Operation Manual

MH860 Series
Hydraulic Servo Drive

INVT INDUSTRIAL TECHNOLOGY (SHANGHAI) CO., LTD

Preface

Thank you for choosing MH860 series hydraulic servo drive developed by INVT Industrial Technology Co., Ltd. If not otherwise specialized, the drive indicates MH860 series hydraulic servo drive in the manual.

Designed for hydraulic equipment such as injection molding machine, die-casting machine, and hydraulic press, the drive features energy saving, high accuracy, high efficiency and durability for adopting high performance vector control. The drive has rich external expansion and CAN communication interfaces, helping to form a multi-pump parallel system to realize the hydraulic control on large flow equipment.

If you use the drive for the first time, please read this manual carefully to ensure correct and safe operation. Please keep this manual in a safe place so that it can be consulted at any time.

We are committed to the continuous product improvement and upgrade. The background software and product information will be updated accordingly. Please download the latest software and electronic document versions from our website www.invt-tech.com.

The target audiences of the manual include:

- Control system designer
- Installation or wiring personnel
- User or maintenance personnel

Please make sure to observe the following:

- The installation environment must be free of water vapor, corrosive gases, or combustible gases.
- Do not connect the grid power directly to the U, V and W terminals of the motor when wiring. Otherwise, incorrect connection will cause drive or motor damage.
- Ground wires must be grounded safely.
- Do not disassemble the drive, motor, oil pump, or change the wiring while the power is on.
- Do not touch the heat sink at work to avoid burns.

We provide all-round after-sales and maintenance services. Do not disassemble the drive or motor housing unless authorized; any modification on the drive or motor or damage accompanied will revoke the warranty rights; and we will not be liable or responsible for the consequences caused.

If you have any questions during use, please consult the dealer or our customer service center.

Contents

1 Safety precautions

Read this manual carefully and follow all safety precautions before moving, installing, operating and servicing the product. Otherwise, equipment damage or physical injury or death may be caused.

We shall not be liable or responsible for any equipment damage or physical injury or death caused due to your or your customers' failure to follow the safety precautions.

1.1 Safety definition

The precautions for safe operation in the manual are classified into "Danger", "Warning" and "Note".

 Danger: Point out potentially dangerous situations that may result in serious personal injury or death if not operated as required.

 Warning: Point out potentially dangerous situations that may result in serious personal injury or death if not operated as required.

Note: Point out potentially dangerous situations that may result in moderate personal injury if not operated as required.

1.2 Safety guidelines

 Danger	1. Only trained and qualified professionals can perform the installation or maintenance.
	2. Do not perform wiring, inspection or component replacement when the power is on. Before wiring or inspection, ensure all the input power supplies have been disconnected, and wait for at least 10 minutes or until the DC bus voltage is lower than 36V.
	3. Please use insulated protective tools for inspection; otherwise, electric shock accident or personal injury may be caused.
	4. Connect the ground wires reliably and ask professionals to performing wiring to avoid electric shock or fire accident.
	5. Do not install the motor, braking resistor, or driver near combustible materials; otherwise, fire may be caused.
	6. Do not modify the product unless authorized; otherwise, electric shock, malfunction, burns, or fire may be caused.
 Warning	1. Do not hold or pull the aviation plug connector to deliver the motor. Otherwise, the connector may be damaged, which may cause the motor to fall and cause injury.
	2. Do not knock the motor when installing the motor. Otherwise, the precision parts on the shaft may be damaged or the accuracy may be degraded.
	3. The surface temperature of the motor may reach 100℃ when running continuously at full load. The temperature is within the allowable range of design and can be operated normally, but you must install the motor in a place unaccessible to people and

	animals to avoid scalding.
	4. The external braking resistor may rise to a high temperature when the motor is frequently braked, which requires well-ventilated heat dissipation. It is recommended to place the motor outside the control cabinet (such as at the top ventilator outlet) with reliably protection measures. When the motor must be installed inside the cabinet, install it near the top ventilator outlet and away from other components.
	5. Check all external wiring carefully before first power-on to avoid major accidents caused by incorrect wiring.
	6. Turn on the motor for the first time with no load if possible, and make ready to turn off it depending on the running conditions.
	7. Do not close or open the power supply, but enable or disable the setup to start or stop the servo system.
	8. The product contains electrolytic capacitors, integrated circuits, epoxy boards and other components. Dispose of a scrap product as industrial waste; otherwise, personal injury or environmental pollution may be caused.
Note	1. Protect the drive against physical shock or vibration during the delivery and installation. Do not carry the drive only by its front cover as the cover may fall off.
	2. Prevent the screws, cables and other conductive parts from falling into the drive.
	3. R, S and T are the power input terminals, while U, V and W are the output motor terminals. Connect the input power cables and motor cables properly; otherwise, damage to the drive may occur.
	4. Close the drive front cover or junction box before using the drive; otherwise, electric shock may occur.
	5. Use proper torque to tighten screws for installation and wiring.
	6. Do not carry out insulation voltage-endurance test on the drive, or measure the control circuits of the drive with a megohmmeter.

For workplaces where the occasional failure of product could cause a major accident or significant damage, please consider equipment safety separately.

The manufacturer, seller, and service provider shall not be liable or responsible for associated damages and joint liability due to servo system failure.

2 Product overview

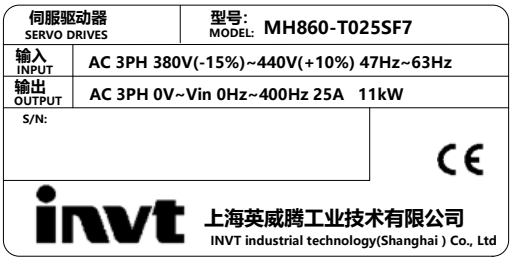
2.1 Product confirmation

Check the following after receiving the product.

Item	Remarks
Whether the product you have received is consistent with the purchased model.	Check according to the models on the motor and drive nameplates.
Whether the motor rotating shaft runs properly.	The motor is proper if the shaft rotates by hand.
Whether there is damage.	View the entire exterior and check for any damage caused during delivery.
Whether all accessories and documents are included.	Check according to the packing list.

If any problems are found, contact our local dealer or office.

2.2 Drive nameplate



2.3 Drive model description

MH860	-T	025	S	F	7	0000
Hydraulic product series	Voltage class T: 380V	Current class 018: 18.5A 025: 25A 032: 32A 038: 38A 043: 43A 060: 60A 070: 70A 092: 92A 115: 115A 150: 150A 170: 170A 180: 180A 215: 215A	Communication method S: Standard C: CAN N: EtherCAT F: PROFINET B: PROFIBUS	Air cooling type F: Air cooling Y: Liquid cooling	Encoder type 7: Rosolver	Management number 0000: Not distinguished
Basic model information (Software display)						

2.4 Drive specifications

Drive model MH860-T	018SF7	025SF7	032SF7	038SF7	043SF7
Applicable motor capacity (kW)	7.5	11	15	18.5	22
Rated output current (Arms)	18.4	25	32	38	43
Overload (Lasts 5min)	26	35	45	49	64
Max. output current [Arms] (Lasts 30s)	31	39	53	58	70
Rated input current (Arms)	25	32	40	47	53
Input power	AC380V(-15%)–440V(+10%) 47Hz–63Hz				
Weight	6.5Kg	7.0kg	9kg	9.5kg	9.5kg
Recommended regenerative braking resistor specifications	68Ω 500W	40Ω 500W			20Ω 500W
Min. braking resistance	47 Ω	31 Ω	23Ω	19 Ω	15Ω

Drive model MH860-T	060SF7	070SF7	092SF7	115SF7	150SF7
Applicable motor capacity (kW)	30	37	45	55	75
Rated output current (Arms)	60	70	92	115	150
Overload (Lasts 5min)	85	91	129	162	201
Max. output current [Arms] (Lasts 30s)	106	124	163	226	297
Rated input current (Arms)	70	76	94	128	160
Input power	AC380V(-15%)–440V(+10%) 47Hz–63Hz				
Weight	11.5Kg	11.5kg	30kg	32kg	51kg
Recommended regenerative braking resistor specifications	20Ω 500W		10Ω 2000W		Two 10Ω 2000W resistors in parallel connection
Min. braking resistance	15 Ω		6.4 Ω		4.4 Ω

Drive model MH860-T	180SF7	215SF7
Applicable motor capacity (kW)	90	110
Rated output current (Arms)	180	215
Overload (Lasts 5min)	234	303
Max. output current [Arms] (Lasts 30s)	332	339
Rated input current (Arms)	170	225
Input power	AC380V(-15%)–440V(+10%) 47Hz–63Hz	
Weight	52Kg	67Kg
Recommended regenerative braking resistor specifications	Two 10Ω 2000W resistors connected in parallel	Two 30Ω 2000W resistors connected in parallel, requiring the braking unit DBU100H-060-4
Min. braking resistance	4.4Ω	/

Drive model MH860-T	060SY7	092SY7	115SY7	150SY7	170SY7
Applicable motor capacity (kW)	30	45	55	75	90
Rated output current (Arms)	60	92	115	150	170
Overload (Lasts 5min)	84	129	162	201	234
Max. output current [Arms] (Lasts 30s)	106	163	226	297	332
Rated input current (Arms)	70	94	128	160	170
Input power	AC380V(-15%)–440V(+10%) 47Hz–63Hz				
Weight	16.5Kg	36.2kg	36.2kg	37.1kg	37.1kg
Recommended regenerative braking resistor specifications	20Ω 500W	10Ω 2000W		Two 10Ω 2000W resistors connected in parallel	
Min. braking resistance	15Ω	6.4 Ω		4.4 Ω	

2.5 Drive technical performance

Basic specifications	Control mode		Three-phase full-wave rectification, IGBT with PWM control on sine wave current drive
	Max. output frequency		400Hz
	Motor position sensor		Resolver resolution: 4096pluse/rev
	Environment	Working temperature	-10°C – +50°C (No freezing. Derating is required if the temperature exceeds 40°C.)
		Storage temperature	-30°C – +60°C (No freezing)
		Relative humidity (RH)	Working/storage RH ≤ 90% (no condensation)
		Air	Indoor (no sunlight, corrosive gas, combustible gas, oil mist, or dust)
		Altitude	Below 3000m (Derating is needed when the altitude exceeds 1000m. Derate by 1% for every increase of 100m.)
	Ingress protection (IP) rating		IP20
	Cooling method		(1) Air cooling. (2) Liquid cooling
	Digital signal	Input	Six inputs. For details, see section 4.7.
		Output	Four outputs. For details, see section 4.7.
	Analog signal	Input	Three inputs, 12-bit A/D, 0–10V
		Output	Two outputs, 10-bit D/A, 0–10V (internal parameter output can be set through the LED panel or external HMI)
	Power supply	Output	Used to externally provide 15V reference power supply. Max. output current: 50mA
	Communication Function		Four types of filed bus available: (Standard) Modbus (Optional) EtherCAT, CANopen, and PROFINET
	LED panel and keypad		Six-digit display, with four function keys
	External HMI		The external HMI communicates with the drive through the RS485 interface to set parameters, copy parameters, and so on.
Control function performance	Process control		Supported input: analog input, internal input, communication input, RS485 continuous input, CANopen input, EtherCAT input, and PROFINET input
	Speed control		Supported control methods: CAN communication, RS485 communication, CANopen input, and EtherCAT input
	Multi-pump parallel control		Able to control 16 pumps in five working modes (multi-pump, hybrid, multi-mode, communication with two models, and communication with four models)

	Pressure control accuracy	±1bar
	Flow control accuracy	±0.5%FS
	Speed control accuracy	±0.5%
	Pressure control stepped response	≤100ms
	Speed stepped response	≤50ms
	Flow calibration function	Able to calibrate pressure for output flow according to various pump characteristics
	Torque response time	≤2ms
Protection	Hardware	Protection against overcurrent, DC overvoltage, DC undervoltage, braking resistor damage, module overtemperature, pressure sensor fault, FWD/REV overspeed, and brake overload, and so on
	Software	Protection against software faults, task re-entry and so on
	Alarm record memory	Able to store five alarm records

When the actual ambient temperature of the drive exceeds 40°C, derate the rated output current by 1% for every increase of 1°C. Do not use the drive when the ambient temperature exceeds 50°C. Note: When the drive is built in a cabinet, the ambient temperature is the temperature of air in the cabinet.

2.6 Dimensions of drive

2.6.1 Dimensions of air-cooled drive

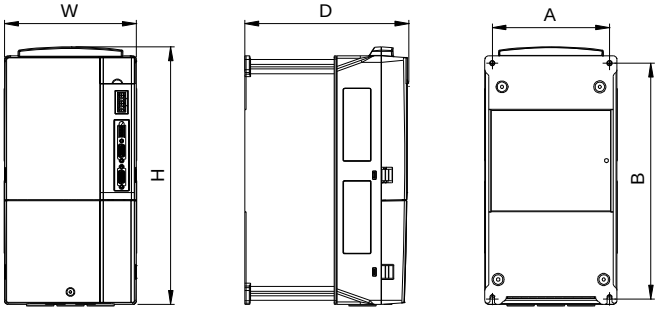


Figure 2-1 Dimensions of MH860-T018SF7–T070SF7

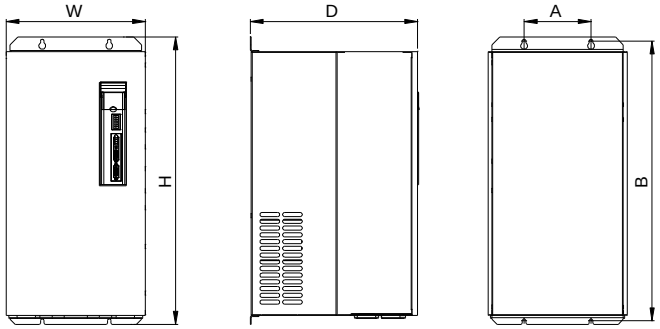


Figure 2-2 Dimensions of MH860-T092SF7–T215SF7

Dimensions of drive:

Model	Outline dimensions			Installation dimensions		Hole diameter (mm)
	H1 (mm)	W (mm)	D (mm)	A (mm)	B (mm)	
MH860-T018SF7	332	170	208	151	303.5	M5(φ6)
MH860-T025SF7						
MH860-T032SF7	342	230	208	210	311	M5(φ6)
MH860-T038SF7						
MH860-T043SF7						
MH860-T060SF7	407	255	245	237	384	M6(φ7)
MH860-T070SF7						
MH860-T092SF7	555	270	325	130	540	M6(φ7)
MH860-T115SF7						
MH860-T150SF7	554	338	329	200	535	M8(φ9.5)
MH860-T180SF7						
MH860-T215SF7	680	325	365	200	661	M8(φ9.5)

2.6.2 Dimensions of liquid-cooled drive

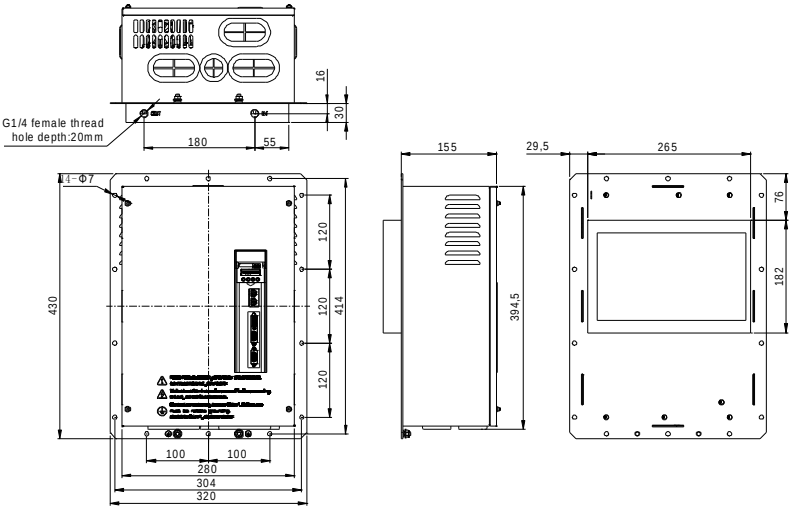


Figure 2-3 MH860-T060SY7

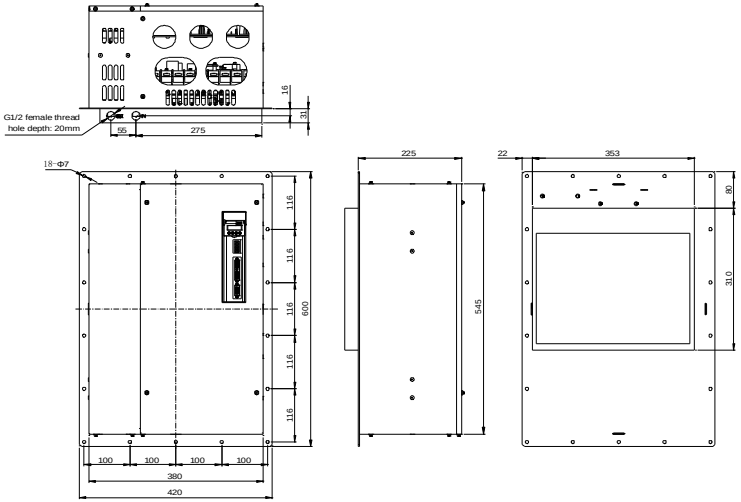
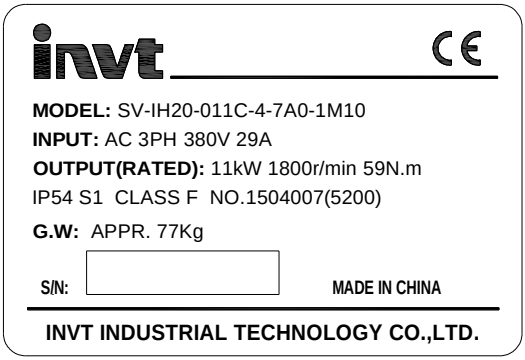


Figure 2-4 MH860-T092SY7/MH860-T115SY7/MH860-T150SY7/MH860-T170SY7

2.7 Motor nameplate



2.8 Motor model description

SV - I H 20 - 011 C - 4 - 7 A 0 - 1 M10
① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫

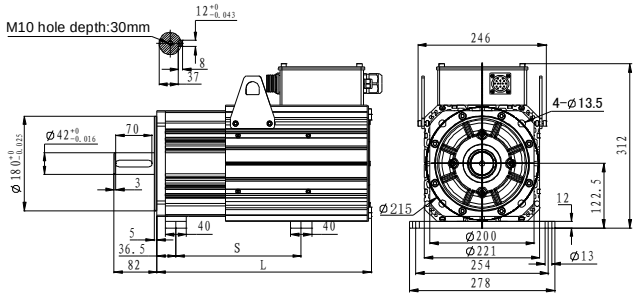
Field	ID	Description	Naming example
Product category	①	Product category	SV: Servo system
Product series	②	Product series	M: M series (common) I: I series (built-in), IPM air cooled
	③	Inertial class	M: General-purpose servo motor with medium inertia H: General-purpose servo motor with high inertia
	④	Base model no.	18: 180mm; 20: 200mm; 26: 263mm
Power range + Load type/rotation speed	⑤	Rated power	(1) For the model < 9.9kW 1R0: 1.0kW (2) For the 10kW and higher 015: 15kW
	⑥	Rated rotation speed	B: 1500rpm C: 1800rpm E: 2000rpm
Voltage class	⑦	Voltage class	4–380VAC
Configuration information	⑧	Encoder type	7–12 bit retoary transformer
	⑨	Shaft end connection	(Standard) Solid with threaded hole and key Solid plain shaft
	⑩	Optional part	With oil seal but no brake Without oil seal or brake
Management number	⑪	Supplier ID	1
	⑫	Product management ID	000: Standard nameplate without a bracket M10: Non-standard nameplate with a bracket M16: Standard nameplate with a bracket

2.9 Motor specifications

Model	Rated speed (rpm)	Rated output power in S1 (kW)	Rated torque (Nm)	Rated current (A) (rms)	Max. torque at rated rotation speed (Nm)	Max. current at rated rotation speed (Arms)	Max. speed (rpm)	Back-EMF (Vrms/ krpm)	Torque (Nm/A)	Rotor inertia (Kg*cm^2)
SV-IH20-011C-4-7A0-1	1800	11	59	29	106	56.6	2500	135	1.89	86.3
SV-IH20-013C-4-7A0-1	1800	13	72	30	122	63.6	2500	141	2.06	101.2
SV-IH20-016E-4-7A0-1	2000	16	77	34	127	76.4	2500	127.5	1.85	98.5
SV-IH20-018C-4_7A0-1	1800	18	95	34.6	159	69.3	2500	165	2.34	144
SV-IH20-022E-4-7A0-1	2000	22	105	45.5	185	91.3	2500	134	1.88	159
SV-IH20-025C-4-7A0-1	1800	25	133	55	239	140	2500	152	1.91	182
SV-IH20-030E-4-7A0-1	2000	30	144	60	233	120.9	2500	146	2.40	201
SV-IH26-035E-4-7A0-1	2000	35	167	71.5	240	115	2500	157	2.13	345
SV-IH26-037C-4-7A0-1	1800	37	195	72	333	142.8	2500	164.5	2.18	370
SV-IH26-041E-4-7A0-1	2000	41	195	84.8	313	163.2	2500	153	2.29	370
SV-IH26-043C-4-7A0-1	1800	43	230	91	385	181	2500	152	2.12	426
SV-IH26-048E-4-7A0-1	2000	48	230	104	349	192.4	2500	137	1.96	426
SV-IH26-056E-4-7A0-1	2000	56	270	115	411	203.7	2500	158	2.27	523
SV-IH26-064E-4-7A0-1	2000	64	306	127	508	248.9	2500	148	2.33	606
Pole pairs	4									
Voltage class (V)	380									
Insulation class	F									
Pressure resistance class	AC1800V, one minute									
Insulation resistance	DC1000V, > 50MΩ									
IP rating	Fully enclosed and self-cooled, IP54 (except the through part of shaft)									
Seismic performance	Able to pass the vibration test under conditions in the classes 1 and 2 (in table 6 in section 4.26) in GB/T 7345-94									
Storage temperature	-25°C – +60°C (No freezing)									
Running environment temperature	-20°C – +40°C (Derating is required if the temperature exceeds 40°C.)									
Running environment humidity	20%–95% (No condensation)									
Exciting method	Permanent magnetic									
Installation method	IMB5									
Position detection	Resolver: one pole									

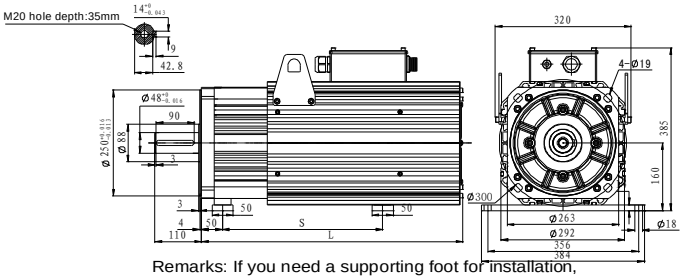
2.10 Motor installation dimensions

For base-200 motors:



Remarks: If you need a supporting foot for installation, note the requirement in the ordering since no supporting foot is provided by default.
The data in the drawing is only for installation reference.

For base-263 motors:



Remarks: If you need a supporting foot for installation, note the requirement in the ordering since no supporting foot is provided by default.
The data in the drawing is only for installation reference.

Model	S	L
SV-IH20-011C-4-7A0	190	376
SV-IH20-013C-4-7A0/SV-IH20-016E-4-7A0/ SV-IH20-018C-4-7A0	230	411
/SV-IH20-022E-4-7A0	300	481
SV-IH20-025C-4-7A0	340	551
SV-IH20-030E-4-7A0	415	586
SV-IH26-035E-4-7A0	255	492
SV-IH26-037C-4-7A0/SV-IH26-041E-4-7A0	300	537
SV-IH26-043C-4-7A0/SV-IH26-048E-4-7A0	370	577
SV-IH26 -056E-4-7A0	400	617
SV-IH26 -064E-4-7A0	440	657

3 Mechanical installation

3.1 Installation environment

To ensure proper performance and long operating life, install the drive in the following recommended environment, which also ensures that the drive is protected from damage.

Note	1. Prevent from direct sunshine, direct outdoor use not recommended.
	2. Do not use in an environment with corrective gas or liquid.
	3. Do not use in an environment with oil mist or splash.
	4. Do not use in an environment with salt mist.
	5. Do not use in a wet or humid environment.
	6. Configure a filtering device when there is metal powder or silk spinning fiber fluttering in the air.
	7. Do not use under mechanical shock or vibration.
	8. Take temperature lowering measures when the ambient temperature exceeds 50°C.
	9. Overcooling and overheating may cause equipment failure. The recommended temperature range is -10°C – +40°C.
	10. Keep away from the power supply noise. For example, welding machines, high-powered electrical equipment will affect the use of the product.
	11. Radioactive materials can affect the use.
	12. Keep away from flammable items, diluent agents, and solvents.

3.2 Installing the drive

1. As shown in the figure, it is recommended to install the drive vertically, and leave sufficient ventilation space and plugging space (more than 200mm) above and below the drive for heat dissipation and operation.
2. Use natural air convection or a fan to cool the drive.
3. Fix the drive firmly to the mounting surface through the four mounting holes.
4. When installing multiple drives in a cabinet:
   a) Keep the front side (with the LED panel) of the drive facing you.
   b) To ensure that cooling can be carried out through a fan as well as natural air convection, pay attention to the installation position of the ventilation fan inside the cabinet. If the fan is not installed in a proper position, the ambient temperature may rise, which will affect the cooling effect of drive.
   c) When installing the drives side by side, leave more than 50mm on each horizontal end and more than 200mm on each vertical end. In addition, install a cooling fan at top of drive. To prevent the ambient temperature of certain drives too high, the temperature inside the control cabinet needs to be kept even.

