Installation, operation and maintenance manual

SG series

Introduction

ABOUT THIS MANUAL

This manual provides information for installing, operating and maintaining the Sea Gyro gyroscopic stabilizer.
Study this manual carefully and observe all warnings and cautions. Using the SG set properly and following a regular maintenance schedule will contribute to longer unit life, better performance and safer operation.

AWARNING

INCORRECT SERVICE OR REPLACEMENT OF PARTS CAN RESULT IN SEVERE PERSONAL INJURY AND/OR EQUIPMENT DAMAGE. SERVICE PERSONNEL MUST BE QUALIFIED TO PERFORM ELECTRICAL AND/OR MECHANICAL SERVICE.

Installation

GENERAL LOCATION

Proper installation is very important. Requirements to consider should include:
Adequate cooling air
Discharge of circulated air
Electrical connections and bonding
Accessibility for operation and servicing
Level mounting surface
Noise levels
The instructions in this section should be used only as a guide as each installation must be considered on an individual basis.

Sea Gyro stabilizers

Generally the location is preferable in the same room or compartment as the propulsion engine, as this is usually a well ventilated area, insulated, close to the electrical supply and is the center of electrical load distribution. A Sea Gyro stabilizer set cannot be installed in the propulsion engine compartment which uses a gasoline fuel system, as this requires the Sea Gyro stabilizer set to operate in a gasoline fuel environment and to be "ignition protected." (This means a set capable of operating in an explosive environment without igniting that environment.)

Gasoline fire or explosion can result in severe personal injury or death.

Keep the Sea Gyro stabilizer set away from living quarters, and away from bilge splash and vapors. Select a location that will allow adequate space on all sides for servicing the set, preferably on and parallel with the keel or vessel center line.

MOUNTING

The floor must be flat and give support directly under the equipments mounting points. A 50mm clearance around the unit is required to permit rocking on its mounts without restraint. Use approved cables and electrical wiring conduit or severe property damage and personal injury may result.

VENTILATION

The Sea Gyro stabilizer electrics will require fresh air for cooling the Motor, VFD unit and for the cooling of the dampers.

ELECTRICAL CONNECTIONS

General

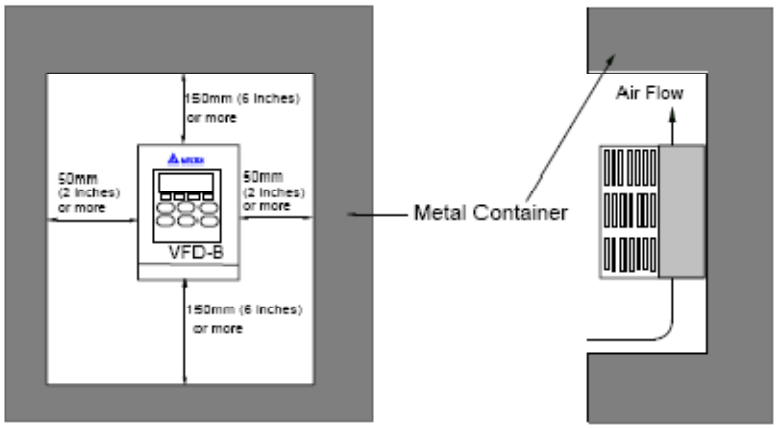
Installing the Sea Gyro stabilizer electrical system includes connecting the motor (load), installing the remote start control (if used), and connecting the VFD. The power must always be connected last to the VFD to avoid accidental starting of the Sea Gyro stabilizer during installation.

VDF UNIT

⚠ CAUTION
The control, power supply and motor leads must be laid separately. They must not be fed through the same cable conduit / trunking.
High voltage insulation test equipment must not be used on cables connected to the drive.

Improper installation of the AC drive will greatly reduce its life. Be sure to observe the following precautions when selecting a mounting location. **Failure to observe these precautions may void the warranty!**

- Do not mount the AC drive near heat-radiating elements or in direct sunlight.
- Do not install the AC drive in a place subjected to high temperature, high humidity, excessive vibration, corrosive gases or liquids, or airborne dust or metallic particles.
- Mount the AC drive vertically and do not restrict the air flow to the heat sink fins.
- The AC drive generates heat. Allow sufficient space around the unit for heat dissipation as shown in the figure shown next page:



Minimum Clearances and Air Flow

Load Connections

All wiring **must** meet the applicable codes. Have a qualified electrician install and inspect the boat wiring. The Sea Gyro wiring diagram does not include components added by customers. When installing the wiring to the stabilizing set, use a section of flexible cable next to it to absorb vibration.
Use flexible multi-strand wire throughout the boat to reduce the danger of breakage from vibration.
The Sea Gyro stabilizer voltage and maximum current rating is specified in the specifications.

Connecting the cable

The cable is connected to the junctions inside the VFD control box as shown in the wiring diagram. Use flexible conduit at the control box to permit movement of the stabilizer set. Grounding procedure must comply with codes.

Earth

Contact with electrically "hot equipment" can result in severe personal injury or death. It is extremely important that bonding and equipment grounding be properly done. All metallic parts which could become energized under abnormal conditions must be properly grounded.

Remote Control Connections

Provision is made for addition of optional remote starting

Dockside Power Connection

Most boats incorporate a dockside connection so the boat can be plugged directly into a commercial source while at dock. If this is done, switching to transfer the load between the ship's generator set and dock power will require restarting the Sea Gyro stabilizer unit. The Sea Gyro VDF must never be operating during the switch over. Doing so will damage the VFD. This procedure does not require that the gyroscopic unit stops spinning, only that the VFD is turned off temporarily during this operation.
On re-establishing the power and re-starting the VFD, the VFD will search the flywheels speed and continue its duties.

INITIAL STARTING AND CHECKS

Before attempting the initial start of the Sea Gyro stabilizer set, be sure it is serviced for operation. Refer to the Maintenance section of this manual for the proper procedures.

Connect Power supply-First spin

WARNING

High voltage can cause severe personal injury or death. Do not disconnect or connect power cables if high voltage is present.

Before applying full speed, perform the following to verify the set will perform correctly:
1. Check ship's generator output frequency, phases and voltage.
Connect an accurate AC voltmeter across two line terminals.
2. Start the Sea Gyro stabilizer set by pressing the Start-Stop switch on the VFD control panel to the Start position.
3. The flywheel should commence to turn within a ten seconds. Allow the gyroscopic unit to run for 20 seconds.
4. Press the Start-Stop button (which will stop power to the electric motor).
5. Monitor the flywheel and note any abnormal sounds. The flywheel should turn freely. Refer to the Operation section of this manual for normal readings. At operating temperature, all readings should stay within the normal range.
6. Check that the flywheel assembly moves freely and does not interfere with the motor power supply cable.
7. Check the Sea Gyro stabilizer set for vibration, smells and debris.
If any are found, shut down the Sea Gyro stabilizer and repair before making any more checks.

WARNING

Accidental starting of the Sea Gyro stabilizer can cause severe personal injury or death. Stop the Sea Gyro stabilizer when repairs are made to the motor, controls, or wiring.

