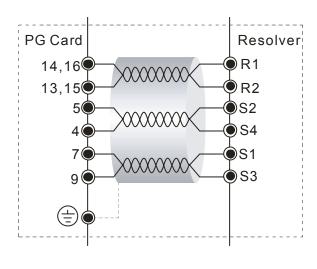
Applicable to the models of 22kW or below (including 22kW models with internal brake unit)	Applicable to the models of 30kW or above (including 30kW models with optional internal brake unit)
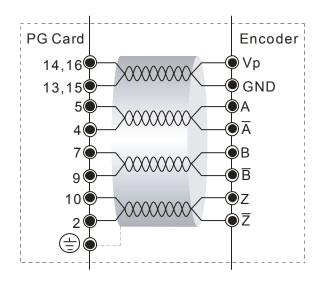
Note 2*

EMVJ-PG01R/PG02R   EMVJ-PG01U
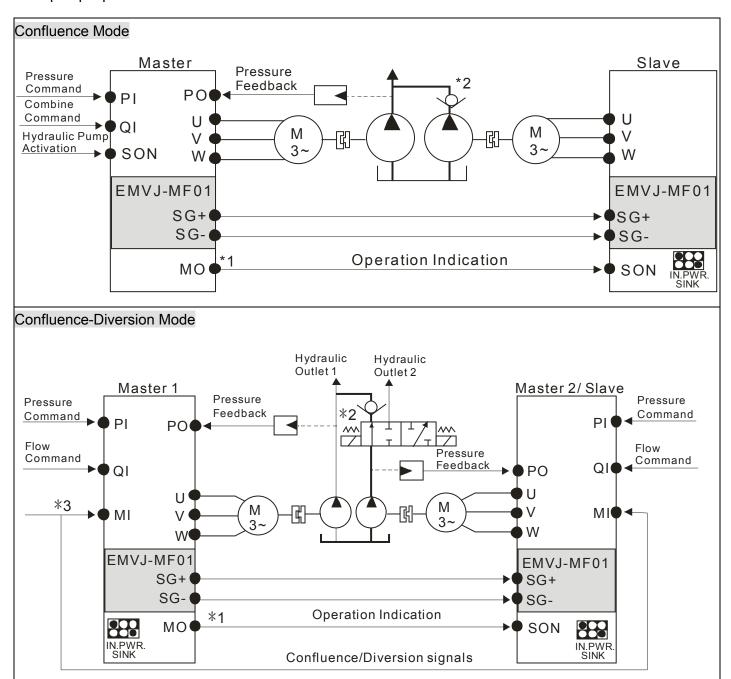
Note 3*

If the motor's temperature protection switches are normally close type, please set the Parameter 03-04 to 4 first, and then carry out the wiring. In this case, the drive may display the EF1 error message. Just clear the message.

Note 4*

Please select the R value in accordance with the thermistor specifications. The related trigger level can be configured by the Parameters 02-08 to 02-10. If the thermistor of Model Number KTY84 is used, select the R value as 2kΩ (1/4W) ± 0.1%, and set the Parameter 02-11 with the value of 1.
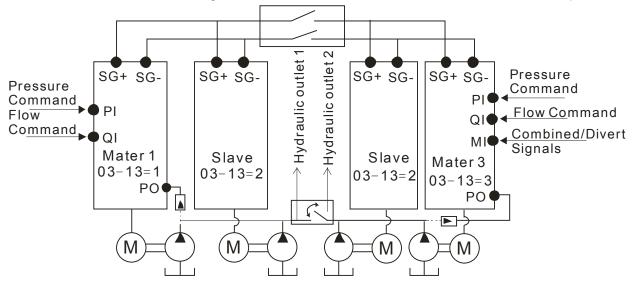
Multi-pump Operation Mode

Confluence Mode

Confluence-Diversion Mode

*1 For firmware version 2.03 and above, the operating commands are given through the communications.
Therefore, the parameters for the slave is 01-01 = 2

*2 For firmware version 2.03 and above, it is not necessary to install this check valve. By selecting the slave
parameter 03-21 at the slave to see if the slave will perform the reverse depressurization. Parameters 03-21
= 0 for not performing the reverse depressurization.

*3 For firmware version 2.03 and above, the diversion/confluence signal is supplied to only Master 2/Slave. It is
not necessary to supply the signal to Master 1.For the following control arrangement, it is necessary to
disconnect the communications during diversion.
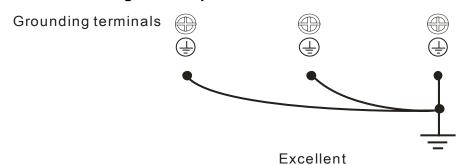
When the signals are confluence, the communication will be a short circuit
When the signals are diversion, the communication becomes an open circui
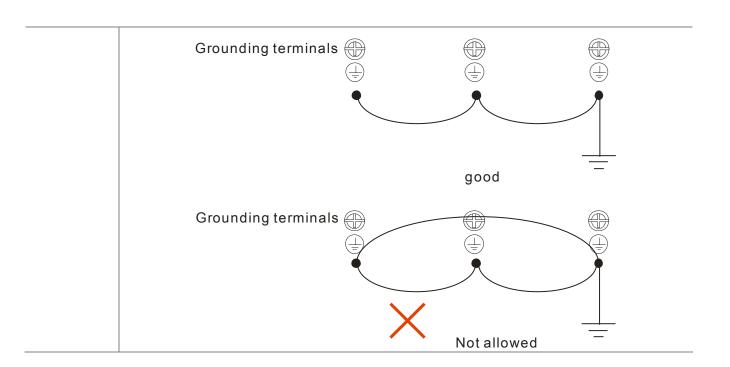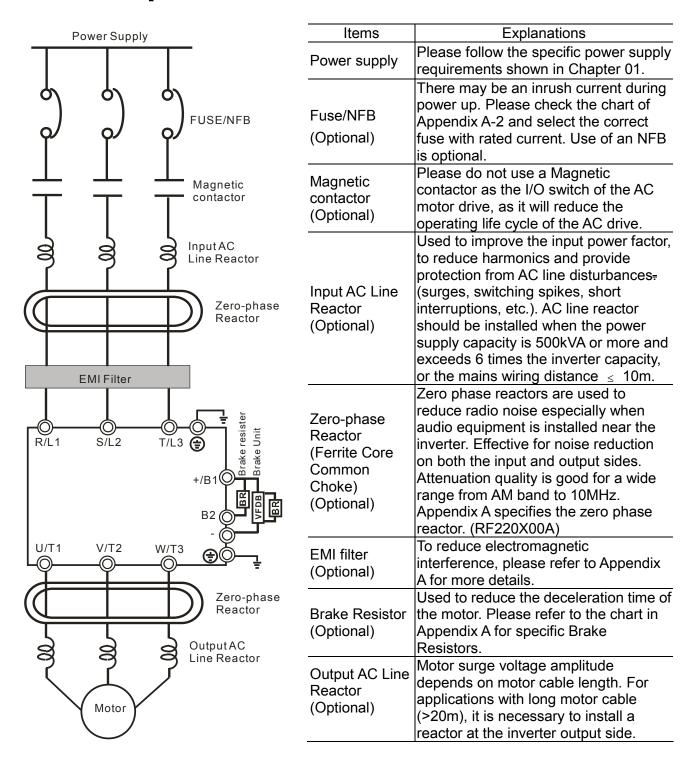
CAUTION	☑ The wiring of main circuit and control circuit should be separated to prevent erroneous actions.
	☑ Please use shield wire for the control wiring and not to expose the peeled-off net in front of the terminal.
	☑ Please use the shield wire or tube for the power wiring and ground the two ends of the shield wire or tube.
	☑ Make sure that the leads are connected correctly and the AC drive is properly grounded. (Ground resistance should not exceed 0.1Ω.)
	☑ Use ground leads that comply with local regulations and keep them as short as possible.
	☑ Multiple VFD-VJ units can be installed in one location. All the units should be grounded directly to a common ground terminal, as shown in the figure below. **Ensure there are no ground loops.**

Excellent

Grounding terminals

good

Grounding terminals

Not allowed

2-2 Description of Terminals on Main Circuit

Items	Explanations
Power supply	Please follow the specific power supply requirements shown in Chapter 01.
Fuse/NFB (Optional)	There may be an inrush current during power up. Please check the chart of Appendix A-2 and select the correct fuse with rated current. Use of an NFB is optional.
Magnetic contactor (Optional)	Please do not use a Magnetic contactor as the I/O switch of the AC motor drive, as it will reduce the operating life cycle of the AC drive.
Input AC Line Reactor (Optional)	Used to improve the input power factor, to reduce harmonics and provide protection from AC line disturbances (surges, switching spikes, short interruptions, etc.). AC line reactor should be installed when the power supply capacity is 500kVA or more and exceeds 6 times the inverter capacity, or the mains wiring distance $\leq$ 10m.
Zero-phase Reactor (Ferrite Core Common Choke) (Optional)	Zero phase reactors are used to reduce radio noise especially when audio equipment is installed near the inverter. Effective for noise reduction on both the input and output sides. Attenuation quality is good for a wide range from AM band to 10MHz. Appendix A specifies the zero phase reactor. (RF220X00A)
EMI filter (Optional)	To reduce electromagnetic interference, please refer to Appendix A for more details.
Brake Resistor (Optional)	Used to reduce the deceleration time of the motor. Please refer to the chart in Appendix A for specific Brake Resistors.
Output AC Line Reactor (Optional)	Motor surge voltage amplitude depends on motor cable length. For applications with long motor cable (>20m), it is necessary to install a reactor at the inverter output side.

Motor

Terminal Identification	Description
R/L1, S/L2, T/L3	AC line input terminals 3-phase
U/T1, V/T2, W/T3	Output terminals of the Hybrid servo drive that are connected to the motor
+1, +2/B1	Connections for DC reactor to improve the power factor. It needs to remove the jumper for installation. (DC reactor is built in for models $\geq$ 22KW)
+2/B1, B2	Connections for Brake Resistor (optional)
⏚	Earth connection, please comply with local regulations..

CAUTION

Power supply input terminals for the main circuit:

☑ Do not connect 3-phase model to one-phase power. R/L1, S/L2 and T/L3 has no phase-sequence requirement, it can be used upon random selection..

☑ It is recommend to add a magnetic contactor (MC) to the power input wiring to cut off power quickly and reduce malfunction when activating the protection function of the AC motor drive. Both ends of the MC should have an R-C surge absorber.

☑ Fasten the screws in the main circuit terminal to prevent sparks condition made by the loose screws due to vibration.

☑ Please use voltage and current within the specification.. Please refer to Chapter 1 for the specifications.

☑ When using a general GFCI (Ground Fault Circuit Interrupter), select a current sensor with sensitivity of 200mA or above and not less than 0.1-second operation time to avoid nuisance tripping.

☑ Please use the shield wire or tube for the power wiring and ground the two ends of the shield wire or tube.

Output terminals for the main circuit:

☑ When it needs to install the filter at the output side of terminals U/T1, V/T2, W/T3 on the Hybrid servo drive. Please use inductance filter. Do not use phase-compensation capacitors or L-C (Inductance-Capacitance) or R-C (Resistance-Capacitance), unless approved by Delta..

☑ DO NOT connect phase-compensation capacitors or surge absorbers at the output terminals of Hybrid servo drives.
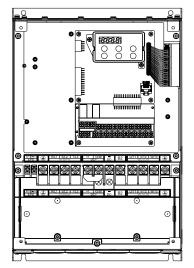
The terminals of the DC reactor [$+1$, $+2$], terminals at DC side [$+1$, $+2$/B1]

☑ This is the terminals used to connect the DC reactor to improve the power factor. For the factory setting, it connects the short-circuit object. Please remove this short-circuit object before connecting to the DC reactor.

☑ For those models without built-in brake resistor, please connect external brake unit and brake resistor (both of them are optional) to increase brake torque.

☑ DO NOT connect [+1, -], [+2, -], [+1/DC+, -/DC-] or brake resistor directly to prevent drive damage.

Specifications of the Terminals on the Main Circuit

Frame No. C

Terminals on the main circuit:
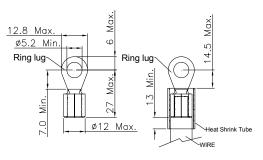
R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, ⏚, +1, +2/B1, -, B2
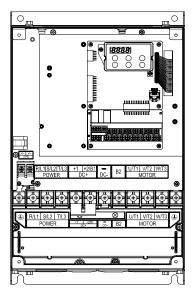
Model	Wire Diameter	Torque	Wire Type
VFD055VL23A-J VFD110VL43A-J	10-6 AWG. (5.3-13.3mm^2)	30kgf-cm (26in-lbf)	Stranded copper only，75°C
VFD055VL43A-J VFD075VL43A-J	12-6 AWG. (3.3-13.3mm^2)		
VFD110VL23A-J	6 AWG. (13.3mm^2)		
VFD075VL23A-J	8-6 AWG. (8.4-13.3mm^2)		

Wire Type: Stranded copper only, 75°C

The right figure below shows the specifications of the UL certified insulation heat shrink tubing which can withstand 600V, YDPU2.

Frame No. D
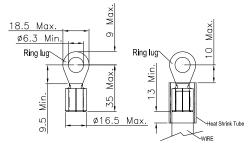
Terminals on the main circuit:

R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, ⏚, +1, +2, -
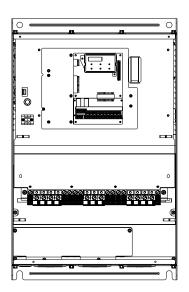
Model	Wire Diameter	Torque	Wire Type
VFD150VL43A-J VFD185VL43A-J	8-2 AWG. (8.4-33.6mm^2)	50Kgf-cm (43.4 lbf-in)	Stranded copper only，75°C
VFD150VL23A-J	4-2 AWG. (21.1-33.6mm^2)		
VFD185VL23A-J	3-2 AWG. (26.7-33.6mm^2)		
VFD220VL43A-J	6-2AWG (13.3-33.6mm^2)		
VFD220VL23A-J	3-2AWG (26.7-33.6mm^2)		

Wire Type: Stranded copper only, 75°C

The right figure below shows the specifications of the UL certified insulation heat shrink tubing which can withstand 600V, YDPU2.

Frame No. E

Terminals on the main circuit:

R/L1, S/L2, T/L3, U/T1, V/T2, W/T3, ⊕, +1, +2, -
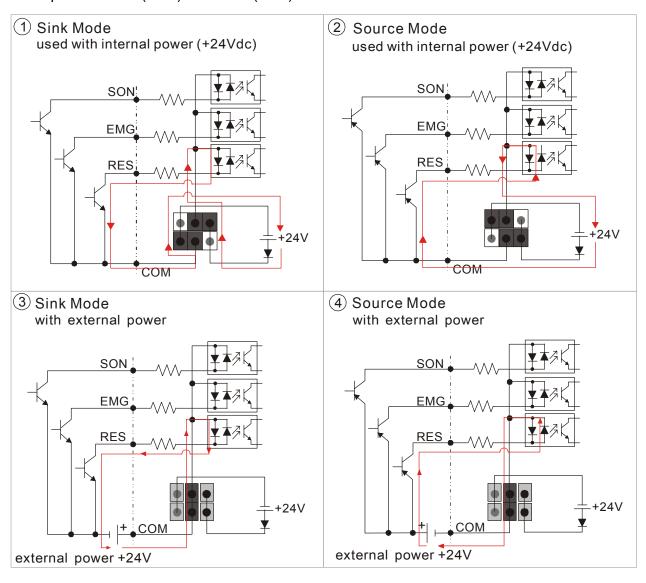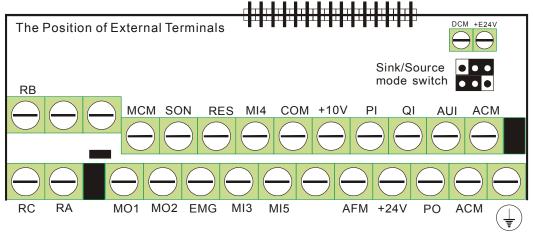
Model	Wire Diameter	Torque	Wire Type
VFD300VL43A-J	4-2 AWG. (21.2-33.6mm^2)	57kgf-cm (49in-lbf)	Stranded copper only，75°C
VFD370VL43A-J			
VFD450VL43A-J			
VFD300VL23A-J		200kgf-cm (173in-lbf)	
VFD370VL23A-J			
VFD550VL43A-J			
VFD750VL43A-J			

Wire Type: Stranded copper only, 75°C

2-3 Description of Terminals on Control Circuit

Description of SINK (NPN)/SOURCE (PNP) Mode Selection Terminals

① Sink Mode
used with internal power (+24Vdc)

② Source Mode
used with internal power (+24Vdc)

③ Sink Mode
with external power

external power +24V

④ Source Mode
with external power

external power +24V

The Position of External Terminals

DCM +E24V

Sink/Source
mode switch

RB

| MCM | SON | RES | MI4 | COM | +10V | PI | QI | AUI | ACM |

RC RA MO1 MO2 EMG MI3 MI5 AFM +24V PO ACM

Frame No.	Torque		Wire Diameter
C, D, E	8 kgf-com (6.9 in-lbf)		22-14 AWG (0.3-2.1mm^2)
	Terminal: 0V/24V	1.6 kgf-com(1.4 in-lbf)	30-16 AWG (0.051-1.3mm^2)

Terminal	Features	Factory Setting (NPN Mode)
SON	Run-Stop	Terminal SON-COM: ON for Running; OFF for Stop
EMG	External error input	External error input
RES	Reset from error	Reset from error
MI3	Multi-function input selection 3	Configured as no function in factory When it is ON, the input voltage is 24Vdc (Max:30Vdc) and then input impedance is 3.75kΩ; when it is OFF, the tolerable leakage current is 10µA.
MI4	Multi-function input selection 4	
MI5	Multi-function input selection 5	
COM	Common ground (Sink) for digital control signals	Common ground for multi-function input terminals
+E24V	Common source for digital control signals	+24V 80mA
DCM	Common ground (Sink) for digital control signals	Common ground for multi-function input terminals
RA	Error terminal 1 (Relay N.O. a)	Resistive load 5A(N.O.)/3A(N.C.) 240VAC 5A(N.O.)/3A(N.C.) 24VDC Inductive load 1.5A(N.O.)/0.5A(N.C.) 240VAC 1.5A(N.O.)/0.5A(N.C.) 24VDC
RB	Error terminal 1 (Relay N.C. b)	
RC	Command contact for multi-function output terminals (Relay)	
MO1	Multi-function output terminal 1 (photocoupler)	The Hybrid servo drive sends various monitoring signals by means of open-collector configuration.
MO2	Multi-function output terminal 2 (photocoupler)	
MCM	Common ground for Multi-function output terminal (photocoupler)	Max 48Vdc 50mA
PO		Pressure feedback Impedance: 200kΩ Resolution: 12 bits Range: 0 – 10V = 0 – the maximum pressure feedback value (Parameter 00-08)
PI		Pressure Command Impedance: 200kΩ Resolution: 12 bits Range: 0 – 10V = 0 – the maximum pressure command value (Parameter 00-07)
QI		Flow rate command Impedance: 200kΩ Resolution: 12 bits Range: 0 – 10V = 0 – the maximum flow rate
AUI	Analog Voltage	Impedance: 11.3kΩ
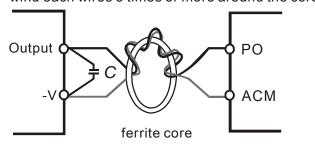
		Resolution: 12 bits Range: -10 ~ +10VDC
+10V	Power supply for configuration	Power supply for analog configuration +10Vdc 20mA (variable resistance 3~5kΩ)
+24V	Power supply terminal for the pressure sensor	Power supply for the pressure sensor +24Vdc 100mA
AFM		Impedance: 16.9kΩ (voltage output) Output current: 20mA max Resolution: 0 – 10V for the maximum operating frequency Range: 0 – 10V Function Setting: Parameter 00-05
ACM	Common ground for analog control signals	Common ground terminal for analog control signals

* Specifications of analog control signal wire: 18 AWG (0.75 mm^2), with shielded twisted pair

Analog Input Terminals (PO, PI, QI, AUI, ACM)

☑ The maximum input voltage of PI, PO, and QI cannot exceed +12V and no more than +/-12V for AUI. Otherwise, the analog input function may become ineffective.

☑ Analog input signals are easily affected by external noise. Use shielded wiring and keep it as short as possible (<20m) with proper grounding. If the noise is inductive, connecting the shield to terminal ACM can bring improvement.

☑ If the analog input signals(pressure sensor) are affected by noise from the Hybrid servo drive, please connect a capacitor and ferrite core as indicated in the following diagrams:

Transistor Output Terminals (MO1, MO2, MCM)

☑ Make sure to connect the digital outputs to the right polarity.

☑ When connecting a relay to the digital outputs connect a surge absorber across the coil and check the polarity.

3. Control Panel and Machine Adjustment Procedure

3-1 Description of Control Panel

3-2 Machine Adjustment Procedure
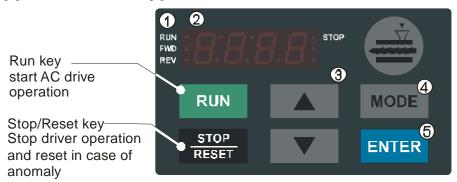
CAUTION	☑ Please re-check if the wiring is correct before start running the machine. Particularly, make sure that the output terminals of the Hybrid servo drive, U/T1, V/T2, and W/T3, must not be used as power input terminals. Make sure that the good ground terminal ⏚ is grounded. ☑ It is not allowed to operate the switches with wet hands. ☑ Make sure that there is no short-circuit or ground short circuit conditions between the terminals or exposed live parts. ☑ The power switch can be turned on only with the cover installed.
WARNING	☑ If any fault occurs during the operation of the Hybrid servo drive and the motor, stop the machine immediately, and refer to "Troubleshooting" to check the cause of the faulty condition. After the Hybrid servo drive stop its output but the main circuit power terminals L1/R, L2/S, and L3/T are not disconnected, if the operator touches the output terminals U/T1, V/T2, and W/T3 of the Hybrid servo drive, electric shock may occur.