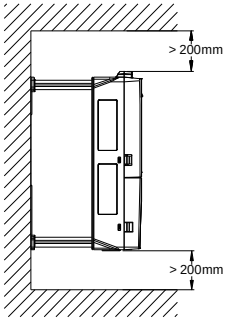


Figure 3-1 Drive installation diagram

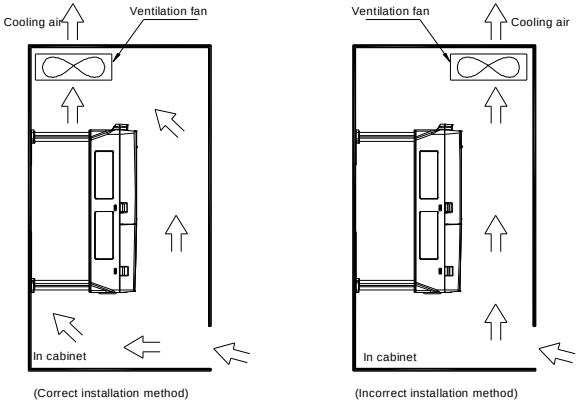
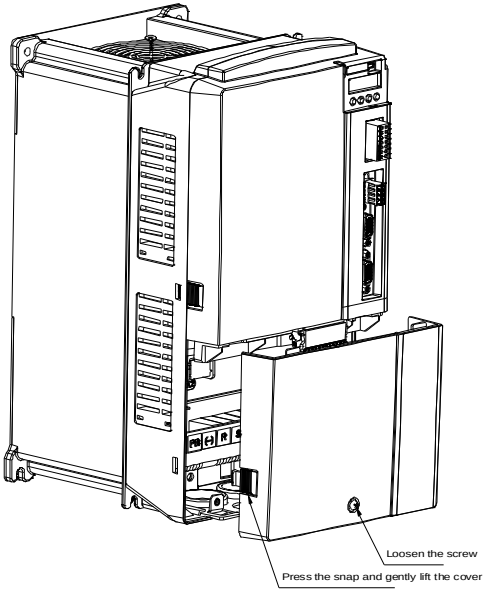


Figure 3-2 Ventilation fan installation position

3.3 Disassembling/assembling the junction box of drive

To disassemble the junction box of drive (for example, MH860-T038SF7), do as follows:

1. Loosen and remove the two fastening screws of the junction box.
2. Pull the junction box outward and take it out.



To assemble the junction box of drive (for example, MH860-T038SF7), do as follows:

1. Put the junction box horizontally into the convex groove, and push the box so that the junction box and the housing slit overlap.

2. Fasten the two fastening screws of the junction box.

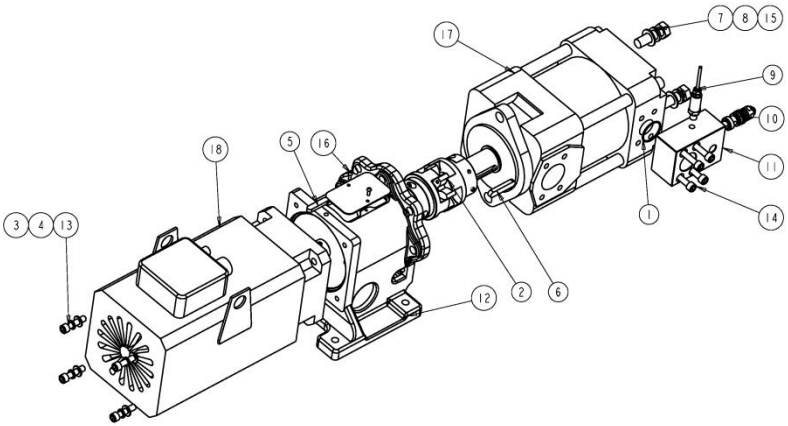
3.4 Installing the motor

To ensure safe and stable running of motor, install the motor according to the following instructions.

Note	1. Install the motor in the horizontal or vertical direction.
	2. When connecting to machinery, it is recommended to use a coupling and keep the axis of motor in a straight line with the axis of machinery. If the concentricity is insufficient, vibration may occur, which will cause damage to shaft bearing or encoder.
	3. The motor has positioning requirements for the installation of feedback elements (such as optical encoder and resolver). To be specific, the feedback elements are required to have a fixed relative position with the rotor and stator of motor, which disallows disassembly or swapping unless authorized.
	4. Do not apply tension to cables. Especially the signal cable core is very thin. Do not stretch it too tightly when wiring.
	5. Prevent the shaft bearing from direct impact. Otherwise, the precision parts on the shaft may be damaged (resolver) or the accuracy may be degraded.

The procedure for installing the motor and pump is as follows:

1. Connect the flat key to the pump as one part, and put on the half of the coupling, and wear the bolt, but not tighten it.
2. Connect the flat key to the motor as one part, and put on the other half of the coupling, and wear the bolt, but not tighten it.
3. Connect the pump to the motor bracket, determine the correct direction, and tighten the bolts.
4. Connect the motor to the motor bracket, determine the correct direction, and tighten the bolts.
5. Adjust the elastic coupling gap by 2–3mm and tighten the bolts at both ends, and rotate freely by hand without any abnormal noise.
6. Place the assembly of the motor, motor bracket, and pump to the installation place, and make motor bracket fastening screw holes on site.
7. Fasten the bolts.



No.	Item	No.	Item	No.	Item
①	O-shaped rubber seal	②	Coupling assembly	③	Spring pad
④	Plain washer	⑤	Motor flat key	⑥	Pump flat key
⑦	Spring washer	⑧	Plain washer	⑨	Pressure sensor
⑩	Detachable threaded relief valve	⑪	Integrated block oiling plate	⑫	Motor bracket
⑬	Hex-socket cylindrical-head screw	⑭	Hex-socket cylindrical-head screw	⑮	Hex-socket bolt
⑯	Cross button-headed screw	⑰	Pump	⑱	Motor

4 Electrical connection

4.1 Wiring precautions

 Warning	1. Only trained and qualified professionals can perform the wiring. Incorrect wiring may cause electric shock or fire.
	2. The drive can be connected directly to an industrial power line. In other words, no transformer is used for isolation. To prevent cross-contact electric shock accidents, use the circuit breaker or fuse with the purpose of wiring.
	3. The drive does not have a built-in ground protection circuit. To build a safer system, please configure a leakage circuit breaker with both overload and short-circuit protection, or configure a ground-wire-protection leakage circuit breaker that is used together with a wiring circuit breaker.
Note	1. It is recommended to use A, B or C grounding method (grounding resistance of 10Ω or less). A point of grounding must be used. When the motor and mechanical firmware are insulated from each other, ground the motor directly.
	2. Use a thick wire (4.0 mm^2 or greater) for grounding whenever possible.
	3. Most leakage protection switches on the market are electronic leakage circuit breakers, of which internal leakage current detection and processing circuits vary greatly with manufacturers. Therefore, the breakers from different manufacturers are different in anti-interference ability. It is recommended to use a relatively strong anti-interference leakage circuit breaker.
	4. Route the electrical cables such as power cable and motor input cable separately from signal cables, with an interval of more than 30cm. Do not put the cables in the same pipe or bundle together.
	5. Do not use the same power supply with a welding machine, electrical discharge processing machine, and so on. Even if different power supplies are used, when there is a high frequency generator nearby, connect a noise filter on the input side of the power cable.
	6. Install surge suppressors on the coils of relay, solenoid, and electromagnetic contactor.
	7. To prevent malfunction caused by noise, configure the input command device and noise filter as close as possible to the drive.
	8. Select a reasonable cable diameter, switch capacity, and contactor capacity. For details, see section 4.2 "Switch, contactor, and cable selection".

Note: Incorrect wiring may cause system faults or personal safety risks.

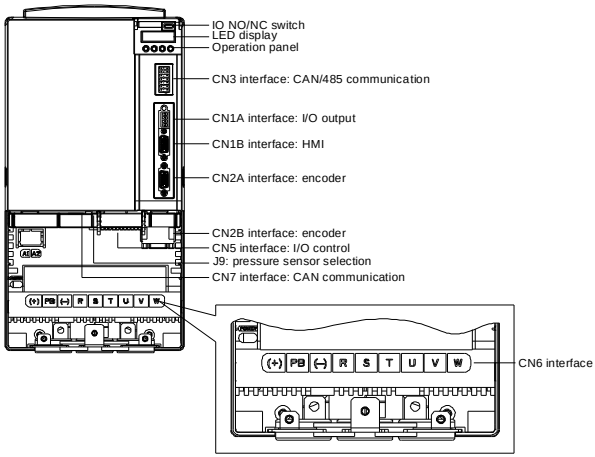
4.2 Switch, contactor, and cable selection

Drive model	Power incoming circuit breaker switch (A)	AC contactor or AC3 rated working current (A)	Main circuit				Control circuit
			Recommended cable size (mm^2)		Connectable cable size (mm^2)		Recommended cable size (mm^2)
			R/S/T U/V/W	PE	R/S/T U/V/W	PE	
MH860-T018SF7	40	25	4	4	4–6	4–6	1.5
MH860-T025SF7	50	40	6	6	6–10	6–10	1.5
MH860-T032SF7	60	40	10	10	10–16	10–16	1.5
MH860-T038SF7	80	50	10	10	10–16	10–16	1.5
MH860-T043SF7	100	65	10	10	10–16	10–16	1.5
MH860-T060SF7	125	80	16	16	16–25	16–25	1.5
MH860-T070SF7	160	95	16	16	16–25	16–25	1.5
MH860-T092SF7	160	115	25	16	25–50	16–25	1.5
MH860-T115SF7	200	150	35	16	35–50	16–25	1.5
MH860-T150SF7	250	185	35	16	35–50	16–25	1.5
MH860-T180SF7	315	225	50	25	35–90	25–50	1.5
MH860-T215SF7	315	260	70	35	50–90	35–50	1.5
MH860-T060SY7	125	80	16	16	16–25	16–25	1.5
MH860-T092SY7	160	115	25	16	25–50	16–25	1.5
MH860-T115SY7	200	150	35	16	35–50	16–25	1.5
MH860-T150SY7	250	185	35	16	35–50	16–25	1.5
MH860-T170SY7	315	225	35	25	35–50	25–50	1.5

The recommended cable for the main circuit can be used at an ambient temperature of 40°C or less. If the ambient temperature is greater than the conditions, it is recommended to use the cable of a higher model. It is recommended to use cables with insulation of at least 500V.

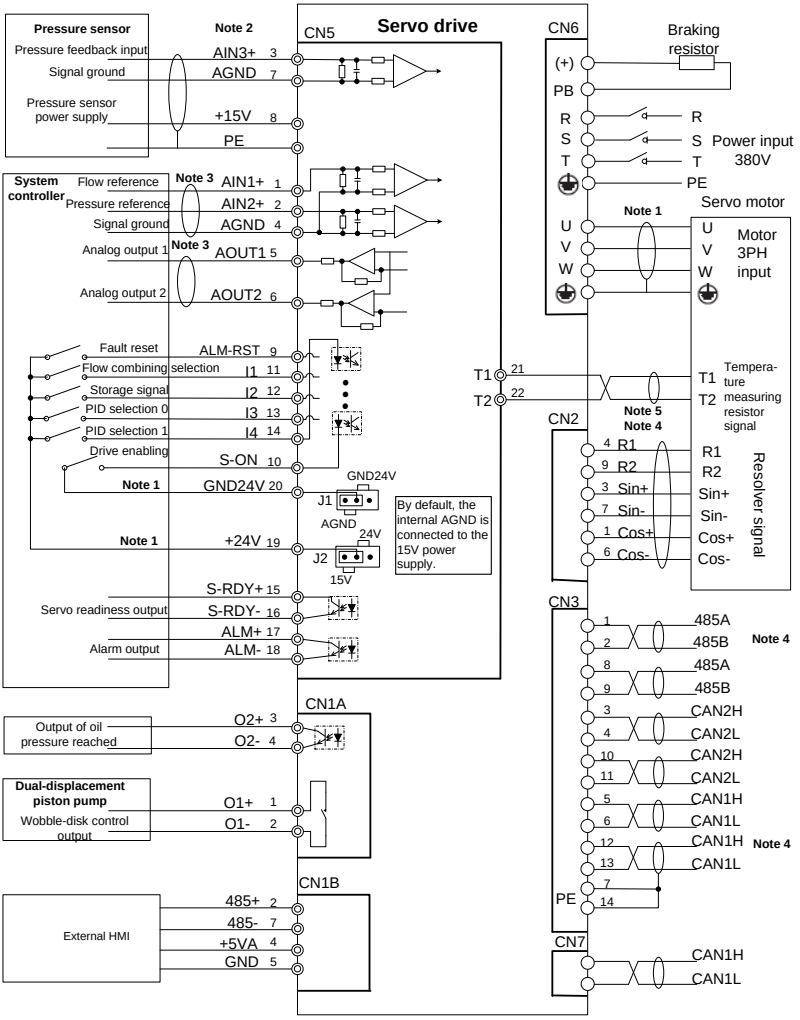
The braking resistor is self-wired. If you want to extend it, the extension wire diameter is not lower than the original resistor wire diameter.

4.3 Terminal layout

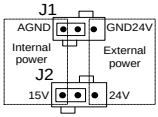


Terminal	Function
CN1A	I/O output signal connector
CN1B	External HMI connector
CN2A	Encoder (or resolver) connector
CN2B	Encoder (or resolver) connector
CN3	CAN/RS485 connector
CN5	I/O control signal connector
CN6	Main circuit terminal
CN7	CAN communication terminal

4.4 Standard wiring



Note 1: In this wiring diagram, digital input signal uses the internal 15V power supply of the drive by default. If you want to use an external power supply, connect J2 to the GND24V side and connect J2 to the 24V side to perform the power supply switchover.



Note 2: The pressure sensor of the drive uses 15V as the power supply, and the accepted pressure signal is the voltage signal of 0–10V or 1–5V, which can be set through J9 on the control board. For details, see sections 4.5 Jumper function and 4.7.1 Input and output signal connector (CN5).

Note 3: To prevent the drive from being affected by interference signal, it is recommended to use shielded cables for all analog signal drive cables and motor three-phase input cables, with the shield layer grounded.

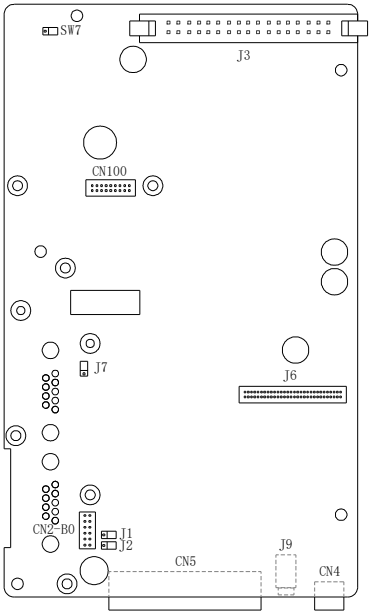
Note 4: The resolver cable and communication cable must use shielded twisted pair cables, with the shield layer grounded. Configure a terminal matching resistor at both the first and last ends of the communication cable. The CAN communication signal connector of the drive has been configured with a built-in 220Ω terminal resistor. The RS485 communication signal connector of the drive has been configured with a built-in 1kΩ terminal resistor.

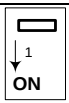
Note 5: You can set motor temperature sensor parameters to determine whether to use motor temperature sensors KTY84 or Pt1000.

Note 6: The AGND terminal can be connected to PE directly or through the resistor and capacitor by configuring jumper J7 on the control board. The AGND terminal is directly connected to PE by default.

Note 7: When using the analog and digital output ports, ensure that the output load resistance is large enough so that the output current is less than the designated value.

4.5 Jumper function



No.	Position	Function	Position	Function
J1		Enables the drive internal power supply to drive digital input signal.		Enables the drive external power supply to drive digital input signal.
J2		Enables the drive internal power supply to drive digital input signal.		Enables the drive external power supply to drive digital input signal.
J7		Enables the AGND terminal to connect to PE directly.		Enables the AGND terminal to connect to PE through the resistor and capacitor.
J9		Enables the pressure sensor to accept the output voltage of 0–10V.		Enables the pressure sensor to accept the output voltage of 1–5V.
SW7		When the switch is on end A, the fault alarm output IO is normally opened by default.		When the switch is on end B, the fault alarm output IO is normally closed by default.

4.6 Wiring of main circuit

4.6.1 Main circuit terminals

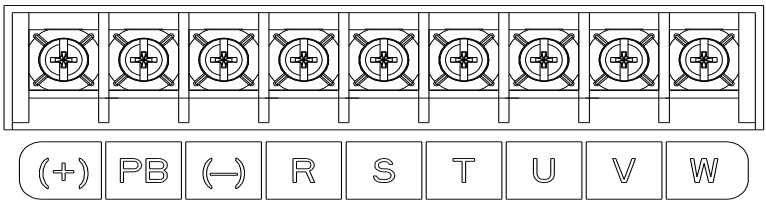


Figure 4-1 Terminal diagram of the 7.5kW–22kW main circuit

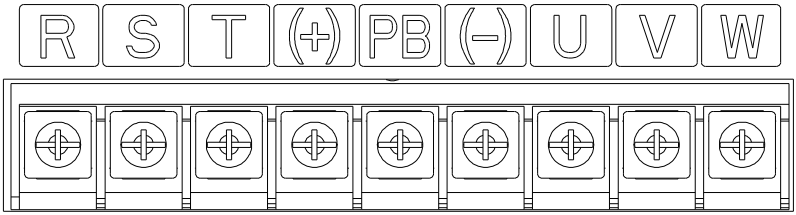


Figure 4-2 Terminal diagram of the 30kW–37kW main circuit

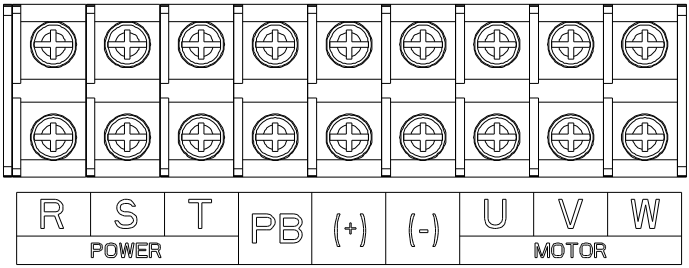


Figure 4-3 Terminal diagram of the 45kW–55kW main circuit

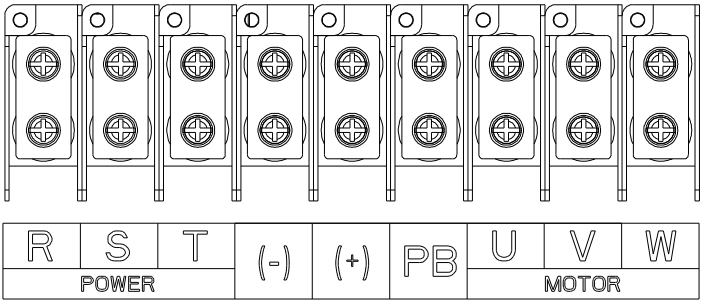


Figure 4-4 Terminal diagram of the 75kW–90kW main circuit

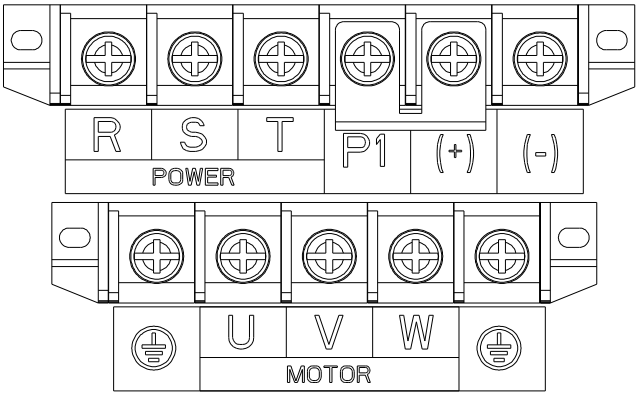


Figure 4-5 Terminal diagram of the 110kW main circuit

Terminal	Terminal symbol	Function
Main circuit power input terminals	R, S, T	AC380V(-15%)–440V(+10%) 47Hz–63Hz
Motor connection terminals	U, V, W	Connect to the motor.
Grounding terminal	⏚	Connects to the power grounding terminal and motor grounding terminal for grounding.
External braking resistor connection terminal (PB terminal available for the model with the rated current of 180A and lower)	(+), PB	An external braking resistor is connected between (+) and PB.
DC reactor terminal (P1 terminal available for the model with the rated current of 215A)	P1, (+)	P1 and (+) connect to external DC reactor terminals.

4.6.2 Resolver signal connectors (CN2A and CN2B)

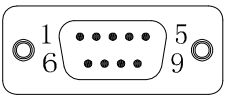


Figure 4-6 Resolver DB9 terminal

Signal name	Symbol	Pin	Function
Resolver sine input + Resolver sine input -	Sin+ Sin-	CN2A-3, CN2B-3 CN2A-7, CN2B-7	Resolver sine feedback signal
Resolver cosine input + Resolver cosine input -	Cos+ Cos-	CN2A-1, CN2B-1 CN2A-6, CN2B-6	Resolver cosine feedback signal
Excitation signal + Excitation signal -	R1 R2	CN2A-4, CN2B-4 CN2A-9, CN2B-9	Resolver excitation signal

4.6.3 Motor power cable and temperature measuring resistor terminals

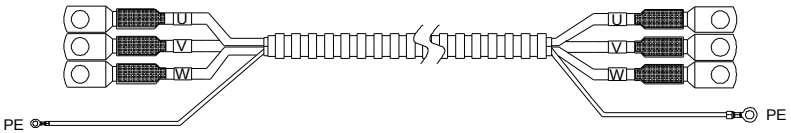


Figure 4-7 Motor power cable

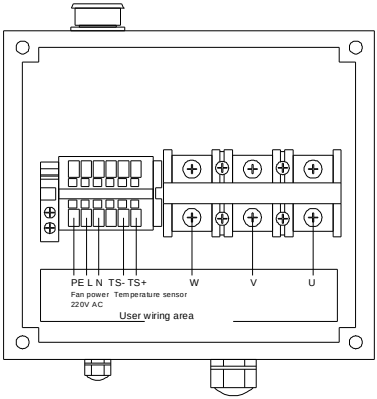
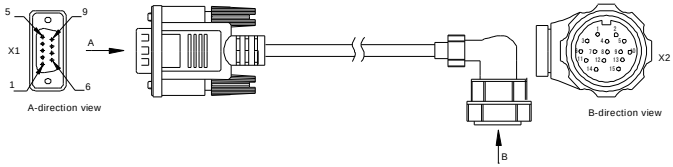


Figure 4-8 Motor wiring terminals

No.	Item	Definition
1	U	Motor three-phase inputs
2	V	
3	W	
4	TS+	Temperature measuring resistor
5	TS-	
6	N	Fan power supply, 220V AC
7	L	
9	PE	Grounding

4.6.4 Motor resolver connection cable and terminals



Wiring mapping			
Signal	**X1**	**X2**	**Core wire structure**
R1	4	2	Twisted pair
R2	9	3	
Sin+	3	4	Twisted pair
Sin-	7	5	
Cos+	1	6	Twisted pair
Cos-	6	7	
PE	Housing	1 (Housing)	Woven

4.6.5 Typical wiring examples of main circuit

Note	
	1. Only one wire can be inserted into each wire insertion port of the connector.
	2. The motor three-phase cable must be a shielded cable, of which one end connects to the drive ground wire, and the other end connects to the motor connector ground wire.
	3. The screws need to be fastened properly to ensure a smooth connection.

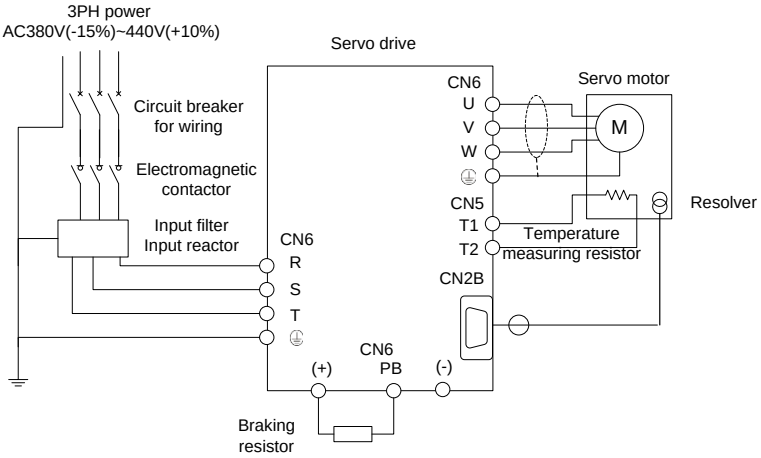


Figure 4-9 Wiring diagram of =<90kW main circuit

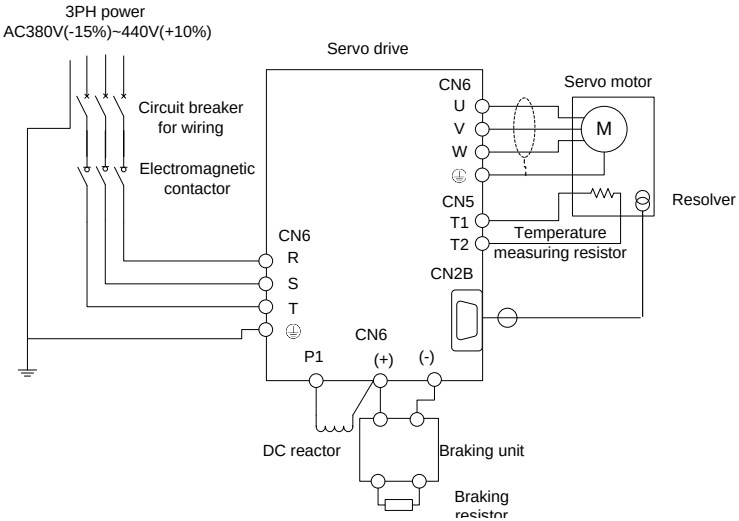


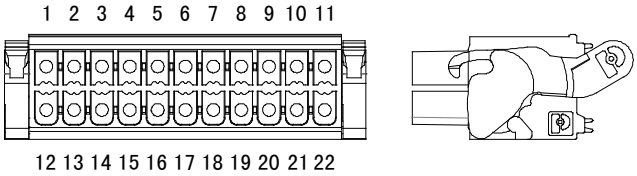
Figure 4-10 Wiring diagram of >=110kW main circuit

4.6.6 Wiring procedure for main circuit terminal CN6

1. Connect the input power cable to the drive power input terminals R, S, and T. Connect the ground conductor of the input power cable to any of drive ground screws and fasten the screw properly to ensure a smooth connection.
2. Connect the motor three-phase input terminals W, V and U to the motor connection terminals W, V and U respectively, and fasten the screws properly to ensure a smooth connection. Connect the motor ground terminal to any of the drive ground screws (screen printed with PE). Connect the motor temperature measuring resistor terminals to the drive terminals T1 and T2. Connect the motor resolver connection terminal to the drive connector CN2, and fasten the screws.
3. Connect the two wiring terminals of braking resistor to the drive terminals U+ and PB respectively, and fasten the screws properly to ensure a smooth connection.