Operation

THE POWER IN THE FLYWHEEL IS DEADLY!
Do not attempt to touch the flywheel when spinning.

GENERAL

This section covers starting and operating the Sea Gyro stabilizer. It is recommended that the operator read through this entire section before attempting to start the set. It is essential that the operator be completely familiar with the Sea Gyro stabilizer to provide safe operation.

PRE-START CHECKS

Before starting, be sure the following checks have been made and the unit is ready for operation. Refer to the MAINTENANCE section for the proper procedures.

LUBRICATION

The units are supplied pre-greased.

CONTROL PANEL

Check ship's generator output frequency, phases and voltage.
Line Circuit Breaker Protects the Sea Gyro stabilizer from a short circuit or other overload.

STARTING

This section covers starting of the Sea Gyro stabilizer at the control panel and remote starting.

Starting at Control Panel

The following steps outline the correct procedures for starting the Sea Gyro stabilizer control panel.
1. Press the Start/Stop switch in the Start position. This activates the VDF control and provides power to the system.
2. The flywheel will begin to turn after a few seconds. Should there be a problem with the startup, a code will be displayed on the VDF unit
3. If the flywheel does not start to turn after **30** seconds, press the start/stop switch again. Wait two minutes and then proceed to trouble shooting.
4. Check exhaust fan for operation (air movement).

Caution

Excessive startup periods can overheat and damage the motor. Do not try to start flywheel rotation for periods longer than 30 seconds.
If the Sea Gyro stabilizer does not start check the main switch and power supply (be sure the three phases are available).

Remote Starting

If the Sea Gyro stabilizer is started from a remote location, the same procedures and caution for starting at the control panel apply.

Start-up Checks

Check current and frequency on VDF after the Sea Gyro stabilizer is started.

STOPPING

Before Stopping

Check current and frequency on VDF before the Sea Gyro stabilizer is stopped.

To Stop

Press the Start/Stop switch of the VDF unit or the remote switch.

OPERATING RECOMMENDATIONS

Break-In

Check for noise, heat and vibration after the first **one** hour of operation on any new Sea Gyro stabilizer.

Refer to the Maintenance section of this manual for the recommended procedures.

After the first 20 hours of operation, Sea Gyro recommends that verification of the ship's generator voltage may be necessary. Due to the normal break-in of a generator's engine, verify if the voltage is within normal specifications**.**

No Load Operation

Long periods of no-load operations should be kept to a minimum and avoid if possible. No-load operation may allow brittling of the radial bearings.

Exercise Period.

Infrequent use of the Sea Gyro stabilizer can result in hard starting. This may be due to grease buildup. Exercise the Sea Gyro stabilizer at least once a month for a minimum of 30 minutes.

TROUBLESHOOTING

The following sections describe operation of the fault systems and suggested items the operator can check. If a major problem is indicated, contact Sea Gyro. The VDF control panel Fault indicator will display for any one of the fault conditions described separately below.
Locate the problem and make the necessary corrections before starting the Sea Gyro stabilizer.

High bearing Temperature:
Observe temperature of bearings for indications of high temperatures over 110^{o}C.
Contact a Sea Gyro representative if this problem exists.
High VDF Temperature:
The VDF will switch off if the temperature is too high. The VDF automatically controls its internal fan. High VDF temperature indicates failure gyroscopic motor, less than three phase supply, poor ventilation or a hot environment.

FAULT SENSOR LOCATION

AC Control
The **VDF** control has a display panel on the face of the unit.
See Figure 16. For a list of codes if a fault is present

Maintenance

Establish and adhere to a definite schedule for maintenance and service. If the Sea Gyro stabilizer will be subjected to extreme operation conditions, the service intervals should be reduced accordingly.
Perform service at the time period or after the number of operating hours shown, whichever comes first. Use the schedule to determine maintenance required and then refer to the sections that follow for the correct service procedures.

PERIODIC MAINTENANCE SCHEDULE

1. Check for noise, vibration and heat stress. Check flywheel audibly and visually with set running and notify of any problems immediately.
2. Perform after first one hour of operation on new sets.
3. Perform more often in extreme conditions.
4. Visually check belts for evidence of slippage.
5. Regularly spray the insides with a rust inhibitor such as WD40.

SET INSPECTION

During operation, be alert for mechanical problems that could create unsafe or hazardous conditions. The following sections cover several areas that should be frequently inspected to insure continued safe operation.

VDF DISPLAY

Check the following readings while the Sea Gyro stabilizer is operating.

Operating frequency:
The operating frequency should be 50/60 hz when the Sea Gyro stabilizer is at maximum operating speed.
Motor current:
The power should be in the range of 50 to 70 % (of maximum rated power) depending on the load and ambient temperature.

Mechanical
With the Sea Gyro stabilizer set stopped, check for loose belts, fittings, or any signs of mechanical damage. If any problems are found, have them corrected immediately. Check for dust and dirt accumulation and clean if necessary.
With the set running, listen for unusual noises that may indicate mechanical problems. Investigate anything that indicates a mechanical malfunction.

LUBRICATION SYSTEM
The Sea Gyro stabilizer is provided pre-greased.
Do not use excessive grease and do not mix different brands of grease.

Drive Belts
Remove the front panel for belt inspection or replacement.
A loose or defective belt can cause the Sea Gyro stabilizer to overheat and cause poor speed regulation. Belts should be checked for excessive slackness, oil soak, wear, tear, cracks and overstretching. Replace if needed.
Adjustment: Proper tension is required with a specified deflection when the belts are pressed down with a pressure of 10 kg at the midpoint between pulleys. Tighten adjustment cap screws when proper tension is achieved.

AC MOTOR
The motor/s should be inspected to check wear and for cleaning as required per the Periodic Maintenance Schedule. Be sure to use the isolation switch to prevent starting of the Sea Gyro stabilizer before proceeding.

Caution
Stop the Sea Gyro stabilizer set and disable the VFD before inspecting the motor.
If dust has accumulated on any motor components, they can be cleaned with filtered, low pressure air.

OUT-OF-SERVICE PROTECTION
If the Sea Gyro stabilizer set will be out of service for more than 30 days, protect it by using the following procedures.
1. Start and run the Sea Gyro stabilizer set until it is thoroughly warm (half hour). Stop the set.
2. Clean and wipe entire unit.
3. Coat parts susceptible to rust with a light coat of rust inhibitor oil or grease. (ie WD40)

Returning Unit to Service
Refer to preceding paragraphs in this Maintenance section for specific service procedures.

VDF UNIT

Modern AC drives are based on solid state electronics technology, preventive maintenance is required to operate this AC drive in its optimal condition, and to ensure a long life. It is recommended to perform a monthly check up of the AC drive by a qualified technician. Before the check up, always turn off the AC Input Power to the unit. Wait at least 2 minutes after all display lamps have gone out, and then confirm that the capacitors have fully discharged.

CH 6-1 Periodic Inspection:

Basic check up items to detect if there were any abnormality during the operation.