3-1 Description of Control Panel

Appearance of Keypad Control Panel KPVJ-LE01

Run key
start AC drive
operation

Stop/Reset key
Stop driver operation
and reset in case of
anomaly
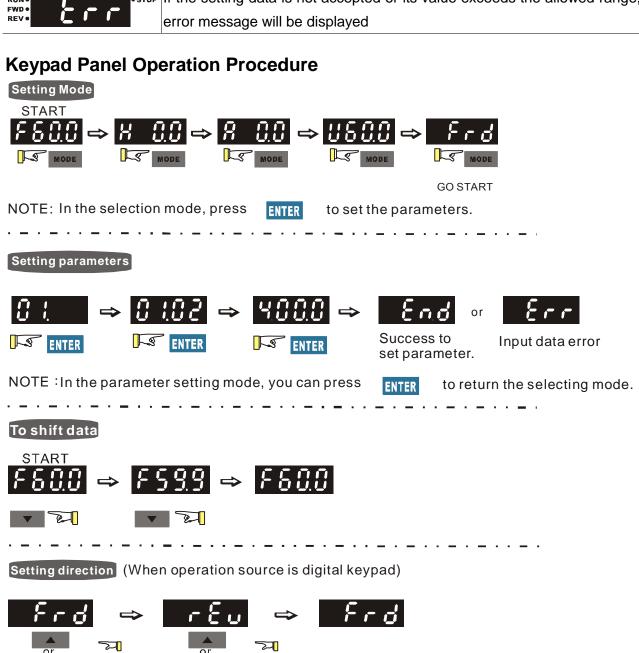
① Status Display

Display the driver's current status.

② LED Display

Indicates frequency, voltage, current, user defined units and etc.

③ UP and DOWN Key

Set the parameter number and changes the numerical data, such as Master Frequenc

④ MODE
Change between different display mode.

⑤ ENTER
Used to enter/modify programming parameters.

Description of Displayed Function Items

Displayed Item	Description
F 60.0	The current frequency set for the Hybrid servo drive
H 50.0	The frequency Hybrid servo drive actually delivers to the motor
U 180	The user-defined physical quantity (Parameter 00-04)
A 5.0	Load current
Frd	Forward command
rEu	Reverse command
01.00	Displays the selected parameter
10	Display the parameter value
EF	Display the external fault

RUN● FWD● REV● **End** ●STOP	If the "End" message (as shown in the left figure) is displayed on the display area for about one second, it means that data has been accepted and automatically stored in the internal memory
RUN● FWD● REV● **Err** ●STOP	If the setting data is not accepted or its value exceeds the allowed range, this error message will be displayed

Keypad Panel Operation Procedure

Setting Mode

START

F60.0 ⇒ H 0.0 ⇒ A 0.0 ⇒ U60.0 ⇒ Frd

MODE   MODE   MODE   MODE   MODE

GO START

NOTE: In the selection mode, press **ENTER** to set the parameters.

- -

Setting parameters

01. ⇒ 01.02 ⇒ 400.0 ⇒ End   or   Err

ENTER   ENTER   ENTER   Success to   Input data error
                            set parameter.

NOTE：In the parameter setting mode, you can press **ENTER** to return the selecting mode.

- -

To shift data

START

F60.0 ⇒ F59.9 ⇒ F60.0

▼   ▼

- -

Setting direction (When operation source is digital keypad)

Frd ⇒ rEu ⇒ Frd

▲   ▲
or   or
▼   ▼

List of Characters Shown on the Seven-segment Display of the Digital Keypad Panel

Numeric	0	1	2	3	4	5	6	7	8	9
Seven-segment Display	0	1	2	3	4	5	6	7	8	9
English Letter	A	a	B	C	c	D	d	E	e	F
Seven-segment Display	A	–	–	C	c	–	d	E	–	F
English Letter	f	G	g	H	h	I	i	J	j	K
Seven-segment Display	–	G	–	H	h	I	L	J	J	K
English Letter	k	L	l	M	m	N	n	O	o	P
Seven-segment Display	–	L	–	M	–	–	n	O	o	P
English Letter	p	Q	q	R	r	S	s	T	t	U
Seven-segment Display	–	–	q	–	r	5	–	T	t	U
English Letter	u	V	v	W	w	X	x	Y	y	Z
Seven-segment Display	–	–	u	–	–	–	–	y	–	≡
English Letter	z									
Seven-segment Display	–									

3-2 Machine Adjustment Procedure

Perform the following operation procedure by using the Digital Keypad (KPVJ-LE01/ KPV-CE01) or the monitoring software VFD-Explorer

Step 1. Enter the motor's parameters

- Restore the factory default values by setting the Parameter 00-02 = 10

  Reset parameter settings

Setting value of Parameter 00-02	10: Reset parameter values

- Please make sure if the command source has been restored to the factory default (operation by external terminals)

  If the KPV-CE01 is used, the Parameter is 01-01=0

  Source of operation command

Setting value of Parameter 01-01	0: Operation by using the digital keypad
	1: Operation by using the external terminals. The Stop button on the keypad is disabled.
	2: Communication using RS-485. The Stop button on the keypad is disabled

  If the VFD-Explorer is used, the Parameter is 01-01=2

  Source of operation command

Setting value of Parameter 01-01	0: Operation by using the digital keypad
	1: Operation by using the external terminals. The Stop button on the keypad is disabled.
	2: Communication using RS-485. The Stop button on the keypad is disabled

- Change the display type from Frequency command (Hz) into Speed (rpm)

  Display the speed (rpm) defined by the user

Setting value of Parameter 00-06	0~39999rpm

- Set the Parameter 01-02

  Motor's maximum operation frequency

Setting value of Parameter 01-02	50.00 – 600.00Hz

■   Set the Parameter 01-03

Motor's rated frequency

Setting value of Parameter 01-03	0.00 – 600.00Hz

■   Set the Parameters 01-05 & 01-06

Acceleration time setting

Setting value of Parameter 01-05	0.00 – 600.00 seconds

Deceleration time setting

Setting value of Parameter 01-06	0.00 – 600.00 seconds

The settings for the induction and synchronous motors are different. Please configure these parameters according to the related adjustment method for the motor.

Induction motor

■   Set the Parameter 01-00 = 0

Control mode

Setting value of Parameter 01-00	0: VF
	1: Reserved
	2: Reserved
	3: FOC vector control + Encoder (FOCPG)
	4: Reserved
	5: FOCPM
	6: Reserved

■   Set the Parameter 01-26 = 0

Encode type

Setting value of Parameter 01-26	0: ABZ
	1: ABZ+HALL (only used for Delta's servo motors)
	2: ABZ+HALL
	3:Resolver

■   Set the Parameter 01-29

Number of pulses for each revolution of the encoder

Setting value of Parameter 01-29	1~20000

- **Set the Parameter 01-08**

    The rated current of the induction motor

Setting value of Parameter 01-08	0~655.35 Amps

- **Set the Parameter 01-09**

    The rated power of the induction motor

Setting value of Parameter 01-09	0.00 – 655.35kW

- **Set the Parameter 01-10**

    The rated speed (rpm) of the induction motor

Setting value of Parameter 01-10	0~65535

- **Set the Parameter 01-11**

    Number of poles of the induction motor

Setting value of Parameter 01-11	2~20

- **Check if the motor can be separated from the pump**
    1. If it can be separated, set the Parameter 01-07 as 1 and carry out a dynamic measurement
    2. If it cannot be separated, open the safety valve, enter the no-load current of the induction motor 01-12 and set the Parameter 01-07 as 2. Then carry out the static measurement

    Motor Parameter Auto Tuning

Setting value of Parameter 01-07	0: No function
	1: Rolling test for induction motor(IM) (Rs, Rr, Lm, Lx, no-load current)
	2: Static test for induction motor(IM)
	3: Reserved
	4: Auto measure the angle between magnetic pole and PG origin
	5: Rolling test for PM motor

- **During the automatic measurement process of the induction motor, the digital keypad will show the message "tun". After the measurement is finished, the motor automatically shuts down, and the measurement values are stored into Parameters 01-13 to 01-16.If the digital keypad shows "AUE", please check if the wiring is correct and if the parameters are set correctly.**

- **The machine will shut off the power and then supply the power again**

- Set the Parameter 01-00 = 3

  Control mode

Setting value of Parameter 01-00	0: VF
	1: Reserved
	2: Reserved
	3: FOC vector control + Encoder (FOCPG)
	4: Reserved
	5: FOCPM
	6: Reserved

- Test run

  When the motor is in a no-load state, the speed command is set to 10 rpm for low-speed test run. Make sure that the output current value is close to the no-load current.

  If no error occurs, gradually increase the value of speed command to the highest speed.

- Make sure that the pump's oil supply direction is the forward direction of the motor.

Synchronous motor

- Set the Parameter 01-00 = 5

  Control mode

Setting value of Parameter 01-00	0: VF
	1: Reserved
	2: Reserved
	3: FOC vector control + Encoder (FOCPG)
	4: Reserved
	5: FOCPM
	6: Reserved

- Set the Parameter 01-26 = 3

  Encode type

Setting value of Parameter 01-26	0: ABZ
	1: ABZ+HALL (only used for Delta's servo motors)
	2: ABZ+HALL
	3:Resolver

- Set the Parameter 01-29

  Number of pulses for each revolution of the encoder

Setting value of Parameter 01-29	1~20000

■   Set the Parameter 01-17

The rated current of the synchronous motor

Setting value of Parameter 01-17	0~655.35 Amps

■   Set the Parameter 01-18

The rated power of the synchronous motor

Setting value of Parameter 01-18	0.00 – 655.35kW

■   Set the Parameter 01-19

The rated speed (rpm) of the synchronous motor

Setting value of Parameter 01-19	0~65535

■   Set the Parameter 01-20

Number of poles of the synchronous motor

Setting value of Parameter 01-20	2~20

■   Set the Parameter 01-21

The inertia of the synchronous motor's rotor

Setting value of Parameter 01-21	$0.0~6553.5 *10^{-4}$ kg.m^2

■   Check if the motor can be separated from the pump

■   If it can be separated, set the Parameter 01-07 as 5 and carry out the parameter measurement of the synchronous motor

■   If it cannot be separated, open the safety valve, set the Parameter 01-07 as 5 and carry out the parameter measurement of the synchronous motor

Motor Parameter Auto Tuning

Setting value of Parameter 01-07	0: No function
	1: Rolling test for induction motor(IM) (Rs, Rr, Lm, Lx, no-load current)
	2: Static test for induction motor(IM)
	3: Reserved
	4: Auto measure the angle between magnetic pole and PG origin
	5: Rolling test for PM motor

■   During the automatic measurement process of the synchronous motor, the digital keypad will show the message "tun". After the measurement is finished, the motor automatically shuts down, and the measurement values are stored into Parameters 01-22 to 01-25.If the digital

keypad shows "AUE", please check if the wiring is correct and if the parameters are set correctly.

■ Set the value of Parameter 01-07 as 4 and press [Run]. When the operation is complete, the PG offset angle of PM motor is written to Parameter 01-27

Motor Parameter Auto Tuning

Setting value of Parameter 01-07	0: No function
	1: Rolling test for induction motor(IM) (Rs, Rr, Lm, Lx, no-load current)
	2: Static test for induction motor(IM)
	3: Reserved
	4: Auto measure the angle between magnetic pole and PG origin
	5: Rolling test for PM motor

■ The machine will shut off power and then supply power again

■ Test run

When the motor is in a no-load state, the speed command is set to 10 rpm for low-speed test run. Make sure that the output current value is close to the zero current.
If no error occurs, gradually increase the value of speed command to the highest speed.
Make sure that the pump's oil supply direction is the forward direction of the motor.

Step 2. Estimation of Inertia

■ Set the speed command as 1000 rpm
■ Set the Parameters 01-05 & 01-06 = 0.3~0.5 seconds

Acceleration time setting

Setting value of Parameter 01-05	0.00 – 600.00 seconds

Deceleration time setting

Setting value of Parameter 01-06	0.00 – 600.00 seconds

■ Set the Parameter 01-31 = 2 and then press [Run]

System control

Setting value of Parameter 01-31	0: No function
	1: ASR automatic tuning
	2: Estimation of inertia

■ Check if the value of Parameter 01-32 is converged. If it is converged, stop the operation. If not, switch the rotation direction after the speed is stable.

The unity value of the system inertia

Setting value of Parameter 01-32	1~65535 (256 = 1 per unit)

■ After the operation stops, select the Parameter 01-32 and press the [PROG/DATA] button to complete the "write" operation.

■ Set Parameter 01-31=1 and the estimation of the motor's inertia is complete.

Step 3. Connect the motor and the pump and then confirm the pressure feedback signal

■ Set the Parameter 00-04 = 11 and then supply voltage to PO
Selection of multi-function display

Setting value of Parameter 00-04	11: display the signal value of the analog input terminal PO with 0~10V mapped to 0~100%

■ Parameter 00-08 = related pressure setting value of the pressure sensor at 10V
Maximum pressure feedback value

Setting value of Parameter 00-08	0~250Bar

■ Set the speed command as 10rpm and press [RUN] to confirm if the pressure value through the pressure gauge > 0.

If the pressure value ≦0
☑ Gradually increase the rotation speed
☑ Confirm the operation direction of the pump
☑ Make sure that the direction valve is in the close state

If the pressure value > 0
☑ Make sure the multi-function display on the keypad panel shows the voltage indicating the same pressure as the pressure gauge

Example: If the pressure sensors indicates 250bar at 10V, when the pressure gauge shows 50 bar, the pressure sensor output voltage should be around 50/250 * 10 = 2V, and the voltage shown on the keypad panel should be 20.0 (%)

■ Observe if there is oil leakage.

Step 4. Confirm the pressure command and flow command

■ Parameter 00-09 = 1 for pressure control mode
Pressure control mode

Setting value of Parameter 00-09	0: Speed control
	1: Pressure control

■ Parameter 00-04 = 12 PI for input voltage
Selection of multi-function display

Setting value of Parameter 00-04	12: display the signal value of the analog input terminal PI with 0~10V mapped to 0~100%

- Parameter 00-07 = related pressure value of the pressure command at 10V

  Maximum pressure command

Setting value of Parameter 00-07	0~250Bar

- Send the maximum pressure command through the controller and then check the multi-function display page to enter this value into Parameter 00-14

- Send a half pressure command through the controller and then check the multi-function display page to enter this value into Parameter 00-15

- Send the minimum pressure command through the controller and then check the multi-function display page to enter this value into Parameter 00-16

  Example: If the pressure sensor indicates 250bar at 10V. If the maximum pressure on the controller is 140bar and corresponds to 10V, then Parameter 00-07=140.
  Set the pressure as 140bar through the controller, the voltage value shown on the display is about 56.0 (140/250 * 100%). Enter this value into the Parameter 00-14.
  Then set the pressure as 70bar on the controller, and now the value displayed on the keypad panel is about 28.0 (70/250 * 100%). Enter this value to the Parameter 00-15. Then set the pressure as 0 bar on the controller, and the voltage value shown on the display is about 0.0 (0/250 * 100%). Enter this value in the Parameter 00-16.

- Parameter 00-04 = 25 for QI input voltage

  Selection of multi-function display

Setting value of Parameter 00-04	25: display the signal value of the analog input terminal OI with 0~10V mapped to 0~100%

- Send the 100% flow rate through the controller and then check the multi-function display page to enter this value into Parameter 00-17

- Send the 50% flow rate through the controller and then check the multi-function display page to enter this value into Parameter 00-18

- Send the 0% flow rate through the keypad panel and then check the multi-function display page to enter this value into 00-19

Step 5. Bleed the circuit and make sure if there is any plastic material in the barrel. The machine can start operation only when there are no plastic materials inside the barrel.

- Parameter 00-09 = 1 for pressure control mode

  Pressure control mode

Setting value of Parameter 00-09	0: Speed control
	1: Pressure control

■ Set the Parameters 01-05 & 01-06 = 0 second

Acceleration time setting

Setting value of Parameter 01-05	0.00 – 600.00 seconds

Deceleration time setting

Setting value of Parameter 01-06	0.00 – 600.00 seconds

■ For low-pressure and low-speed conditions (within 30% of the rated values), use the "manual operation" through the controller for the operation of each cylinder. During the operation, check the pipe connection for leaks or strange noise in the pump.

■ When the air is bleeding completely, if there is any pressure fluctuation during operation, please adjust the pressure control Parameter PI in accordance with the method described in the "Description of Parameters".

Step 6. Send operation command though the controller

■ Parameter 01-01=1

Source of operation command

Setting value of Parameter 01-01	0: Operation by using the digital keypad
	1: Operation by using the external terminals. The Stop button on the keypad is disabled.
	2: Communication using RS-485. The Stop button on the keypad is disabled

Step 7. Adjustment for injection/pressure holding

■ Heat up the barrel to the required temperature and set the controller in manual control mode.
■ Set the Ki values for the three stages PI to 0 (Parameters 00-21, 00-23 , and 00-25) and Kp values to small values ($\leqq$50.0)
■ Start the plastic injection operation. The "Target value" is low pressure ($<$50Bar) and low flow rate ($<$30%)。
■ Press the "injection" button on the operation panel for the injection operation or the machine will enter the pressure holding operation (depending on the position of the cylinder)
■ In the pressure holding state, use the software (VFD-Explorer) to observe the waveform. Without causing the vibration of the motor, increase the speed bandwidth to the maximum value 40Hz (Parameter 00-10).
■ In the pressure holding condition, if the pointer of the pressure gauge or the monitored pressure waveform has no fluctuation, it means that the pressure is stably fed back. It is allowed to increase the three Kp values.

- When the pressure feedback becomes unstable, reduce the three Kp values by 20% (example: the three Kp values are reduced from 100.0 to 80.0). Adjust the three Ki values to eliminate the steady-state error so as to speed up system response.
- When the above steps are completed, increase the "target value" for the pressure command.
- Observe if the pressure feedback is stable. If there is an abnormal condition, please solve it as follows:
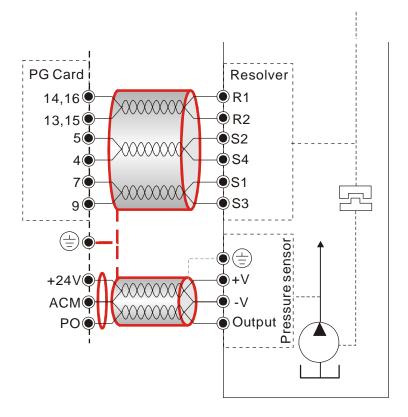
Solve the pressure instability problem

Instability at high pressure

If the Hybrid servo drive has an overload condition, please increase the power rating of the Hybrid servo drive

Instability over the entire pressure range

1. Set Parameter 00-09 = 0 to switch to the speed control

2. If the hydraulic circuit is in the closed state, send a low speed command so as to allow a pressure feedback value of 40-50% of the value for pressure command (parameters 00-07)

3. By using the monitoring software, observe if the pressure waveform has irregular fluctuations.

    - Pressure waveform fluctuates
      It may be a ground interference problem. If the motor or the three-phase power supply is grounded, disconnect the ground wire. If the motor or three-phase power supply has no ground wire, you can install a ground wire for anti-interference protection.

      It may be a grounding problem of the shield mesh (as the red thick line shown below). If the shield mesh is properly grounded, the ground wire can be removed; if the shield mesh has no grounding wire, install a ground wire for anti-interference protection.

4. If there is any abnormal condition that can not be solved, please contact the manufacturer.

Step 8. Adjustment of system transient response

■ Reduce the pressure rise time, increase Kp1 (Parameter 00-20) and reduce the Ki1 time (Parameter 00-21)

■ For pressure overshoot, increase the Kp3 time (Parameter 00-24) and reduce the Ki3 time (Parameter 00-25)

Confluence Machine Tuning Procedure

Wiring according to Chapter 2

Carry out the automatic measurement of the motor's parameters according to Step 1 and Step 2 described above for the Master and Slave, respectively. Then perform the following procedure

Master setting

- Set the Parameter 03-06 = 1
  Multifunction Output 2 (MO1)

Setting value of Parameter 03-06	1: Operation indication

- Connect the Master's MO1 output terminal to the Slave's SON terminal and Master's MCM terminal to the Salve's COM terminal.

- For the firmware version 2.03 and above, it is not necessary to perform the two steps described above

- Set the Parameter 03-13 = 1
  Confluence Master/Slave Selection

Setting value of Parameter 03-13	0: No function
	1: Master 1
	2: Slave/Master 2
	3: Slave/Master 3

- Set the Parameter 03-14
  Slave's proportion of the Master's flow

Setting value of Parameter 03-14	0.0~6553.5%

- For firmware version 2.03 and above, the Parameter 03-17 can be configured to determine the activation level for the Slave
  Slave's activation level

Setting value of Parameter 03-17	0~100%

Slave setting

■   Parameter 01-01=1

Source of operation command

Setting value of Parameter 01-01	0: Operation by using the digital keypad
	1: Operation by using the external terminals. The Stop button on the keypad is disabled.
	2: Communication using RS-485. The Stop button on the keypad is disabled

■   For firmware version 2.03 and above, set the Parameter 01-01=2

Source of operation command

Setting value of Parameter 01-01	0: Operation by using the digital keypad
	1: Operation by using the external terminals. The Stop button on the keypad is disabled.
	2: Communication using RS-485. The Stop button on the keypad is disabled

■   Set the Parameter 03-15 = 1

Source of Frequency Command

Setting value of Parameter 03-15	0: Digital Operation Panel
	1: RS485 Communication
	2~5: reserved

■   Shut down the power and then supply the power again
Set an arbitrary value of the frequency command at the Master to check if the Slave has the same value of the frequency command
Set 10rpm at the Master and then press RUN to see if the Slave is also running. If not, check the wiring or the parameter setting for any problem

■   Set the Slave Parameter 03-13 = 2

Confluence Master/Slave Selection

Setting value of Parameter 03-13	0: No function
	1: Master 1
	2: Slave/Master 2
	3: Slave/Master 3

■   For firmware version 2.03 and above, the Parameter 03-21 can be set at the Slave to decide if the Salve is performing the reversed operation for depressurization.
Note: If it is required to reverse the operation for depressurization at the Slave, it is necessary to make sure that the pump outlet port is not installed with a check valve and the Parameter 03-16 should be set as 500%

Slave reverse operation for depressurization

Setting value of Parameter 03-21	0: Disable 1: Enable

Limit for the Slave reverse depressurization torque

Setting value of Parameter 03-16	0~500%

- Shut off the power and the re-supply power for the Slave, and then set the Slave in the speed control mode

Speed Control Mode

Setting value of Parameter 00-09	0: Speed control 1: Pressure control

In this case, the Master can be tuned according to the Step 3 – Step 8 described above

Confluence/Diversion Mode Adjustment Procedure

Wiring according to Chapter 2

In a diversion condition, adjust various parameters of the Hybrid servo drive according to the Step 1 – Step 8 describe above

In a confluence condition, please refer to the machine adjustment procedure for the confluence operation

Complete the above steps

Set the Master for pressure control mode

- Parameter 00-09 = 1 for pressure control mode

Pressure control mode

Setting value of Parameter 00-09	0: Speed control 1: Pressure control

Set the Slave for speed control mode

- Parameter 00-09 = 0 for speed control mode

Speed Control Mode

Setting value of Parameter 00-09	0: Speed control 1: Pressure control

Respectively set the master/slave multi-function input state. For the firmware version 2.03 and above, it is necessary to set these parameters for the Slave only

■   Parameter 03-00~03-02 = 45 confluence/diversion signal input

Multi-function Input

Setting values of Parameters 03-00~03-02	0: No function 45: Confluence/Diversion signal input

■   Through the controller, perform the entire confluence/diversion operation.