4.7 Input and output signal wiring

4.7.1 Input and output signal connector (CN5)



CN5 connector definition

Signal name	Symbol	Pin	Function
Input + of analog reference 1	AIN1+	CN5-1	Flow command input: Input gains can be changed through the LED panel or HMI.
Input + of analog reference 2	AIN2+	CN5-2	Pressure command input: Input gains can be changed through the LED panel or HMI.
Feedback input +	AIN3+	CN5-3	Pressure feedback input: Input gains can be changed through the LED panel or HMI.
Analog output 1	AOUT1	CN5-5	Monitoring output. Internal parameter output can selected through the LED panel or HMI.
Analog output 2	AOUT2	CN5-6	
Pressure sensor power supply	+15V	CN5-8	Voltage: +15VDC, ±5% (in full scale range), output < 100mA at 25°C
Analog ground	AGND	CN5-4 CN5-7	Analog signal ground terminal
Fault reset signal	ALM-RST	CN5-9	Releasing the servo alarm status
Enabling the drive	S-ON	CN5-10	Unlocking the gate of drive to switch the motor to enter the energized state Note: Active low is applied.
Digital input 1 Digital input 2	I1 I2	CN5-11 CN5-12	I1: Selection of splitting or combining flow (used with the multi-pump distribution work function) Splitting flow for high level, while combing flow for low level. I2: Storage signal input (used with the electronic back pressure function) A high-level injection molding machine works in the storage state, while a low-level injection molding machine works in another state. Motor rotation direction signal (used with the node flow loop) Forward direction for low level, while reverse direction for high level.
Digital input 3	I3	CN5-13	Stepped PID parameter selection for single-pump pressure (4 steps)
Digital input 4	I4	CN5-14	I4 I3 KP No. KI No. KD No. low low 0 0 0 low high 1 1 1 high low 2 2 2 high high 3 3 3 Stepped PID parameter selection for multi-pump pressure control (4 steps) I4 I3 KP No. KI No. KD No. low low 0 0 0 low high 1 1 1 high low 2 2 2 high high 3 3 3

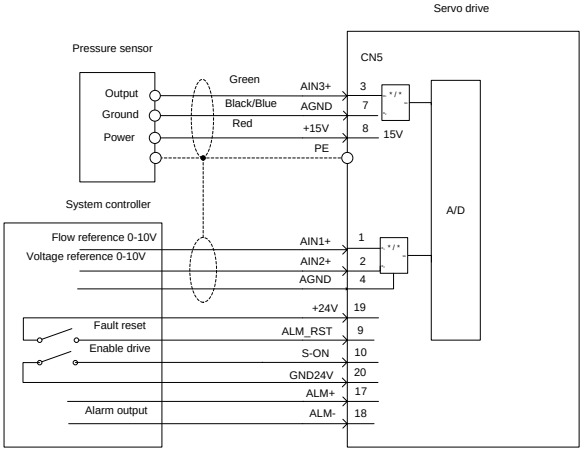
Signal name	Symbol	Pin	Function
Servo readiness + Servo readiness -	S-RDY+ S-RDY-	CN5-15 CN5-16	If the main circuit is powered on without alarm output, the drive is on when the drive enabling end is at low level.
Alarm output + Alarm output -	ALM+ ALM-	CN5-17 CN5-18	The effective state (normally open or normally closed) is switched through SW7. If an exception is detected, the output signal state is reversed. Max. output voltage: DC30V. Max. output current: DC50mA
Control power input for digital signal	+24V	CN5-19	User-supplied +24V power. Valid voltage range: +8V – +25V Note: For details how to switch to an external power supply, see section 4.5.
Digital signal ground	GND24V	CN5-20	Digital signal ground terminal Note: For details how to switch to an external power supply, see section 4.5.
Motor temperature sensor 1	T1	CN5-21	The motor temperature sensor terminals (T1, T2) do not distinguish the positive or negative pole.
Motor temperature sensor 2	T2	CN5-22	The drive supports the motor temperature sensors (or resistors) of the KTY84 and PT1000 types. You can change the motor temperature sensor type through the LED panel or HMI. Then the hardware circuit automatically selects the corresponding temperature sensor detection circuit.

4.7.2 I/O output signal connector (CN1A)

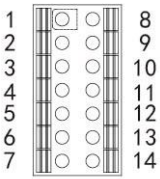
CN1A connector definition

Signal name	Symbol	Pin	Function
Digital output 1	O1+ O1-	CN1A-1 CN1A-2	Wobble-disk output signal (used with the dual-displacement pump wobble-disk control function) On for small flow, while off for heavy flow. Relay output contact capacity: 3A/250VAC, 1A/30VDC
Digital output 2	O2+ O2-	CN1A-3 CN1A-4	Oil pressure reaching output: It is on when the feedback pressure reaches a certain percentage of the given pressure. This percentage can be set. Optocoupler output. Max. voltage: DC30V. Max. current: DC50mA

4.7.3 Typical control signal wiring examples



4.8 CAN/RS485 connector terminal (CN3)



CN3 connector definition

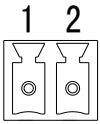
The drive carries two CAN communication interfaces and one RS485 communication interface, which supports the standard Modbus RTU communication protocol. The RS485 communication end has been configured with a built-in 1kΩ terminal resistor.

CAN communication port 1 supports the CANopen communication protocol and internally connects to a 220Ω terminal resistor.

CAN communication port 2 is used to connect multiple drives in multi-pump parallel connection system, also used as the CAN communication interface for INVT PC debugging software SCM. It internally connects to a 220Ω terminal resistor.

Signal name	Symbol	Pin	Function
RS485 communication interface	RS485_A RS485_B	CN3-1, 8 CN3-2, 9	Semi-duplex. Supporting 9600bps, 19200bps, 38400 bps, and 57600bps (19200bps by default)
CAN communication port 1	CAN1H CAN1L	CN3-3, 10 CN3-4, 11	Standard CAN protocol signal, using the optocoupler for isolation, supporting direct access to CAN-BUS
CAN communication port 2	CAN2H CAN2L	CN3-5, 12 CN3-6, 13	
Shield ground	PE	CN3-7, 14	Connecting to the housing

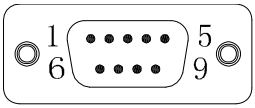
4.9 CAN connector terminal (CN7)



CN7 (CAN communication port 1) supports the standard CANopen communication protocol and internally connects to a 10kΩ terminal resistor.

Signal name	Symbol	Pin	Function
CAN communication port 1	CAN1H CAN1L	CN7-1 CN7-2	Standard CAN protocol signal, using the optocoupler for isolation, supporting direct access to CAN-BUS

4.10 Serial communication signal connector (CN1B)



The serial communication signal connector is the public connector of the external HMI. If you use the external HMI for debugging, insert the connection cable of the HMI.

Signal name	Symbol	Pin	Function
RS485 communication interface	RS485_A RS485_B	CN1B-7 CN1B-2	Semi-duplex. Max. communication rate: 57600bits/s (default value: 19200bits/s)
Communication power supply	+5VA	CN1B-4, 8	Max. output current: 200mA. Accuracy: ±5%
GND	GND_5VA	CN1B-5, 9	Communication power ground

4.11 Interface circuit

4.11.1 Analog input circuit interface

The analog input circuit is described as follows:

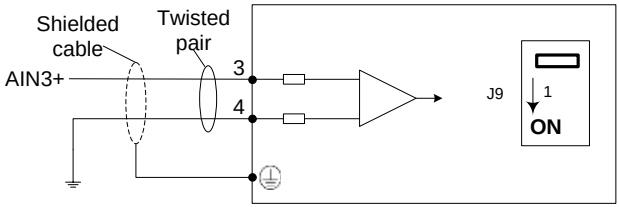
1. For pin 1 (flow reference) and pin 2 (pressure reference) of CN5 connector:

Input resistance for voltage input: about 30kΩ; max. allowed voltage: 15V

2. Pin 3 (feedback input) of CN5 connector

The analog signal is the oil pressure feedback signal. You can use J9 to select whether the pressure sensor output is 0–10V or 1–5V. It is 1–5V at ON, while 0–10V at OFF. Default: 0–10V

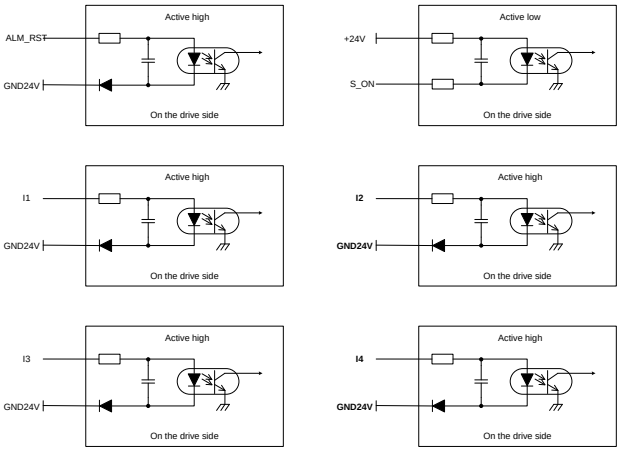
Input resistance: about 90kΩ. Max. allowed voltage: 15V



4.11.2 Digital input circuit interface

Pins 9 to 14 of CN5 connector are described as follows:

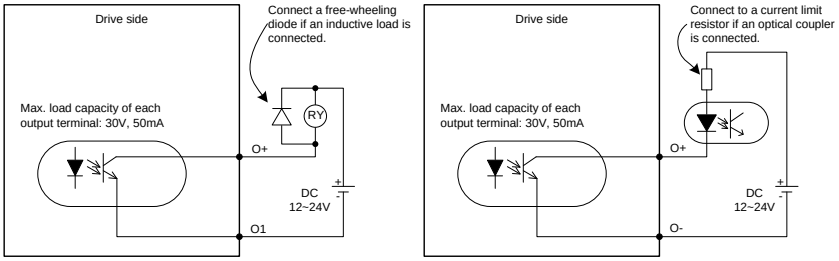
By default, pin 10 S-ON is an active low circuit, while the others are active high circuits. If you need active low circuits, inform us to modify. The circuits are as follows.



4.11.3 Digital output circuit interface

1. The optocoupler output circuit is described as follows:

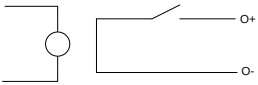
For pins 15 to 18 of CN5 connector and pins 3 to 4 of CN1A connector:
Digital output signals (S_RDY, ALM, O1, O2) are output from the optocoupler collector. Use the optocoupler circuit, relay circuit, or bus receiver circuit to receive the signals. The following shows the interface circuits.



- Max. voltage: DC30V
- Max. current: DC50mA

2. The relay output circuit is described as follows:

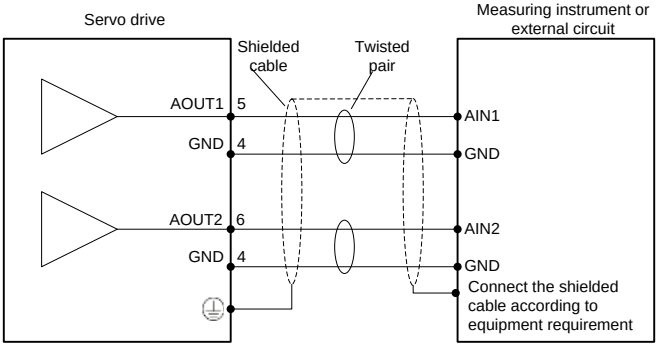
For pins 1 to 2 of CN1A connector:
Digital output signal (O1) is output from the relay. The following shows the interface circuit



- Contact capacity: 3A/250VAC, 1A/30VDC

3. The analog output circuit is described as follows:

For pins 5 to 6 of CN5 connector:
Analog output signals (AOUT1, AOUT2) are output from the OPA, with which the AGND makes up an output circuit. You can select internal parameter output through the LED panel, HMI, or SCM. By default, AOUT1 is pressure output, while AOUT2 is motor speed output. The following shows the interface circuit.

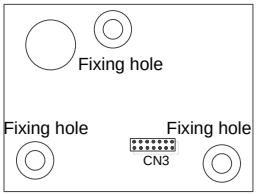


- Output accuracy: 10-bit D/A
- Voltage range: 0–10V
- Max. current: DC10mA

4.12 Expansion card

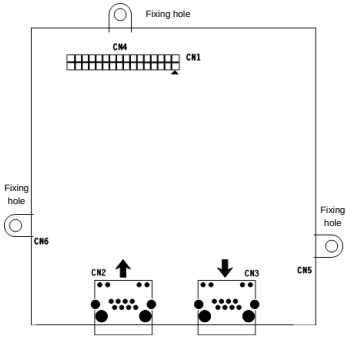
4.12.1 CAN communication card

The drive can connect to a high-speed CANopen communication network by connecting the CN3 terminal on the CAN communication card to the CN100 terminal on the main control board, implementing field bus control. The following shows the CAN communication card.



4.12.2 EtherCAT communication card

The drive can implement EtherCAT communication by connecting the CN1 terminal on the EtherCAT communication card to the J6 terminal on the control board. The drive uses the RJ45 terminal interfaces CN2 and CN3 to communicate external equipment. The following shows the EtherCAT communication card.

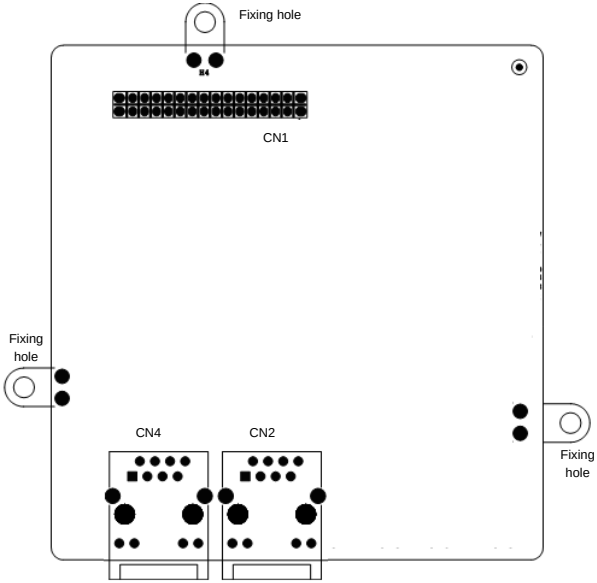


RJ45 pins are described as follows:

Pin	Signal name	Symbol	Signal direction
1	Send data +	TD+	Output
2	Send data -	TD-	Output
3	Receive data +	RD+	Input
4	-	-	-
5	-	-	-
6	Receive data -	RD-	Input
7	-	-	-
8	-	-	-
9	-	-	-

4.12.3 PROFINET communication card

The drive can implement PROFINET communication by connecting the CN1 terminal on the PROFINET communication card to the J6 terminal on the control board. The drive uses the RJ45 terminal interfaces CN2 and CN4 to communicate external equipment. The following shows the PROFINET communication card.

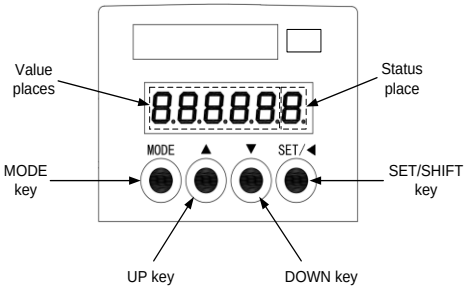


RJ45 pins are described as follows:

Pin	Signal name	Symbol	Signal direction
1	Send data +	TD+	Output
2	Send data -	TD-	Output
3	Receive data +	RD+	Input
4	-	-	-
5	-	-	-
6	Receive data -	RD-	Input
7	-	-	-
8	-	-	-
9	-	-	-

5 Operating through the LED panel

5.1 LED panel description



Key	Description	Key	Description
MODE	Used to switch over menu items or cancel operations.	▲	Upward key.
SET/◀	Used for setup when pressed and held (about 0.6s). Used to move leftward when pressed short.	▼	Downward key.

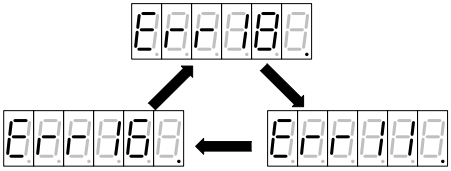
LED display description:

Display	Means	Display	Means	Display	Means	Display	Means	Display	Means	Display	Means
0	0	1	1	2	2	3	3	4	4	5	5
6	6	7	7	8	8	9	9	A	A	b	b
C	C	d	d	E	E	F	F	G	G	h	h
I	I	J	J	K	K	L	L	M	M	N	N
o	O	P	P	q	q	r	R	S	S	T	T
U	U	V	V	W	W	X	X	Y	Y	Z	Z
-	-	-	-	-	-	-	-	-	-	-	-

When the drive is powered on, the LED turns on, with the first 5 digits indicating the value and the last digit indicating the system status. The LED digital value displays the motor rotation speed (rpm) by default, accurate to the ones place.

If a fault occurs during power-on or running, the decimal point on the LED status places blinks (at an interval of 1s) and the LED value places display the fault code. The fault code consists of a fault ID (the first three digits on the digital tube from left to right display Err) and a fault code number (the last two digits on the digital tube from left to right display two digits). When a fault occurs, the fault code is displayed in a blinking mode (at an interval of 1s).

If there are multiple faults that occur at the same time, multiple fault codes are displayed in a repeated cycle.

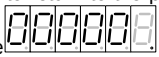


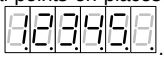
Keypad unlocking:

A. In the speed or fault display state, if you want to perform a keyboard operation, you need to press and hold the ▲▼ keys together for 1 second. When the LED value places display ULOCK, the system keyboard is unlocked, after which you can perform keyboard operations.

If the drive does not have a fault at this time, the drive keyboard enters the shortcut mode. If the drive is faulty, press MODE to enter the shortcut mode.

At any moment of performing keyboard operations, you can press and hold ▲▼ together for 1 second, and the LED value places display LOCK, indicating that the system keyboard is locked, and the LED value places return to the speed or fault display status.

B. You can either enter the password for unlocking, in speed or fault display state. Press the MODE key to enter the password input prompt interface  (you can press the MODE key to return to the previous interface), press the SET key to enter the password input interface  (you can press the MODE key to return to the previous interface), during which you can press the ◀ key to move the blinking place, and press the ▲ or ▼ key to change the value of the blinking place. After setting the password, press the SET key. If the password is correct, the shortcut mode is entered. If the password is incorrect, the password error notification interface  is displayed, which lasts for a few seconds, and then the the password input interface is displayed. The initial password is 0.

When the absolute value of a negative number is less than 9999, the five-digit LED cannot display "-" (negative sign), but the decimal points on places 1, 2, 3, and 4 (from left to right) are on, which indicate a negative number  .

5.1.1 LED status place

The last place on the LED tube displays the actual run status of the servo system.

No.	Display	Cycle	Control status
1		1s	Electronic
2		0s	Electricity
3		0s	Ready to run
4		1s	Run
5		1s	Fault
6		2s	Diagnosis
7		2s	Factory test

5.2 LED panel functions

5.2.1 Keypad operation mode

The drive provides six keypad operation modes, which can be switched over through the MODE key after the keypad is unlocked.

Shortcut mode: used to display key parameters

Quick setup mode: used to set key parameters and debug the motor

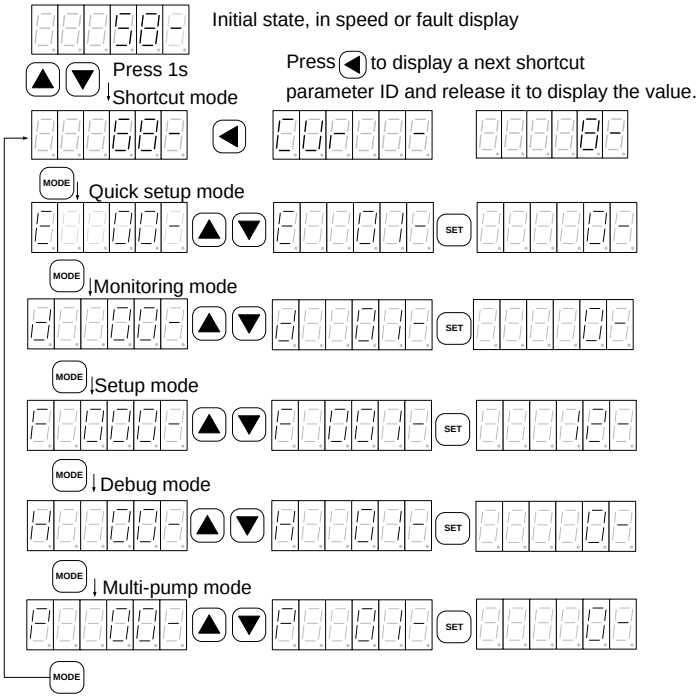
Monitoring mode: used to display status parameters

Setup mode: used to set basic parameters

Debug mode: used to debug the motor and save parameters

Multi-pump mode: used to set multi-pump parallel connection parameters

Operation flowchart:



5.2.2 Shortcut mode

In shortcut mode, you can press the key to quickly observe the important parameters of drive. In lock state, if you press and hold the key for 1s to enter the shortcut mode, the LED displays the values of selected parameters. If you press the key, the LED displays the next parameter ID. If you release the key, the LED displays the parameter value.

Note: In shortcut mode, if no key acts within 1min, the speed or fault display interface automatically appears.

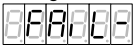
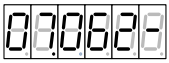
Parameters displayed in shortcut mode:

ID	DEFINITION	RANGE	UNIT
SPD	Speed feedback	[-6000,6000]	rpm
CUR	Current feedback	[0,900.0]	A
RES	Resolver feedback	[0,4096]	-
PRS	Pressure feedback	[0,500]	bar
PIDS	PID step no.	[0,3]	-

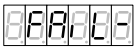
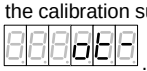
5.2.3 Quick setup mode

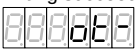
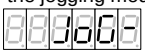
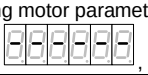
If you press the key to select the quick setup mode, the LED value places display "E--xx",

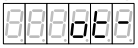
in which "xx" indicates a parameter ID. You can press the ▲ or ▼ key to select a parameter ID. When you press and hold the SET key and then release it, the selection is completed. Then the LED value places display the parameter value. If you want to modify a parameter, you can press the ◀ key to move the blinking place and press the ▲ or ▼ key to change the value of the blinking place. After the value is modified, press and hold the SET key and release it. Then the modification is automatically saved and blinking stops. If you press the SET or ▲▼ key again at this time, you can modify the parameter again. The places which can be modified blink. Press the MODE key to exit.

Code	Definition	Range	Default	Unit
E00	Enabling run Press and hold the SET key to enter the run enabling mode. The LED displays the ON or OFF state of run enabling. Press and hold the SET key and then release it to switch the state.	OFF: Disable ON: Enable	Related to IO level enabling of drive	-
E01	Motor model selection After the access, the LED displays  . Select the sequence number at the first two places, and select the motor model code at the last three places. Press the ▲ or ▼ key to select the required motor. Press and hold the SET key and then release it. Then the LED displays  for you to set the motor. If the setting succeeds, the LED displays the selected motor model. If the setting failed, the LED displays  .	For details, see the motor model table.	K132F18C18P 	-
E02	Pump model selection After the access, the LED displays  . Select the sequence number at the first two places, and select the oil pump displacement at the last three places. Press the ▲ or ▼ key to select the required pump. Press and hold the SET key and then release it. Then the LED displays  for you to set the pump. If the setting succeeds, the LED displays the selected pump model. If the setting failed, the LED displays  .	For details, see the oil pump model table.	PUMP 100 mL/r 	-

Code	Definition	Range	Default	Unit
E03	After the access to the pressure feedback zero calibration, the LED displays the analog voltage feedback of pressure sensor. Press and hold the SET key and release it for calibration. Then the LED displays  . If the calibration succeeds, the LED displays  . If the calibration failed, the LED displays  .	-	-	-
E04	Measuring the initial angle The initial angle can be measured only when the run enabling state is OFF. Press and hold the SET key and then release it to enter the initial angle measuring menu. Then the LED displays the previous resolver offset. Press and hold the SET key and then release it to measure the initial angle. If the LED displays  , measuring is being performed. If the measuring is completed, the LED displayed the actual measured offset. If the measuring failed, the LED displays  . During measuring, you can press the MODE key to exit.	-	-	-
E05	Full pressure scale range This value also determines the max. pressure. In addition, it also adjusts the pressure reference gain so that when the pressure reference input is 9.99V, the pressure reference corresponds to the recently set pressure full scale range value. After the access, the LED displays the recently set full pressure scale range value. Press the ◀▲▼ key to change to the required value. Press and hold the SET key and then release it to confirm the value.	[1,500]	175	bar
E06	Full flow scale range This value also determines the max. flow. In addition, it also adjusts the flow reference gain so that when the flow reference input is 9.99V, the flow reference corresponds to the recently set flow full scale range value. After the access, the LED displays the recently set full flow scale range value. Press the ▲▼ key to change to the required value. Press	[1,2400]	200	L/min

Code	Definition	Range	Default	Unit
	and hold the SET key and then release it to confirm the value.			
E07	Pressure zero calibration Press and hold the SET key and then release it for access. Then the LED displays the pressure reference analog value. Press and hold the SET key and then release it for zero calibration. Then the LED displays  . If the calibration succeeds, the LED displays  . If the calibration failed, the LED displays  .	Analog voltage range [0.00,9.99]	-	V
E08	Full pressure scale range calibration Press and hold the SET key and then release it for access. Then the LED displays the actual pressure reference analog value. After confirming the value, press and hold the SET key and then release it for zero calibration. Then the LED displays  . If the calibration succeeds, the LED displays  . If the calibration failed, the LED displays  .	Analog voltage range [0.00,9.99]	-	V
E09	Flow zero calibration Press and hold the SET key and then release it for access. Then the LED displays the flow reference analog value. Press and hold the SET key and then release it for zero calibration. Then the LED displays  . If the calibration succeeds, the LED displays  . If the calibration failed, the LED displays  .	Analog voltage range [0.00,9.99]	-	V
E10	Full flow scale range calibration Press and hold the SET key and then release it for access. Then the LED displays the actual flow reference analog value. After confirming the value, press and hold the SET key and then release it for zero calibration.	Analog voltage range [0.00,9.99]	-	V

Code	Definition	Range	Default	Unit
	Then the LED displays  . If the calibration succeeds, the LED displays  . If the calibration failed, the LED displays  .			
E11	Writing parameters Press and hold the SET key and then release it for access. Then the LED displays  . Press and hold the SET key and then release it to start parameter writing. Then the LED displays  . If the writing succeeds, the LED displays  . If the writing failed, the LED displays  .	-	-	-
E12	Jogging Press and hold the SET key and then release it to enter the jogging mode. Then the LED displays  , prompting you to jog. Press the ▲ or ▼ key to run the motor forward or reversely. Press the MODE key to exit the jogging mode and return to the "Exx" menu.	▲: Jog forward ▼: Jog reversely	-	-
E13	Enabling diagnosis Press and hold the SET key to enter the diagnosis enabling mode. The LED displays  or  . Press and hold the SET key and then release it to switch the state.	OFF: Disable ON: Enable	OFF	-
E14	Motor parameter autotuning Diagnosis enabling takes effect only when motor parameter autotuning is enabled. Press and hold the SET key and then release it to enter the motor parameter autotuning menu. Then the LED displays "0". After selecting a parameter autotuning mode, press and hold the SET key and then release it to start autotuning motor parameters. Then the LED displays  , which indicates	0: Disable 1: Dynamic 2: Static	0: Disable	-

Code	Definition	Range	Default	Unit
	autotuning. If autotuning succeeds, the LED displays  . If autotuning failed, the LED displays  . During autotuning, you can press the MODE key to exit and return to the "Exx" menu.			
E15	Pressure sensor model selection Press and hold the SET key and then release it for access. Select a pressure sensor model. Press and hold the SET key and then release it for setting. You can press the MODE key to exit and return to the "Exx" menu.	5V: 1–5V, 0–200bar sensor 10V: 0–10V, 0–250bar sensor 400bar: 0–10V, 0–400bar sensor	10V	-
E16	Pressure proportional gain Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,32767]	13000	-
E17	Pressure integral gain Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,32767]	100	-
E18	Speed proportional gain 0 Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,32767]	7000	-
E19	Speed integral gain 0 Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,32767]	170	-
E20	Speed proportional torque boost	[0,1000]	0	%

Code	Definition	Range	Default	Unit
	Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.			
E21	Speed integral torque boost Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,1000]	0	%
E22	Max. speed for pump reverse run Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,-6000]	-300	Rpm
E23	Reverse torque upper limit Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,100]	100	%
E24	Overpressure protection threshold Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	[0,500]	195	bar
E25	Pump stuck detection Press and hold the SET key and then release it for access. Press the ▲ or ▼ key to set parameters. Press and hold the SET key and then release it for setup. You can press the MODE key to exit and return to the "Exx" menu.	0: Disable 1: Enable	1: Enable	-

5.2.4 Monitoring mode

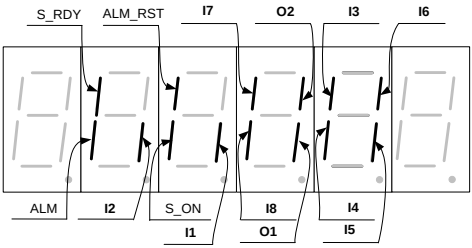
If you press the MODE key to select the monitoring mode, the value places on the LED display

"d--xx", in which "xx" indicates a parameter ID. You can press the ▲ or ▼ key to select a parameter ID. If you press the SET key after the selection, the LED value places display the parameter value. Then you can press the MODE key to exit.

