

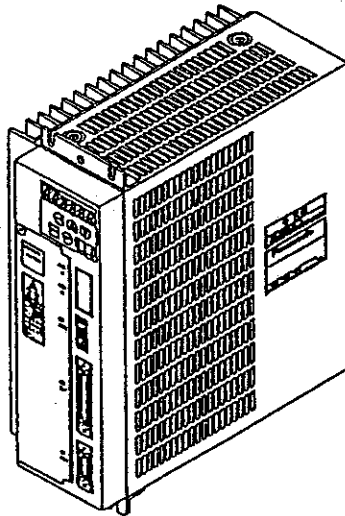
Panasonic

MINAS

AC Servo Driver

V Series

Operation Manual



(Figure shows MSD253A1V.)

- Thank you very much for your purchasing our Panasonic Digital AC Servo Driver; V Series.
- Though the operating procedures and operating methods are not so difficult, wrong operation might cause accidents no one expects, the service life of the driver might be shortened and the performance might be declined. So never fail to read this operation manual thoroughly before you use it in order to use it properly and use it as long as possible.
- Please keep this manual carefully for later use.
- Please be sure to deliver this manual to an end user.
- This manual is subject to change for improvement of contents.

Precautions in Handling it Safely

Before installing, operating, maintaining and checking this driver, be sure to read this operation manual and all of other attached documents thoroughly, in order to use it properly.

In addition, before using it, it is also necessary to become skillful in operating it and to learn all of the knowledge of this equipment, various information about safety and all of the precautions required.


In this operation manual, cautions to keep safety are ranked "DANGER" and "CAUTION".

DANGER

: In case of making mistakes when operating or handling it, dangerous conditions can cause then these conditions might kill persons or persons might be seriously injured.

CAUTION

: In case of making mistakes when operating or handling it, dangerous conditions can cause then injury of medium or slight level cause to persons or only damages on materials can be caused.

Besides, although contents included in  CAUTION can result in quite serious damages or accident, according to the condition. Then be sure to follow the contents in both cases.

1. General Comments

DANGER

☆ Be sure to observe the following requirements to prevent you from an electric shock and injury.

1. Never touch anywhere inside the driver. It might cause an electric shock.
2. Be sure to ground the earth cable of the driver and motor in order to avoid an electric shock.
3. Be sure to cut the power off and confirm that the LED to indicate that the power is off, before moving (installing), wiring, maintaining and checking the driver in order to avoid an electric shock.



DANGER

4. Do not damage the cable, give an excessive stress on it and put an heavy thing on it or not to be caught in something in order to avoid an electric shock.
5. During operating the driver, never to touch the rotating section of the motor to prevent from being injured.



CAUTION

1. The models of the motor and the driver should be matched when using.
There is a possibility of a fire.
2. Never use the driver, around the place where water splash, corrosive atmosphere, atmosphere of combustible gas and near an inframable thing.
There is a possibility of a fire.
3. Do not touch the driver, the motor and the peripheral device, since the temperature of them become too high.
There is a possibility of being burned.
4. While the power is on or after a while when the power is off, do not touch the radiator, the regenerative resistor and the motor, since they become very hot.
There is a possibility of being burned.

2. Storage



PROHIBITION

1. Do not store in the place where water, splash, harmful gas and liquid are.



OBLIGATION

1. Store the driver in the place where it isn't exposed to the sunshine directly and where between the specific range of the humidity.
2. In case of the time of the storage is quite long, please contact the store you bought it or the reference written in this manual.

3. Carrying



CAUTION

1. While carrying it, do not have the cables and the axes of the motor.
There is a possibility of being injured.
2. In case of motors with hang bolts, be sure to use the hang bolts, and in case of motors without hang bolts, use hang belts, etc. for hanging.
However, do not hang the whole machine with the motor hang bolts, after installing the machine. Check weight of motor before hanging, with the package case or catalog, and do not hang load exceeding the rating of the hang device.
In lifting, do not lift up abruptly, or do not go under the hung motor.
Perform hanging work by certified personnel.
Injuries and unit breakage due to dropping and overturning are liable to occur.



OBLIGATION

1. Over-stacking of the products can cause to fall to pieces. Then stack the products according to the instruction.

4. Installation



CAUTION

1. Do not ascend the driver and put heavy things.
There is a possibility of being injured.
2. Do not shut the intake and outlet valve, and try to not intake foreign things.
There is a possibility of a fire.
3. Be sure to install according to the specified installing direction.
If the direction is wrong, there is a possibility of a fire.
4. The distances between the body and the inside of the control panel and those between other equipments should be kept as specified.
There is a possibility of a fire.
5. Do not give a strong shock.
Abnormal operation might occur then there is a possibility of being injured.
6. Do the installation work properly according to the output power and the weight of the body.
There is a possibility of being injured.
7. Install the driver to the incombustible material like metal.
There is a possibility of a fire.

5. Wiring



CAUTION

1. The wiring should be performed properly and certainly.
There is a possibility of getting an electric shock, an injury and a fire.

6. Control, Operation



CAUTION

1. The motor is not equipped with a protection device. An over-current protection device, an earth leakage breaker, a protection device for high-limit of temperature and an emergency system should be installed.
There is a possibility of getting an electric shock, an injury and a fire.
2. Check that the specification of the power supply is normal.
There is a possibility of getting an electric shock, an injury and a fire.
3. After performing the test working with the motor fixed to check the operation without the mechanical systems, install it to the driver.
There is a possibility of being injured.
4. Since the retaining brake is equipped for retaining the position of the machine, do not use it to obtain the security of the machine itself.
There is a possibility of being injured.
5. Never perform extreme adjustments and changes. If you do so, the operation become so unstable.
There is a possibility of being injured.
6. In case of the emergency occurs, first remove the cause then secure the safety then reset the alarm. After this start the machine again.
There is a possibility of being injured.
7. Immediately after a short power failure, it is possible that the machine sometimes restart suddenly. So do not get near the machine in such a case. (Even when you restart the machine, design the machine so that the security for the human being can be obtained.)
There is a possibility of being injured.



PROHIBITION

1. Since the brake equipped with the motor is for the retainment, do not use it for usual control.



OBLIGATION

1. Install an emergency stop circuit outside the machine so that the operation can be stopped immediately and shut the power supply.

7. Maintenance and Check



CAUTION

1. The capacity of the condenser of the power supply line will lower owing to the degradation. Then, in order to avoid the secondly-accident caused by some trouble, we recommend replacement of it each 5 years.



PROHIBITION

1. When the overhaul is required, be sure to be performed by our company.

8. Scrapping



CAUTION

1. In case of throw away the driver, treat it as an industrial waste.

9. Others

General Notices

Figures in this Operation Manual are described mostly by removing cases, covers and shields for safety for explaining details. In operating the units, be sure to fit the specific cases, covers and shields as they are, and start running according to the Operation Manual.

< Meanings of the other signs used in this operation manual >



: Things that you should not do.



: Things that you should do.

Contents

Precautions in Handling it Safely	2	6-5 Protective functions.....	35
1. Before operation	9	6-5-1 Outline	35
1-1 After opening the package	9	6-5-2 Detail of protective functions.....	36
1-2 Confirmation of the applicable motor	9	7. Running	38
2. Cosmetics and title of each part	10	7-1 Before running	38
3. Notices in use	11	7-2 Trial run	38
3-1 Caution for safety	11	8. Adjustment.....	40
3-2 In order to use the driver properly	12	8-1 Voltage confirmation of the rotary encoder.....	40
3-3 Notices on setting and storing.....	13	8-2 Gain adjustment.....	40
4. Installation place	15	8-2-1 Basics of gain adjustment	41
5. Wiring.....	16	8-2-2 Caution on the gain adjustment ..	41
5-1 Notices in wiring	16	9. Parameter.....	42
5-1-1 Wiring to the terminal block	16	9-1 Outline of parameter.....	42
5-1-2 Regenerative resistor use method	17	9-2 Detail of user parameter	44
5-1-3 Wiring to Connector CN I/F	18	10. Operation.....	54
5-1-4 Wiring to Connector CN SIG ...	20	10-1 Key operation of the front panel and display	54
5-1-5 Wiring to Connector CN SER ...	22	10-1-1 Composition of the front panel/display	54
5-2 Selection of a wiring equipment.....	22	10-1-2 Outline of the operation.....	55
6. Function.....	23	10-1-3 Example of operation execution.....	56
6-1 Configuration of input circuit.....	23	10-1-4 Detail of Operation.....	58
6-1-1 Control input	23	10-2 Operation with computer	63
6-1-2 Control output.....	24	10-2-1 Outline	63
6-1-3 Analog signal input	25	11. Specifications	64
6-1-4 Analog signal output (monitor output).....	25	12. Dimensions	65
6-1-5 Pulse row command, Counter clear, Command pulse input prohibition input	26	13. Option parts	66
6-2 Input/Output signal.....	28	13-1 Software for communication control PANATERM.....	66
6-3 Dynamic brake	33	13-2 Connector kit for connecting external equipment	66
6-4 Automatic gain tuning	34	13-3 Connector kit for connecting motor encoder	66
6-4-1 Outline of automatic gain tuning.....	34	13-4 RS232C Connection Cable	67
6-4-2 Applicable range.....	34	14. Trouble Shooting	68
6-4-3 Notices.....	34		
6-4-4 Automatic gain tuning operation.....	35		
6-4-5 How to operate	35		

1. Before operation

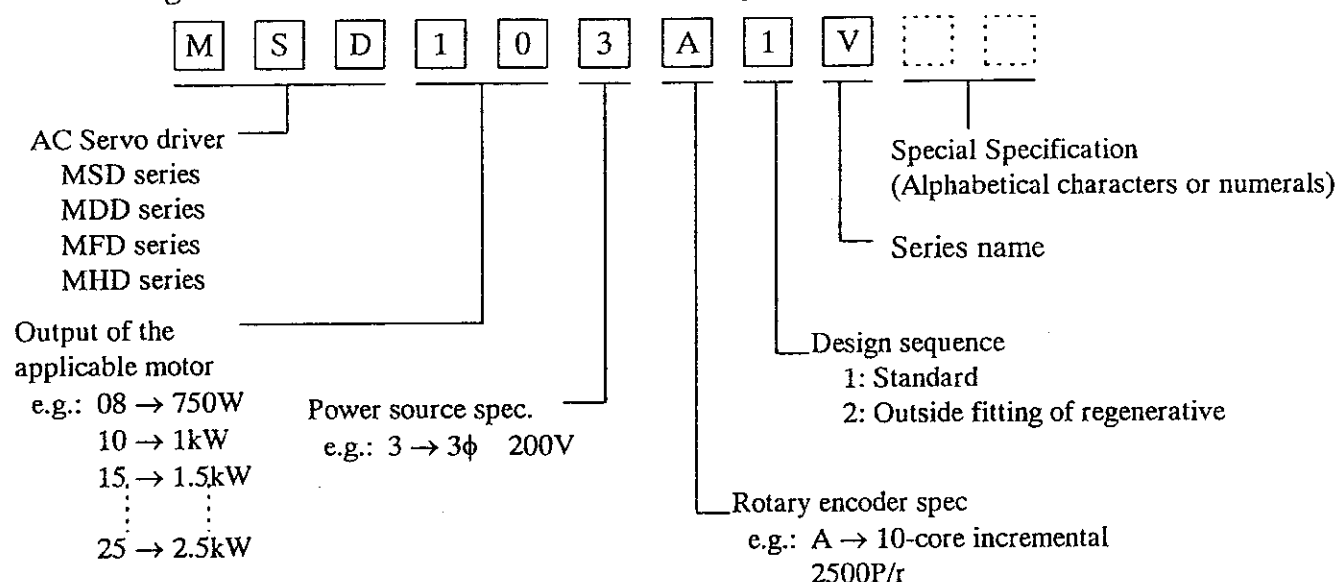
1-1 After opening the package

■ Please check the followings:

- (1) Right model No.?
- (2) Any damage during the transportation?

If you find any damage, please contact to your dealer/distributor

■ Following shows how to read the model No. and its symbols;



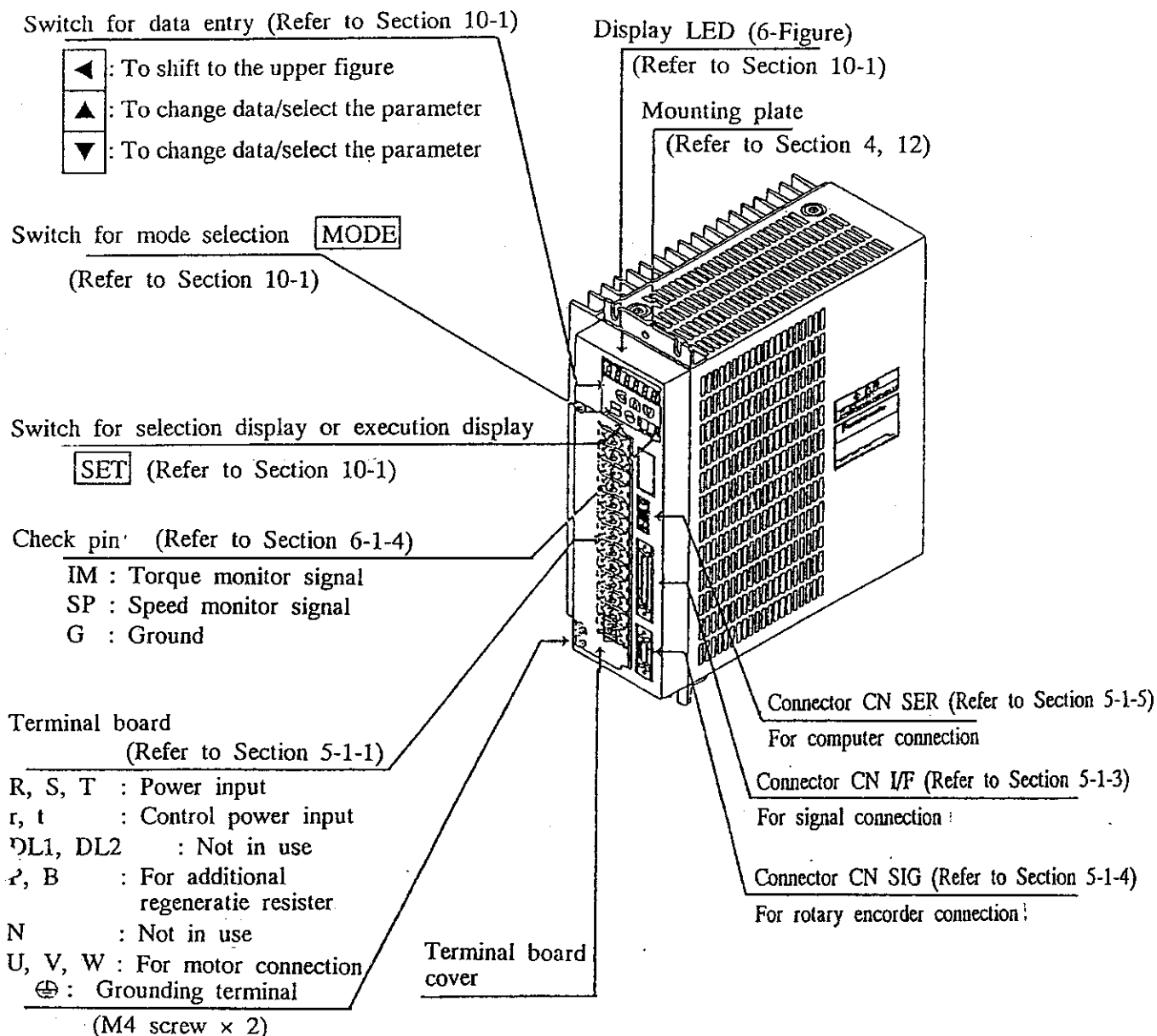
1-2 Confirmation of the applicable motor

This driver is designed to be used with Panasonic AC servo motor. Please refer to the following table for the correct combination of the driver and the motor, and make sure that the number of the encoder pulses matches each other.

Model No. of driver	Suffix of driver	Applicable motor				
		Model No.	Rated output	Voltage spec.	Rated speed	Encoder pulses (10-lead-wires)
MSD103A1V	B-1	MSM102A**	1.0kW	200V	3000r/min	10-core 2500P/r
MSD153A1V	B-2	MSM152A**	1.5kW	200V	3000r/min	10-core 2500P/r
MSD203A1V	B-3	MSM202A**	2.0kW	200V	3000r/min	10-core 2500P/r
MSD253A1V	B-3	MSM252A**	2.5kW	200V	3000r/min	10-core 2500P/r
MDD083A1V	B-1	MDM082A**	750W	200V	2000r/min	10-core 2500P/r
MDD103A1V	B-1	MDM102A**	1.0kW	200V	2000r/min	10-core 2500P/r
MDD153A1V	B-2	MDM152A**	1.5kW	200V	2000r/min	10-core 2500P/r
MDD203A1V	B-3	MDM202A**	2.0kW	200V	2000r/min	10-core 2500P/r
MDD253A1V	B-3	MDM252A**	2.5kW	200V	2000r/min	10-core 2500P/r
MFD083A1V	B-1	MFM082A**	750W	200V	2000r/min	10-core 2500P/r
MFD153A1V	B-2	MFM152A**	1.5kW	200V	2000r/min	10-core 2500P/r
MFD253A1V	B-3	MFM252A**	2.5kW	200V	2000r/min	10-core 2500P/r
MHD053A1V	B-1	MHM052A**	500W	200V	2000r/min	10-core 2500P/r
MHD103A1V	B-1	MHM102A**	1.0kW	200V	2000r/min	10-core 2500P/r
MHD153A1V	B-2	MHM152A**	1.5kW	200V	2000r/min	10-core 2500P/r
MHD203A1V	B-3	MHM202A**	2.0kW	200V	2000r/min	10-core 2500P/r

Note Please refer to section 12. "Dimensions" (P.65) for the suffix.

2. Cosmetics and title of each part



3. Notices in use

Be sure to observe the followings to prevent electric shock and injuries.

3-1 Caution for safety

- (1) Never touch the servo driver inside during running, since the high-voltage circuit is in the servo driver. Never perform overhauling by yourself, but request to our company or agents appointed by our company.
- (2) Even after the power is turned off, inside of the circuit is still charged with high voltage for a while. If you want to touch the terminals of the terminal board, or inside of the driver, please turn off the main power and control power externally and wait for 5 min or more.
- (3) Please put on the cover to the terminal board for prevention of an electric shock while using the driver.
- (4) Do not touch the driver, motor and peripheral units during turning ON power, since temperature of these units rise. Specifically, in intending the regenerative resistor, the regenerative resistor becomes quite high in temperature. Never touch the resistor.
- (5) Please keep enough distance from the motor and the machine when you turn on the power.
- (6) Never touch the motor rotating parts during running.
- (7) Since the driver radiator, regenerative resistor and motor are quite high in temperature for a while even after shutting off Power supply, never touch these units.
- (8) When alarm occurred, remove causes to assure safety, re-set alarm and re-start.
- (9) In restoring power after instant stop, sudden re-start may occur. Never come near the machine. (Design the machine to assure safety to people in re-starting.)
- (10) While you do not use the motor and the machine for a long time, please turn off power.
- (11) Capacitor of the power supply rectification circuit is lowered in capacity due to aging. Fan motor for cooling is lowered in cooling drop due to aging. Replacing in about 5 years is recommendable, to prevent secondary disaster due to troubles.

Panasonic driver is designed and manufactured through the highest quality control however, unexpectedly higher external noise or application of high static electricity, or wrong wire connection may cause a misoperation. Please pay extra attention for the safety of your machine.

- (12) Please use a Non-Fuse Breaker as per the wiring example of section 5-1-1.

- Surely set and install the equipment to prevent physical injuries due to insufficient setting ad installation on occurrence of earthquake.
- After earthquake, be sure to check on safety.

3-2 In order to use the driver properly

- Since a misuse of the driver may leads to a wrong operation, or may damage the driver in the worst case, please carefully read the following cautions operation.
- Please keep and refer to this manual anytime you encounter questions.

- (1) Please do not apply a higher voltage than the rating to the power input terminals (R, S, T, r, t).
- (2) Please do not input the power to other terminals than the power input terminals (R, S, T, r, t) in any case. Please refer to section 5-1-1 (P.16) for wiring.
- (3) Input power side is capacitor input type. When you turn on the power, a high charge current runs and you may see the great voltage drop. We recommend you to have an independent power supply for the driver.
- (4) Refer to section 5-2 (P.22) for the capacity of the power supply.
- (5) Please install the driver at ambient temperature of $0^{\circ}\text{C} \sim +50^{\circ}\text{C}$. If the temperature exceeds this, it may cause malfunction or damage to the driver.
- (6) Please do not perform a dielectric strength test or megger test.
(When you perform a dielectric strength test, or megger test to an external circuit, please pull out all terminals of the driver and connector so that no test voltage may be applied to the driver.)
- (7) Please do not operate the driver under overcapacity conditions (such as continuous overcurrent operation).
- (8) When power is turned off, please keep an interval about 6 to 11 seconds before you turn it on again. If this interval is too short, the system may not start up normally because its internal circuit is not initialized.
- (9) If you use a leakage current breaker, please use that for the "Inverter" which withstands high frequency.
- (10) Use the motor and the driver in the designated combination.
- (11) After checking on input voltage matching with the driver specification, turn ON power supply and run. If voltage above the rating is input, fire and smoke may be generated in the driver inside, liable to cause motor abnormal operation and burning.