4. Description of Parameters

4-1 Summary of Parameters

4-2 Detailed Description of Parameters

4-1 Summary of Parameters

00 System Parameters

✐ the parameter can be set during operation

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
00-00	Hybrid servo drive model code ID	12：230V, 7.5HP 13：460 V, 7.5HP 14：230V, 10HP 15：460V, 10HP 16：230V, 15HP 17：460V, 15HP 18：230V, 20HP 19：460V, 20HP 20：230V, 25HP 21：460V, 25HP 22：230V, 30HP 23：460V, 30HP 24：230V, 40HP 25：460V, 40HP 26：230V, 50HP 27：460V, 50HP 29：460V, 60HP 31：460V, 75HP 33：460V, 100HP	Read only	○	○	○
00-01	Display of rated current of the Hybrid servo drive	Display the model specific values	Read only	○	○	○
00-02	Reset parameter settings	5: Rest the kWh at drive stop 10: Reset parameter values	0	○	○	○
00-03	Software version	Read only	Read only	○	○	○

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
✗ 00-04	Selection of multi-function display	0: Display the output current (A) 1: Reserved 2: Display the actual output frequency (H) 3: Display the DC-BUS voltage (U) 4: Display the output voltage (E) 5: Display the output power angle (n) 6: Display the output power in kW (P) 7: Display the actual motor speed rpm (r) 8: Display the estimated output torque (%) 9: Display the PG feedback (G) 10: Reserved 11: Display the signal value of the analog input terminal PO % (1.) 12: Display the signal value of the analog input terminal PI % (2.) 13: Display the signal value of the analog input terminal AUI % (3.) 14: Display temperature of the heat sink in °C (t.) 15: Display temperature of IGBT in °C (T) 16: The status of digital input (ON/OFF) (i) 17: The status of digital output (ON/OFF) (o) 18: Reserved 19: The corresponding CPU pin status of the digital input (i.) 20: The corresponding CPU pin status of the digital output (o.) 21~24: Reserved 25: Display the signal value of the analog input terminal QI % (5.) 26: Display the actual pressure value (Bar) (b.) 27: Display the kWh value (K) 28: Display the motor temperature (currently only support KTY84) (T.)	0	○	○	○
✗ 00-05	Analog output function selection	0: Output frequency (Hz)	0	○	○	○
		1: Frequency command (Hz)		○	○	○
		2: Motor speed (Hz)		○	○	○
		3: Output current (A)			○	○
		4: Output voltage		○	○	○
		5: DC Bus voltage		○	○	○
		6: Power factor		○	○	○
		7: Power				
		8: Output torque				
		9: PO				
		10: PI				
		11: AUI		○	○	○
		12~20: Reserved		○	○	○
00-06	Display the speed (rpm) defined by the user	0~39999 rpm	0	○	○	○
✗ 00-07	Maximum value for the pressure command	0~250 Bar	250	○	○	○
✗ 00-08	Maximum pressure feedback value	0~400 Bar	250	○	○	○

	Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
	00-09	Pressure control mode	0: Speed control 1: Pressure control	0	○	○	○
	00-10	Speed bandwidth	0~40Hz	20		○	○
✎	00-11	Pressure feedback filtering time PO	0.000~1.000 second	0.000	○	○	○
✎	00-12	Pressure command filtering time PI	0.000~1.000 second	0.000	○	○	○
✎	00-13	Flow command filtering time QI	0.000~1.000 second	0.000	○	○	○
✎	00-14	Percentage for the pressure command value (Max)	0.0~100.0%	100.0	○	○	○
✎	00-15	Percentage for the pressure command value (Mid)	0.0~100.0%	50.0	○	○	○
✎	00-16	Percentage for the pressure command value (Min)	0.0~100.0%	0.0	○	○	○
✎	00-17	Percentage for the flow command value (Max)	0.0~100.0%	100.0	○	○	○
✎	00-18	Percentage for the flow command value (Mid)	0.0~100.0%	50.0	○	○	○
✎	00-19	Percentage for the flow command value (Min)	0.0~100.0%	0.0	○	○	○
✎	00-20	P gain 1	0.0~1000.0	50.0	○	○	○
✎	00-21	I integration time 1	0.00~500.00 seconds	2.00	○	○	○
✎	00-22	P gain 2	0.0~1000.0	50.0	○	○	○
✎	00-23	I integration time 2	0.00~500.00 seconds	2.00	○	○	○
✎	00-24	P gain 3	0.0~1000.0	50.0	○	○	○
✎	00-25	I integration time 3	0.00~500.00 seconds	2.00	○	○	○
✎	00-26	Pressure stable region	0~100%	25	○	○	○
✎	00-27	Base pressure	0.0~100.0%	1.0	○	○	○
✎	00-28	Depressurization speed	0~100%	25	○	○	○
✎	00-29	Ramp up rate of pressure command	0~1000ms	0	○	○	○
✎	00-30	Ramp down rate of pressure command	0~1000ms	100	○	○	○
✎	00-31	Ramp up rate of flow command	0~1000 ms	80	○	○	○
✎	00-32	Ramp down rate of flow command	0~1000 ms	80	○	○	○

	Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
✗	00-33	Valve opening delay time	0~200 ms	0	○	○	○
	00-34	Reserved					
✗	00-35	Over-pressure detection level	0~250 Bar	230	○	○	○
✗	00-36	Detection of disconnection of pressure feedback	0 : No function 1: Enable (only for the pressure feedback output signal within 1~5V)	0	○	○	○
✗	00-37	Differential gain	0.0~100.0 %	0.0	○	○	○
	00-38	Pressure/flow control function selection	Bit 0: 0: Switch the PI Gain according to the pressure feedback level 1: Switch the PI Gain according to the multi-function input terminal Bit 1: 0: No pressure/flow control switch 1: Switch between the pressure and flow control	0	○	○	○

01 Motor Parameters

✗ the parameter can be set during operation

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
01-00	Control mode	0: VF 1: Reserved 2: Reserved 3: FOCPG 4: Reserved 5: FOCPM 6: Reserved	5	○	○	○
✗ 01-01	Source of operation command	0: Operation by using the digital keypad 1: Operation by using the external terminals. The Stop button on the keypad is disabled. 2: Communication using RS-485. The Stop button on the keypad is disabled	1	○	○	○
01-02	Motor's maximum operation frequency	50.00~600.00Hz	60.00/50.00	○	○	○
01-03	Motor's rated frequency	0.00~600.00Hz	60.00/50.00	○	○	○
01-04	Motor's rated voltage	230V Series: 0.1V~255.0V 460V Series: 0.1V~510.0V	220.0 440.0	○	○	
✗ 01-05	Acceleration time setting	0.00~600.00 seconds	0.00	○	○	○
✗ 01-06	Deceleration time setting	0.00~600.00 seconds	0.00	○	○	○
01-07	Motor Parameter Auto Tuning	0: No function	0	○	○	
		1: Rolling test for induction motor(IM) (Rs, Rr, Lm, Lx, no-load current)		○	○	
		2: Static test for induction motor(IM)		○	○	
		3: Reserved		○	○	
		4: Auto measure the angle between magnetic pole and PG origin				○
		5: Rolling test for PM motor				○
01-08	Rated current of the induction motor (A)	40~120% of the drive's rated current	#.##		○	
✗ 01-09	Rated power of the induction motor	0~655.35kW	#.##		○	
✗ 01-10	Rated speed of the induction motor	0~65535rpm 1710 (60Hz 4-pole); 1410 (50Hz 4-pole)	1710		○	
01-11	Number of poles of the induction motor	2~20	4		○	

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
01-12	No-load current of the induction motor (A)	0~Default value of Parameter 01-08	#.##		○	
01-13	Stator resistance (Rs) of the induction Motor	0~65.535Ω	#.###		○	
01-14	Rotor resistance (Rr) of the induction Motor	0~65.535Ω	#.###		○	
01-15	Magnetizing inductance (Lm) of the induction Motor	0.0~6553.5mH	#.#		○	
01-16	Total leakage inductance (Lx) of the induction motor	0.0~6553.5mH	#.#		○	
01-17	Rated current of the synchronous motor	0~655.35 Amps	0.00			○
01-18	Rated power of the synchronous motor	0.00 – 655.35kW	0.00			○
01-19	Rated speed of the synchronous motor	0~65535rpm	0			○
01-20	Number of poles of the synchronous motor	2~20	6			○
01-21	Inertia of the synchronous motor's rotor	$0.0\sim6553.5 *10^{-4}$ kg.m^2	0.0			○
01-22	Stator's phase resistance (Rs) of the synchronous motor	0.000~65.535Ω	0.000			○
01-23	Stator's phase inductance (Ld) of the synchronous motor	0.00.0~655.35mH	0.00			○
01-24	Stator's phase inductance (Lq) of the synchronous motor	0.00.0~655.35mH	0.00			○
01-25	Back EMF of the synchronous motor	0~65535 V/krpm	0			○
01-26	Encode type	0: ABZ 1: ABZ+HALL (only used for Delta's servo motors) 2: ABZ+HALL 3: Resolver	3			○
01-27	PG Offset angle of synchronous motor	0.0~360.0°	0.0			○

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
01-28	Number of poles of the resolver	1~5	1			○
01-29	Encoder pulse	1~20000	1024		○	○
01-30	Encoder's input type setting	0: No function 1: Phase A leads in a forward run command and phase B leads in a reverse run command 2: Phase B leads in a forward run command and phase A leads in a reverse run command 3: Phase A is a pulse input and phase B is a direction input. (low input=reverse direction, high input=forward direction) 4: Phase A is a pulse input and phase B is a direction input. (low input=forward direction, high input=reverse direction) 5: Single-phase input	1		○	○
01-31	System control	0: No function 1: ASR automatic tuning 2: Estimation of inertia	1		○	○
✗ 01-32	Unity value of the system inertia	1~65535 (256 = 1 per unit)	400		○	○
01-33	Carrier frequency	5KHz; 10KHz	5	○	○	○
✗ 01-34	Reserved					
01-35	Motor ID	0 : No function 16: Delta's Hybrid servo motor ECMA-ER181BP3 (11kW220V) 17: Delta's Hybrid servo motor ECMA-KR181BP3 (11kW380V) 18: Delta's Hybrid servo motor ECMA-ER221FPS (15kW220V) 19: Delta's Hybrid servo motor ECMA-KR221FPS (15kW380V) 21: Delta's Hybrid servo motor ECMA-KR222APS (20kW380V)	0	○	○	○
01-36	Change the rotation direction	0: When the driver runs forward, the motor rotates counterclockwise. When the driver runs reverse, the motor rotates clockwise. 1: When the driver runs forward, the motor rotates clockwise. When the driver runs reverse, the motor rotates counterclockwise..	0	○	○	○

0-2 Parameters for Protection

✗ the parameter can be set during operation

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
✗ 02-00	Software brake level	230V series: 350.0~450.0Vdc 460V series: 700.0~900.0Vdc	380.0 760.0	○	○	○
02-01	Present fault record	0: No error record	0	○	○	○
02-02	Second most recent fault record	1: Over-current during acceleration (ocA)	0	○	○	○
02-03	Third most recent fault record	2: Over-current during deceleration (ocd)	0	○	○	○
02-04	Fourth most recent fault record	3: Over-current during constant speed (ocn)	0	○	○	○
02-05	Fifth most recent fault record	4: Ground fault (GFF)	0	○	○	○
02-06	Sixth most recent fault record	5: IGBT short-circuit (occ)	0	○	○	○
		6: Over-current at stop (ocS)		○	○	○
		7: Over-voltage during acceleration (ovA)		○	○	○
		8: Over-voltage during deceleration (ovd)		○	○	○
		9: Over-voltage during constant speed (ovn)		○	○	○
		10: Over-voltage at stop (ovS)		○	○	○
		11: Low-voltage during acceleration (LvA)		○	○	○
		12: Low-voltage during deceleration (Lvd)		○	○	○
		13: Low-voltage during constant speed (Lvn)		○	○	○
		14: Low-voltage at stop (LvS)		○	○	○
		15: Phase loss protection (PHL)		○	○	○
		16: IGBT over-heat (oH1)		○	○	○
		17: Heat sink over-heat for 40HP and above (oH2)		○	○	○
		18: TH1 open: IGBT over-heat protection circuit error (tH1o)		○	○	○
		19: TH2 open: heat sink over-heat protection circuit error (tH2o)		○	○	○
		20: Fan error signal output (Fan)		○	○	○
		21: Hybrid servo drive overload (oL)		○	○	○
		22: Motor over-load (EoL1)		○	○	○
		23: Reserved				
		24: Motor over-heat, detect by PTC (oH3)		○	○	○
		25: Reserved				
		26: Over-torque 1 (ot1)		○	○	○

Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
		27: Over-torque 2 (ot2)		○	○	○
		28: Reserved		○	○	○
		29: Reserved		○	○	○
		30: Memory write error (cF1)		○	○	○
		31: Memory read error (cF2)		○	○	○
		32: Isum current detection error (cd0)		○	○	○
		33: U-phase current detection error (cd1)		○	○	○
		34: V-phase current detection error (cd2)		○	○	○
		35: W-phase current detection error (cd3)		○	○	○
		36: Clamp current detection error (Hd0)		○	○	○
		37: Over-current detection error (Hd1)		○	○	○
		38: Over-voltage detection error (Hd2)		○	○	○
		39: Ground current detection error (Hd3)		○	○	○
		40: Auto tuning error (AuE)			○	○
		41: Reserved		○	○	○
		42: PG feedback error (PGF1)			○	○
		43: PG feedback loss (PGF2)			○	○
		44: PG feedback stall (PGF3)			○	○
		45: PG slip error (PGF4)			○	○
		46: Reserved		○	○	○
		47: Reserved		○	○	○
		48: Reserved				
		49: External fault input (EF)		○	○	○
		50: Emergency stop (EF1)		○	○	○
		51: Reserved				
		52: Password error(PcodE)		○	○	○
		53: Reserved		○	○	○
		54: Communication error (cE1)		○	○	○
		55: Communication error (cE2)		○	○	○
		56: Communication error (cE3)		○	○	○
		57: Communication error (cE4)		○	○	○
		58：Communication time out (cE10)		○	○	○
		59: PU time out (cP10)		○	○	○
		60: Braking transistor error (bF)		○	○	○
		61~63: Reserved		○	○	○
		64: Safety relay Error (SRY)		○	○	○
		65: PG card information error (PGF5)				○
		66: Over pressure (ovP)		○	○	○

	Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
✗	02-07	Low voltage level	67: Pressure feedback fault (PfbF)	180.0 360.0	○	○	○
			160.0~220.0Vdc		○	○	○
			320.0.0~440.0Vdc				
✗	02-08	PTC action selection	0: Warn and keep operation	0	○	○	○
			1: Warn and ramp to stop				
			2: Warn and coast to stop				
✗	02-09	PTC level	0.0~150.0%	50.0	○	○	○
			0.0~150.0℃				
✗	02-10	PTC detection filtering time	0.00~10.00 seconds	0.20	○	○	○
✗	02-11	PTC type	0: Not assigned	0	○	○	○
			1: KTY84				
✗	02-12	Motor fan activation level	0.0~100.0%	50.0	○	○	○
			0.0~150.0℃				
✗	02-13	Electronic thermal relay selection 1	0: Inverter motor	2	○	○	○
			1: Standard motor				
			2: Disable				
✗	02-14	Electronic thermal characteristic for motor	30.0~600.0 seconds	60.0	○	○	○
	02-15	Output frequency at malfunction	0.00~655.35 Hz	Read only	○	○	○
	02-16	Output voltage at malfunction	0.0~6553.5 V	Read only	○	○	○
	02-17	DC voltage at malfunction	0.0~6553.5 V	Read only	○	○	○
	02-18	Output current at malfunction	0~655.35 Amps	Read only	○	○	○
	02-19	IGBT temperature at malfunction	0.0~6553.5 ℃	Read only	○	○	○

03 Digital/Analog Input/Output Parameters ✗ the parameter can be set during operation

	Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
	03-00	Multi-function input command 3 (MI3)	0: No function 44: Injection signal input	0	○	○	○
	03-01	Multi-function input command 4 (MI4)	45: Confluence/Diversion signal input 46: Reserved	0	○	○	○
	03-02	Multi-function input command 5 (MI5)	47: Multi-level pressure PI command 1 48: Multi-level pressure PI command 2	0	○	○	○
✗	03-03	Digital input response time	0.001~ 30.000 sec	0.005	○	○	○
✗	03-04	Digital input operation direction	0~65535	0	○	○	
✗	03-05	Multi-function output 1 (Relay 1)	0: No function 1: Operation indication	11	○	○	○
✗	03-06	Multi-function Output 2 (MO1)	9: Hybrid servo drive is ready 11: Error indication	0	○	○	○
✗	03-07	Multi-function Output 3 (MO2)	44: Displacement switch signal 45: Motor fan control signal	0	○	○	○
✗	03-08	Multi-function output direction	0~65535	0		○	
✗	03-09	Low-pass filter time of keypad display	0.001~65.535 seconds	0.010	○	○	○
	03-10	Maximum output voltage for pressure feedback	5.0~10.0 V	10.0	○	○	○
	03-11	Minimum output voltage for pressure feedback	0.0~10.0 V	0.0	○	○	○
✗	03-12	Reserved					
	03-13	Confluence Master/Slave Selection	0: No function 1: Master 1 2: Slave/Master 2 3: Slave/Master 3	0	○	○	○
	03-14	Slave's proportion of the Master's flow	0.0~65535.5 %	100.0	○	○	○
✗	03-15	Source of frequency command	0: Digital keypad 1: RS485 Communication 2~5: Reserved	0	○	○	○
✗	03-16	Limit for the Slave reverse depressurization torque	0~500%	20	○	○	○
✗	03-17	Slave's activation level	0.0~100.0%	50.0	○	○	○

	Parameter code	Function of the parameter	Settings	Default value	VF	FOCPG	FOCPM
✗	03-18	Communication error treatment	0: Warn and keep operation 1: Warn and ramp to stop 2: Warn and coast to stop 3: No action and no display	3	○	○	○
✗	03-19	Time-out detection	0.0~100.0 seconds	0.0	○	○	○
✗	03-20	Start-up display selection	0: F (frequency command) 1: H (actual frequency) 2: Multi-function display (user-defined 00-04) 3: A (Output current)	0	○	○	○
✗	03-21	Slave reverse operation for depressurization	0: Disabled 1: Enabled	0	○	○	○

4-2 Detailed Description of Parameters

00 System Parameters

✗ the parameter can be set during operation

┣┫-┣┫ Hybrid servo drive model code ID

Control mode   **VF**   FOCPG   FOCPM   Factory default: Read only

      Settings   Read only

┣┫-┣┫┃ Display of rated current of the Hybrid servo drive

Control mode   **VF**   FOCPG   FOCPM   Factory default: Read only

      Settings   Read only

📖 Parameter 00-00 is used to determine the capacity of the Hybrid servo motor which has been configured in this parameter in factory. In addition, the current value of Parameter (00-01) can be read out to check if it is the rated current of the corresponding model. Display value of the current value of Parameter 00-01 for the related Parameter 00-00.

230V Series								
Power (KW)	5.5	7.5	11	15	18.5	22	30	37
Horse Power (HP)	7.5	10	15	20	25	30	40	50
Model ID	12	14	16	18	20	22	24	26

460V Series											
Power (KW)	5.5	7.5	11	15	18.5	22	30	37	45	55	75
Horse Power (HP)	7.5	10	15	20	25	30	40	50	60	75	100
Model ID	13	15	17	19	21	23	25	27	29	31	33

┣┫-┣┫┃ Reset parameter settings

Control mode   **VF**   FOCPG   FOCPM   Factory default: 0

      Settings   0: No function

                          5: Rest the kWh at drive stop

                          10: Reset parameter values

📖 If it is necessary to restore the parameters to factory default, just set this parameter to "10".

┣┫-┣┫┃ Software version

Control mode   **VF**   FOCPG   FOCPM   Factory default: #.##

      Settings   Read only

✗ **┣┫-┣┫┃ Selection of multi-function display**

Control mode   **VF**   FOCPG   FOCPM   Factory default: 0

      Settings   0: Display the output current (A)   `A 2.00`

                       1: Reserved

                       2: Display the actual output frequency (H)   `H 230`

3: Display the DC-BUS voltage (U) `U 03103`

4: Display the output voltage (E) `U E2203`

5: Display the output power angle (n) `U n 0.0`

6: Display the output power in kW (P) `U P0.000`

7: Display the actual motor speed(r 00: forward speed; - 00: negative speed) `U r 00` `U - 00`

8: Display the estimated output torque (%) (t 0.0: positive torque; - 0.0: negative torque) (%) `U t 00` `U - 0.0`

9: Display the PG feedback (G) `U G 00`

10: Reserved

11: Display the signal value of the analog input terminal PO with 0~10V mapped to 0~100% `U 1. 0.0`

12: Display the signal value of the analog input terminal PI with 0~10V mapped to 0~100% `U 2. 0.0`

13: Display the signal value of the analog input terminal PI with -10~10V mapped to 0~100% `U 3. 0.0`

14: Display temperature of the heat sink in °C (t.) `U t. 0.0`

15: Display temperature of the IGBT power module °C `U r 0.0`

16: The status of digital input (ON/OFF) `U C 00`

17: The status of digital output (ON/OFF) `U o 0.0`

18: Reserved `U S 0`

19: The corresponding CPU pin status of the digital input `U CFFFF`

20: The corresponding CPU pin status of the digital output `U oFFFF`

21~24: Reserved

25: Display the signal value of the analog input terminal OI with 0~10V mapped to 0~100% `U S. 0.0`

26: Display the actual pressure value (Bar) `U b. 0.0`

27: Display the kWh value `U P 0.0`

28: Display the motor temperature (currently only support KTY84) `U r. 0.0`

📖 This parameter defines the contents to be displayed in the U page of the digital keypad KPV-CE01 (as shown in the figure).

