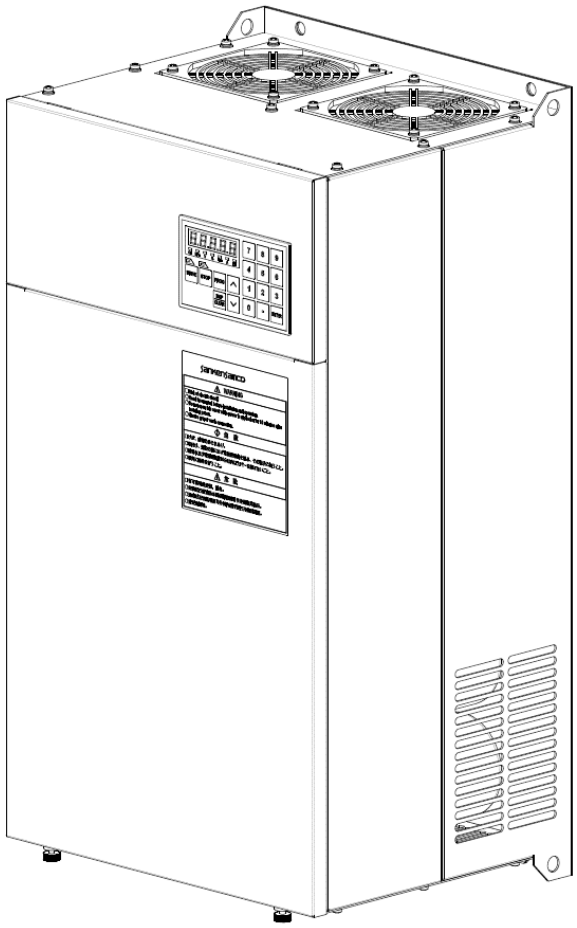
三墾力達

Vector Control Drive

LeaderSamco-NS

Technical Manual



Three Phase 400V Input: 30kW～315kW

1. Safety

1-1 Important notes

Danger	
	■ **Caution: risk of electric shock**
	The disassembly of cover is absolutely probibited, otherwise the risk of electric shock and casualty may exist.
	■ **Caution: Fire Hazard**
	Immediately shut down the power supply and contact with the Seller when peculiar smell, abnormal noise, smoke or sparks, etc. are found in the device.
	In case of a fire, please use the extinguisher for electrical fire (dry powder), but do not use water for fire fighting.

1-2 Instructions for use

Caution	
	■ Before starting the inverter, confirm the safety status of the load first, and then start running operation following the instruction manual.
	Failure to observe this may result in the danger of electric shock and other accidents.
	■ Do not smoke or use fireworks around the inverter.
	Failure to observe this may result in personal injury and fire.
	■ Do not keep containers which contain water above the equipment, such as vase, etc.
	The water may infiltrate into the equipment interior and cause a fire.
	■ During operation, do not short-circuit the input terminal and output terminal.
	The current return will result in electric arc, which can cause personal burns and visual impairment.
	■ Do not insert sticks, fingers etc. into the fan.
	The rotating fan would cause personal injury.
	■ During operation, do not short-circuit the input terminal and output terminal.
	The current return will result in electric arc, which can cause personal burns and visual impairment.
	■ Its use in the following applications is absolutely prohibited.
	a) Medical equipment which are directly related to life.
	b) Trolley buss which may lead to personal injury.
	c) Important computer systems for the community and public utilities.
	d) Equipment with these as standards.
	Otherwise it may have significant impact on personal safety and the maintenance of public functions.
	Please consult the Company in advance when it is used in the above-mentioned load equipment.

1-3 Instructions for installation

Caution	
	■ It is absolutely prohibited to store or use the inverter under the environmental conditions described below.
	Failure to observe this warning may result in a fault, damage or deterioration, which could lead to fire.
	◆ Very hot, cold, humid or outdoor locations, of which the environmental conditions are beyond that recorded in the instruction manual.
	◆ Locations which are in direct sunlight or near a heater or other heat sources.
	◆ Locations subject to vibration or physical shock.
	◆ Locations near machinery that generates sparks.
	◆ Locations subject to dust, corrosive gas, salt, inflammable gas and water droplets.
	◆ Locations higher than 3000 meters above sea level.
	◆ Other similar environments.
	■ Mount the inverter on a metal surface or other non-flammable surfaces.
	Failure to observe this may result in a fire.
	■ Install the inverter in a location that can bear its weight according to the instruction manual.
	Failure to observe this may result in injuries as the inverter falls down.
	■ Do not plug up the air inlet/exhaust.
	Failure to observe this may result in a fire due to internal temperature rise of the equipment.
	■ Do not place the inverter near flammable materials.
	Failure to observe this may result in a fire.
	■ Do not allow foreign objects into the inverter or attach to the cooling fans.
	Failure to observe this may result in a fire or an accident.
	■ Do not operate an inverter which is damanged, lacking parts or dented.
	Failure to observe this may result in an electric shock, injury, fire or other accidents.

1-4 Instructions for transportation and relocation

Caution
■ During handling and moving, do not tilt the equipment.
Failure to observe this may result in personal injury due to falling down of equipment.
■ Prior to handling and moving, confirm the weight marking attached to the equipment first; please prepare alternative handling machine for work as necessary.
Failure to observe this may result in personal injury.

1-5 Instructions for wiring

Danger
■ Wiring must be performed by qualified personnel.
Improper wiring may result in electric shock or fire.
■ Do not connect AC power to an output terminal (U, V or W).
Failure to observe this may result in personal injury or fire.
■ Do not use if rated voltage is exceeded.
Failure to observe this may result in personal injury or fire.
■ Do not connect a resistor directly to the DC terminals (P and X).
Failure to observe this may result in a fire.
■ Connection between the ground terminals must be reliable.
Failure to observe this may result in an electric shock.
■ Please tighten the terminal block screws according to specified tightening torques.
Failure to observe this may result in a fire.
■ Check that the AC power voltage is consistent with the rated voltage of the inverter.
Failure to observe this may result in personal injury or fire.
■ For cable types and diameters, please use the cables specified in the instruction manual.
Failure to observe this may result in a fire due to wire heating.
■ Secure the inverter before wiring.
Failure to observe this may result in personal injury or fire.

Caution
■ The inverter, motor or wiring may cause interference. Please note misoperation of peripheral devices.
Failure to observe this may result in accidents.
■ If the input and output are terminal blocks, the wire heads must be connected with crimp terminals.
Failure to observe this may result in personal injury or fire.

1-6 Instructions for operation

Danger
■ Connect the input power only after attaching the front cover, and never remove the cover when the power is on.
Failure to observe this may result in an electric shock.
■ Do not touch any switch with wet hands.
Failure to observe this may result in an electric shock.
■ Do not touch any inverter terminal when the inverter is energized, even if the motor is not running.
Failure to observe this may result in an electric shock.
■ Do not get close to the motor when the restart function is enabled, as it will re-start suddenly after the alarm stops. (Design the system to ensure personal safety at restart.)
Failure to observe this may result in personal injury.
■ Provide a separate emergency stop switch.
Failure to observe this may result in personal injury.
■ If the alarm is reset with the operation signal set, the equipment will restart suddenly. Therefore, please cut off the operation signal before releasing an alarm.
Failure to observe this may result in personal injury.

Caution	
	■ Do not touch the radiator fins or DC reactor, beacause they become very hot.
	Failure to observe this may result in burns.
	■ It is easy to set the inverter drive speed from low to high, so be sure to confirm the allowable operating range of the motor or machinery before the operation.
	Failure to observe this may result in personal injury.
	■ Please set separate brake if it is required to keep braking.
	Failure to observe this may result in personal injury.
	■ Do not start or stop the inverter by turning the main circuit ON or OFF.
	Failure to observe this may result in equipment faults.

1-7 Instructions for maintenance and examination

Caution	
	■ Works such as maintenance, inspection and replacement of parts can only be carried out by professional electricians.
	[Take off any metal item (such as watch, bracelet, etc.) before working on the equipment.][Use insulated tools]
	Failure to observe this may result in electric shock or burns.
	■ Cut off the input power (OFF) for maintenance and inspection; only carry out the works with the voltage between DC terminals P and X less than 30VDC after the [CHARGE] indicator lamp goes out.
	Failure to observe this may result in electric shock and personal injury.

1-8 Instructions for disposal

Caution	
	■ When disposing this product, please entrust a specialized industrial waste disposal service.
	If it is not handled by professionals, personal injury may be caused by capacitor explosion or the generated harmful

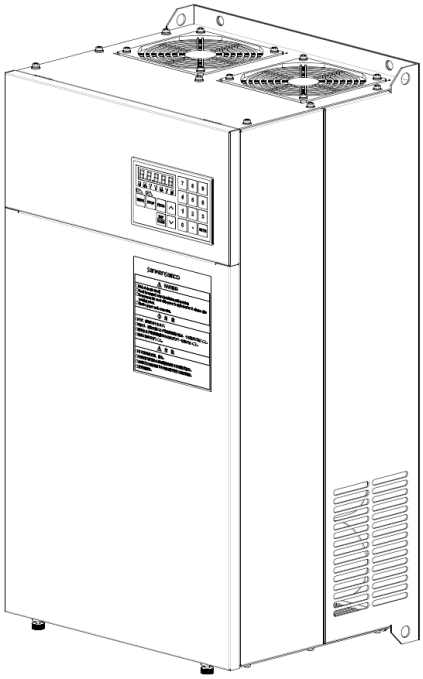
1-9 other notes

Danger	
	■ Reformation of the product without authorization is strictly prohibited.
	Failure to observe this may result in the risks of electric shock, personal injury, fault, damage or fire.
	■ This product is designed for operation of a three-phase induction motor. Therefore it can not be used for single-phase motor or other purposes.
	Failure to observe this may result in a fire or an accident.
	■ Do not use this product for life-support equipment, or other purposes directly related to dangers to human.
	Failure to observe this may result in an accident.
	■ Install a safety device when the failure of this product may cause a serious accident or damage.
	Failure to observe this may result in an accident.

2. Product confirmation and notes

2-1 Product confirmation

Note: The pictures quoted in this book are intended to guide installation and use. The appearance details will be slightly different due to product upgrades, please ignore.



After unpacking, please confirm the following items.
Please make sure that the product has not been damaged during transportation, such as dents in the shell.
If you find such doubts, please contact the agency dealer.

NS series ontology description (take NS-4A152-B** as an example)

2-2 Type code

N S - 4 A 1 5 2 - B X X

- NS: Series name
- 4: Voltage class 4:3-phase 400V
- A152: Rated curent calibration. For example: A152 represents the motor capacity corresponding to the rated current of 152 is 75kW
- B: Overload. B stands for light overload which can work for 1 minute @ 120%
- XX: Internal code

2-3 Label

Drive Model
Input spec
Output spec

MODEL: NS-4A152-B		
SOURCE	3PH 380-460V 50/60Hz	
OUTPUT	115A	152A
MOTOR	Max.55kW	Max.75kW
OVERLOAD	150% 1min.	120% 1min.
SERIAL No.: C0123456789		MASS: 40kg

SANKEN L.D. ELECTRIC(JIANG YIN)CO.,LTD

2-4 Notes before use:

■Failure to observe the following warnings may cause serious damage to the inverter:

◆Never connect the power cable (input) to the output port of the motor! Otherwise, serious damages may be casued to the inverter!

◆Do not connect the power input cable to any terminal other than R, S, T! Otherwise, serious damages may be caused to the inverter!

◆The output port of the inverter should never be connected to capactive loads! Otherwise, damages may be caused!

■ Failure to observe the following notes may shorten the lifespan of the device:

◆Make sure to use the device in standard environments(including conditions related to temperature, humidity, vibration, dust, water-drop, toxic gas, etc.).

◆The lifespan of the inverter is highly impacted by the environment temperature, thus it is recommended to use the device after environment temperature reduction.

◆Please fully consider the size and ventilation conditions of the control cabinet when installing the inverter in the control cabinet.

■Failure to observe the following notes may cause malfunction of the device:

◆Please choose leakage protectors that can cope with higher harmonics and surges

◆A priori, no electromagnetic contactor should be installed between the inverter and the motor. Otherwise excessive current may occur.

◆Since the chracteristics of electromagnetic MCCB may change due to higher harmonics, please choose a model with bigger capacity.

Please make sure to conduct examinations based on above warnings and notes, and to avoid the inappropriate operations! Otherwise, irreparable financial loss may be caused!

3. Installation

3-1 Installation lacation and storage

Table 3-1 Working environment parameters

Ambient temperature	-10℃～+50℃（ice fee）；heavy overload、-10℃～+40℃（ice free）；light overload
Storage temperature	-20℃～+65℃（short-term storage in transportation）
Relative humidity	Below 95%RH（No dewing）
Altitude	Below altitude 3000m (lower current when over 1000m）
Vibration	Below 5.9m/s^2（0.6G）（JIS C 60068-2-6 standard；IEC60068-2-6）
Gas medium	Indoor（no corrosive gas, flammable gas, oil mist, or dust, etc.)

Table 3-2 Storage environment

Storage temperature	-20℃～+65℃ Storage temperature refers to temperatures in short-term period such as transportation. When storage period exceeds three months, please take into consideration aging of the electrolytic capacitor and set the ambient temperature below 30℃. Moreover, if storage period exceeds one year, one electrified operation is required each year.
Relative humidity	Below 95%RH（No frost）
Storage environment	No direct sunlight, corrosive gas, flammable gas, oil, mist, dust, vapor, water-drop, vibration or high salinity

3-2 Mounting direction and space

(1) This inverter is a wall-mounted type, please install on a flat vertical surface.

(2) This inverter is prone to heat up, please leave enough space around it to ensure smooth dissipation of heat.

(3) When installing the inverter in the control cabinet, please install a ventilator to ensure the ambient temperature stays below 40℃.

(4) If the inverter is installed in the control cabinet, to place the radiator outside the control cabinet can help reduce the temperature inside the cabinet.

(5) This inverter is IP20 structured device; please apply according to your purposes.

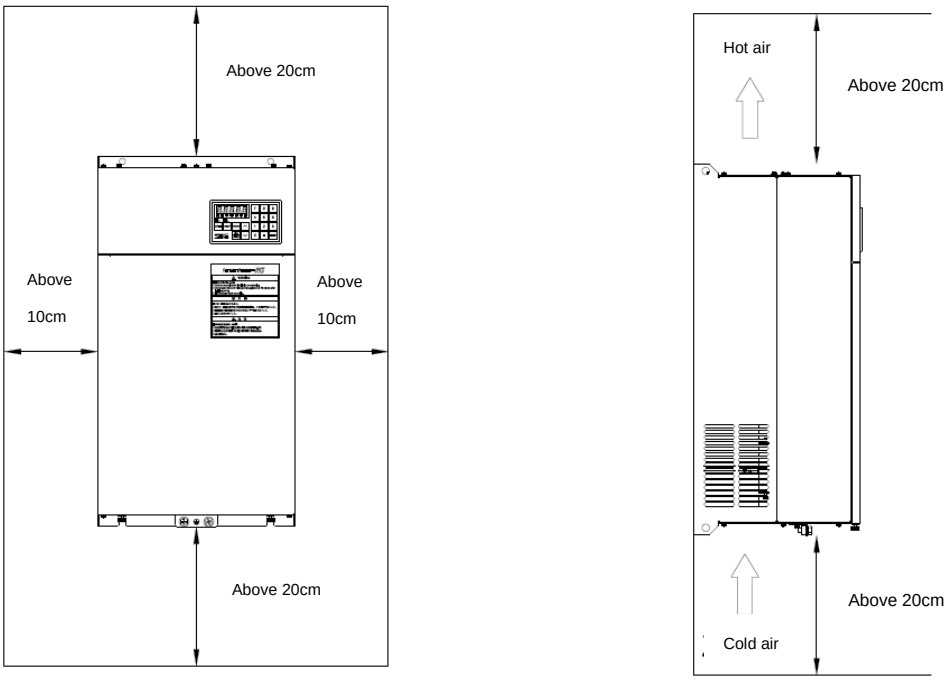


Figure 3-1 Surrounding space

When multiple inverters are installed in the control cabinet, please pay attention to the installation position of the ventilation fan in the cabinet. If the installation method is not properly installed, the surrounding temperature of the inverter will increase, which will affect the cooling effect of the inverter.