1. Whether the motors are operating as expected.
2. Whether the installation environment is abnormal.
3. Whether the cooling system is operating as expected.
4. Whether any irregular vibration or sound occurred during the operation.
5. Whether the motors are overheated during the operation.
6. Always check the input voltage of the AC drive with Voltmeter.

CH 6-2 Periodic Maintenance

It is necessary to stop the motor operation during the check up.

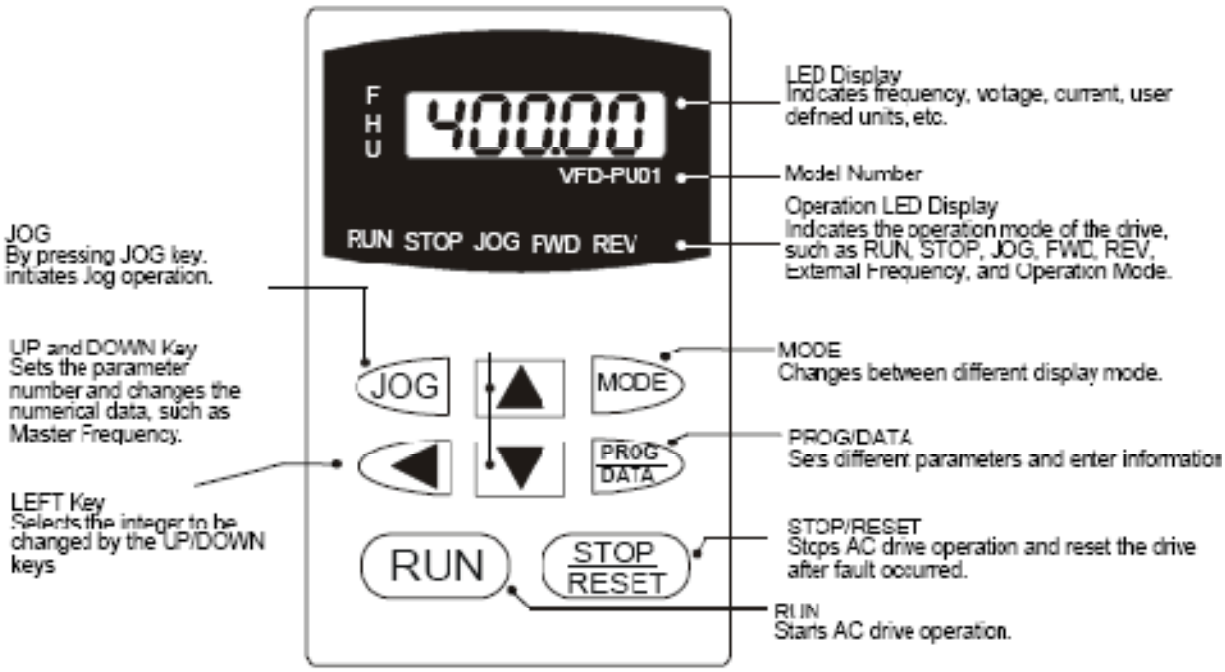
1. Tighten and reinforce the screws of the AC drive if necessary, cause it may loose due to the vibration or changing of temperatures.
2. Whether the conductors or insulators were corroded and damaged.
3. Check the resistance of the insulation with Megaohmeter.
4. Often check and change the capacitors and relays.
5. If use of the AC drive is discontinued for a long period of time, turn the power on at least once every two years and confirm that it still functions properly. To confirm functionality, disconnect the motor and energize the AC drive for 5 hours or more before attempting to run a motor with it.
6. Clean off any dust and dirt with a vacuum cleaner. Place special emphasis on cleaning the ventilation ports and PCBs. Always keep these areas clean, as adherence of dust and dirt can cause unforeseen failures.

Voltage Class			460V Class												
Model Number VFD-•••B			007	015	022	037	055	075	110	150	185	220	300	370	450
Max. Applicable Motor Output (kW)			0.75	1.5	2.2	3.7	5.5	7.5	11	15	18.5	22	30	37	45
Max. Applicable Motor Output (HP)			1.2	2.0	3.0	5.0	7.5	10	15	20	25	30	40	50	60
Output Rating	Rated Output Capacity (KVA)		2.3	3.2	4.2	6.5	9.5	13.7	18.3	24.4	28.9	34.3	45.7	55.6	69.3
	Rated Output Current(A)		2.7	4.2	5.5	8.5	13	18	24	32	38	45	60	73	91
	Maximum Output Voltage (V)		Proportional to Input Voltage												
	Rated Frequency (Hz)		0.1 to 400 Hz												
Input Ratin	Rated Voltage/Frequency		3-phase 342-582 V												
	Frequency Tolerance		47 to 63 Hz												
Control Characteristics	Control System		SPWM (Sinusoidal Pulse Width Modulation, carrier frequency 1-15kHz)												
	Output Frequency Resolution		0.01Hz												
	Torque Characteristics		Including the auto-torque, auto-slip compensation; starting torque can be 150% at 1.0Hz												
	Overload Endurance		150% of rated current for 1 minute												
	Accel/Decel Time		0.1to 3600 seconds (2 Independent settings for Accel/Decel Time)												
	V/F Pattern		Adjustable V/F pattern												
	Stall Prevention Level		20 to 250%, Setting of Rated Current												
Operating Characteristics	Frequency Setting	Keypad	Setting by (▲)(▼) or Potentiometer												
		External Signal	Potentiometer-5KΩ/0.5W, DC 0 to +10V or 0 to +5V (Input impedance 47KΩ); RS-485 interface; 4 to 20mA (Input impedance 250Ω); Multi-Function Inputs 1 to 6 (7 steps, Jog, up/down)												
	Operation Setting Signal	Keypad	Set by RUN, STOP and JOG												
		External Signal	M0 to M5 can be combined to offer various modes of operation, RS-485 serial interface (MODBUS).												
	Multi-Function Input Signal		Multi-step selection 0 to 15, Jog, accel/decel inhibit, first/second accel/decel switch, counter, PLC operation, external Base Block (NC, NO).												
	Multi-Function Output Indication		AC Drive Operating, Frequency Attained, Non-zero, Base Block, Fault Indication, Local/Remote indication, PLC Operation indication, and Auxiliary Motor Output												
	Analog Output Signal		Analog frequency/current signal output.												
Other Functions			AVR, S-Curve, Over-Voltage, Over-Current Stall Prevention, Fault Records, Adjustable Carrier Frequency, DC Braking, Momentary Power Loss restart, Auto Tuning, Frequency Limits, Parameter Lock/Reset, Vector Control, Counter, PID Control, Fan & Pump Control, PLC, MODBUS Communication, Reverse Inhibition.												
Protection			Self-testing, Over Voltage, Over Current, Under Voltage, Overload, Overheating, External Fault, Electronic thermal, Ground Fault.												
Cooling Systems			Natural air-cooling	Forced air-cooling											
Environment	Installation Location		Altitude 1,000 m or lower, keep from corrosive gasses, liquid and dust												
	Ambient Temperature		-10• to 40• (-10• to 50• without blind plate) Non-Condensing and not frozen												
	Storage/ Transportation Temperature		-20• to 60•												
	Ambient Humidity		Below 90% RH (non-condensing)												
	Vibration		9.80665m/s^2 (1G) less than 20Hz, 5.88m/s^2 (0.6G) at 20 to 50Hz												