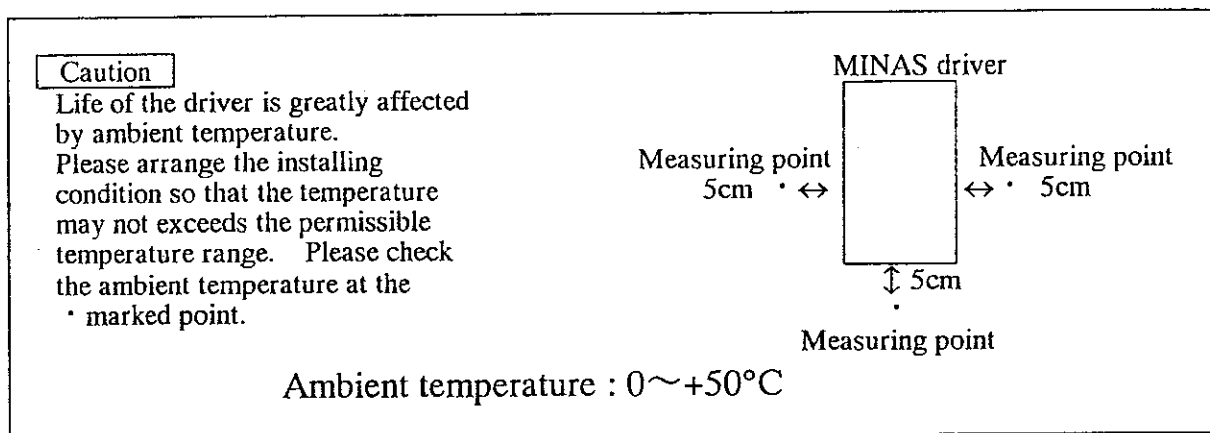
- (12) In trial running, fix the motor, check on operation in the state separating from the mechanical system, and then, fit the motor to the machine.
- (13) The brake incorporated into the motor is used for holding. Do not use this brake as the stopping unit for acquiring safety of the machine or as usual brake.
- (14) Do not perform excessive adjustment change, to prevent unstable operation.

3-3 Notices on setting and storing

- In transporting, treat carefully to prevent breakage of the driver. Do not grasp the cable and motor shaft when carrying.
- Do not apply excessive force to the driver front panel and side plates.

- (1) To the servo motor, high-frequency switching current is carried; accordingly, leak current exists. To release this leak current, be sure to connect the driver earth terminal (⊕) and the motor earth terminal (⊕), and earth at one position. Also, earth the machine main unit. Class 3 Earthing (under 100Ω, φ1.6mm or above) or above is recommendable for preventing electric shock and error operation. In case of using the leak breaker, use the breaker provided with high-frequency measures as "for inverter".
- (2) This driver is of vertical installation type. Be sure to observe the fitting direction.
- (3) Fit to noncombustibles such as metal.
- (4) Fit appropriately to match with output and main unit weight.
- (5) This driver is not of water-proof structure. Do not use the driver outdoors.
- (6) Do not ride on the drive or put heavy articles on the drive.
- (7) Do not close the inlet/exhaust ports, and do not let foreign matters into the ports.
- (8) Perform wiring correctly and firmly. Incorrect and uncertain wiring causes motor abnormal operation and burning.
- (9) Do not harm the cable, apply excessive stress to the cable, put heavy articles on the cable or nip the cable.
- (10) Set the emergency stop circuit outside enabling stopping running instantly and shutting off power supply.
- (11) Never store, install and use the driver at places where vibration and shock (above 0.5G) are applied, there are much metal powders & dusts, water, oil and grinding fluid splash, there are combustibles nearby, and corrosive gases and inflammable gases are generated. Also, do not use continuously at the resonance point.

- (12) Do not apply strong shock.
- (13) Take care not to be affected by radiation. In turning ON power supply, heat is generated at the servo driver control part. In running the motor, heat by motor current is added. If the driver is housed in the enclosed control box and used, temperature in the control box may rise abnormally. In case the driver is housed in the control box, take care for cooling to lower the driver ambient temperature under the max. ambient temperature. Take specified distance between the main unit and the control board inside or other units.



- (14) Do not install the driver near heating elements such as heaters and large size wire wound resistor. When such installation is unavoidable in terms of mounting and installing conditions, provide thermal shield, etc. between the servo driver and the heating elements, not to be affected by heating elements.
- (15) In case of using a regenerative resistor, temperature of the regenerative resistor may rise excessively. Set not to be touched during running. Also, take care for cooling of the regenerative resistor.
- (16) Do not store at places affected by rain, water dropping, toxic gases and toxic liquid.
- (17) Store at places not exposed by direct sunlight in temperature/humidity ranges within specification.
- (18) When the unit is stored for a long time, contact your sales agent or the information destination put in this Manual.
- (19) Package products according to indication, to prevent package collapsing due to overloading.

4. Installation place

- (1) This driver is the vertical installation type.
Fit perpendicularly and acquire sufficient space for ventilation.

- Firmly install the driver with screws and bolts without applying stress such as bending and twisting to the driver main unit.
- Use fitting screws and bolts of size M4 or M5.
- As for fitting pitch, refer to 12. [Outside Dimension Drawing] (Page 65).

- (2) Do not install at places with high temperature, high humidity, dusts, dirt, iron powders and chips.
- (3) Install at places of ambient temperature 0°C ~ +50°C.
- (4) Avoid places exposed with direct sunlight.
- (5) Install at places not affected by corrosive gases and grinding fluid.
- (6) The driver is not of water-proof structure.
- (7) Do not use outdoors. Install at places without vibration. Do not use continuously at the resonance point.

5. Wiring

5-1 Notices in wiring

5-1-1 Wiring to the terminal block

- (1) The cover of the terminal block is fit with screws. In wiring to the terminal block, remove the screws and open the cover.
- (2) Firmly wire according to Fig. 5-1 "Example of wiring to terminal block".
- (3) As for units for wiring and electric wires to be used, refer to 5-2 [Selection of units for wiring] (Page 22).
- (4) As for voltage of main power supply and control power supply, apply voltage indicated by the name plate.
- (5) Do not confuse in connecting the main power supply input terminals (R.S.T) and the output terminals for motor (U.V.W).
- (6) Do not earth or short-circuit the output terminals for motor (U.V.W)

Note

The terminal for earth \oplus is structured to be directly connected to the frame other than connecting to the terminal block. If the earth wire is connected to the terminal block by mistake, the driver may be damaged.

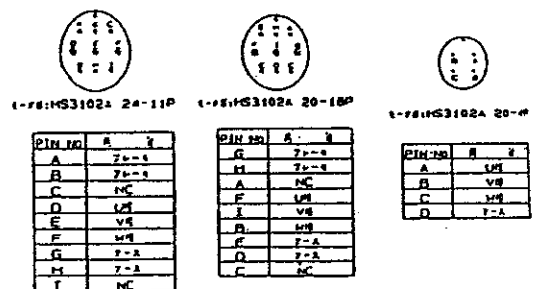
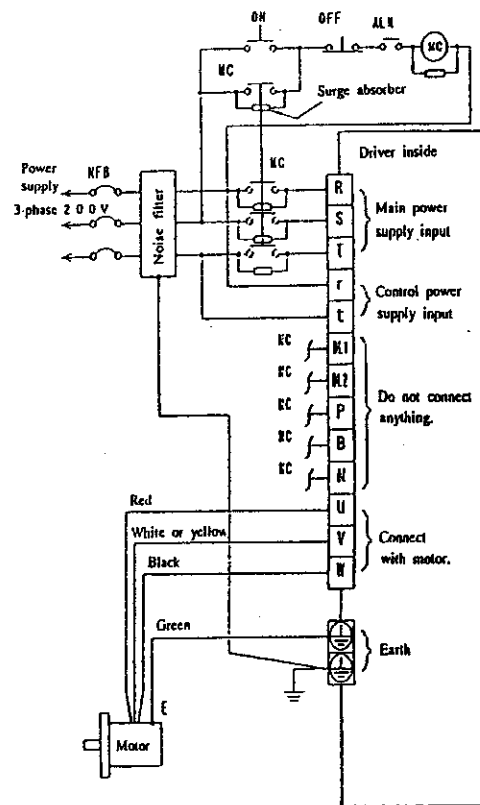


Fig. 5-1 Example of wiring to terminal block

- (7) Do not connect any wire to the terminal P.B.N.DL1 and DL2, in principle. In case absorption capacity of regenerative energy is insufficient only by built-in regenerative resistance, consult with your sales agent.
- (8) Terminals P and B are applied with high-voltage. Never touch the terminals P and B, to prevent electric shock.
- (9) The AC servo motor can not change rotating direction by exchanging the 3-phase as in induction motor. Be sure to match the driver motor output terminal and the motor lead wire GREEN (pin symbol in case of Cannon Plug).

- (10) For connecting the terminal block to each terminal, be sure to use crimp-style terminals with insulating coating.
- (11) Firmly connect the terminal for motor earth and terminal for driver earth, and earth at one position together with terminal for noise filter earth. Earthing the machine main unit is recommendable. Use Class 3 Earthing (earthing resistance 100 Ω or under, ϕ 1.6mm or above) for earthing.
- (12) After finishing wiring to the terminal block, close the terminal block cover and fix the cover with screws for preventing electric shock.
- (13) Insert the surge absorbing circuits to the contact points of the electromagnetic contactor and relay provided around the driver, coils and brake winding of the motor with brake, for preventing error operation.
- (14) Provide no-fuse breaker, to shut off power supply outside the driver in emergency. In case of using the earth leakage breaker, use the one provided with high-frequency measures of "for inverter".
- (15) Provide the noise filter for reducing radio noise and preventing error operation.
(Refer to 5-2 [Selection of units for wiring] (Page 22).)
- (16) Prepare power supply for brake of the motor with brake by users.

After wiring, before turning ON power supply, check for error wiring once again.

5-1-2 Regenerative resistor use method

- (1) Regenerative power consumable by the regenerative resistor incorporated in the standard driver is as follows.

Driver outside symbol	B-1	B-2	B-3
Regenerative power	Approx. 16W	Approx. 27W	Approx. 60W

For using in generating regenerative power exceeding the above power, the regenerative resistor incorporated in the driver can not be used. When overvoltage error protection (Error No.12) occurs in speed-reducing operation, etc. the regenerative resistor must be fit outside.

- (2) Outside fitting of regenerative resistor

Driver special for outside fitting the regenerative resistor is necessary.

If the regenerative resistor is fit outside to the standard driver P.B terminals and running is made, the driver may be damaged.
Consult with your sales agent. (Refer to 1-1 "Machine model symbol" (Page 9).)

- (3) Recommendable regenerative resistor to be fit outside

Driver model name	Driver outside symbol	Driver rated output	Recommendable resistance	Recommendable capacity	Instant stop consumed power
MSD103A2V	B-1	1 kW	40 Ω	400W	3706W
MSD153A2V	B-2	1.5 kW	30 Ω	600W	4941W
MSD203A2V	B-3	2 kW	20 Ω	1000W	7411W
MSD253A2V	B-3	2.5 kW	20 Ω	1000W	7411W
MDD083A2V	B-1	750 W	60 Ω	300W	2470W
MDD103A2V	B-1	1 kW	40 Ω	400W	3706W
MDD153A2V	B-2	1.5 kW	30 Ω	600W	4941W
MDD203A2V	B-3	2 kW	20 Ω	1000W	7411W
MDD253A2V	B-3	2.5 kW	20 Ω	1000W	7411W

Driver model name	Driver outside symbol	Driver rated output	Recommendable resistance	Recommendable capacity	Instant stop consumed power
MFD083A2V	B-1	750 W	60Ω	300W	2470W
MFD153A2V	B-2	1.5 kW	30Ω	600W	4941W
MFD253A2V	B-3	2.5 kW	20Ω	1000W	7411W
MHD053A2V	B-2	500 W	60Ω	300W	2470W
MHD103A2V	B-1	1 kW	40Ω	400W	3706W
MHD153A2V	B-2	1.5 kW	30Ω	600W	4941W
MHD203A2V	B-3	2 kW	20Ω	1000W	7411W

- (4) Shorten the wire between the driver and the regenerative resistor as much as possible. (within 50cm)
Take care not to touch the wire to the regenerative resistor main unit.
- (5) Wire the regenerative resistor surely according to Fig. 5-1 "Example of wiring to terminal block".
- (6) When absorption capacity of regenerative energy is insufficient in using the regenerative resistor fit outside, the resistor also can not be used. In this state, reduce regenerative energy by reducing load inertia, max. speed and acceleration/deceleration time, etc.

Note

Never touch the regenerative resistor, since the resistor may be highly heated, causing burn.

When the regenerative resistor is highly heated, take measures such as increasing capacity of the regenerative resistor or cooling the resistor.

5-1-3 Wiring to Connector CN I/F

- (1) Please make wiring per Fig. 5-2, "Wiring example to connector, CN I/F".
- (2) Please prepare a power supply for a control signal with DC12-24V, used for external control connected between COM + and COM -.
- (3) Please shorten the wiring of the driver and other equipment as much as possible (3 m or shorter).
- (4) Please separate this wiring from the power lines (R, S, T, r, t, U, V, W, \oplus), as much as possible (30 cm or more). Please avoid passing both wires into the same duct or binding them together. It may cause malfunction.
- (5) Please do not apply more than DC 24V or 50mA, to each terminal of the control output (S-RDY, ALM, COIN, TLC, ZSP, BRK-OFF, EXOUT2, EXOUT1, EXOUT0), or avoid applying reverse polarity. This may cause damage to the driver.
- (6) If you directly drive a relay with the control output terminals, please install a diode in parallel with the relay as Fig. 5-2 shows. If you do not install a diode, or install it in reverse direction, this may cause damage to the driver.

- (7) As per Fig. 5-2, please use shielded, twisted pair wires for a signal line of CN I/F (analog command input, command pulse input, feed-back pulse output of the encoder etc.). Please ground the shield to the signal ground (GND) of the driver. (Though the shield of other equipment normally open, in case affected by extreme noise, connect shield of both driver and other equipment to frame ground.)
- (8) Frame ground terminal (FG) is connected with the earth terminal (\oplus) in the driver.

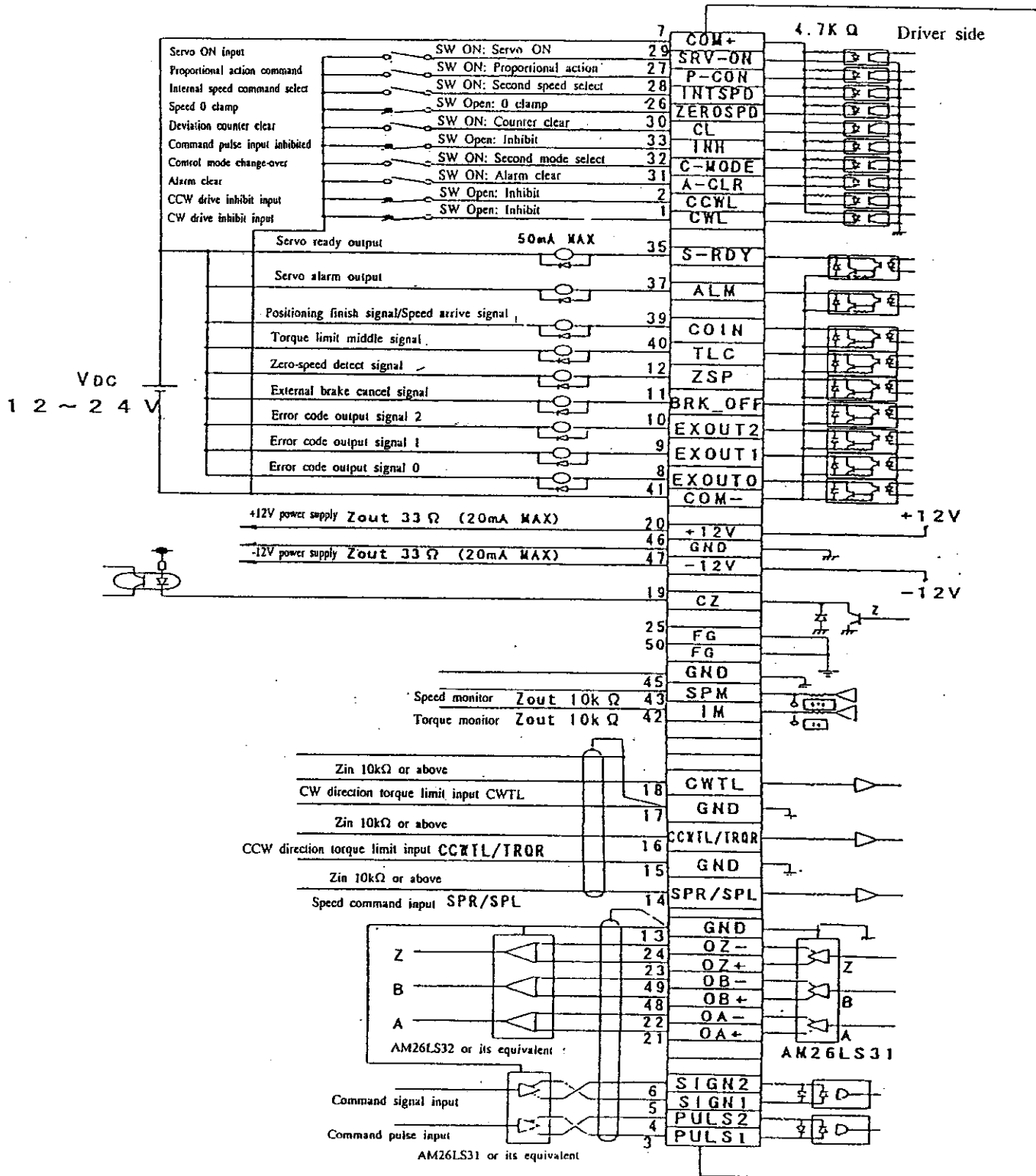


Fig. 5-2 Example of wiring to connector CN I/F

5-1-4 Wiring to Connector CN SIG

- (1) For the encoder cable, use a stranded wire having core of 0.18mm² or above, a twisted pair of wire having overall shield.
- (2) The length of the cable must be within 20m max. When wiring is long, we recommend double wiring in order to reduce influence by voltage fall for 5V (3.4 pin) and 0V (1.2 pin) power supply.
- (3) Be sure to connect the envelope of the shield on the relay cable driver side to the frame ground (20 pin) of the connector CN SIG, to minimize effect of noise. Connect the envelope on the motor side of the relay cable to the envelope of the shield wire from the encoder.
- (4) Separate wiring to the power line (R.S.T.r.t.U.V.W. \oplus) as much as possible. (30cm or more) Do not pass them through the same duct or bind them together, to prevent error operation.
- (5) In case of Cannon plug specification, connect the envelope of the shield on the encoder cable motor side to the J terminal.
- (6) Do not connect anything to the vacant terminal (5,6,13,14,15,16,19 pins) of the connector CN SIG.
- (7) The frame ground terminal (FG) is connected with the earth terminal (\oplus) in the driver.

Connector for CN I/F, CN SIG

Receptacle on driver side		Applicable plug on user side		Manufacturer
Connector mark	Product No.	Part name	Product No.	
CN I/F	10250-52A2JL	Plug (Solder type)	10150-3000VE	Sumitomo 3M, Ltd.
		Shell	10350-52A0-008	
CN SIG	10220-52A2JL	Plug (Solder type)	10120-3000VE	
		Shell	10320-52A0-008	

Note 1) Parts equivalent to product number above made by other manufacturers may be used for receptacle and plug.

Note 2) As plug shell kit, use the above article No.s or articles equivalent to the above article No.s made by other manufacturers.

5-1-5 Wiring to Connector CN SER

- (1) With a personal computer designated in section 13.1 PANATERM, Software for communication control (Option/P.66), you can operate this driver with the following functions;
(Please refer to section 10-2, P.63 for detail.)

- Setting/change of each parameter
- Control state reference
- Error condition reference
- Error record reference
- Automatic gain tuning
- Waveform graphic function
- Saving/loading of the parameter data

- (2) For connecting the personal computer and the driver, use the special cable prepared as option. As for option cable, refer to 13-2 [Cable for connecting RS-232C] (P. 67).

Insert surely the option cable connector to the "RS-232C" connector set on the rear side of the personal computer and the "CN SER" of the driver.

After inserting, firmly tighten the screw for holding the connector. (Insert/pull out the connector when both power supplies of the personal computer and the driver are shut off.)

5-2 Selection of a wiring equipment

Applicable motor		Power consumption (At rated power)	No-fuse breaker (Rated current) Note 1	Recommended noise filter Note 2	Electromagnetic switch (Composition of contact) Note 1	Main circuit wire diameter (R, S, T, U, V, W, Φ)	Control circuit electric wire diameter (r,t)
Series	Output						
MDM MFM	750W	about 1.3kVA	BBP3-10 (10A)	LF-310	BMF61042N (4a)	2mm ²	1.25mm ²
MSM MDM	1kW	about 18.kVA	BBP3-15 (15A)	LF-315	BMF61542N (4a)	3.5mm ²	1.25mm ²
MSM MDM MFM	1.5kW	about 2.3kVA	BBP3-20 (20A)	LF-320	BMF61842N (4a)	3.5mm ²	1.25mm ²
MSM MDM	2kW	about 3.3kVA	BBP3-30 (30A)	LF-330	BMF6252N (3P+2a2b)	3.5mm ²	1.25mm ²
MSM MDM MFM	2.5kW	about 3.8kVA	BBP3-40 (40A)	LF-340	BMF6352N (3P+2a2b)	3.5mm ²	1.25mm ²

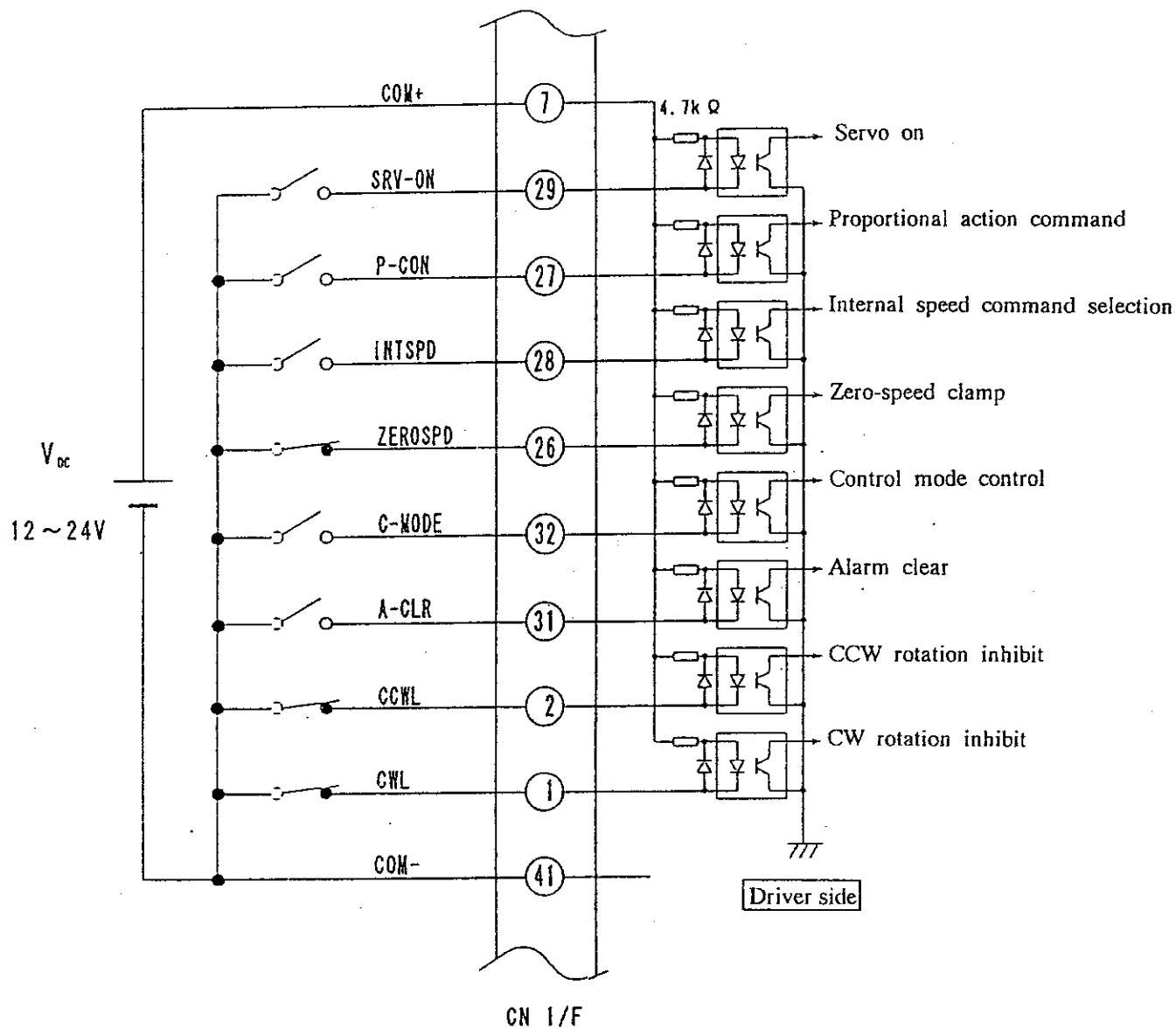
Note 1) The product number of no-fuse breaker and electromagnetic switch belongs to Matsushita Electric Works, LTD.