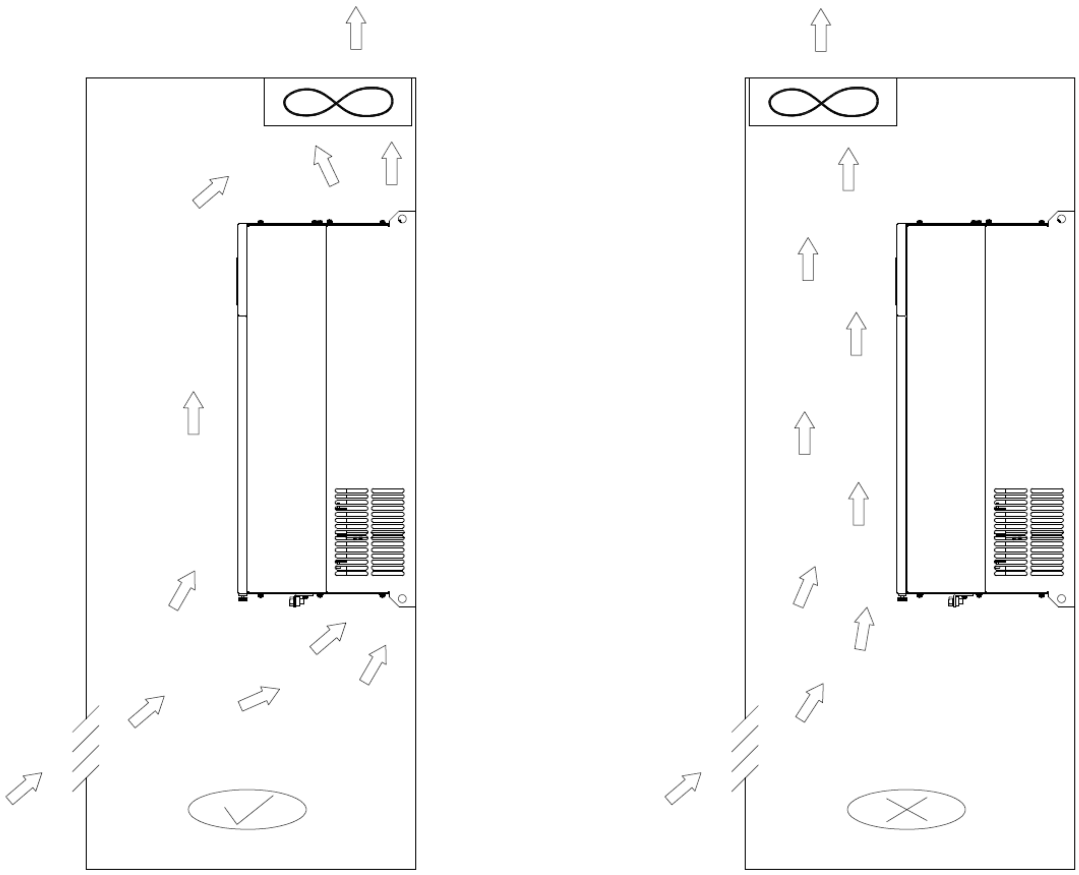


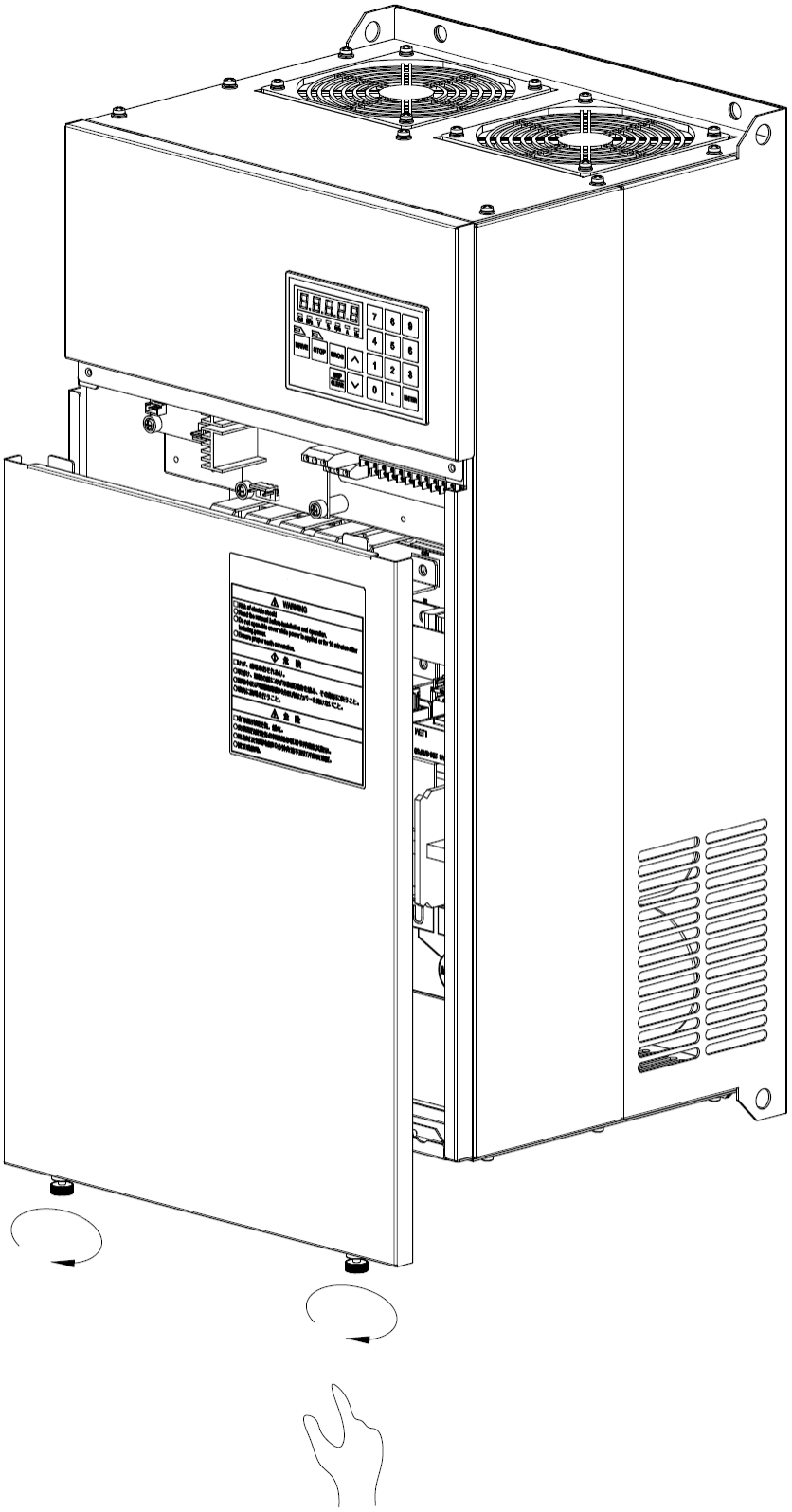
Figure 3-2 Installation position of ventilation fan in the cabinet

3-3 Mount and remove the front cover

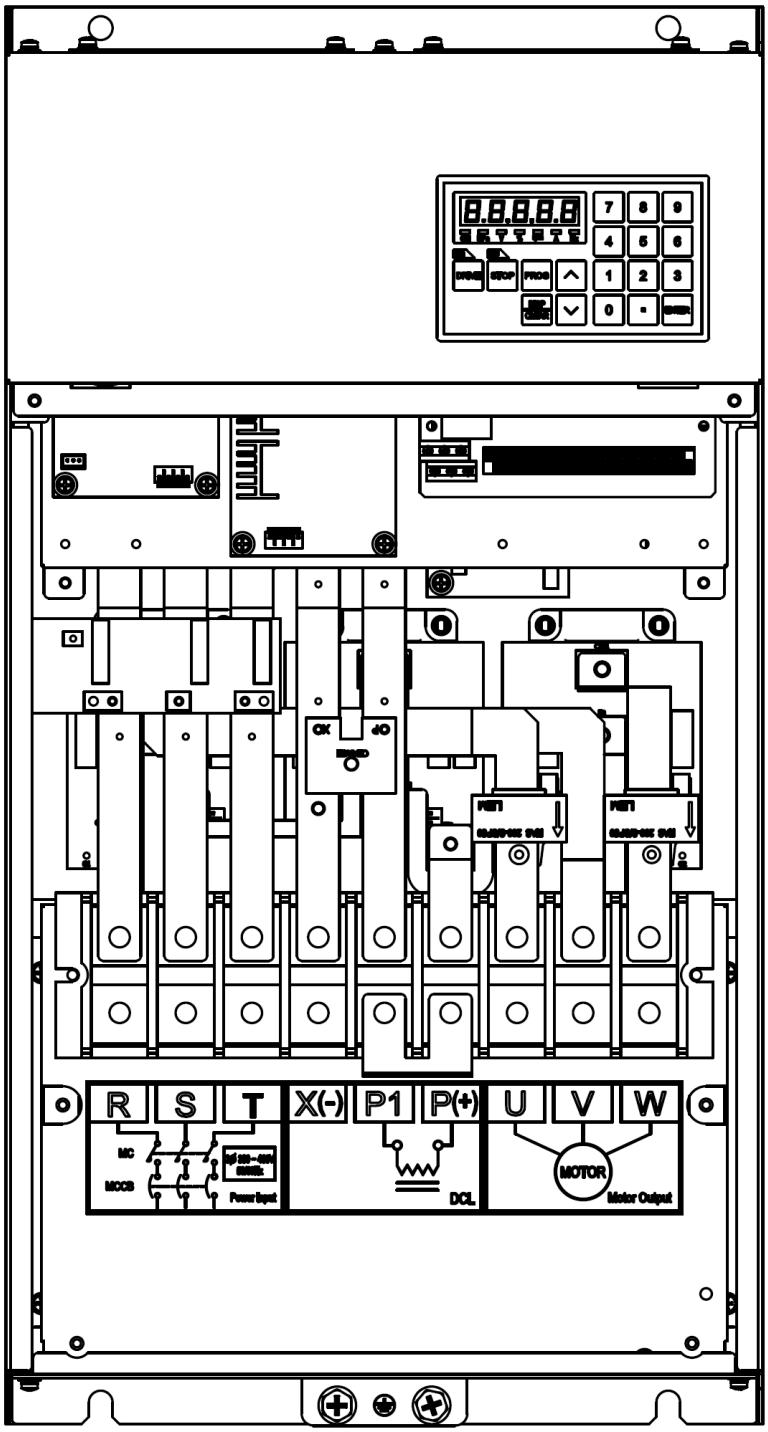
（1） Remove front cover

Remove the M4 screw and take off the front cover.

- Remove the front cover only while main circuit wiring or control circuit wiring.



Schematic diagram of removing the lower cover



Schematic diagram after removing the lower cover

（2）Operation panel external lead

During installation, the operation panel and front panel need to be disassembled, and the front panel must be reinstalled after installation.

（3）Mounting

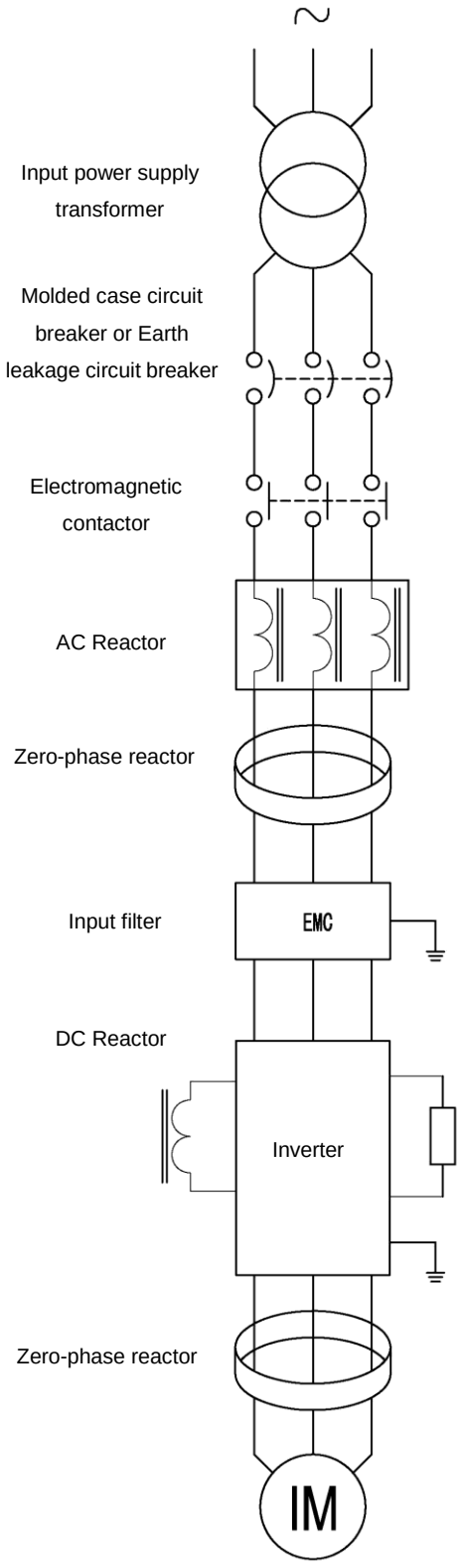
When installing, follow the reverse steps of disassemblage.

4. Connection layout

■ Please confirm the wiring precautions (1-5) before wiring work.
Otherwise, there is a danger of personal injury and fire.

4-1 Connection to Peripheric equipment

Name	Purposes and Detailed Description
Input power supply transformer	When the system power supply voltage and the inverter rated input, voltage need to be matched, please set the input power transformer. When using multiple inverters, please install an input power transformer to reduce the impact of higher harmonic currents on another load equipment.
breaker or leakage circuit breaker	Please connect a wiring circuit breaker or a leakage circuit breaker to the overload protection circuit during the protection of the power supply system and the wiring process. When using a leakage circuit breaker, please use products that correspond to higher harmonics.
Electromagnetic contactor	The coil must be provided with a surge absorber.
Surge absorber	Please install the surge absorber for suppression of surge generated on opening and closing of electromagnetic contactors and control relays.
AC reactor DC reactor	To achieve the following objectives, please install the Reactor - Improve the inverter 's input power factor - Reduce the impact on inverter due to unbalance between phases of power supply voltage ·Prevent tripping of inverter due to action of phase lead compensation capacitors in the system ·When the capacity of power supply is large (above 500kVA)
Zero sequence reactor Line noise filter	Reduce the input power system and the interference caused by the wiring to the inverter. It is recommended to insert components such as zero-sequence reactors as close to the inverter as possible. Model name RC5078 RC5096 [Product of Soshin Electric Co., Ltd.]
Radio noise filter	It is used to suppress the radio noise radiated to the power terminal of the inverter. ■ Model name 200V class: 3XYEB-105•104 400V class: 3XYHB-105•104 [Product of Okaya Electric Industry Co., Ltd.]
Noise filter	Reduce the interference caused by entering the inverter input power system and wiring. It is recommended to install the noise filter as close to the inverter as possible when connecting. ■Recommended EMC filter products (please consult separately.)



4-2 Wiring

◆ When wiring, you must disconnect the power supply on the input side of the inverter and confirm that there is no external voltage on the input side before wiring operations.

(1) A circuit breaker must be connected between the power supply and the input power terminals (R, S, T). (When using a leakage circuit breaker, please use a product for higher harmonics). In order to ensure the safety of the system, please Connect MC (electromagnetic contactor) between the circuit breaker and the input power source.