Note: In monitoring mode, if no key acts within 1min, the speed or fault display interface automatically appears.

Parameters in monitoring mode:

Code	Item	Range	Unit
d00	Flow reference	[0,2400.0]	L/min
d01	Pressure reference	[0,500.0]	bar
d02	System fault	System fault alarm(s)	-
d03	Motor current	[0,900.0] (Valid value)	A
d04	AC voltage	[0,500]	Vrms
d05	DC voltage	[0,800]	V
d06	Torque limit	[0,1800]	Nm
d07	Speed feedback	[-6000,6000]	Rpm
d08	Resolver feedback	[0,32767]	-
d09	Pressure feedback	[0,500]	bar
d10	Torque feedback	[-1800,1800]	Nm
d11	Run mode	3: Speed mode 4: Process mode	-
d12	Motor temperature	[-52,244]	°C
d13	Drive temperature	[-46,244]	°C
d14	Ambient temperature	[-18,114]	°C
d15	Machine information	[0,999]	-
d16	Software version (DSP)	-	-
d17	Panel software version	-	-
d18	System max. pressure	[0,500.0]	bar
d19	System max. flow	[0,2400.0]	L/min
d20	Power	[0.00,327.67]	kW
d21	Combining type	0: Single pump. 1: Hybrid. 2: Multiple pumps. 3: Multiple modes. 4: Communication with two models 5: Communication with four models	-
d22	Actual PID step	[0,3]	-

Code	Item	Range	Unit
d23	Flow reference voltage	[0,10.00]	V
d24	Pressure reference voltage	[0,10.00]	V
d25	Pressure feedback voltage	[0,10.00]	V
d26	Output voltage	[-1000,1000]	V
d27	Digital input/output	 When the input signal is valid, the LED turns off. For example, when I1 has signal, the LED turns off; when I1 has no signal, the LED turns on (when S_ON input port indicator is on, it is high level). When the output signal is invalid, the LED turns on; when the output signal is valid, the LED turns off.	-
d28	Motor configuration table version	-	-
d29	Motor power	[-327.67,327.67]	kW
d30	Energy consumption for this run	[0,999.9]	kW.h
d31	Five low bits of accumulative power consumption	[0,999.9]	kW.h
d32	Five high bits of accumulative power consumption	[0,9999]	1000 kW.h
d33	Motor power factor	[0,1.00]	-

5.2.5 Setup mode

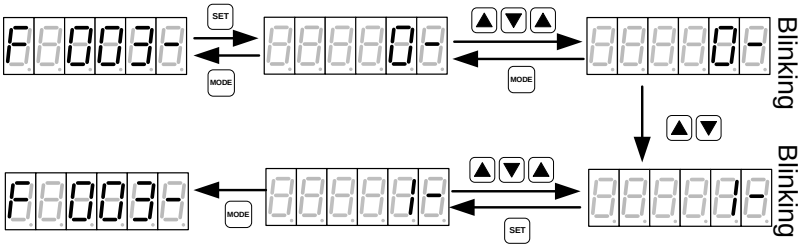
If you press the MODE key to select the setup mode, the LED value places display "F--xxx", in which "xxx" indicates a parameter ID. You can press the ▲ or ▼ key to select a

parameter ID. If you press and hold the SET key and then release it, the LED displays the parameter value. If you press the ◀ or ▲▼ key, the changeable places blink. If you want to modify a parameter, you can press the ◀ key to move the blinking place and press the ▲ or ▼ key to change the value of the blinking place. After the value is modified, press and hold the SET key and release it. Then the modification is automatically saved and blinking stops. If you press the ◀ or ▲▼ key again at this time, you can modify the parameter again. The places which can be modified blink. Press the MODE key to exit.

Note:

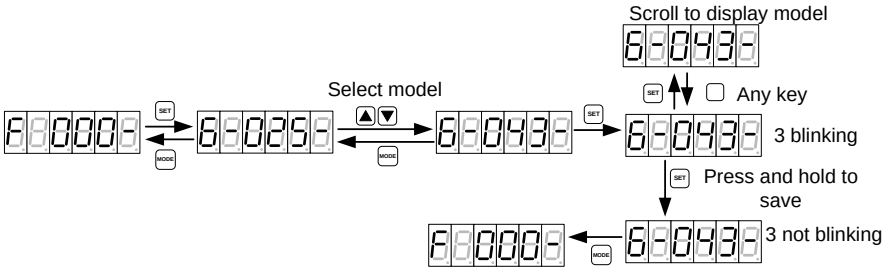
The drive, motor, and oil pump selection is different from other parameter selection.

Parameter setting flowchart:

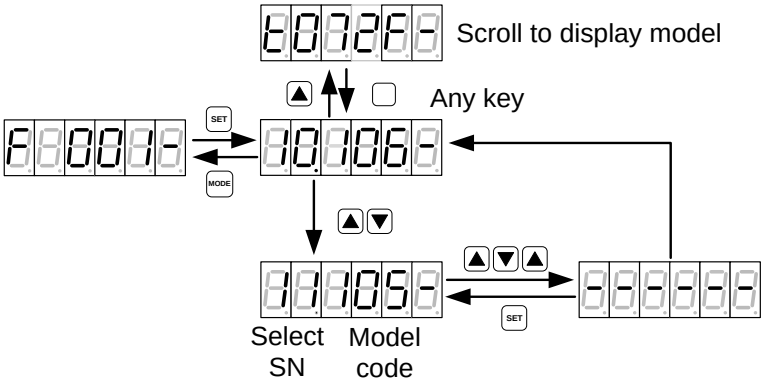


- For calibration commands, such as pressure linear zero calibration, after the setting: if the LED displays 0, the calibration succeeds; if the LED always displays 1, the calibration failed.

Drive setup flowchart:



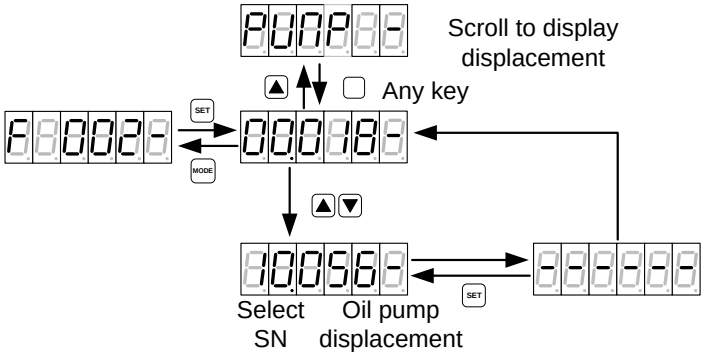
Motor setup flowchart:



Select SN: sequence number for a motor model

Model code: digital code for a motor model

Oil pump setup flowchart:



Select SN: sequence number for an oil pump model

- In setup mode, if no key acts within 1min, the speed or fault display interface automatically appears.

1) Drive model table:

Drive selection SN	LED display mode	Drive model	Drive model code
1	6–018	MH860-T018SF7	55
2	6–025	MH860-T025SF7	56
3	6–032	MH860-T032SF7	58
4	6–038	MH860-T038SF7	59
5	6–043	MH860-T043SF7	60
6	6–060	MH860-T060SF7	61

Drive selection SN	LED display mode	Drive model	Drive model code
		MH860-T060SY7	
7	6–070	MH860-T070SF7	62
8	6–092	MH860-T092SF7 MH860-T092SY7	63
9	6–115	MH860-T115SF7 MH860-T115SY7	64
10	6–150	MH860-T150SF7 MH860-T150SY7	65
11	6–170	MH860-T170SY7	66
12	6–180	MH860-T180SF7	67
13	6–215	MH860-T215SF7	68

2) Motor model table:

Motor selection SN	Motor model	Motor model code	Brand	Temperature winding resistor model
0	K038F18C18P	60	INVT	Pt1000
1	K036F20C18P	65	INVT	Pt1000
2	K058F18C18P	33	INVT	Pt1000
3	K060F18C18P	66	INVT	Pt1000
4	K072F18C18P	61	INVT	Pt1000
5	K091F15C18P	34	INVT	Pt1000
6	K111F15C18P	35	INVT	Pt1000
7	K132F18C18P	62	INVT	Pt1000
8	K187F18C25P	63	INVT	Pt1000
9	K208F15C25P	98	INVT	Pt1000
10	K072F20C18P	106	INVT	Pt1000
11	K148F18C25P	105	INVT	Pt1000
12	K210F20C25P	104	INVT	Pt1000
13	IH20-011C-4	210	INVT	Pt1000
14	IH20-013C-4	200	INVT	Pt1000
15	IH20-016E-4	201	INVT	Pt1000
16	IH20-018C-4	211	INVT	Pt1000
17	IH20-022E-4	212	INVT	Pt1000
18	IH20-025C-4	202	INVT	Pt1000
19	IH20-030E-4	203	INVT	Pt1000
20	IH26-035E-4	213	INVT	Pt1000
21	IH26-037C-4	204	INVT	Pt1000
22	IH26-041E-4	205	INVT	Pt1000
49	IH26-043C-4	206	INVT	Pt1000
50	IH26-048E-4	207	INVT	Pt1000
51	IH26-050E-4	208	INVT	Pt1000
52	IH26-056E-4	209	INVT	Pt1000
53	IH26-064E-4	214	INVT	Pt1000

Motor selection SN	Motor model	Motor model code	Brand	Temperature winding resistor model
55	K130F22C18P	90	INVT	Pt1000
56	K135F25C25P	91	INVT	Pt1000
57	K341F18C25P	30	INVT	Pt1000
58	K105F20C18P	31	INVT	Pt1000
59	K122F23C25P	92	INVT	Pt1000
60	K148F21C25P	93	INVT	Pt1000
61	K148F23C25P	94	INVT	Pt1000
62	K194F23C25P	95	INVT	Pt1000
63	K224F23C25P	96	INVT	Pt1000
64	K240F22C25P	97	INVT	Pt1000
65	K290F18C25P	99	INVT	Pt1000
66	K395F15C25P	100	INVT	Pt1000
67	MM18-5R5B47	101	INVT	Pt1000
68	MM18-4R4B47	102	INVT	Pt1000
69	K145F22C18P	103	INVT	Pt1000
70	K235F20C25P	78	INVT	Pt1000
72	K078F20C18P	79	INVT	Pt1000
73	K239F18C25P	83	INVT	Pt1000

3) Oil pump model table:

Oil pump selection SN	Oil pump model	Displacement mL/r	Default max. flow
0	PUMP 018 mL/r	18	40 L/min
1	PUMP 025 mL/r	25	55 L/min
2	PUMP 028 mL/r	28	62 L/min
3	PUMP 031 mL/r	31	68 L/min
4	PUMP 032 mL/r	32	70 L/min
5	PUMP 036 mL/r	36	79 L/min
6	PUMP 037 mL/r	37	81 L/min
7	PUMP 040 mL/r	40	88 L/min
8	PUMP 045 mL/r	45	99 L/min
9	PUMP 050 mL/r	50	110 L/min
10	PUMP 056 mL/r	56	123 L/min
11	PUMP 062 mL/r	62	136 L/min
12	PUMP 063 mL/r	63	139 L/min
13	PUMP 064 mL/r	64	141 L/min
14	PUMP 071 mL/r	71	142 L/min
15	PUMP 075 mL/r	75	150 L/min
16	PUMP 078 mL/r	78	156 L/min
17	PUMP 080 mL/r	80	160 L/min
18	PUMP 090 mL/r	90	180 L/min
19	PUMP 100 mL/r	100	200 L/min

Oil pump selection SN	Oil pump model	Displacement mL/r	Default max. flow
20	PUMP 101 mL/r	101	202 L/min
21	PUMP 120 mL/r	120	240 L/min
22	PUMP 125 mL/r	125	250 L/min
23	PUMP 130 mL/r	130	260 L/min
24	PUMP 140 mL/r	140	280 L/min
25	PUMP 150 mL/r	150	300 L/min
26	PUMP 160 mL/r	160	320 L/min

Note: For dual-pump configuration, select the model with max. displacement.

Parameters in the setup mode:

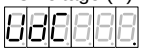
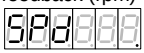
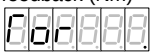
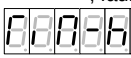
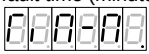
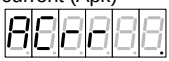
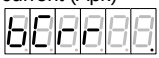
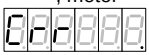
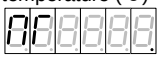
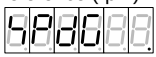
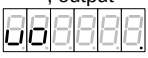
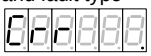
Code	Definition	Range	Default	Unit
F000	Drive model selection	For details, see the drive model table.	Same as the drive nameplate	-
F001	Motor model selection	For details, see the motor model table.	07.062	-
F002	Pump model selection	For details, see the oil pump model table.	19.100	-
F003	Pressure feedback zero calibration	0: No calibration 1: Calibration	0	-
F004	Pressure calibration mode	0: Straight line 1: Fold line	0	-
F005	Flow calibration mode	0: Straight line 1: Fold line	0	-
F006	Pressure calibration	0: Disable 1: Straight-line zero place 2: Straight-line scale range 3: Fold-line point 0 4: Fold-line point 1 5: Fold-line point 2 6: Fold-line point 3 7: Fold-line point 4 8: Fold-line point 5 9: Fold-line point 6 10: Fold-line point 7 11: Fold-line point 8 12: Fold-line point 9 13: Fold-line point 10 14: Fold-line point 11 15: Fold-line point 12	0	After the setting for straight-line zero place or scale range calibration, if the LED displays 0, the calibration succeeds; if the LED displays a non-zero value, the calibration failed. After the setting for fold-line calibration, if
F007	Flow calibration	0: Disable 1: Straight-line zero place 2: Straight-line scale range 3: Fold-line point 0	0	

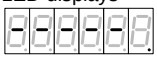
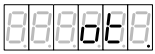
Code	Definition	Range	Default	Unit
		4: Fold-line point 1 5: Fold-line point 2 6: Fold-line point 3 7: Fold-line point 4 8: Fold-line point 5 9: Fold-line point 6 10: Fold-line point 7 11: Fold-line point 8 12: Fold-line point 9 13: Fold-line point 10 14: Fold-line point 11 15: Fold-line point 12		the LED displays the original value, the calibration succeeds; if the LED displays 1, the calibration failed.
F008	Pressure filtering	[1,32]	6	Average sampling count of moving (1ms)
F009	Flow filtering	[1,32]	6	Average sampling count of moving (1ms)
F010	Full pressure scale range	[1,500] This value also determines the max. pressure. In addition, it also adjusts the pressure reference gain so that when the pressure reference input is 9.99V, the pressure reference corresponds to the recently set pressure full scale range value.	175	bar
F011	Full flow scale range	[1,2400] This value also determines the max. flow. In addition, it also adjusts the flow reference gain so that when the flow reference input is 9.99V, the flow reference corresponds to the recently set flow full scale range value.	200	L/min
F012	Max. pressure	[0,500]	180	bar
F013	Max. flow	[0,2400]	200	L/min
F014	Speed proportional gain 0	[0,32767]	6000	-
F015	Speed integral gain 0	[0,32767]	120	-

Code	Definition	Range	Default	Unit
F016	Pressure feedback gain	[0,32767]	8182	-
F017	Pressure reference rise slope	[0,32767]	16000	0.007629 bar/ms
F018	Pressure reference fall slope	[0,32767]	16000	0.007629 bar/ms
F019	Pressure proportional gain 0	[0,32767]	13000	-
F020	Pressure integral gain 0	[0,32767]	100	-
F021	RS485 communication baud rate	0: 9600bps 1: 19200bps 2: 38400bps 3: 57600bps	0	-
F022	Pressure proportional gain 1	[0,32767]	13000	-
F023	Pressure integral gain 1	[0,32767]	100	-
F024	RS485 communication parity method	0: (N,8,1) 1: (E,8,1) 2: (O,8,1) 3: (N,8,2) 4: (E,8,2) 5: (O,8,2)	0	N: No parity bit E: Even parity O: Odd parity 8-bit data. 1 or 2 stop bits.
F025	Pressure proportional gain 2	[0,32767]	13000	-
F026	Pressure integral gain 2	[0,32767]	100	-
F027	RS485 communication address	[1,127]	10	-
F028	Pressure proportional gain 3	[0,32767]	13000	-
F029	Pressure integral gain 3	[0,32767]	100	-
F030	Reserved	[0,32767]	0	-
F031	Pump displacement	[0,32767]	100	mL/r
F032	Pump leakage	[0,1.00]	0.00	L/min/bar
F033	Max. speed for pump reverse run	[0,-6000]	-300	rpm
F034	Max. motor rotation speed	[0,6000]	2200	rpm
F035	DC voltage calibration	[0,800] (Only slight change allowed)	DC voltage at menu access	V

Code	Definition	Range	Default	Unit
F036	AC voltage calibration	[0,800] (Only slight change allowed)	AC voltage at menu access	V
F037	Enabling base flow	0: No base flow 1: With base flow	0	-
F038	Base flow pressure	[0, 500.0]	3.00	bar
F039	Base flow	[0,327.67]	0.95	L/min
F040	Overshoot threshold	[5,50]	30	bar
F041	Motor rotation direction	0: Forward 1: Reverse	0	-
F042	Resolver direction	0: Forward 1: Reverse	0	-
F043	Back pressure method	0: Manual 1: Automatic	0	-
F044	Pressure sensor model selection	5V 10V 400bar	10V	-
F045	Plunger pump model selection	0: Single displacement 1: Dual displacement	0	-
F046	Pump displacement rate	[0,100.0]	20	%
F047	Wobble-disk switchover pressure threshold	[0, 500.0]	195	bar
F048	Displacement pressure judging delay	[0,32767]	100	ms
F049	DA1	0: Pressure reference 1: Pressure feedback 2: Flow reference 3: Flow feedback 4: Speed reference 5: Speed feedback 6: Torque reference 7: Torque feedback 8: Resolver feedback 9: DC voltage 10: Phase current 11: Fault word 1 12: Fault word 2 13: Communication command	1	-
F050	DA1 max. value	[-32767,32767]	16384	-
F051	DA1 min. value	[-32767,32767]	0	-
F052	DA2	0: Pressure reference 1: Pressure feedback 2: Flow reference	5	-

Code	Definition	Range	Default	Unit
		3: Flow feedback 4: Speed reference 5: Speed feedback 6: Torque reference 7: Torque feedback 8: Resolver feedback 9: DC voltage 10: Phase current 11: Fault word 1 12: Fault word 2 13: Communication command		
F053	DA2 max. value	[-32767,32767]	16384	-
F054	DA2 min. value	[-32767,32767]	-16384	-
F055	DA output	[-32767, 32767]	0	-
F056	Rise delay of wobble-disk switchover	[0,32767]	10	ms
F057	Fall delay of wobble-disk switchover	[0,32767]	10	ms
F058	Speed switchover upper limit	[0,6000]	1200	rpm
F059	Speed switchover lower limit	[0,6000]	200	rpm
F060	Zero-place dead zone of flow reference	[0.00,100.00]	0.5	%
F061	Zero-place dead zone of pressure reference	[0.00,100.00]	0.5	%
F062	Zero-place dead zone of pressure feedback	[0.00,100.00]	0.0	%
F063	OUT2 conduction pressure coefficient	[0.00,100.00]	90.0	%
F064	Negative torque suppression control	0: Disable. 1: Enable	0	-
F065	Displacement switchover mode	0: Overvoltage. 1: Over retaining-pressure	0	-
F066	Restoring to default	0: Disable. 1: Enable	0	-
F067	Viewing fault records (displaying fault codes)	1: Fault 1 2: Fault 2 3: Fault 3 4: Fault 4 5: Fault 5 After the access, the LED displays the most recent fault (SN: 1). You can press the	Present fault code	-

Code	Definition	Range	Default	Unit
		◀ key to display the previous fault (SN: 2). You can press the ▲ key to display the following information at a fault: DC voltage (V)  , speed feedback (rpm)  , torque feedback (Nm)  , fault time (hour)  , fault time (minute)  , phase-A current (Apk)  , phase-B current (Apk)  , motor current (A)  , drive temperature (℃)  , motor temperature (℃)  , speed reference (rpm)  , torque reference (Nm)  , output voltage (V)  , and fault type 		
F068	Writing parameters	Writing parameters Press and hold the SET key and then release it for	SAVE	-

Code	Definition	Range	Default	Unit
		access. Then the LED displays  . Press and hold the SET key and then release it to start parameter writing. Then the LED displays  . If the writing succeeds, the LED displays  . If the writing failed, the LED displays  .		
F069	Password for keypad unlocking	[0,99999]	00000	-
F070	Motor rated voltage	[0,800]	351	V
F071	Motor rated current	[0,900]	51	A
F072	Motor rated speed	[0,6000]	1467	rpm
F073	Motor rated frequency	[0,600]	97.8	Hz
F074	Motor counter-emf	[0.0,800.0]	199.9	V/Krpm
F075	Motor temperature sensor type	0: NTC 1: PTC 2: KTY84 3: PT1000	3	-
F076	Reserved	-	-	-
F077	Reserved	-	-	-
F078	Reserved	-	-	-
F079	Pressure sensor scale range	[0, 500.0]	250.0	bar
F080	Pressure feedback adjustment coefficient	[50,200]	100	%
F081	Min. value of flow reference	[0,2400.0]	0.0	L/min
F082	Enabling overmodulation	[0,1]	0	1: Enable
F083	Overmodulation rate	[100,115]	105	%
F084	Carrier frequency	[4k,5k,8k,10k,3k,2k]	3k	Hz
F085	Overload protection method	[0: Current limiting. 1: IT protection. 2–3: Reserved]	0	-
F086	Bus overvoltage protection@	[0,1000]	770	V
F087	Bus protection time	[0,30000]	20	5ms
F088	Bus overvoltage	[0,1000]	800	V

Code	Definition	Range	Default	Unit
	protection			
F089	Bus undervoltage protection@	[0,1000]	380	V
F090	Bus undervoltage protection @time	[0,30000]	150	5ms
F091	Bus undervoltage protection	[0,1000]	320	V
F092	Bus undervoltage protection for pipe opening	[0,1000]	315	V
F093	AC overvoltage protection@	[0,1000]	504	V
F094	AC overvoltage protection @time	[0,30000]	300	5ms
F095	AC overvoltage	[0,1000]	1500	V
F096	AC undervoltage protection@	[0,1000]	290	V
F097	AC undervoltage protection @time	[0,30000]	101	5ms
F098	AC undervoltage	[0,1000]	0	V
F099	Power-on timeout time	[0,30000]	2000	5ms
F100	Motor protection temperature	[0,500]	125	℃
F101	Module protection temperature	[0,500]	86	℃
F102	Air protection temperature	[0,500]	400	℃
F103	Overcurrent protection value	[0,900]	018→50 025→70 032→95 038→105 043→120 060→180 070→220 092→260 115→360 150→440 170→480 180→480 215→530	A
F104	Forward speed protection value	[0,6000]	2700	rpm
F105	Reverse speed protection value	[-6000,0]	-2700	rpm
F106	Overpressure	[0, 500]	195	bar

Code	Definition	Range	Default	Unit
	protection threshold			
F107	Pressure sensor fault value	[0,32767]	0	-
F108	ACDC sampling error voltage	[0,800]	80	V
F109	Braking resistance heating factor	[0,500]	018→35 025→35 032→35 038→35 043→69 060→69 070→69 092→40 115→40 150→40 170→40 180→40 215→0	-
F110	Braking resistor cooling factor	[0,500]	1	-
F111	Braking resistor overload threshold	[0,30000]	018→374 025→374 032→374 038→374 043→374 060→374 070→374 092→292 115→292 150→292 170→292 180→292 215→374	-
F112	Motor short-circuit protection value	[0,900]	10.0	A
F113	Protection against phase loss	0: Disable. 1: Enable	0	-
F114	Rectifier overload protection	0: Disable 1: Enable	0	-
F115	Speed feedback filtering method	0: Moving average. 1: Ordinary least squares You need to perform re-power on for the setting to take effect.	0	-
F116	Low speed proportional gain	[0,32767]	7000	-