Note 2) The product number of noise filter belongs to Tokin, LTD.

6. Function

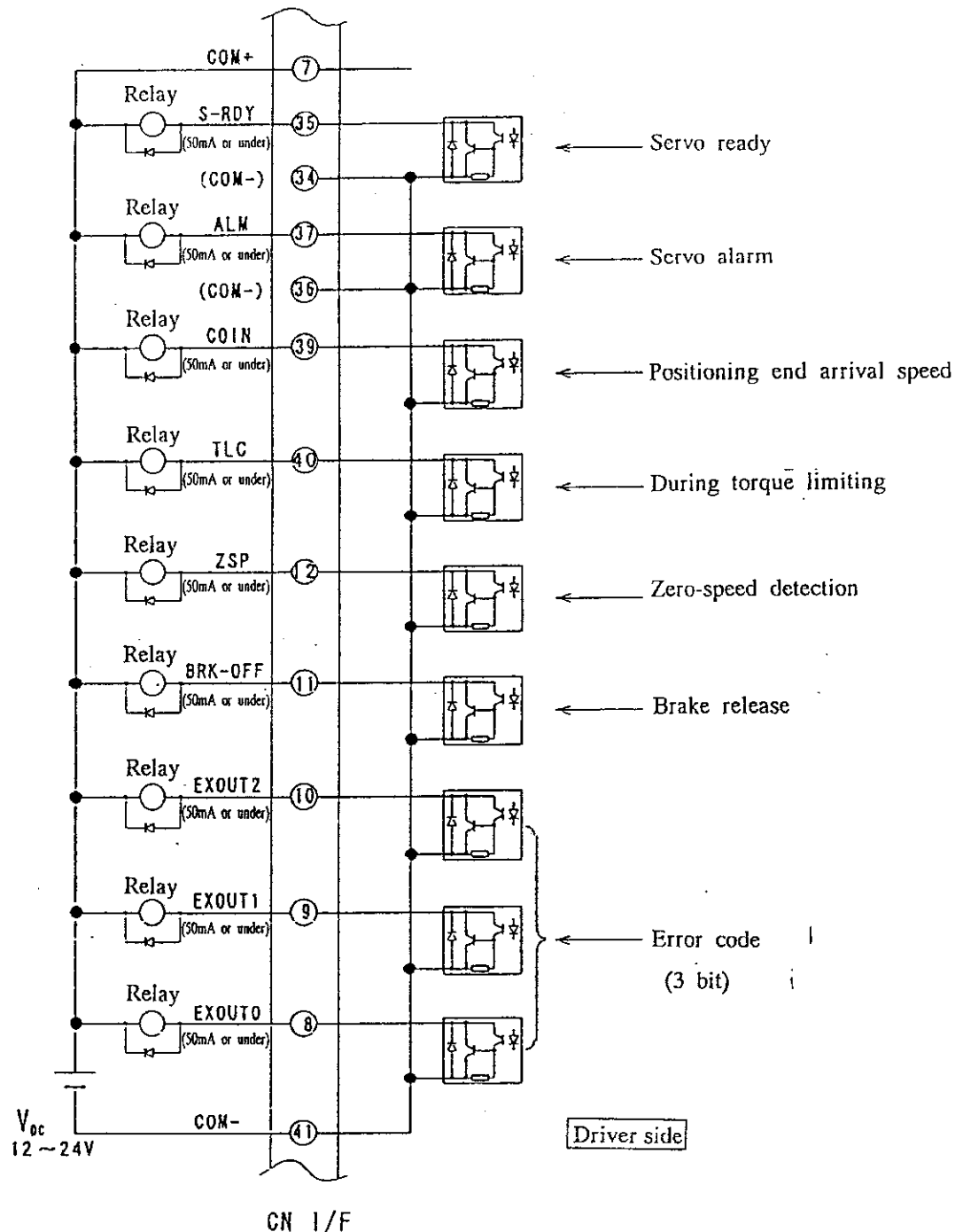
6-1 Configuration of input circuit

6-1-1 Control input



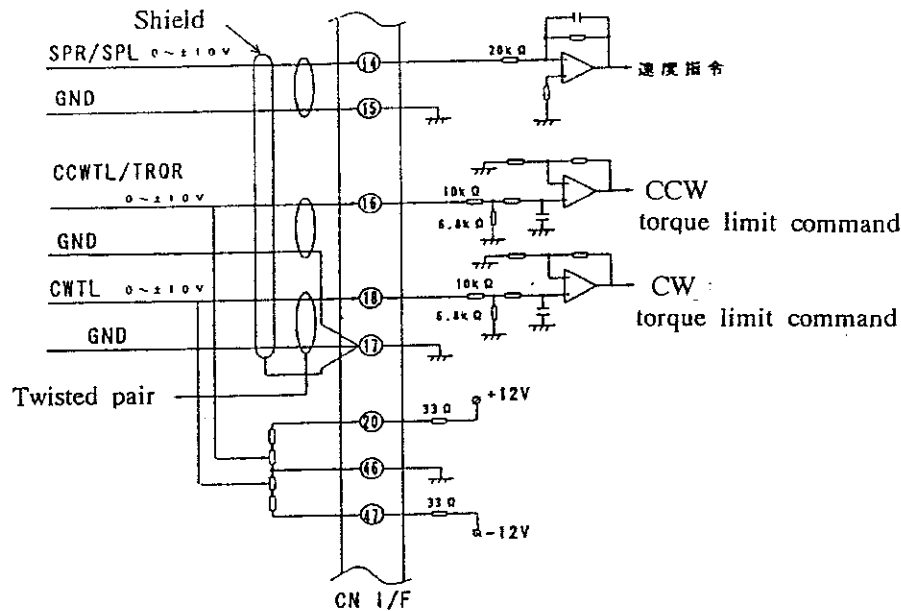
Note) Please prepare a power supply (V_{DC}) for the control signal at your side. (DC 12~24V/0.5A or more)

6-1-2 Control output



- Note 1) Please prepare a power supply (V_{DC}) for the control signal at your side. (DC12V ~ 24V, 0.5A or more)
- Note 2) Please pay attention for the polarity of V_{DC} . Reversed polarity of the above fig. will damage the driver.
- Note 3) When you directly drive a relay with each output signal, please install a diode in parallel to the relay as the above fig. shows. If you do not install a diode or install it in reverse direction, the driver get damaged.
- Note 4) When each output signal is received by logic circuit such as a gate, be sure to eliminate influence by noise.
- Note 5) Please limit the current fed to each output to 50mA or less.

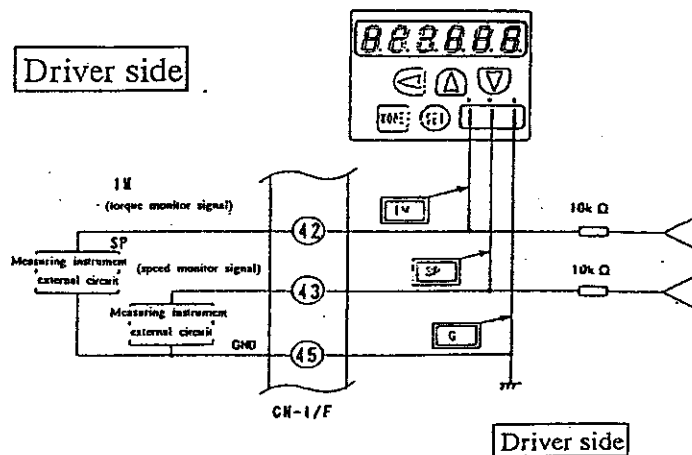
6-1-3 Analog signal input



Note) Please use SPR/SPL and CCWTL/TRQR input separately based on the following control mode;

- SPR/SPL input
 - at speed control mode Speed command input
 - at torque control mode Speed limit input (in absolute value)
 - at the position control mode Inactive
- CCWTL/TRQR input
 - at speed, position control mode CCW torque limit input
 - at torque control mode Torque command input

6-1-4 Analog signal output (monitor output)



Note 1) Output of both IM and SP has output impedance of 10KΩ. When you connect a measuring instrument or an external circuit to IM or SP output, use the ones which have high input impedance in order to minimize an error. (Such as Multimeter or Oscilloscope etc.)

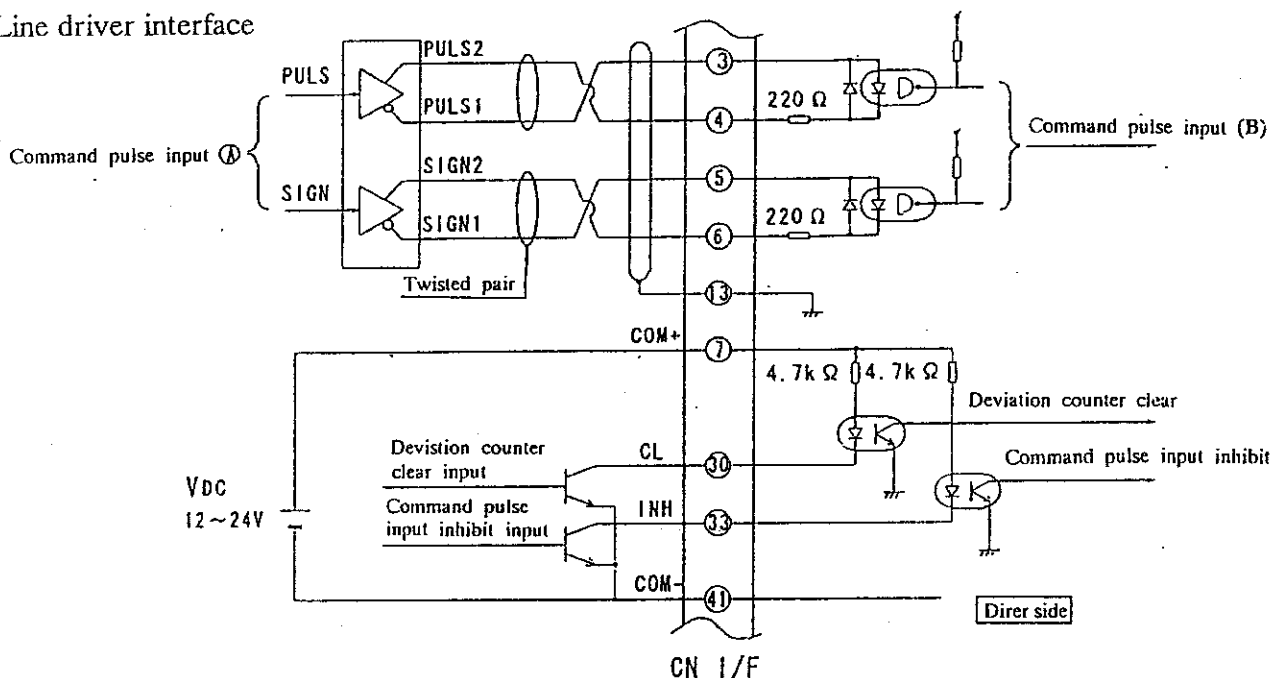
Note 2) IM and SP are also output to check pins on the front of resin case.

6-1-5 Pulse row command, Counter clear, Command pulse input prohibition input

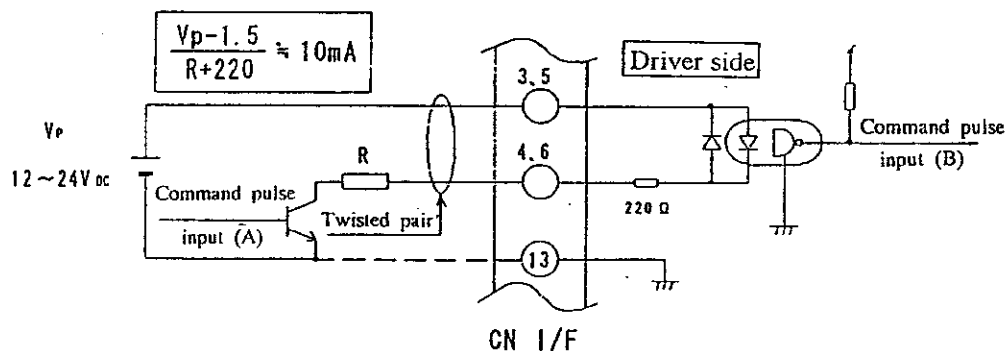
The command pulse input can respond to either interface of a line driver or an open collector however, we recommend you to use a line driver interface as the above Fig. shows in order to deliver a signal securely.

Take notice that connection to the driver is different in the line driver interface and the open collector interface.

• Line driver interface



• Open collector interface



Note 1) Caution on using an open collector interface

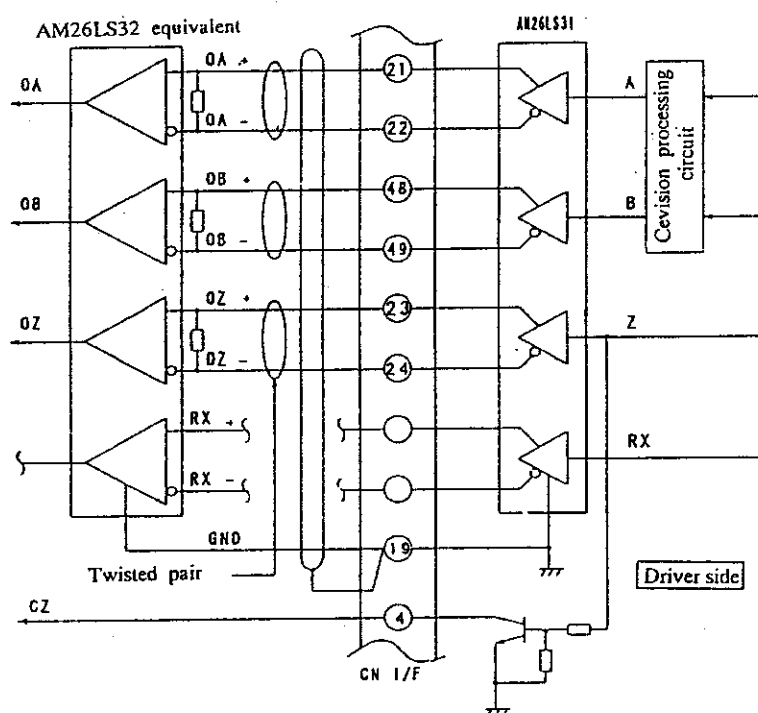
- ① Please shorten the wiring as much as possible (1 m or shorter).
- ② Please note that the max. input pulse frequency is 200kpps at an open collector interface while that is 500kpps at a line driver interface.
- ③ When you compose a command pulse input circuit at an open collector interface, you need to install a separate power supply (12~24VDC) for pull-up. Higher the power supply voltage (less than 24VDC), higher the resistance to the noise you can expect. Please set the value of the series resistor R in the following formula so that the primary current of the photo-coupler becomes approx. 10mA depending on the power supply voltage. (Setting Vp to 24V, R shows 1.8~2.0kΩ, and setting to 12V, R shows 780~820Ω.)

- ④ Note that logic relation of pulse input (relation of command pulse input (A) and (B) in preceding page) is reversed as shown below respectively for line driver and open collector interface. (See 9-2 (P.44~53).)

Provision of pulse		(A) (Supply side)	(B) (Driver side)
Line driver	I/F	H (L)	H (L)
Open collector	I/F	H (L)	L (H)

- ⑤ If there should be any fault due to influence of noise, it may be corrected by connecting signal GND on pulse supply side and signal GND on driver side (such as pin 13 of CN I/F) (Broken line in the open collector interface figure).

Note 2) Pulse input inhibit signal (1NH) inhibits the input of pulse as connection is open between pin 33 and 41. When 1NH input is unused, short between pin 33 and 41 outside the driver.



Note 1) The output pulse (A/B-phase) of the rotary encoder will be entered into a division processing circuit, then will be fed out through the line driver(AM26LS31) after the division processing. Z-signal alone will be fed out through the No. 4 pin (CZ) with an open collector. If using this CZ-signal, be sure to eliminate influence by noise.

Note 2) Please receive the output pulse with the line receiver (AM26LS32 or equivalent). In this case, please install an appropriate resistor (Approx. 330Ω) between the line receiver inputs.

Note 3) In Z-phase signal, note that logic is reversed respectively for line receiver output (OZ) and open collector output (CZ).

Note 4) When you use division function of feedback pulse, note that:

- ① Pulse width of Z-phase signal becomes relatively small, according to division ratio, compared to that of A or B phase signal after division.
- ② When the division ratio is "1", Z-phase signal is synchronized with A-phase signal, while if it is not "1", they are unsynchronized.

6-2 Input/Output signal

Type	Title	Symbol	Pin No.	Contents/function
Control signal power supply	Control signal power supply	COM +	7	<input type="checkbox"/> Connect (+) of the control signal power supply (12~24V) to the COM+ (7 pin), and (-) to the COM- (41 pin). <input type="checkbox"/> Prepare a control signal power supply at your side. Capacity varies depending on a composition of the control output circuit. Allow extra capacity.
		COM -	41	
Control input	Servo-ON input	SRV-ON	29	<input type="checkbox"/> When you connect to (-) of the control signal power supply, dynamic brake will be released and the driver turns to "Servo-ON". <input type="checkbox"/> When you open the connection to (-), the driver turns to "Servo-OFF", and shuts off the current to the motor and dynamic brake will be activated, and also the deviation counter will be cleared. Note 1. When you shift from "Servo-OFF" to "Servo-ON", make sure that the motor is at stop. Note 2. Turn on/turn off the power at "Servo-OFF" status in order to avoid transitional trouble. Note 3. Allow 50 ms or more before input the command (speed/pulse etc.) after shifting to "Servo-ON".
	Proportional action command input	P-CON	27	<input type="checkbox"/> In connecting to COM-, operation of the speed amp becomes only proportional action (P action). <input type="checkbox"/> In case of using for positioning, etc. without setting position loop, etc., when leaving for a long time after finishing positioning, positioning point may move by drift of the analog signal processing circuit. To prevent the above trouble, by switching P1 action of speed amp to only P action on finishing positioning, loop gain of the control system is lowered, reducing drift amount. With friction load, the motor stops more firmly.
	Internal speed command select input	INTSPD	28	<input type="checkbox"/> When internal speed command is selected by parameter No.16 "Speed setting internal/external change-over", internal speed setting first speed and second speed are changed over with this input. In connecting to COM-, second speed is selected. <input type="checkbox"/> First speed and second speed of internal speed command setting can be set by parameters. As for details, refer to Page 50 and 51.
	Zero-speed clamp input	ZEROSPD	26	<input type="checkbox"/> In opening between COM-, external and internal speed command inputs are separated, and instead, zero-speed command is given as data value and the motor becoes servo lock state. (however, effective when set value of the parameter No.17 is "0" and control mode is other than position control mode) <input type="checkbox"/> Accordingly, this input can remove fluctuation factors such as extenal speed command signal and following offset drift by A/D converter. <input type="checkbox"/> This input is also used as control input in internal speed command setting run, in combining with the INTSPD input above stated. Refer to Page 51.