WARNING

- Always read this manual thoroughly before using VFD-B series AC Motor Drives.
- **DANGER!** AC input power must be disconnected before any maintenance. Do not connect or disconnect wires and connectors while power is applied to the circuit. Maintenance must be performed by qualified technicians.
- **CAUTION!** There are highly sensitive MOS components on the printed circuit boards. These components are especially sensitive to static electricity. To avoid damage to these components, do not touch these components or the circuit boards with metal objects or your bare hands.
- **DANGER!** A charge may still remain in the DC-link capacitor with hazardous voltages even if the power has been turned off. To avoid personal injury, do not remove the cover of the AC drive until all "DISPLAY LED" lights on the digital keypad are off. Please note that there are live components exposed within the AC drive. Do not touch these live parts.
- **CAUTION!** Ground the VFD-B using the ground terminal. The grounding method must comply with the laws of the country where the AC drive is to be installed. Refer to Basic Wiring Diagram (CH 3-1).
- **DANGER!** The AC drive may be destroyed beyond repair if incorrect cables are connected to the input/output terminals. Never connect the AC drive output terminals U, V, and W directly to the AC main circuit power supply.
- **CAUTION!** The final enclosures of the AC drive must comply with EN50178. (Live parts shall be arranged in enclosures or located behind barriers that meet at least the requirements of the Protective Type IP20. The top surface of the enclosures or barrier that is easily accessible shall meet at least the requirements of the Protective Type IP40).
- **CAUTION!** Heat sink may heat up over 70• (158•), during the operation. Do not touch the heat sink.

◆ Description of the Digital Keypad VFD-PU01



Display Message	Descriptions
F 60.00	The AC drive Master Frequency.
H 50.00	The actual operation frequency present at terminals U, V, and W.
U 1800.0	User defined unit, where (U = F x 00-05)

Display Message	Descriptions
	The output current present at terminals U, V, and W.
	The AC drive forward run status.
	The AC drive reverse run status.
	The counter value (C).
	The specified parameter.
	The actual value stored within the specified parameter.
	External Fault.
	"End" displays for approximately 1 second if input has been accepted. After a parameter value has been set, the new value is automatically stored in memory. To modify an entry, use the ▲ or ▼ keys.
	"Err" Displays, if the input is invalid.

Parameters	Settings	Comment	Parameters	Settings	Comment	
0-04	06	Power reading	1-09	1800	Acceleration time	sec
1-00	60	Max frequency	1-10	1800	Deceleration time	sec
1-01	60	Max frequency	1-15	04	Auto accel/dec	
1-02	220-440	Depends on input voltage	2-02	1	Coast stop	
1-03	5	Midpoint frequency	2-04	1	Reverse disabled	
1-04	30	Midpoint volts	8-04	01	Power loss	
1-05	0.1	Minimum output frequency	8-07	80	Search current%	
1-06	30	Minimum output volts	8-19	1	Auto search	

Parameters	Explanation	Settings	Factory Setting
0-00	Identity Code of Drive	Read-only	#
0-01	Rated Current Display	Read-only	##.#
0-02	Parameter Reset	d10: reset parameter to factory setting	0
0-03	Start-up Display of AC Drive ★	d0: F (setting frequency)	0
		d1: H (actual frequency•	
		d2: u (user-defined unit)	
		d3: A (output current•	
		d4: FWD/REV	
0-04	User-Defined Unit ★	d0: Display User-Defined Unit (u)	0
		d1: Display Counter Value (C)	
		d2: Display Process Operation (1= tt)	
		d3: Display DC-BUS Voltage (U)	
		d4: Display output voltage (E)	
		d5: Output Power Factor	
0-05	User-Defined Coefficient K ★	0.01 to 160	1.0
0-06	Software Version	Read-only	3.0
0-07	Password Input	0 to 65535	0
0-08	Password Setting	0 to 65535	0
0-09	Control Methods	d0: V/F control	0
		d1: V/F control + PG	
		d2: Vector Control	
		d3: Vector Control + PG	

Parameters	Explanation	Settings	Factory Setting
1-00	Maximum Output Freq. (Fo,max)	50.0 to 400 Hz	60.0
1-01	Maximum Voltage Frequency (Base Freq) (Fmax)	0.1 to 400 Hz	60.0
1-02	Maximum Output Voltage (Vmax)	0.1V to 255V*	220*
1-03	Mid-Point Frequency (Fmid)	0.1 to 400 Hz	1.5
1-04	Mid-Point Voltage (Vmid)	0.1V to 255V*	10*
1-05	Minimum Output Frequency (Fmin)	1.0 to 400.0 Hz	1.5
1-06	Minimum Output Voltage (Vmin)	1.0V to 255V*	10*
1-07	Upper bound of freq.	1 to 110%	100
1-08	Lower bound of freq.	0 to100 %	00
1-09	Accel Time 1 ★	0.1 to 3600 Sec	10.0
1-10	Decel Time 1 ★	0.1 to 3600 Sec	10.0
1-11	Accel Time 2 ★	0.1 to 3600 Sec	10.0
1-12	Decel Time 2 ★	0.1 to 3600 Sec	10.0
1-13	Jog accel/decel Time ★	0.1 to 3600 Sec	1.0
1-14	Jog Frequency ★	0.1 Hz to 400 Hz	6.0
1-15	Auto Accel/Decel	d0: Linear Accel/Decel d1: Auto Accel, Linear Decel d2: Linear Accel, Auto Decel d3: Auto Accel/Decel d4: Linear Accel/Decel Stall Prevention during Deceleration	00
1-16	S-Curve in Accel	0 to 7	00
1-17	S-Curve in Decel	0 to 7	00
1-18	Accel Time 3 ★	0.1 to 3600 Sec	10.0
1-19	Decel Time 3 ★	0.1 to 3600 Sec	10.0
1-20	Accel Time 4 ★	0.1 to 3600 Sec	10.0
1-21	Decel Time 4 ★	0.1 to 3600 Sec	10.0

Parameters	Explanation	Settings	Factory Setting
02-00	Source of Frequency Command	d0: Digital Keypad	00
		d1: 0 to 10V from AVI	
		d2: 4 to 20mA from ACI	
		d3: Potentiometer Control	
		d4: RS-485 communication Interface	
2-01	Source of Operation Command	d0: by Digital Keypad	00
		d1: by external terminals, keypad STOP enabled	
		d2: by external terminals, keypad STOP disabled	
		d3: -10V to +10V from AVI	
		d4: by RS-485 communication interface, keypad STOP disabled	
2-02	Stop Method	d0: Ramp Stop	00
		d1: Coast Stop	
2-03	PWM Carrier Frequency	d1: 1KHz	15
		d2: 2KHz	
		d3: 3KHz	
		d4: 4KHz	
		d5: 5KHz	
		d6: 6KHz	
		to	
		d15: 15KHz	
2-04	Reverse Operation Inhibit	d0: Enable REV	00
		d1: Disable REV	
2-05	2-wire/3-wire Operation Control Mode Selection	d0: 2-wire Operation Control Mode (1)	00
		d1: 2-wire Operation Control Mode (2)	
		d2: 3-wire Operation Control Mode	
2-06	Line Start Lockout	d0: Disable	0
		d1: Enable	