✗ **00 - 05** Analog output function selection

Control mode   VF   FOCPG FOCPM   Factory default: 0

Settings   0~20

Summary of functions

Setting Value	Function	Description
0	Output frequency (Hz)	The maximum frequency is 100%
1	Frequency command (Hz)	The maximum frequency is 100%
2	Motor speed (Hz)	600Hz is used as 100%

3	Output current (A)	2.5 times of the rated current of the Hybrid servo drive is used as 100%
4	Output voltage	2 times of the rated current of the Hybrid servo drive is used as 100%
5	DC BUS voltage	450V (900V) =100%
6	Power factor	-1.000~1.000=100%
7	Power	Rated power of the drive =100%
8	Output torque	Rated torque =100%
9	PO	(0~10V=0~100%)
10	PI	(0~10V=0~100%)
11	AUI	(-10~10V=0~100%)
12~20	Reserved	

🔓 00-06 Display the speed (rpm) defined by the user

Control mode   **VF   FOCPG FOCPM**   Factory default: 0

        Settings   0~39999 rpm

📖   Set the maximum speed of the motor corresponding to the 100% flow.

✐ 00-07 Maximum value for the pressure command

Control mode   **VF   FOCPG FOCPM**   Factory default: 250

        Settings   0~250Bar

📖   The 0~10V for the pressure command on the controller is mapped to 0~the value of this parameter.

✐ 00-08 Maximum pressure feedback value

Control mode   **VF   FOCPG FOCPM**   Factory default: 250

        Settings   0~400Bar

📖   The 0~10V for the pressure sensor is mapped to 0~the value of this parameter.

00-09 Pressure control mode

Control mode   **VF   FOCPG FOCPM**   Factory default: 0

        Settings   0: Speed control

                         1: Pressure control

📖   This parameter determines the control mode of the Hybrid servo drive. It is recommended to use the speed control at the initial start up. After the motor, pump, pressure sensor, and the entire system are checked without any error, switch to the pressure control mode to enter the process control.

00-10 Speed bandwidth

Control mode   **FOCPG FOCPM**   Factory default: 20

        Settings   0~40Hz

📖   Set the speed response. The larger value indicates the faster response.

✐ 00-11 Pressure feedback filtering time PO

✗ `00-12` Pressure feedback filtering time PI
✗ `00-13` Pressure feedback filtering time QI

Control mode	**VF**	FOCPG	FOCPM	Factory default: 0.000
	Settings	0.000~1.000 seconds		

📖 Noises may reside in the analog input signals of the control terminals PO, PI, and QI. The noise may affect the control stability. Use an input filter to eliminate such noise.

📖 If the time constant is too large, a stable control is obtained with poorer control response. If it is too small, a fast response is obtained with unstable control. If the optimal setting is not known, adjust it properly according to the instability or response delay.

✗ `00-14` Percentage for the pressure command value (Max)
✗ `00-15` Percentage for the pressure command value (Mid)
✗ `00-16` Percentage for the pressure command value (Min)

Control mode	**VF**	FOCPG	FOCPM	Factory default: 100.0
	Settings	0.0~100.0%		

📖 To set these parameters, it is necessary to set Parameter 00-09 as 1

Parameter 00-04 = 12 for PI input voltage

Send the maximum pressure command through the controller and then check the multi-function display page to enter this value into 00-14

Send a half pressure command through the controller and then check the multi-function display page to enter this value into 00-15

Send the minimum pressure command through the controller and then check the multi-function display page to enter this value into 00-16

Example: If the pressure sensor indicates 250bar at 10V. If the controller's maximum pressure of 140bar corresponds to 10V, then Parameter 00-07=140. Set the pressure as 140bar by using the controller, the voltage value shown on the display is about 56.0 (140/250 * 100%). Enter this value into the Parameter 00-14. Then set the pressure as 70bar on the controller, and now the value displayed on the keypad is about 28.0 (70/250 * 100%). Enter this value to the Parameter 00-15. Then set the pressure as 0 bar on controller, and the voltage value shown on the keypad is about 0.0 (0/250 * 100%). Enter this value in the Parameter 00-16.

✗ `00-17` Percentage for the flow command value (Max)
✗ `00-18` Percentage for the flow command value (Mid)
✗ `00-19` Percentage for the flow command value (Min)

Control mode	**VF**	FOCPG	FOCPM	Factory default: 100.0
	Settings	0.0~100.0%		

📖 To set these parameters, it is necessary to set Parameter 00-09 as 1

📖 Parameter 00-04 = 25 for QI input voltage

Send the 100% flow rate through the controller and then check the multi-function display page to enter this value into 00-17

Send the 50% flow rate through the controller and then check the multi-function display page to enter this value into 00-18

Send the 0% flow rate through the controller and then check the multi-function display page to enter this value into 00-19

✗ `00-20` P gain 1
✗ `00-22` P gain 2
✗ `00-24` P gain 3

Control mode	VF	FOCPG	FOCPM	Factory default: 50.0
Settings	0.0～1000.0			

✗ `00-21` I integration time 1
✗ `00-23` I integration time 2
✗ `00-25` I integration time 3

Control mode	VF	FOCPG	FOCPM	Factory default: 2.00
Settings	0.00 – 500.00 seconds			

✗ `00-37` Differential gain

Control mode	VF	FOCPG	FOCPM	Factory default: 0.0
Settings	0.0~100.0 %			

✗ `00-26` Pressure stable region

Control mode	VF	FOCPG	FOCPM	Factory default: 25
Settings	0～100%			

📖 Adjust the Kp value to a proper level first, and then adjust the Ki value (time). If the pressure has overshoot, adjust the kd value.

Appropriate Ki value (time)   Ki value is too high (time)   Ki value is too low (time)

Kd value is too low   Appropriate Kd value   Kd value is too high

✗ **00-27** Base pressure

Control mode   VF   FOCPG   FOCPM   Factory default: 1.0

Settings   0.0~100.0%

☐ Set the minimum pressure value 100% corresponding to Parameter 00-08

☐ Typically, it is necessary to maintain a certain base pressure to ensure that the oil pipe is in fully filled condition so as to avoid the activation delay of the cylinder when a pressure/flow command is activated.

✗ **00-28** Depressurization speed

Control mode   VF   FOCPG   FOCPM   Factory default: 25

Settings   0~100%

☐ Set the highest rotation speed at depressurization. The 100% value is mapped to Parameter 01-02 (the maximum rotation speed of the motor)
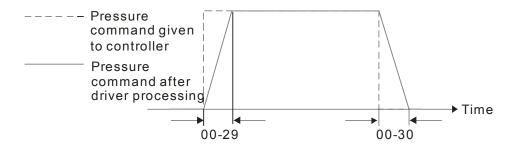
✗ **00-29** Ramp up rate of pressure command
✗ **00-30** Ramp down rate of pressure command

Control mode   VF   FOCPG   FOCPM   Factory default: 100

Settings   0~1000ms

☐ Ramp the pressure value for the pressure command so as to reduce the vibration of the machine.

☐ Set the time required for ramping the pressure from 0~the maximum pressure (00-08).

- - - - - Pressure command given to controller

———— Pressure command after driver processing

Time

00-29   00-30

✗ **00-31** Ramp up rate of flow command
✗ **00-32** Ramp down rate of flow command
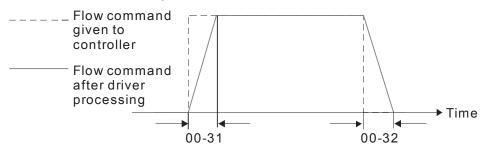
Control mode | VF | FOCPG | FOCPM | Factory default: 80

Settings | 0~1000ms

 Ramp the flow value for the flow command so as to reduce the vibration of the machine.

 Set the time required for ramping the flow from 0~the maximum flow (01-02).

00-33 Valve opening delay time
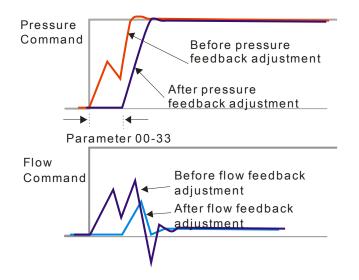
Control mode | VF | FOCPG | FOCPM | Factory default: 0

Settings | 0 – 200ms

 When both the pressure command and flow command activate the machine to start from idle, the flow starts to output. However, due to the slower response of the valve in the hydraulic circuit, the sudden surge of the pressure may occur. The pressure may recover to normal till the valve is fully opened. To avoid the aforementioned effect, set this parameter to increase time for the flow output delay.

00-34 Reserved

00-35 Over-pressure detection level

Control mode | VF | FOCPG | FOCPM | Factory default: 230

Settings | 0~250 Bar

 When the pressure feedback exceeds this parameter setting, an "ovP over pressure" error message may occur.

00-36 Detection of disconnection of pressure feedback

Control mode | VF | FOCPG | FOCPM | Factory default: 0

Settings | 0: No function

1: Enable (only for the pressure feedback output signal within 1~5V)

📖 When this parameter is set as 1 and if the pressure feedback signal is below 1V, an "Pfbf pressure feedback fault" error message may occur.

✒ **`00-38`** Pressure/flow control function selection

| Control mode | VF | FOCPG | FOCPM | | Factory default: 0 |

Settings   Bit 0:
0: Switch the PI Gain according to the pressure feedback level
1: Switch the PI Gain according to the multi-function input terminal
Bit 1:
0: No pressure/flow control switch
1: Switch between the pressure and flow control

📖 When the Bit 0 of this parameter is set as 1, the PI Gain for the pressure can be switched in conjunction with the multi-function input terminal

Multi-function input terminal = 47	Multi-function input terminal = 48	
OFF	OFF	PI1(Parameters 00-20 & 00-21)
ON	OFF	PI2(Parameters 00-22 & 00-23)
OFF	ON	PI3(Parameters 00-24 & 00-25)

📖 When the Bit 1 of this parameter is set as 1, the pressure feedback is lower than the pressure stable region (please refer to the description of Parameter 00-26) so the flow control will be performed. When it enters the pressure stable region, the pressure control will be performed.

01 Motor Parameters

`01-00` Control mode

Control mode	VF	FOCPG	FOCPM		Factory default: 5
			0 : V/F		
			1: Reserved		
			2: Reserved		
Settings			3: FOCPG		
			4: Reserved		
			5: FOCPM		
			6: Reserved		

📖 This parameter determines the control mode of this AC motor.

    0: V/F control, the user can design the required V/F ratio. It is used for induction motors.

    1~2: Reserved

    3: FOC vector control + Encoder. It is used for induction motors.

    4: Reserved

    5: FOC vector control + Encoder. It is used for synchronous motors.

    6: Reserved

✎ `01-01` Source of operation command

Control mode	VF	FOCPG	FOCPM	Factory default: 1
Settings		0: The operation command is controlled by the digital operation panel		
		1: The operation command is controlled by the external terminals. The STOP button on the keypad panel is disabled		
		2: The operation command is controlled by the communication interface. The STOP button on the keypad panel is disabled		

📖 For the operation command, press the PU button to allow the "PU" indicator to be lit. In this case, the RUN, JOG, and STOP button are enabled.

`01-02` Motor's maximum operation frequency

Control mode	VF	FOCPG	FOCPM	Factory default: 60.00/50.00
Settings	50.00 – 600.00Hz			

📖 Set the maximum operation frequency range of the motor. This setting is corresponding to the maximum flow for the system.

`01-03` Motor's rated frequency

Control mode	VF	FOCPG	FOCPM	Factory default: 60.00/50.00
Settings	0.00~600.00Hz			

📖 Typically, this setting is configured according to the rated voltage and frequency listed in the specifications on the motor's nameplate. If the motor is intended for 60Hz, set this value as 60Hz; if the motor is intended for 50Hz, set this value as 50Hz.

`01-04` Motor's rated voltage

Control mode	VF	FOCPG		Factory default: 220.0/440.0
Settings	230V series: 0.1 – 255.0V			

460V series: 0.1 – 510.0V

 Typically, this setting is configured according to the rated operation voltage shown on the motor's nameplate. If the motor is intended for 220V, set this value as 220.0V; if the motor is intended for 200V, set this value as 200.0V.

01-05 Acceleration time setting

Control mode   **VF   FOCPG   FOCPM**   Factory default: 0.00

Settings   0.00 – 600.00 seconds

01-06 Deceleration time setting

Control mode   **VF   FOCPG   FOCPM**   Factory default: 0.00

Settings   0.00 – 600.00 seconds

 The acceleration time determines the time required for the Hybrid servo motor to accelerate from 0.0Hz to [the motor's maximum frequency] (01-02). The deceleration time determines the time required for the Hybrid servo motor to decelerate from [the motor's maximum frequency] (01-02) to 0.0Hz.

01-07 Motor Parameter Auto Tuning

Factory default: 0

Settings	Control mode	VF	FOCPG	FOCPM
0: No function		○	○	
1: Rolling test for induction motor(IM) (Rs, Rr, Lm, Lx, no-load current)		○	○	
2: Static test for induction motor(IM)		○	○	
3: Reserved				
4: Auto measure the angle between magnetic pole and PG origin				○
5: Rolling test for PM motor				○
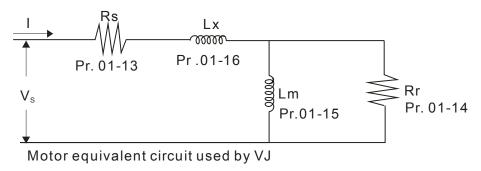
 If the parameter is set as 1~2, it will perform the parameter automatic tuning for the Induction motor. In this case, press the [Run] button to perform the automatic measurement operation immediately. After the measurement is complete, the values are filled into Parameters 01-13~16 (no-load current, Rs, Rr, Lm, and Lx), respectively.

Induction motor *AUTO-Tuning procedure:*(Rolling test)

1. All parameters of the Hybrid servo drive are set to factory settings and the motor is connected correctly.

2. Users are strongly advised to disconnect the motor from any load before tuning. That is to say, the motor contains only the output shaft and connects to neither a belt nor a decelerator. Otherwise, it will be impossible to disconnect the motor from any loads. Static tuning is advised※.

3. Set the rated voltage 01-04, rated frequency 01-03, rated current 01-08, rated power 01-09, rated speed 01-10, and number of poles 01-11 of the motor with correct values, respectively. For the acceleration/deceleration time, please set the correct values.

4. Set Parameter 01-07 as 1 and then press the RUN button on the keypad. The auto tuning process for the motor is carried out immediately. (Note: the motor starts running).

5. After the process is finished, check if the motor's parameters (parameters 01-13 ~ 16) have

been automatically entered with the measurement data.

6. Equivalent circuit of the motor

Motor equivalent circuit used by VJ

NOTE

* When the static tuning (parameters 01-07 = 2) is used, you must enter the no-load current ot the motor. It is generally 20 to 50% of the rated current.

📖 If the parameter is set as 5, it will perform the parameter automatic tuning for the synchronous motor. In this case, press the [Run] button to perform the automatic measurement operation immediately. After the measurement is complete, the values are filled into Parameters 01-22 (Rs), 01-23 & 24 (Ld & Lq), 01-25 (Back EMF of the synchronous motor), respectively.

Synchronous motor *AUTO-Tuning procedure:*(static measurement)
1. All parameters of the Hybrid servo drive are set to factory settings and the motor is connected correctly.
2. Set the rated current 01-17, rated power 01-18, rated speed 01-19, and number of poles 01-20 of the motor with correct values, respectively. For the acceleration/deceleration time, please set the values according to the motor's capacity.
3. Set Parameter 01-07 as 5 and then press the RUN button. The auto tuning process for the motor is carried out immediately. (Note: the motor starts running slightly).
4. After the process is finished, check if the motor's parameters (parameters 01-22 ~ 01-25) have been automatically entered with the measurement data.

📖 If the Parameter is set as 4, the automatic measurement of the angle between magnetic pole and the PG origin for the synchronous motor is performed. In this case, press the [Run] button to immediately perform automatic measurement. The measured data will be entered into Parameter 01 -27.

Angle between magnetic pole and the PG origin Auto-Tuning process for the synchronous motor:
1. After the measurement process for parameter value of 5 is performed completely or manually enter the Parameters 01-03, 01-17 and 01-25, respectively.
2. Before tuning, it is recommended to separate the motor and the load.
3. Set Parameter 01-07 as 4 and then press the RUN button on the keypad. The auto tuning process for the motor is carried out immediately. (Note: the motor starts running).
4. After the process is complete, please check if the values for the angle between magnetic poles and PG origin have been automatically entered in the Parameter 01-27.

`01-08` Rated current of the induction motor (A)

Control mode   **FOCPG**

Unit: Ampere

Factory default: #.##

Settings   40~120% of the rated driving current

📖 To set this parameter, the user can set the rated motor current range shown on the motor's nameplate. The factory default is 90% of the rated current of the Hybrid servo drive.

For example: For the 7.5HP (5.5kW) motor, the rated current is 25, the factory settings: 22.5A.

The customers can set the parameter within the range 10 ~ 30A.

25*40%=10   25*120%=30

✗ `01-09` Rated power of the induction motor

Control mode   **FOCPG**   Factory default: #.##

Settings   0 – 655.35kW

📖 Set the motor's rated power. The factory default value is the power of the Hybrid servo drive.

✗ `01-10` Rated speed of the induction motor

Control mode   **FOCPG**

Factory default:

1710 (60Hz 4-pole)

1410 (50Hz 4-pole)

Settings   0~65535

📖 This parameter sets the rated speed of the motor. It is necessary to refer to the specifications shown on the motor's nameplate.

`01-11` Number of poles of the induction motor

Control mode   **FOCPG**   Factory default: 4

Settings   2~20

📖 This parameter sets the number of motor number of poles (odd number is not allowed).

`01-12` No-load current of the induction motor (A)

Control mode   **FOCPG**

Unit: Ampere

Factory default: 40

Settings   0~ Default value of Parameter 01-08

📖 The factory default is 40% of the rated current of the Hybrid servo drive.

`01-13` Stator resistance (Rs) of the induction motor

Control mode   **FOCPG**   Factory default: #.##

`01-14` Rotor resistance (Rr) of the induction motor

Control mode   **FOCPG**   Factory default: #.##

Settings   0~65.535Ω

`01-15` Magnetizing inductance (Lm) of the induction motor

Control mode   **FOCPG**   Factory default: #.##

`01-16` Total leakage inductance (Lx) of the induction motor

Control mode   **FOCPG**   Factory default: #.##

	Settings	0.0~6553.5mH

`01-17` Rated current of the synchronous motor

Control mode	FOCPM	Factory default: 0.00
	Settings	0~655.35 Amps

📖 The user can set the rated current shown on the synchronous motor's nameplate.

`01-18` Rated power of the synchronous motor

Control mode	FOCPM	Factory default: 0.00
	Settings	0.00 – 655.35kW

📖 This Parameter sets the rated power of the synchronous motor.

`01-19` Rated speed of the synchronous motor

Control mode	FOCPM	Factory default: 0
	Settings	0~65535

📖 This parameter sets the rated speed of the synchronous motor. It is necessary to refer to the specifications shown on the motor's nameplate.

`01-20` Number of poles of the synchronous motor

Control mode	FOCPM	Factory default: 6
	Settings	2~20

📖 This parameter sets the number of the synchronous motor's number of poles (odd number is not allowed).

`01-21` Inertia of the synchronous motor's rotor

Control mode	FOCPM	Factory default: 0.0
	Settings	0.0~6553.5 *10^{-4} kg.m2

`01-22` Stator's phase resistance (Rs) oth the synchronous motor

Control mode	FOCPM	Factory default: 0
	Settings	0~65.535Ω

📖 Enter the phase resistance of the synchronous motor.

`01-23` stator's phase inductance(Ld) of the synchronous motor
`01-24` stator's phase inductance(Lq) of the synchronous motor

Control mode	FOCPM	Factory default: 0.00
	Settings	0.0~655.35mH

📖 Enter the synchronous motor's phase inductance. For surface type magnets (SPM), Ld = Lq; for built-in magnets (IPM), Ld ≠ Lq.

`01-25` Back EMF of the synchronous motor

Control mode	FOCPM	Factory default: 0
	Settings	0~65535 V/krpm

📖 Enter the back EMF of the synchronous motor.

01-26 **Encoder type selection**

Control mode   **FOCPM**   Factory default: 3

Settings   0: ABZ

              1: ABZ+HALL (only used for Delta's servo motors)

              2: ABZ+HALL

              3: Resolver

📖   Look up table for Encoders & PG cards

Parameter Setting	Encoder Type	Applicable PG Card
01-26=0	A, B, Z	EMVJ-PG01U
01-26=1,2	A, B, Z+U, V, W	EMVJ-PG01U
01-26=3	Resolver	EMVJ-PG01/02R

01-27 **PG Offset angle of synchronous motor**

Control mode   **FOCPM**   Factory default: 0.0

Settings   0.0～360.0°

📖 Offset angle of the PG origin for the synchronous motor.

01-28 **Number of poles of the resolver**

Control mode   **FOCPM**   Factory default: 1

Settings   1~5

01-29 **Encoder Pulse**

Control mode   **FOCPG**   **FOCPM**   Factory default: 1024

Settings   1~20000
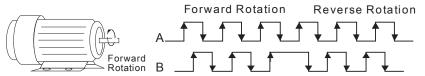
📖 This parameter can be set the encoder's number of pulses per revolution (PPR).