Type	Title	Symbol	Pin No.	Contents/function
Control input	Control mode control input	C-MODE	32	<input type="checkbox"/> You can select six modes through the parameter of "Selection of control mode", in single mode, among ① Position control mode, ② Speed control mode, and ③ Torque control mode, and in addition to these in combination mode, among ④ Position (1st.) · Speed (2nd.) control mode, ⑤ Position (1st.) · Torque (2nd.) control mode, and ⑥ Speed (1st.) · Torque (2nd.) control mode. <input type="checkbox"/> In the case where any of control modes combining ④ to ⑥ above is selected, when connection to the (-) pole is open, the first mode is selected.
	Alarm clear input	A-CLR	31	<input type="checkbox"/> You can clear the alarm status when you connect to (-), and you can return to the normal run. (Signal width needs to be 120ms or more.) <input type="checkbox"/> At the same time, the deviation counter will be cleared Note You cannot clear the overload (OL), overcurrent (OC), encoder error (ST) and system error, parameter error, CPU error and DSP error with this input. In order to clear the above, please remove the error factor first, then turn off/on the power.
	CCW rotation inhibit input	CCWL	2	<input type="checkbox"/> In case of a linear drive, connect to the limit SW in CCW direction (viewed from the motor shaft), and close this limit in case of a normal run. If the SW becomes open exceeding the limit, no CCW torque will be generated. <input type="checkbox"/> When you do not use the limit SW, please mask this input through the parameter No. 09, or connect between (-) at any time. <input type="checkbox"/> You can activate a dynamic brake with this input. Refer to section 6-3 (P.33) for a detail.
	CW rotation inhibit input	CWL	1	<input type="checkbox"/> You can prohibit a generation of CW torque. Refer to the above "CCW rotation inhibit input" for the function and composition.
Control output	Servo-ready output	S-RDY	35	<input type="checkbox"/> Transistor will turn ON, when the main power is on, and the driver is not in "Servo-alarm" status. Note When you turn off the power but the main capacitor is kept charged, Servo-ready output is ON.
	Servo-alarm output	ALM	37	<input type="checkbox"/> Transistor turns off when the driver detects the error and activates the protective function.
	Positioning end signal output or Speed arrival signal output	COIN	39	<input type="checkbox"/> At position control mode, when the reserved pulse amount of the deviation counter gets within the positioning end range which you set through the parameter No.22, transistor turns on. <input type="checkbox"/> At speed or torque control mode, this signal becomes a speed arrival signal. Transistor turns on when the motor speed reaches the preset speed preset through the parameter No.12.
	Signal output during torque limiting	TLC	40	<input type="checkbox"/> Output transistor turns ON in speed or position control mode when torque limit function is operating.

Type	Title	Symbol	Pin No.	Contents/function																																										
Control output	Zero-speed detection signal output	ZSP	12	<input type="checkbox"/> Output transistor turns ON when motor rotating speed is lowered to zero (low) speed set by parameter No.11 or under. Detectable rotating speed is 20r/min or above.																																										
	External brake cancel	BRK-OFF	11	<input type="checkbox"/> With this signal output, external mechanical brake is controlled. Structure the external circuit to cancel brake when the external transistor is turned ON. As for timing sequence of this signal, refer to page 48.																																										
	Alarm code output	EXOUT2	10	<input type="checkbox"/> When error is detected and protection function operates to make alarm state, code is output in 3-bit for each factor. Relation of factor and code output is shown in the below table. <table><tr><th colspan="3">Error code</th><th rowspan="3">Error contents</th></tr><tr><th>EXOUT2</th><th>EXOUT1</th><th>EXOUT0</th></tr><tr><th>CN I/F 10 pin</th><th>CN I/F 9 pin</th><th>CN I/F 8 pin</th></tr><tr><td>0</td><td>0</td><td>0</td><td>Normal</td></tr><tr><td>0</td><td>0</td><td>1</td><td>System error, DSP error, CPU error</td></tr><tr><td>0</td><td>1</td><td>0</td><td>EEPROM parameter error, Receiving parameter error, Command pulse dividing error</td></tr><tr><td>0</td><td>1</td><td>1</td><td>Encoder error(ST), Drive inhibit input error</td></tr><tr><td>1</td><td>0</td><td>0</td><td>Positional deviation excessive error, Deviation over error, Over speed error(OS)</td></tr><tr><td>1</td><td>0</td><td>1</td><td>Insufficient voltage error (LV), Voltage error(OV)</td></tr><tr><td>1</td><td>1</td><td>0</td><td>Overload error(OL), Overheat error(OH), Over current error(OC)</td></tr><tr><td>1</td><td>1</td><td>1</td><td>Other errors</td></tr></table>	Error code			Error contents	EXOUT2	EXOUT1	EXOUT0	CN I/F 10 pin	CN I/F 9 pin	CN I/F 8 pin	0	0	0	Normal	0	0	1	System error, DSP error, CPU error	0	1	0	EEPROM parameter error, Receiving parameter error, Command pulse dividing error	0	1	1	Encoder error(ST), Drive inhibit input error	1	0	0	Positional deviation excessive error, Deviation over error, Over speed error(OS)	1	0	1	Insufficient voltage error (LV), Voltage error(OV)	1	1	0	Overload error(OL), Overheat error(OH), Over current error(OC)	1	1	1	Other errors
		Error code			Error contents																																									
EXOUT2		EXOUT1	EXOUT0																																											
CN I/F 10 pin	CN I/F 9 pin	CN I/F 8 pin																																												
0	0	0	Normal																																											
0	0	1	System error, DSP error, CPU error																																											
0	1	0	EEPROM parameter error, Receiving parameter error, Command pulse dividing error																																											
0	1	1	Encoder error(ST), Drive inhibit input error																																											
1	0	0	Positional deviation excessive error, Deviation over error, Over speed error(OS)																																											
1	0	1	Insufficient voltage error (LV), Voltage error(OV)																																											
1	1	0	Overload error(OL), Overheat error(OH), Over current error(OC)																																											
1	1	1	Other errors																																											
	EXOUT1	9																																												
	EXOUT0	8																																												
			Note) 0: Output transistor ON 1: Output transistor OFF																																											
Analog signal input	Speed command input	SPR/SPL	14	i) At speed control mode: <ul style="list-style-type: none">You can input the analog speed command.You can set the speed command input gain (relation between the motor speed and the command input level), and the polarity of the speed command input through the parameter No.13 or 14. (Refer to P.50).																																										
		GND	15	ii) At torque control mode: <ul style="list-style-type: none">You can input the speed limit command. You can limit the speed responding to the external input signal level.A relation between the limited speed and the input level is the same as that of the commanded voltage level and the motor speed at the parameter No.13. Refer to P.50. Note 1. You can use both + and - polarity of the speed limit input, and you can limit both CCW and CW speed. Note 2. This input becomes inactive at position control mode.																																										

Type	Title	Symbol	Pin No.	Contents/function		
Analog signal input	CW torque limit input	CWTL	18	<div><input type="checkbox"/> You can individually limit the CW and CCW torque (current) externally at speed and position control mode, responding to the input signal level.</div> <div><input type="checkbox"/> Input negative command voltage to CWTL (No. 18 pin) to limit the CW torque, and positive command voltage to CCWTL (No. 16 pin) to limit the CCW torque.</div> <div><input type="checkbox"/> A relation between the commanded voltage and the torque limiting ratio (against the rated current) is described as follows;</div> <div><p>Ratio against the rated current (%)</p><p>CW command -3 -6 -9 (V) CCW command +3 +6 +9 (V)</p></div>		
		GND	17			
	CCW torque limit input	CCWTL	16		<div>Note 1. At the factory setting, the CCW and CW torque limit function is masked through the Parameter No.7. When you use this function, input command voltage to CWTL or CCWTL, after releasing the mask (Refer to P.45.)</div> <div>Note 2. This function becomes inactive at torque control mode.</div> <div>Note 3. Some models show saturation when the torque limit input exceeds approx. $\pm 6V$.</div>	
		GND	17			
	Torque command input	TRQR	16			<div><input type="checkbox"/> You can input the torque command at a torque control mode.</div> <div><input type="checkbox"/> You can set the torque command input gain (a relation between command input level and generated torque of the motor), and polarity of torque command input through the parameter No.1A, 1B. (Refer to P.51)</div> <div>Note 1. This input is used in common with CCW torque limit input (CCWTL).</div> <div>Note 2. As soon as torque input equivalent to about 200% or more is given, some models may show saturation phenomenon of generated torque.</div>
		GND	17			

Note Please apply voltage within $\pm 10V$ for analog command input of SPR/SPL, CWTL, CCWTL, TRQR.

Type	Title	Symbol	Pin No.	Contents/function
Analog signal input	Speed monitor signal	SP	43	<input type="checkbox"/> The driver outputs voltage with polarity in proportion to the motor speed or position deviation. You can select the motor speed or the position deviation through the parameter No.08 "Speed monitor gain". + : CCW rotation - : CW rotation
		GND	45	<input type="checkbox"/> You can set 2 types of full scale value of a speed monitor signal through the parameter No.08 "Speed monitor gain". (Refer to P.45.) Note. Output impedance of the speed monitor signal is 10k Ω . Pay attention to input impedance of measuring instruments and circuits to which you connect.
	Torque monitor signal	IM	42	<input type="checkbox"/> The driver outputs voltage with polarity in proportion to the generated torque of the motor. + : CCW rotation - : CW rotation <input type="checkbox"/> A relation between output voltage of the torque monitor signal and the generated torque is; 3V/100% torque
		GMD	45	Note. Output impedance of the speed monitor signal is 10k Ω . Pay attention to input impedance of measuring instruments and circuits to which you connect.
Pulse row comanc input	Command pulse input	PULS1	4	<input type="checkbox"/> You can input command pulses through this terminal. The driver receives them with a high-speed photo-coupler IC. <input type="checkbox"/> You can select input status of command pulse among the followings through the parameter No.29; (Refer to P.53.) ① 2-phase input (A/B-phase) ② CW (PULS)/CCW (SIGN) pulse input ③ Command pulse (PULS)/Symbol (SIGN) pulse input
		PULS2	3	
	Command symbol input	SIGN1	6	<input type="checkbox"/> You can set a multiplication of the 2-phase input (multiplication of 1, 2, 4), and select the polarity of the input command pulse through the parameter. Note Input impedance of command pulse input signal and command symbol input signal is 220 Ω .
		SIGN2	5	
Control input (at position control mode)	Deviation counter clear input (Count clear)	CL	30	<input type="checkbox"/> You can clear the deviation counter connecting to COM- of signal power for control. You can also prohibit a command pulse input and a feed-back pulse input from the encoder. Note. Allow more than 30 μ s of clear signal width.
	Command pulse input inhibit	INH	33	<input type="checkbox"/> In connecting to COM- of control signal power supply, input of command pulse (PULS.SIGN) becomes effective. In releasing connection to COM-, input of command pulse is inhibited. When this function is not used, be sure to connect to COM-.

Type	Title	Symbol	Pin No.	Contents/function
Encoder pulse output	A-phase output	OA+	21	<input type="checkbox"/> An output pulse from the rotary encoder built-in the driver will be entered into the division processing circuit, and be fed out through the line driver (AM26LS31) after the division processing.
		OA-	22	
	B-phase output	OB+	48	<input type="checkbox"/> You can select a logic relation of B-phase, or Z-phase against A-phase pulse through the parameter No.0D. (Refer to P.42.)
		OB-	49	
	Z-phase output	OZ+	23	
		OZ-	24	
	Z-phase output	CZ	19	<input type="checkbox"/> Open collector output.
	Power supply output	+12V	20	<input type="checkbox"/> Allowable current is 20mA both in +12V and -12V.
		-12V	47	
		GND	46	
	Signal ground	GND	13, 15, 17, 44, 45	
	Frame ground	FG	25, 50	<input type="checkbox"/> Connected with driver earth terminal.

6-3 Dynamic brake

MSD Series have built-in dynamic brake for emergency stop. The dynamic brake will be activated in the following cases;

- (1) when you turn off the main power,
- (2) when you turn the driver to "Servo-OFF",
- (3) when a protective function is activated,
- (4) during deceleration, when the limit SW, connected to "CW rotation inhibit input (CWL)" of the Connector, CN I/F is turned to "open" while the motor is running at CW.
- (5) during deceleration, when the limit SW, connected to "CCW rotation inhibit input (CCWL)" of the Connector, CN I/F is turned to "open" while the motor is running at CCW.

[Note] 1. In case of the above (2), (3), (4) and (5), you can select whether or not to activate the dynamic brake through the parameter No.OA. (Refer to section 9-2 P.44~53.)

Parameter No. OA DB operation setting	Deceleration operation in inputting CW.CCW drive inhibit	In servo OFF or operating protection function	In power supply OFF
0	Deceleration and stop by operating brake	Deceleration and stop by operating brake, Brake operates after stopping	Deceleration and stop by operating brake, Brake operates after stopping
1	Free run stop without operating brake	Brake operating after stopping, Brake operates after stopping	
2	Deceleration and stop by operating brake	Deceleration and stop by operating brake, Brake canceled after stopping	
3	Free run stop without operating brake	Deceleration and stop by operating brake, Brake operating after stopping	

Note 2. The dynamic brake is rated for a short duration. Use this only for emergency.

Please set a pause in approx. 3 minutes when the dynamic brake worked at high speed operation.

Specifically, if servo ON/OFF is repeated frequently, the dynamic brake circuit incorporated in the driver may be damaged. Do not repeat turning ON/OFF the servo frequently.

6-4 Automatic gain tuning

6-4-1 Outline of automatic gain tuning

The driver selects the most proper gain automatically, by presuming the load inertia from the required torque when you drive the motor. Please refer to section 10-1-4 (P.58), for how to operate automatic gain tuning.

6-4-2 Applicable range

☐ You can apply this function only when the following conditions are satisfied.

☐ Even if the conditions are satisfied, there may be the cases when you cannot apply this function, due to various load conditions.

In these occasions, please setting manually. (Refer to section 8-2 P.40)

	Applicable conditions
Motor	MSM, MDM, MFM, MHM series
Load inertia	To be more than 2 times, but less than 5 times that of the rotor inertia of the motor.
Load	<ul style="list-style-type: none">• Machine stiffness to be as high as possible, including a coupling to the motor. (No belt drive is applicable.)• Backlash of the gear to be as small as possible.• Eccentric load to be less than 1/4th, of the rated torque (especially in the use at vertical shift axis).• Viscous load torque to be less than 1/4th of the rated torque.• No safety problem nor machine damage to be expected, even when an oscillation occurs.• Machine to allow two revolutions of the motor for CCW and CW in both forward and reverse direction.

6-4-3 Notices

Take special care for safety. When oscillation state occurred, immediately shut off power supply or turn OFF servo, and return gain to the delivery setting value by parameter setting.

- (1) When error, servo OFF and deviation counter clear occurred during operating auto gain tuning, auto gain tuning error is made. As for details, refer to 10-1-4(4) "Details on auto gain tuning mode" (page 62).
- (2) Motor output torque during operating auto gain tuning is allowed up to the max. output torque set by Parameter No.06 "Torque limit setting". CW and CCW drive inhibit input is ignored.
- (3) In certain load state, oscillation may occur, abruptly changing speed.
- (4) If error occurred during operating auto gain tuning, immediately shut off power supply or turn OFF servo.

- (5) In case auto gain tuning is executed but load inertia can not be presumed, gain is the same value before executing tuning, not being changed.

6-4-4 Automatic gain tuning operation

- (1) When you set the machine stiffness No. (higher the setting No., stiffer the tuning you can set) and execute, you can start the automatic gain tuning operation.
- (2) Rotate 2 revolutions to CCW and 2 revolutions to CW 2 times. Take this process as one cycle, and repeat max. 5 cycles.
- (3) Operation acceleration will be increased by double from the 3rd. cycle onward. Depending on the state of load, there may be some cases when the auto-tuning will be completed before 5 cycles, or the operation acceleration will not change. These are not malfunctions.

Regarding the machine stiffness No.

- ☐ This No. represents the stiffness of the machine, and ranges from 1 to 9. You can set a higher value and higher gain with a higher stiffness machine.
- ☐ Normally you start setting with smaller No., and repeat the automatic gain tuning until you encounter the oscillation, abnormal noise or vibration.

6-4-5 How to operate

- ① Shift the load where no problem to be seen when the motor rotates 2 revolutions.
- ② Inhibit the command.
- ③ Turn to "Servo-ON".
- ④ Start up the automatic gain tuning. (Refer to section 10-1-4 (4).)
- ⑤ Write into EEPROM if no problem to be seen.

Note If "Alarm", "Servo-OFF" or "Deviation counter clear" occur during the automatic gain tuning operation, this leads to "Automatic gain tuning error". Please refer to section 10-1-4 (4) P.62.)

6-5 Protective functions

6-5-1 Outline

■ This driver have various protective functions, and the driver trips while an alarm output signal (ALM) is turned "off" from "on" when these functions are activated.

■ When the driver trips;

- (1) All digits of 7-segment LED will flash, if you operate with the front panel. Please refer to section 10-1-4 (1) (P.58), in order to check the error code which represents the error factor.
- (2) You can monitor on the monitor screen as described in the section of [Control state reference] or [Error condition reference], if you use a computer.
- (3) At the same time, code is output to the connector CN I/F (EXOUT2.1.0) in 3-bit for each error factor.

6-5-2 Detail of protective functions

Protective function	Error code No.	Code output			Content	Corrective action
		EXOUT2	EXOUT1	EXOUT0		
Overvoltage protection	12	1	0	1	Voltage at converter exceeds 400V due to regenerative energy.	<ul style="list-style-type: none"> • Extend deceleration time. Or reduce load inertia. <p>Note This cannot be applied to use regenerative brake continuously.</p>
Undervoltage protection	13	1	0	1	Power supply voltage drops due to instantaneous power shut off or lack of power capacity.	<ul style="list-style-type: none"> • Check if power supply voltage is within permissible range or not. <p>Note Check voltage drop due to lack of power capacity, or rush current at Power-ON. Also check open phase of power supply.</p>
Overcurrent protection	14	1	1	0	Output current of converter increases extraordinarily.	<ul style="list-style-type: none"> • Check short of each of motor leads (U,V,W), after shutting off power. • Verify insulation resistance between motor leads (U,V,W) and motor ground (E), and check any deterioration of insulation resistance. • If this protection recurs, even after checking and turning on power again, it represents malfunction. Shut off power immediately.
Overheat protection	15	1	1	0	Power element in driver is overheated	Check the ambient temp. and cooling condition of the driver.
Overload protection	16	1	1	0	<ul style="list-style-type: none"> • Driver is used continuously with current which exceeds ratings. • Error such as incorrect wiring and disconnection occurred in connection of motor connecting wire U.V.W. 	<ul style="list-style-type: none"> • Extend accel./decel. time or reduce load. Or extend capacity motor/driver. • Check on connection of the motor connecting wire U.V.W. • Adjust by lowering position loop gain and speed loop gain and raising speed loop integral time constant, according to adjusting method.
Encoder error protection	22	0	1	1	<ul style="list-style-type: none"> • Some errors on encoder wiring occur. (such as broke wire) • Encoder malfunction 	<ul style="list-style-type: none"> • Check wiring or connection between driver and encoder, or connection of Connector, CN SIG. • Check power supply voltage at encoder side (5V \pm5%) (especially when you use longer cables).
Position error limit protection	24	1	0	0	Position error pulse exceeds permissible range set through the parameter No.23 (Position error limit setting).	<ul style="list-style-type: none"> • Check if motor runs per position command pulse or not. • Check saturation of output torque at torque monitor. • Set value of parameter No.06 "Torque limit" to the max. (300% normally) • Verify gain adjustment. • Extend accel./decel. time or reduce load, if above check does not show any error.

Protective function	Error code No.	Code output			Content	Corrective action
		EXOUT2	EXOUT1	EXOUT0		
Deviation counter overflow protection	29	1	0	0	Position error pulse exceeds 2^{27} (134217728).	• Check as same as above.
Overspeed protection	26	1	0	0	Motor speed exceeds a limit set through the parameter No.35.	• Check if you input excess speed command or not. Or check input frequency of command pulse and division/multiplication ratio of command pulse. • Check if overshoot occurs at acceleration due to mis-adjustment of gain.
Rotation inhibit input error protection	38	1	0	0	Driver trips when both CCW and CW rotation inhibit input turns to off, interpreting this as an error.	• Check any errors of SW, wire, or power supply connected to CCW/CW rotation inhibit input. • Especially, check start-up delay of power supply for control signal (12~24V _{DC}).
Command pulse division error protection	27	0	1	0	Driver trips when division/multiplication ratio which you set through parameter No.25, 26 is not proper. (too high).	Set division/multiplication ratio so that command pulse frequency after division/multiplication becomes less than the max. input pulse frequency (500kpps).
EEPROM parameter error protection 36	36	0	1	0	The data is damaged, when you read it from EEPROM upon the power on.	Set all the parameter again and write into EEPROM.
Receiving parameter error protection 84	84	0	1	0	Driver trips by judging some possible error by self-diagnosis function.	Turn off power once, then turn on again. If driver still trips, showing the left display, this may represent some malfunction. Shut off power immediately.
System error protection 98	98	0	0	1		
DSP error protection 23	23	0	0	1		
CPU error protection 30	30	0	0	1		
Other error protection 99	99	1	1	1		

• The column "Code output" in the above table shows the below contents.

- 0 : Output transistor ON
1 : Output transistor OFF

- Note 1) In order to restart the driver after the trip, please remove the trip factor by turning off the power. Then turn on the power gain, or enter an alarm clear signal (A-CLR). Please note that you cannot reset when the following protective functions are activated, and please reset by turning on the power again;
- Overcurrent protection
 - Overheat protection
 - Overload protection
 - Encoder error protection
 - Self-diagnosis trips (Error code No. 36, 84, 98, 23, 30)
- Turn on power again for resetting.
- Note 2) When EEPROM parameter error protection (No. 36) has worked, turn on power again, then check all parameters and reset them.
- Note 3) When encoder error protection (error code No. 22) works as soon as system is started up, mostly the cause is wrong wiring and connection between driver and encoder. See the section 5-1-4 (P.20), and check it again.

7. Running

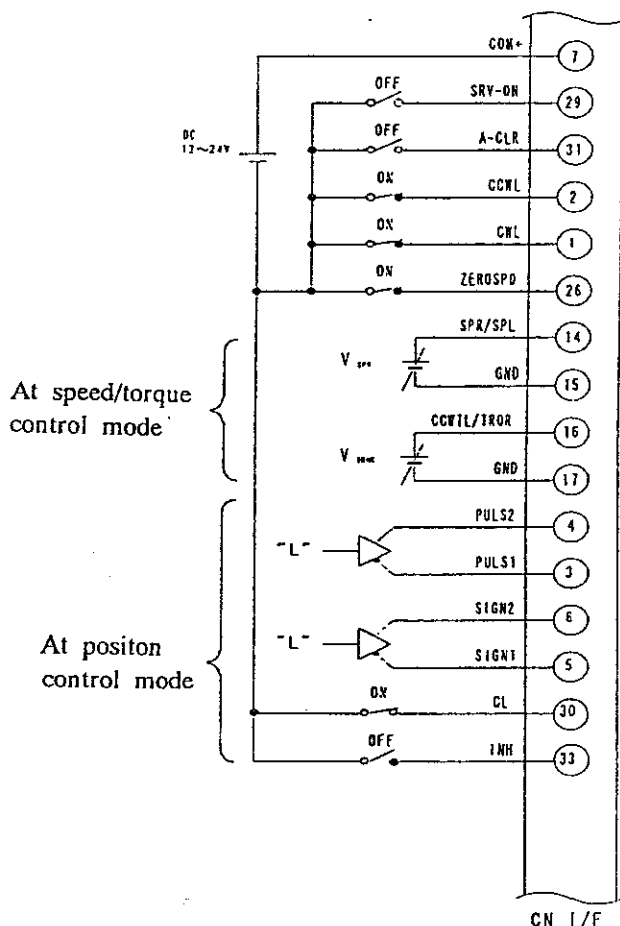
7-1 Before running

After you finish installation and wiring, please check the followings before running;

- (1) Any wrong wiring?
Especially wrong wiring of the power input R, S, T, r, t and the motor output U, V, W, \oplus , and loose connection.
- (2) Is the input power correct?
Main power supply: 3-phase 200~230V 50/60Hz)
Control power supply: Single phase 200~230V $^{+10\%}_{-15\%}$ 50/60Hz)
- (3) Any short portion with wire refuse?
- (4) Any loose screw or connector? Is the connector inserted securely?
- (5) Is the motor connecting cable shorted or grounded?