(2) The wiring connected to the input power terminals (R, S, T) does not need to consider the phase sequence.

(3) Please connect the wiring from the motor to the output terminals (U, V, W) correctly.

◆ When the wiring distance between the inverter and the motor is too long, the high-order harmonic leakage current will increase correspondingly, which will have a bad influence on the peripheral equipment.

The total wiring length between the inverter and the motor should not exceed the value shown in Table 4-1.

Table 4.1 Length of wiring between the inverter and the motor

Wiring length between inverter and motor	50m	100m	200m
Carrier frequency (setting of F1009)	F1009=130 or less	F1009=90 or less	F1009=40or less

- When driving several motors at the same time, the total wiring length connected to each motor should not exceed the value shown in Table 4-1. However, the wiring length for vector control should be limited to a maximum of 100m. (If it exceeds 30m, please implement automatic measurement 2.)
- The surge voltage generated by the switching of the inverter components is superimposed on each other and will be added to the terminal voltage of the motor. Especially for 400V motors, when the wiring length is too long, the insulation performance of the motor will deteriorate. Therefore, please review the following countermeasures.

① Use reinforced motor isolation.

② Length of wiring between the inverter and the motor should be as short as possible (Generally about 10 - 20m) .

(4) See 4-5-4 for capacity of MCCB and MC and wire sizes. Use sleeved crimp terminals for the power and motor cables.

(5) Use shielded or twisted-pair wires for wiring to the control circuit terminals. Keep the wires well away from the main and high-voltage circuits (including logic circuit of 200V relay).

(6) Use a micro-signal contact or two-contact relay for the control circuit terminal to prevent poor contact.

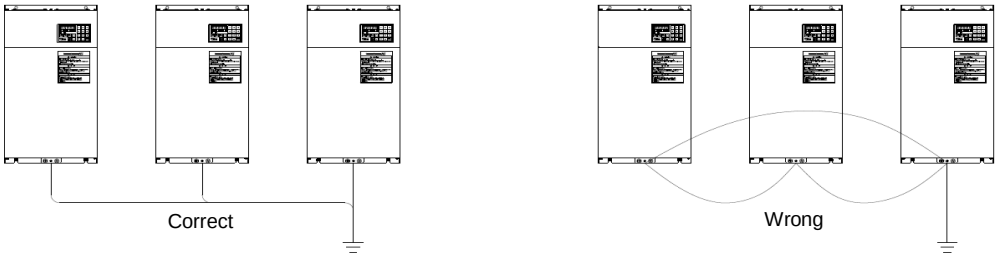
(7) Ground the ground terminal (⏚) securely. (Do not use the casing or the chassis.)

According to technical standards for electrical equipment, 200V class shall be connected to the grounding electrode for type D grounding; while 400V class connected to the grounding electrode for type C grounding.

Table 4-2 Types of grounding

Voltage	Types of grounding	Grounding resistance
400V class	Type C grounding	10Ω or less

- Do not share the grounding wire with the welding machine or the power equipment.
- Use the grounding wire prescribed in the technical standards for electrical equipment and shorten wiring length as much as possible.
- Be careful not to loop the grounding wire when using multiple inverters.



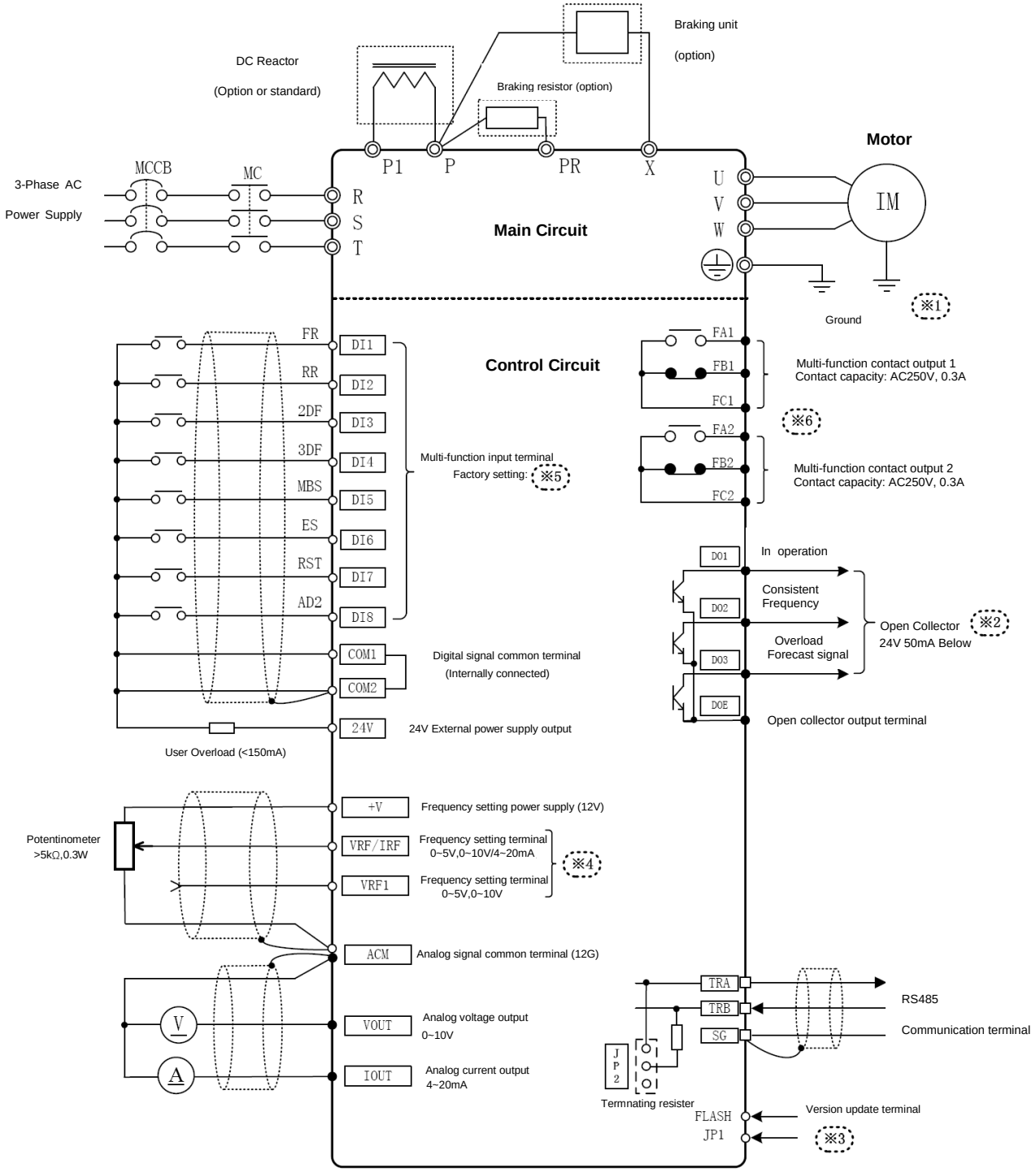
(8) During wiring, please note that the inside of inverter shall be free from chips of wires.

◆ Precautions for control circuit wiring

- Please use shielded wire for analog input, output wire and contact input wire (digital multi-function input terminal).
- In order to prevent interference and malfunction, the signal line and power line should be separated as much as possible during wiring (about 10cm or more).
- When the operation panel is used for operation, it can be realized only through the main circuit wiring. (No need to run from outside or input frequency command).
- Between the power supply and the input terminals, please connect MCCB (circuit breaker) for circuit protection, etc.

- When the protection function of the inverter is activated or other accidents occur, in order to cut off the inverter power supply to prevent further expansion of the fault or accident, please connect the MC (electromagnetic contactor) between the MCCB and the input terminal. In addition, the MC connection position should be as close as possible to the inverter.

4-3 Terminal power connection diagram



Note 1: Ground Inverter and Motor before use

Note 2: The output terminal is a multi-function terminal, it can set various functions through the function code F1509-F1511

Note 3: This is the terminal for version upgrade, please do not connect under normal circumstances

Note 4: Please use function code F1002 for conversion. Also used as input terminal

Note 5: The input terminal is a multi-function terminal, it can set various functions through the function code F1414-F1421

Note 6: 2 groups of independent multi-function contact output terminals, different functions can be set through function codes F1513-F1514

◎ Main circuit terminal

○ Main circuit terminal

● Control circuit output terminal

□ Communication circuit terminal

4-4 Main circuit terminal structure

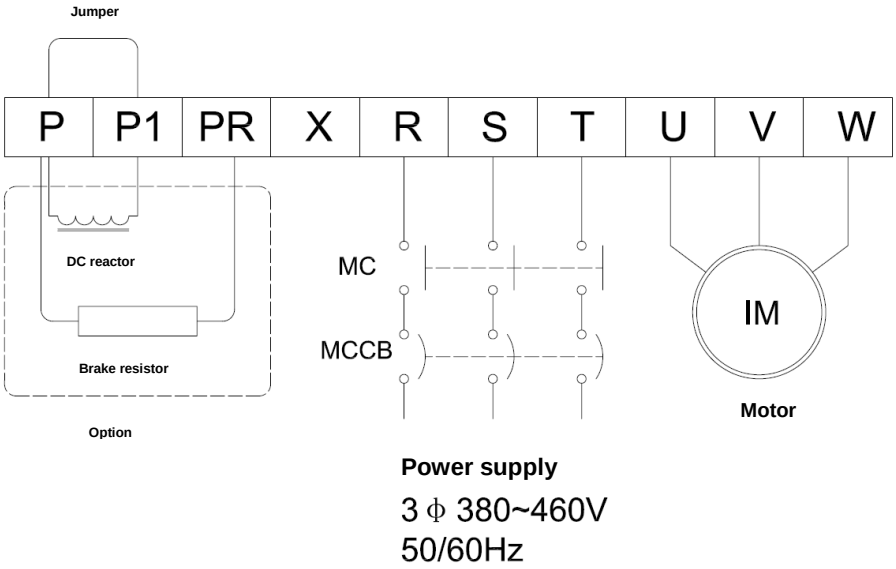
4-4-1 Description of main circuit terminals

Terminal symbol	Name	Description
R, S, T	Power input terminal	Terminal connected 3-phase AC
U, V, W	Inverter output terminal	Terminal connected to three-phase induction motor
P, P1	DC reactor connection terminal	Terminal connected to DC reactor ※**1**
P, PR	Braking resistor connection terminal	Terminal connected to braking resistor between P-PR
P, X	DC side voltage terminal	Terminal connected to braking unit P refers to DC anode, X refers to DC cathode
⏚	Ground terminal	Terminal connected to Earth for the inverter

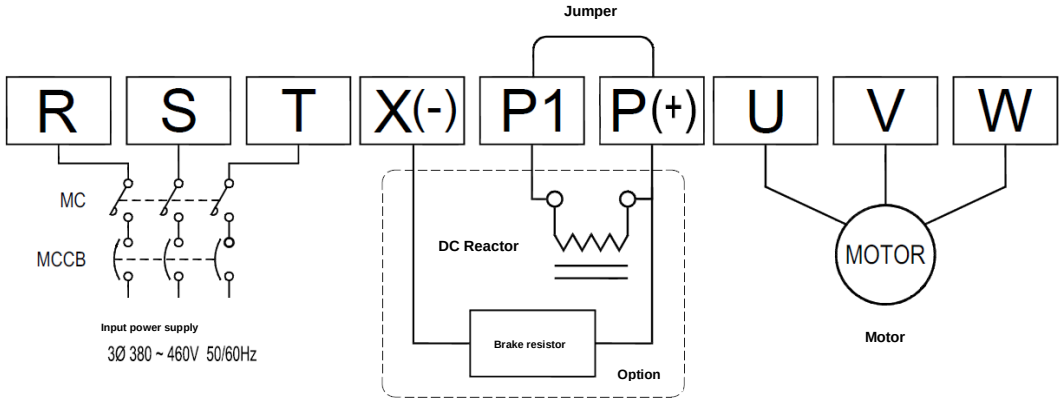
※1 While connecting to DC reactor, please remove connector between P1.P

4-4-2 Main circuit terminal connection diagram

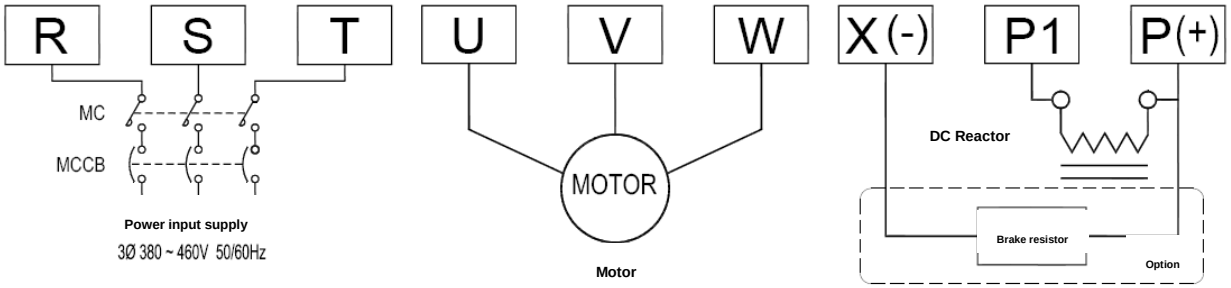
(1) **NS-4A061**



(2) NS-4A076～4A211



(3) NS-4A253～4A590



4-4-3 External braking resistor selection suggestions:

Model	External braking resistor (recommended)		External braking resistor (limit value)	
	Resistance value	Capacity ※1	Resistance value	Capacity ※1
NS-4A061-B**	40Ω above	1500W	32Ω above	1800W

※1 Above braking resistances are selected based on the maximum usage rate 10%ED. If necessary, to set the rate above 10%ED, please expand the braking resistor capacity proportionally. For example: when the rate is set at 20%ED, the capacity should be twice that at 10%ED.

4-4-4 Capacities of MCCB and MC and wire size

Model	MCCB [A]	MC（Electromagnetic contactor）		Main Circuit						
		Rated Current [A]	Rated making current [A]	Recommended wire size [mm^2]				Screw diameter	Tighte-ning torque [N•m]	Max. wire size [mm^2]
				Input wire	P, P1wire	Output wire	ground			
NS-4A061-B**	100	65	100	22（14）	22（14）	22（14）	14	M6	4.5	38
NS-4A076-B**	125	75	135	38（14）	38（14）	38（14）	14			
NS-4A092-B**	150	75	135	38（22）	60（38）	38（22）	22	M8	12.5	60
NS-4A115-B**	175	150	200	60（38）	60（38）	60（38）	22	M8	12.5	60
NS-4A152-B**	225	150	200	60（38）	60（38）	60（38）	22			
NS-4A173-B**	250	150	200	60（38）	100（38）	60（38）	22	M10	24.5	150
NS-4A211-B**	250	180	260	100（60）	150（60）	100（60）	38			
NS-4A253-B**	300	180	260	150（60）	150（100）	150（60）	38	M10	24.5	200
NS-4A304-B**	350	265	350	150（100）	200（100）	150（100）	38			
NS-4A386-B**	450	400	420	200（150）	325（150）	200（150）	38	M12	42	325
NS-4A426-B**	500	600	660	250（150）	325（200）	250（150）	38			
NS-4A472-B**	600	600	660	325（150）	150×2（200）	325（150）	60	M16	100	325
NS-4A540-B**	600	600	660	150×2（200）	250×2（200）	150×2（200）	60	M16	100	-
NS-4A590-B**	700	600	660	200×2（200）	250×2（200）	200×2（200）	60	M16	100	-

Note: The type of main circuit wire is the case of 600V IV vinyl insulated wire (60°C) when the ambient temperature of the inverter is 40°C. The numbers in () are for 600V cross-linked polyethylene wires (90°C). The so-called maximum wire diameter refers to the maximum wire cross-sectional area restricted by the terminal block.