Parameters	Explanation	Settings	Factory Setting
03-00	Multi-Function Output1 (Relay Output)	d0: Not Used	00
		d1: AC Drive Operational	08
		d2: Max. Output Freq. Attained	
		d3: Zero Speed	
		d4: Over Torque	
03-01	Multi-Function Output2 (Photocoupler Output)	d5: Base-Block (B.B.)	
		d6: Low Voltage Detection	
		d7: AC Drive Operation Mode	
		d8: Fault Indication	
03-02	Multi-Function Output3	d9: Desired Freq. Attained	
		d10: PLC Program Running	
		d11: PLC Program Step Complete	
		d12: PLC Program Complete	
		d13: PLC Program Operation Pause	
		d14: Terminal Count Value Attained	
03-03	Multi-Function Output4	d15: Preliminary count Value Attained	
		d16: Auxiliary Motor No.1	
		d17: Auxiliary Motor No.2	
		d18: Auxiliary Motor No.3	
		d19: Heat sink overheat warning	
3-04	Desired Freq. Attained	1.0 to 400 Hz	0.0
3-05	Analog Output Signal	d0: analog frequency	0
		d1: analog current	
		d2: output voltage	
		d3: frequency command	
		d4: motor speed	
3-06	Analog Output Gain ★	1 to 200%	100
3-07	Digital Output Gain ★	1 to 20	01
3-08	Terminal Count Value	0 to 65500	0
3-09	Preliminary Count Value	0 to 65500	0

Parameters	Explanation	Settings	Factory Setting
4-00	Potentiometer Bias Frequency ★	0.0 to 350 Hz	0.0
4-01	Potentiometer Bias Polarity ★	d0: Positive Bias	0
		d1: Negative Bias	
4-02	Potentiometer Frequency Gain ★	1 to 200 %	100
4-03	Potentiometer Reverse Motion Enable	d0: Forward Motion Only	0
		d1: Reverse Motion enabled	
4-04	Multi-Function Input Terminal 1 (M0, M1)	d0: Parameter Disable	0
		d1: Multi-Step Speed Command 1	1
4-05	Multi-Function Input Terminal 2 (M2)	d2: Multi-Step Speed Command 2	2
4-06	Multi-Function Input Terminal 3 (M3)	d3: Multi-Step Speed Command 3	3
4-07	Multi-Function Input Terminal 4 (M4)	d4: Multi-Step Speed Command 4	4
4-08	Multi-Function Input Terminal 5 (M5)	d5: Reset	5
		d6: Accel/Decel Speed Inhibit	06
		d7: First or Second Accel/Decel Time Selection	
		d8: Third or Forth Accel/Decel Time Selection	
		d9: E.F. External Fault Input (N.C)	
		d10: E.F. External Fault Input (N.O)	
		d11: Increase Master Frequency	
		d12: Decrease Master Frequency	
		d13: Counter Reset	
		d14: Run PLC Program	
		d15: Pause PLC	
		d16: Auxiliary Motor No.1 output failure	
		d17: Auxiliary Motor No.2 output failure	
		d18: Auxiliary Motor No.3 output failure	

Parameters	Explanation	Settings	Factory Setting
5-00	1st Step Speed Freq.	0.0 to 400 Hz	0.0
5-01	2nd Step Speed Freq.	0.0 to 400 Hz	0.0
5-02	3rd Step Speed Freq.	0.0 to 400 Hz	0.0
5-03	4th Step Speed Freq.	0.0 to 400 Hz	0.0
5-04	5th Step Speed Freq.	0.0 to 400 Hz	0.0
5-05	6th Step Speed Freq.	0.0 to 400 Hz	0.0
5-06	7th Step Speed Freq.	0.0 to 400 Hz	0.0
5-07	8th Step Speed Freq.	0.0 to 400 Hz	0.0
5-08	9th Step Speed Freq.	0.0 to 400 Hz	0.0
5-09	10th Step Speed Freq.	0.0 to 400 Hz	0.0
5-10	11th Step Speed Freq.	0.0 to 400 Hz	0.0
5-11	12th Step Speed Freq.	0.0 to 400 Hz	0.0
5-12	13th Step Speed Freq.	0.0 to 400 Hz	0.0
5-13	14th Step Speed Freq.	0.0 to 400 Hz	0.0
5-14	15th Step Speed Freq.	0.0 to 400 Hz	0.0
5-15	PLC Mode	d0: Disable PLC Operation d1: Execute one program cycle d2: Continuously execute program cycles d3: Execute one program cycle step by step d4:Continuously execute one program cycle step by step	00
5-16	PLC Forward/ Reverse Motion	0 to 65535 (0:FWD 1:REV)	00
5-17	Time Duration Step 1	0 to 65500 sec	00
5-18	Time Duration Step 2	0 to 65500 Sec	0
5-19	Time Duration Step 3	0 to 65500 Sec	0
5-20	Time Duration Step 4	0 to 65500 Sec	0
5-21	Time Duration Step 5	0 to 65500 Sec	0
5-22	Time Duration Step 6	0 to 65500 Sec	0
5-23	Time Duration Step 7	0 to 65500 Sec	0

Parameters	Explanation	Settings	Factory Setting
5-24	Time Duration Step 8	0 to 65500 Sec	0
5-25	Time Duration Step 9	0 to 65500 Sec	0
5-26	Time Duration Step 10	0 to 65500 Sec	0
5-27	Time Duration Step 11	0 to 65500 Sec	0
5-28	Time Duration Step 12	0 to 65500 Sec	0
5-29	Time Duration Step 13	0 to 65500 Sec	0
5-30	Time Duration Step 14	0 to 65500 Sec	0
5-31	Time Duration Step 15	0 to 65500 Sec	0

Parameters	Explanation	Settings	Factory Setting
6-00	Over-Voltage Stall Prevention	d0: Disable	1
		d1: Enable	
6-01	Over-Current Stall Prevention during Accel	20 to 250%	170
6-02	Over-Current Stall Prevention during Operation	20 to 250%	170
6-03	Over-Torque Detection Mode	d0: Disabled	0
		d1: Enabled during constant speed operation and continues until the continuous limit (Pr.6-05) is reached.	
		d2: Enabled during Constant Speed Operation and halted after detection	
		d3: Enabled during Accel and continues before Continuous Output Time Limit (Pr.6-05)is reached	
		d4: Enabled during Accel and halted after Over-Torque detection	
6-04	Over-Torque Detection Level	30 to 200%	150
6-05	Continuous Output Time Limit	0.1 to 60.0 Sec	0.1
6-06	Electronic Thermal Overload Relay	0 to 2	02
6-07	Electronic Thermal characteristic ★	30 to 300 Sec	60
6-08	Present Fault Record	d0: No Fault occurred	00
6-09	Second Most Recent Fault Record	d1: Over Current (oc)	
6-10	Third Most Recent Fault Record	d2: Over Voltage (ov)	
		d3: Over Heat (oH)	
		d4: Over Load (oL)	
		d5: Over Load (oL1)	
		d6: External Fault (EF)	