Code	Definition	Range	Default	Unit
F117	Low speed integral gain	[0,32767]	140	-
F118	Low rotation speed of gain switchover	[0,6000]	5994	rpm
F119	High rotation speed of gain switchover	[0,6000]	5994	rpm
F120	Speed control rigidity	[1,14]	8	-
F121	Motor inertia	[0,0.655]	0.018	Kgm2
F122	Motor torque coefficient	[0,100.00]	3.20	Nm/Arms
F123	Motor autotuning direction	0: Forward. 1: Reverse	0	-
F124	Drive rated power	[0.00,327.67]	-	kW
F125	Drive rated current	[0,900]	-	A
F126	Torque limit	[0,1800]	425	Nm
F127	Disturbance compensation gain	[0,200]	0	%
F128	Disturbance compensation filtering frequency	[0,5000]	500	Hz
F129	Disturbance compensation lagging period	[0,15]	5	Cycle (of speed loop)
F130	Overspeed protection time	[0,5000]	100	ms
F131	Flow reference rise slope	[0,32767]	16000	0.07324(L/min)/ms
F132	Flow reference fall slope	[0,32767]	16000	0.07324(L/min)/ms
F133	Braking resistor fault detection	0: Disable 1: Enable	1	-
F134	PWM voltage compensation	0: Disable 1: Enable	0	-
F135	Pump stuck detection	0: Disable 1: Enable	1	-
F136	Oil path depressurization mode	0: Common oil path 1: Self-depressurization oil path	0	-
F137	Reverse torque upper limit	[0,100]	100	%
F138	Speed integral torque boost	[0,1000]	0	%
F139	Enabling multi-step PI of speed	0: Disable 1: Enable	0	-
F140	Enabling multi-step PI	0: Disable	0	-

Code	Definition	Range	Default	Unit
	of pressure	1: Enable		
F141	Speed proportional gain 1	[0,32767]	7000	-
F142	Speed integral gain 1	[0,32767]	140	-
F143	Speed proportional gain 2	[0,32767]	7000	-
F144	Speed integral gain 2	[0,32767]	140	-
F145	Speed proportional gain 3	[0,32767]	7000	-
F146	Speed integral gain 3	[0,32767]	140	-
F147	Self-depressurization startup speed	[-300,300]	250	rpm
F148	Self-depressurization startup pressure	[0, 500]	59	bar
F149	Self-depressurization shutdown pressure	[0, 500]	57	bar
F150	Retaining-pressure feedforward cut-in speed	[-6000,6000]	100	rpm
F151	Retaining-pressure feedforward cut-in pressure	[0, 500]	200	bar
F152	Retaining-pressure feedforward gain	[0,32767]	0	-
F153	Voltage in full pressure scale range	[0,11.00]	9.99	V
F154	Voltage in full flow scale range	[0,11.00]	9.99	V
F155	Resolver fault detection	0: Disable 1: Enable	1	-
F156	PID terminal use purpose	0: General 1: Only for die-casting machines	0	-
F157	ALM_RST input selection	0: No function 1: Reset faults 2: Enabling the drive 3: Selection of splitting or combining flow 4: Material storage signal input 5: Motor rotation direction 6: PID terminal 1	1	-
F158	S_ON input selection		2	-
F159	I1 input selection		3	-
F160	I2 input selection		4	-
F161	I3 input selection		6	-

Code	Definition	Range	Default	Unit
F162	I4 input selection	7: PID terminal 2 8: PID terminal 3 9: PID terminal 4 10: Trigger method selection 11: Enabling inclined-disk control (Over retaining-pressure method) 12: Inclined-disk switchover command 13: Pressure/flow control selection signal 14: Enabling unit follow-up 15: Internal reference 1 16: Internal reference 2 17: Internal reference 3 18: Slave node address selection 1 19: Slave node address selection 2 20: Selection 1 of splitting or combining flow 21–63: Reserved	7	-
F163	Reserved		0	-
F164	Reserved		0	-
F165	Reserved		0	-
F166	Reserved		0	-
F167	S_RDY output selection	0: No function 1: Servo readiness 2: Alarm output 3: I2 terminal status 4: Inclined-disk control output 5: Output of oil pressure being reached 6: Self-depressurization output 7–63: Reserved	1	-
F168	ALM output		2	-
F169	Reserved		0	-
F170	O1 output		4	-
F171	O2 output		5	-
F172	Five low bits of accumulative power consumption	[0,999.9]	6.8	kW.h
F173	Five high bits of accumulative power consumption	[0,9999]	0	1000 kW.h
F174	Enabling depressurization pressure PI	0: Disable. 1: Enable	0	-
F175	Proportion 0 of depressurization pressure drop P	[0,32767]	13000	-
F176	Integral 0 of depressurization pressure drop P	[0,32767]	10	-

Code	Definition	Range	Default	Unit
F177	Proportion 1 of depressurization pressure drop P	[0,32767]	13000	-
F178	Integral 1 of depressurization pressure drop P	[0,32767]	10	-
F179	Enabling depressurization speed PI	0: Disable. 1: Enable	0	-
F180	Depressurization speed proportion 0	[0,32767]	6000	-
F181	Depressurization speed integral 0	[0,32767]	50	-
F182	Depressurization speed proportion 1	[0,32767]	6000	-
F183	Depressurization speed integral 1	[0,32767]	50	-
F184	High pressure difference 0 of gain switchover	[0,500]	0	bar
F185	Low pressure difference 0 of gain switchover	[0,500]	0	bar
F186	High pressure difference 1 of gain switchover	[0,500]	0	bar
F187	Low pressure difference 1 of gain switchover	[0,500]	0	bar
F188	Pressure proportion 0 with high pressure difference	[0,32767]	8000	-
F189	Pressure integral 0 with high pressure difference	[0,32767]	50	-
F190	Pressure proportion 1 with high pressure difference	[0,32767]	8000	-
F191	Pressure integral 1 with high pressure difference	[0,32767]	50	-
F192	Self-depressurization startup delay	[0,32767]	1	ms
F193	Self-depressurization shutdown delay	[0,32767]	2	ms

Code	Definition	Range	Default	Unit
F194	Pressure at self-depressurization low-pressure switch-on	[0,500]	30	bar
F195	Pressure at self-depressurization low-pressure switch-off	[0,500]	20	bar
F196	Pressure forward overshoot suppression	[0,3000.0]	25.0	%
F197	Pressure reverse overshoot suppression	[0,3000.0]	100.0	%
F198	Multi-step flow fall slope 1	[0,32767]	16000	0.07324(L/min)/ms
F199	Forward rotation depressurization method	0: One step. 1: Two steps. 2: Three steps	0	-
F200	Depressurization step-2 pressure threshold	[0,500]	45	bar
F201	Depressurization step-3 pressure threshold	[0,500]	4	bar
F202	Depressurization step-2 fall slope	[0,32767]	125	0.007629 bar/ms
F203	Depressurization step-3 fall slope	[0,32767]	10	
F204	Multi-step depressurization pressure proportion	[0,32767]	9000	-
F205	Multi-step depressurization pressure integral	[0,32767]	10	-
F206	Multi-step depressurization speed proportion	[0,32767]	6000	-
F207	Multi-step depressurization speed integral	[0,32767]	50	-
F208	Depressurization pressure PI fall threshold	[0,500]	7	bar
F209	Low-pressure reverse rotation speed limited	[-6000,6000]	-300	rpm

Code	Definition	Range	Default	Unit
F210	Multi-step depressurization startup delay	[0,32767]	5	ms
F211	Multi-step depressurization end delay	[0,32767]	500	ms
F212	Enabling pressure-boost speed PI	0: Disable. 1: Enable	0	-
F213	Enabling depressurization bidirectional control	0: Disable. 1: Enable	0	-

5.2.6 Debug mode

If you press the MODE key to select the debug mode, the LED displays "h--xx", in which "xx" indicates a parameter ID. You can press the ▲ or ▼ key to select a parameter ID. When you press and hold the SET key and then release it, the selection is completed. Then the LED displays the parameter value. If you want to modify a parameter, you can press the ◀ key to move the blinking place and press the ▲ or ▼ key to change the value of the blinking place. After the value is modified, press and hold the SET key and release it. Then the modification is automatically saved and blinking stops. If you press the SET or ▲ ▼ key again at this time, you can modify the parameter again. The places which can be modified blink. Press the MODE key to exit.

Note: In debug mode, if no key acts within 1min, the speed or fault display interface automatically appears.

Parameters in the setup mode:

Code	Definition	Range	Default	Unit
h00	Enabling run	0: Disable 1: Enable	Related to IO level enabling of drive	-
h01	Enabling diagnosis	0: Disable 1: Enable	0	-
h02	Diagnosis content (Valid only when diagnosis enabled)	0: Disable 1: Measure the initial angle 2: Enable jogging 3–5: Invalid 6: Drive test	0	-
h03	Jogging (Valid only when diagnosis enabled)	▲: Jog forward ▼: Jog reversely	0	-
h04	Control mode	3: Speed mode 4: Process mode	4	-

Code	Definition	Range	Default	Unit
h05	Speed reference (Valid in speed control mode)	Motor model related	0	rpm
h06	Process command mode	0: Digital input 1: Analog input 2: Continuous CAN communication input 3: Continuous RS485 communication input 4: CANopen communication input 5: EtherCAT communication input 6: Internal reference 7: PROFINET communication input	1	-
h07	Flow reference (Process command mode is communication input)	[0, Max. flow]	0.0	L/min
h08	Pressure reference (Process command mode is communication input)	[0, Max. pressure]	0.0	bar
h09	Max. jogging speed	The motor runs at the max. speed when you press ▲ or ▼. [0,100]	15	rpm
h10	Resolver offset	[0,4095]	0	-
h11	Motor parameter autotuning (Valid only when diagnosis enabled)	0: Disable 1: Dynamic 2: Static	0	-
h12	Enabling advanced parameter operation	11111: Disable 99999: Enable Other values: No functions	00000	-
h13	Clearing faults	0: Disable. 1: Enable	0	-
h14	Internal flow reference 0	[0,100.0]	0.0	%
h15	Internal flow reference 1	[0,100.0]	0.0	%
h16	Internal flow reference 2	[0,100.0]	0.0	%
h17	Internal flow reference 3	[0,100.0]	0.0	%

Code	Definition	Range	Default	Unit
h18	Internal flow reference 4	[0,100.0]	0.0	%
h19	Internal flow reference 5	[0,100.0]	0.0	%
h20	Reserved	[0,100.0]	0.0	-
h21	Reserved	[0,100.0]	0.0	-
h22	Internal pressure reference 0	[0,100.0]	0.0	%
h23	Internal pressure reference 1	[0,100.0]	0.0	%
h24	Internal pressure reference 2	[0,100.0]	0.0	%
h25	Internal pressure reference 3	[0,100.0]	0.0	%
h26	Internal pressure reference 4	[0,100.0]	0.0	%
h27	Internal pressure reference 5	[0,100.0]	0.0	%
h28	Speed integral torque boost 1	[0,100.0]	0.0	8%
h29	Speed proportional torque boost 1	[0,100.0]	0.0	8%

5.2.7 Multi-pump mode

If you press the MODE key to select the multi-pump mode, the LED displays "P--xx", in which "xx" indicates a parameter ID. You can press the ▲ or ▼ key to select a parameter ID. When you press and hold the SET key and then release it, the selection is completed. Then the LED displays the parameter value. If you want to modify a parameter, you can press the ◀ key to move the blinking place and press the ▲ or ▼ key to change the value of the blinking place. After the value is modified, press and hold the SET key and release it. Then the modification is automatically saved and blinking stops. If you press the SET or ▲ ▼ key again at this time, you can modify the parameter again. The places which can be modified blink. Press the MODE key to exit.

Code	Definition	Range	Default	Unit
P00	Enabling the network	0: Disable 1: Enable	0	-
P01	Opening network pipes	0: Close 1: Open	Related to IO level enabling of drive	-
P02	Combining type	0: Single pump 1: Hybrid 2: Multiple pumps 3: Multiple modes	0	-

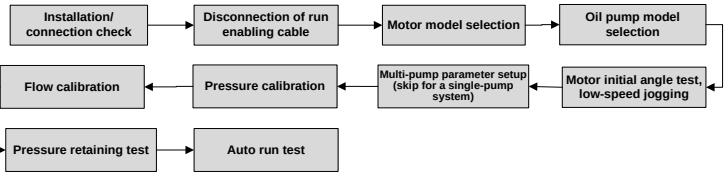
Code	Definition	Range	Default	Unit
		4: Communication with two models 5: Communication with four models		
P03	Node No.	[0,15]	0	-
P04	Slave count	[0,15]	0	-
P05	Node type	0: Independent unit 1: Control unit 2: Follow-up unit 3: Flow-loop unit	0	-
P06	Flow switch-in threshold	[0,100.0]	25.0	%
P07	Flow switch-in hysteresis upper limit	[0,100.0]	5.0	%
P08	Flow switch-in hysteresis lower limit	[0,100.0]	2.5	%
P09	Multi-pump pressure proportional gain 0	[0,32767]	8000	-
P10	Multi-pump pressure integral gain 0	[0,32767]	88	-
P11	Depressurization step-1 delay	[0,32767]	500	ms
P12	Multi-pump pressure proportional gain 1	[0,32767]	8000	-
P13	Multi-pump pressure integral gain 1	[0,32767]	88	-
P14	Speed proportional torque boost	[0,1000]	0	%
P15	Multi-pump pressure proportional gain 2	[0,32767]	8000	-
P16	Multi-pump pressure integral gain 2	[0,32767]	88	-
P17	Quick depressurization coefficient	[0,32767] A greater value indicates quicker depressurization. 0: Invalid	0	-
P18	Multi-pump pressure proportional gain 3	[0,32767]	8000	-
P19	Multi-pump pressure integral gain 3	[0,32767]	88	-
P20	Depressurization overshoot suppression factor	[0,32767] A smaller value indicates greater suppression. 0: Invalid	0	-
P21	ECAT synchronization method	0: Run freely 1: Synchronization manager	0	-

Code	Definition	Range	Default	Unit
		2: Synchronization clock		
P22	ECAT synchronization time	0: 500μs 1: 1ms 2: 2ms 3: 4ms	0	-
P23	RS485 communication address	[1,255]	10	-
P24	RS485 communication parity method	0: (N,8,1) 1: (E,8,1) 2: (O,8,1) 3: (N,8,2) 4: (E,8,2) 5: (O,8,2) Note: N: No parity bit. E: Even parity. O: Odd parity. 8-bit data. 1 or 2 stop bits.	0	-
P25	RS485 communication baud rate	0: 9600bps 1: 19200bps 2: 38400bps 3: 57600bps	1	-
P26	CANOpen communication node No.	[1,127]	1	-
P27	CANopen communication baud rate	0: 1000kbps 1: 500kbps 2: 250kbps 3: 125kbps 4: 50kbps 5: 20kbps	1	-
P28	Proportion 0 of depressurization pressure boost P	[0,32767]	8000	-
P29	Integral 0 of depressurization pressure boost P	[0,32767]	5	-
P30	Proportion 1 of depressurization pressure boost P	[0,32767]	8000	-
P31	Integral 1 of depressurization pressure boost P	[0,32767]	5	-
P32	Reserved	[0,32767]	6000	-
P33	Reserved	[0,32767]	5	-
P34	CAN slave-node address 1	Four slave-node addresses. Range: 0–65535	0	-
P35	CAN slave-node address 2		0	-
P36	CAN slave-node address 3		0	-
P37	CAN slave-node address 4		0	-

6 Commissioning

You can perform commissioning for the servo system by operating the embedded LED of the drive.

6.1 Commissioning flowchart



6.2 Commissioning procedure

The following describes how to perform commissioning for the servo system by operating the embedded LED.

6.2.1 Preparing

1. Check the installation and connection.

Check the connection of each terminal and ensure that all screws for fixing are reliably locked and no slippage occurs.

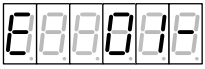
2. Switch off enabling.

To ensure system safety during commissioning, disconnect the drive enabling terminal wires before turning on the three-phase AC power for commissioning.

6.2.2 Motor model selection

Motor model selection method

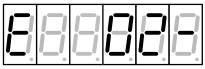
If you use a motor in the motor model table in section 5.2.5, select the model by setting E01 or F001. If you use a motor exclusive from the table, ensure the rated speed and torque of motor are adjacent, and set F075 to the motor model. See F075 option 2 (KTY84).

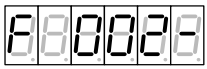


6.2.3 Pump model selection

1. Pump model selection method

If you use a pump in the pump model table in section 5.2.5, select the model by setting E02 or F002. If you use a pump exclusive from the table, manually set pump parameters. In the setup menu, set F031 and F032.





2. Pressure sensor model selection F044 (Default: 10V)

   a) 5V: Sensor output range of 1–5V, measuring range of 0–200bar

   b) 10V: Sensor output range of 0–10V, measuring range of 0–250bar

   c) 400bar: Sensor output range of 0–10V, measuring range of 0–400bar

6.2.4 Motor parameter autotuning and motor initial angle measuring

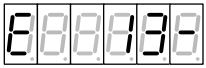
If you use a motor exclusive from the motor model table in section 5.2.5, perform motor parameter autotuning first. The procedure is as follows:

1. Set motor parameters.

In the setup menu on the LED panel, set F070 (Motor rated voltage), F071 (Motor rated current), F072 (Motor rated rated rotation speed), F073 (Motor rated frequency), F074 (Motor back-emf), and F075 (Motor temperature sensor).

2. Enable the diagnosis function.

Set E13 to ON.



3. Motor parameter autotuning

Perform motor parameter autotuning.

0: Disable Motor parameter autotuning is disabled.

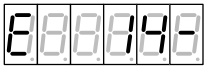
1: Static If the motor back-emf has been obtained, but the motor does not rotate during measuring, you can perform the autotuning without opening the relief valve.

2: Dynamic It is used if the motor back-emf is not obtained, while the motor rotates at high speed during measuring. It is recommended to open the relief valve. With-load measuring affects the accuracy of motor parameter measuring and the control effect. In addition, high voltage is present in the oil path, which causes safety risks.

When autotuning starts if the setup is completed, the LED displays "— — — — — —". When autotuning is completed, the LED displays 0.

If the drive reports an alarm during testing, find out the cause, handle the problem, and then continue the autotuning.

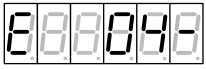
Set parameters on the LED:



4. Measure the motor initial angle.

If you have completed motor parameter autotuning, you do not need to measure the motor initial angle.

Set parameters on the LED:

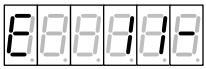


When the initial angle measuring menu is accessed, the LED displays "READY". If you press

and hold the SET key and then release it, the system automatically measures the initial angle, and the LED displays "————————". When the measuring is completed, the LED displays "OK".

You need to save the measured values to the EEPROM by using the parameter writing function of the shortcut menu. Otherwise, after the system is shut down, the calibration status is restored to the previous status.

Set parameters on the LED:



6.2.5 Low-speed jogging

The test purpose is to check whether the basic functions of the servo system are normal.

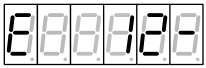
1. Check and prepare for the running.

For the first run of the servo system, you must check whether the hydraulic loop connection and the servo system electrical connection are correct; whether the values of the oil pump displacement and working pressure are consistent with those on the nameplate. At the earlier period, adjust the system so that the oil discharged from the pump goes directly back to the tank, for example, by setting the overflow pressure of relief valve to the lowest.

2. Run at low speed with light load.

When the LED displays the E12 status, press and hold the SET key and then release it to enter the jogging mode. Then the LED displays "JOG". You can press the ▲ or ▼ key to make the motor jog forward or reversely. You can press and hold the ▲ or ▼ key to make the motor accelerate to the max. forward or reverse jogging speed.

Set parameters on the LED:



3. Confirm the working situation.

When you are sure that the motor runs forward, the pump rotates in the same direction as the arrow on the pump label; the noise and vibration are in the normal range and the pump can suck oil normally.

Fault	Symptom	Solution
Condition 1	The motor does not rotate, and the torque is great.	Access the setup menu, and change the motor rotation direction. Repeat the operations in section 6.2.4.
Condition 2	When the motor runs forward, the pump rotates in the a direction different from the arrow on the pump label.	Access the setup menu, and change the motor rotation direction and resolver direction. Repeat the operations in section 6.2.4.

a) Discharge air.

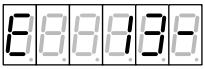
After step 2 is performed properly without any exception, run the pump forward to

discharge all the air in the hydraulic system.

Note: At the startup, there is noise due to air merging in the hydraulic oil, which is a normal phenomenon. If the noise does not disappear within a certain period of time, discharge air for the hydraulic oil path.

b) Disable jogging and diagnosis.

Set E13 to OFF.

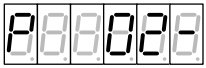


Multi-pump parameter settings (Skip this section for a single-pump system)

1) Set the flow combining type.

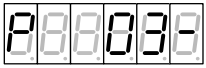
Set P02 (Flow combining type).

0: Single pump. 1: Hybrid. 2: Multiple pumps. 3: Multiple modes. 4: Communication with two models. 5: Communication with four models



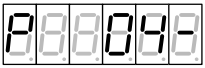
2) Set node No.

Set P03 (Node No.).



3) Set P04 (Slave count).

Set the number of slave nodes. (It is mandatory for node 0; skip the operation for other nodes.)



4) Set multi-pump flow.

Set P06 (Flow switch-in threshold), which is usually set to 25%.

Set P07 (Flow switch-in hysteresis upper limit), which is usually set to 5%.

Set P08 (Flow switch-in hysteresis lower limit), which is usually set to 2.5%.

5) Set network enabling and network pipe opening.

Enable the network: In the sequence of from the slave to the master, set P00=1 to enable the network for the drive.

6.2.6 Pressure and flow calibration

1. Se the max. pressure and flow values.

The calibration varies slightly depending on the flow combining type.

- For the single-pump type: Perform calibration directly, without considering the setting of P00.
- For the types of hybrid, multi-mode, communication with two models, and communication with four models:

  Set P00=0 (Disable), and perform calibration for each node as a single-pump system.
- For the multi-pump type:

  Set P00=0 (Disable), set F013 (Max. flow) and F012 (Max. pressure) for each node. Then set P00=1 in the sequence from the slave to the master. At this time, the system max. pressure depends on the min. value of max. pressure of the master/slave nodes, while the system max. flow is the sum of max. flow on each node. During flow calibration, max. flow does not need to be set.

2. Adjust the pressure/flow command filtering.

   Increasing the pressure/flow filtering parameter value will slow down the command response and reduce command fluctuation.

Pressure/flow command filtering parameters:

Code	Definition	Range	Default	Unit
F008	Pressure filtering	[1,32]	6	Average sampling count of moving (1ms)
F009	Flow filtering	[1,32]	6	Average sampling count of moving (1ms)

Increasing the pressure/flow command rise speed will improve the oil pump output flow and oil pressure response, have greater impact on the run, and increase the overshoot; decreasing the speed will slow down the speed, and decrease the overshoot.

Pressure/flow command rise/fall parameters:

Code	Definition	Range	Default	Unit
F017	Pressure reference rise slope	[0,32767]	16000	0.007629 bar/ms
F018	Pressure reference fall slope	[0,32767]	16000	0.007629 bar/ms
F131	Flow reference rise slope	[0,32767]	16000	0.07324(L/min)/ms
F132	Flow reference fall slope	[0,32767]	16000	0.07324(L/min)/ms

3. Set nominal pressure.

   a) Set the max. pressure and full pressure scale range.

   The purpose of setting the max. pressure is to avoid the system damage that is caused when the setting on the upper computer exceeds the upper limit allowed by the servo system. For the multi-pump type, this parameter has been set.

   You only need to set E05 (Full pressure scale range) on the LED panel to modify the full pressure scale range and max. pressure simultaneously (except for the multi-pump mode).

   b) Perform straight-line calibration.

Set the pressure reference to 0bar on the upper computer. Access the setting of E07. The LED displays the pressure reference voltage. Press and hold the SET key and then release it to perform pressure zero-place calibration. Then the LED displays  . If the calibration succeeds, the LED displays  .

Set the pressure reference to full pressure scale range on the upper computer. Access the setting of E08. The LED displays the pressure reference voltage. Press and hold the SET key and then release it to perform full pressure scale range calibration. Then the LED displays  . If the calibration succeeds, the LED displays  .

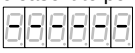
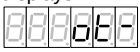
4. Set nominal flow.

   a) Set the max. flow and full flow scale range.

   You only need to set E06 (Full flow scale range) on the LED panel to modify the full flow scale range and max. flow simultaneously (except for the multi-pump mode).

   b) Perform straight-line calibration.

   Set the flow reference to 0% on the upper computer. Access the setting of E09. The LED displays the pressure reference voltage. Press and hold the SET key and then release it to perform pressure zero-place calibration. Then the LED displays  . If the calibration succeeds, the LED displays  .

   c) Set the flow reference to 99.9% on the upper computer. Access the setting of E10. The LED displays the pressure reference voltage. Press and hold the SET key and then release it to perform full pressure scale range calibration. Then the LED displays  . If the calibration succeeds, the LED displays  .

5. Writing parameters

   The preceding parameter settings need to be written (E11) before the drive is powered off. Otherwise, the parameter settings fail.

6.2.7 Pressure retaining test

1. Restart the servo system.

After the system power is off, connect the drive enabling terminal wire for re-power on. The drive control permission is given to the device control computer. When the drive enters the run state (the last place on the LED displays  in blinking mode), perform the following tests:

2. Test of low pressure retaining

Maximize the overflow pressure of the relief valve before the following operations.

On the upper computer, set the flow reference to 10% and the pressure reference to 20bar. Check the oil path for leakage. Check whether d09 (Pressure feedback) and device-read pressure are 20bar.

3. Test of high pressure retaining

After the successful test of low pressure retaining, you can perform the test of high pressure retaining. Set the flow reference to 80% on the upper computer, and gradually increase the pressure reference to max. pressure required. View d09 (Pressure feedback) and d07 (Speed feedback).

If the actual system pressure cannot reach the set pressure, check the oil path for leakage.

If the actual system pressure reaches the set pressure, but the motor average rotation speed is higher than the normal one, check whether:

There is abnormal leakage in the oil pump.