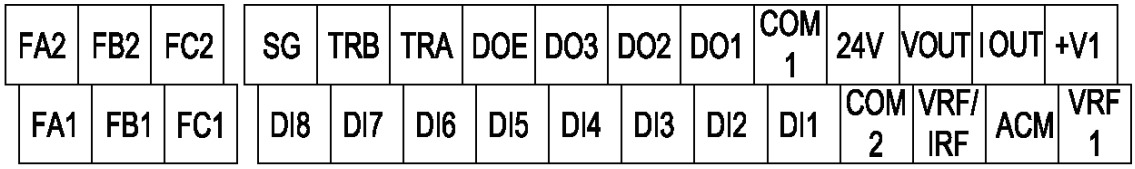
4-5 Composition of Control Circuit Terminals

4-5-1 Wire Size and Terminal Arrangement

Terminal screw diameter：M3
Recommended wire size 0.75 [mm2]
Tigthening torque：0.5[N・m]

※ **The common end of the control circuit terminal must not be grounded to earth.**
※ **COM1/COM2 and ACM must not be used for each other.**
※ **Do not input voltage to the multi-function input terminals (DI1~DI8)**

4-5-2 Functions of Control Circuit Terminals



4-5-3 Functions of control circuit terminal

Type	Terminal symbol	Terminal name	Function Description	Rated Specification
1. Multi function input	COM1 COM2	Digital signal common terminal	Digital input and output signal common terminal and 24V power supply common terminal	Total current consumption: Below 100mA
	DI1 DI2 DI3 DI4 DI5 DI6 DI7 DI8	Digital multi-function input terminal	(1) Various selected functions can be set through function codes F1414～F1421.	Input resistance: about 6.6kΩ When short circuit: about DC3～5mA (1) If any one of COM1 and COM2 is short-circuited, the signal input will be turned on (2) If any one of COM1 and COM2 is disconnected, the signal input will be closed
2. Analog input	ACM	Analog signal common terminal	Analog input and output signal common terminal	Total current consumption: below 100mA
	+V	Analog input potentiometer terminal	Connect a 5kΩ 0.3W or more potentiometer	DC 10～12V ※Except for the potentiometer, other components shall not be connected
	VRF1	Analog voltage input terminal	● Frequency setting through voltage input ● Use voltage input to set the gain frequency corresponding to 5V or 10V. ● When selecting "External analog forward and reverse running", use the external analog to set the gain frequency corresponding to 10V (5+5V) or 0V (5-5V)	Input resistance: About 34kΩ Maximum allowable voltage: DC12V
	VRF /IRF	Analog current/voltage input terminal (Current and voltage input are used together)	● The current/voltage of this channel can be switched separately ● When the frequency setting is selected, the current/voltage input can be selected through the setting content of F1002. ● When setting the frequency through the voltage input, use the voltage input to set the gain frequency corresponding to 5V or 10V. ● When selecting "External analog forward and reverse running", use the external analog to set the gain frequency corresponding to 10V (5+5V) or 0V (5-5V) ● When the frequency is set through the current input, the gain frequency corresponding to 20mA.	When voltage input: Input resistance is about 34kΩ Maximum allowable voltage: DC12V When current input: Input resistance is about 250Ω Maximum allowable current: 30mA

3. Power source	24V	Power Output	● Provide users with DC24V power supply	DC 24V maximum allowable output current 150mA
4. Multi Function Output	DOE	Multi-function output common terminal	● This terminal is a common terminal common to DO1～DO3	Allowable load: DC48V, 50mA
	DO1 DO2 DO3	Multi-function output terminal	● Open collector output ● Send signals through each function selected by the function code	
5. Analog Output	VOUT IOUT	Analog output terminal	● The signal output can be selected and set through F1501～F1506 ● Shared grounding with ACM analog signal	VOUT: Signal output: DC 0～10V Maximum output current: 15mA IOUT: Signal output: 4～20mA Maximum impedance: 250 ohms
6. Communication terminal	TRA	RS485 communication transceiver terminal (+)	● When connecting to the computer with the RS485 communication interface, connect the "+" signal terminal	Communication speed: 1200-57600bps Total length: 500m ※If the switch JP2 is in the ON position, the terminal resistance is connected: 100Ω
	TRB	RS485 communication transceiver terminal (-)	● When connecting to the computer with the RS485 communication interface, connect the "-" signal terminal	
	SG	RS485 communication common terminal	● Common terminal for RS485 communication. ● Connect with SG terminal of communication equipment。	※Select the single-ended grounding on the inverter side or the communication equipment side according to the site conditions
7. Contact Output	FA1 FB1 FC1 FA2 FB2 FC2	Abnormal alarm signal output and multi-function contact output	● This terminal is a contact output terminal that indicates that the device stops due to the protection start of the inverter. ● F1513, F1504: Implement multi-function contact output according to the content set by relay 1, 2 contact output selection.	Contact capacity: AC250V/0.3A When the alarm contact is selected Normal time: FA1,2-FC1,2 open When abnormal: FA1,2-FC1,2 closed
8. Jumper	JP1	Jumper for version update	Short-circuit when the version is updated	※Please do not connect otherwise
	JP2	Communication terminal resistance connection selection jumper	Choose whether to connect 100Ω terminal resistance	When in the OFF position, the terminal resistance is open When in the ON position, the terminal resistance is turned on

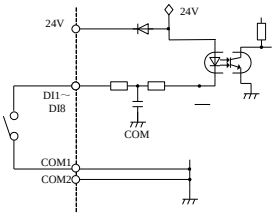
4-5-4 Wiring instructions for control circuit terminals

① Multi-function input terminal

The digital multi-function input terminals of DI1～DI8 can be set to any kind of function, using the function codes F1414～F1421. In addition, the composite terminal can combine several functions in one terminal.

For example, when the function code is set to F1414=13, you only need to connect DI1 terminal to realize inching operation.

Table 4-4 List of multi-function input codes

Function code number	Input terminal name	data range	Initial value (mark)	
F1414	DI1	0～255	1 (FR)	
F1415	DI2		2 (RR)	
F1416	DI3		3 (2DF)	
F1417	DI4		4 (3DF)	
F1418	DI5		5 (MBS)	
F1419	DI6		6 (ES)	
F1420	DI7		7 (RST)	
F1421	DI8		8 (AD2)	

※For details, please refer to the description of input terminal DI1～DI8 selection function.

② Analog input terminal

1) Potentiometer setting frequency

- Analog input has VRF1 voltage input, VRF/IRF voltage or current 2 channels. They can be connected to the potentiometer respectively, the power terminal of the potentiometer is the +V common terminal, and the ground terminal is ACM.
- Please install a 5kΩ potentiometer of 0.3W or more, by selecting function code F1002: set 1 speed frequency and select the frequency setting for current and voltage.
- Please use shielded wire for wiring. Please connect the shielding of the control terminal to the ACM terminal of the shielding terminal, and do not connect the other end.

2) 4～20mA current setting frequency

- Input the external 4-20mA control current through the VRF/IRF terminal and ACM. The direction of the current: flow in from VRF/IRF and flow out from ACM.
- By selecting function code F1002: set 1 speed frequency, select the frequency setting for current and voltage.

③ 24V Power Terminal

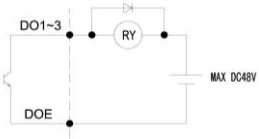
- Provide users with DC24V power supply for connecting encoders, transmitters or sensors, etc. The maximum load current does not exceed 150mA.
- Do not overload or short circuit, otherwise it may cause damage.

④ Multi-function output terminal

- With the function codes F1509～F1511 corresponding to each function, the multi-function output terminals of DO1～DO3 can be set as the open collector output of any function.
- The multi-function output is an open-collector output terminal with a maximum voltage of 48V and a maximum current of 50mA.

When using relays and other components, be sure to install a surge suppressor (diodes in reverse parallel).

Table 4-5 List of multi-function output codes

Function code number	Input terminal name	data range	Initial value (function)※	
F1509	DO1	0～99	1（In operation1）	
F1510	DO2		5（Frequency consistency）	
F1511	DO3		8（Overload forecast）	

※For details, please refer to the DO1～DO3 selection function description.

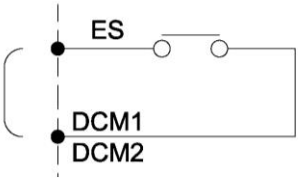
⑤ **RS485 communication terminal**

- Use the RS485 communication terminal block on the main control board below to realize communication control with peripheral equipment.
- JP2 is a switch for ON/OFF (on/off) terminal resistance. Please only set the switch of the terminal resistance of the farthest inverter to ON. (Factory setting=OFF: terminal resistance OPEN).

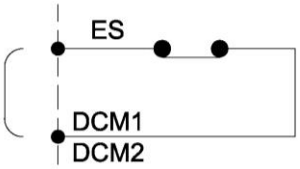
⑥ **Contact output terminal**

1) Emergency stop (multi-function input ES terminal) signal mode switching

- The signal switching method when the multi-function input terminal is selected as the external emergency stop command (ES) is as follows.
- The switching of signal action is realized by function code F1413: ES input terminal function.



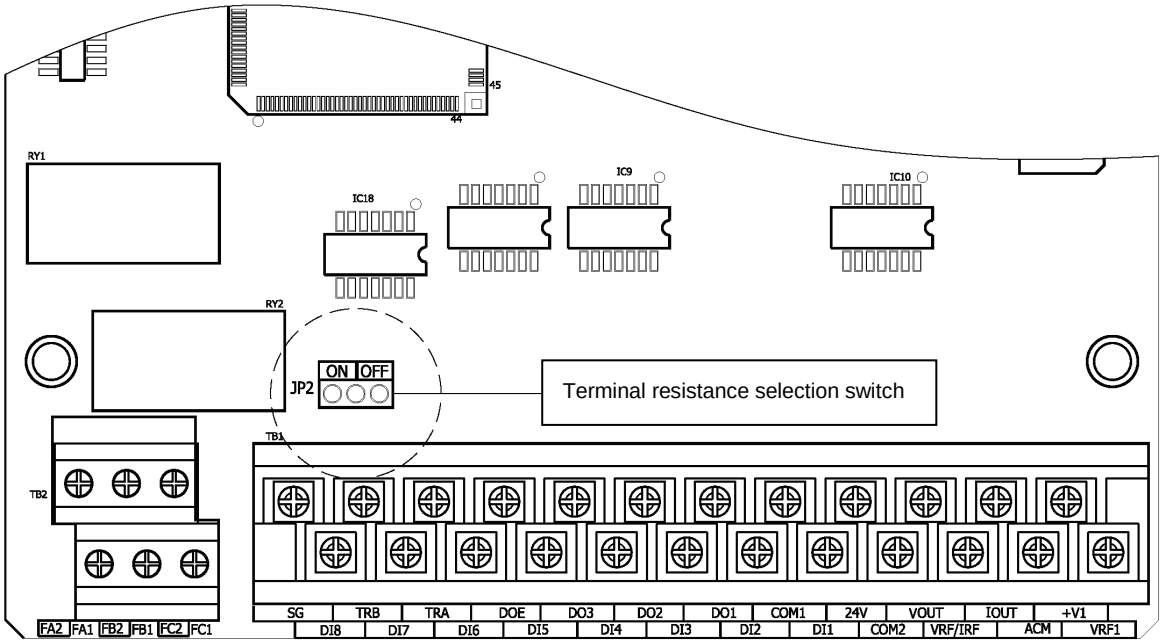
When inputting "normally OPEN" signal: F1413=2



When inputting "normally CLOSED" signal: F1413=2

⑦ **Jumper(JP2 communication terminal resistance connection selection jumper)**

- When several inverters are communicating, the JP2 is in the ON position, the terminal resistance is connected at this time, the factory setting is OFF



4-6 Installation Option and wiring

4-6-1 Overview of optional board

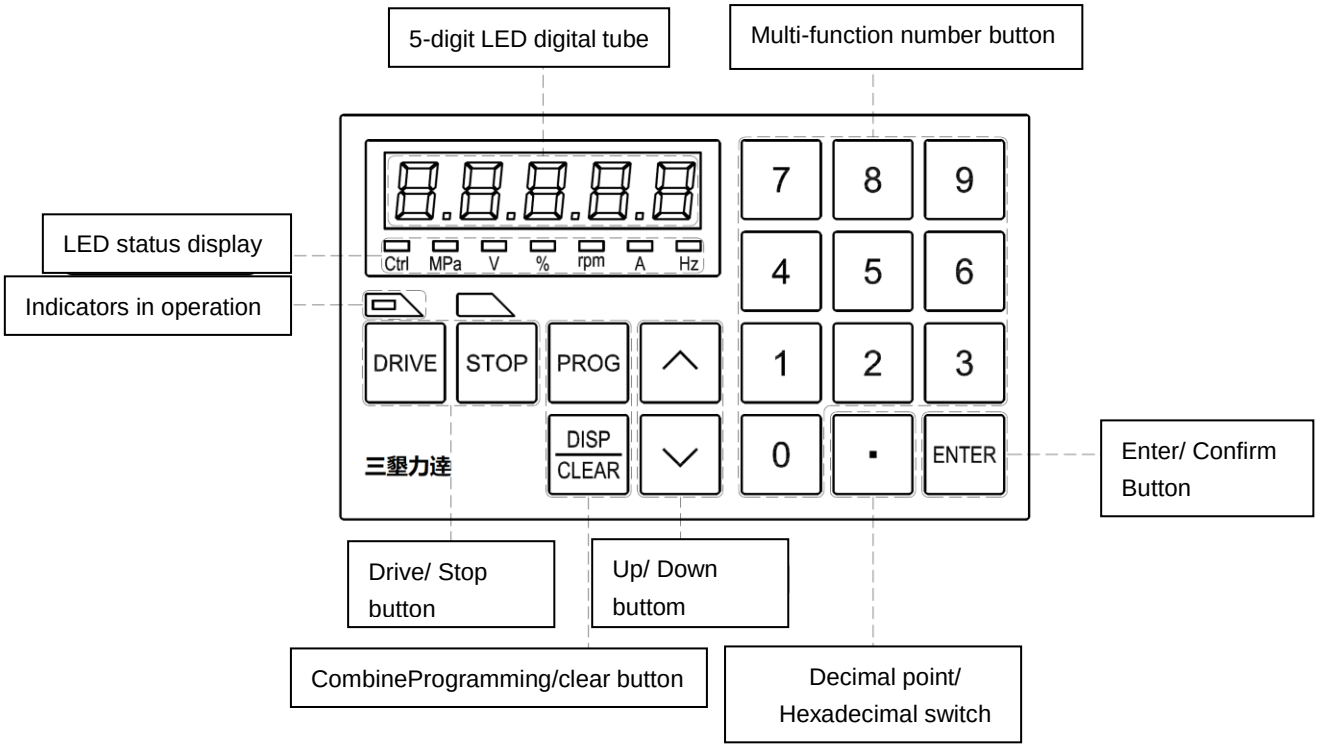
- Please consult the seller

4-6-2 How to install option board

- Please consult our seller

5. Operation panel

5-1 Names and functions of each part of the operation panel



In order to facilitate the operation, this series is equipped with a digital key operation panel as standard, which brings you the following convenience and speed:

- The numeric keyboard with decimal 0-9 digital input and even 0-F hexadecimal digital input function can easily directly input parameter codes, change parameter settings, set and change the operating frequency.
- The 5-digit 7-segment LED digital tube can clearly display the current operating frequency, output current, speed, Load rate, output voltage, pressure value, non-unit display value, set value and alarm content by switching the DISP key.
- The LED status display light can directly indicate the content and unit displayed by the 7-segment digital tube through the on/off/flashing state, such as: frequency (Hz), output current (A), speed (Rpm), load rate (%)), output voltage (V), pressure value (MPa).
- There is also a control indicator (Ctrl), which displays the status of external terminal operation setting/operation setting other than external terminals.
- The running indicator located above the [DRIVE] button, turns on/off to indicate running/stop status, or blinks to indicate standby/deceleration/DC braking status.
- Independently set DRIVE/STOP buttons allow easier operations of RUN and STOP.
- Independently set UP/DOWN buttons allow to adjust frequency or to modify codes through

5-2 Key description of the operation panel

Button name	Button symbol	Function overview	Mentioned in this manual
Run button	DRIVE	● Start forward/reverse rotation	【DRIVE】
Stop button	STOP	● stop running ● In case of alarm, it can be used to clear the alarm	【STOP】
Programming button	PROG	● In the status display mode, switch the status display mode to the function code display mode ● In function code display mode, return to the menu state of the previous page	【PROG】
Clear/Display switching	DISP CLEAR	● In the status display mode, switch the display content of the 7-segment monitor ● In the function code display mode, the entered content can be eliminated	【CLEAR/DISP】
UP button	∧	● Frequency increase operation in status display mode ● Code ascending operation in function code display mode ● Input as "+" sign when input with sign ● Confirmation when setting some codes	【UP】
DOWN button	∨	● Frequency reduction operation in status display mode ● Code down operation in function code display mode ● Input as "-" sign when inputting with sign	【DOWN】
Number button (0-9)	6	● In the status display mode, you can directly enter the set frequency ● Code data can be directly input in function code display mode	【0-9】
Decimal button	.	● Enter the decimal point ● Combine with the number keys to input hexadecimal code A-F	【DOT】
Enter/ confirm button	ENTER	● Confirmation when inputting the value on the 7-segment digital display into the host	【ENTER】

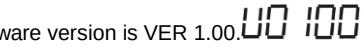
5-3 Operation panel display mode

■ The 7-segment digital display on the operation panel is divided into two modes: [Status Display] and [Function Code Display], which can be switched through the [PROG] key.