01-30 **Encoder's input type setting**

Control mode   **FOCPG**   **FOCPM**   Factory default: 1
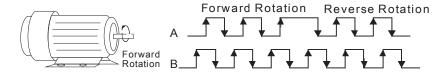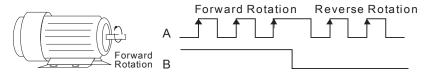
Settings   0: No function

             1: Phase A leads in a forward run command and phase B leads in a reverse run command.

             2: Phase B leads in a forward run command and phase A leads in a reverse run command.

3: Phase A is a pulse input and phase B is a direction input. (low input=reverse direction, high input=forward direction).

4: Phase A is a pulse input and phase B is a direction input. (low input=forward direction, high input=reverse direction).
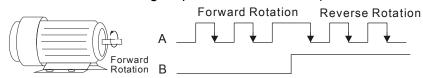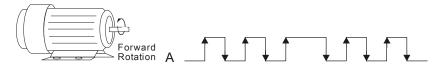
5: Single-phase input

 📖 Enter the correct setting for the pulse type is helpful in controlling the stability.

01-31 System control

Control mode   **FOCPG**   **FOCPM**   Factory default: 1

    Settings   0: No function

          1: ASR automatic tuning

          2: Estimation of inertia

 📖 If the setting value is 1: The speed control gain is determined by Parameters 00-10

   If the setting value is 2: The system inertia is estimated. Please refer to descriptions in Chapter 3

✗ 01-32 **Unity value of the system inertia**

Control mode   **FOCPG**   **FOCPM**   Factory default: 400

    Settings   1~65535 (256 = 1 per unit)

01-33 **Carrier frequency**

Control mode   **FOCPG**   **FOCPM**   Factory default: 5

    Settings   5 kHz; 10kHz

 📖 When this parameter is configured, please re-start the Hybrid servo drive.

 📖 The carrier frequency of the PWM output has a significant influence on the electromagnetic noise of the motor. The heat dissipation of the Hybrid servo drive and the interference from the environment may also affect the noise. Therefore, if the ambient noise is greater than the motor noise, reducing the carrier frequency of the drive may have the benefits of reducing a temperature rise; if the carrier frequency is high, even if a quiet operation is obtained, the overall wiring and interference control should be taken into consideration.

✗ 01-34 **Reserved**

01-35 **Motor ID**

Control mode   **FOCPG**   **FOCPM**   Factory default: 0

Settings   0 : No function

16: Delta's Hybrid servo motor ECMA-ER181BP3 (11kW220V)

17: Delta's Hybrid servo motor ECMA-KR181BP3 (11kW380V)

18: Delta's Hybrid servo motor ECMA-ER221FPS (15kW220V)

19: Delta's Hybrid servo motor ECMA-KP221FPS (15kW380V)

21: Delta's Hybrid servo motor ECMA-KR222APS (20kW380V)

01-36 Change the rotation direction

Control mode   **FOCPG**   **FOCPM**   Factory default: 0

Settings

0: When the driver runs forward, the motor rotates counterclockwise. When the driver runs reverse, the motor rotates clockwise.

1: When the driver runs forward, the motor rotates clockwise. When the driver runs reverse, the motor rotates counterclockwise.

📖 This parameter can be modified only when the machine is shut down. For an induction motor after the parameters are configured completely, it will change the running direction. For a synchronous motor, it is necessary to perform the magnetic pole detection and re-start the drive.

0-2 Parameters for Protection

✗ **02-00** **Software brake level**

Control mode   VF   FOCPG   FOCPM

Factory default: 380.0/760.0

Settings   230V series: 350.0~450.0Vdc

460V series: 700.0~900.0Vdc

📖 Sets the reference point of software brake. The reference value is the DC bus voltage.

02-01 **Present fault record**
02-02 **Second most recent fault record**
02-03 **Third most recent fault record**
02-04 **Fourth most recent fault record**
02-05 **Fifth most recent fault record**
02-06 **Sixth most recent fault record**

Settings	Control mode	VF	FOCPG	FOCPM
0: No error record		○	○	○
1: Over-current during acceleration (ocA)		○	○	○
2: Over-current during deceleration (ocd)		○	○	○
3: Over-current during constant speed (ocn)		○	○	○
4: Ground fault (GFF)		○	○	○
5: IGBT short-circuit (occ)		○	○	○
6: Over-current at stop (ocS)		○	○	○
7: Over-voltage during acceleration (ovA)		○	○	○
8: Over-voltage during deceleration (ovd)		○	○	○
9: Over-voltage during constant speed (ovn)		○	○	○
10: Over-voltage at stop (ovS)		○	○	○
11: Low-voltage during acceleration (LvA)		○	○	○
12: Low-voltage during deceleration (Lvd)		○	○	○
13: Low-voltage during constant speed (Lvn)		○	○	○
14: Low-voltage at stop (LvS)		○	○	○
15: Phase loss protection (PHL)		○	○	○
16: IGBT over-heat (oH1)		○	○	○
17: Heat sink over-heat for 40HP and above (oH2)		○	○	○
18: TH1 open: IGBT over-heat protection circuit error (tH1o)		○	○	○
19: TH2 open: heat sink over-heat protection circuit error (tH2o)		○	○	○
20: Fan error signal output (Fan)		○	○	○
21: Hybrid servo drive overload (oL)		○	○	○
22: Motor 1 overload (EoL1)		○	○	○
23: Reserved				
24: Motor over-heat, detect by PTC (oH3)		○	○	○
25: Reserved				

26: Over-torque 1 (ot1)	○	○	○
27: Over-torque 2 (ot2)	○	○	○
28: Reserved			
29: Reserved			
30: Memory write error (cF1)	○	○	○
31: Memory read error (cF2)	○	○	○
32: Isum current detection error (cd0)	○	○	○
33: U-phase current detection error (cd1)	○	○	○
34: V-phase current detection error (cd2)	○	○	○
35: W-phase current detection error (cd3)	○	○	○
36: Clamp current detection error (Hd0)	○	○	○
37: Over-current detection error (Hd1)	○	○	○
38: Over-voltage current detection error (Hd2)	○	○	○
39: Ground current detection error (Hd3)	○	○	○
40: Auto tuning error (AuE)			○
41: Reserved	○	○	○
42: PG feedback error (PGF1)		○	○
43: PG feedback loss (PGF2)		○	○
44: PG feedback stall (PGF3)		○	○
45: PG feedback slip (PGF4)		○	○
46: Reserved	○	○	○
47: Reserved	○	○	○
48: Reserved			
49: External fault input (EF)	○	○	○
50: Emergency stop (EF1)	○	○	○
51: Reserved			
52: Password error (PcodE)	○	○	○
53: Reserved			
54: Communication error (cE1)	○	○	○
55: Communication error (cE2)	○	○	○
56: Communication error (cE3)	○	○	○
57: Communication error (cE4)	○	○	○
58: Communication time out (cE10)	○	○	○
59: PU time out (cP10)	○	○	○
60: Braking transistor error (bF)	○	○	○
61~63: Reserved	○	○	○
64: Safety relay Error (SRY)	○	○	○
65: PG card information error (PGF5)			○
66: Over pressure (ovP)	○	○	○
67: Pressure feedback fault (PfbF)	○	○	○

📖 As a fault occurs and the machine is forced shutting down, the event will be recorded. During shutting down, the LvS is not recorded.
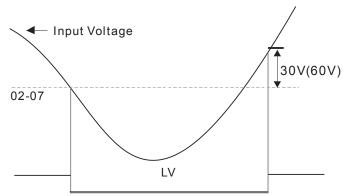
✗ **⌷⌷-⌷⌷ Low voltage level**

Control mode	VF	FOCPG	FOCPM	Factory default: 180/360

Settings   230V Series: 160 – 220V

                  460V Series: 320 – 440V

📖 This parameter is used to set the LV discrimination level.

✗ **⌷⌷-⌷⌷ PTC action selection**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

Settings   0: Warn and keep operation

                  1: Warn and ramp to stop

                  2: Warn and coast to stop

📖 Parameter 02-08 is used to define the operation mode of the drive after the PTC is activated.

✗ **⌷⌷-⌷⌷ PTC level**

Control mode	VF	FOCPG	FOCPM	Factory default: 50.0

Settings   0.0~150.0%

                  0.0~150.0℃

📖 This parameter defines the maximum value of the analog input for 100% of the activation level of the PTC.

✗ **⌷⌷-⌷⌷ PTC detection filtering time**

Control mode	VF	FOCPG	FOCPM	Factory default: 0.20

Settings   0.00 – 10.00 seconds

✗ **⌷⌷-⌷⌷ PTC type**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

Settings   0: Not assigned

                  1: KTY84

📖 When this parameter is set as 1, the unit for Parameters 02-09 and 02-12 will be changed from % to °C.

✗ **⌷⌷-⌷⌷ Motor fan activation level**

Control mode	VF	FOCPG	FOCPM	Factory default: 50.0

Settings   0.0~100.0%

                  0.0~150.0℃

📖 When the Parameters 03-05 to 03-07 for the multi-function output terminal are set to 45, the motor fan will start or stop according to this parameter setting.

✓ **`02-13` Electronic thermal relay selection 1**

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 2

Settings   0: Inverter motor

           1: Standard motor

           2: Disable

✓ **`02-14` Electronic thermal characteristic for motor**

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 60.0

Settings   30.0 – 600.0 seconds

📖 To prevent self-cooled motor from over heating at low speed operation, the user can set the electronic thermal relay to limit the allowed output power of the Hybrid servo drive.

`02-15` Output frequency at malfunction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: Read only

Settings   0.00 – 655.35Hz

`02-16` Ourput voltage at malfunction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: Read only

Settings   0.0 – 6553.5V

`02-17` DC side voltage at malfunction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: Read only

Settings   0.0 – 6553.5V

`02-18` Ourput current at malfunction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: Read only

Settings   0.00~655.35Amp

`02-19` IGBT temperature at malfunction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: Read only

Settings   0.0~6553.5℃

03 Digital/Analog Input/Output Parameters

✗ the parameter can be set during operation

03-00 **Multi-function input command 3 (MI3)**
03-01 **Multi-function input command 4 (MI4)**
03-02 **Multi-function input command 5 (MI5)**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

Settings   0: No function
           44: Injection signal input
           45: Confluence/Diversion signal input
           46: Reserved
           47: Multi-level pressure PI command 1
           48: Multi-level pressure PI command 2

 📖 When the value of this parameter is set as 44, the pressure feedback is lower than the pressure stable region (please refer to the description of Parameter 00-26) so the flow control will be performed. When it enters the pressure stable region, the pressure control will be performed.

 📖 If the setting value is 45, the confluence (OFF)/diversion (ON) function will be performed. For detailed operation, please refer to Chapter 2 for wiring and Chapter 3 for tuning.

 📖 Please refer to the description Parameters 00-36 if the setting value is 47 and 48,

✗ **03-03** **Digital input response time**

Control mode	VF	FOCPG	FOCPM	Factory default: 0.005

Settings   0.001~30.000 sec

 📖 This parameter is used to delay and confirm the signal on the digital input terminal.

✗ **03-04** **Digital input operation direction**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

Settings   0~65535

 📖 This parameter defines the activation level of the input signal.

 📖 Bit 0 for the SON terminal, bit 2 for the EMG terminal, bit 3 for the RES terminal, bits 4~6 correspond to MI3~MI5, respectively.

✗ **03-05** **Multi-function output 1 (Relay 1)**

Control mode	VF	FOCPG	FOCPM	Factory default: 11

✗ **03-06** **Multi-function Output 2 (MOI)**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

✗ **03-07** **Multi-function Output 3 (MO2)**

Control mode	VF	FOCPG	FOCPM	Factory default: 0

Settings   0: No function
           1: Operation indication
           9: Hybrid servo drive is ready
           11: Error indication
           44: Displacement switch signal
           45: Motor fan control signal

✓ 𝟬𝟯-𝟬𝟴 Multi-function output direction

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0

      Settings   0~65535

 📖 This parameter is used for bit-wise setting. If the corresponding bit is 1, the multi-function output is set as reverse direction.

✓ 𝟬𝟯-𝟬𝟵 Low-pass filtering time of keypad display

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0.010

      Settings   0.001~65.535 seconds

 📖 This parameter can be set to reduce the fluctuation of the readings on the keyapd.

𝟬𝟯-𝟭𝟬 Maximum output voltage for pressure feedback

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 10.0

      Settings   5.0~10.0 V

𝟬𝟯-𝟭𝟭 Minimum output voltage for pressure feedback

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0.0

      Settings   0.0~1.0V

 📖 This parameter defines the pressure feedback output voltage type.

 📖 If the pressure feedback has a bias, can adjust this parameter to eliminate the bias.

𝟬𝟯-𝟭𝟮 Reserved

𝟬𝟯-𝟭𝟯 Confluence Master/Slave Selection

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0

      Settings   0: No function

                       1: Master 1

                       2: Slave/Master 2

                       3: Slave/Master 3

 📖 In a stand-alone system, this parameter is set as 0

 📖 In a confluence system, the parameter is set as 1 for the Master and 2 for the Slave

 📖 With multi-function input terminal function 45, the confluence/diversion can be configured. For detailed operation, please refer to Chapter 2 for wiring and Chapter 3 for tuning.

 📖 The difference between Master 2 and Master 3 is that the Master 3 can be configured as confluent with other Slaves during confluence, however, the Master 2 can be configured for stand-alone operation.

𝟬𝟯-𝟭𝟰 Slave's proportion of the Master's flow

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 100.0

      Settings   0.0~65535.5 %

 📖 This parameter setting is required only for the Master but not needed for the Slave.

 📖 In a confluence system, this parameter value defines the Slave's portion of the Master's flow.

Example: Slave is 60L/min and Master is 40L/min, so the setting is 60/40 * 100% = 150%

For confluence of more than 2 pump, the values for the slaves must be the same. For example, if the total flow for a three-pump system is 200L/min, where the Master is 40L/min, then the two Slaves should be 80L/min. The setting of Parameter 03-14 should be 160/40 = 400%

✗ 𝟢𝟥-𝟣𝟧 Source of frequency command

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0

Settings   0: Digital Operation Panel

                     1: RS485 Communication

                     2~5: Reserved

📖 This parameter is used for EMVJ-MF01.For detailed operation, please refer to Chapter 3 for tuning.

📖 In a confluence system, if the Slave's frequency command is given through the RS485 communication, the setting value should be 1.

✗ 𝟢𝟥-𝟣𝟨 Limit for the Slave reverse depressurization torque

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 20

Settings   0~500%

📖 Set the torque limit for the Slave's reverse operation.

𝟢𝟥-𝟣𝟩 Slave's activation level

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 50

Settings   0~100%

📖 This parameter setting is required only for the Master but not needed for the Slave.

📖 This parameter determines the activation level for the Slave. A 100% value corresponds to the full flow of the Master.

✗ 𝟢𝟥-𝟣𝟪 Communication error treatment

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0

Settings   0: Warn and keep operation

                     1: Warn and ramp to stop

                     2: Warn and coast to stop

                     3: No action and no display

📖 This parameter is used to set the handling status of the drive when a communication timeout error (such as disconnection) occurs.

✗ 𝟢𝟥-𝟣𝟫 Time-out detection

Control mode   **VF**   **FOCPG**   **FOCPM**   Factory default: 0.0

Settings   0.0~100.0 seconds

📖 This parameter is used to set the time of the time-out event for the communication and the keypad transmission.

✗ 𝟢𝟥-𝟤𝟢 Start-up display selection

Control mode   VF   FOCPG   FOCPM   Factory default: 0

        Settings   0: F (frequency command)

                        1: H (actual frequency)

                        2: Multi-function display (user-defined 00-04)

                        3: A (Output current)

    📖 This parameter is used to set the contents of the start-up screen. The content of the user-defined option is displayed in accordance with the setting value of Parameter 00-04.

✗ 03-21 Slave reverse operation for depressurization

Control mode   VF   FOCPG   FOCPM   Factory default: 0

        Settings   0: Disabled

                        1: Enabled

    📖 This parameter setting is required only for the Slave but not needed for the Master.

    📖 When the parameter is set as 1, it is necessary to make sure that the outlet end of the Slave is not installed with any one-way valve and the parameter 03-16 is set as 500.

5. Fault Codes and Descriptions
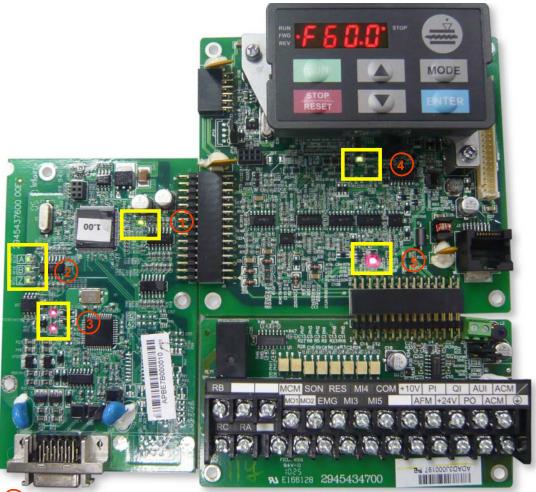
The Hybrid servo drive has warning messages and protection functions such as over-voltage, low-voltage, over-current, etc. Once a fault occurs, the protection function is activated, the Hybrid servo drive stops output, and the motor coast to stop. Please look up the cause for the fault and perform the countermeasure according to the error message of the Hybrid servo drive. The error records are stored in the internal memory of the Hybrid servo drive (last six error messages can be recorded) and can be read out through the keypad or through the communication port.

CAUTION	☑ After a fault occurs, the RESET button will be effective only 5 seconds after the fault condition is released. ☑ For Hybrid servo drives of power rating $\leq$ 22kW, it is necessary to wait for 5 minutes (10 minutes for $\geq$ 30kW) after the power is shut down to confirm that the indicator light is off and the measured DC voltage across the terminals $\oplus$ and $\ominus$ is below DC 25V before opening the cover for inspection.

5-1 Error Messages

5-1-1 Light indication

① Indicator of PG card power	④ Power indicator
② Indicator of Encoder feedback	⑤ Power indicator
③ Warning indicator	

③ Warning indicator
When the sin or cos phase voltage is lower than required values in the rotational transformer, the warning indicator will be on. Please check if the encoder wire is connected correctly. If it happens in operation, please check for any interference.

5-1-2 Error Messages Displayed on KPVJ-LE01 Digital Keypad Panel

Displayed Code	Description of Failure	Solutions
oc A	Over current during acceleration; the output current exceeds three times the rated current of the Hybrid servo drive.	Check the connection from U-V-W to the motor for any improper insulation. Check if the motor is jammed. Replace with an AC motor drive with a larger output capacity.
oc d	Over current during deceleration; the output current exceeds three times the rated current of the Hybrid servo drive.	
oc n	Over current during constant speed operation; the output current exceeds three times the rated current of the Hybrid servo drive.	
oc S	Over-current when the machine stops. Malfunction of the current detection circuit	Return to factory for repair.
occ	The Hybrid servo drive detects short circuit between the IGBT module's upper and lower bridges.	Return to factory for repair.
ou A	During acceleration, the Hybrid servo drive detects over-voltage at the internal DC side.	230V: DC 450V 460V: DC 900V Check if the input voltage is within the Hybrid servo drive's rated voltage range; and monitor if there is any voltage surge. For Hybrid servo drives below 22kW, the Parameter 02-00 can be adjusted for the activation level of the braking transistor For Hybrid servo drives above 22kW, adjust the brake activation level of the braking unit (For detailed description, please refer to the operation manual of the braking unit)
ou d	During deceleration, the Hybrid servo drive detects over-voltage at the internal DC side.	
ou n	During the constant speed operation, the Hybrid servo drive detects over-voltage at the internal DC side.	
ou S	Over-voltage when the machine stops. Malfunction of the voltage detection circuit	Check if the input voltage is within the Hybrid servo drive's rated voltage range; and monitor if there is any voltage surge.
Lu A	During acceleration, the Hybrid servo drive's DC side voltage is lower than the setting value of Parameter 02-07.	Check if the voltage of the input power supply is normal. Check if there is any sudden heavy load. Adjust Parameter 02-07 for the low-voltage level

Displayed Code	Description of Failure	Solutions
Lud	During deceleration, the Hybrid servo drive's DC side voltage is lower than the setting value of Parameter 02-07.	
Lun	During constant speed operation, the Hybrid servo drive's DC side voltage is lower than the setting value of Parameter 02-07.	
LuS	When the machine stops, the Hybrid servo drive's DC side voltage is lower than the setting value of Parameter 02-07.	
PHL	Phase loss protection	Check if the single-phase input is used for the three-phase model or there is any phase loss. Check if it is a model with capacity higher than 40HP. If so, please check the AC-side fuse for burning.
GFF	Ground protection is activated. When the Hybrid servo drive detects the output end is grounded and the grounding current is larger than 50% of the Hybrid servo drive's rated current. Note: Such a protection is used for protecting the Hybrid servo drive not for human body.	Check the connection to the motor for short circuit or ground fault. Make sure if the IGBT power module is damaged. Check the connection at the output side is improperly insulated.
oH1	The Hybrid servo drive detects overheat of the IGBT with a temperature higher than the protection level 7.5 – 15HP: 90℃ 20 – 100HP: 100℃	Check if the ambient temperature is too high. Check if the heat sink for any external object. Check if the fan is running. Check if the Hybrid servo drive has sufficient space.
oH2	The Hybrid servo drive detects overheat of the heat sink with a temperature higher than the protection level (90℃)	Check if the ambient temperature is too high. Check if the heat sink for any external object. Check if the fan is running. Check if the Hybrid servo drive has sufficient space.
oH3	The Hybrid servo drive detects the motor internal overheat which is higher than the protection level (02-09 PTC level)	Check if the motor is jammed. Check if the ambient temperature is too high. Increase the capacity of the motor
FAn	Fan fails	Check if the fan is blocked. Return to factory for repair.
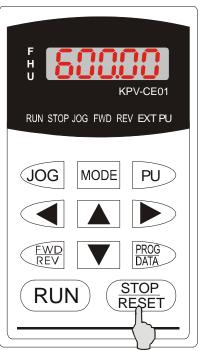
Displayed Code	Description of Failure	Solutions
oL	The output current is higher than the withstand current of the Hybrid servo drive.	Check if the motor for overload. Increase the output capacity of the Hybrid servo drive.
EoL1	Motor overload	Change the product condition
FuSE	DC side fuse (FUSE) burns for models of 30HP and below.	Check if the fuse of the transistor module is burning. Check the load side for any short circuit
cF1	Memory write error.	Press the RESET button to reset the parameters to factory default settings.
cF2	Memory read error.	If this method does not work, return to factory for repair.
cd0	Error of the sum of the three-phase output current is detected	After restart the power supply, if the error still exists, return to factory for repair.
cd1	Error U-phase current is detected.	
cd2	Error V-phase current is detected.	
cd3	Error W-phase current is detected.	
EF	When the external EF terminals close, the Hybrid servo drive stops output.	After clearing the cause of the error, press the "RESET" button.
EF1	When the external EMG terminals close, the Hybrid servo drive stops output.	After clearing the cause of the error, press the "RESET" button.
bF	The Hybrid servo drive detects errors from the braking transistor.	After press the RESET button, if the message bF still exists, please return to factory for repair.
tH1o	OH1 hardware circuit error	Return to factory for repair.
tH2o	OH2 hardware circuit error	Return to factory for repair.
Hd0	cc protection hardware circuit error	After restart the power supply, if the error still exists, return to factory for repair.
Hd1	oc protection hardware circuit error	
Hd2	ov protection hardware circuit error	
Hd3	GFF protection hardware circuit error	