7-2 Trial run

- (1) Please make a trial run per below:
 - Run the motor with no load (no load connected to the motor shaft).
 - Fix the motor to avoid any movement due to the quick accel/decel. operation.
- (2) Release a brake if you use the motor with a brake.
- (3) Set polarity of signals, or switches connected to the input signal pins of CN I/F per the right Fig., and apply a signal power supply (single-phase 200V). (Do not turn on the main power of the main power to the driver yet.)



(4) Turn on the power to the driver

- ① 7-segment LED of the front panel displays shows one of the followings depending on the setting value at the Parameter No.

P										Position deviation
r										Motor speed
t										Output torque

Refer to Section 10-1-4 (1)
(P.58)

- ② Confirm that the parameter value is in accord with the factory setting by referring to Section 9, "Parameter", and Section 10, "Operation". Also confirm again the following parameter settings;

- Parameter No.07 "Torque limit inhibit": Check if the setting is "1" or not. (Refer to P.45)
- Parameter No.29 "Pulse input mode": (Refer to P.53) (running at only position control) Input style command pulse set by this parameter must be given to inputting PULS1, PULS2 and SIGN1, SIGN2 in running.

(5) Input a Servo-ON signal. The motor is now ready to be run.

- ① At speed control mode;
- By increasing a speed command input (SPR) from 0V gradually, the motor runs at the speed in proportion to the input voltage.
- ② At torque command mode;
- By increasing a torque command input (TRQR) from 0V gradually after applying about 1V to speed limit input (SPL) to make a speed limit state, the motor starts running.
- ③ At position control mode;
- Make a deviation counter clear signal (CL) to clear release (L→H), and make a command pulse input inhibit signal (INH) to inhibit release (H→L). Now the motor becomes the Servo-Lock state.
 - Input a command pulse, responding to the setting value of Parameter No.29 Pulseinput mode", to the terminal of PULS/SIGN. The motor runs at a speed in proportion to an input pulse frequency.

Note A relation between an input pulse frequency and a motor speed can be calculated per the following formula; (when the input pulse status is CW, CCW pulse row, or pulse row plus sign input)

$$\begin{aligned} & (\text{Input pulse frequency [pps]} \times (\text{Input pulse division} \cdot \text{multiplication ratio})) \\ & = [\text{Number of encoder pulses (P / r)}] \times \frac{\text{speed [r / min]}}{60} \times 4 \end{aligned}$$

e.g. where

Number of encoder pulses	: 2500 (p/r)
Division · Multiplication ratio	: 1
Input pulse frequency	: 300 (kpps)

$$\text{Motor speed N (r / min)} = \frac{300 \times 10^3 \text{ (pps)} \times 1 \times 60 \text{ (s)}}{4 \times 2500 \text{ (P / r)}} = 1800 \text{ (r / min)}$$

Since encoder feedback pulse is processed in four-multiplication in the driver, the motor rotates once in command input pulse 10000 (P), in standard delivery setting.

(6) Please try other functions such as parameter change or gain adjustment.

8. Adjustment

8-1 Voltage confirmation of the rotary encoder

- ◆ This driver has a built-in power supply for the rotary encoder. In order to operate this encoder properly, the power supply voltage should be maintained $5V \pm 5\%$.

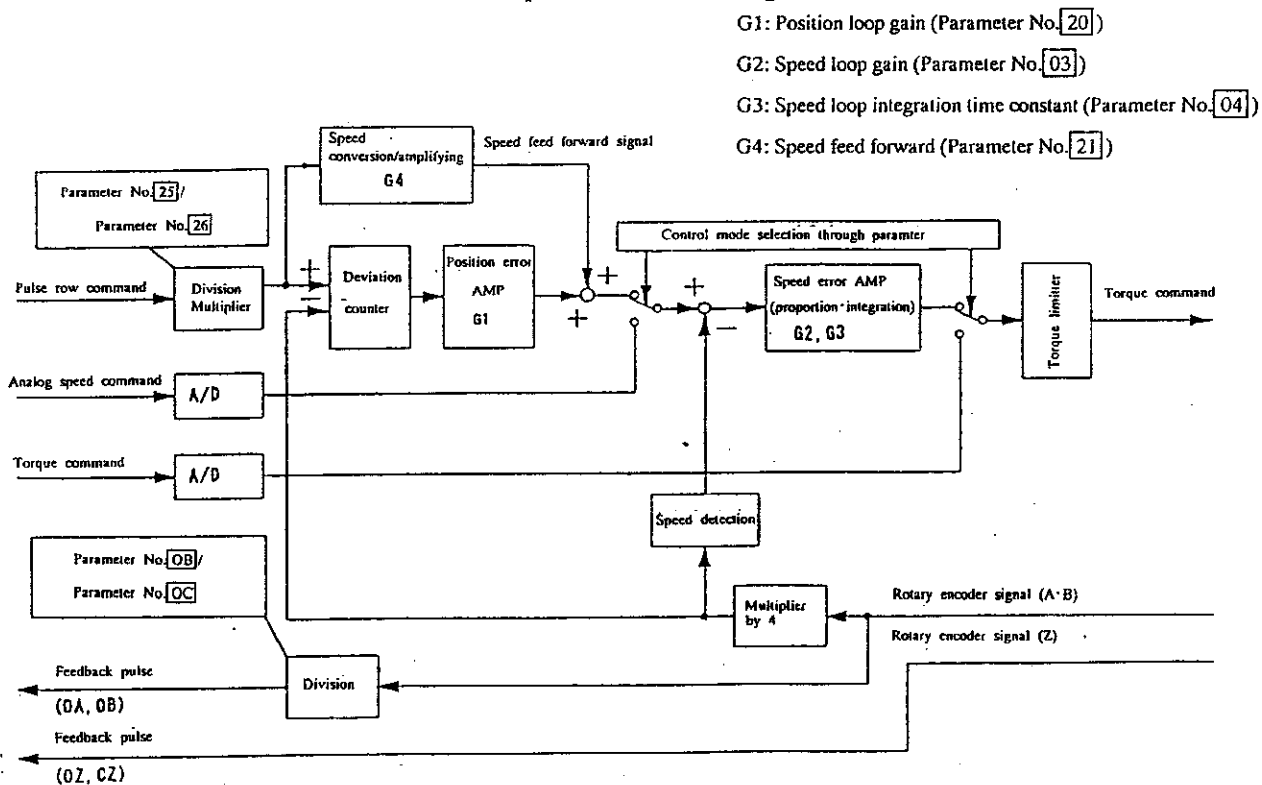
If you use longer connecting cables for the rotary encoder, the voltage may be maintained with the above range due to the voltage drop. In this case, please confirm the rotary encoder voltage near the motor and in the state of connection to the encoder (between the H terminal (+5V) and the G terminal (0V) of the canon plug) is within $4.75 \sim 5.25V$. If this becomes below 4.75V, refer to Section 5-1-4 and make the double wiring for the power supply.

8-2 Gain adjustment

Some models of driver have the automatic gain tuning function. If you encounter the case when the automatic gain tuning cannot be performed well due to the load condition, or when the vibration or noise is generated at the stopping or running while using non-auto-type, or when you want to obtain the most proper response or stability matching to the various load conditions, you may need the re-adjustment. In this case, please refer to section 8-2-1, "Basics of gain adjustment", and readjust.

- Though this driver consist of the digital AC Servo, you can make an analog adjustment for the servo gain adjustment. Following chart illustrates the image of making an equivalent conversion of the servo control to the analog servo control:

Equivalent block diagram



8-2-1 Basics of gain adjustment

(1) In case of the position control mode;

- ① Set a speed feed forward gain to the minimum (0%) through the Parameter No.21 (Refer to section 9, "Parameter" and section 10, "Operation").
- ② Set a larger value of the speed loop gain (within the range that no oscillation occurs) through the Parameter No.03.
- ③ Set the larger value of the position loop gain through the Parameter No.20 within the range that no oscillation occurs.

Note If you set the larger position loop gain, the machine stiffness (at Servo-lock) becomes high. Higher stiffness may cause the oscillation.

- ④ Set the smaller value of the speed loop integration time constant through the Parameter No.04. Smaller the value you set, faster the speed you can obtain to make the position deviation toward 0.
 - ⑤ When you want to obtain an extremely fast response speed, increase the speed feed forward gain gradually through the Parameter No.21. If you set too large, it may cause the overshoot.
- ### (2) In case of the speed control mode;
- ① Adjust the speed loop gain and speed loop integration time constant to the most proper value, by referring to the above mentioned ② and ④.
 - ② If you use an oscilloscope, measure the check pins, SP (speed monitor signal) and IM (torque monitor) of the front panel. Then adjust the speed loop gain and the integration time constant so that you can obtain the minimum overshoot of the speed monitor a signal at the accel/deceleration, against the stepped speed command, or the minimum ripple of the torque monitor signal.

8-2-2 Caution on the gain adjustment

- (1) The most proper value of the gain setting varies depending on the load. Please make re-adjustment when the load is changed.
- (2) When you set the maximum value of the speed loop integration time constant (1000[ms]) at the position control mode, the position-finish may not reach within the range set through the Parameter No.22 and the positioning end signal (COIN) may not be fed out. Please set this value to "100[ms]" or less at normal condition.
- (3) If you compose a Servo Drive System in combination with this driver set at the speed control mode and an external positioning unit, the position loop gain of the servo system may vary due to the setting value of the input gain in speed control mode (Parameter No.13).
- (4) If you set too high value of the gain setting, it may cause the oscillation. In this case, lower the gain setting to stop the oscillation. If you cannot stop the oscillation, turn the Servo-ON command to OFF by turning off the main power then turn on again to reset the gain from the lower value.

9. Parameter

9-1 Outline of parameter

- (1) This driver have parameters through which you can set/adjust various features and functions. And you can refer, set or adjust, ① with the operation panel · display in the front of the driver, or ② with a computer.
- (2) Parameters are classified as follows;
 - ① User parameter which you can set and change the data
 - ② System parameter which you can refer but cannot set nor change the data Each parameter consists of 4 pages, and each page is divided by max. 16.
- (3) Following is the list of parameters; Please refer to section 9-2 (P.44~53) for the detail.

Type	Parameter No.	Parameter	Related control mode	Adjustable range	Standard factory setting
User parameter	0 0	Name of axis	T.S.P	0~9	0
	0 1	Selection of initial display	T.S.P	0~2	1
	0 2	Selection of control mode	T.S.P	0~5	1
	0 3	Speed loop gain	T.S.P	25~3500	*
	0 4	Speed loop integration time constant	T.S.P	1~1000[ms]	*
	0 5	Speed detection filter	T.S.P	0~4	4
	0 6	Torque limit	T.S.P	0~400[%]	*
	0 7	Torque limit inhibit	S.P	0/1	1
	0 8	Speed monitor gain	T.S.P	0~1	0
	0 9	Inactive drive inhibit input	T.S.P	0/1	1
	0 A	Dynamic brake	T.S.P	0/1	0
	0 B	Numerator of pulse frequency division (feed back)	T.S.P	1~10000	10000
	0 C	Denominator of pulse frequency division (feed back)	T.S.P	1~10000	10000
	0 D	Pulse inversion	T.S.P	0~3	0
	0 E	Mechanical brake setting	T.S.P	0~100	0
	0 F	(internal use)	-	-	-
User parameter	1 0	Acceleration/Deceleration time period	S	0~5000	0
	1 1	Zero-speed	T.S	0~10000[r/min]	50
	1 2	Arrival speed	T.S	0~10000[r/min]	1000
	1 3	Input gain in speed control mode	T.S	10~2600	225/150 Note 3
	1 4	Input reversal in speed control mode	T.S	0/1	0
	1 5	Offset voltage in speed control mode	T.S	-127~127	0
	1 6	Internal/external speed selection	T.S	0/1	0
	1 7	Zero-speed clamp cancel	T.S	0/1	1
	1 8	First internal speed	T.S	-7000~7000	0
	1 9	Second internal speed	T.S	-7000~7000	0
	1 A	Input gain in torque control mode	T	25~2500	250
	1 B	Input reversal in torque control mode	T	0/1	0
	1 C	Offset voltage in torque control mode	T	-127~127	0
	1 D	Torque control filter	T.S.P	0~2500	0
	1 E	(not in use)	-	-	-
	1 F	(internal use)	-	-	-

Type	Parameter No.	Parameter	Related control mode	Adjustable range	Standard factory setting
User parameter	2 0	Position loop gain	P	10~1000[1/s]	*
	2 1	Speed feed forward	P	0~100[%]	0
	2 2	Positioning end range	P	0~32766[P]	10
	2 3	Position error limit setting	P	1~32766	30000
	2 4	Cancel of position error limit	P	0/1	0
	2 5	Numerator of pulse frequency division	P	1~10000	10000
	2 6	Denominator of pulse frequency division	P	1~10000	10000
	2 7	Multiplier setting	P	1~4	4
	2 8	Logical inversion	P	0~3	0
	2 9	Pulse input mode	P	0~3	1
	2 A	(not in use)	-	-	-
	2 B	Feed forward filter	P	0~6400	0
	2 C	(not in use)	-	-	-
	2 D	(internal use)	-	-	-
	2 E	(internal use)	-	-	-
	2 F	(internal use)	-	-	-
System parameter	3 0	Motor pole	<ul style="list-style-type: none"> • These parameters are set by factory corresponding to the applicable motor and driver. • You cannot change the value of these parameters. 		
	3 1	Encoder pulse			
	3 2	J/T ratio			
	3 3	Current proportional gain			
	3 4	Current integration gain			
	3 5	Overspeed level			
	3 6	Max. output torque			
	3 7	Overload time constant			
	3 8	Overload criteria			
	3 9	(internal use)	-	-	-
	3 A	(internal use)	-	-	-
	3 B	(internal use)	-	-	-
	3 C	(internal use)	-	-	-
	3 D	(internal use)	-	-	-
	3 E	(internal use)	-	-	-
	3 F	(internal use)	-	-	-

Note 1) Please note that "Standard factory setting" may vary from the above values depending on the applicable motor specifications.

Note 2) Factory setting value differs of parameters with * depending on the driver model.

Note 3) Speed command input gain

225 when pulse of the applied motor encoder is 2500P/r and rated speed is 3000r/min

150 when pulse of the applied motor encoder is 2500P/r and rated speed is 2000r/min

Note 4) Symbols used in this column stand as follows:

T : Torque control mode

S : Speed control mode

P : Position control mode

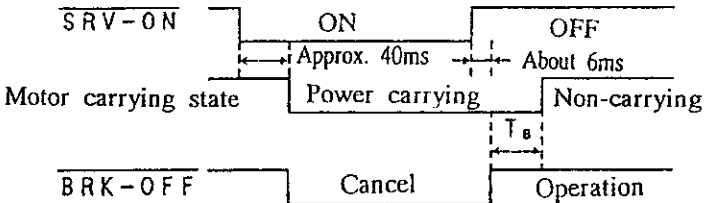
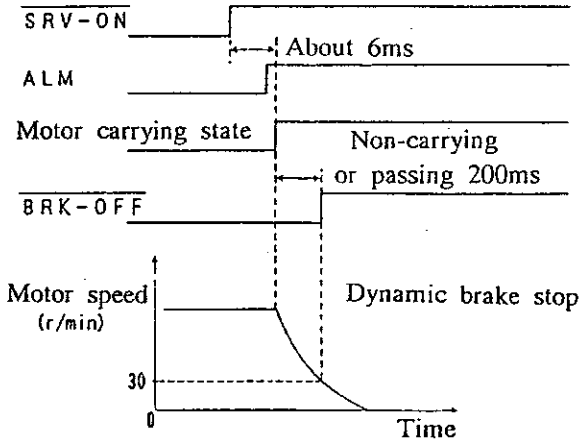
9-2 Detail of user parameter

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
0 0	Name of axis	0~9	<input type="checkbox"/> When you use a computer to refer or monitor the parameter setting, you can monitor which axis the computer is accessing, while you control multi-axis. <input type="checkbox"/> Setting value of this parameter becomes the part of prompt, displayed on the initial screen at a serial communication. (* of Prompt AXIS*%). <input type="checkbox"/> This setting does not affect any servo operation.
0 1	Selection of initial display	0... ▶ 1... ▶ 2... ▶	<input type="checkbox"/> You can select the type of data displayed at 7 segment LED, among the followings when you first turn on the power. 0... ▶ Displays the reserved pulse amount of position error counter. ① Range of display is -32767~+32767. If the reserved pulse amount exceeds this range, the display saturates at the upper or lower limit of this range. ② Polarity display (+) : generates CCW torque - : generates CW torque 1... ▶ Displays the motor speed. unit : [r/min] Polarity display (+) : rotates at CCW - : rotates at CW 2... ▶ Displays the motor torque. ① Range of display is 0~±1500 (Displayed value)×0.2 represents the actual generated torque (in % against the rated torque). e.g. If the displayed value is "+1500", the motor generates 300% of the rated torque at CCW. ② Polarity display (+) : generates CCW torque - : generates CW torque Note 1. This parameter becomes inactive when you operate with computer. Note 2. When the polarity is +, + will not be displayed.
0 2	Selection of control mode	0... ▶ 1... ▶ 2... ▶ 3... ▶ 4... ▶ 5... ▶	<input type="checkbox"/> You can select the control mode with which you use this driver among the followings; 0... ▶ Position (pulse row) control mode 1... ▶ Speed (analog) control mode 2... ▶ Torque (analog) control mode 3... ▶ Position (1st.) · Speed (2nd.) control mode 4... ▶ Position (1st.) · Torque (2nd.) control mode 5... ▶ Speed (1st.) · Torque (2nd.) control mode <input type="checkbox"/> You can select either a 1st. or a 2nd. mode with a control mode control input (C-MODE), when you choose one of the above "3", "4" or "5" as follows: When you select "H" of C-MODE, you can select the 1st. mode. When you select "L" of C-MODE, you can select the 2nd. mode. Note Please input C-MODE when the command signal to the shifting control mode is "0", or the motor is at complete stop, since this driver has not interlocking function between the receiving of the control mode control input and the existence or nonexistence of the command (pulse row command, speed/torque command), or the reserved pulse amount of the deviation counter.