Display mode	Display content
Status Display	State of the inverter during operation and stop <frequency> <output current> <speed> <load rate> <output voltage> <pressure value> <no unit>
Function code display	Code number and data For example: Press【PROG】key, display F and input "1202" Display code F1202 (selection of status display content) Press【ENTER】to view the code Display 1 (default value without unit display) Input options via numeric keys: for example, "2" (output voltage) After the setting is completed, the panel will display the output voltage by default

The status display mode can perform status monitoring, alarm display, output frequency setting of the inverter, and operation and stop of the inverter.

5-3-1 Version display

After the equipment is electrified, the main screen shows the software version of the inverter host. Below shows an example of display when the host software version is VER 1.00. 

When the machine is electrified and powered on, but the host computer and the operation panel cannot communicate, the 7-segment monitor will display the software version of the operation panel. And display PXXXX

5-3-2 Status mode of the inverter

Display the status mode of the inverter.

In the operation mode display, the various states of the inverter's operation and stop are displayed.

Table 5-2 Contents of operation mode display

Running state	Display content
Stopping	● Operation indicator
Operating	○ Operation indicator
From forward rotation to deceleration to stop、Waiting for forward operation From reverse rotation to deceleration to stop, Waiting for reverse operation, DC braking	◐ Operation indicator
Frequency locked	○ Operation indicator
Position control operation (zero servo operation)	◐ Operation indicator

○ Light on ◐ Flashing ● Lights off

Monitor mode display refers to the content displayed on the 7-segment monitor

Table 5-3 Content display of monitor mode

Display content	Unit	Display content	7-Segment monitor display
Frequency	Hz	○Hz ●A ●rpm ●% ●V ●MPa	During operation: the light indicates the output frequency Stopping: flashing indicates the set frequency
Output current	A	●Hz ○A ●rpm ●% ●V ●MPa	During operation: the light indicates the output current Stopping: flashing means 0.0
Rotating speed	rpm	●Hz ●A ○rpm ●% ●V ●MPa	During operation: the light is on to indicate the speed（※1） Stopping: flashing indicates speed（※1）
Load rate	%	●Hz ●A ●rpm ○% ●V ●MPa	During operation: the light shows the load rate Stopping: flashing 0.0
Output voltage	V	●Hz ●A ●rpm ●% ○V ●MPa	During operation: the light indicates the output voltage Stopping: flashing 0.0
Pressure value (optional)	MPa	●Hz ●A ●rpm ●% ●V ○MPa	During operation: the light shows the pressure value Stopping: flashing 0.0
Status monitor display (No unit indication)	-	●Hz ●A ●rpm ●% ●V ●MPa	During operation: lights up to indicate the value selected by F1202 Stopping: flashing indicates the value selected by F1202

○ Light on ◐ Flashing ● Lights off

※1 Due to the different motor control modes, the display content is also somewhat different. Specific display content, as shown in Table 5-4

Table 5-4 Speed display content

Motor control mode	In operation	Stopping
Sensorless vector control	Estimated speed of the motor	0
Other （V/f, Vector）	-	-

When the inverter's status is monitored and displayed, every time you press the [CLEAR/DISP] key, you can switch the display content of the 7-segment monitor once. The display content of the 7-segment monitor can also be switched by function codes. For details, please refer to the function code F1201 in [7-3 Description of Various Functions].

※ Regarding the operation command from the external terminal/communication command, please refer to the function code F1101 in [7-3 Description of Various Functions] for details.

※ By setting the function code of the inverter, at times function may not be functioning properly.

5-3-3 Alarm display

When the alarm stops, the 7-segment monitor on the inverter will display the type of alarm. At this time, the monitoring mode shows that all the LEDs are flashing. As for the details of the alarm display, please refer to [8-4 Alarm Status]

Content display	Monitor mode display	7-segment monitor display
Alarm display	◐Hz ◐A ◐rpm ◐% ◐ V ◐ MPa	The light is on to indicate the type of alarm

○ Light on ◐ flashing ● lights off

※ During the alarm display process, even if the [CLEAR/DISP] key is operated, the display on the 7-segment monitor cannot be switched.

※ During the alarm display process, you can switch to the function code display mode by operating the [PROG] key.

5-3-4 Frequency input

Use the number keys, [UP]/[DOWN] and [ENTER] keys to input the set frequency to the inverter. There are two setting methods.

(1) Frequency setting A

- Press the numeric keyboard to modify the frequency you want to set, and then press the [ENTER] key to confirm. This is the method of frequency setting A.
- It is an effective setting method when setting the desired frequency.
- In the frequency setting process, it can be eliminated.
- The method of frequency setting A can be used when the equipment is running or stopping when the status monitoring is displayed.
- This method cannot be used when the alarm is displayed.

Operation example: Change from 5Hz to 50Hz

Operate	Display	Description
	500 or 500	Display status monitoring (frequency display)
【5】	5	The entered value will be displayed in the rightmost digit (※1)
【0】	50	Each time you press the number key, the displayed data will move one place to the left. (※1)
【ENTER】（press）	50.00 or 50.00	Press the key and the set value will be saved as the new frequency value. The interface returns to the status monitor display mode. If it is running, the output frequency will start to change to the new set value.

50.00 light on、50.00: Flashing

※1 When there is no need to set the frequency, you can return to the status monitoring display mode by operating the [CLEAR/DISP] key.

(1) Frequency setting B

- Frequency setting B is a method to change the frequency by pressing 【UP】/【DOWN】 each time.
  - This is an effective setting method for fine-tuning the set frequency while observing the load condition.
  - This method can be used in the state monitoring display, even if the equipment is in the process of running or stopping。
- When the alarm is displayed, it cannot be used.

Operation example: Change the frequency from 5Hz to 50Hz

Operate	Display	Description
	500 or 500	Display status monitoring (frequency display)
【UP】/【DOWN】	500 ⇒ 501 ⇒ 502 ⇒…	Press【UP】/【DOWN】, the display will increase or decrease, and the changed frequency will be immediately saved as the new frequency setting value, and when the equipment is in operation, its output frequency will begin to change to the new setting value.

50.00 Lights on、50.00: flashing

The function code display mode can be used to set various functions of the inverter.

5-4 Basic operation

5-4-1 Set function code

Basic operations are used to change the value of the function code.

Operation example: when setting F1414=10

Operation	Display	Description
	50.00 or 50.00	Display status monitoring (frequency display)
【PROG】	F_ _ _ _	Press【PROG】key to display the function code input interface
Number input button 【1】【4】【1】【4】	F 1401	Enter the target function code, or use【UP】/【DOWN】to adjust the current input
Press【ENTER】	1	Press【ENTER】key to display the set value of function code
【UP】/【DOWN】or number button【1】【0】	10	Press【UP】/【DOWN】, or press the number keys to set the desired value (※1)
【ENTER】	F 14 14	Press [ENTER] or [PROG] key, the new setting is confirmed, and the display returns to the function code selection. (※2)
【CLEAR/DISP】	F_ _ _ _	Press the [CLEAR/DISP] key, the display will return to the function code input interface
【PROG】	50.00 or 50.00	Press the【PROG】key, the display will return to the state monitoring mode

※1 Use【UP】/【DOWN】to accurately index the value that can be set to ensure that the input value is valid, but not when using the numeric keys.

※2 When there is no need to set a new value, you can use the [PROG] key to return the display to the status monitoring mode.

5-4-2 Operation Confirmation

For some function codes, in order to prevent the phenomenon of data rewriting due to misoperation, it is necessary to reconfirm the operation.

Operation example: when setting F1001=10

Operation	Dsiplay	Description
	50.00 or 50.00	Display status monitoring (frequency display)
【PROG】	F_ _ _ _	Press【PROG】key to display the function code input interface
Number input button 【1】【0】【0】【1】	F 1001	Enter the target function code, or use【UP】/【DOWN】to adjust the current input
【ENTER】	1	Press the [ENTER] button, the display shows the set value of the function code.
【UP】/【DOWN】or number button【1】【0】	10	Modifying the new setting value, will render the decimal point button invalid
【ENTER】	10 rEAdY	Press the [ENTER] key, the set value and will be displayed alternately rEAdY , prompting that the set value is being confirmed (※1)
【UP】	F 1001	Press [UP] again, the new setting is confirmed, and the display returns to the function code selection interface. (※2)
【CLEAR/DISP】	F_ _ _ _	Press [CLEAR/DISP] button, the display returns to the function block selection interface
【PROG】	50.00 or 50.00	After Pressing the【PROG】button, the display returns to the state monitoring mode interface

※1 During the alternate display period, if you want to interrupt the input due to an operation error, you can press the [CLEAR/DISP] key to return the display to the function code selection state.

※2 Press【PROG】key to directly return to the status monitoring interface.

5-4-3 Sign Operation

For some function codes, the sign (polarity) can be included for setting.

Operation example: when setting F1503=-5.0

Operation	Display	Description
	50.00 or 50.00	Display status monitoring (frequency display)
【PROG】	F____	Press【PROG】key to display the function code input interface
Number input button 【1】【5】【0】【3】	F 1503	Enter the target function code, or use【UP】/【DOWN】 to adjust the current input
【ENTER】	00	Press [ENTER] or [PROG], the display shows the set value of the function code.
Number button input 【5】 【DOT】【0】 【DOWN】	-50	Modify the new set value,【DOWN】key is the symbol switch (※1)
【ENTER】	F 1503	Press [ENTER], the new setting will be confirmed, and the display returns to the function code selection interface. (※2)
【CLEAR/DISP】	F____	Press [CLEAR/DISP] button and the display return to the function code input interface
【PROG】	50.00 or 50.00	Press the【PROG】button and the display returns to the state monitoring mode interface

※ 1 When you need to return to the function code selection interface, please press the [CLEAR/DISP] key. At this time, the set value is cleared and will not be saved.

※ 2 Press【PROG】key to return to status monitoring mode.

5-5 Special Function

5-5-1 Copy function operation

The so-called copy function is the function which transfers the function code data to other inverters after transferring the function code data from one inverter side to the operation panel.

The copy function is an effective function where several inverters need to be set with the same function code data.

Only 1 inverter is set, while other inverters can also receive the same function code data, thus the same function code setting can be easily implemented.

※The copy function can be implemented only when the inverter stops working. Therefore, this operation shall be carried out after the inverter has been stopped.

Operation example: copying from the inverter to the operation panel

Operation	Display	Description
	F 1601	Select function code F1601 (copy function)
【ENTER】	0	Press the (ENTER) button, then the set value of function code will be displayed.
【UP】/【DOWN】 or number butto【1】	1	select 1 When F1601 = 1, the current value of the function code data will be transferred to the operation panel
【ENTER】	rEAdY	Waiting for confirmation
【UP】		COPY flashes on the 7-segment monitor, and data will start to transfer
After transfer is completed	F 1601	After the transmission is over, the display will return to the function code selection interface

For detailed function description and operation methods, please refer to the content of function code F1601 in [7-3 Description of Various Functions].

5-5-2 Modified code display

Considering current function code data may be different from the factory presets of product or the user's initial value, the function for displaying a changed function code and its data.

This is an effective function for inquiring the difference between current function code and product ‘s factory preset or the user initial value.

Confirmation of maintenance and other function codes can be easily achieved by this function.

Operation example: displaying difference with product ‘s factory preset data

Operation	Display	Description
	F 1602	Select function code F1602 (changed code display function)
【ENTER】	0	Press 【ENTER】button，then the set value of function code will be displayed.
【UP】/【DOWN】or number button	1	Press【UP】/【DOWN】or number button，select 1 If F1602 = 1, the current function code data will be compared with the factory preset function code data.
【ENTER】	Find	Press【ENTER】button，to start searching the number of a function code which has been changed and is different from the factory preset function code data. While the function is searching, a flashing Find will be displayed on
After searching	FXXXX or End	After searching, the changed function code starts flashing on display screen. If there is no changed function code, a flashing End will be displayed on screen.
【UP】/【DOWN】	FXXXX or End	If there are more than one changed function codes, they can be switched by adjusting the quick knob.
【ENTER】	XXXXX	Press【ENTER】button，then the set value of function code will be displayed flashing.
【CLEAR/DISP】	FXXXX	Press【CLEAR/DISP】button to return to the changed function code (flashing display state).
【CLEAR/DISP】	F 1602	Press【CLEAR/DISP】button，to return to function code selection interface.

See the contents of function code F1602 in [7-3 Description of Functions] for detailed description of the function and its operation method.

5-5-3 Function Code Initialization Operation

The inverter ‘s function code settings can be returned to factory presets through this function.

Inverter ‘s initial value can be set to the factory preset or the data determined by the user (i.e. user ‘s initial value).

Also, the initial value can be selected between the factory presets and the user ‘s initial value. By setting the user ‘s initial value, the function code data can be initialized to the user ‘s initial value even if it is overwritten for some reason, allowing for resetting the function code within a minimum range.

Operation example: recovering to the factory presets

Operation	Display	Description
	F 1604	Select function code F1604 (data initialization)
【ENTER】	0	Press【ENTER】button，then the set value of function code will be displayed.
【UP】/【DOWN】or number button	1	Press【UP】/【DOWN】or number button，select 1 If F1604 = 1, all the function code data will recover to the factory presets
【ENTER】	1 rEAdy	Press【ENTER】button，then set value and rEAdy wil be alternately displayed, suggesting that the settings is being confirmed（※1）
【UP】	init	Press【UP】，to start initialization of the function code. During initialization, a flashing init，will be displayed on 7-segment monitor
After initialization	F 1604	When initialization is completed, the interface will return to function code selection.

※1： In the alternate display，if an operation error occurs and it is hoped to interrupt input，you can press 【CLEAR/DISP】button，to make the interface return to the state of function code selection.

See the contents of function code F1604 in [7-3 Description of Functions] for detailed description of the function and its operation method

5-5-4 Alarm Contents Reading Operation

Alarm history record display is a function for displaying alarms occurred in the past.

The latest 5 alarms will be recorded. If a new alarm occurs, then the 1st alarm will be deleted.