Displayed Code	Description of Failure	Solutions
PGF2	PG feedback loss	Check the PG feedback connection.
PGF3	PG feedback stall	Check the PG feedback connection. Check if the PI gain and the acceleration/deceleration settings are proper. Return to factory for repair.
PGF4	PG feedback slip error	
PGF5	PG Card information error	Check if the setting value of the Parameter 01-26 matches the installed PG Card. For details, please refer to the description of Parameter 01-26. If there is no error found, please return it to factory for repair.
Sr Y	Safe circuit card/control board jumper JP18 has improper installation or faulty activation	Check if the safety circuit card is installed correctly in the control board and the output action for any fault. Check the control board jumper JP18 for incorrect position.
ouP	Over pressure	Check if the pressure sensor for any fault. Adjust the pressure PI control parameters 00-20~00-37
PFbF	Pressure feedback loss	Check if the wiring of the pressure sensor is correct. Check if the signal of the pressure sensor is lower than 1V.
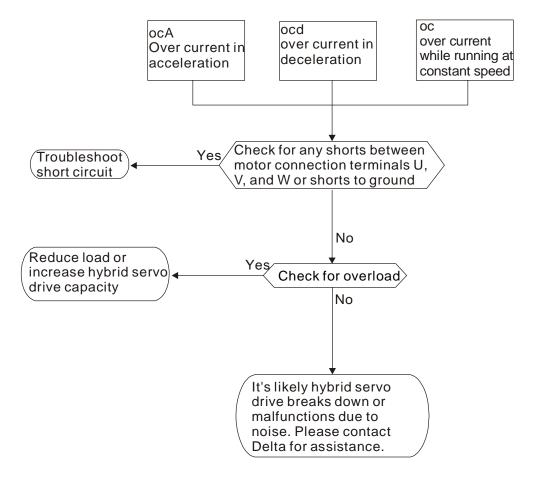
Alarm Reset

After the cause of the alarm is cleared from the tripped state, press the RESET button on the keypad (as shown in the figure), set the external terminal as a "Error Reset Command" and then connect the terminal, or send error reset command through the communication port to release the tripped state of the machine. Before rest any error alarm, the operation signal should be open (OFF) so as to prevent the sudden running of the machine immediately after the recovery from error signal and causing damage or injury.

5-2 Over Current oc

```
┌─────────────────┐   ┌─────────────────┐   ┌─────────────────┐
│ ocA             │   │ ocd             │   │ oc              │
│ Over current in │   │ over current in │   │ over current    │
│ acceleration    │   │ deceleration    │   │ while running at│
│                 │   │                 │   │ constant speed  │
└─────────────────┘   └─────────────────┘   └─────────────────┘
```

```
┌──────────────────┐       Yes    ╱ Check for any shorts between ╲
│ Troubleshoot     │ ◄─────────────  motor connection terminals U,
│ short circuit    │              ╲ V, and W or shorts to ground  ╱
└──────────────────┘
```

No

```
┌──────────────────────┐   Yes    ╱ Check for overload ╲
│ Reduce load or       │ ◄──────────                    
│ increase hybrid servo│          ╲                    ╱
│ drive capacity       │
└──────────────────────┘
```

No

```
┌──────────────────────┐
│ It's likely hybrid   │
│ servo drive breaks   │
│ down or malfunctions │
│ due to noise. Please │
│ contact Delta for    │
│ assistance.          │
└──────────────────────┘
```

5-3 Ground Fault Factor GFF

```
┌─────────────────┐
│ GFF             │
│ Ground fault    │
│                 │
└─────────────────┘
```

```
╱ Check if the output   ╲      No    ┌──────────────────────┐
  circuit (cable or motor)  ─────────►│ It's likely hybrid   │
  of hybrid servo drive is            │ servo drive breaks   │
╲ shorted to ground     ╱             │ down or malfunctions │
                                      │ due to noise. Please │
                                      │ contact Delta for    │
                                      │ assistance.          │
                                      └──────────────────────┘
```

Yes

```
┌──────────────────┐
│ Resolve          │
│ ground fault     │
└──────────────────┘
```

5-4 Over Voltage ov

```
                                            ┌─────────────────────┐
                                            │  OV: Over voltage    │
                                            └──────────┬──────────┘
                                                       │
                                                       ▼
  ┌────────────────────┐       No      ┌─────────────────────────┐
  │ Lower voltage of   │◄──────────────│ Check if voltage of     │
  │ power supply within│               │ power supply is within  │
  │ the upper limit    │               │ the regulated range     │
  └────────────────────┘               └──────────┬──────────────┘
                                              Yes  │
                                                   ▼
  ┌────────────────────┐       No      ┌─────────────────────────┐
  │ It's likely hybrid │◄──────────────│ If the voltage of DC BUS│
  │ servo drive breaks │               │ exceeds the protection  │
  │ down or malfunctions│              │ value in action         │
  │ due to noise. Please│              └──────────┬──────────────┘
  │ contact Delta for   │                    Yes  │
  │ assistance.         │                         ▼
  └────────────────────┘               ┌─────────────────────────┐
                                        │ Consider                │
                                        │ implementing brake      │
                                        │ unit                    │
                                        └─────────────────────────┘
```

5-5 Low Voltage Lv

```
                          ┌─────────────┐
                          │ Lv          │
                          │ Low voltage │
                          └──────┬──────┘
                                 │
                                 ▼
          ┌──────────────────────────────┐    Yes   ┌──────────────┐
          │ If there is power outage      │─────────►│ Reset and    │
          │ (including momentary blackout)│          │ restart      │
          └──────────────┬───────────────┘          └──────────────┘
                      No  │
                          ▼
          ┌──────────────────────────────┐    Yes   ┌─────────────────────────┐
          │ Any broken devices or bad     │─────────►│ Replace broken          │
          │ connection in the supply      │          │ components and correct  │
          │ circuit                       │          │ connection              │
          └──────────────┬───────────────┘          └─────────────────────────┘
                      No  │
                          ▼
          ┌──────────────────────────────┐    No    ┌─────────────────────────┐
          │ If voltage of power supply    │─────────►│ Modify power supply     │
          │ is within regulated range     │          │ system to comply with   │
          └──────────────┬───────────────┘          │ the regulations         │
                     Yes │                           └─────────────────────────┘
                          ▼                                      ▲
          ┌──────────────────────────────┐                      │ No
          │ Any load in the same power    │                      │
          │ supply system that has larger │                      │
          │ load of starting current      │                      │
          └──────────────┬───────────────┘                      │
                      No  │                                      │
                          ▼                                      │
          ┌──────────────────────────────┐  Yes  ┌──────────────────────────┐
          │ If Lv occurs when the circuit │──────►│ If the capacity of power │
          │ breaker and electromagnetic   │       │ supply transformer is    │
          │ contactor are ON              │       │ appropriate              │
          └──────────────┬───────────────┘       └──────────┬───────────────┘
                      No  │                              Yes │
                          ▼                                  │
          ┌──────────────────────────────┐                  │
          │ It's likely hybrid servo drive│◄─────────────────┘
          │ breaks down or malfunctions   │
          │ due to noise. Please contact  │
          │ Delta for assistance.         │
          └──────────────────────────────┘
```

5-6 Over Heating oH1

```
┌─────────────────────┐
│ Hybrid servo drive is│
│     overheated       │
└─────────────────────┘

              ┌──────────────┐
              │ Heat sink is │
              │  overheated  │
              └──────────────┘
                     │
                     ▼
         ╱Is the temperature of heat sink╲   No    ╭────────────────────────────╮
         ╲  higher than 90°C            ╱ ───────▶ │ Temperature detection circuit on│
                     │ Yes                         │ circuit board malfunctions. Please│
                     ▼                             │ contact Delta for assistance.    │
              ╱Is load too heavy╲  Yes    ╭──────────────╮
              ╲                 ╱ ───────▶ │ Reduce load  │
                     │ No                  ╰──────────────╯
                     ▼
         ╱Is cooling fan running╲   No    ╭──────────────────╮
         ╲                      ╱ ───────▶ │ Replace cooling fan│
                     │ Yes                 ╰──────────────────╯
                     ▼
      ╱Is airway of cooling fan clogged╲ Yes   ╭──────────────╮
      ╲                                ╱ ─────▶ │ Remove the clog│
                     │ No                       ╰──────────────╯
                     ▼
    ╱Is environment temperature within╲ No   ╭────────────────────────────────╮
    ╲        regulated range          ╱ ────▶ │ It's likely hybrid servo drive breaks down or│
                     │ Yes                     │ malfunctions due to noise. Please contact     │
                     ▼                         │ Delta for assistance.                         │
        ╭──────────────────────────╮          ╰────────────────────────────────╯
        │ Adjusted the environment  │
        │ temperature to regulated range│
        ╰──────────────────────────╯
```

5-7 Over Load oL

```
              ┌─────────────────────┐
              │ Hybrid servo drive is│
              │     overloaded       │
              └─────────────────────┘
                        │
                        ▼
            ╭──────────────────────────╮
            │ Reduce load or increase the│
            │ capacity of hybrid servo drive│
            ╰──────────────────────────╯
```

5-8 Phase Loss PHL

```
                        ┌──────────────────────┐
                        │  Power supply suffers │
                        │      phase loss       │
                        └──────────────────────┘
                                   │
                                   ▼
         ┌─────────────────────────────────────┐   No    ┌──────────────────┐
         │ Are main circuit power terminals R,  ├───────▶ │ Connect the three│
         │ S, and T all connected completely    │         │ phases securely  │
         └─────────────────────────────────────┘         └──────────────────┘
                            │ Yes
                            ▼
              ┌──────────────────────────┐      No      ┌──────────────────┐
              │ Are all screws on terminal├───────────▶ │ Tighten all screws│
              │    plate tightened        │             └──────────────────┘
              └──────────────────────────┘
                          │ Yes
                          ▼
              ┌──────────────────────────┐   Yes    ┌────────────────────────┐
              │ Is voltage of the three  ├────────▶ │ Please check wiring and │
              │ phase power supply        │          │ power system for        │
              │ unbalanced                │          │ abnormal behavior       │
              └──────────────────────────┘          └────────────────────────┘
                         │ No
                         ▼
              ┌──────────────────────────────┐
              │ It's likely hybrid servo drive│
              │ breaks down or malfunctions   │
              │ due to noise. Please contact  │
              │ Delta for assistance.         │
              └──────────────────────────────┘
```

5-9 Electromagnetic/Induction Noise

There are many noises surround the Hybrid servo drive and invade it by radiation or power circuit. It may cause the misoperation of control circuit and even damage the Hybrid servo drive. Of course, that is a solution to increase the noise tolerance of the Hybrid servo drive. But it is not the best one due to the limit. Therefore, solve it from the outside as following will be the best.

1. Add surge killer on the relay or contact to suppress switching surge between ON/OFF.

2. Shorten the wiring length of the control circuit or serial circuit and separate from the main circuit wiring.

3. Comply with the wiring regulation for those shielded wire and use isolation amplifier for long wire.

4. The grounding terminal should comply with the local regulation and ground independently, i.e. not to have common ground with electric welding machine and power equipment.

5. Connect a noise filter at the input terminal of the Hybrid servo drive to prevent noise from power circuit.

In a word, three-level solutions for electromagnetic noise are "no product", "no spread" and "no receive".

5-10 Environmental Condition

Since Hybrid servo drive is an electronic device, you should comply with the environmental condition stated in the appendix A. Following are the remedial measures for necessary.

5-13

6. To prevent vibration, anti-vibration spacer is the last choice. The vibration tolerance must be within the specification. The vibration effect is equal to the mechanical stress and it cannot occur frequently, continuously or repeatedly to prevent damaging Hybrid servo drive.

7. Store in a clean and dry location free from corrosive fumes/dust to prevent rustiness, poor contact. It also may cause short by low insulation in a humid location. The solution is to use both paint and dust-proof. For particular occasion, use the enclosure with whole-seal structure.

8. The surrounding temperature should be within the specification. Too high or low temperature will affect the lifetime and reliability. For semiconductor components, damage will occur once any specification is out of range. Therefore, it is necessary to clean and periodical check for the air cleaner and cooling fan besides having cooler and sunshade. In additional, the microcomputer may not work in extreme low temperature and needs to have heater.

    1. Store within a relative humidity range of 0% to 90% and non-condensing environment. Do not turn off the air conditioner and have exsiccator for it.

6. Suggestions and Error Corrections for Hybrid Servo Drives

The Hybrid servo drive has a comprehensive fault diagnostic system that includes several different alarms and fault messages. Once a fault is detected, the corresponding protective functions will be activated. The following faults are displayed as shown on the Hybrid servo drive digital keypad display. The six most recent faults can be read from the digital keypad or communication.

The Hybrid servo drive is made up by numerous components, such as electronic components, including IC, resistor, capacity, transistor, and cooling fan, relay, etc. These components can't be used permanently. They have limited-life even under normal operation. Preventive maintenance is required to operate this Hybrid servo drive in its optimal condition, and to ensure a long life.

Check your Hybrid servo drive regularly to ensure there are no abnormalities during operation and follows the precautions:

⚠ **CAUTION**	☑ Wait 5 seconds after a fault has been cleared before performing reset via keypad of input terminal.
	☑ When the power is off after 5 minutes for ≦ 22kW models and 10 minutes for ≧ 30kW models, please confirm that the capacitors have fully discharged by measuring the voltage between + and -. The voltage between + and - should be less than 25VDC.
	☑ Only qualified personnel can install, wire and maintain drives. Please take off any metal objects, such as watches and rings, before operation. And only insulated tools are allowed.
	☑ Never reassemble internal components or wiring.
	☑ Make sure that installation environment comply with regulations without abnormal noise, vibration and smell.

6-1 Maintenance and Inspections

Before the check-up, always turn off the AC input power and remove the cover. Wait at least 10 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged by measuring the voltage between DC+ and DC-. The voltage between DC+ and DC-should be less than 25VDC.

Ambient environment

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check the ambient temperature, humidity, vibration and see if there are any dust, gas, oil or water drops	Visual inspection and measurement with equipment with standard specification	○		
If there are any dangerous objects	Visual inspection	○		

Voltage

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Check if the voltage of main circuit and control circuit is correct	Measure with multimeter with standard specification	○		

Digital Keypad Display

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
Is the display clear for reading	Visual inspection	○		
Any missing characters	Visual inspection	○		

Mechanical parts

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual and aural inspection		○	
If there are any loose screws	Tighten the screws		○	
If any part is deformed or damaged	Visual inspection		○	
If there is any color change by overheating	Visual inspection		○	
If there is any dust or dirt	Visual inspection		○	

Main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose or missing screws	Tighten or replace the screw	○		
If machine or insulator is deformed, cracked, damaged or with color change due to overheating or ageing	Visual inspection **NOTE: Please ignore the color change of copper plate**		○	
If there is any dust or dirt	Visual inspection		○	

Terminals and wiring of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If the terminal or the plate is color change or deformation due to overheat	Visual inspection		○	
If the insulator of wiring is damaged or color change	Visual inspection		○	
If there is any damage	Visual inspection	○		

DC capacity of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any leak of liquid, color change, crack or deformation	Visual inspection	○		
If the safety valve is not removed? If valve is inflated?	Visual inspection	○		
Measure static capacity when required			○	

Resistor of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any peculiar smell or insulator cracks due to overheat	Visual inspection, smell	○		
If there is any disconnection	Visual inspection	○		
If connection is damaged?	Measure with multimeter with standard specification	○		

Transformer and reactor of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal vibration or peculiar smell	Visual, aural inspection and smell	○		

Magnetic contactor and relay of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws	Visual and aural inspection	○		
If the contact works correctly	Visual inspection	○		

Printed circuit board and connector of main circuit

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there are any loose screws and connectors	Tighten the screws and press the connectors firmly in place.		○	
If there is any peculiar smell and color change	Visual and smell inspection		○	
If there is any crack, damage, deformation or corrosion	Visual inspection		○	
If there is any liquid is leaked or deformation in capacity	Visual inspection		○	

Cooling fan of cooling system

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any abnormal sound or vibration	Visual, aural inspection and turn the fan with hand (turn off the power before operation) to see if it rotates smoothly		○	
If there is any loose screw	Tighten the screw		○	
If there is any color change due to overheat	Change fan		○	

Ventilation channel of cooling system

Check Items	Methods and Criterion	Maintenance Period		
		Daily	Half Year	One Year
If there is any obstruction in the heat sink, air intake or air outlet	Visual inspection		○	

📝 **NOTE**

Please use the neutral cloth for clean and use dust cleaner to remove dust when necessary.

6-2 Greasy Dirt Problem

Serious greasy dirt problems generally occur in processing industries such as machine tools, punching machines and so on. Please be aware of the possible damages that greasy oil may cause to your drive:

1. Electronic components that silt up with greasy oil may cause the drive to burn out or even explode.
2. Most greasy dirt contains corrosive substances that may damage the drive.

Solution:

Install the Hybrid servo drive in a standard cabinet to keep it away from dirt. Clean and remove greasy dirt regularly to prevent damage of the drive.

6-3 Fiber Dust Problem

Serious fiber dust problems generally occur in the textile industry. Please be aware of the possible damages that fiber may cause to your drives:

1. Fiber that accumulates or adheres to the fans will lead to poor ventilation and cause overheating problems.
2. Plant environments in the textile industry have higher degrees of humidity that may cause the drive to burn out, become damaged or explode due to wet fiber dust adhering to the devices.

Solution:

Install the Hybrid servo drive in a standard cabinet to keep it away from fiber dust. Clean and remove fiber dust regularly to prevent damage to the drive.
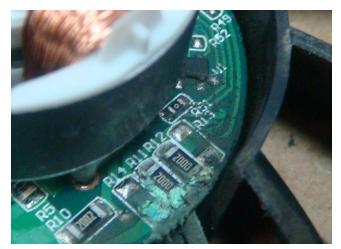
6-4 Erosion Problem

Erosion problems may occur if any fluids flow into the drives. Please be aware of the damages that erosion may cause to your drive.
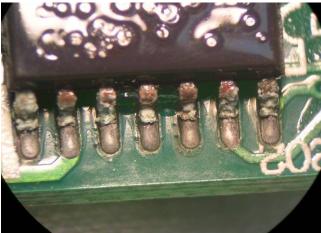
1.   Erosion of internal components may cause the drive to malfunction and possibility to explode.

Solution:

Install the Hybrid servo drive in a standard cabinet to keep it away from fluids. Clean the drive regularly to prevent erosion.

6-5 Industrial Dust Problem

Serious industrial dust pollution frequently occurs in stone processing plants, flour mills, cement plants, and so on. Please be aware of the possible damage that industrial dust may cause to your drives:

1. Dust accumulating on electronic components may cause overheating problem and shorten the service life of the drive.
2. Conductive dust may damage the circuit board and may even cause the drive to explode.

Solution:

Install the Hybrid servo drive in a standard cabinet and cover the drive with a dust cover. Clean the cabinet and ventilation hole regularly for good ventilation.

6-6 Wiring and Installation Problem

When wiring the drive, the most common problem is wrong wire installation or poor wiring. Please be aware of the possible damages that poor wiring may cause to your drives:

1. Screws are not fully fastened. Occurrence of sparks as impedance increases.
2. If a customer has opened the drive and modified the internal circuit board, the internal components may have been damaged.

Solution:

Ensure all screws are fastened when installing the Hybrid servo drive. If the Hybrid servo drive functions abnormally, send it back to the repair station. DO NOT try to reassemble the internal components or wire.
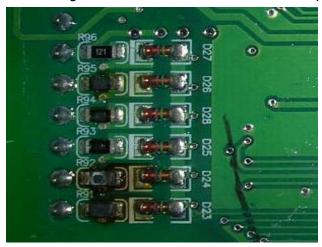
6-7 Multi-function Input/Output Terminals Problem
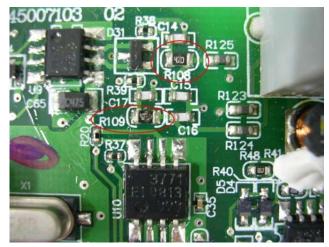
Multi-function input/output terminal errors are generally caused by over usage of terminals and not following specifications. Please be aware of the possible damages that errors on multi-function input/output terminals may cause to your drives:
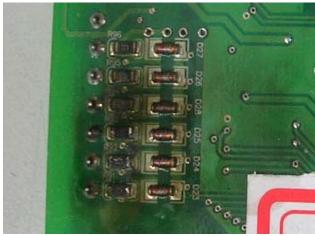
1.   Input/output circuit may burns out when the terminal usage exceeds its limit.

Solution:

Refer to the user manual for multi-function input output terminals usage and follow the specified voltage and current. DO NOT exceed the specification limits.

7. Recommended Operations for Customers and Troubleshooting

TheHybrid servo drive itself has warning messages and protection functions such as over-voltage, low-voltage, over-current, etc. Once a fault occurs, the protection function is activated, theHybrid servo drive stops output, and the motor comes to stop freely. Please look up the cause for the fault and perform the countermeasure according to the error message of theHybrid servo drive. The error records are stored in the internal memory of theHybrid servo drive (last six error messages can be recorded) and can be read out through the digital keypad or through the communication port.