Parameters	Explanation	Settings	Factory Setting
6-10	Third Most Recent Fault Record	d7: occ	0
		d8: CPU Fault (cF3)	
		d9: Hardware Protection failure (HPF)	
		d10: Current exceed during Acceleration (ocA)	
		d11: Current exceed during Deceleration (ocd)	
		d12: Current exceed during Steady State (ocn)	
		d13: Ground Fault (GF)	
		d14: Lv	
		d15: CF1	
		d16: CF2	
		d17: Base Block (b.b)	
		d18: oL2	
		d19: CFA	
		d20: codE	

Parameters	Explanation	Settings	Factory Setting
7-00	Motor Rated Current ★	30 to 120%	100
7-01	Motor No-Load Current★	0 to 90%	40
7-02	Torque Compensation ★	0 to 10	00
7-03	Slip Compensation ★	0.0 to 10.0	0.0
7-04	Number of Motor Poles	02 to 10	04
7-05	Motor Auto Detection	d0: Disable	00
		d1: Auto adjustable	
7-06	Motor Line-to-Line Resistance (R1)	0.00 to 655.35	0.0
7-07	Equivalent Rotator Resistance (R2)	00 to 200%	100

Parameters	Explanation	Settings	Factory Setting
8-00	DC Braking Voltage Level	0 to 100%	0
8-01	DC Braking Time during Start-Up	0.0 to 25.0 Sec	0.0
8-02	DC Braking Time during Stopping	0.0 to 25.0 Sec	0.0
8-03	Start-Point for DC Braking	0.0 to 400 Hz	0.0
8-04	Momentary Power Loss	d0: Stop Operation after Momentary Power Loss	0
		d1: Continues after Momentary Power Loss, speed search starts with Master Frequency	
		d2: Continues after Momentary Power Loss, speed search starts with Minimum Output Frequency	
8-05	Maximum Allowable Power Loss Time	0.3 to 5.0 Sec	2.0
8-06	B.B. Time for Speed Search	0.3 to 5.0 Sec	0.5
8-07	Maximum Speed Search Current Level	30 to 200%	150
8-08	Skip Frequency 1 Upper Bound	0.0 to 400 Hz	0.0
8-09	Skip Frequency 1 Lower Bound	0.0 to 400 Hz	0.0
8-10	Skip Frequency 2 Upper Bound	0.0 to 400 Hz	0.0
8-11	Skip Frequency 2 Lower bound	0.0 to 400 Hz	0.0
8-12	Skip Frequency 3 Upper bound	0.0 to 400 Hz	0.0
8-13	Skip Frequency 3 Lower Bound	0.0 to 400 Hz	0.0

Parameters	Explanation	Settings	Factory Setting
8-14	Auto Restart After Fault	0 to 10	0
8-15	Auto Energy Saving	d0: Disable	0
		d1: Enable	
8-16	AVR Function	d0: AVR Function Enable	0
		d1: AVR Function Disable	
		d2: AVR Function Disable for Decel	
8-17	Dynamic Braking Voltage	350 to 450V (for 230V)	380
		460 to 860V (for 460V)	760

Parameters	Explanation	Settings	Factory Setting
9-00	Communication Address ★	1 to 254	1
9-01	Transmission Speed ★	d0: Baud Rate 4800bps	1
		d1: Baud Rate 9600bps	
		d2: Baud Rate 19200bps	
		d3: Baud Rate 38400bps	
9-02	Transmission Fault Treatment ★	d0: Alarm and Continue Running	0
		d1: Alarm and Ramp to Stop	
		d2: Alarm and Coasting Stop	
9-03	Overtime Detection	d0: Disable	1
		d1: Enable	
9-04	Communication Protocol ★	d0: 7,N,2 (Modbus, ASCII)	0
		d1: 7,E,1(Modbus, ASCII)	
		d2: 7,O,1(Modbus, ASCII)	
		d3: 8,N,2(Modbus, ASCII)	
		d4: 8,E,1(Modbus, ASCII)	
		d5: 8,O,1(Modbus, ASCII)	
		d6: 8,N,2(Modbus, RTU)	
		d7: 8,E,1(Modbus, RTU)	
		d8: 8,O,1(Modbus, RTU)	

Parameters	Explanation	Settings	Factory Setting
10-00	Input terminal for Frequency	d0: Inhibit PID operation d1: PID input from external terminal (AVI) 0 to +10V d2: PID input from external terminal (ACI) 4 to 20mA	1
10-01	Gain over Frequency Input	d0.0 to d10.0	1
10-02	Proportional Gain (P)	d0.0 to d10.0	1
10-03	Integral Gain (I)	d0 to d100	1
10-04	Derivative Control (D)	d0 to d1	0
10-05	Upper Bound for Integral Control	d0 to d100%	100
10-06	Derivative Filter time Constant	d0 to d2.5 sec	0
10-07	PID Output Freq Limit	d0 to d110%	100
10-08	Feedback Signal Detection time	d0 to d3600 sec	100
10-09	Transmission Fault Treatment	d0: Alarm and keep operation d1: Alarm and stop by RAMP d2: Alarm and stop by COAST	0
10-10	PG Pulse Range	d100 to d40000	600
10-11	PG Input	d0: Disable PG d1: Single phase d2: Forward / Counterclockwise rotation d3: Reverse / Clockwise rotation	00
10-12	Proportional Speed control (P)	d0 to d10	0.1
10-13	Integral Speed Control (I)	d0 to d100	1
10-14	Speed Control Output Frequency Limit	d0 to d10 Hz	10

Parameters	Explanation	Settings	Factory Setting
11-00	V/F Curve Selection	d0: Random V/F Curve d1: 1.5 Power Curve d2: 1.7 Power Curve d3: Square Curve d4: Cube Curve	0
11-01	Start Frequency of the Auxiliary Motor	d0 to d400 Hz	0
11-02	Stop Frequency of Auxiliary Motor	d0 to d400 Hz	0
11-03	Time Delay before Starting the Auxiliary Motor	d0 to d3600 Hz	0
11-04	Time Delay before Stopping the Auxiliary Motor	d0 to d3600 Hz	0

CH 3-2 Terminal Explanations

Terminal Symbol	Explanation of Terminal Function
R,S,T	AC line input terminals
U,V,W	AC drive output and motor connections
P1,P2	Connections for DC Link Reactor (optional)
P-B,P2/B1-B2	Connections for Braking Resistor (optional)
P2-N,P2/B1-N	Connections for Braking Resistor (VFD-B series)
⏚	Earth Ground