Operation example: reading alarm contents

Operation	Display	Description
	F 1805	Select function code F1805 (Reading alarm data)
【ENTER】	0	Press【ENTER】button, then the set value of function code will be displayed.
【UP】/【DOWN】or number button	1	Select 1 then if F1805=1 the alarm contents will be read
【ENTER】	1 XXXXX or End	Press【ENTER】button, to execute the alarm reading function. Alarm history record number and alarm contents XXXXX are alternately displayed and End will be displayed if there is no alarm record.
【UP】/【DOWN】	2 XXXXX or End	Press【UP】/【DOWN】, the alarm displayed will be shifted continually. In alarm history record, the alarm with the smallest number is the latest alarm.
【PROG】	F 1805	Press【PROG】, The interface returns to the function code selection

5–5–5 Alarm Status Confirmation Operation

Alarm status confirmation is a function for displaying the inverter ‘s status when an alarm occurs.

It can be used to confirm the latest 5 alarm statuses through function codes F1806 - F1810. If a new alarm occurs, then the 1st alarm will be deleted. F1806 is the latest alarm, while the F1810 is the 1st alarm.

Operation example: Confirming the inverter status when the latest alarm occurs

Operation	Display	Description
	F 1806	Select function code F1806 (alarm status confirmation)
【ENTER】or【PROG】	ALtyP YYYYY or End	Press【ENTER】or【PROG】then the alarm name YYYYY and ALtyP Indicating display of [alarm name] will be displayed alternately. The End will be displayed if the alarm status is not recorded.
【UP】/【DOWN】	XXXXX YYYYY or End	After the alarm has been stored, press【UP】/【DOWN】, to switch the contents displayed. Now, the detonation XXXXX（※1）and the value YYYYY（※2）when alarm occurred will be displayed
【PROG】	F 1806	Press【PROG】key, the interface will return to function code selection

If the function code is set to F1805 = 9, alarm records will be eliminated. At this time, all the alarm records from F1806 to F1810 will be deleted.

※1： The denotations are shown in the table below

Denotation	Meaning	Unit
ALtyP	Alarm name	-
FrE	Output frequency	Hz
ioUt	Output current	A
uoUt	Output voltage	V
udC	DC voltage	V
P	Output power	kW
t	Heat sink temperature	℃

※2：The value displayed indicates the inverter status before occurrence of an alarm. Therefore, if an alarm is caused by transient over-current or over-voltage, the stored value is somewhat different from the current value or voltage value at the occurrence of the alarm (factors causing alarm).

5-5-6 7-Segment Monitor Display List

Monitor display	Description
in it	During initialization, the data is displayed flashing.
in ity	During initialization of user data, the data is displayed flashing.
dEC id	During confirmation of user data, the data is displayed flashing.
rEAdy	The detonation indicates the need for reconfirmation operation using function code
F ind	It is displayed flashing during search of the function code, of which the user data is discrepant from default settings.
SEnd	It is displayed flashing during transfer of the host function code data to operation panel.
rEAd	It is displayed flashing during transfer of the operation panel function code data to host.
End	It is displayed flashing when the desired data can not be found through the function code search and alarm history record.
tUnE	Indicates auto tuning
2Ero	Indicates zero speed running (in position control mode or zero-servo running).

※In addition to the above, alarms, warnings, errors etc. are also displayed on 7-segment monitor. See Chapter 8 for details of these contents.

6.Operation

6-1 Operation Steps

The following flowchart shows all the operation steps before and after operation of the inverter.

Please follow the following flow chart to carry out test run.

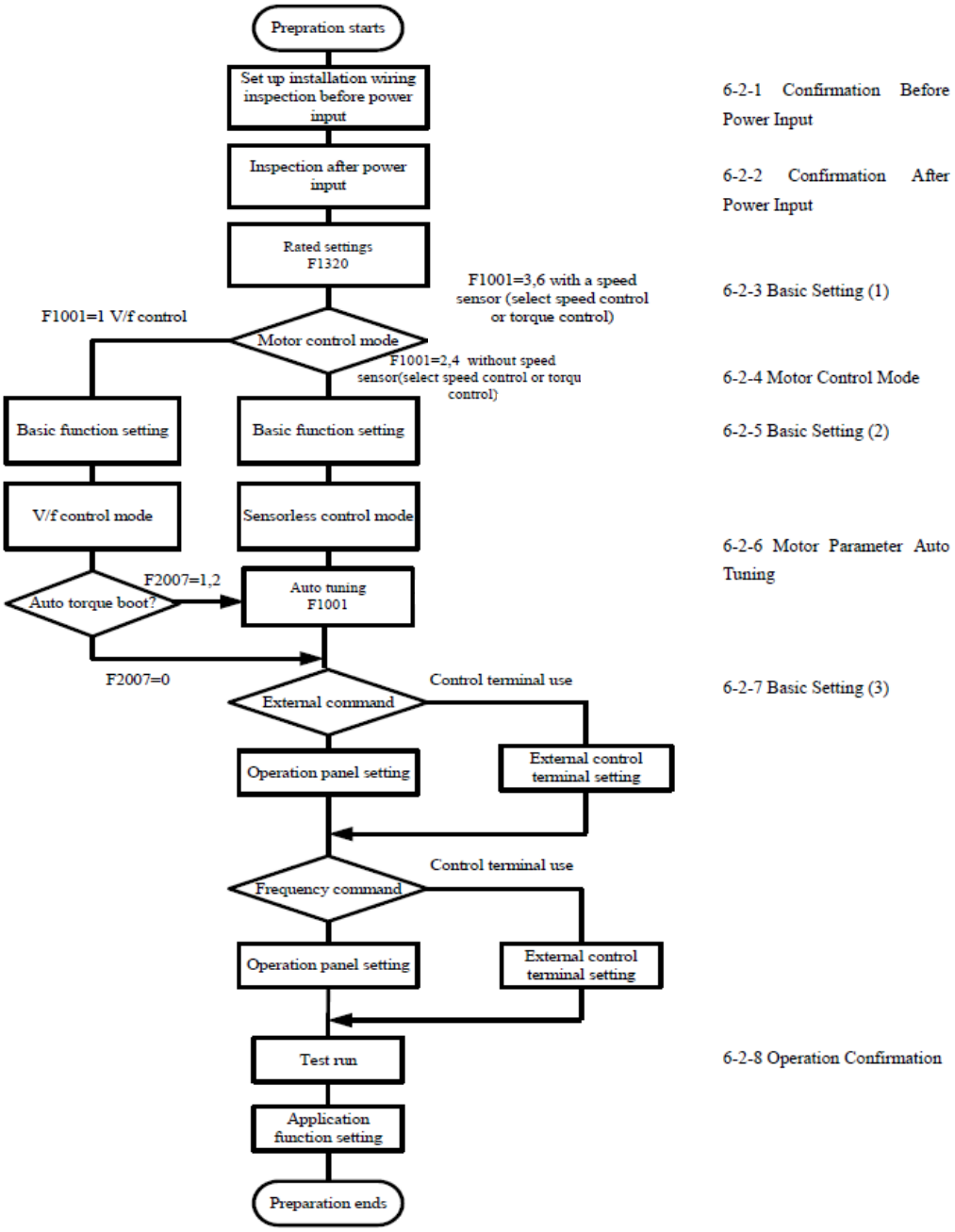


Figure 6-1 Operation step flow

6-2 Test run

6-2-1 Confirmation before power input

Please check the following items after installation wiring and other works and before power-on.

Table 6-1 Confirmation items before power input

Item	Content
Power supply voltage confirmation	● If the power supply voltage coincides with the inverter 's capacity and voltage.
Main wiring confirmation	● If the connection of input wirings R, S and T is correct. ● If the connection of output wirings U, V and W with the motor 's U, V and W is correct. ● If grounding of the ground terminals of inverter and motor is reliable. ● If there is any place where short-circuit is caused by wiring debris. ● If there is any loose screw or connection terminal. ● If there is any short-circuit or grounding place in output end or sequence circuit.
Control wiring confirmation	● If wiring of control terminals is correct. ● If the control signal is in OFF (disconnected) state.

6-2-2 Confirmation After Power Input

If it is confirmed that there is no problem before the power supply input, connect to the power supply. And then check the following:

Table 6-2 Confirmation items after power input

Item	Content
Status of operation panel	After the display of software version, When the LED panel displays "  " Stopped state, and 7-segment monitor shows all the digits represent of numerical values are flashing, indicating the equipment is stopped.
Fan drive status	If the cooling fan at the top of inverter host is in stopped state. (Note) Do not drive the fan immediately after power input. Because it is subject to temperature control, if the designated temperature is exceeded, the fan will run. * Setting the function code F1318 (Cooling fan ON/OFF control) =1 will make the fan ON all the time, i.e., the fan will fun all the time.

6-2-3 Basic Setting (1)

Carry out setting after the basic operation settings have been confirmed. The selection of rated values can be made by switching through the following function code.

Table 6-3 Basic function (1)

Function code	Name		Overload capacity	Maximum frequency	Remarks
F1320	Rating selection	1：Mode A （Heavy overload）	150%1min	400Hz	Used for setting the rated values of inverter
		2：Mode B （Light overload）	120%1 min	240Hz	

If the function code is set to 2, but the overload capacity is reduced even though the value has increased by one. See Standard Specifications in Chapter 11 for details.

6-2-4 Motor Control Setting

Please refer to the function code F1001 to set the desired motor control mode as the inverter has all the motor control modes shown in the following table.

Table 6-4 Motor control mode

Function code F1001	Control mode	Speed sensor Yes/No	Basci control mode	Remarks
1	V/f control	No	V/f control	Torque boost
2	Speed control		Vector control	
40	V•f separation control		V/f control	

Table 6-5 Auto torque boost

Function code	Name	Setting content	Remarks
F2007	Auto torque boost selection	0: No 1: Voltage compensation 2: Slip compensation	

(1) V/f control

The set V (voltage) / f (frequency) is a constant control output for making the motor operate.

(2) Sensorless control (speed, torque)

The so-called speed sensorless control mode is a mode that controls always at a constant speed no matter what the state

of the load is, and a control mode that can generate high torque at a low frequency range.

(3) V•f separation control

A function which can set the inverter ‘s output voltage independently. This control mode is also a V/f control mode. According to V•f separation selection, its separation mode can be divided into two modes: complete separation and V•f Separate control.

(4) Sensor control (speed, torque and position)

By feeding back the pulse signal sent by pulse generator (PG) from the motor to inverter, the motor ‘s position and speed can be measured. This enables high-precision speed control, torque control and position control.

(5) Auto torque boost control

The inverter is provided with voltage compensation function and slip compensation function. The former is used for auto-regulating the inverter output voltage, while the latter is used for slip frequency compensation based on the load.

Use F2007 to select the above functions.

6-2-5 Basic Setting (2)

Please follow the operation steps to set the following function codes.

Table 6-6 Basic function (2)

Function code	Name	Content	Remarks
F1005	Base voltage	200Vclass 0：no AVR,50～240V	Please check the rated voltage
		400V class 0：no AVR,50～460V	
F1006	Base frequency	0.1～400Hz	
F1007	Upper frequency limit	5～400Hz	
F1009	Carrier frequency adjustment	0～130	
F1101	Operation command selection	1. Operation Panel 2. External terminal 3. Communication	
F1110	Direction of motor rotation (Operation panel)	1: Forward, 2: Reverse	
F1701	Output current limiting function	Mode A (heavy overload) 0: null 50-200 Mode B (light overload) 0: null 50-150	
F1702	Electric thermal setting	0: Null 20-105%	

Please confirm the factory presets which can be set again only when the need for change really exists.

6-2-6 Motor Parameter Auto Tuning

The so-called auto tuning mode is a function which automatically measures the parameters of the connected motor which will be stored to the inverter ‘s memory. This function is a useful function when it is hoped to implement vector control and auto torque control with the motor parameters not fully known. It is also a useful function when it is hoped to implement speed control and torque control if the distance between the inverter and motor is more than 30m.

<For F1001=10, 11 (Motor parameter auto tuning)> The auto tuning function has two modes for selection.

Table 6-7 Auto tuning mode

Function Code F1001	Function	Motor Parameters	Remarks
10	Auto tuning mode 1: Measure when the motor shaft is fixed	Primary resistance R1 Secondary resistance R2 Leakage inductance l Excitation inductance M	For cases where the motor can not operate
11	Auto tuning mode 2: Measure when the motor is operating	Primary resistance R1 Secondary resistance R2 Self-inductance L Excitation current I.	For cases where the motor can operate

Before setting the above auto tuning, set the following function codes in order.

Table 6-8 Auto tuning setting

Function Code	Content	Settings	Remarks
F5001	Motor poles, voltage and capacity	XYZZZ X: Polarity, Y: Rated voltage Z: Motor capacity	See below for details Express. ※1
F5002	Motor current rating	30 - 110% of the inverter current rating (0.1A stepping)	
F5003	Motor frequency rating	10～400Hz	
F5004	Motor speed rating	0 - 24000 rpm (1rpm stepping)	
F5005	Motor insulation type	1: Type A 2: Type E 3: Type B 4: Type F 5: Type H	
F5006	The motor ‘s rated voltage during auto tuning of motor parameters	0: Use function code F5001 Selected voltage 100 - 460 (the voltage of F5001 is inactive)	
F5007	Rated motor slip ratio	0～50%	

*If motor parameters are known, please enter the parameters into the following function codes.

F5009 Motor stator resistance [Ω or m Ω]

F5010 Motor rotator resistance [Ω or m Ω]

F5011 Motor stator inductance [mH]

F5012 Motor rotator inductance [mH]

F5013 Motor mutual inductance [mH]

F5014 Motor excitation current [A]

F5015 Motor inertia moment [kgm2]

F5016 Load inertia moment ratio

[Motor parameter auto tuning steps]

(1) Setting of motor ratings

Set all the motor ratings into function codes F5001-F5005 correctly

- Please press【PROG】button，for function code display.
- Through the number button, select F5001。
- Please press【ENTER】（setting）button for input value。
- After input，Press【ENTER】（setting）button again for confirmation.

Set function codes F5002 - F5005 in order in the same way.

① F5001 Motor poles, voltage and capacity

- The configurable values and contents denoted are as follows.

1) Number of poles: 2 - 8 (4 types).

2	4	6	8

2) Rated voltage: the setting range of rated voltage is denoted by serial numbers. Unit: [V].

Display number.	1	2	3	4	5	6	7	8
Rated corresponding voltage	200	220	230	380	400	415	440	460

3) Motor capacitor: the setting range of motor capacitor is denoted as follows. Unit: [kW].

22. 0	30. 0	37. 0	45. 0	55. 0	75. 0	90. 0
110. 0	132. 0	160. 0	185. 0	200. 0	220. 0	

The symbol △ indicates a space.

Example) When using a motor of 4 poles, 380V, 30kW, the 7-segment monitor displays the following:

44 30

Operation example) in case where a motor of 4 poles, 400V, 30kW is used, operation for changing the rated voltage is as follows:

44 30 → 44 30 → 45 30

Note: During vector control and auto torque boost control, standard values of various control constants necessary for inverter control needs to be obtained from the settings of the function code, thus please make correct setting according to the motor used. In addition, the basic range of configurable value for vector control is shown as follows. Please consult separately about use of other specifications for vector control. Number of poles: 2, 4, 6. Rated voltage: three or less for 200V class inverters, while four or more for 400V class inverters

Motor capacity: If the motor does not have a capacity equal to or one level lower than the inverter,

(Only 8 pole motors, 3 levels lower motor can be chosen.)

Exxxx Or Er C may be displayed

② Setting of F5002 − F5005

- Set rated current, frequency, speed and insulation type of the connected motor. Under normal circumstances, please set according to the motor ratings. If the value set is incorrect, the motor parameters auto tuning results and the control characteristics of torque control will become adverse.

Note 1): The settings are interdependent with the settings of motor poles, voltage and capacity (F5001). Therefore, if F5001 is changed, then function codes F5002 - F5005, F5009 - F5015 which are associated with the motor parameters will be automatically set with the settings of F5001 as the standard values.

Note 2): These settings can not be used in V/f control mode.

Note 3): The special motors shall be set according to F5006 Special Motor Voltage Rating.

(2) The setting of motor parameter auto tuning mode

Set the auto tuning modes 1 and 2 through F1001 (F1001 = 10 and F1001 = 11). (Check the status of mechanical system).