TheHybrid servo drive consists of a large number of parts including ICs, resistors, capacitors, transistors, other electronic components, cooling fans, and relays, etc.　These parts are not permanent and will eventually need replacing. Even in a normal environment, the components are prone to failure after the lifespan is reached. Therefore, preventive and regular inspection should be carried out so as to find out the part that does not meet the specifications or has poor quality so as to exclude the causes that may cause the failure of theHybrid servo drives. In addition, the inspection also helps the user to replace various parts that have reached their lifespan in order to ensure normal and safe operation.

It is necessary to visually inspect the operation of theHybrid servo drives routinely to make sure that no abnormal condition occurs. Meanwhile, check if the following conditions occur:

⚠ CAUTION	☑ After a fault occurs, the RESET button will be effective only 5 seconds after the fault condition is released. ☑ ForHybrid servo drives of power rating ≦ 22kW, it is necessary to wait for 5 minutes (10 minutes for ≧ 30kW) after the power is shut down to confirm that the indicator light is off and the measured DC voltage across the terminals ⊕ and ⊖ is below DC 25V before opening the cover for inspection. ☑ Non-authorized personnel are not allowed to perform the maintenance work and component replacement operation, (Before operation, it is necessary to remove the metal objects such as watches and rings. Use insulated tools during the operation.） ☑ It is absolutely forbidden to modify theHybrid servo drive. ☑ Make sure that the operational performance and surrounding environment meet the standards and there is no abnormal noise, vibration and odor.

7-1 Regular Maintenance and Check

For regular inspection, stop the machine operation, shut off the power, and remove the cover. Even the power supply of theHybrid servo drive is disconnected, the filtering capacitor may still have charging voltage which may take some time to be discharged completely. To avoid danger, it is necessary to wait for the charging indicator to go off and use a voltmeter to test the voltage to confirm that the voltage is below a safe value ($\leqq$ 25Vdc) before the inspection operation can be started.

Surrounding Environment

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Check the ambient temperature, humidity, vibration, and if there is dust, gas, oil mist, water droplets, etc.	Visual inspection and measurement by instrument	○		
Is there any external object such as a tool or other hazardous object around the device?	Visual inspection	○		

Voltage

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Are the voltages for the Main Circuit and the Control Circuit correct?	Measurement by instrument	○		

Keypad Display Panel

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Are the displayed messages readable?	Visual inspection	○		
Is there any omitted character?		○		

Mechanical Parts

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is there any abnormal sound or vibration?	Visual and auditory inspection		○	
Are the bolts (fasteners) loose?	Fastening		○	
Is the part deformed or damaged?	Visual inspection		○	
Is the part discolored due to over heating?	Visual inspection		○	
Does the part have any dust or stain?	Visual inspection		○	

Main Circuit

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Are bolts loose or falling off?	Fastening	○		
Are the machine and insulators deformed, cracked, damaged, or discolored due to over-heating and aging?	Visual inspection		○	
Does the part have any dust or stain?	Visual inspection		○	

Main Circuit – Terminals and Wiring

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Are the terminals and copper plates discolored or deformed due to over heating?	Visual inspection		○	
Is the shield layer of the wire damaged or discolored?	Visual inspection		○	

Main Circuit – Terminal Block

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is it damaged?	Visual inspection	○		

Main Circuit - Filtering Capacitor

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is there any leakage, discoloring, cracking, or swollen housing?	Visual inspection	○		
Does the safety valve not come out? Is the valve body notably swollen?	Visual inspection	○		
Measure the static capacitance as required.		○		

Main Circuit - Resistor

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Does the insulator have strange odor or crack due to over heating?	Visual and auditory inspection	○		
Is the wire broken?	Visual inspection	○		
Is the connection joint damaged?	Measurement by	○		

	multi-meter			

Main Circuit – Transformer and Reactor

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is there any abnormal vibration or strange odor?	Visual and auditory inspection	○		

Main Circuit – Electromagnetic Contactor and Relay

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is there any vibration sound during operation?	Auditory inspection	○		
Does the contactor have good contact property?	Visual inspection	○		

Control Circuit – Control PCB and Connectors

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Are the screws and connectors loose?	Fastening		○	
Is the part with a strange odor or discolored?	By smelling, visual inspection		○	
Is there any cracked damaged, deformed, or corroded part?	Visual inspection		○	
Does the capacitor have any trace of leakage or deformation?	Visual inspection		○	

Cooling System – Cooling Fan

Inspection Item	Inspection Method	Inspection Period		
		Daily	Half year	One year
Is there any abnormal sound or vibration?	Auditory and visual inspection by manual rotating the fan. (It is necessary to disconnect the power)		○	
Are the bolts loose?	Fastening		○	
Id the part discolored due to over heating?	Visual inspection		○	

Cooling System – Ventilation Tunnel

Inspection Item	Inspection Method	Inspection Period

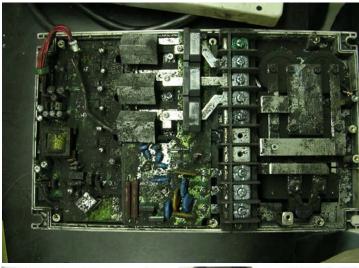|		Daily	Half year	One year
Are the inlet and outlet of the heat dissipation plate blocked or attached with external objects?	Auditory inspection		○	

NOTE

The contaminated area should be wiped clean with a chemically neutral cloth. Use electrical cleaner to remove dust, etc.

7-2 Oil Contamination

Oil contamination is more serious for applications such as machine tools, presses, and other manufacturing industries. It is necessary to note the following:

1: When the oil accumulation around the electronic components, it may cause a short circuit between the components, resulting in blowing up the machine.

2: Most oils are slightly corrosive which may damage product easily.

Recommended measure: It is recommended that customers install the inverter in a dedicated cabinet and keep it as far as possible away from the oil spill. Meanwhile, regular cleaning procedure should also be performed to avoid oil spills damaging the inverter.
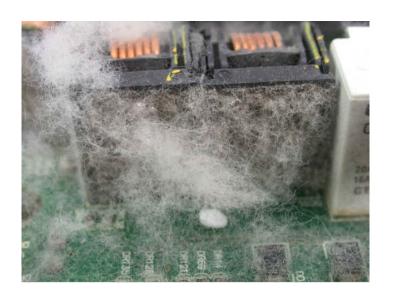
7-3 Lint Issue

Lint contamination is a serious issue for applications in the textile industries. It is necessary to note the following:

1: The lint often accumulates on the fans and other devices through the airflow. It may easily block the air duct of the inverter, resulting in over heating.

2: The textile industry usually has high humidity, so lint may enhance the condensation of moisture so that the components on the circuit board, leading to short-circuit and resulting in damage or blowing up the machine.

Recommended measures: may install the inverter in a dedicated cabinet. Meanwhile, a regular cleaning procedure should be performed to avoid lint accumulation in the inverter.
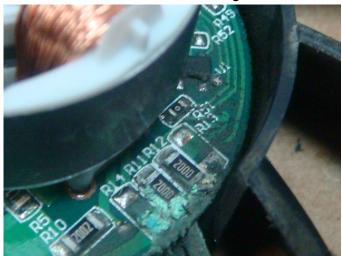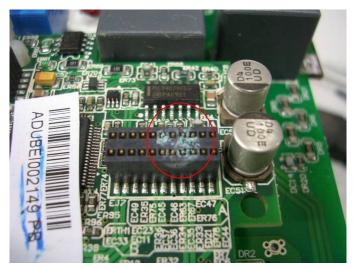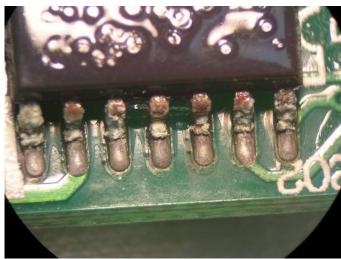
7-4 Corrosion Issue

Most of the applications with corrosive substances may have the issue of unknown liquid vertically flowing into the inverter; it should be noted: if the internal electronic components of the inverter are corroded, it may lead to malfunction or even blowing up.

Recommended measure: It is recommended that customers install the inverter in a dedicated cabinet and avoid liquid flowing into the inverter. Meanwhile, regular cleaning procedure should also be performed to prevent the inverter from corrosion damage.
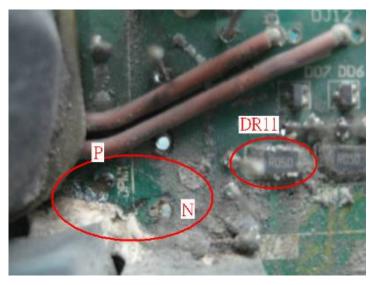
7-5 Dust Issue

Dust contamination often occurs in the dusty environments such as the stone processing plants, flour mills, cement plants, etc. It is necessary to note the following:

1: When dust accumulates on the electronic components, it may cause over heating, thereby affecting the lifespan of the product.

2: In case of conductive dust, it is very likely to cause damage to the circuit or lead to possible blowing up.

Recommended measure: It is recommended that customers install the inverter in a dedicated cabinet and install a dust-proof cover. Meanwhile, regular cleaning procedure should also be performed to allow the inverter to dissipate the heat normally.

7-6 Installation and Wiring/Connection Issue

Notices for wiring: Most of such kind of faults usually occur when the customers perform improper wiring.

Impact on the product:

(1) The screws for the wiring are not securely fastened so that the contact resistance is too high, resulting in arcing damage to the inverter.

(2) If the customer arbitrarily modifies the internal circuit of the inverter, it may cause damage to the related parts.

Recommended measure: While installing the inverter, it is necessary to have all the screws fastened securely. If the machine has malfunction, please do not attempt to repair. Please return the product to the dedicated service center for repair!
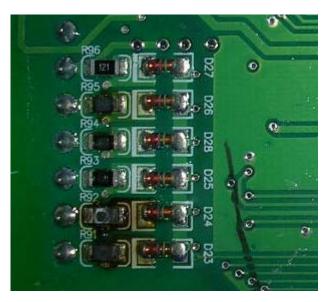
7-7 Multi-function Input/Output Terminal Application Issue

Such kind of faults usually occur when the external I/O are used in a way exceeding their specifications. Notices for using the external I/O of the product: The components of the related I/O circuits may be burned by the extra-high energy, resulting in loss of function.

Recommended measure: While using such kind of I/O contacts, it is necessary to refer to the rated voltage and current indicated in the operation manual. Do not exceed the upper limit of the specifications.

Appendix A Optional Accessories

CAUTION	☑ This Hybrid servo drive has gone through rigorous quality control tests at the factory before shipment. If the package is damaged during shipping, please contact your dealer. ☑ The accessories produced by Delta are only for using with Delta Hybrid servo drive. Do NOT use with other drive to prevent damage.

A-1 Braking Resistor Selection Chart

230V

Applicable Motor		*[1] 125% Braking Torque 10%ED				Maximum Braking Torque Limit		
HP	kW	Braking Unit VFDB*[3]	Braking Resistor Models for the Corresponding Brake Unit *[2]	Effective Braking Resistance of Each Drive	Total Braking Current (A)	Minimum Resistance Limit (Ω)	Highest Total Braking Current Limit (A)	Maximum Peak Power (kW)
7.5	5.5	-	BR1K0W020*1	1000W20Ω	19	15.6	24.4	9.3
10	7.5	-	BR1K5W013*1	1500W13Ω	29	11.5	33.0	12.5
15	11	-	BR1K5W013*1	1500W13Ω	29	9.5	40.0	15.2
20	15	-	BR1K0W4P3*2	2 in series	2000W8.6Ω	44	8.3	46.0	17.5
25	18	-	BR1K2W3P9*2	2 in series	2400W7.8Ω	49	5.8	66.0	25.1
30	22	-	BR1K5W3P3*2	2 in series	3000W6.6Ω	58	5.8	66.0	25.1
40	30	2015*2	BR1K0W5P1*2	2 in series	4000W5.1Ω	75	4.8	80.0	30.4
50	37	2022*2	BR1K2W3P9*2	2 in series	4800W3.9Ω	97	3.2	120.0	45.6

460V

Applicable Motor		*[1] 125% Braking Torque 10%ED				Maximum Braking Torque Limit		
HP	kW	Braking Unit VFDB*[3]	Braking Resistor Models for the Corresponding Brake Unit*[2]	Effective Braking Resistance of Each Drive	Total Braking Current (A)	Minimum Resistance Limit (Ω)	Highest Total Braking Current Limit (A)	Maximum Peak Power (kW)
7.5	5.5	-	BR1K0W075*1	1000W75Ω	10.2	48.4	15.7	11.9
10	7.5	-	BR1K5W043*1	1500W43Ω	17.6	39.4	19.3	14.7
15	11	-	BR1K5W043*1	1500W43Ω	17.6	30.8	24.7	18.8
20	15	-	BR1K0W016*2	2 in series	2000W32Ω	24	25.0	30.4	23.1
25	18	-	BR1K5W013*2	2 in series	3000W26Ω	29	20.8	36.5	27.7
30	22	-	BR1K5W013*2	2 in series	3000W26Ω	29	19.0	40.0	30.4
40	30	4030*1	BR1K0W5P1*4	4 in series	4000W20.4Ω	37	19.0	40.0	30.4
50	37	4045*1	BR1K2W015*4	2 in parallel 2 in series	4800W15Ω	50	12.7	60.0	45.6
60	45	4045*1	BR1K5W013*4	2 in parallel 2 in series	6000W13Ω	59	12.7	60.0	45.6
75	55	4030*2	BR1K0W5P1*4	4 in series	7200W10Ω	76	9.5	80.0	60.8
100	75	4045*2	BR1K2W015*4	2 in parallel 2 in series	9600W7.5Ω	100	6.3	120.0	91.2

*[1] Calculation for 125% brake toque: (kw)*125%*0.8; where 0.8 is motor efficiency.

Because there is a resistor limit of power consumption, the longest operation time for 10%ED is 10sec (on: 10sec/ off: 90sec).

*[2] For heat dissipation, a resistor of 400W or lower should be fixed to the frame and maintain the surface temperature below 50℃; a resistor of 1000W and above should maintain the surface temperature below 350℃.
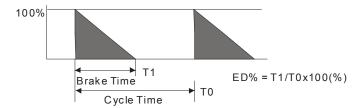
*[3] Please refer to VFDB series Braking Module Instruction for more detail on braking resistor.
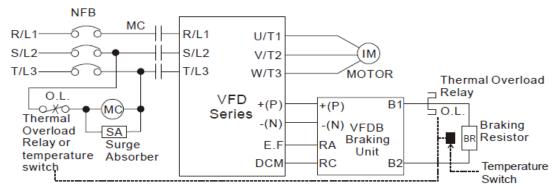
⬛▷ **NOTE**

1.   Definition for Brake Usage ED%:

Explanation: The definition of the brake usage ED (%) is for assurance of enough time for the brake unit and brake resistor to dissipate away heat generated by braking. When the brake resistor heats up, the resistance would increase with temperature, and brake torque would decrease accordingly. Recommended cycle time is one minute.

Definition of Brake Usage ED%

$$ED\% = T1/T0 \times 100(\%)$$

For safety concern, install an overload relay (O.L) between the brake unit and the brake resistor in conjunction with the magnetic contactor (MC) prior to the drive for abnormal protection. The purpose of installing the thermal overload relay is to protect the brake resistor from damage due to frequent brake, or due to brake unit keeping operating resulted from unusual high input voltage. Under such circumstance, just turn off the power to prevent damaging the brake resistor.

Note1: When using the AC drive with DC reactor, please refer to wiring diagram in the AC drive user manual for the wiring of terminal +(P) of Braking unit.
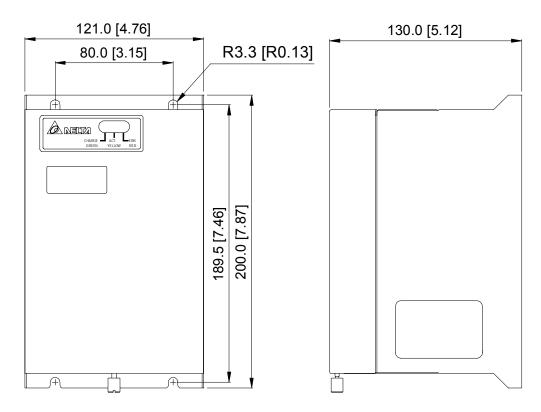Note2: **Do NOT** wire terminal -(N) to the neutral point of power system.

2.   If damage to the drive or other equipment is due to the fact that the brake resistors and brake modules in use are not provided by Delta, the warranty will be void.

3.   Take into consideration the safety of the environment when installing the brake resistors. If the minimum resistance value is to be utilized, consult local dealers for the calculation of Watt figures.

4.   When using more than 2 brake units, equivalent resistor value of parallel brake unit can't be less than the value in the column "Minimum Equivalent Resistor Value for Each Hybrid Servo Drive" (the right-most column in the table). Please read the wiring information in the user manual of brake unit thoroughly prior to operation.

5.   This chart is for normal usage; if the Hybrid servo drive is applied for frequent braking, it is suggested to enlarge 2~3 times of the Watts.
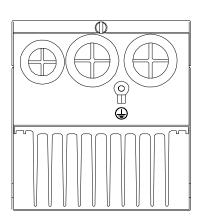
Specifications of VFDB Brake Unit

Voltage Rating		230V Series		460V Series	
Model No. VFDB-□□□□		2015	2022	4030	4045
Maximum applicable motor capacity (KW)		15	22	30	45
Output Rating	Peak Discharge Current (Ipeak)10ED%	40	60	40	60
	Continuous Discharge Current (A)	15	20	15	18
	Braking Start Voltage (DC)	330/345/360/380/400/415±3V		660/690/720/760/800/415±3V	
Power Supply	DC Voltage	200~400VDC		400~800VDC	
Protection	Over Heating of Heat Sink	Temperature Switch +95°C			
	Fault output	Relay Contact 5A120Vac/28Vdc(RA.RB.RC)			
	Charge Indication	It goes off when the main loop (P-N) voltage is below 50VDC			
Environment	Installation Location	Indoor (no corrosive gases or metal dusts)			
	Ambient temperature	-10°C～+50°C			
	Storage Temperature	-20°C～+60°C			
	Humidity	Non-condensing below 90%RH			
	Vibration	$9.8m/S^2$(1G) for < 20Hz, $2m/S^2$(0.2G) for 20 – 50Hz			
Mechanical Construction		Wall Mount IP50			

Dimensions of Brake Unit

Brake Unit: VFDB2015, VFDB2022, VFDB4030, and VFDB4045

A-2 Non-fuse Circuit Breaker

Comply with UL standard: Per UL 508, paragraph 45.8.4, part a,

The rated current of the breaker shall be 2~4 times of the maximum rated input current of Hybrid servo drive.

Three-phase		Three-phase	
Model	Recommended Current (A)	Model	Recommended Current (A)
VFD055VL23A-J	50	VFD220VL23A-J	175
VFD055VL43A-J	30	VFD220VL43A-J	100
VFD075VL23A-J	60	VFD300VL23A-J	225
VFD075VL43A-J	40	VFD300VL43A-J	125
VFD110VL23A-J	100	VFD370VL23A-J	250
VFD110VL43A-J	50	VFD370VL43A-J	150
VFD150VL23A-J	125	VFD450VL43A-J	175
VFD150VL43A-J	60	VFD550VL43A-J	250
VFD185VL23A-J	150	VFD750VL43A-J	300
VFD185VL43A-J	75		

A-3 Fuse Specifications

Smaller fuses than those shown in the table are permitted

230V Series	Input Current I (A)	Line Fuse	
		I (A)	Bussmann P/N
VFD055VL23A-J	25	50	JJN-50
VFD075VL23A-J	31	60	JJN-60
VFD110VL23A-J	47	100	JJN-100
VFD150VL23A-J	60	125	JJN-125
VFD185VL23A-J	80	150	JJN-150
VFD220VL23A-J	90	175	JJN-175
VFD300VL23A-J	106	225	JJN-225
VFD370VL23A-J	126	250	JJN-250

460V Series	Input Current I (A)	Line Fuse	
		I (A)	Bussmann P/N
VFD055VL43A-J	14	30	JJN-30
VFD075VL43A-J	18	40	JJN-40
VFD110VL43A-J	24	50	JJN-50
VFD150VL43A-J	31	60	JJN-60
VFD185VL43A-J	39	75	JJN-70
VFD220VL43A-J	47	100	JJN-100
VFD300VL43A-J	56	125	JJN-125
VFD370VL43A-J	67	150	JJN-150
VFD450VL43A-J	87	175	JJN-175
VFD550VL43A-J	101	250	JJN-250
VFD750VL43A-J	122	300	JJN-300

A-4 Reactor

A-4-1 AC Input Reactor Recommended Value

460V, 50/60Hz, Three-phase

kW	HP	Rated Current of Reactor	Maximum Continuous Current	Inductance (mh)	
				3% Impedance	5% Impedance
5.5	7.5	12	18	2.5	4.2
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2
15	20	35	52.5	0.8	1.2
18.5	25	35	52.5	0.8	1.2
22	30	45	67.5	0.7	1.2
30	40	55	82.5	0.5	0.85
37	50	80	120	0.4	0.7
45	60	80	120	0.4	0.7
55	75	100	150	0.3	0.45
75	100	130	195	0.2	0.3

A-4-2 AC Output Reactor Recommended Value

230V, 50/60Hz, Three-phase

kW	HP	Rated Current of Reactor	Maximum Continuous Current	Inductance (mh)	
				3% Impedance	5% Impedance
5.5	7.5	25	37.5	0.5	1.2
7.5	10	35	52.5	0.4	0.8
11	15	55	82.5	0.25	0.5
15	20	80	120	0.2	0.4
18.5	25	80	120	0.2	0.4
22	30	100	150	0.15	0.3
30	40	130	195	0.1	0.2
37	50	160	240	0.075	0.15

460V, 50/60Hz, Three-phase

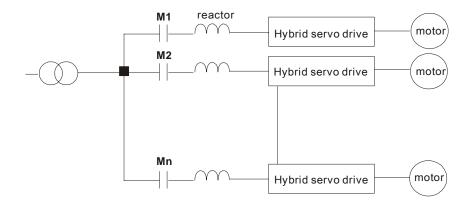| kW	HP	Rated Current of Reactor	Maximum Continuous Current	Inductance (mh)	
				3% Impedance	5% Impedance
5.5	7.5	18	27	1.5	2.5
7.5	10	18	27	1.5	2.5
11	15	25	37.5	1.2	2
15	20	35	52.5	0.8	1.2
18.5	25	45	67.5	0.7	1.2
22	30	45	67.5	0.7	1.2
30	40	80	120	0.4	0.7
37	50	80	120	0.4	0.7
45	60	100	150	0.3	0.45
55	75	130	195	0.2	0.3
75	100	160	240	0.15	0.23

Application Example of AC Reactor

Connected in input circuit

Application 1

When more than one Hybrid servo drive is connected to the same mains power and one of them is ON during operation.