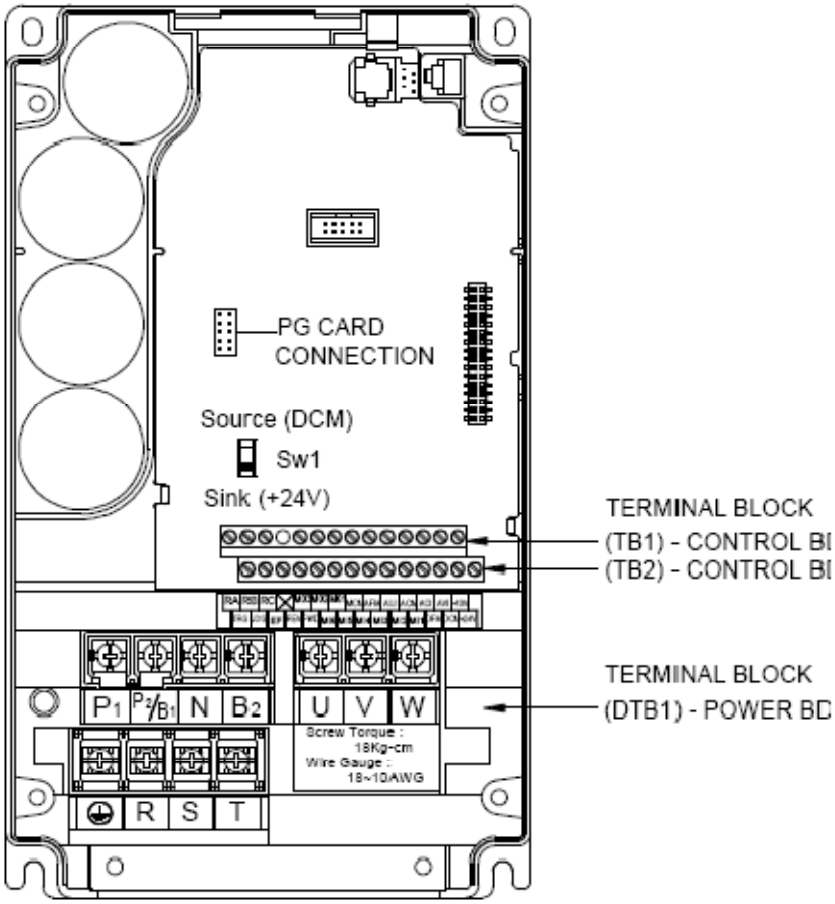
CH 3-3 Control Terminals Explanations

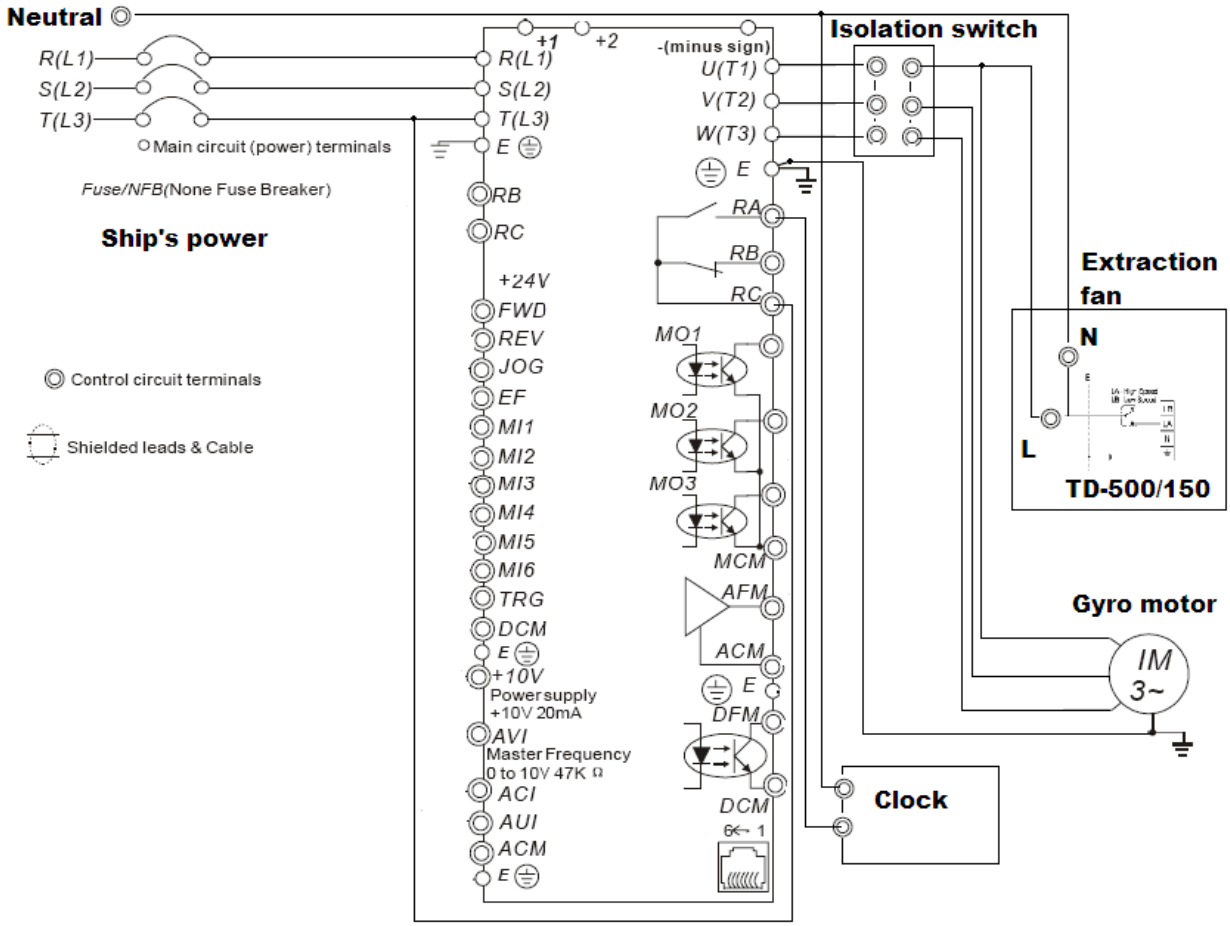
Terminal Symbols	Terminal Functions	Factory Settings
FWD	Forward-Stop command	
REV	Reverse-Stop command	
JOG	Jog-Stop command	
EF	External fault	
TRG	External counter input	
MI1	Multi-function Input 1	Refer to Pr.04-04 to Pr.04-09
MI2	Multi-function Input 2	
MI3	Multi-function Input 3	
MI4	Multi-function Input 4	
MI5	Multi-function Input 5	
MI6	Multi-function Input 6	
DFM	Digital Frequency	Factory setting 1:1
+24V	Digital control signal (Source mode)	+24V, 20mA
DCM	Digital control signal (Sink mode)	

Terminal Symbols	Terminal Functions	Factory Settings
RA	Multi-function Relay output (N.O.) a	240Vac, 2.5A 120Vac, 5A 28Vdc, 5A
RB	Multi-function Relay output (N.C.) b	
RC	Multi-function Relay common	
MO1	Multi-function output 1 (Photocoupler)	Refer to Pr.03-01 to Pr.03-03
MO2	Multi-function output 2 (Photocoupler)	
MO3	Multi-function output 3 (Photocoupler)	
MCM	Multi-function output (Photocoupler)	Max 48VDC 50mA
+10V	speed setting power source	+10V 20mA
AVI	Analog voltage Input	0 to +10V (maximum output frequency)
ACI	Analog current Input	4 to 20mA (maximum output frequency)
AUI	Auxiliary analog voltage input	-10 to +10V (maximum output frequency)
AFM	Analog frequency /current meter	0 to 10V (maximum output frequency)
ACM	Analog control signal (common)	

* Analog control signal (common): 18 AWG (0.75 mm^2).