- Press【PROG】button，for display function code.
- Use the number buttons to select F1001
- Press【ENTER】（setting）button，please input the value, after inputting, press [ENTER] (set) value to confirm

(3) Auto tuning starts

Auto tuning will begin if the operation signal is input, and the operation panel displays "TUNE" during this process and returns to —Stopped‖ display upon completion of the process. In addition, in auto tuning mode 2, operation starts in the rotation direction of operation signals until the motor frequency rating (F5003) is reached, and then operation will continue within 50% of the motor frequency rating.

Press 【DRIVE】button to start the auto tuning.

(4) Motor parameter auto tuning ends

If the auto tuning goes smoothly, then the operation panel will return to the initial interface.

After completion of auto tuning, the parameters obtained through auto tuning will be set into the function code.

(5) Auto tuning error

① If the auto tuning fails, then " Er S " will be displayed on the operation panel.

During auto tuning, please confirm the contents displayed on operation panel. If a " Er S " is displayed, please confirm the following contents and conduct auto tuning again.

- Reconfirm the settings of F5001 - F5005
- When using special motors, change the range of F5008 if auto tuning is out of range.

Note 1): Enlarging auto tuning range of F5008 will make the error of auto tuning become bigger, therefore please set appropriate auto tuning range.

(6) Forced ending of auto tuning

The auto tuning mode can be forcibly ended according to stop signal.

Pressing【STOP】button，can also realize forced ending.

[Note: Notes on carrying out motor parameter auto tuning mode]

① Before carrying out auto tuning mode 2, be sure to disengage the load shaft of motor. If the load is not disengaged (for example, one-piece brake motor), then the auto tuning mode 2 can not carry out correct auto tuning.

② If F5001 - F5008 are not correctly set, then the right auto tuning can not be implemented.

③ Please carry out the auto tuning under normal temperature of the motor. As other test run items have been conducted, the motor may be overheated. And correct auto tuning can not be achieved in this condition.

④ The actions of auto tuning mode are executed based on normal operation steps, therefore sometimes it does not act according to the settings of function codes. In this case, please confirm if there is any conflict between data settings of function codes as in normal operation.

Example) If the frequency setting is lower than operation start frequency, the operation can not be started. Although the frequency setting is inactive in auto tuning mode action, it is active as an operation start condition.

Example) The auto tuning mode will not act if the frequency setting is higher than the upper frequency limit or lower than the lower frequency limit.

⑤ Performance of the auto-tuning with small motor in the extreme compared with the capacity of the inverter may possibly burn out the motor. Please make sure to choose appropriate motor that is equivalent to 2 levels lower than the capacity of the inverter.

⑥ During action of auto tuning mode 2, if the operation signal is input again during deceleration, then the motor will rerun at the frequency of F5003. Therefore, do not enter operation command before the auto tuning is fully completed.

⑦ During auto tuning, when this function is stopped or temporarily stopped because of alarm, please return back to the auto tuning mode.

⑧ During action of auto tuning mode 2, if it enters the idling state temporarily because of MBS signals input by multifunctional input terminals, after that, correct auto tuning can not be achieved by continuing auto tuning action even if the signal is released.

⑨ The acceleration / deceleration time of auto tuning mode 2 acts with the 1st acceleration / deceleration time as standard.

⑩ Depending on the results of parameter auto tuning for motor with shaft fixed, auto tuning with shaft fixed may be reconducted.

6-2-7 Basic Setting (3)

Please set the function codes used for setting the operation command and frequency command.

Table 6-9 Basic function (2)

Function code	Name	Content	Remarks
F1002	1st speed frequency setting selection	1: Operation panel 2: External analog VRF1 voltage (0-5V) 3: External analog VRF1 voltage (0-10V or potentiometer) 4: External analog VRF/IRF voltage (0-5V) 5: External analog VRF/IRF voltage (0-10V or potentiometer) 6: Reserved 7: Reserved 8: External analog VRF1 current (4-20mA) 9: External analog VRF/IRF current (4-20mA) 10: Reserved 11: External analog VRF1 voltage +VRF/IRF voltage 12: Reserved 13: Reserved 14: External analog VRF1 voltage -VRF/IRF voltage 15: External analog VRF/IRF voltage – VRF1 voltage 16: Reserved 17: Reserved 18: External analog VRF1 voltage +VRF/IRF current 19: External analog VRF1 voltage -VRF/IRF current 20: External analog VRF1 current -VRF/IRF voltage 21: Terminal block stepping 22: Communication 25: Pulse train input 26: External analog VRF1 forward / reverse operation (0 - 10V, 5V reference) 27: External analog VRF/IRF forward / reverse operation (0 - 10V, 5V reference) 28: Reserved	Please set the setting to values other than 1 when using control terminals.
F1101	Operation command selection	1: Operation panel 2: External terminal 3: Communication	

Note 1) During test run, confirm the factory presets through the operation panel without additional configuration.

Note 2) Before setting external operation signals, check that the control terminals are in OFF (disconnected) state.

Frequency command selection can be switched using the status of multifunctional input terminals. Depending on the status of multifunctional input 1DFA or 1DFB, the frequency command shall be determined according to the method set by F1002, or F1034 - F1036. See F1034-F1036 in Chapter 7-3 for details.

1DFA terminal	1DFB terminal	1st speed frequency action
OFF	OFF	The method selected by F1002
ON	OFF	The method selected by F1034
OFF	ON	The method selected by F1035
ON	ON	The method selected by F1036

Operation command values can be changed using the status of multifunctional input terminals. According to the status of multifunctional input ROPE or RCOM, the operation commands as shown in the table below can be selected. See F1101 in Chapter 7-3 for details.

ROPEterminal	RCOMterminal	Operation Command
OFF	OFF	The method selected by F1101
ON	OFF	Operation Panel
OFF	ON	Communication
ON	ON	Terminal block (FR terminal or RR terminal)

6-2-8 Operation Confirmation

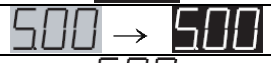
After setting has been made by following the steps for test run, the operation shall be confirmed as follows.

Once the inverter or motor is in abnormal conditions, please stop operating immediately. See [Chapter 9 Fault Analysis] for details.

（1）Test run steps

Please refer to the operation methods of operation panel for implementation of 5Hz operation.

Table 6-10 Test run steps

	Operation	Display
①	After checking the wiring for correctness, turn on the power	
②	Set the operating frequency to 5Hz according to the operation panel	
③	Press【DRIVE】button to operate	
④	Pres【STOP】button to stop	

※The state where F1101 (operation command selection) is set to 1 (operation by operation panel)

① After power turn on, check that the frequency "  " displayed on the operation panel is flashing.

② Set the frequency to a low frequency of about 5Hz through the control panel. （Check that the set frequency displayed on LED monitor is flashing）

③ Press【DRIVE】button，to start forward running operation. (Check that the set frequency displayed on LED monitor is flashing)

④ Press【STOP】button，key to stop operation of the equipment.

（2）Confirmation items during test run

Please confirm the contents listed in the table below

Table 6-11 Confirmation items

	Item	Result
①	Motor rotation direction	Is it the specified rotation direction?
②	Motor operation 1	Are the acceleration and deceleration smooth?
③	Motor operation 2	Is there any abnormal sound or vibration?
④	Inverter fan operation	Is the fan running?
⑤	Inverter display and others	Are the display on operation panel and equipment normal?

※In the factory default configuration, fans of the inverter performs the ON / OFF control automatically by the fin temperature of the inverter. The trial operation, set to (F1318 = 1) ON always control the fan, please check the operation of the fan.

（3） Operation preparation

After confirmation of test run and normal operation confirmation of motor, please implement the connection with the mechanical system.

① Please set the function codes related to machine action.。

② Check the interface matched with peripheral mechanical equipment.

（4） Operation confirmation

Before delivery, various functions of the inverter have been set up as shown in the function code list.

If change of settings of operation command is required, please refer to [5-6 Basic Operation] for implementation.

（5） Operation methods besides commands from operation panel

■Operation by commands from external signals

① When controlling operation / stop according to external signals, please set the function code F1101 to 2, that is, F1101 = 2.

② When carrying out frequency setting by external potentiometer, 4 - 20mA, 0 - 10V etc., please set the function code F1002 = 2 - 20.

③ Please refer to [4-6 Connection Diagram of Control Circuit Terminals] for correct use of external signals

Note 1: If both input signals FR (Forward) and RR (Reverse) are input at the same time, then the inverter will not operate. And if both signals are simultaneously input during operation, then [Output Frequency Lock] will act. If this is done during accelerating or decelerating, the change of output frequency will also be locked. And when the output frequency is locked, the FWD and REV on the operation panel will be lit.

Note 2: If the operation signal is turned off and a signal to drive the motor in the opposite direction from the present direction of rotation is input before the inverter stops, the inverter operates according to the value of F1001 (motor control mode selection).

- F1001 = 1 (V/f control mode) and F1309 = 0

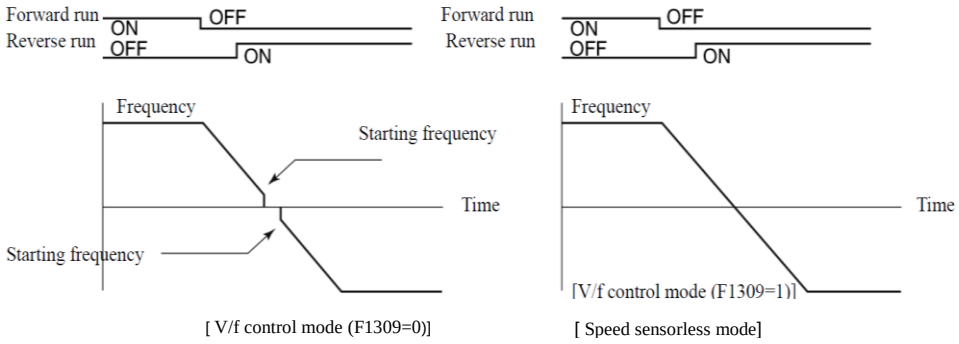
The inverter operates according to the function code settings when starting and stopping. Consequently, the change in output frequency around 0 Hz may not follow a straight line, depending on settings such as the starting frequency. Since DC braking does not work when reversing the direction of rotation, set the DC braking start frequency low.

- F1001 = 1 (V/f control mode) and F1309 = 1

A process of continuous deceleration to acceleration in the opposite direction, which has nothing to do with the relevant function codes for starting and stopping.

F1001 = 2 (Speed sensorless control mode), Braking excitation or starting excitation is not applied when switching the direction of rotation. This allows —forward and reverse run in a continuous operation.

Note 3: During torque control, the direction of motor rotation depends on the load side, therefore, both FR (Forward run) and RR (Reverse run) signals are provided with the function of setting ON / OFF of torque control. Because this function has nothing to do with the direction of rotation, please only use one of FR and RR during torque control.



[V/f control mode (F1309=0)] [Speed sensorless mode]

Figure 6-2 External operation command action

6-3 Special Function

6-3-1 JOG Operation

(1) Short-circuiting the multifunctional terminal JOG with DCM1, 2 forms a JOG operation mode.

(2) For JOG operation, please set the F1101 = 2, and then short-circuit the multifunctional terminal FR or RR with DCM1, 2 after short-circuiting the multifunctional terminal JOG with DCM1, 2. (JOG operating is active only in operation by external signal command.)

(3) Use F1021 to set frequency, and F1020 to set the acceleration / deceleration time.

(4) During operation, the JOG signal will not work even if it is input. The JOG signal must be input at the same time or in advance. Also, during JOG operation, the jog operation will still continue even if the short circuit between JOG and DCM1, 2 is disconnected. (To stop, set the operation signal to OFF.).

(5) In JOG operation mode, the setting of F1102 = 2 (Flying start) becomes inactive, and the setting of F1102 = 1 (Starting frequency) is active. Other actions shall be made according to settings of corresponding function codes.

(6) Once the JOG operation is started, it will continue until the inverter stops. Therefore, during slowdown of JOG operation, if acceleration is started again before the inverter stops, it is still in JOG operation regardless of status of the JOG terminal. For normal operation after stopping the inverter, please turn the operation command ON (connected) only after the inverter has fully stopped and the JOG terminal is OFF (disconnected).

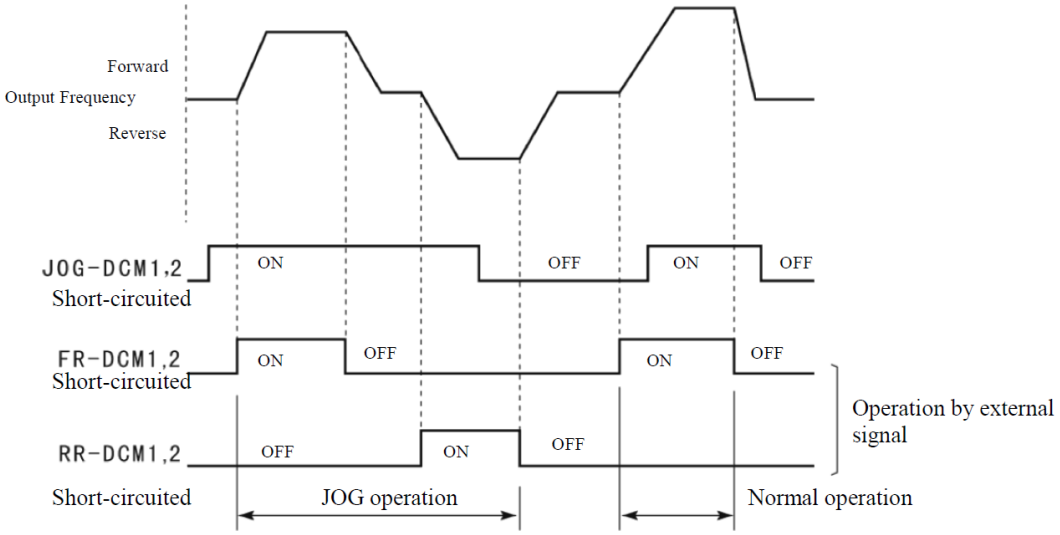


Figure 6-3 JOG action

6-3-2 Hold Operation

(1) To use a push-button switch or other momentary contact to control operation, wire the circuit as shown in Figure 6-4 and set the appropriate function codes (codes related to the multifunctional input terminals and F1101 = 2).

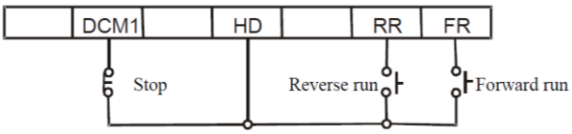


Figure 6-4 Operation signal hold circuit

（2）When the external signal terminals are used to operate and stop the inverter, and you do not want the motor to automatically restart after recovery from a power failure, use the above circuit and set F1108=0.

（2） When operating with the hold function, the inverter does not restart after recovery from the following conditions.

① Recovery from free run stop with MBS multifunctional input terminal

② Recovery from alarm stop with the auto alarm recovery function

③ Recovery from a momentary power failure by the ‘restart after momentary power failure’ function

6-3-3 Notes on Free Run Stop Terminal (MBS)

The free run stop terminal is provided for systems in which mechanical braking is used to stop the motor. When setting the motor to the free run status using this terminal, be sure to turn OFF any operation signal.

If the free run stop signal is released with an operation signal on, the inverter restarts according to normal operating procedure and the function code settings. Therefore, depending on the free run speed of the motor, an unexpected over current or overvoltage may occur and result in an alarm stop.

For example: if flying start is not set as the starting method and the free run stop signal is released when the motor is still slowly rotating, the inverter will restart from the starting frequency or after DC braking depending on the starting method.