There is abnormal leakage in the hydraulic oil path.

There is leakage in the relief valve.

Ensure the retained pressure and motor rotation speed at retaining meet requirements, and ensure the pressure fluctuation meets requirements according to the following table.

Measuring indicator	Expected result (recommended)
Pressure fluctuation (100% of pressure reference)	≤3bar

6.2.8 Calibration review

In the pressure retaining test, set the pressure reference to 10bar, 100bar, and full scale pressure on the upper computer. Check whether the read data in the pressure table matches the setting. If not, perform pressure calibration again.

Set the flow reference to 5%, 50%, and 100% on the upper computer. Check whether the motor rotation speed and given flow are in a proportion. If not, perform flow calibration again.

6.2.9 Fully automatic run and system performance adjustment

1. Set multi-step speed/pressure PI.

If the servo system uses stepped PI control in different working conditions, connect the digital input ports I3 (CN3-9) and I4 (CN3-10) as the indication signals of control stages, and then enable multi-step PI of speed/pressure. The following table lists the mapping between digital input signals and speed/pressure PI steps.

I4	I3	KP No.	KI No.
low	low	0	0
low	high	1	1
high	low	2	2
high	high	3	3

2. Adjust system performance.

The servo system uses the following gain parameters for oil pressure control. You can adjust the response characteristics and steady-state accuracy of the servo system by setting these parameters.

Speed PI adjustment:

Code	Definition	Setting	Range	Default
F139	Enabling multi-step PI of speed		0: Disable 1: Enable	0

Code	Definition	Setting	Range	Default
E18 F014	Speed proportional gain 0	Increasing the speed proportional gain can improve the transient responsiveness of motor speed control, enhance the motor speed stability, and suppress interference, but setting the gain too great will cause oscillation.	[0,32767]	7000
F141	Speed proportional gain 1		[0,32767]	7000
F143	Speed proportional gain 2		[0,32767]	7000
F145	Speed proportional gain 3		[0,32767]	7000
E19 F015	Speed integral gain 0	Increasing the speed integral gain can improve the transient responsiveness of motor speed control, reduce the motor speed deviation, and increase speed overshoot, but setting the gain too great will cause oscillation.	[0,32767]	170
F142	Speed integral gain 1		[0,32767]	140
F144	Speed integral gain 2		[0,32767]	140
F146	Speed integral gain 3		[0,32767]	140

Pressure PI adjustment:

Code	Definition	Setting	Range	Default
F140	Enabling multi-step PI of pressure		0: Disable 1: Enable	0
Settings for the single-pump or flow splitting type:				
E16 F019	Pressure proportional gain 0	Increasing the pressure proportional gain can improve the transient responsiveness and stability of pressure control, suppress interference, and reduce pressure overshoot, but setting the gain too great will cause oscillation.	[0,32767]	13000
F022	Pressure proportional gain 1		[0,32767]	13000
F025	Pressure proportional gain 2		[0,32767]	13000
F028	Pressure proportional gain 3		[0,32767]	13000
E17 F020	Pressure integral gain 0	Increasing the pressure integral gain can improve the transient response speed of pressure control, reduce the pressure speed deviation, and increase pressure overshoot, but setting the gain too great will cause oscillation.	[0,32767]	100
F023	Pressure integral gain 1		[0,32767]	100
F026	Pressure integral gain 2		[0,32767]	100
F029	Pressure integral gain 3		[0,32767]	100
Settings for the the flow combining type:				
P09	Multi-pump pressure proportional gain 0	Increasing the pressure proportional gain can improve the transient responsiveness and stability of pressure control, suppress interference, and reduce pressure overshoot, but	[0,32767]	8000
P12	Multi-pump pressure proportional gain 1		[0,32767]	8000
P15	Multi-pump pressure proportional gain 2		[0,32767]	8000

Code	Definition	Setting	Range	Default
P18	Multi-pump pressure proportional gain 3	setting the gain too great will cause oscillation.	[0,32767]	8000
P10	Multi-pump pressure integral gain 0	Increasing the pressure integral gain can improve the transient response speed of pressure control, reduce the pressure speed deviation, and increase pressure overshoot, but setting the gain too great will cause oscillation.	[0,32767]	170
P13	Multi-pump pressure integral gain 1		[0,32767]	170
P16	Multi-pump pressure integral gain 2		[0,32767]	170
P19	Multi-pump pressure integral gain 3		[0,32767]	170

When the motor and pump model selection settings are completed, the drive automatically selects the values matching the motor and pump. If the system performance indicators do not meet requirements, adjust the preceding parameters.

7 Multi-pump combined flow control

For the hydraulic control of large tonnage injection molding machines, a single-pump system is far from being able to meet the flow requirements due to the limitation of pump displacement or motor power. Therefore, the outlets of multiple single-pump systems must be connected in parallel to achieve a large flow rate. In a combined-flow system, to improve the production efficiency and shorten the product process cycle, two or more actions need to be completed at the same time, the single-loop hydraulic system needs to be divided into double loops or three loops that are independently controlled. At split flow control, each loop independently completes the flow and pressure control. At combined flow control, a master drive is responsible for pressure control and total system flow control, while the other drives perform single-loop flow control by converting the total system flow commands to respective-loop flow commands. The total system output flow is the sum of the flow output of each loop.

7.1 Flow distribution method for multi-pump flow combining

You can add nodes for flow control to ensure that the output flow is linear within 0%–100% of flow command.

Each node (or single-pump system) can carry a certain flow on its own, called the max. private flow.

Max. private flow = Node max. flow x Flow switch-in threshold ratio

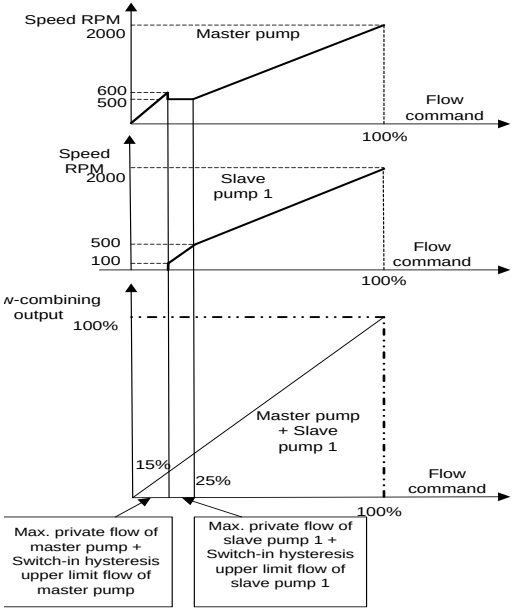


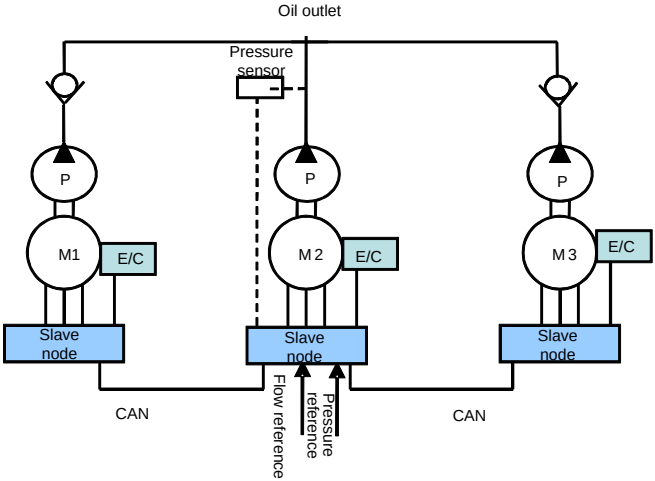
Figure 7-1 Slave pump responding to master node flow commands

For a total system flow reference command: When it is less than the max. private flow of master pump 0, master pump 0 carries all the system flow. When it is greater than the max. private flow of master pump 0, master pump 0 carries its own max. private flow, while the slave pumps carry the remaining flow. When the remaining flow is less than the max. private flow of slave pump 1, the remaining flow is carried by slave pump 1; when the remaining flow is greater than the max. private flow of slave pump 1, slave pump 1 carries its own max. private flow, and other slave pumps carry the other flow; and so on, until the remaining flow is completely carried. If the max. private flow of the last slave pump is less than the remaining flow, the system flow is equally (or proportionally) distributed to all pumps.

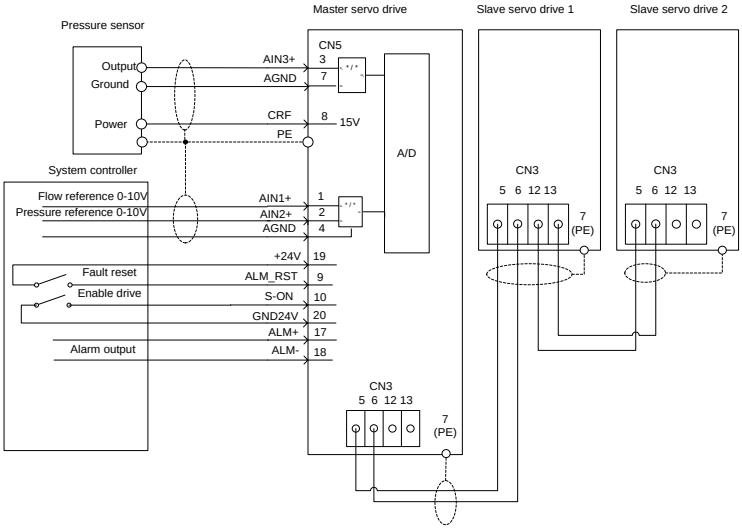
7.2 Multiple pumps

After the flow combining type of each node (or single-pump system) is set to the multi-pump mode, each node can only work in flow combining control, in which the master node is responsible for receiving pressure reference, flow reference, and run enabling signal from the upper control system and pressure sensor signal from system outlets to perform pressure and total system flow control. The slave nodes simply perform speed control based on the total system flow commands transmitted through CAN communication, which are converted into speed commands according to the flow distribution algorithm described above.

1. Multi-pump systematic diagram:



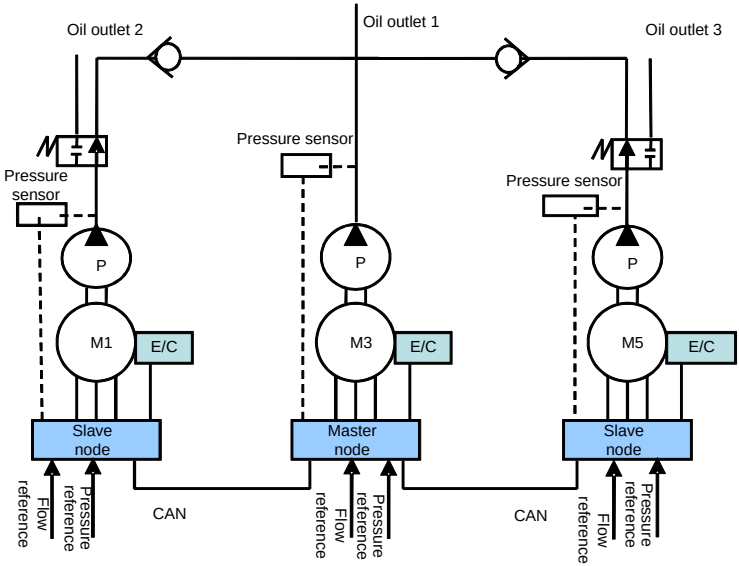
2. Multi-pump wiring diagram:



7.3 Hybrid

The system has two control modes: flow combining and splitting, with digital input I1 (C/D) signal to switch the control mode of each node. At flow splitting, each node is used as a single-loop hydraulic system to complete the flow and pressure control. At flowing combining, similar to the multi-pump method, the master node is responsible for pressure and total system flow control, while the slave nodes simply perform speed control based on the total system flow commands transmitted through CAN communication, which are converted into speed commands according to the flow distribution algorithm described above.

Hybrid method systematic diagram:

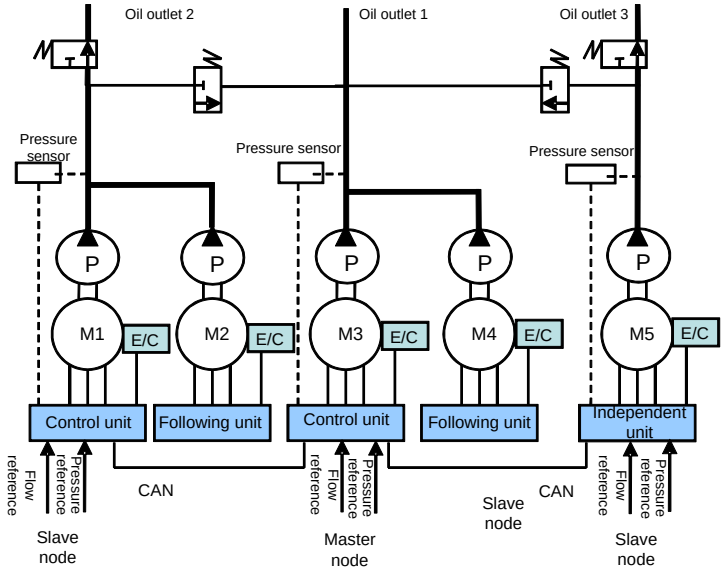


7.4 Multiple modes

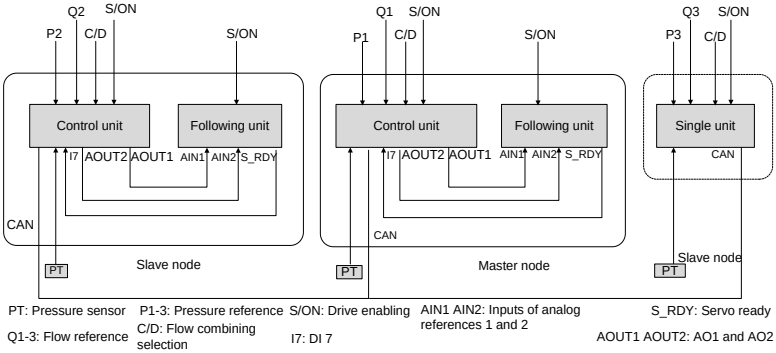
The system consists of three nodes, of which each node consists of one or more single-pump systems. A single-pump system is called a control unit. A node consisting of one control unit is an independent unit node, while a multi-unit node consisting of multiple control units can be regarded as a node consisting of a dual or multiple pumps. A multi-unit node consists of a control unit and one or more following units. Each node has a pressure sensor connected to the control unit, while the control unit is connected to the upper control system through the AIN1 and AIN2 analog interfaces to receive pressure and flow reference signals. The two DA outputs of control unit connect to the analog inputs AIN1 and AIN2 of following unit to function as the motor speed reference signal and drive enabling signal. The RDY outputs of following unit are in serial connection, with the positive end connected to the 24V power supply, while the negative end connected to digital input port I7 of control unit, through which the control unit obtains the run status of following unit drive.

Each node uses the digital input signal I1(C/D) to switch the control mode. When I1(C/D) is high, the node works in flow combining state. When I1(C/D) is low, the node works in flow splitting state. When the system works in the flow combining state, the number of nodes with flow combined can be changed. The master node completes pressure control and total system flow control. The master and slave nodes run at the same speed in flow combing state. The flow distribution algorithm described earlier is not applicable to the multi-mode method. The control unit of each node controls the pressure and flow in flow splitting mode, and the following unit keeps the same speed as the control unit.

Multi-mode systematic diagram:



Hybrid and multi-mode wiring diagram:



7.5 Communication with two models

In this mode, there is one master node (single-pump system), and multiple slave nodes (of which each is also a single-pump system). The master node controls which slave nodes combine flow through the flow splitting/combining selection terminal. There are two types of node combination.

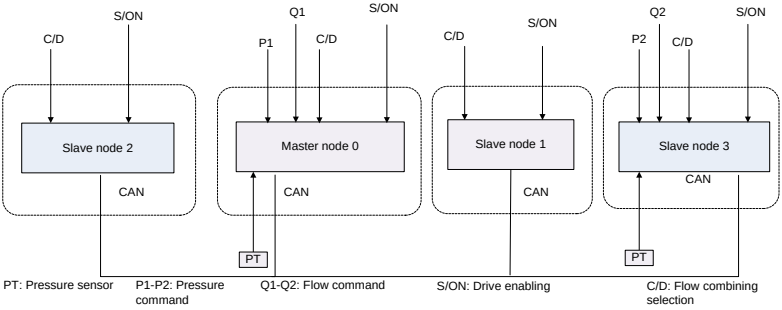
Flow splitting/combining selection	CAN slave node address selection
Low	CAN slave-node address 1
High	CAN slave-node address 2

P34 (CAN slave-node address 1) and P35 (CAN slave-node address 2): used to select a

slave node with the flow combined with the master node. Each is a 16-bit integer. A total of 15 slave nodes can be set. The value 1 of a bit indicates combining flow with the master node, while the value 0 indicates splitting flow and independent oil pump control. When the master node combines flow with slave nodes, bit 0 is 1; when the master node independently works, bit 0 is 0.

CAN slave node address Range in hexadecimal format: 0x0000–0xffff Range in decimal format: 0–65535															
16-bit integer, with each bit corresponding to a node															
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
Slave node 15	Slave node 14	Slave node 13	Slave node 12	Slave node 11	Slave node 10	Slave node 9	Slave node 8	Slave node 7	Slave node 6	Slave node 5	Slave node 4	Slave node 3	Slave node 2	Slave node 1	Master node 0

Wiring diagram for communication with two models:



Example: The hydraulic system has four oil pumps, with the addresses set to 0, 1, 2, and 3. There may be two types of action combination:

Combination 1: Nodes 0, 1, and 2 combine the flow, while node 3 splits the flow and serves as the master node.

The upper computer provides all flow splitting/combining selection terminals from the low level to all the master and slave nodes. CAN slave node address selection: Address 1

P34 (CAN slave-node address 1) = 7 (0x0007)

Nodes 0, 1, and 2 combine the flow, while node 3 splits the flow and serves as the master node.

Combination 2: Nodes 0, 1, 2, and 3 combine the flow.

The upper computer provides all flow splitting/combining selection terminals from the high level to all the master and slave nodes. CAN slave node address selection: Address 2

P35 (CAN slave-node address 2) = 15 (0x000f)

The four nodes combine the flow to work.

7.6 Communication with four models

In this mode, there is one master node (single-pump system), and multiple slave nodes (of

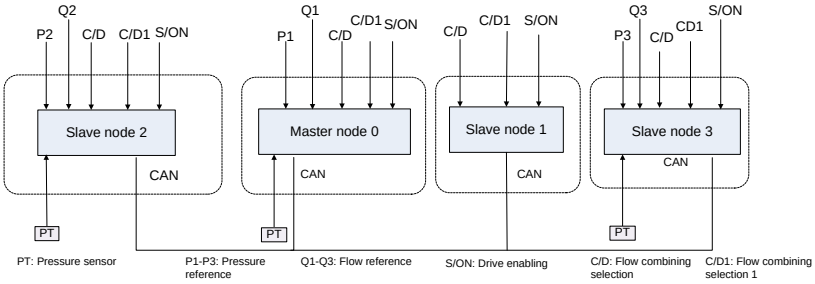
which each is also a single-pump system). The master node controls which slave nodes combine flow through the flow splitting/combining selection terminal and the terminal of flow splitting/combining selection 1. There are four types of node combination.

Terminal of flow splitting/combining selection 1	Terminal of flow splitting/combining selection	CAN slave node address selection
Low	Low	CAN slave-node address 1
Low	High	CAN slave-node address 2
High	Low	CAN slave-node address 3
High	High	CAN slave-node address 4

P34, P35, P36, and P37 (CAN slave-node addresses 1, 2, 3, and 4): used to select a slave node with the flow combined with the master node. Each is a 16-bit integer. A total of 15 slave nodes can be set. The value 1 of a bit indicates combining flow with the master node, while the value 0 indicates splitting flow and independent oil pump control. When the master node combines flow with slave nodes, bit 0 is 1; when the master node independently works, bit 0 is 0.

CAN slave node address Range in hexadecimal format: 0x0000–0xffff Range in decimal format: 0–65535																
16-bit integer, with each bit corresponding to a node																
Bit 15	Bit 14	Bit 13	Bit 12	Bit 11	Bit 10	Bit 9	Bit 8	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	
Slave node 15	Slave node 14	Slave node 13	Slave node 12	Slave node 11	Slave node 10	Slave node 9	Slave node 8	Slave node 7	Slave node 6	Slave node 5	Slave node 4	Slave node 3	Slave node 2	Slave node 1	Master node 0	

Wiring diagram for communication with four models:



Example: The hydraulic system has four oil pumps, with the addresses set to 0, 1, 4, and 3. There may be two types of action combination:

Combination 1: Nodes 0 and 1 combine the flow, while nodes 2 and 3 split the flow and serve as the master nodes.

The upper computer provides the flow splitting/combining selection terminal from the low level to all nodes, and the low level connects to the terminal of flow splitting/combining selection 1.
CAN slave node address selection: Address 1
P34 = 3 (0x0003)

Nodes 0 and 1 combine the flow, while nodes 2 and 3 split the flow and serve as the master nodes.

Combination 2: Nodes 0, 1, and 2 combine the flow, while node 3 splits the flow and serves as the master node.

The upper computer provides the flow splitting/combining selection terminal from the high level to all nodes, and the low level connects to the terminal of flow splitting/combining selection 1. CAN slave node address selection: Address 2
P35 = 7 (0x0007)

Nodes 0, 1, and 2 combine the flow, while node 3 splits the flow and serves as the master node.

Combination 3: Nodes 0, 1, and 3 combine the flow, while node 2 splits the flow and serves as the master node.

The upper computer provides the flow splitting/combining selection terminal from the high level to all nodes, and the low level connects to the terminal of flow splitting/combining selection 1. CAN slave node address selection: Address 3
P36 = 11 (0x000B)

Nodes 0, 1, and 2 combine the flow, while node 3 splits the flow and serves as the master node.

Combination 4: Nodes 0, 1, 2, and 3 combine the flow.

The upper computer provides the flow splitting/combining selection terminal and terminal of flow splitting/combining selection 1 from the high level to all the master and slave nodes. CAN slave node address selection: P37 (CAN slave node address 1) = 15 (0x000F)

The four nodes combine the flow to work.

Debug parameters for multi-node parallel connection control

Displayed code	Name	Description	Initial value	Unit
P00	Enabling the network	Indicates whether to enable the network. First, you need to debug the parameters used for the single pump type, flow splitting/combining selection, and node number for each node. For the master node, you need to set the number of slave nodes, the flow switch-in threshold, and the flow switch-in hysteresis upper limit and lower limit. Then, execute the network enabling command in a sequence from slave nodes to master nodes. 0: Disable. 1: Enable	0: Disable	
P01	Opening network pipes	Controls whether to enable the drives of all nodes. Applicable to the muti-mode type. 0: Close. 1: Open	0: Close	-
P02	Combining type	Selects the flow combining type.	0: Single	-

Displayed code	Name	Description	Initial value	Unit
		0: Single pump. 1: Hybrid. 2: Multiple pumps. 3: Multiple modes	pump	
P03	Node No.	The node No. 0 indicates the master node. A node No. ranging from 1 to 15 indicates a slave node.	0	-
P04	Slave count	When the node No. is 0, this parameter indicates the number of slave nodes connected to the master node.	0	-
P05	Node type	Specifies the working method of drive on a node. 0: Independent unit. 1: Control unit. 2: Following unit. 3: Flow-loop unit	0: Independent unit	-
P06	Flow switch-in threshold	Specifies the condition for a next pump to join the work. When the system flow exceeds the flow switch-in threshold of the working pump, a next pump is asked to join the work.	25	%
P07	Flow switch-in hysteresis upper limit	Specifies the condition for a next pump to join the work, used to prevent the pump from repeated startup and shutdown when the flow is at the threshold.	5	%
P08	Flow switch-in hysteresis lower limit	Specifies the condition for a next pump to join the work, used to prevent the pump from repeated startup and shutdown when the flow is at the threshold.	2.5	%
P09	Multi-pump pressure proportional gain 0	Step 0 of proportion parameter for multi-pump pressure PID control	8000	-
P10	Multi-pump pressure integral gain 0	Step 0 of integral parameter for multi-pump pressure PID control	88	-
P12	Multi-pump pressure proportional gain 1	Step 1 of proportion parameter for multi-pump pressure PID control	8000	-
P13	Multi-pump pressure integral gain 1	Step 1 of integral parameter for multi-pump pressure PID control	88	-
P15	Multi-pump pressure proportional gain 2	Step 2 of proportion parameter for multi-pump pressure PID control	8000	-
P16	Multi-pump pressure integral gain 2	Step 2 of integral parameter for multi-pump pressure PID control	88	-
P18	Multi-pump pressure proportional gain 3	Step 3 of proportion parameter for multi-pump pressure PID control	8000	-
P19	Multi-pump pressure integral gain 3	Step 3 of integral parameter for multi-pump pressure PID control	88	-

Displayed code	Name	Description	Initial value	Unit
P34	CAN slave-node address 1	Four slave-node addresses. Range: 0–65535	0	-
P35	CAN slave-node address 2		0	-
P36	CAN slave-node address 3		0	-
P37	CAN slave-node address 4		0	-

8 Troubleshooting

8.1 Display list for protection

The drive alarms with messages and protects against faults such as overvoltage and overcurrent. Once upon a fault occurs, the protection function is enabled, the drive stops output, and the motor stops running. Please view the displayed content to find out the cause and remove the faults. Fault records are stored in the internal memory of drive. The memory always show information and generation time of the last five faults, which can be viewed through the LED panel. The fault codes are listed in the following table. If the working condition is not improved after fault handling, contact our local dealer or service personnel.

Code	Name	Definition	Code	Name	Definition
Err01	IPM fault	Short-circuit current goes through the power module transiently.	Err02	Overcurrent	The output current exceeds the allowed working current of drive.
Err03	DC overvoltage	The DC voltage on the main circuit is abnormally high.	Err04	DC undervoltage	When the motor is powered on to run, the DC voltage on the main circuit decreases lower than the protection value.
Err05	FWD overspeed	The motor rotation speed exceeds the forward speed protection value.	Err06	Module overtemperature	The drive temperature exceeds the module protection temperature.
Err07	Motor overtemperature	The motor temperature exceeds the motor protection temperature.	Err08	Software fault	The drive software runs abnormally.
Err09	CAN fault	The drive reports the fault upon a CAN communication exception when the process command mode is continuous CAN communication input or multi-pump joint application.	Err10	Reserved	-
Err11	Self-check fault	The internal hardware of drive is abnormal.	Err12	Task re-entry	An error occurred when invoking a software program.