3 HP to 5 HP


PG CARD
CONNECTION
Source (DCM)
Sw1
Sink (+24V)
TERMINAL BLOCK
(TB1) - CONTROL BI
(TB2) - CONTROL BI
TERMINAL BLOCK
(DTB1) - POWER BD
P1
P2/B1
N
B2
U
V
W
Screw Torque :
18Kg-cm
Wire Gauge :
18~10AWG
R
S
T


Neutral
R(L1)
S(L2)
T(L3)
Main circuit (power) terminals
Fuse/NFB(None Fuse Breaker)
Ship's power
Control circuit terminals
Shielded leads & Cable
+1
+2
-(minus sign)
R(L1)
S(L2)
T(L3)
E
RB
RC
+24V
FWD
REV
JOG
EF
MI1
MI2
MI3
MI4
MI5
MI6
TRG
DCM
E
+10V
Power supply
+10V 20mA
AVI
Master Frequency
0 to 10V 47K Ω
ACI
AUI
ACM
E
U(T1)
V(T2)
W(T3)
E
RA
RB
RC
MO1
MO2
MO3
MCM
AFM
ACM
E
DFM
DCM
6 1
Isolation switch
Extraction fan
N
L
TD-500/150
Gyro motor
IM 3~
Clock

The AC motor drive has a comprehensive fault diagnostic system that includes several different alarms and fault messages. Once a fault is detected, the corresponding protective functions will be activated to shut down the AC drive output. Below are the fault descriptions, for a fault shown on the AC drive digital keypad display. The three most recent faults can be read on the digital keypad display.

NOTE: After faults occurred, press RESET to begin using the drive again.

Common Problems and Solutions:

Fault Name	Fault Descriptions	Corrective Actions
oc	The AC drive detects an abnormal increase in current.	1. Check whether the motors horsepower corresponds to the AC drive output power. 2. Check the wiring connections between the AC drive and motor for possible short circuits. 3. Increase the Acceleration time. 4. Check for possible excessive loading conditions at the motor. 5. If there are any abnormal conditions when operating the AC drive after short-circuit being removed, it should be sent back to manufacturer.
ov	The AC drive detects that the DC bus voltage has exceeded its maximum allowable value.	1. Check whether the input voltage falls within the rated AC drive input voltage. 2. Check for possible voltage transients. 3. Bus over-voltage may also be caused by motor regeneration. Either increase the decel time or add an optional braking resistor. 4. Check whether the required braking power is within the specified limits.
oH	The AC drive temperature sensor detects excessive heat.	1. Ensure that the ambient temperature falls within the specified temperature range. 2. Make sure that the ventilation holes are not obstructed. 3. Remove any foreign objects on the heatsinks and check for possible dirty heat sink fins. 4. Provide enough spacing for adequate ventilation.

Fault Name	Fault Descriptions	Corrective Actions
Lv	The AC drive detects that the DC bus voltage has fallen below its minimum value.	1. Check whether the input voltage falls within the rated AC drive's input voltage.
oL	1. The AC drive detects excessive drive output current. Note: The AC drive can withstand up to 150% of the rated current for a maximum of 60 seconds.	1. Check whether the motor is overloaded. 2. Reduce torque compensation setting as set in Pr.7-02. 3. Increase the AC drive's output capacity.
oL1	Internal electronic overload trip	1. Check for possible motor overload. 2. Check electronic thermal overload setting. 3. Increase motor capacity. 4. Reduce the current level so that the drive output current does not exceed the value set by the Motor Rated Current Pr.7-00.
oL2	Motor overload. Check the parameter settings (Pr.6-03 to Pr.6-05)	1. Reduce the motor load. 2. Adjust the over-torque detection setting to an appropriate setting (Pr.06-03 to Pr.06-05).
ocA	Over-current during acceleration: 1. Short-circuit at motor output. 2. Torque boost too high. 3. Acceleration time too short. 4. AC drive output capacity is too small.	1. Check for possible poor insulation at the output line. 2. Decrease the torque boost setting in Pr.7-02. 3. Increase the acceleration time. 4. Replace with the AC drive with one that has a higher output capacity (next HP size).

Fault Name	Fault Descriptions	Corrective Actions
ocd	Over-current during deceleration: 1. Short-circuit at motor output. 2. Deceleration time too short. 3. AC drive output capacity is too small.	1. Check for possible poor insulation at the output line. 2. Increase the deceleration time. 3. Replace with the AC drive with one that has a higher output capacity (next HP size).
ocn	Over-current during steady state operation: 1. Short-circuit at motor output. 2. Sudden increase in motor loading. 3. AC drive output capacity is too small.	1. Check for possible poor insulation at the output line. 2. Check for possible motor stall. 3. Replace with the AC drive with one that has a higher output capacity (next HP size).
EF	The external terminal EF-GND goes from OFF to ON.	1. When external terminal EF-GND is closed, the output will be turned off. (under N.O. E.F.)
cF1	Internal memory IC can not be programmed.	1. Return to the factory. 2. Check the EEPROM on the control board.
cF2	Internal memory IC can not be read.	1. Return to the factory. 2. Reset drive to factory defaults.
cF3	Drive's internal circuitry abnormal.	1. Return to the factory.
HPF	Hardware protection failure	1. Return to the factory.
codE	failure	1. Return to the factory.

Fault	Fault Descriptions	Corrective Actions
cFA	Auto accel/decel failure	1. Don't use the function of auto acceleration /deceleration.
GFF	Ground fault : The AC drive output is abnormal. When the output terminal is grounded (short circuit current is 50% more than the AC drive rated current), the AC drive power module may be damaged. The short circuit protection is provided for AC drive protection, not user protection.	Ground fault : 1. Check whether the IGBT power module is damaged. 2. Check for possible poor insulation at the output line.
CE1	Communication Error	1. Check the connection between the AC drive and computer for loose wires. 2. Check if the communication protocol is properly set.
bb	External Base Block. AC drive output is turned off.	1. When the external input terminal (B.B) is active, the AC drive output will be turned off. 2. Disable this connection and the AC drive will begin to work again.