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
0 3	Speed loop gain	25~3500	<input type="checkbox"/> Proportional gain of the speed amplifier. Larger the value you set, larger the gain you can obtain. <input type="checkbox"/> Most appropriate value of the speed loop gain depends on the load inertia and the motor model. Please refer to section 8-2 (P.40), "Gain adjustment" for detail.
0 4	Speed loop integration time constant	1~1000 (ms)	<input type="checkbox"/> Integration time constant of the speed amplifier. Smaller the value you set, faster the integration is made. <input type="checkbox"/> Please refer to section 8-2 (P.40), "Gain adjustment" for detail. Note If you set this to the max. (1000), the integration time constant becomes infinite (no integration).
0 5	Speed detection filter	0~4	<input type="checkbox"/> You can select the type (time constant) of the digital filter for speed detection signal. Larger the value you set, quieter the noise you can expect from the motor. <input type="checkbox"/> We recommend you to set this to "4" unless you need excessive speed response.
0 6	Torque limit	0~400 (%)	<input type="checkbox"/> This driver is designed to accept the max. torque of 300% of the rated torque for short duration. You can limit this max. torque when you expect any mechanical problem with the motor load or the machine. <input type="checkbox"/> You set the value in percentage of the rated torque (100%). e.g. When the setting is "200". Permissible output torque is 200% (2 times) of the rated torque Note You cannot set a higher value than the factory setting value of the system parameter No.36 (Max. output torque setting). Even if you set a higher value, the max. output torque will be automatically adjusted to the max. output torque of the factory setting.
0 7	Torque limit inhibit	0/1	<input type="checkbox"/> You can ignore the analog torque limit input (CWTL, CCWTL) by setting this to "1". Note No torque will be generated when you set this to "0", and the torque limit input (CWTL, CCWTL) is open.
0 8	Speed monitor gain	0~3	<input type="checkbox"/> You can set the full scale value of the speed monitor signal (SP). <div style="display: flex; align-items: center;"> <div style="margin-right: 10px;"> "0" : 4095 r/min full scale "1" : 16383 r/min full scale "2" : 255 P "3" : 32767 P </div> <div style="margin-left: 10px;"> } Motor speed } Positional deviation </div> </div> <input type="checkbox"/> It is set to "0" (4095 [r/min] full scale) in normal specifications. If it is insufficient, set the parameter to "1". For outputting positional deviation, set this parameter to "2" or "3". <input type="checkbox"/> Relation between the positional deviation and the monitor voltage is described as below; <div style="margin-top: 10px;"> <p>Speed monitor voltage</p> <p>Motor speed (r/min)</p> <p>3000</p> <p>4095 8191 12287 16383</p> <p>apprx. 8.2V</p> <p>apprx. 6V</p> <p>apprx. 1.5V</p> <p>"0"</p> <p>"1"</p> </div> <div style="margin-top: 10px;"> <p>Speed monitor voltage</p> <p>Positional deviation (P)</p> <p>255 32767</p> <p>apprx. 8.2V</p> <p>"2"</p> <p>"3"</p> </div>

Parameter No.	Parameter	Adjustable range	Function/contents																								
Page No.																											
0 9	Inactive drive inhibit input	0/1	<input type="checkbox"/> You can ignore the CW rotation inhibit input (CWL) and CCW rotation inhibition input (CCWL) by setting this to "1", and the driver runs normally judging this as "non-inhibit". Note No torque of CW will be generated if you set this to "0" and the CW rotation inhibit input (CWL) is open. Same is applied to CCW. If both CWL and CCWL is open, the driver trips due to "Drive inhibit input error".																								
0 A	Dynamic brake	0~3	<input type="checkbox"/> You can select among the below, while the CW rotation inhibit input (CWL) or the CCW rotation inhibit input (CCWL) is working, and the motor is decelerating; "0" or "2" : Dynamic brake is activated and the motor stops. "1" or "3" : Dynamic brake is not activated and the motor makes free run stop. Note For canceling brake after stopping the motor in servo OFF or operation of protection function in error, set this parameter to "2" or "3". In case set value is "0" or "1", brake operates even after stopping. As for details, refer to 6-3 [Dynamic brake] (page 33).																								
0 B	Numerator of pulse frequency division	1~10000	<input type="checkbox"/> You can set the numerator of the division of the feed back pulse from the encoder.																								
0 C	Denominator of pulse frequency division	1~10000	<input type="checkbox"/> You can set the denominator of the division of the feed back pulse from the encoder. Note 1. Please make a division ratio lower than 1 after reducing to a common denominator. $\text{Division ratio} = \frac{\text{Numerator}}{\text{Denominator}} \leq 1$ Note 2. Please do not set a extreme ratio (such as 1/10000). We recommend you to set a ratio between 1/32 and 1. However, in certain set dividing ratio, duty ratio of output pulse after dividing does not reach 50% continuously. Note 3. This driver is designed for the motor with 2500 [P/r] encoder as a standard. Following table gives you example when you need to adjust to the necessary pulse number based on the system; <table><tr><th></th><th colspan="5">Necessary feed back pulses at the system [P/r]</th></tr><tr><th></th><th>500</th><th>1000</th><th>1500</th><th>2000</th><th>2500</th></tr><tr><td>Setting value of numerator</td><td>500</td><td>1000</td><td>1500</td><td>2000</td><td>2500 (10000)</td></tr><tr><td>Setting value of denominator</td><td>2500</td><td>2500</td><td>2500</td><td>2500</td><td>2500 (10000)</td></tr></table> Note 4. When you use division function of feedback pulse, Z-phase pulse is synchronized with A-phase pulse when division ratio is "1", while note that they are unsynchronized if it is not "1". Therefore, dislocation occurs when origin is positioned with the logical formula of phase-A pulse and phase-Z pulse, requiring notice.		Necessary feed back pulses at the system [P/r]						500	1000	1500	2000	2500	Setting value of numerator	500	1000	1500	2000	2500 (10000)	Setting value of denominator	2500	2500	2500	2500	2500 (10000)
	Necessary feed back pulses at the system [P/r]																										
	500	1000	1500	2000	2500																						
Setting value of numerator	500	1000	1500	2000	2500 (10000)																						
Setting value of denominator	2500	2500	2500	2500	2500 (10000)																						

Parameter No.	Parameter	Adjustable range	Function/contents																																				
Page No.																																							
0 D	Pulse inversion	0~3	<p><input type="checkbox"/> Phase relation of the output pulse from the rotary encoder; B-phase pulse is behind of A-phase at CW B-phase pulse is ahead of A-phase at CW</p> <p><input type="checkbox"/> You can inverse the phase relation between the above A and B phase through this parameter by inverse the logic of B-phase. You can do the same to Z-phase.</p> <p><input type="checkbox"/> The table below represents each relation (at CW)</p> <table border="1"> <thead> <tr> <th>Value of 0 D parameter</th><th>A-phase</th><th></th><th></th></tr> </thead> <tbody> <tr> <td>0</td><td>B-phase</td><td></td><td>logic non-inversion</td></tr> <tr> <td></td><td>Z-phase</td><td></td><td>logic non-inversion</td></tr> <tr> <td>1</td><td>B-phase</td><td></td><td>logic inversion</td></tr> <tr> <td></td><td>Z-phase</td><td></td><td>logic non-inversion</td></tr> <tr> <td>2</td><td>B-phase</td><td></td><td>logic non-inversion</td></tr> <tr> <td></td><td>Z-phase</td><td></td><td>logic inversion</td></tr> <tr> <td>3</td><td>B-phase</td><td></td><td>logic inversion</td></tr> <tr> <td></td><td>Z-phase</td><td></td><td>logic inversion</td></tr> </tbody> </table>	Value of 0 D parameter	A-phase			0	B-phase		logic non-inversion		Z-phase		logic non-inversion	1	B-phase		logic inversion		Z-phase		logic non-inversion	2	B-phase		logic non-inversion		Z-phase		logic inversion	3	B-phase		logic inversion		Z-phase		logic inversion
Value of 0 D parameter	A-phase																																						
0	B-phase		logic non-inversion																																				
	Z-phase		logic non-inversion																																				
1	B-phase		logic inversion																																				
	Z-phase		logic non-inversion																																				
2	B-phase		logic non-inversion																																				
	Z-phase		logic inversion																																				
3	B-phase		logic inversion																																				
	Z-phase		logic inversion																																				

Parameter No. Page No.	Parameter.	Adjustable range	Function/contents
0 E	Mechanical brake operation setting	0~100	<p> <input type="checkbox"/> This driver has output signal controlling brake of the motor with brake. <input type="checkbox"/> This parameter sets time T_B from turning OFF (brake operation) the external brake cancel signal (BRK-OFF) in stopping the motor (servo lock) to making motor non-carrying state. Relation of set value of this parameter and T_B Set value = $T_B(\text{ms})/2.1$ </p>  <p>Note In case protection function operates changing motor carrying state to non-carrying state, BRK-OFF signal is turned OFF (brake operation) by $T_B=0$ not by this parameter.</p> <p> <input type="checkbox"/> In case SRV-ON signal turns OFF or alarm is made in operation of protection function and the motor state is changed from carrying to non-carrying during rotating the motor, BRK-OFF signal turns OFF (brake operation) on the time when motor speed is lowered to about 30r/min or under or 200ms passed after making motor non-carrying state, not by this parameter. </p>  <p>Note In setting "T_B" by this parameter, set not to rotate the motor during operating external brake, considering delay time of the relay turning ON/OFF the external brake or operation delay time of the external brake itself.</p>

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
1 0	Acceleration /Decelera- tion time period	0~5000	<input type="checkbox"/> You can set the acceleration and deceleration time through this parameter. <input type="checkbox"/> Relation between the setting value and the accel./decel. time is described as follows; Setting value = Acceleration time from 0[r/min] to 1000[r/min][s] $\times 500$ or Setting value = Deceleration time from 1000[r/min] to 0[r/min][s] $\times 500$ e.g. When you want to start up from 0[r/min] to 3000[r/min] in 6s, 0[r/min] \leftrightarrow 1000[r/min] in 2s \downarrow Setting value = $2 \times 500 = 1000$ Note 1. Acceleration/Deceleration limit function is not valid at the position control mode and torque control mode. Also do not use the accel./decel. limit function at the speed control mode while you compose a position control loop externally. (Set this parameter to "0".) This may cause an oscillation. Note 2. Please note that you cannot set the acceleration and deceleration time individually.
1 1	Zero-speed	0~10000 (r/min)	<input type="checkbox"/> Directly set the detection judgement level of zero-speed detection signal output (ZSP) by motor speed (r/min). <input type="checkbox"/> ZSP turns ON when motor speed is lowered to the set value or under.
1 2	Arrival speed	0~10000 (r/min)	<input type="checkbox"/> You can directly set the detection level of the speed arrival signal (COIN) at the speed control or torque control mode, in motor speed [r/min]. <input type="checkbox"/> COIN signal will be turned on when the motor speed exceeds the setting value. Note 1. Please use the output COIN differently per the following control mode; At the speed, torque control mode ... Speed arrival signal At the position control mode Positioning end signal Therefore, this parameter is invalid at the position control mode. Note 2. Note 2. Relation between parameter "Zero-speed" described in the previous item, "Speed arrival" and ZSP.COIN is shown in the below figure. <div style="text-align: right;"> </div>

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
1 3	Input gain in speed control mode	10~2600	<p><input type="checkbox"/> You can set the analog speed command (SPR) input gain (relation between the necessary motor speed and the speed command voltage value).</p> <p><input type="checkbox"/> Please calculate the setting value per the following formula; Setting value = $0.00003 \times \text{number of encoder pulses} \times \text{necessary motor speed at 6V input [r/min]}$ e.g. Number of encoder pulses 2500 [P/r] Necessary motor speed at 6V input 3000 [r/min] Setting value = $0.00003 \times 2500 \times 3000 = 225$</p> <p>Note Please pay attention to the possible oscillation caused by the change of the position gain of the servo system, which is set through the parameter, when you compose the position control loop and use this driver at the speed control mode.</p>
1 4	Input reversal in speed control mode	0/1	<p><input type="checkbox"/> You can reverse the polarity (rotational direction) of the analog speed command signal (SPR), "0" : Rotates at CW with the speed command of (+) "1" : Rotates at CCW with the speed command of (+)</p> <p>Note In case the servo driving system is structured by combination of the driver set to the speed control mode and the external position unit, take notice to make polarity of the speed command signal of the position unit and polarity of this parameter identical, to prevent error operation of the motor.</p>
1 5	Offset voltage in speed control mode	-127~127	<p><input type="checkbox"/> You can make an offset adjustment of the analog speed command input circuit.</p> <p><input type="checkbox"/> Please proceed as follows when you make the offset adjustment with the driver alone;</p> <ul style="list-style-type: none"> Enter exactly "0" V to the speed command input (or connect SPR to the signal GND). Set the value so that the motor does not rotate.
1 6	Internal/ External speed selection	0/1	<p><input type="checkbox"/> You can separate the analog speed command input (SPR) by setting this parameter to "1", and the internal speed command which you set through the parameter No.18 (First internal speed, described later) becomes valid.</p> <p><input type="checkbox"/> Change-over of motor stop and the first speed is made by two command inputs of speed-zero clamp input (ZEROSPD) and internal speed command select input (INTSPD).</p> <p><input type="checkbox"/> Fig. below shows the example of variable speed running when you select the internal speed command;</p> <div style="text-align: center;"> <p>The diagram illustrates the motor speed response to input changes. When SRV-ON transitions from high to low, the motor starts. As ZEROSPD transitions from high to low, the motor speed ramps up to 'First speed'. When INTSPD transitions from high to low, the speed ramps up to 'Second speed'. When INTSPD transitions from low to high, the speed ramps down. When ZEROSPD transitions from low to high, the motor stops.</p> </div>

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
1 7	Zero-speed clamp cancel	0/1	<input type="checkbox"/> You can invalidate the zero-speed clamp input (ZEROSPD), by setting this parameter to "1", and the driver runs normally. Note Zero-speed clamp input (ZEROSPD, No. 10 pin of CN I/F) which is described in section 6-2, becomes valid when you open this and (-) of the control signal power supply (COM No. 28 pin). If you set this parameter to "0" and open the ZEROSPD input, the driver becomes to "Zero-speed clamp" at any time, and the motor does not run.
1 8	First internal speed	-7000~ 7000	<input type="checkbox"/> Set the first internal speed [r/min] with the following formula, when the internal speed command becomes valid. (Refer to parameter No.16.) $\text{Setting value} = \frac{\text{Necessary 1st. speed (r / min)} \times \text{Number of encoder pulses (P / r)}}{7140}$ e.g. Number of encoder pulses 2500 [P/r] Necessary 1st. speed 1500 [r/min] $\text{Setting value} = \frac{1500 (\text{r / min}) \times 2500 (\text{P / r})}{7140} = 525$ Note Polarity of the setting value represents the polarity of the internal speed command. (+) : Rotates at CCW - : Rotates at CW
1 9	Speed setting The second speed	-7000~ 7000	<input type="checkbox"/> Just like in Parameter No.18, set the second speed used when internal speed command becomes effective.
1 A	Input gain in torque control mode	25~2500	<input type="checkbox"/> You can set the torque command (TRQR) input gain (relation between the generated motor torque and the torque command input voltage) at the torque control mode. <input type="checkbox"/> Set the value with the following formula; $\text{Torque command input gain (V / 100\%)} \cong 3 \times \frac{250}{\text{Setting value}}$ e.g. When you want to obtain the rated torque with the torque command input of 1.5V; $\text{Setting value} \cong \frac{3 \times 250}{1.5 (\text{V / 100\%})} = 500$ Note If you enter the torque command input which corresponds to 200% or more of the rated torque, this may cause a saturation despite of the above formula.
1 B	Input reversal in torque control mode	0/1	<input type="checkbox"/> You can reverse the polarity (direction of the generated torque) of the analog torque command signal (TRQR) with this parameter. "0" : Generates CW torque with the torque command of (+) "1" : Generates CCW torque with the torque command of (+)
1 C	Offset voltage in torque control mode	-127~- 127	<input type="checkbox"/> You can make an offset adjustment of the analog torque command input circuit. <input type="checkbox"/> Please proceed as follows when you make the offset adjustment with the driver alone; · Input exactly "0" V to the torque command input (TRQR), (or connect TRQR to the signal GND) after setting to the torque control mode. · Set the value so that the motor does not rotates.
1 D	Torque command filter	0~2500	<input type="checkbox"/> Calculate the time constant of the primary delay filter of torque command with the below formula, and set the time constant. $\text{Filter time constant } (\mu\text{s}) = \text{Set value} \times 10 (\mu\text{s})$ Note Filter time constant is 0 (μs) in case set value is 0 ~ 51. Note When this filter is used, set parameter No.05 (speed detection filter) to "0".

Parameter No. Page No.	Parameter	Adjustable range	Function/contents
2 0	Position loop gain	10~1000 (1/s)	<input type="checkbox"/> You can set the position gain at the position control mode with the unit of [1/s]. <input type="checkbox"/> Larger the value you set, larger the gain, and higher the servo stiffness(stiffness at servo-lock) you can obtain. Note Too large setting may cause an oscillation.
2 1	Speed feed forward	0~100 (%)	<input type="checkbox"/> You can add a speed feed forward function at the position control mode when you need high speed response. (Refer to section 8-2 (P.40) "Gain adjustment".) <input type="checkbox"/> Set the speed feed forward volume in percentage against the commanded volume. Note Too large setting may cause an oscillation. We recommend you to set this parameter to "0" unless you need excessive speed response.
2 2	Positioning end range	0~32766 (P)	<input type="checkbox"/> You can set the detection level of judging the positioning end, with the number of pulses. <input type="checkbox"/> The driver will judge the positioning end when the number of reserved pulses of the deviation counter becomes within the preset range, the driver outputs the positioning end signal (COIN). (turns on the output transistor.) Note Feedback pulse of rotary encoder is multiplied 4 times and input to deviation counter, so the positioning end range is converted into motor rotation angle as: $\text{Setting value} = \frac{\text{Positioning end range}}{4 \times (\text{Pulse count of rotary encoder})}$
2 3	Position error limit	0~32766	<input type="checkbox"/> Set the detection level of judging the position error, with the number of reserved pulses of the deviation counter. <input type="checkbox"/> Calculate the setting value with the following formula; $\text{Setting value} = \frac{\text{Judging level of position error (P)}}{16}$ <input type="checkbox"/> The driver trips when the number of reserved pulses of the deviation counter exceeds the above setting value, judging as an error.
2 4	Cancel of position error limit	0/1	<input type="checkbox"/> You can mask the protective function of the position error limit with this parameter. <input type="checkbox"/> You can cancel the detection of the position error limit, and the driver keeps operating even when the number of reserved pulses of the deviation counter exceeds the detection level, set through the parameter No.23(Position error limit).
2 5	Numerator of pulse frequency division	1~10000	<input type="checkbox"/> You can set the numerator of command pulse frequency division · multiplication. <input type="checkbox"/> Set value can be arbitrary between 1 ~ 10000, but in setting excessive dividing ratio or multiplication ratio, operation is not guaranteed. As for allowable ranges of dividing ratio and multiplication ratio, observe the Note described in Parameter No.26 in the next item.
2 6	Denominator of pulse frequency division · multiplication	1~10000	<input type="checkbox"/> You can set the denominator of command pulse frequency division · multiplication. Note 1. Like the above section, you set any value of the denominator between 1 and 10000, but we recommend you to use with the range per the below; $\frac{1}{50} \leq \frac{\text{Setting value of numerator}}{\text{Setting value of denominator}} \leq 20$ Note 2. Please set the multiplication ratio so that the command pulse frequency after the multiplication may not exceed the max. command pulse frequency. (500kpps in case of the line driver output, 200kpps in case of the open collector output.) Note 3. See the section 7-2 (P.38) "Trial run" for the relation between command pulse frequency, division/multiplication ratio, and motor revolutions.

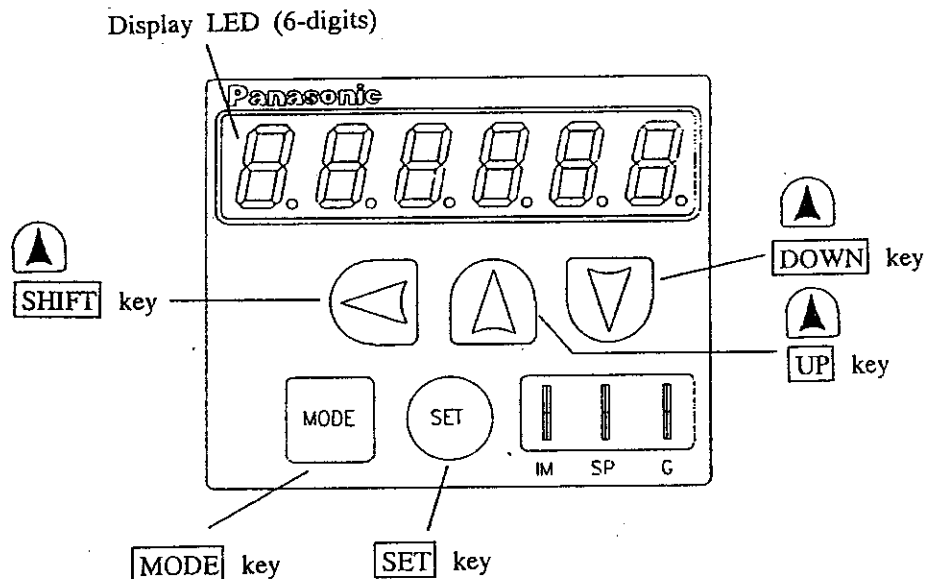
Parameter No.	Parameter	Adjustable range	Function/contents																					
Page No.																								
2 7	Multiplier setting	1~4	<input type="checkbox"/> You can set the multiplication when you select "2-phase pulse input mode" at the parameter No.29 (Pulse input mode) described later. <input type="checkbox"/> Relation between the setting value and the multiplication becomes as below; "1" Multiplication of 1 "2" Multiplication of 2 "3" and "4" Multiplication of 4																					
2 8	Logic inversion	0~3	<input type="checkbox"/> You can set the logic of the command input of 2 systems (PULS, SIGN) individually as below; "0" ... "PULS" signal logic non-inversion, "SIGN" signal logic non-inversion "1" ... "PULS" signal logic inversion, "SIGN" signal logic non-inversion "2" ... "PULS" signal logic non-inversion, "SIGN" signal logic inversion "3" ... "PULS" signal logic inversion, "SIGN" signal logic inversion																					
2 9	Pulse input mode	0~3	<input type="checkbox"/> Input status of command pulse may be selected from 3 types shown below by setting this parameter. "0" or "2" ... 2-phase pulse input (Phase-A, Phase-B) of 90° phase difference: "1" CW direction command pulse and CCW direction command pulse input "3" Pulse train command input and symbol input <table border="1"><thead><tr><th>Setting</th><th>Input status</th><th>Signal of CN I/F</th><th>CCW command</th><th>CW command</th></tr></thead><tbody><tr><td>"0" or "2"</td><td>2-phase pulse with 90° difference (A-phase +B-phase)</td><td>PULS SIGN</td><td> B-phase advance of A-phase by 90°</td><td> B-phase behind of A-phase by 90°</td></tr><tr><td>"1"</td><td>CW pulse row + CCW pulse row</td><td>PULS SIGN</td><td> t1, t2</td><td> t1, t2</td></tr><tr><td>"3"</td><td>Pulse row + Sign</td><td>PULS SIGN</td><td> t1, t2 "H"</td><td> t1, t2 "L"</td></tr></tbody></table>	Setting	Input status	Signal of CN I/F	CCW command	CW command	"0" or "2"	2-phase pulse with 90° difference (A-phase +B-phase)	PULS SIGN	 B-phase advance of A-phase by 90°	 B-phase behind of A-phase by 90°	"1"	CW pulse row + CCW pulse row	PULS SIGN	 t1, t2	 t1, t2	"3"	Pulse row + Sign	PULS SIGN	 t1, t2 "H"	 t1, t2 "L"	
Setting	Input status	Signal of CN I/F	CCW command	CW command																				
"0" or "2"	2-phase pulse with 90° difference (A-phase +B-phase)	PULS SIGN	 B-phase advance of A-phase by 90°	 B-phase behind of A-phase by 90°																				
"1"	CW pulse row + CCW pulse row	PULS SIGN	 t1, t2	 t1, t2																				
"3"	Pulse row + Sign	PULS SIGN	 t1, t2 "H"	 t1, t2 "L"																				
Minimum required time width																								
<table border="1"><thead><tr><th></th><th>Line driver interface</th><th>Open collector interface</th></tr></thead><tbody><tr><td>t1</td><td>2 μs or longer</td><td>5 μs or longer</td></tr><tr><td>t2</td><td>1 μs or longer</td><td>2.5 μs or longer</td></tr><tr><td>t3</td><td>1 μs or longer</td><td>2.5 μs or longer</td></tr><tr><td>t4</td><td>1 μs or longer</td><td>2.5 μs or longer</td></tr><tr><td>t5</td><td>1 μs or longer</td><td>2.5 μs or longer</td></tr><tr><td>t6</td><td>1 μs or longer</td><td>2.5 μs or longer</td></tr></tbody></table>					Line driver interface	Open collector interface	t1	2 μs or longer	5 μs or longer	t2	1 μs or longer	2.5 μs or longer	t3	1 μs or longer	2.5 μs or longer	t4	1 μs or longer	2.5 μs or longer	t5	1 μs or longer	2.5 μs or longer	t6	1 μs or longer	2.5 μs or longer
	Line driver interface	Open collector interface																						
t1	2 μs or longer	5 μs or longer																						
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t3	1 μs or longer	2.5 μs or longer																						
t4	1 μs or longer	2.5 μs or longer																						
t5	1 μs or longer	2.5 μs or longer																						
t6	1 μs or longer	2.5 μs or longer																						
Note 1. The table above shows the logic relation on pulse input (B) side (driver side) illustrated in section 6-1-5. When the logic is considered on pulse input (A) side (supply side), note that logic is inverted when pulse is supplied by line driver and by open collector. (See Note 1 of 6-1-5. (P.26))																								
Note 2. When logic relation of PULS, SIGN signal has to be changed for convenience of signal polarity on command pulse supply side (A), use the function of parameter No.28.																								
2 B	Feed forward filter	0~6400	<input type="checkbox"/> Set time constant of feed forward filter. Filter time constant (μs) = Set value x 10 (μs) <input type="checkbox"/> Time constant increases in increasing set value.																					