Problem: When applying power to one of the Hybrid servo drive, the charge current of the capacitors may cause voltage dip. The Hybrid servo drive may be damaged when over current occurs during operation.
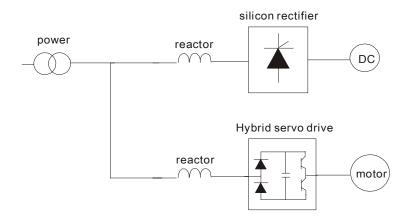
Correct wiring:

Application 2

Silicon rectifier and Hybrid servo drive are connected to the same power.

Problem: Switching spikes will be generated when the silicon rectifier switches ON/OFF. These spikes may damage the mains circuit.
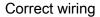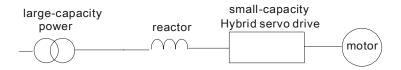
Correct wiring:

Application 3

When the power supply capacity exceeds 10 times of the inverter capacity.
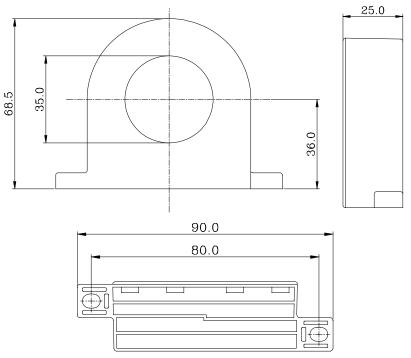
Problem: When the mains power capacity is too large, line impedance will be small and the charge current will be too high. This may damage Hybrid servo drive due to higher rectifier temperature.

Correct wiring

A-4-3 Zero-phase Reactor

RF220X00A   UNIT: mm (inch)

Cable Type (Note)	Recommended Wire Size (mm²)			Qty.	Wiring Method
	AWG	mm²	Nominal (mm²)		
Single-core	≤10	≤5.3	≤5.5	1	Figure A
	≤2	≤33.6	≤38	4	Figure B
Three-core	≤12	≤3.3	≤3.5	1	Figure A
	≤1	≤42.4	≤50	4	Figure B

NOTE

600V insulated power line.

1. The table above gives approximate wire size for the zero phase reactors but the selection is ultimately governed by the type and diameter of cable fitted i.e. the cable must fit through the center hole of zero phase reactors.

2. Only the phase conductors should pass through, not the earth core or screen.

3. When long motor output cables are used an output zero phase reactor may be required to reduce radiated emissions from the cable.

Figure A

Please wind each wire 4 times around the core. The reactor must be put at inverter output as close as possible.
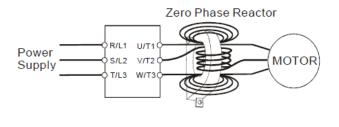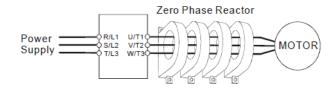

Figure B

Please put all wires through 4 cores in series without winding.

A-4-4 DC Reactor

230V DC Choke

Input Voltage	kW	HP	DC Amps	Inductance (mh)
230Vac 50/60Hz 3-Phase	5.5	7.5	32	0.85
	7.5	10	40	0.75
	11	15	62	Built-in
	15	20	92	Built-in
	18.5	25	110	Built-in
	22	30	125	Built-in
	30	40	-	Built-in
	37	50	-	Built-in
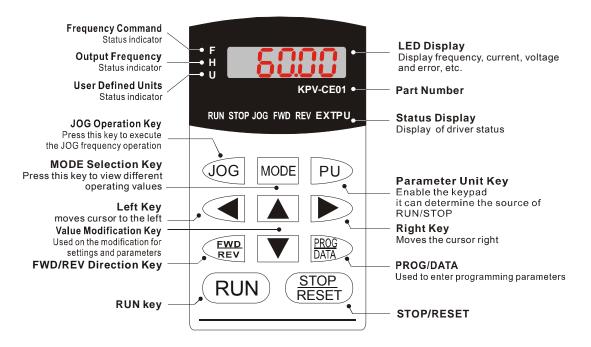
460V DC Choke

Input Voltage	kW	HP	DC Amps	Inductance (mh)
460Vac 50/60Hz 3-Phase	5.5	7.5	18	3.75
	7.5	10	25	4.00
	11	15	32	Built-in
	15	20	50	Built-in
	18.5	25	62	Built-in
	22	30	80	Built-in
	30	40	92	Built-in
	37	50	110	Built-in
	45	60	125	Built-in
	55	75	200	Built-in
	75	100	240	Built-in

A-5 Digital Keypad KPV-CE01

The VFD-VJ series products use the digital keypad VFD-KPV-CE01 as the display unit. For the actual keypad appearance, please refer to the actual product. This picture shows the schematic diagram for illustrative purposes only.

Keypad Panel Appearance
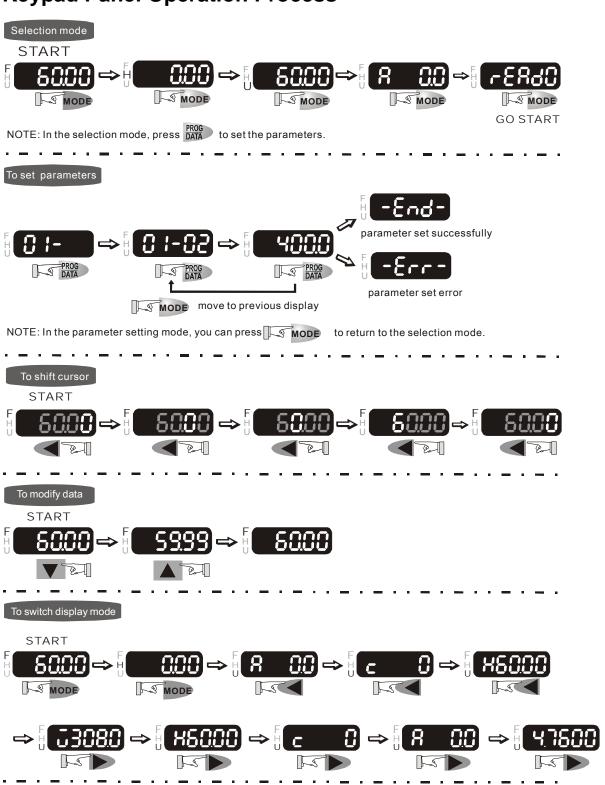
Description of Displayed Function Items

Displayed Item	Description
F **60.00**	Show the current frequency set for the Hybrid servo drive.
H **50.00**	Show the frequency Hybrid servo drive actually delivers to the motor.
U **1800.0**	Show the user-defined physical value (U = F x 00-05)
A **5.0**	Show the load current
c **20**	Show the value of the counter
01-00	Show the selected parameter
10	Show the parameter value
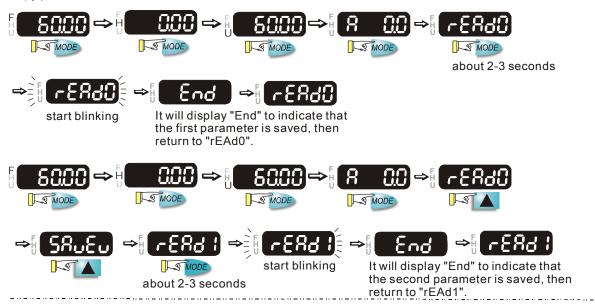
EF	Show the external error
-End-	If the message "End" is displayed (as shown in the left figure) for approximately 1 second, it means that the data have been accepted and automatically stored in the internal memory
-Err-	If the configured data are not accepted or the values exceed the limits, this message will be displayed

Keypad Panel Operation Process

Selection mode

START

NOTE: In the selection mode, press $\boxed{\text{PROG DATA}}$ to set the parameters.

To set parameters

parameter set successfully

parameter set error

move to previous display

NOTE: In the parameter setting mode, you can press $\boxed{\text{MODE}}$ to return to the selection mode.

To shift cursor

START

To modify data

START

To switch display mode

START
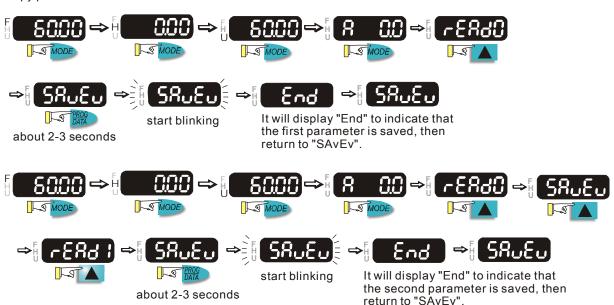
To copy parameters 1

Copy parameters from the AC Motor Drive to the KPV-CE01

F H U **60.00** ⟹ MODE → F H U **0.00** ⟹ MODE → F H U **60.00** ⟹ MODE → F H U **A 0.0** ⟹ MODE → F H U **rEAd0** ⟹ MODE

about 2-3 seconds

⟹ F H U **rEAd0** → F H U **End** → F H U **rEAd0**

start blinking   It will display "End" to indicate that the first parameter is saved, then return to "rEAd0".

F H U **60.00** ⟹ MODE → F H U **0.00** ⟹ MODE → F H U **60.00** ⟹ MODE → F H U **A 0.0** ⟹ MODE → F H U **rEAd0** ⟹ ▲

⟹ F H U **SAvEv** ▲ → F H U **rEAd1** MODE → F H U **rEAd1** → F H U **End** → F H U **rEAd1**

about 2-3 seconds   start blinking   It will display "End" to indicate that the second parameter is saved, then return to "rEAd1".

To copy parameters 2

Copy parameters from the KPV-CE01 to the AC Motor Drive

F H U **60.00** ⟹ MODE → F H U **0.00** ⟹ MODE → F H U **60.00** ⟹ MODE → F H U **A 0.0** ⟹ MODE → F H U **rEAd0** ⟹ ▲

⟹ F H U **SAvEv** PROG DATA → F H U **SAvEv** → F H U **End** → F H U **SAvEv**

about 2-3 seconds   start blinking   It will display "End" to indicate that the first parameter is saved, then return to "SAvEv".

F H U **60.00** ⟹ MODE → F H U **0.00** ⟹ MODE → F H U **60.00** ⟹ MODE → F H U **A 0.0** ⟹ MODE → F H U **rEAd0** ▲ ⟹ F H U **SAvEv** ▲

⟹ F H U **rEAd1** ▲ → F H U **SAvEv** PROG DATA → F H U **SAvEv** → F H U **End** → F H U **SAvEv**

about 2-3 seconds   start blinking   It will display "End" to indicate that the second parameter is saved, then return to "SAvEv".
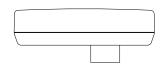
Mechanical Dimensions of Digital Keypad KPV-CE01

Unit: mm [inch]
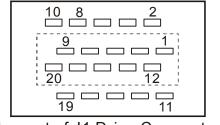
Characters of Digital Keypad Displayed on the LCD

Number	0	1	2	3	4	5	6	7	8	9
LCD	0	1	2	3	4	5	6	7	8	9
Eng. Letter	A	b	Cc	d	E	F:.	G	Hh	I	Jj
LCD	A	b	Cc	d	E	F	G	Hh	I	JJ
Eng. Letter	K	L	n	Oo	P	q	r	S	Tt	U
LCD	K	L	n	Oo	P	q	r	S	Tt	U
Eng. Letter	v	Y	Z							
LCD	u	y	Z							

A-6 Speed Feedback PG Card Selection
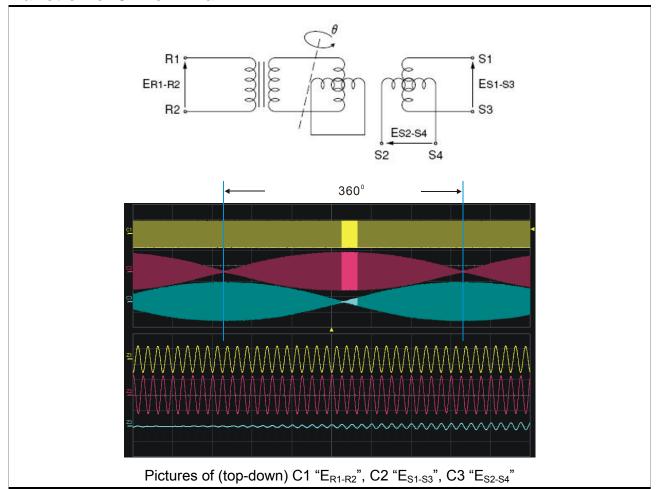
EMVJ-PG01R/PG02R

Layout of J1 Drive Connector

Function of J1 Terminal

Pictures of (top-down) C1 "E_{R1-R2}", C2 "E_{S1-S3}", C3 "E_{S2-S4}"

Pin No	Terminal Mark	Function, Description	Specifications
4	SIN- (S4)	Resolver Signal Output	3.5±0.175Vrms, 10kHz
5	SIN+ (S2)		
7	COS+ (S1)		
9	COS- (S3)		
14,16	REF+ (R1)	Resolver Power Input	7Vrms, 10kHz
13,15	REF- (R2)		
	Shield	Shield	
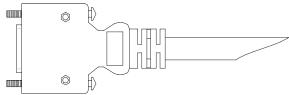
Wiring Length

Encoder Wiring - Diameter mm² (AWG)			
Core Size	**Number of Cores**	**Wire Standard**	**Standard Wire Length**
0.13（AWG26）	10 (4 pairs)	UL2464	3 m (9.84 feet)

NOTE

1） For wiring the encoder, please use the shielded twisted-pair cable so as to reduce the interference due to noise.

2） The shield net must be firmly connected with the SHIELD terminal⏚.

3） During wiring, please follow the corresponding provisions for cable wiring so as to avoid hazards and accidents.
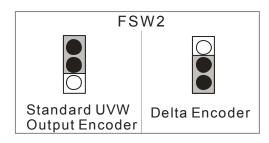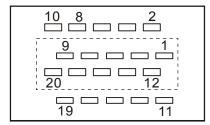
Connector Specifications

Title	Part No.	Manufacturer
PLUG	3M 10120-3000PE	3M
SHELL	3M 10320-52A0-008	3M

EMVJ-PG01U

FSW2

Standard UVW Output Encoder | Delta Encoder

Layout of J1 Drive Connector

Functions of Terminals

Pin No	Terminal Mark	Function, Description	Specifications
4	$\overline{A}$	Differential incremental signal input of the encoder	Line Driver (Line Driver RS422) Maximum Input Frequency 300kHz
5	A		
7	B		
9	$\overline{B}$		
10	Z		
2	$\overline{Z}$		
14, 16	VP	Encoder power output Note: FSW3 can be used to configure the output as +5V or +12V.	Voltage: +5V±0.5V or +12V±1V Current: 200mA max
13, 15	0V	Power common dedicated for the encoder	Reference level for the encoder power
19	U	Differential absolute signal input of the encoder (UVW 3-bit encoding)	Line Driver (Line Driver RS422) Maximum Input Frequency 50kHz
8	$\overline{U}$		
6	V		
1	$\overline{V}$		
11	W		
3	$\overline{W}$		
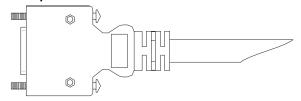
Wiring Length

Encoder Wiring - Diameter mm² (AWG)			
Core Size	Number of Cores	Wire Standard	Standard Wire Length
0.13（AWG26）	10 (4 pairs)	UL2464	3 m (9.84 feet)

NOTE

1) For wiring the encoder, please use the shielded twisted-pair cable so as to reduce the interference due to noise.

2) The shield net must be firmly connected with the SHIELD terminal⏚.

3) During wiring, please follow the corresponding provisions for cable wiring so as to avoid hazards and accidents.

Connector Specifications

Title	Part No.	Manufacturer
PLUG	3M 10120-3000PE	3M
SHELL	3M 10320-52A0-008	3M

A-7 Communication Card

EMVJ-MF01

Terminal	Description
⏚	Ground terminal
SG-	RS485 terminals
SG-	
GND	Common ground for signals

NOTE

1. For wiring, please use the shielded twisted-pair cable so as to reduce the interference due to noise.

2. The shield net must be firmly connected with the SHIELD terminal ⏚.

A-8 EMI Filter

Drive	Applicable Filter Model No.	Reference Website
VFD055VL23A-J VFD075VL23A-J VFD150VL43A-J	KMF336A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF336A Three Phase Industrial Mains Filters - High Performance 36 Amps
VFD055VL23A-J VFD150VL43A-J VFD220VL43A-J	KMF350A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF350 Three Phase Industrial Mains Filters - General Purpose 50 Amps
VFD150VL43A-J VFD300VL43A-J VFD370VL43A-J	KMF370A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF336A Three Phase Industrial Mains Filters - High Performance 70 Amps
VFD185VL23A-J VFD220VL23A-J VFD450VL43A-J	KMF3100A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF3100A Three Phase Industrial Mains Filters - High Performance 100 Amps
VFD300VL23A-J VFD370VL23A-J VFD550VL43A-J VFD750VL43A-J	KMF3150A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF3150A Three Phase Industrial Mains Filters - High Performance 150 Amps
VFD055VL43A-J	KMF318A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF318 Three Phase Industrial Mains Filters - General Purpose 18 Amps
VFD075VL43A-J VFD110VL43A-J	KMF325A	http://www.dem-uk.com/roxburgh/products/emc_emi_industrial_filters/ KMF325A Three Phase Industrial Mains Filters - High Performance 25 Amps

EMI Filter Installation

All electrical equipment, including Hybrid drives, will generate high-frequency/low-frequency noise and will interfere with peripheral equipment by radiation or conduction when in operation. By using an EMI filter with correct installation, much interference can be eliminated. It is recommended to use DELTA EMI filter to have the best interference elimination performance.

We assure that it can comply with following rules when Hybrid drive and EMI filter are installed and wired according to user manual:

- **EN61000-6-4**
- **EN61800-3: 1996**
- **EN55011 (1991) Class A Group 1 (1st Environment, restricted distribution)**

General precaution
1. EMI filter and Hybrid drive should be installed on the same metal plate.
2. Please install Hybrid drive on footprint EMI filter or install EMI filter as close as possible to the Hybrid drive.
3. Please wire as short as possible.
4. Metal plate should be grounded.
5. The cover of EMI filter and Hybrid drive or grounding should be fixed on the metal plate and the contact area should be as large as possible.

Choose suitable motor cable and precautions

Improper installation and choice of motor cable will affect the performance of EMI filter. Be sure to observe the following precautions when selecting motor cable.

1. Use the cable with shielding (double shielding is the best).
2. The shielding on both ends of the motor cable should be grounded with the minimum length and maximum contact area.
3. Remove any paint on metal saddle for good ground contact with the plate and shielding.

Remove any paint on metal saddle for good ground contact with the plate and shielding.
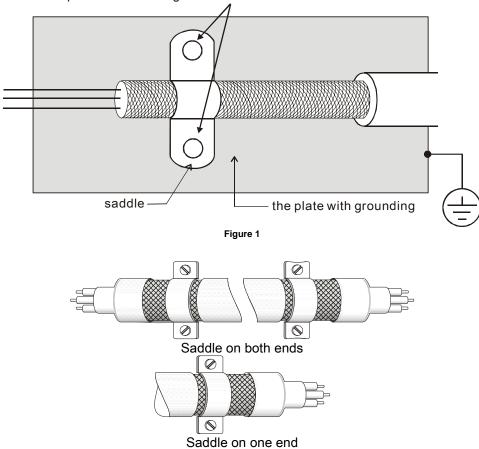

Figure 1

Saddle on both ends

Saddle on one end

Figure 2

The length of motor cable

When motor is driven by an Hybrid drive of PWM type, the motor terminals will experience surge voltages easily due to components conversion of Hybrid drive and cable capacitance. When the motor cable is very long (especially for the 460V series), surge voltages may reduce insulation quality. To prevent this situation, please follow the rules below:

- Use a motor with enhanced insulation.
- Connect an output reactor (optional) to the output terminals of the Hybrid drive
- The length of the cable between Hybrid drive and motor should be as short as possible (10 to 20 m or less)
- For models 7.5hp and above:

Insulation level of motor	1000V	1300V	1600V
460VAC input voltage	66 ft (20m)	328 ft (100m)	1312 ft (400m)

230VAC input voltage	1312 ft (400m)	1312 ft (400m)	1312 ft (400m)

■ For models 5hp and less:

Insulation level of motor	1000V	1300V	1600V
460VAC input voltage	66 ft (20m)	165 ft (50m)	165 ft (50m)
230VAC input voltage	328 ft (100m)	328 ft (100m)	328 ft (100m)

NOTE

Never connect phase lead capacitors or surge absorbers to the output terminals of the Hybrid drive.
   ■ If the length is too long, the stray capacitance between cables will increase and may cause leakage current. It will activate the protection of over current, increase leakage current or not insure the correction of current display. The worst case is that Hybrid drive may damage.
   ■ If more than one motor is connected to the Hybrid drive, the total wiring length is the sum of the wiring length from Hybrid drive to each motor.
   ■ For the 460V series Hybrid drive, when an overload relay is installed between the drive and the motor to protect motor over heating, the connecting cable must be shorter than 50m. However, an overload relay malfunction may still occur. To prevent the malfunction, install an output reactor (optional) to the drive or lower the carrier frequency setting (Pr.00-17).

NOTE

When a thermal O/L relay protected by motor is used between Hybrid drive and motor, it may malfunction (especially for 460V series), even if the length of motor cable is only 165 ft (50m) or less. To prevent it, please use AC reactor and/or lower the carrier frequency (Pr. 00-17 PWM carrier frequency).