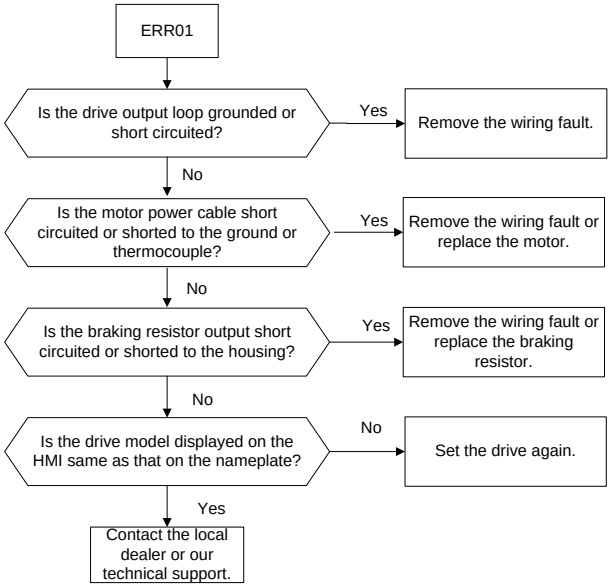
Code	Name	Definition	Code	Name	Definition
Err13	System overpressure	The system pressure exceeds the overpressure protection threshold.	Err14	REV overspeed	The motor rotation speed exceeds the reverse speed protection value.
Err15	Pressure sensor fault	The pressure sensor is incorrectly wired or damaged.	Err16	Braking pipe fault	The braking pipe is damaged.
Err17	AC overvoltage	The input AC voltage exceeds AC overvoltage protection@	Err18	EEPROM error	There is a drive EEPROM data exception.
Err19	Reserved	-	Err20	AC undervoltage	The input AC voltage is lower than AC undervoltage protection@
Err21	Braking resistor overload	The braking resistor overload rate exceeds the braking resistor overload threshold.	Err22	Node fault	In multi-pump parallel connection application, if a slave node encounter a fault, the master drive reports it.
Err23	Input phase loss	Input phase loss occurs or three phases are unbalanced.	Err24	Reserved	-
Err25	RS485 communication fault	The drive encounters an RS485 communication exception when the process command mode is continuous RS485 communication input.	Err26	Current feedback channel fault	The zero drift in power-on self-check is too great.
Err27–Err32	Reserved	-	Err33	Resolver sampling fluctuation fault	When the drive is tested in diagnosis mode, the resolver sampling value fluctuates greatly.
Err34	Phase-A current sampling fluctuation fault	When the drive is tested in diagnosis mode, the phase-A	Err35	Phase-B current sampling fluctuation fault	When the drive is tested in diagnosis mode,

Code	Name	Definition	Code	Name	Definition
		current sampling value fluctuates greatly.			the phase-B current sampling value fluctuates greatly.
Err36	Phase-A current sampling zero drift fault	When the drive is tested in diagnosis mode, the phase-A current sampling zero drift is too great.	Err37	Phase-B current sampling zero drift fault	When the drive is tested in diagnosis mode, the phase-B current sampling zero drift is too great.
Err38	DC voltage sampling fluctuation fault	When the drive is tested in diagnosis mode, the DC voltage sampling value fluctuates greatly.	Err39	Pressure feedback sampling fluctuation fault	When the drive is tested in diagnosis mode, the pressure feedback sampling value fluctuates greatly.
Err40	Pressure feedback sampling zero drift fault	When the drive is tested in diagnosis mode, the pressure feedback sampling zero drift is too great.	Err41	Pressure reference sampling fluctuation fault	When the drive is tested in diagnosis mode, the pressure reference sampling value fluctuates greatly.
Err42	Flow reference sampling fluctuation fault	When the drive is tested in diagnosis mode, the flow reference sampling value fluctuates greatly.	Err43	Reserved	-
Err44	Module temperature sampling fluctuation fault	When the drive is tested in diagnosis mode, the module temperature sampling value fluctuates greatly.	Err45	Motor temperature sampling fluctuation fault	When the drive is tested in diagnosis mode, the motor temperature sampling value fluctuates greatly.
Err46–Err48	Reserved	-	Err49	Encoder initial angle measuring fault	During motor parameter autotuning in diagnosis mode, a fault occurs in the encoder initial angle measuring, for example, current does not

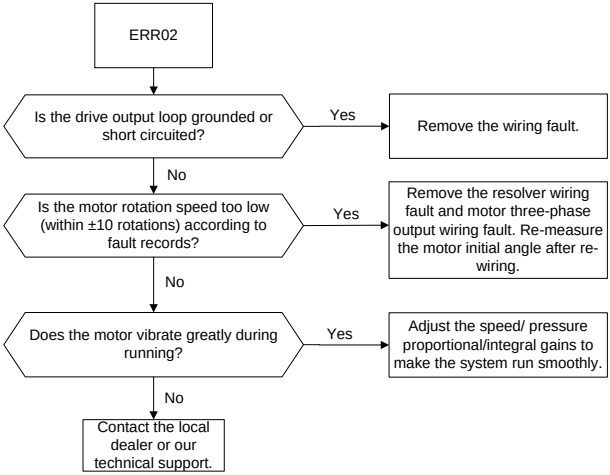
Code	Name	Definition	Code	Name	Definition
					follow, and timeout occurs.
Err50	Phase sequence test fault	During motor parameter autotuning in diagnosis mode, the number of motor pole pairs is calculated incorrectly, the rotation speed limit value is invalid, current does not follow, or timeout occurs.	Err51	Motor resistance test fault	During motor parameter autotuning in diagnosis mode, current does not follow, timeout occurs, or the resistance test value is invalid.
Err52	Motor parameter dynamic test fault	During motor parameter autotuning in diagnosis mode, the speed deviation is too great, current does not follow, the load is too great, timeout occurs, or the test value is invalid.	Err53	Motor parameter static test fault	During motor parameter autotuning in diagnosis mode, the motor parameter calculation result is invalid.
Err54	Diagnosis interrupted	If a fault occurs during diagnosis, the drive terminates the diagnosis and displays "Err54".	Err55	Reserved	-
Err56	EtherCAT initialization fault	The EtherCAT chip is in poor contact.	Err57	EEPROM fault in EtherCAT communication	The EEPROM does not have data or it fails to read data.
Err58	EtherCAT disconnection	After the drive is enabled, the network cable is not inserted properly, or the EtherCAT master node does not run properly. Run	Err59	EtherCAT communication fault	No PDO data is received after the drive has been enabled for a period of time.

8.2 Fault handling flowcharts

Err01: IPM fault



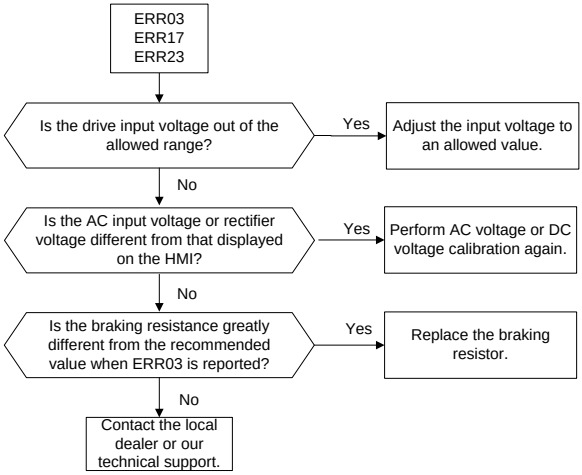
Err02: Overcurrent



Err03: DC overvoltage

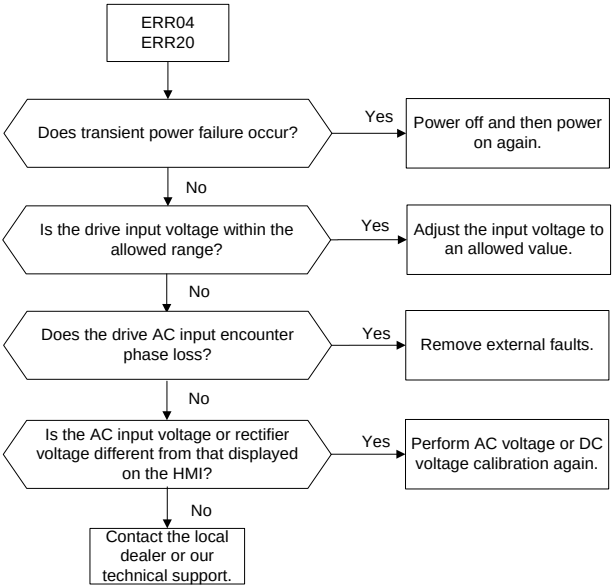
Err17: AC overvoltage

Err23: Input phase loss



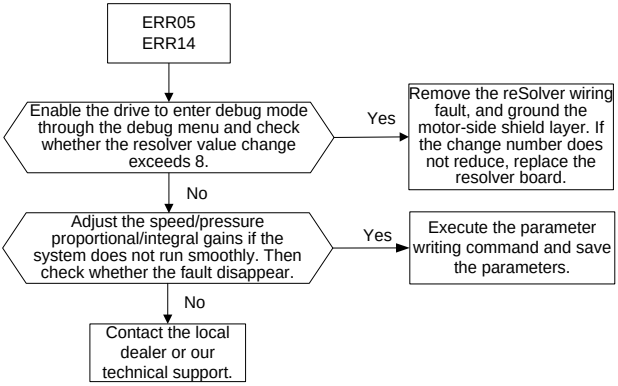
Err04: DC undervoltage

Err20: AC undervoltage

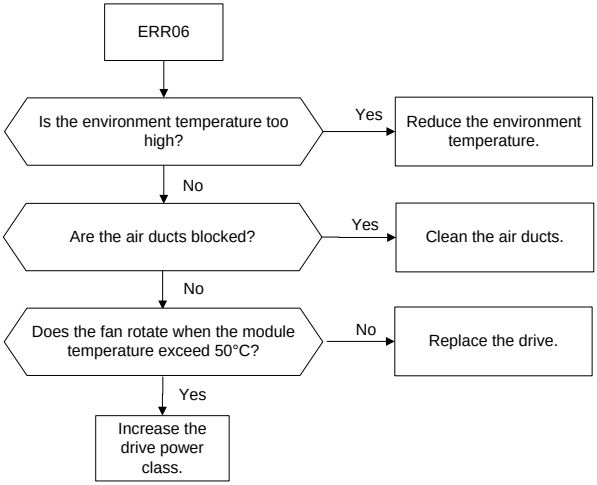


Err05: FWD overspeed

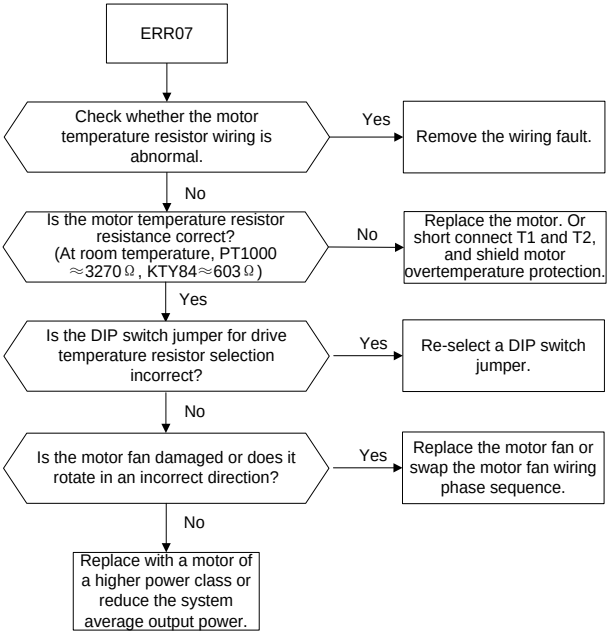
Err14: REV overspeed



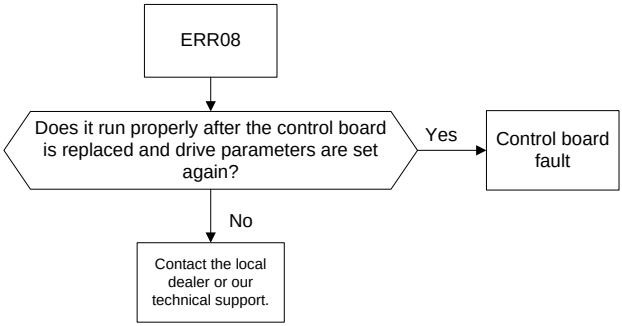
Err06: Module overtemperature



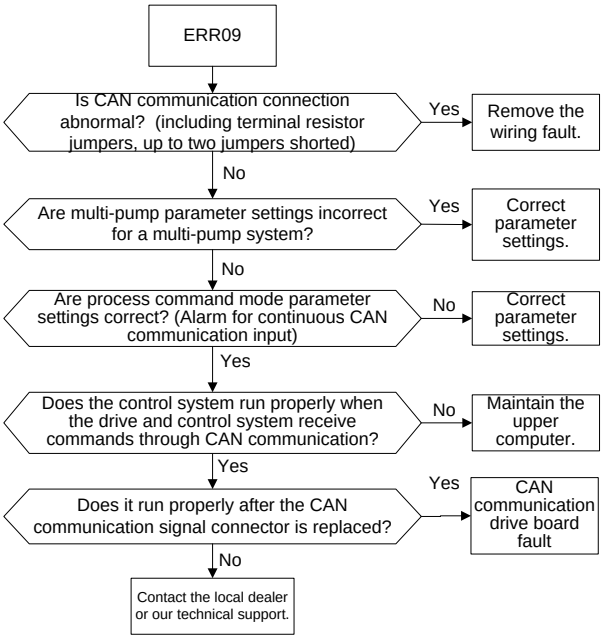
Err07: Motor overtemperature



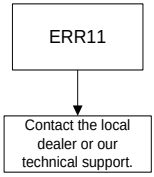
Err08: Software fault



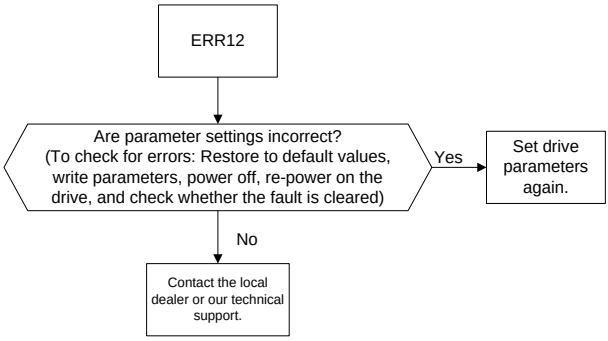
Err09: CAN fault



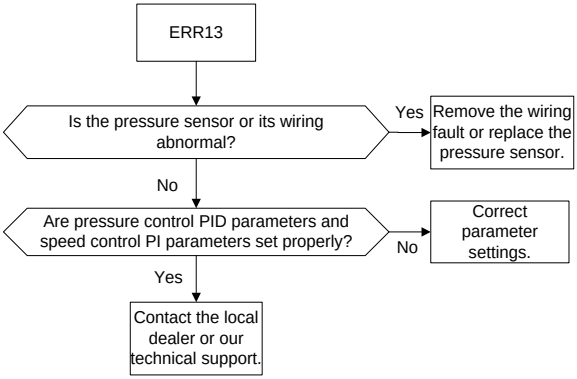
Err11: Self-check fault



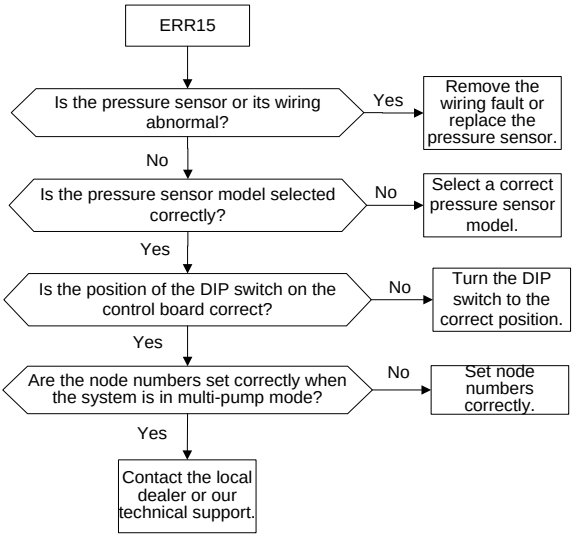
Err12: Task re-entry



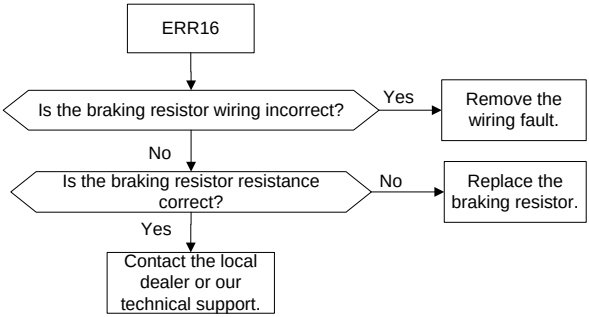
Err13: System overpressure



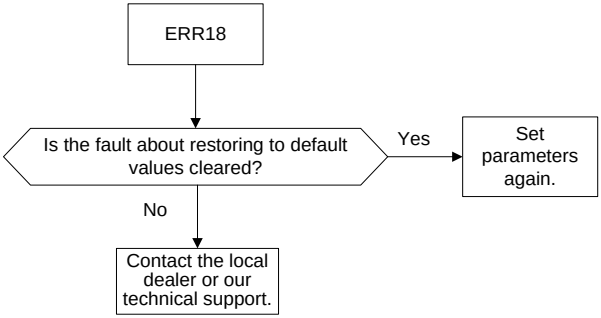
Err15: Pressure sensor fault



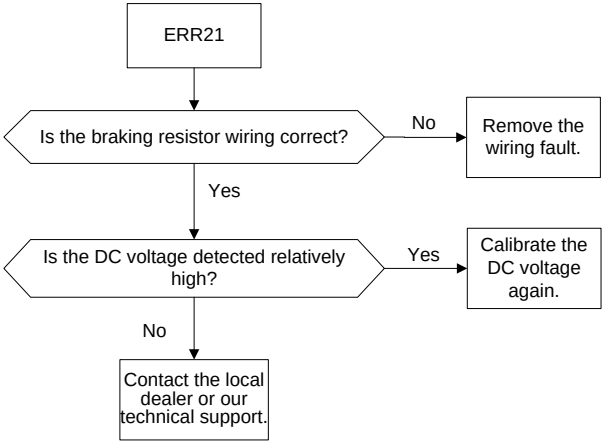
Err16: Braking pipe fault



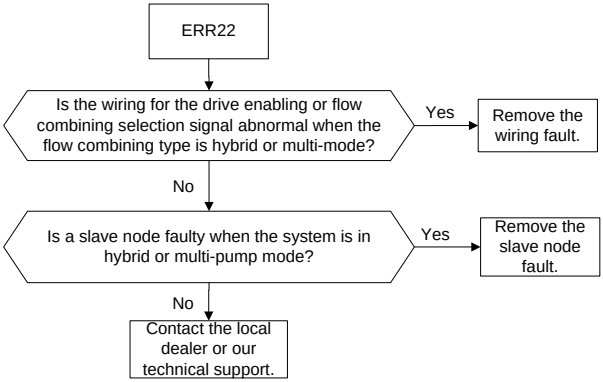
Err18: EEPROM error



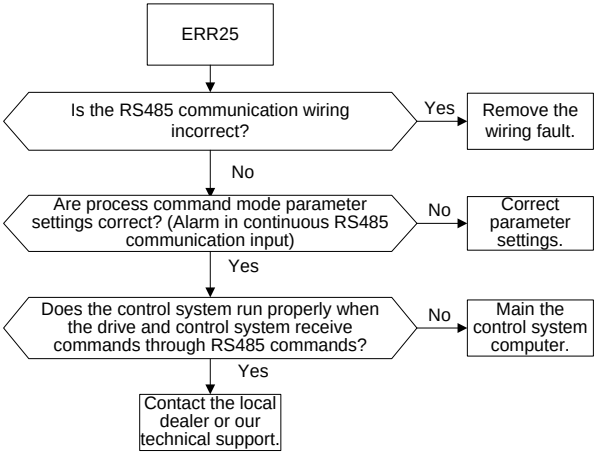
Err21: Braking resistor overload



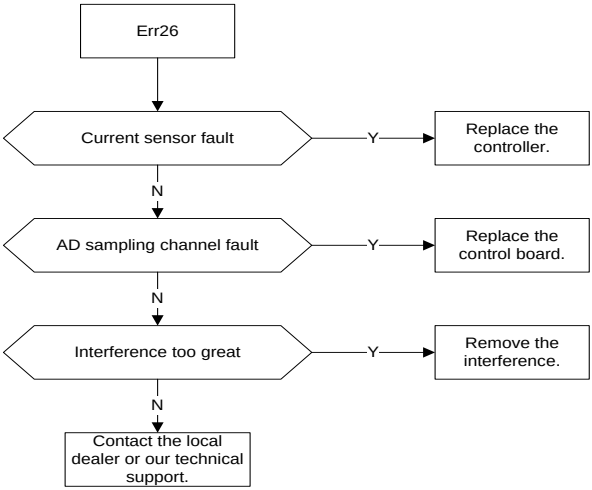
Err22: Node fault



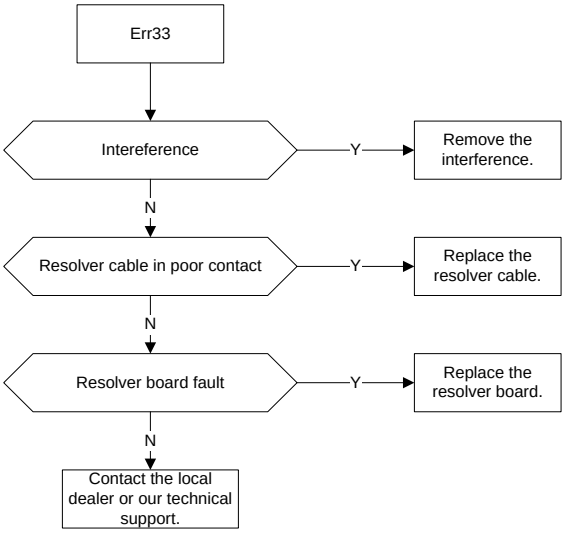
Err25: RS485 communication fault



Err26: Current feedback channel fault



Err33: Resolver sampling fluctuation fault

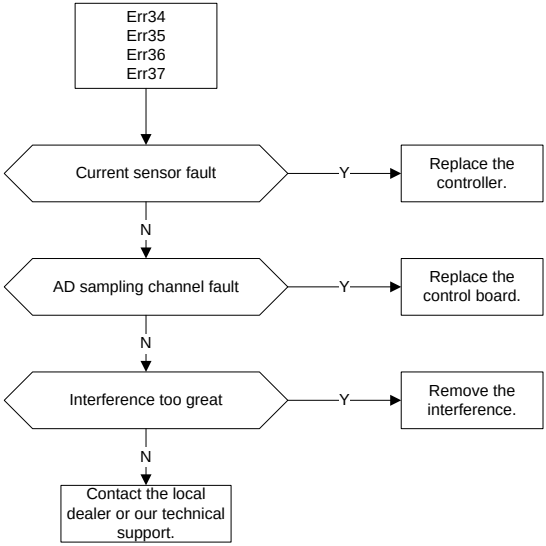


Err34: Phase-A current sampling fluctuation fault

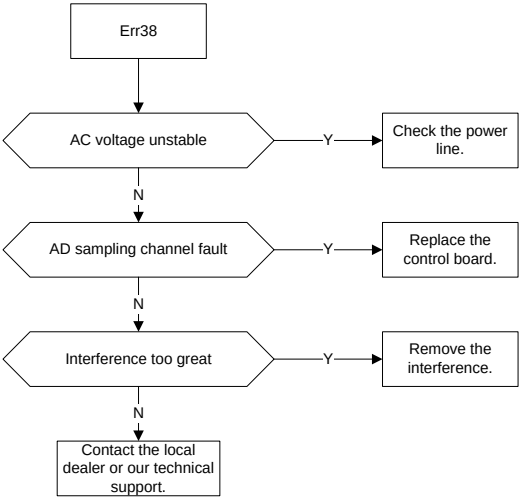
Err35: Phase-B current sampling fluctuation fault

Err36: Phase-A current sampling zero drift fault

Err37: Phase-B current sampling zero drift fault

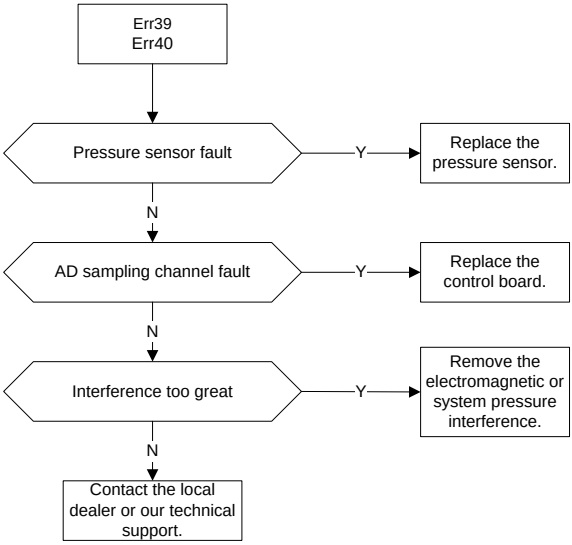


Err38: DC voltage sampling fluctuation fault



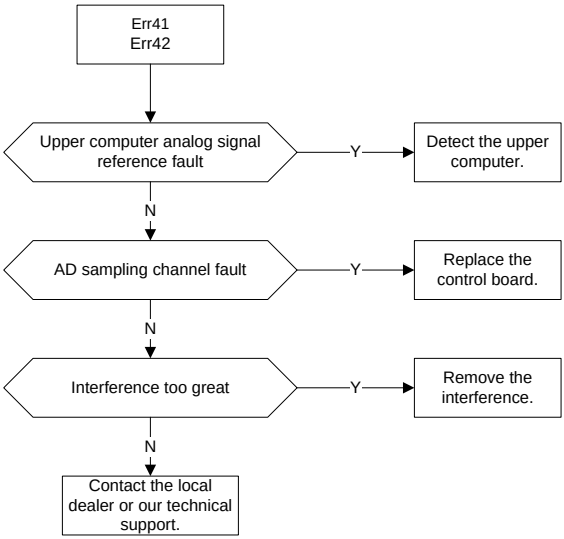
Err39: Pressure feedback sampling fluctuation fault