10. Operation

- (1) This driver have various parameters through which you can adjust/set the performance or functions. Please use these parameters so that you can operate the driver at the most appropriate condition.
- (2) Among various functions of this driver are;
 - Monitoring functions of such as the number of reserved pulses of the deviation counter (position error), motor speed and generated torque.
 - Display of the status of the control input/output signals connected to the connector, CN I/F.
 - Display of the error factors and the record.
- (3) There are 2 ways of operating the above functions as below;
 - Key operation and the display of the front panel or,
 - Computer display

10-1 Key operation of the front panel and display

10-1-1 Composition of the front panel/display



- There are 4 modes which you can work with, when you operate through the key SW or LED on the front panel. These are, "Monitor mode", "Parameter setting mode", "EEPROM writing mode" and "Automatic gain tuning mode". Please use **MODE** key to select these modes.

Each mode consists of **Selection display** and **Execution display**, and use **SET** key to select these displays. Use **▲▼◀** keys to select or execute each mode.

- You can only change the data at the figure which decimal point is flashing.
▲▼◀ keys are not valid unless the flashing of the decimal point is displayed.

SW	Valid condition	Function
MODE	At the selection display	Select the mode.
SET	At any time	Select the selection display or execution display.
▲▼	When the flashing decimal point is displayed.	Change the data · Select the parameter · Execute the operation
◀		Shift to upper figure for data changing.

- At the selection display of each mode, upper figures consist of 2 alphabets + under bar.

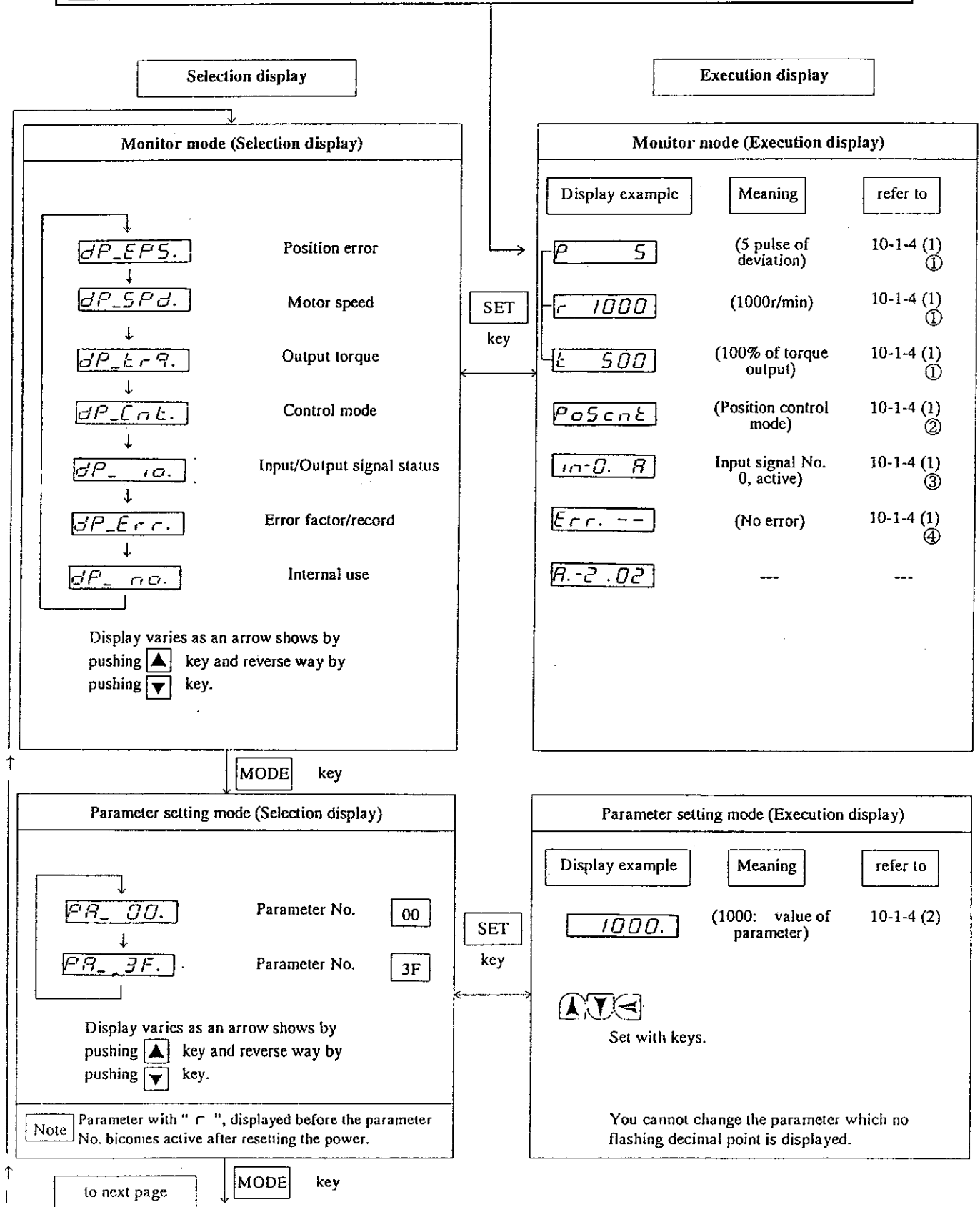
Mode	Upper figures at the selection display
Monitor mode	<u> </u> □□□□
Parameter setting mode	<u> </u> □□□□
EEPROM writing mode	<u> </u> □□□□
Automatic gain tuning mode	<u> </u> □□□□

- When all the figures flash, this represents the trip.

Display	Motor status
All the figures flash	Trip
Normal display	Normal operation

10-1-3 Example of operation execution

When you turn on the power, LED display shows the execution display (either one of the position error, motor speed, or torque output), following the setting of the parameter No. 01 ("Selection of initial display", after displaying the LED check (about 2s).



from the previous page

EEPROM Writing on mode (Selection display)

EE_SET

Shift to the execution display by **SET** key when you write on the parameter into EEPROM.

SET
key

EEPROM Writing on mode (Execution display)

Display example

Meaning

refer to

10-1-4 (3)

-.

keep pushing **▲**

Start

start writing

Finish.

finish writing

When you execute writing, keep pushing pushing **▲** until the display shows **Start**

In case of the moter which you cannot make automatic gain

MODE key

Automatic gain tuning mode (Selection display)

At_1-1.

Machine stiffness No.1 (low)

At_1-9.

Machine stiffness No.9 (high)

Pushing **▲** proceeds as an arrow shows, and **▼** reverses.

Shift to the execution display after seting the machine stiffness, by pushing **SET** key.

Note refer section 6-4 for the machine stiffness.

SET
key

Automatic gain tuning mode (Execution display)

Display example

Meaning

refer to

10-1-4 (4)

-.

keep pushing **▲**

Start

start writing

Finish.

finish tuning

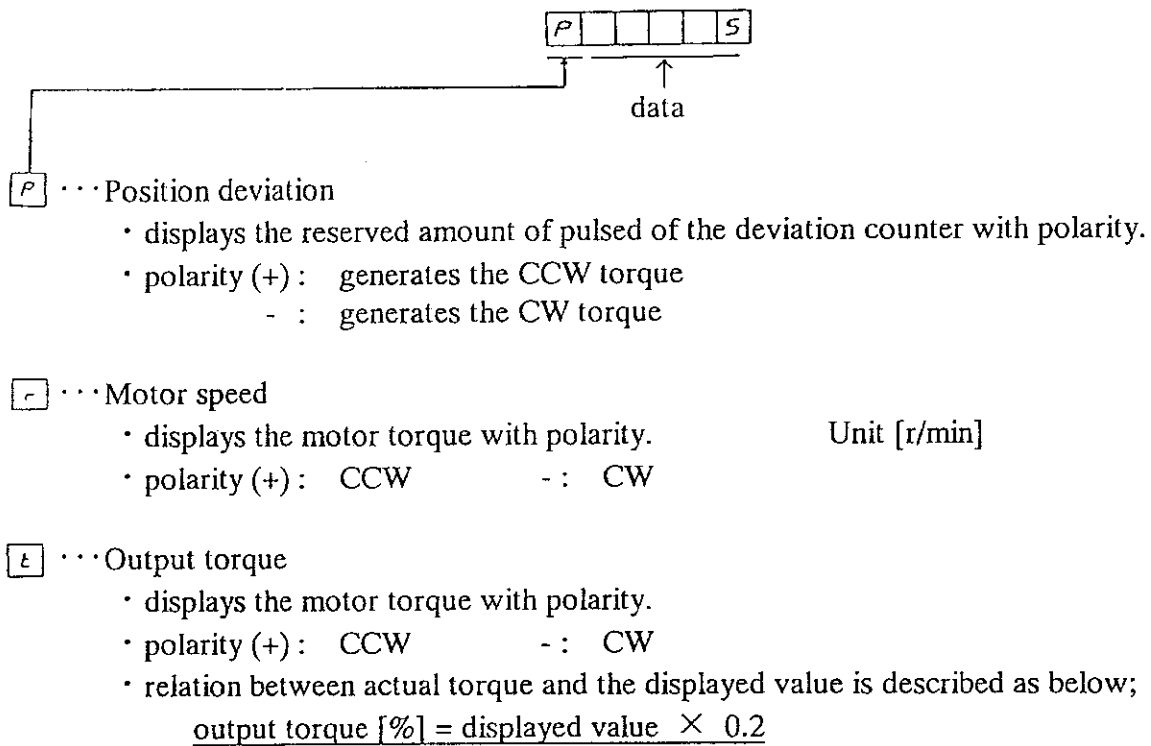
When you execute tuning, keep pushing

▲ until the display shows **Start**

MODE key

(1) Detail of monitor mode

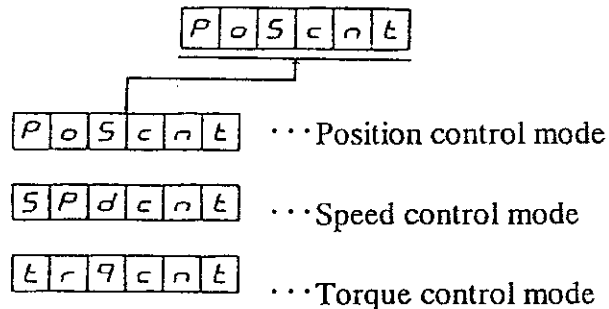
① Display of the position error, motor speed and output torque



Note when the polarity is +, + will not be displayed.

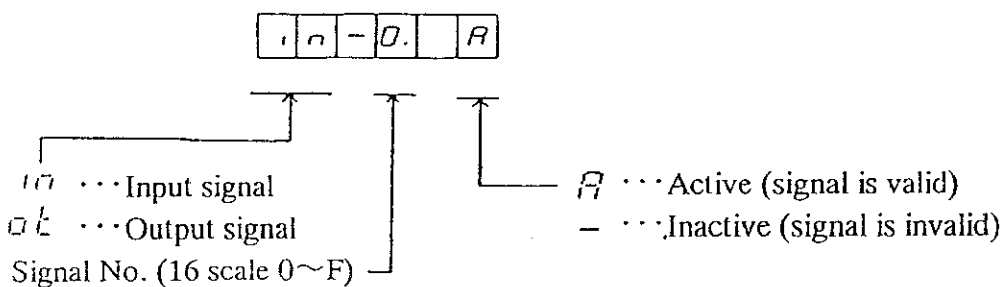
② Display of control mode



Displays the current control mode.




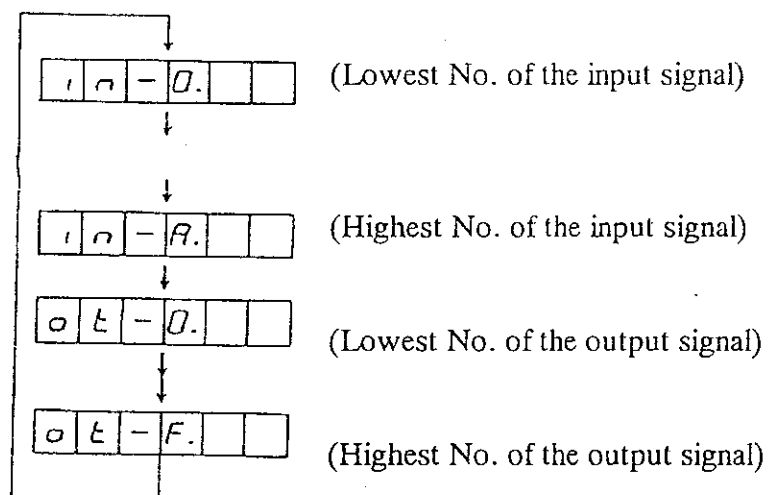
③ Display of input/output signal

■ Displays the status of the control input and output signal to the connector CN I/F. You can use for checking the right connection.



■ Push   to select the desired signal No.

Example of shifting
when pushing ,

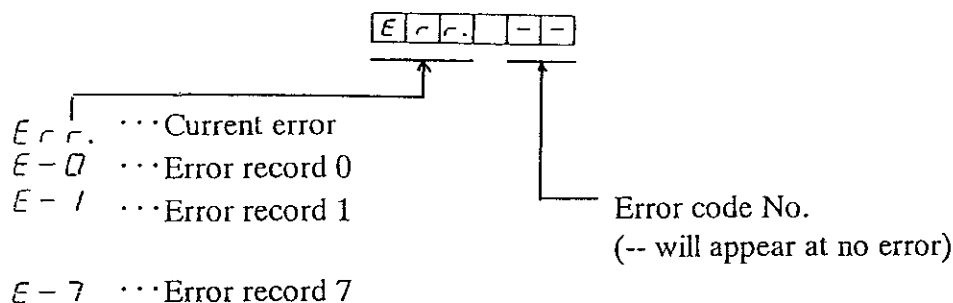


■ Signal No. and its title

Input signal				Output signal			
Signal No.	Title	Symbol	Pin No. of CN I/F	Signal No.	Title	Symbol	Pin No. of CN I/F
0	Servo-ON	SRV-ON	29	0	Servo-ready	S-RDY	35
1	Alarm clear	A-CLR	31	1	Servo-alarm	ALM	37
2	CW rotation inhibit	CWL	1	2	Error code 0 (LSB)	EXOUT 0	8
3	CCW rotation inhibit	CCWL	2	3	Error code 1	EXOUT 1	9
4	Control mode control	C-MODE	32	4	Error code 2 (MSB)	EXOUT 2	10
5	Zero-speed clamp	ZEROSPD	26	5	External BR release	BRK-OFF	11
6	Internal speed command	INTSP-D	28	6	Positioning end Arrival speed	COIN	39
7	(not in use)	-	-	7	Torque limit control	TLC	40
8	Pulse input inhibit	INH	33	8	Zero-speed derrection	ZSP	12
9	Proportional control	P-con	27	9	(not in use)	-	-
A	Deviation counter clear	CL	30	A	(not in use)	-	-
B	(not in use)	-	-	B	(not in use)	-	-
C	(not in use)	-	-	C	(not in use)	-	-
D	(not in use)	-	-	D	(not in use)	-	-
E	(not in use)	-	-	E	(not in use)	-	-
F	(not in use)	-	-	F	Dynamic BR release	-	-

④ Error factor and its record

- You can trace the error factor back to its past 8 errors including present one.



- You can trace by pushing (By pushing , you can select older record.)

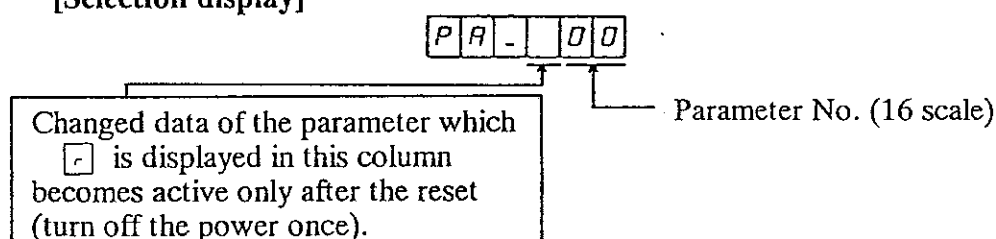
Note If the error occurred which was stored as a record, same error No. will be displayed for the current and the error record 0.

- Relation of error code No. and its content

Error code No.	Content	Error code No.	Content
12	Overvoltage error	38	Drive inhibit input error
13	Undervoltage error		
14	Overcurrent error		
15	Overheat error	23	DSP problem
16	Overload error	30	CPU problem
		36	EEPROM parameter error
22	Encoder signal error	84	Received parameter error
24	Error caused by POS. error		
26	Overspeed error	98	System error
27	Pulse frequency division error		
29	POS. error counter overflow	99	Other error

Note Error history can not be erased.

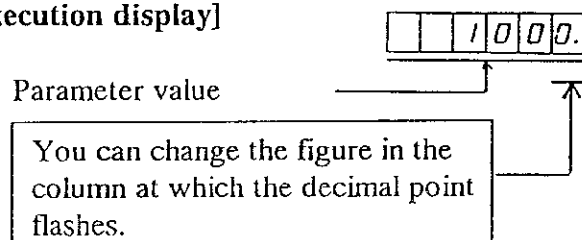
(2) Parameter setting [Selection display]








- Push to select the parameter which you want to refer or set.

Note Please refer to section 9-1, "Outline of parameter" for the relation of the Parameter No. and its content.

[Execution display]




■ Set the parameter value by pushing   With , the value increases and decreases with .

■ Shift the flashing decimal point with  to the upper digit.


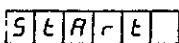
Note Each parameter has a limit for the shift to the upper digit.

■ Upon changing the parameter value, the content will be reflected to the control.

Note 1. Please change the data little by little, instead of changing drastically if you change the parameters which affect the motor movement (such as the speed loop gain or position loop gain). Some parameters inhibits to use .

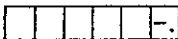
Note 2. Some parameters substantially change the motion of motor because of their function (e.g. parameter No. 02 "Selection of control mode", No. 14 "Input reversal in speed control mode.", No. 25/26 "Numerator/Dominator of pulse frequency division.", etc.). In changing these parameters, be sure to be state of Servo-off.

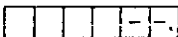
(3) Detail of EEPROM writing on mode

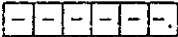
■ Keep  pushing until the display shows 

Keep pushing 


for about 5 secs,
then the bar will
increase.



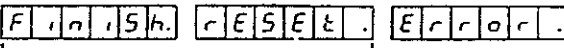




Start writing



Finish writing



Finish writing


Writing error

■ When you change the parameter setting which becomes active after the reset, the display shows at the finish of writing.

Please turn off the power to reset.

Note Parameters whose changed contents become active after resetting power supply are;

- Parameter No.27 "Command pulse multiplication setting"
- Parameter No.28 "Command logic inversion"
- Parameter No.29 "Command pulse input mode setting"

■ If you keep pushing  after the end of writing, you can re-write in the parameter.

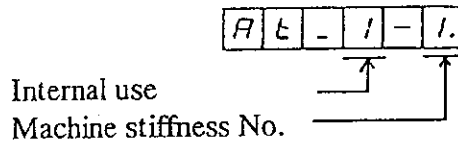
Note 1. When you encounter the error at writing, please re-write. If you still encounter the error, this may be the driver's malfunction. Please contact the shop purchased this driver.

Note 2. Please do not turn off the power while writing. Wrong data may be written. If this happens, please set all the parameters and write-in again after the complete check.

(4) Detail of automatic gain tuning

- Note** 1. Please refer to section 6-4 for the detail of the automatic gain tuning function. Especially read and understand the applicable range and notes described in section 6-4 before you use this function.
- Note** 2. At the automatic gain tuning mode, the motor turns 2 revolutions each to CW and CCW. Please allow your mechanism to accept such movement.

[Selection display]

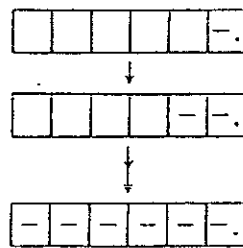


- Push to select the machine stiffness No. (refer to section 6-4 for the machine stiffness No.)

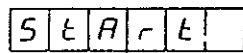
[Execution display]

- When you execute the auto-gain tuning, turn to Servo-ON and keep pushing until the display shows;

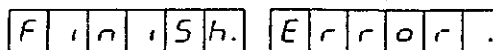
Keep pushing
for about 5 secs,
then the bar will
increase.



Start writing



Finish writing



Finish tuning

Tuning error

- You can restart by keep pushing after the end.

- Note** 1. When automatic gain tuning is executed and normally terminated, if the gain is out of "application range" described in section 6-4-2, the machine operation may not be improved. (Gain remains unchanged before and after automatic gain tuning.) In this case, adjust the gain manually according to the section 9-2.

- Note** 2. When auto gain tuning error has occurred:

A tuning error occurs when the following condition occurs during tuning operation.

- ① During tuning operation,
 - Error has occurred.
 - Servo-on is inactive.
 - Deviation counter is cleared.
- ② Inertia or load is too large, causing saturation of output torque.
- ③ Tuning is not executed successfully because of resonance, etc.

When any tuning error has occurred, each gain returns to a value before tuning. The system does not trip except when an error has occurred, so fully note the safety especially when resonance occurs.

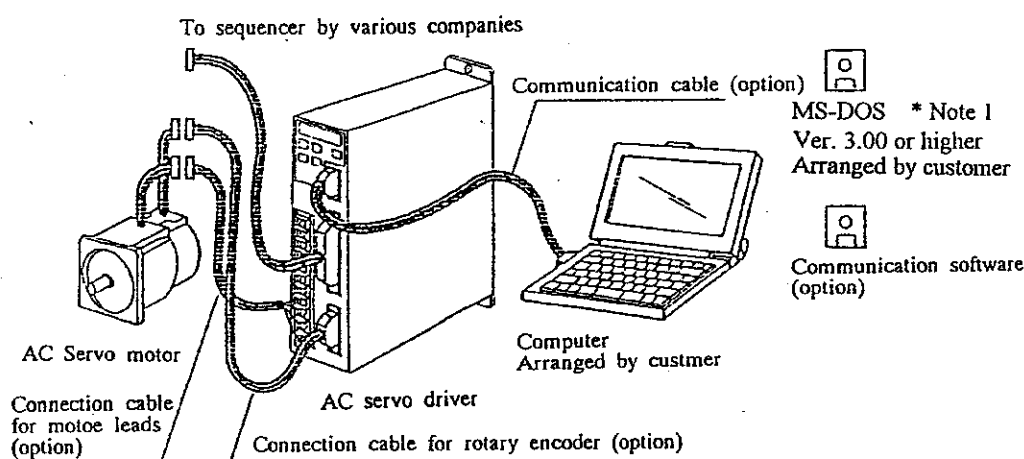
- Note** 3. Parameter data after automatic gain tuning is not written in EEPROM. When power is off, it returns to former data before execution. If you want to reflect the result of automatic gain tuning here and after, write the parameter in EEPROM before cutting off power according to section 10-1-4 (3).

10-2 Operation with computer

10-2-1 Outline

This driver has the function which you can make serial communication with the computer via RS232C, and you can use this computer as a console. You can set, change the parameter, or monitor the control state on the CRT screen of the computer.

Composition of using the computer is described as below:



★Note 1: MS-DOS is the trade mark of U.S. Microsoft Co.

- Note** In operating with the personal computer, RS-232 C cable and software for communication control (PANATERM) are necessary as option parts. (Refer to 13-1 and 13-2 (page 66).)
- As for operation method, refer to the operation manual attached to PANATERM.
- As for details, please ask your sales agent.

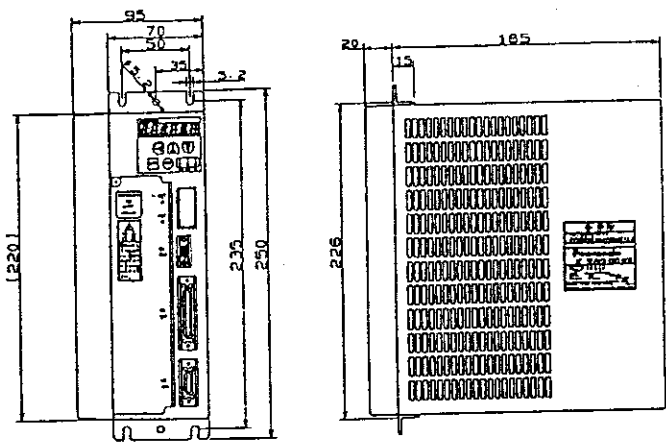
11. Specifications

Model			MCD * V			
Basic Spec	Applicable motor/ output (kW)	MSM	1.0	1.5	2.0 · 2.5	
		MDM	0.75 · 1.0	1.5	2.0 · 2.5	
		MFM	0.75	1.5	2.5	
		MHM	0.5	1.5	2.0	
	Input power source	Main circuit power supply	3-phase	200-230V +10% -15%	50/60Hz	
		Control circuit power supply	Single phase	200-230V +10% -15%	50/60Hz	
	Control method		Transistor PWM (Sine-wave form) 10-core type			
	Feed back		Incremental encoder (2,500P/r)			
	Ambient condition	Temperature	Working: 0-50° C, Storage: -20+80° C			
		Humidity	Working/storage: 90%RH or less (no condensation)			
Vibration		4.9m/s ² (0.5G) or less, 10~60Hz (no continuous operation at resonance point is permissible)				
Altitude		1000m or under				
Function	Control mode		①Analog speed control ②Position control ③Torque control ④Position · Speed control ⑤Position · Torque control ⑥Speed · Torque control			
	Input signal	Control input		①Servo-ON input ②Alarm clear input ③CW rotation inhibit input ④CCW rotation inhibit input ⑤Zero-speed clamp input ⑥Control mode control input		
		Analog command input	Speed command	2[V/Kr/min] scale setting and command polarity through parameter		
			Torque command	Used with CCW torque limit, 3V/rated torque (effective at torque command mode)		
			Torque limit command	Individually settable of CW/CCW torque limit. 3V/rated torque		
		Pulse row command input	Input pulse row status	Differential input. Selectable through parameter. (①Forward/Reverse run ②A/B phase ③Command/Direction)		
	Control input		Open collector input. ①Deviation counter clear input ②Command pulse prohibition input			
	Output signal	Control output		①Servo-alarm ②Servo-ready ③Arrive speed (Speed · Torque control mode)/Position-finish (Position control mode) ④during torque limiting ⑤Zero-speed signal ⑥External brake cancel signal ⑦Alarm code output (3bit)		
		Encoder feed back signal		Line driver output of encoder pulse (A, B, Z) after division, Opencollector output of Z-phase pulse		
		Monitor output		①Speed monitor 2V/Kr/min ②Torque monitor 3V/rated torque		
		Control power supply output		±12V 20mA max.		
	Built-in function	Regenerative Dynamic brake		Built-in resistor ①At Servo-OFF ②At alarm occurs ③At main power OFF ④Auto D/B function in over-travel (Invalidity possible by parameter)		
		Automatic gain tuning		Built-in (applicable to certain motor models)		
		Masking of unnecessary input wiring		①Drive inhibit input (CW/CCW) ②Torque limit command input ③Zero-speed clamp input		
		Soft-start/down		0-10sec/1000r/min (setting through parameter)		
		Zero-speed clamp		Enter to Servo-lock with zero-speed clamp input (in case of speed control mode)		
		Dvsn/Mltplctn of cmmnd pulse (Elec. gear)		1-10000/1-10000		
		Dvsn of RE feed back pulse		1-10000/1-10000 (Numerator ≤ Denominator)		
		Protective function	Hard error	OV, LV, OS, OL, OH, OC, ST		
			Soft error	CPU error, DSP error, System error etc.		
		Trace back of alarm data		Traceable back to the past 8 error data (including current error)		
		Setting key, LED display		①5 keys (MODE, SET, UP, DOWN, SHIFT) ②6-DIGIT LED		
		Communication with RS232C		Parameter setting and monitoring of the status with IBM (PC/AT) series		
		Perform- ance	Applicable load inertia		Less than 5 times the inertia of motor	
	Max. command pulse frequency		500 [Kpps] (200 [Kpps], in case of opencollector input)			
	Frequency characteristics		200 [Hz] or more (at J _M =J _L) (depends on motor model)			
Weight			3.9 [kg]	4.5 [kg]	4.3 [kg]	
Dimensions (refer to section 12)			suffix B-1	suffix B-2	suffix B-3	

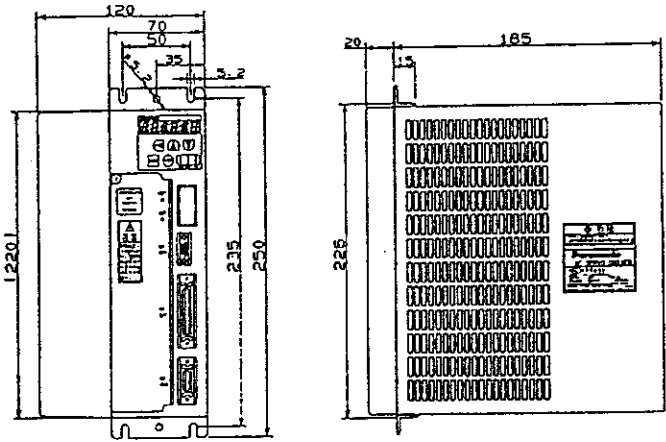
[Note] Regarding the meaning of □, * refer to section 1-1 (p.9).

12. Dimensions

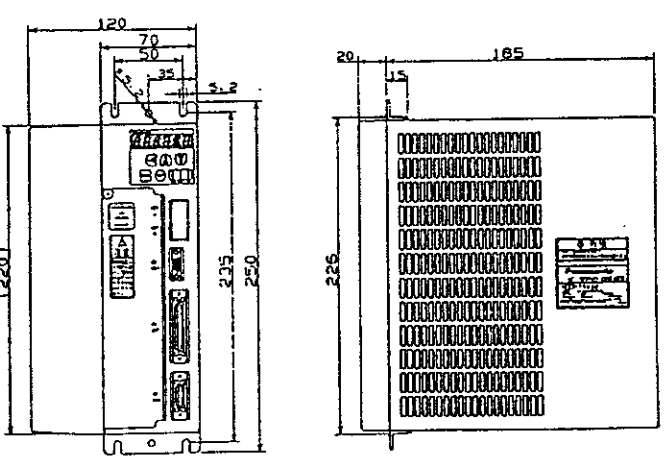
Dimension suffix B-1



Dimension suffix B-2



Dimension suffix B-3



13. Option parts

13-1. Software for communication control PANATERM

(1) Article No. **DV0P0461**

(2) Action environment

Hardware (corresponding personal computer model):

Action with the below models is checked by model auto recognition by software.

☐ NEC personal computers, PC-98 Series or their compatible computers

(e.g.) PC-9801N,NV,NS/E

☐ IBM PC/AT or their compatible computers

Software (corresponding OS)

Operation is checked by DOS version corresponding to each hardware below described.

☐ in case of using PC98 Series

• Please prepare MS-DOS ver3.0 or higher by customers.

• Incorporate the file for controlling RS-232C "RSDRV.SYS" into MS-DOS as device driver.

☐ IBM PC/AT or their compatible computers

• MS-DOS 6.2 (J) (DOS/V)

Supplied media: 3.5" 2DD floppy disk

Note 1) Please check on hardware and OS versions other than the above by customers.

Note 2) This software may be changed without prior notice for version up, etc.

13-2. Connector kit for connecting external equipment

(1) Product No.DV0P0490

(2) Constituents

Name	Manufacturer's product No.	Quantity	Manufacturer's name	Remarks
Plug	10150-3000VE	1	Sumitomo 3M, Ltd.	For CN SIG (50 pins)
Shell kit	10350-52A0-008	1		

13-3. Connector kit for connecting motor encoder

(1) Product No.DV0P0690

(2) Constituents

Name	Manufacturer's product No.	Quantity	Manufacturer's name	Remarks
Plug	10120-3000VE	1	Sumitomo 3M, Ltd.	For CN SIG (20 pins)
Shell kit	10320-52A0-008	1		
Straight plug	MS3106B 20-18S	1	Nihon Koku Denshi	Motor power line for relay
Cable clamp	MS3057-12A	1		
Straight plug	MS3106B 20-29S	1		Encoder cable for relay
Cable clamp	MS3057-12A	1		

(1) Product No.DV0P0960

(2) Constituents

Name	Manufacturer's product No.	Quantity	Manufacturer's name	Remarks
Plug	10120-3000VE	1	Sumitomo 3M, Ltd.	For CN SIG (20 pins)
Shell kit	10320-52A0-008	1		
Straight plug	MS3106B 20-4S	1	Nihon Koku Denshi	Motor power line for relay
Cable clamp	MS3057-12A	1		
Straight plug	MS3106B 20-29S	1		Encoder cable for relay
Cable clamp	MS3057-12A	1		

(1) Product No.DV0P0970

(2) Constituents

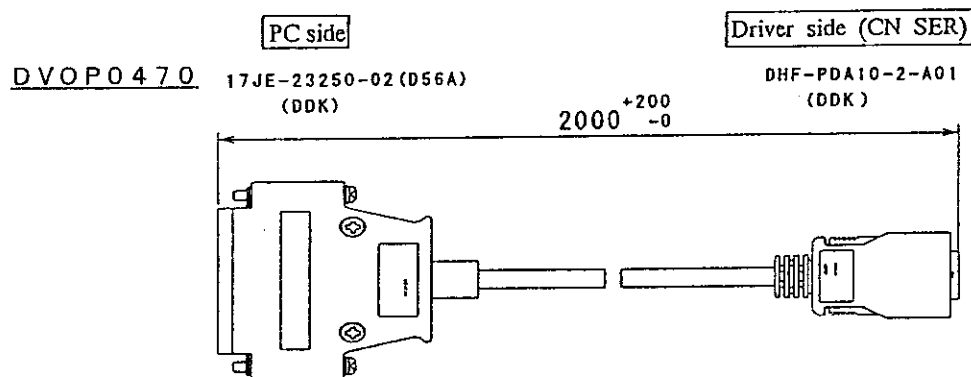
Name	Manufacturer's product No.	Quantity	Manufacturer's name	Remarks
Plug	10120-3000VE	1	Sumitomo 3M, Ltd.	For CN SIG (20 pins)
Shell kit	10320-52A0-008	1		
Straight plag	MS3106B 24-11S	1	Nihon Koku Denshi	Motor power line for relay
Cable clamp	MS3057-16A	1		Encoder cable for relay
Straight plag	MS3106B 20-29S	1		
Cable clamp	MS3057-12A	1		

13-4. RS232C Connection Cable

(1) Product No. DVOP0470 (for PC-98 series)

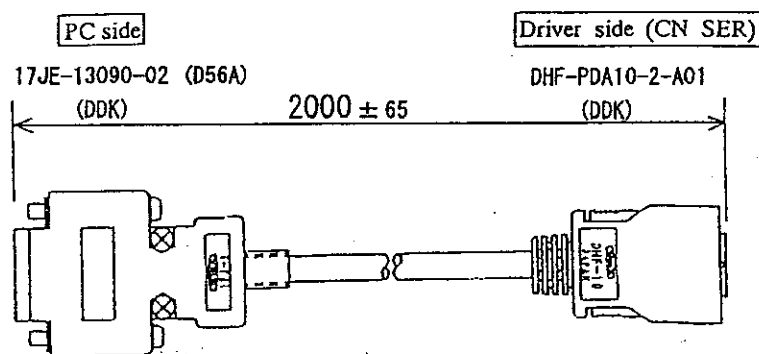
DVOP0630 (for IBM, PC/AT or the compatible)

(2) Outer dimension



Note) This connection cable cannot be used for other equipment.

In case the RS-232C connector on the personal computer side is half-pitch connector, prepare a conversion connector separately.



Below parts are prepared as option, in addition to option parts above mentioned.

- Relay cable for encoder Article No. MFECA****ESA
- Relay cable for motor Article No. MFMCA****ACT
- Relay cable for motor (with brake) Article No. MFMCA****BCT

As for details, refer to the catalog of MINAS Series or ask your sales agent.

14. Trouble Shooting

- ◆ If a trouble should occur, for example "the motor doesn't rotate", "unstable rotation", "positioning accuracy is wrong", "the machine datum isn't in the right position" and so on, first check the following points and then take proper action.

Not rotating

Driver trips.

Error occurs and driver protection function operates. As for details on protection function contents and measures, refer to 6-5 [Protection functions] (page 35).

Note Some protection functions can be cleared (alarm clear) with A-CLR signal, and other protection functions can not be cleared. For protection functions unable to be cleared, power supply must be input again.

Check point	Condition to be confirmed	Solution
Check the wiring of the main circuit.	Is the power of the driver turned ON?	If the power isn't turned ON, LEDs do not light up.
	Is the power supply (R, S, T, r, t) of the driver connected properly ?	If the power isn't supplied, the motor doesn't rotate.
	Is the connector for connecting to the motor (U, V, W, \oplus) connected properly.	If the phases of wiring to the motor isn't the same as the motor, the motor doesn't rotate.
Check that the user parameter of the driver and the external input switches.	Check whether the driving inhibition input switch of CW or CCW is not turned ON when the setting of the user parameter No.09 "Driving inhibition input invalid" is set to "0" or not.	When the driving inhibition input is ON, torque output to the direction should be turned OFF.
	Check whether the setting value of the user parameter No.06 "torque limit setting" is set to "0" or not.	Set the value of the torque limit to "0", and the driver doesn't generate torque.
	Check whether the setting values of the user parameter No.21 "Speed feed forward" are set to "0" or not.	The command input pulse is set to "0" by the gain of the parameter shown left, then it is judged there is no command input.
	Check whether the setting value of the user parameter No.23 "position error limit setting" is set to the value near "1".	When this setting value is small, the motor start to rotate and as soon as the positioning deviation occurs, it is judged that the positioning deviation is excessive and the emergency stop function operates to stop the rotation of the motor.
	Is not the connector CN I/F 33 pin (INH) and 41 pin (COM-) connected?	When command pulse input inhibit is effective, even in inputting command pulse, the driver does not receive pulse and the motor does not rotate.
Check the brake.	Check whether the electro- magnetic brake or the mechanical brake operates or not.	If the brake operates owing to the external force, the brake will be damaged or it becomes the cause to burn down or damage the motor. Be careful in such a case.

Unstable Rotation

Check point	Condition to be confirmed	Solution
Check whether the fluctuation of the voltage of the power supply is excessive or not.	Check whether the capacity of the power supply and the transformer are too small or capacity of the load is too large.	When the voltage of the power supply is too low, the rotating speed is sometimes delayed.
Check the command input pulse.	Check whether the shield or the installation work is proper, and the peripheral relay and magnet are installed surge absorber or not.	When the countermeasure against noise isn't secure, the driver sometimes operates unexpectedly.
	Check the length of the wires and cables as specified or not.	When the length of the wires and cables are too long, the waveform is weakened and the command can not be received normally.
	Check whether there are any distortion or crack on the output waveform from the external command device or not.	When there are any distortion or crack on the output waveform, normal operation can not be expected. Check the external command device again.
Check whether the capacity correspond to the load is selected or not.	Check whether the load inertia is extremely large or not. Adjust the user parameter No.03 : "Speed loop gain", user parameter No.04 : "Speed loop integration time constant" and user parameter No.20 : "position loop gain".	In case of the value is beyond the adjustable range, take proper action, for example, lower the load inertia, increase the capacity of the motor and so on.
	Check whether the friction load is extremely high or not.	When the friction load is extremely high, hunting (a kind of starting phenomenon) may occur around the stopping position. Though this phenomenon calms down when making the speed loop controlled by proportional control, positioning deviation will be noticeable at the stopping position.
	Check whether the load change is excessive or not. Adjust the user parameter No.03 : "Speed loop gain", user parameter No.04 : "Speed loop integration time constant" and user parameter No.20 : "position loop gain".	In case of the value is beyond the adjustable range, take proper action, for example, lower the load inertia, increase the capacity of the motor and so on.
	Check whether there is some break down or resonance or not. Perform check on the coupling, timing belt, gear and so on.	In case of the rigidity of the coupling is low, the tension of the timing belt is weak, back rush sometimes occurs and so on, phenomenon like resonance sometimes occurs. Please remedy the state of the mechanical system.
Check the signal of the rotary encoder.	Check whether the shield or the installation work is proper, and the peripheral relay and magnet are installed on the surge absorber or not.	When the countermeasure against noise isn't secure, the driver sometimes operates unexpectedly.

Positioning accuracy is wrong

Check point	Condition to be confirmed	Solution
Check whether the same error always can be get or not.	Check whether the user parameter No.25 "Numerator of pulse frequency division" and that of No.26 "Denominator of pulse frequency division", are set properly or not.	When the setting of the pulse frequency division is different, migration length is also different.
	Check whether the positioning program and data of the external devices are set properly or not.	Please set the positioning program and data of the external devices properly.
Check whether errors can be seen frequently in case of the same driving conditions or not.	Check whether a relay or a magnet and the like operates or not around the driver or not. If a relay or a magnet works, error can be seen or not.	Check the countermeasures against noise. Check whether the following noises invade or not ; servo on signal, counter clear signal, command pulse, and rotary encoder feedback signal.
	Check whether the positioning program and data of the external devices are set properly or not.	Please set the positioning program and data of the external devices properly.
Check whether errors can be seen irregularly or not.	Check whether the countermeasures against noise are taken properly.	Check the countermeasures against noise. Check whether the following noises invade or not ; servo on signal, counter clear signal, command pulse, and rotary encoder feedback signal.
	Check the speed loop is controlled by proportional control or not.	Set the user parameter No.04 "Speed loop integration time constant" to "1000" and the proportional control will begin. Then the stopping accuracy will be decreased.
	Check whether the integration time constant of the speed loop is too large or not.	If the user parameter No.04 "Speed loop integration time constant" is too large, it takes long time before the positioning.
	Check whether the position loop gain is too small or not.	If the user parameter No.20 "position loop gain" is too small, it takes long time before the positioning.

Countermeasures against noise

- Set the noise filter to power supply input.
- Use the twist-pair wire with shield for command pulse wire and encoder wire.
- Fit the ferrite core for command pulse wire and motor wire.
- Fit separately the command pulse wire, encoder wire and motor wire.
- Connect the shield wire of the command pulse wire to the signal ground (GND) on the driver side, and connect the shield wire of the encoder wire to the frame ground (FG) on both of the motor and driver sides.

The machine datum isn't in the right position

Check point	Condition to be confirmed	Solution
Check whether the dimension of the offset is usually the same or not.	Is there any wrong operation like chattering of the datum sensor.	Check the wiring of the datum sensor, take countermeasures against noise and replace the datum sensor.
	Check whether there is trouble about the Z-phase signal of the rotary encoder.	Perform check on the wiring around the rotary encoder.
	Check whether the relation of the position of the Z-phase of the datum sensor and rotary encoder is proper or not.	Move the position of the Z-phase of the rotary encoder to the middle of the position of the datum sensor.
Is the length of the datum sensor enough ?	Does the driver slow down around the origin ?	Reduce the speed of returning to the machine datum or lengthen the datum sensor.
Check whether noise invade to the Z-phase of the rotary encoder or not.	Check whether the shield or the installation work is proper, and the peripheral relay and magnet are installed on the surge absorber or not.	Take proper measures so that noise doesn't invade to the signal of the rotary encoder.
	Is the waveform of the rotary encoder normal ?	In case where the waveform is abnormal even if you take the counter-measures against noise, there is a possibility that the rotary encoder itself has some trouble.
Check whether chattering or wrong operation of the datum sensor or not.	Is there any trouble in the datum sensor ?	Try to replace the datum sensor.
	Check whether the power supply of the datum sensor is surely supplied and noise invades to the signal or not.	Check the wiring of the datum sensor.