Err40: Pressure feedback sampling zero drift fault



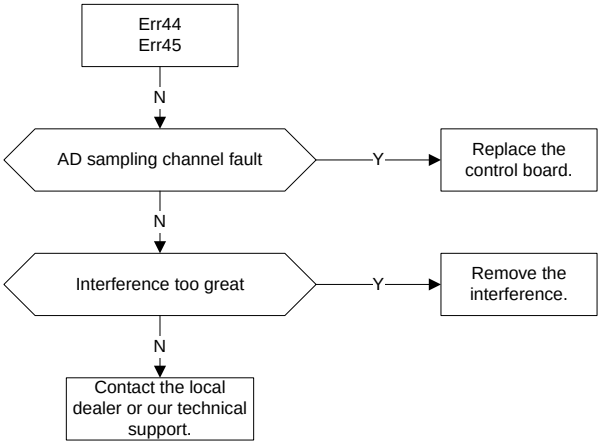
Err41: Flow reference sampling fluctuation fault

Err42: Pressure reference sampling fluctuation fault

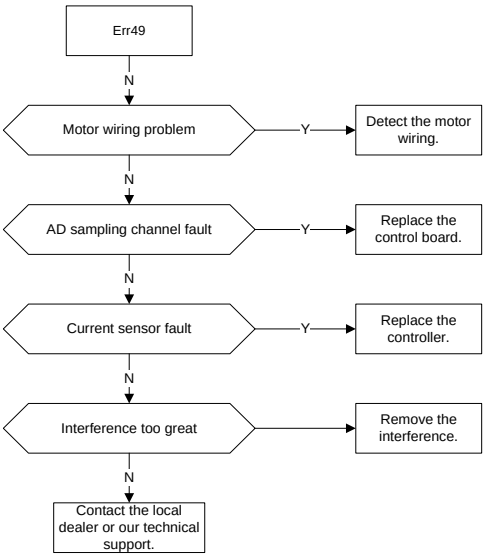


Err44: Module temperature sampling fluctuation fault

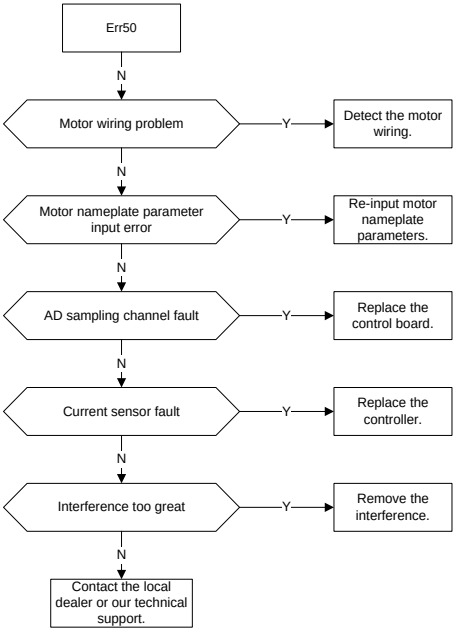
Err45: Motor temperature sampling fluctuation fault



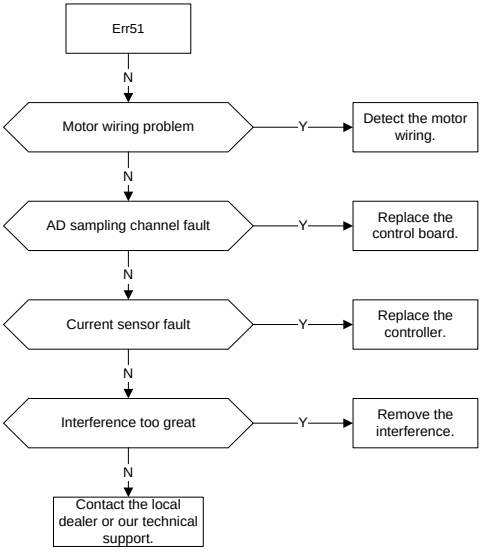
Err49: Encoder initial angle measuring fault



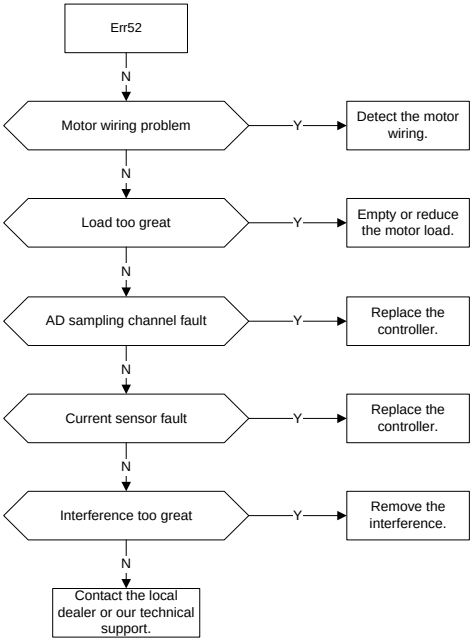
Err50: Phase sequence detection fault



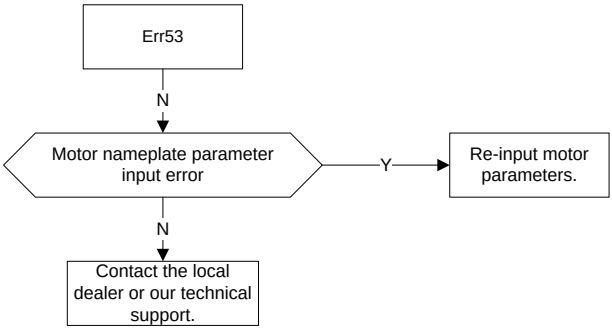
Err51: Motor resistance test fault



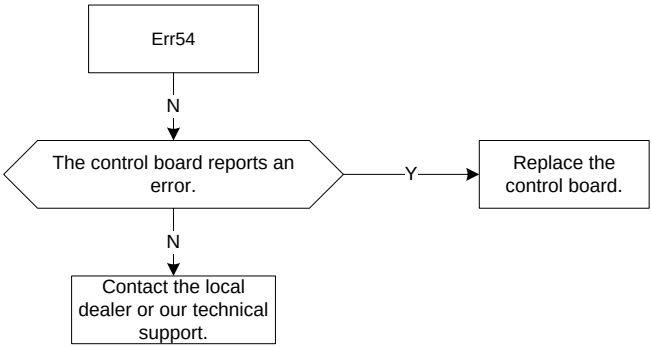
Err52: Motor parameter dynamic test fault



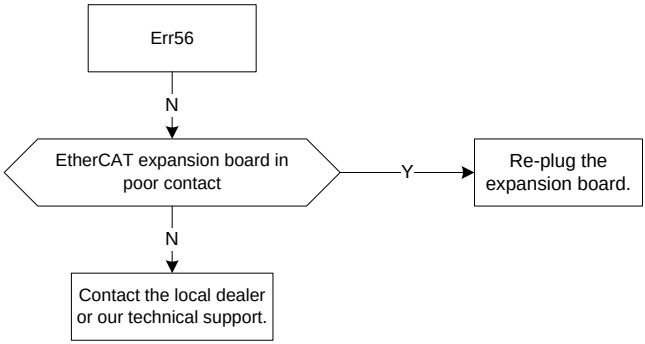
Err53: Motor parameter static test fault



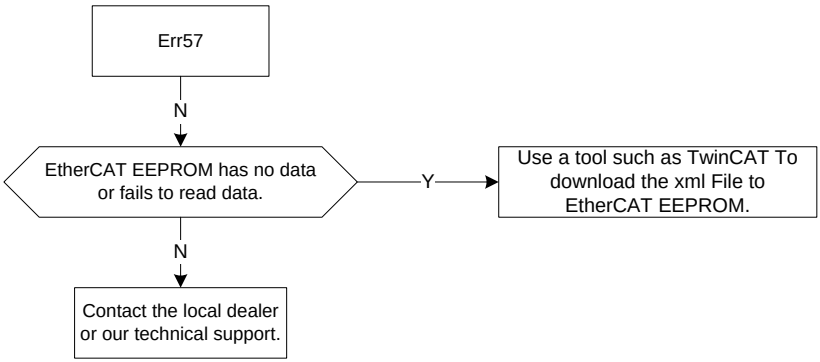
Err54: Diagnosis interrupted



Err56: EtherCAT initialization fault

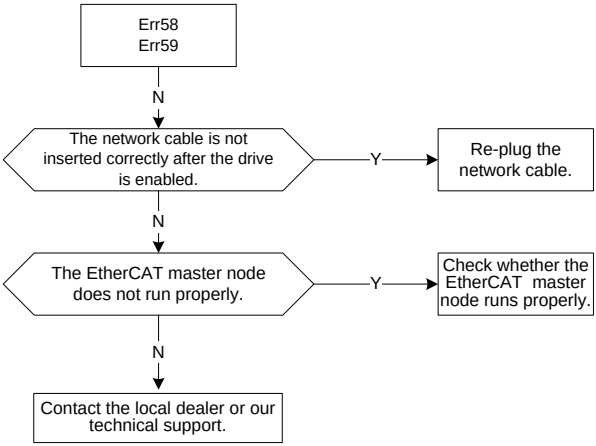


Err57: EEPROM fault in EtherCAT communication



Err58: EtherCAT disconnection

Err59: EtherCAT communication fault



8.3 Common faults and solutions

The following table lists the common faults that the servo may encounter and the solutions.

No.	Fault	Possible cause	Solution
1	No display at power-on	(1) Drive power input in poor condition. (2) Loose connection between the drive board and control board. (3) Internal drive component fault.	(1) Check the input power. (2) Remove and insert the connection wires. (3) Ask for manufacturer service.
2	Drive DI terminal invalid	(1) Loose DI terminal wires. (2) Incorrect parameter settings. (3) Loose short contact tag of J1 and J2, or incorrect internal or external power supply selected. (4) Control board terminal fault.	(1) Remove and insert the connection wires. (2) Check and set parameters correctly. (3) Ensure the short contact tag is in good contact and the short connection method is correct. (4) Ask for manufacturer service.
3	Motor not rotate as drive runs	(1) Resolver wires in poor contact. (2) Motor damaged or stalled. (3) Incorrect drive parameter settings.	(1) Perform correct wiring. (2) Replace the motor or check for mechanical faults. (3) Check and set drive parameters correctly.
4	Overcurrent	(1) Abnormal motor wiring (wire	(1) Correct motor wiring.

No.	Fault	Possible cause	Solution
	fault	damage or loose connection). (2) Incorrect parameter settings. (3) Load fluctuation or oil pump damage. (4) Abnormal position sensor wiring (wire damage or loose connection). (5) Drive fault.	(2) Set overcurrent parameters properly. (3) Calibrate the load system and oil system again. (4) Correct position sensor wiring. (5) Replace the faulty drive.
5	Overvoltage fault	(1) AC input power voltage too high. (2) Incorrect parameter settings. (3) Braking unit exception. (4) Drive fault.	(1) Adjust the AC power voltage to a normal value. (2) Set overvoltage parameters properly. (3) Ask for manufacturer service. (4) Replace the faulty drive.
6	Undervoltage fault	(1) AC input power voltage too low (or voltage drop too great). (2) AC 3PH input voltage with phase loss (3) Soft-startup relay not closed. (4) Drive fault.	(1) Adjust the AC power voltage to a normal value. (2) Check the power supply and run again. (3) Ask for manufacturer service. (4) Replace the faulty drive.
7	Motor/drive overtemperature fault	(1) Rated load exceeded. (2) Ambient temperature higher than 50℃. (3) Incorrect motor temperature sensor wiring. (4) Air duct blocked or fan damaged. (5) Internal drive circuit fault.	(1) Check the load condition, run condition, or motor capacity again. (2) Lower the ambient temperature to less than 50℃. (3) Correct motor temperature sensor wiring. (4) Replace the fan and clear the air duct. (5) Replace the faulty drive.
8	Pressure sensor fault	(1) Incorrect pressure sensor wiring. (2) Pressure sensor exception. (3) Incorrect pressure sensor model selection. (4) Drive fault.	(1) Correct pressure sensor wiring. (2) Replace the pressure sensor. (3) Reselect a pressure sensor model. (4) Replace the faulty drive.

9 Maintenance and inspection

The internal components of drive will become ageing due to the influence of environmental temperature, humidity, dust, vibration and other factors, which causes the potential failure or shortens the service life. Therefore, routine inspection and periodic maintenance must be performed for the drive.

9.1 Precautions

Do not perform inspection when the power is on. Otherwise, electric shock may result.

Before inspection, cut off all the equipment power supplies; wait for more than 10 minutes or measure the voltage with a multimeter at the U+ and U- terminals is lower than 36V. This avoids the danger caused by the residual voltage of drive internal capacitor.

9.2 Check item

The following items need to be checked on a regular basis.

Check item	Details	Method	Expected result
Running environment	Ambient temperature, humidity, dust volume, dust composition, oil/acid mist, and so on	Visual inspection, thermometer, and hygrometer	Requirements in the manual are met.
Power supply voltage	Whether the supply voltage is normal	Voltmeter and multimeter	Requirements in the manual are met.
	Whether power-on logic actions (such as contactor and air switch) are normal		
Drive exterior and internal components	Whether there is abnormal vibration, noise, deformation, or breakage	Screw fastening Visual inspection Multimeter	No exception occurs.
	Whether the external braking resistor connection is loose, resistor is aged, and resistance is normal		
Cable	Whether the power cable and its connection position are decolored, aged, or broken in the insulation layer.	Visual inspection	No ageing symptom such as decoloring or breakage
Air duct	Whether the air duct or heat sink is blocked	Visual inspection	No blocking

9.3 Main circuit insulation test

The megohmmeter test is limited to the insulation between the motor windings and the housing. Before the test, all wires between the motor and drive must be disconnected already. Only the 1000V megohmmeter can be used, with the insulation resistance greater than 50MΩ.

An improper insulation test method may damage the drive. You are not advised to perform the insulation test by yourself.

9.4 Replacement of wearing parts

9.4.1 Service life

The wearing parts of drive mainly include the cooling fan and electrolytic capacitor for filtering, whose service life is closely related to the running environment and maintenance condition. The following table lists the service life of the wearing parts, which can be replaced based on the accumulative run time.

Part	Service life	Test condition
Fan	≥ 5 years	Ambient temperature: 40°C Load rate: 80% Run time: 24 hours/day
Electrolytic capacitor	≥ 5 years	

9.4.2 Replacement

The fan or electrolytic capacitor that reaches the service life or has a damage needs to be replaced in time to avoid affecting the normal use of drive. The following table lists the replacement criteria and method.

Part	Symptom	Criteria	Replacement method
Fan	The shaft bearing is much worn out, the blades are aging, or the blades do not run.	The blades have cracks. There are abnormal noises or vibrations.	Loosen the screws, remove the fan cover, and pull it outward. After replacement, ensure that the wind blows outward.
Electrolytic capacitor	There is liquid outflow, the safety valve is loose, or the electrostatic capacitance value changes.	There is breakage in the exterior, the safety valve is loose, or the electrostatic capacitance value changes.	Do not replace the electrolytic capacitor by yourself since drive internal components are related. Please contact the supplier for the replacement.

10 Accessories

10.1 Accessory model list

ACCESSORY	MODEL	APPLICATION
Filter	DL-35EBK5	018/025
	DL-50EBK5	032/038/043
	DL-65EBK5	060/070
	DL-100EBK5	092/115
	DL-130EBK5	150/180
	DL-160EBK5	215
AC reactor	ACL2-5R5-4	018/025
	ACL2-015-4	032/038/043
	ACL2-022-4	060/070
	ACL2-037-4	092/115
	ACL2-055-4	150/180
	ACL2-075-4	215
Braking resistor	40Ω, 500W	018/025/032/038
	20Ω, 500W	043/060/070
	10Ω, 2000W	092/115
	10Ω, 2000W (two, in parallel connection)	150/180
	30Ω, 2000W (two, in parallel connection)	215
Braking unit	DBU100H-060-4	215
Pressure sensor	U5176-000005-250BG	All series
External HMI	H038-HA	All series

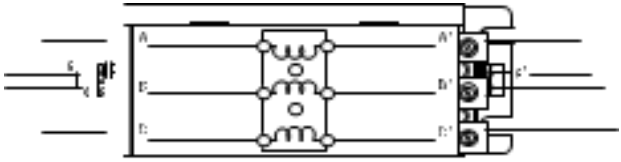
10.2 Noise filter model selection

1. Mapping between drive models and noise filter models

Drive model	Noise filter model	
	Model	Specifications
MH860-T018SF7 MH860-T025SF7	DL-35EBK5	35A,200nF
MH860-T032SF7 MH860-T038SF7 MH860-T043SF7	DL-50EBK5	50A,320nF
MH860-T060SF7 MH860-T060SY7	DL-65EBK5	65A,320nF
MH860-T070SF7	DL-65EBK5	65A,320nF
MH860-T092SF7 MH860-T092SY7	DL-100EBK5	100A,320nF
MH860-T115SF7 MH860-T115SY7	DL-100EBK5	100A,320nF
MH860-T150SF7	DL-130EBK5	130A,690nF

Drive model	Noise filter model	
	Model	Specifications
MH860-T150SY7		
MH860-T180SF7 MH860-T170SY7	DL-130EBK5	130A,690nF
MH860-T215SF7	DL-160EBK5	160A,690nF

2. Filter terminal definition



Symbol	Definition
A	Input 3PH power
B	
C	
G	Input power ground
A’	Output 3PH power
B’	
C’	
G’	Output power ground

3. Filter dimensions (mm)

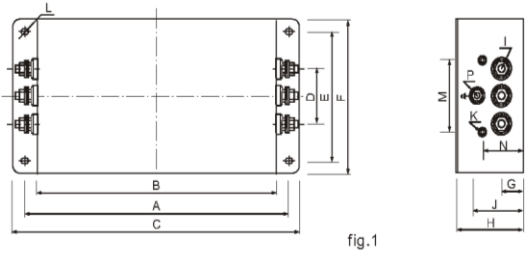


fig.1

Model	A	B	C	D	E	F	G	H	I	J	K	M	N	P	L
DL-35EBK5	243	224	265	58	70	102	25	92	M6	58	M4	74	49	M6	6.4×9.4
DL-50EBK5															
DL-65EBK5															
DL-100EBK5	354	323	388	66	155	188	30	92	M8	62	M4	86	56	M8	6.4×9.4
DL-130EBK5															
DL-160EBK5															

The noise filter is bolted to a well-ventilated area, and the input and output ground terminals must be reliably connected to the system ground. For details about the connection method,

see section 4.6.5 Typical wiring examples of main circuit.

10.3 Braking resistor model selection and installation

1. Mapping between drive models and braking resistor/unit specifications/models

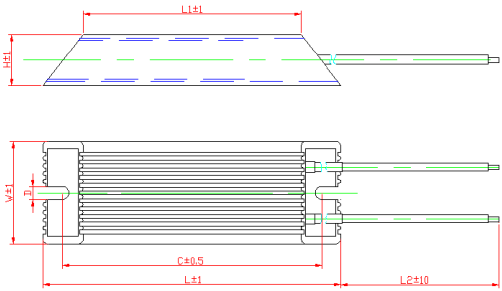
Drive model	Braking resistor specifications		Braking unit model
	Resistance (Ω)	Power (W)	
MH860-T018SF7	40	500	Built-in braking unit
MH860-T025SF7	40	500	
MH860-T032SF7	40	500	
MH860-T038SF7	40	500	
MH860-T043SF7	20	500	
MH860-T060SF7 MH860-T060SY7	20	500	
MH860-T070SF7	20	500	
MH860-T092SF7 MH860-T092SY7	10	2000	
MH860-T115SF7 MH860-T115SY7	10	2000	
MH860-T150SF7 MH860-T150SY7	5	4000 (two of 10Ω/2000kW, in parallel connection)	
MH860-T180SF7 MH860-T170SY7	5	4000 (two of 10Ω/2000kW, in parallel connection)	
MH860-T215SF7	15	4000 (two of 30Ω/2000kW, in parallel connection)	DBU100H-060-4

The 90kW and lower drive models have built-in braking units, while the 110kW and higher models need to use external braking units. The drive does not have an internal braking resistor, and it must connect to an external braking resistor assembly. The braking resistor with higher power may be needed when the motor brakes frequently. In this situation, you can order the braking resistor with small resistance but high power. The external braking resistor must be installed in a well-ventilated area, away from combustible objects or non heat-resistant parts.

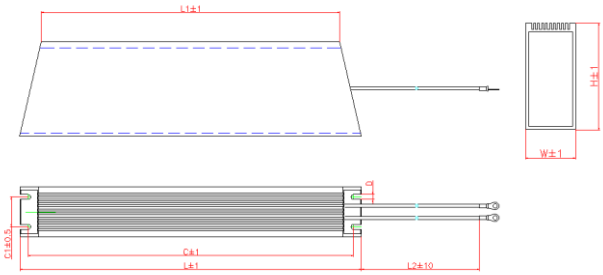
When configuring the external braking resistor by yourself, you must ensure the resistance value is at least equal to the specified value. Otherwise, drive damage may result.

2. Braking resistor dimensions (mm)

The aluminum-housed braking resistors RXLG-500W-40R (for 018/025/032/038) and JRXLG-500W-20RJ (for 043/060/070 drives) are as follows.



The aluminum-housed braking resistors RXLG-2000W-10RJ (for 092/115 drives, or for two of 150/170/180 drives in parallel connection), and RXLG-2000W-30RJ (for two of 215 drives in parallel connection) are as follows.



Model	L	L1	W	H	C	C1	D	L2
RXLG-500W-20R J RXLG-500W-40R J	335	290	60	30	315	/	5.6	800
RXLG-2000W-10R J RXLG-2000W-30R J	550	510	50	107	530	30.5	5.5	1000

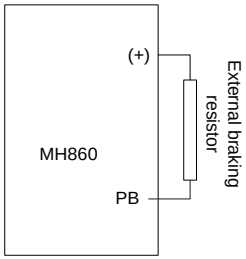
3. Braking resistor installation

All resistors must be installed in places with good cooling conditions.

	The materials near the braking resistor or braking unit must be flame resistant. since the surface temperature of the resistor is high and air flowing from the resistor is of hundreds of degrees Celsius. Prevent any materials from coming into contact with the resistor.

Braking resistor installation

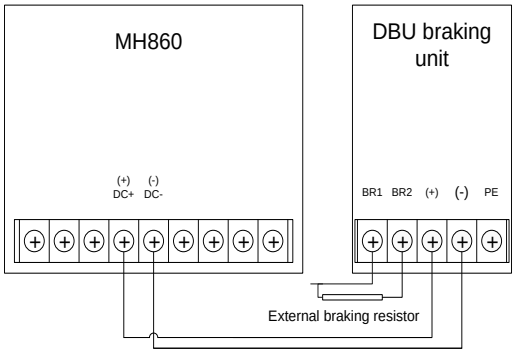
	• The 90kW and lower drive models needs to be configured only with external braking resistors. • PB and (+) are the terminals for connecting braking resistors.



Braking unit installation

	• The 110kW and higher models need to be configured with external braking units. • (+) and (-)are the terminals for connecting braking units. • The connection cable length between the (+) and (-) terminals of the VFD and those of a braking unit must be shorter than 5m, and the connection cable length between the BR1 and BR2 terminals of a braking unit and the terminals of a braking resistor must be shorter than 10m.

Single connection:



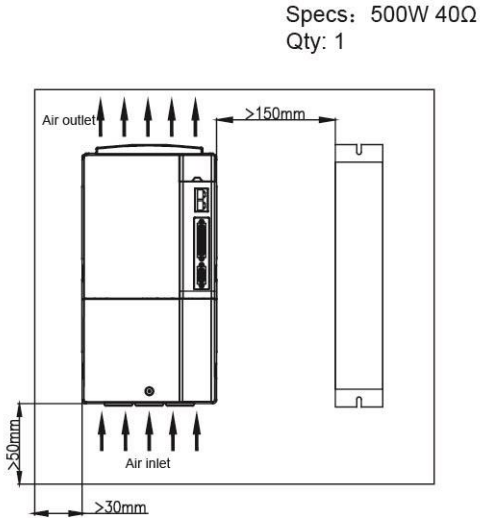


Figure 10-1 MH860-018/025/032/038/043/060/070/092/115 drive and braking resistor layout (mm)

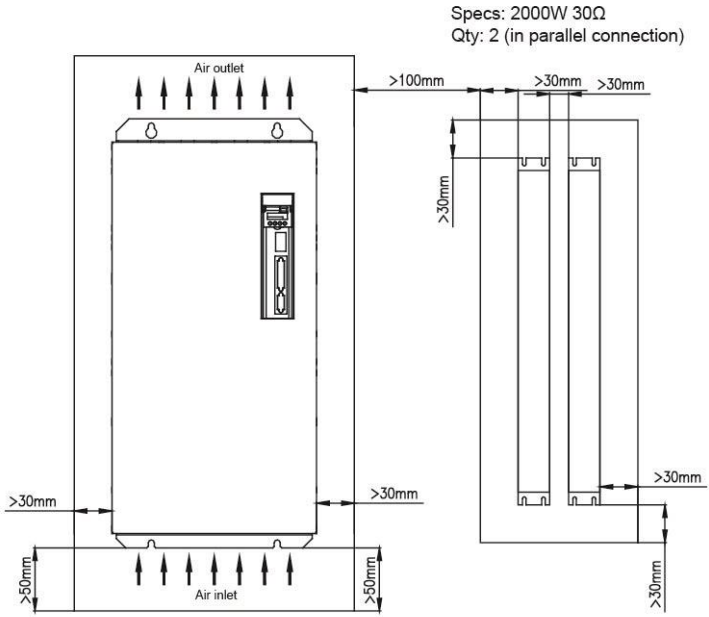
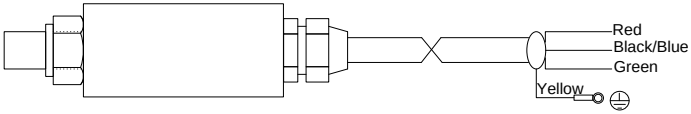


Figure 10-2 MH860-150/170/180/215 drive and braking resistor layout (mm)

10.4 Pressure sensor model selection

Pressure sensor terminal



Color	Item	Definition
Red	+15V	15V power supply
Black/Blue	AGND	Pressure analog signal output
Green	AIN3+	
Yellow	PE	Ground wire

The raw tape is used to seal the connection between the pressure sensor and the oil path. During installation, the pressure sensor must be fastened securely to avoid leakage.

Service line: 400-700-9997; 86-21-34637660 Website: www.invt-tech.com

INVT INDUSTRIAL TECHNOLOGY (SHANGHAI) CO.,LTD.

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