6-4 Definition of Technical Terms

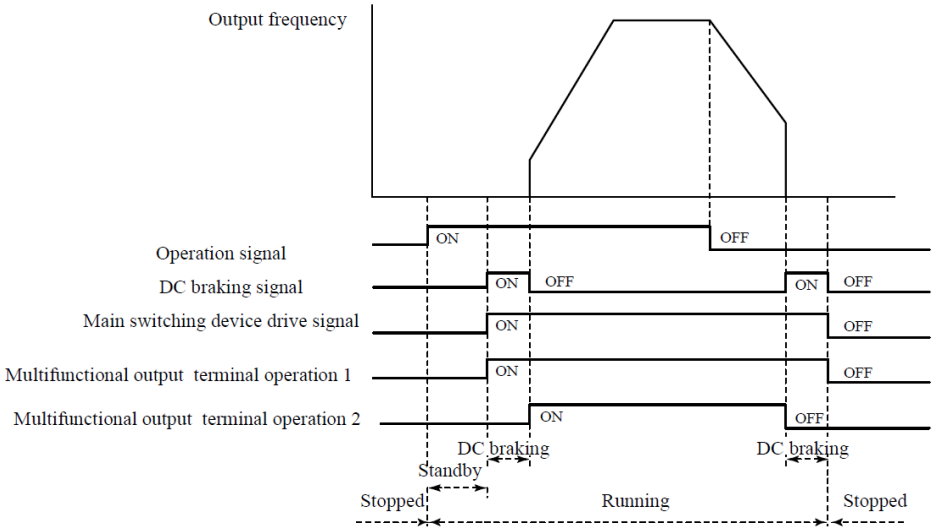


Figure 6-5 Operation action

Table 6-12 Explanation of Terms

Term	Definition
Operation	General term describing both "forward run" and "reverse run" implying that the inverter is in operation.
Operation signal	Signal requesting inverter operation, which is input by pressing the (drive) key on the operation panel or using signals input through multifunctional control input terminals FR and RR.
In operation (operating)	Condition where the operation signal is being input or a drive signal is being output to the main switching device. In the stop status, the operation signal is OFF, but the main switching device operates until DC braking, etc. is completed.
In constant speed (operation)	Condition when the inverter is in operation at the frequency setting value.
Stopped	Condition where the operation signal is not being input and the drive signal is not being output to the main switching device. Even when the operation signal input is on, the input to the multifunctional control input terminal MBS disables the drive signal output to the main switching device.
Standby	Condition where the operation signal is being input but there is no output for some reason, for example, while waiting for the start delay time to expire or when the set frequency is lower than the operation start frequency.
DC braking	Condition where DC braking is applied when starting and stopping.
Frequency setting value or set frequency	Frequency set on F2101-F2116 and F1021. Frequency value corresponding to an external signal when setting F1002=2-21 and 25-28 with external signals for frequency setting.
Output frequency or frequency output value	Actual inverter output frequency. • V/f mode When the load is stable, the output frequency normally coincides with the frequency setting value. • When used in vector control mode or for slip compensation in V/f mode, even if the load is stable, the output frequency does not coincide with the frequency setting value but keeps changing.
Command frequency	Frequency value used by the inverter. As a command value frequency, its change in frequency setting value not only depends on the results of controls such as the acceleration/deceleration function and the current limiting function but also the actual output frequency. The command frequency normally coincides with the set frequency at the end of acceleration/deceleration. • V/f mode: If there is feedback operation such as PID control mode, the command frequency equals the output frequency. • When used in vector control mode or for slip compensation in V/f mode, the command frequency and the output frequency may not match in this mode because the synchronous speed specified by the number of motor poles and the command frequency is used as the speed command.

7. Function code

7-1 Representation and Description of Function Codes

By changing the function code, the inverter action can be changed.
Function codes are functionally classified into "function blocks". To change the function code, 1st select the function block, and then select the serial number of the function code to be changed.
A function code can be set through operation panel (see sections 5-4 and 5-5), or communication (see section 7-4).

Function	Function Block	Function Block Name
Basic Operation Function	F10XX	Basic function
	F11XX	Starting • braking function
	F12XX	LED display function
	F13XX	Auxiliary function
Input/Output-Related Function	F14XX	Input function
	F15XX	Output function
System-Related Function	F16XX	System function
	F17XX	Protection function
	F18XX	Information function
Special Function	F19XX	Energy-saving function
	F20XX	V/f characteristics
Scheduled Operation Function	F21XX	Multi-speed function
	F22XX	Scheduled operation function
PID Function	F30XX	Basic PID1 function
	F31XX	Basic PID2 function
	F32XX	Combined function of PID1 and PID2
	F33XX	PID control parameter reading
Water supply function	F34XX	Water supply function
Communication Function	F40XX	Serial communication function
	F41XX	Modbus communication function
Motor Parameters	F5XXX	Motor Parameters
Vector Control	F60XX	Vector speed control function

7-2 Function Code List

The set value cannot be changed during operation.

※1：The representative parameters suitable for each model have been entered.

Code No.	Function Name	Data Content	Setting Resolution	Factory Presets	User Setting Value
Basic Operation Function					
1001	Motor control mode selection	1: V/f control mode 2: Speed control (speed sensorless vector control) 10: Auto tuning mode 1 11: Auto tuning mode 2 40: V•f separation control	1	1	
1002	1st speed frequency setting selection	1: Operation panel 2: External analog VRF1 voltage (0-5V) 3: External analog VRF1 voltage (0-10V or potentiometer) 4: External analog VRF/IRF voltage (0-5V) 5: External analog VRF/IRF voltage (0-10V or potentiometer) 9: External analog VRF/IRF current (4-20mA) 11: External analog VRF1 voltage +VRF/IRF voltage 14: External analog VRF1 voltage -VRF/IRF voltage 15: External analog VRF/IRF voltage – VRF1 voltage 18: External analog VRF1 voltage +VRF/IRF current 19: External analog VRF1 voltage -VRF/IRF current 20: External analog VRF1 current -VRF/IRF voltage 21: Terminal block stepping 22: Communication 25: Pulse train input (option function) 26: External analog VRF1 forward / reverse run operation (0 - 10V, 5V reference) 27: External analog VRF/IRF forward / reverse run operation (0 - 10V, 5V reference)	1	1	
1003	V/f pattern selection	1: Linear pattern 2: Square-law decreasing pattern (weak) 3: Square-law decreasing pattern (strong)	1	1	
1004	Torque boost	0-20% (maximum voltage ratio)	0.1%	※1	
1005	Base voltage	400V class 0：No AVR 50～460V	1V	※1	
1006	Base frequency	0.1～400Hz	0.01Hz	※1	
1007	Upper frequency limit	5～400Hz	0.01Hz	60	
1008	Lower frequency limit	0.05～200Hz	0.01Hz	0.05	

1009	Carrier frequency adjustment	0～130	1	※1	
1010	Acceleration/deceleration curve	1: Linear 2: S-Shaped 3: Reduction of acceleration/deceleration	1	1	
1011	Reference frequency for acceleration/deceleration	1～120Hz	0.01Hz	※1	
1012	1st acceleration time	0～6500sec	0.1sec	※2—1	
1013	2nd acceleration time	0～6500sec	0.1sec	※2—2	
1014	3rd acceleration time	0～6500sec	0.1sec	※2—3	
1015	4th acceleration time	0～6500sec	0.1sec	※2—4	
1016	1st deceleration time	0～6500sec	0.1sec	※2—5	
1017	2nd deceleration time	0～6500sec	0.1sec	※2—6	
1018	3rd deceleration time	0～6500sec	0.1sec	※2—7	
1019	4th deceleration time	0～6500sec	0.1sec	※2—8	
1020	JOG acceleration/ deceleration time	0～20sec	0.1sec	0.1	
1021	JOG frequency	0～60Hz	0.01Hz	5	
1022	1st Start of S-Shaped acceleration	0～200%	1%	50	
1023	1st End of S-Shaped acceleration	0～200%	1%	50	
1024	Gradient of middle of 1st S-Shaped Acceleration	0～100%	1%	0	
1025	1st Start of S-Shaped deceleration	0～200%	1%	50	
1026	1st End of S-Shaped deceleration	0～200%	1%	50	
1027	Gradient of middle of 1st S-Shaped Deceleration	0～100%	1%	0	
1028	2nd Start of S-Shaped acceleration	0～200%	1%	50	
1029	2nd End of S-Shaped acceleration	0～200%	1%	50	
1030	Gradient of middle of 2nd S-Shaped Acceleration	0～100%	1%	0	
1031	2nd Start of S-Shaped deceleration	0～200%	1%	50	
1032	2nd End of S-Shaped deceleration	0～200%	1%	50	
1033	Gradient of middle of 2nd S-Shaped Deceleration	0～100%	1%	0	
1034 1035 1036	1st speed frequency selection A 1st speed frequency selection B 1st speed frequency selection C	1: Operation panel 2: External analog VRF1 voltage (0-5V) 3: External analog VRF1 voltage (0-10V or potentiometer) 4: External analog VRF/IRF voltage (0-5V) 5: External analog VRF/IRF voltage (0-10V or potentiometer) 9: External analog VRF/IRF current (4-20mA) 21: Terminal block stepping 22: Communication 25: Pulse train input 26: External analog VRF1 forward / reverse run operation (0 - 10V, 5V reference) 27: External analog VRF/IRF forward / reverse run operation (0 -10V, 5V reference)	1	1 1 1	
1037	Terminal block step set	0.1Hz～10.0Hz	0.1	2.5	
1038	Keep or clear frequency	0: Keep the frequency 1: Reset frequency after power off 2: Reset frequency after stop	1	0	
1101	Operation command selection	1: Operation panel 2: External terminal 3: Communication 4：External terminal (three-wire type)	1	1	
1102	Starting method	1: Starting frequency 2: Flying start 3: Starting frequency after DC braking 4：External terminal (three-wire type)	1	1	
1103	Starting frequency	0.05～60Hz	0.01Hz	1	
1104	Operation start frequency	0～20Hz	0.01Hz	0	
1105	Start delay time	0～5sec	0.1sec	0	
1106	Start standby time	0～120sec	0.1sec	0	
1107	Start standby frequency	0.05～60Hz	0.01Hz	5	
1108	Restart after momentary power failure	0: Do not restart 1: Restart 2: Compensation for momentary power failure	1	0	
1109	Direction of motor rotation	1: Forward and reverse run 2: Forward run only 3: Reverse run only	1	1	
1110	Direction of motor rotation (Operation panel)	1: Forward run 2: Reverse run	1	1	
1111	Braking method	1: Deceleration to stop 2: Deceleration to stop + DC braking 3: Free run stop 4：Deceleration stop + continuous DC braking	1	1	
1112	DC braking start frequency	0.05～20Hz	0.01Hz	0.5	
1113	DC braking time	0.1～25sec	0.1sec	2	
1114	DC braking force	1～10	1	5	

1115	Duty cycle of brake resistor	0: No brake resistor 2-25%ED 98: No discharge resistor protection (with discharge) 99: External brake unit	1%ED	※1	
1116	Discharge resistor on signal output time	0.01～10.00sec	0.01sec	0.1	
1117	Continuous DC braking set by parameters	0: The terminal enables continuous DC braking 1: Continuous DC braking set effective by parameters 2: Continuous DC braking time set effective by parameters	1	0	
1118	DC braking beginning frequency to stop	0.05～60Hz	0.01Hz	0.5	
1119	DC braking time T1	0.1～6500.0sec	0.1sec	2	
1120	DC braking time T2	0.1～6500.0sec	0.1sec	2	
1121	DC braking time T3	0.1～6500.0sec	0.1sec	2	
1122	DC braking force F1	1～10	1	5	
1123	DC braking force F2	1～10	1	5	
1124	Deceleration ratio of overexcitation	0.01～4.00	1	1	
1201	Monitor display options (optional parts)	1: frequency [Hz] 2: output current [A] 3: rotation speed [rpm]. 4: load rate [%] 5: pressure [MPa] 6: unit-free display	1	1	
1202	State display selection	1: No unit (magnification of F1203) 2: output voltage [V] 3: DC voltage [V] 4: active power [kW] 5: apparent power [kVA]. 6: Heat sink Temperature [℃] 7: command speed [rpm] 8: PID1 feedback value [Hz] 9: PID2 feedback value [Hz] 10: VRF analog input value [Hz] 11: VRF/IRF analog input value [Hz] 14: excitation partial current [A] 15: torque partial current [A] 17: set pressure [MPa] 18: instructed pressure [MPa] 19: feedback pressure [MPa] 29: instructed frequency [Hz] 35: detected rotation speed [rpm] 44: target frequency [Hz] 45: output frequency [Hz]	1	1	
1203	Multiple for no-unit display	0～100 times (magnification against output frequency)	0.01time	1	
1301	1st jump bottom frequency	0～400 [Hz]	0.01 [Hz]	0	
1302	1st jump top frequency	0～400 [Hz]	0.01 [Hz]	0	
1303	2nd jump bottom frequency	0～400 [Hz]	0.01 [Hz]	0	
1304	2nd jump top frequency	0～400 [Hz]	0.01 [Hz]	0	
1305	3rd jump bottom frequency	0～400 [Hz]	0.01 [Hz]	0	
1306	3rd jump top frequency	0～400 [Hz]	0.01 [Hz]	0	
1307	Auto alarm recovery	0: no auto-reset function 1: auto-reset function exists	1	0	
1308	Elimination instability	0～20	1	※1	
1309	Movement direction switch under V/f control mode	0: restart in reverse direction after breaking off 1: continuous movement	1	0	
1315	Minimum operation time	0～99.99sec	0.01sec	0	
1316	2nd Upper frequency limit	5～400 [Hz]	0.01 [Hz]	60	
1317	3rd Upper frequency limit	5～400 [Hz]	0.01 [Hz]	60	
1318	ON/OFF control of cooling fan	0: ON/OFF control 1: normally ON	1	0	
1319	Functions for high-altitude areas	1：1000m below 2：1000m～1500m below 3：1500m～2000m below 4：2000m～2500m below 5：2500m～3000m	1	1	
1320	Rating selection	1: Mode A (heavy load method) 150%1 minute 2: Mode B (light load method) 120%1 minute	1	2	
1401	Offset frequency (VRFI)	0～±400 [Hz] （0 Vfrequency）	0.1 [Hz]	0	
1402	Gain frequency (VRFI)	0～±400 [Hz] （5V or 10V frequency）	0.1 [Hz]	60	
1403	Offset frequency (VRF/IRF)	0～±400 [Hz] （0V or 4mA frequency）	0.1 [Hz]	0	
1404	Gain frequency (VRF/IRF)	0～±400 [Hz] （5V or 10V or 20mA frequency）	0.1 [Hz]	60	
1405	Reserve				
1406	Reserve				
1407	Filter time constant of external analog input (VRFI)	1～500（set value1=10ms）	1	10	

1408	Filter time constant of external analog input (VRF/IRF)	1～500（set value1=10ms）	1	10	
1409	Reserve				
1410	Set frequency gain	0～100	1	0	
1411	Set frequency gain Analog input switchover	0: no analog input 1: external analog VRFI voltage (0～5V) 2: external analog VRFI voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRF current (4～20mA)	1	0	
1412	Input method for MBS terminal	1: level-triggered 2: edge-triggered	1	1	
1413	ES input signal options	1: NO external thermistor signal 2: NC external thermistor signal	1	1	
1414 1415 1416 1417 1418 1419 1420 1421	Input terminal DI1 definition Input terminal DI2 definition Input terminal DI3 definition Input terminal DI4 definition Input terminal DI5 definition Input terminal DI6 definition Input terminal DI7 definition Input terminal DI8 definition	0：Unused 1：FR， 2：RR， 3：2DF， 4：3DF 5：MBS， 6：ES， 7：RST， 8：AD2， 9：AD3 10：JOG， 11：5DF， 12：9DF， 13：FR+JOG， 14：RR+JOG， 15：FR+AD2， 16：RR+AD2， 17：FR+AD3， 18：RR+AD3， 19：FR+2DF， 20：RR+2DF， 21：FR+3DF， 22：RR+3DF， 23：FR+2DF+3DF， 24：RR+2DF+3DF， 25：FR+AD2+2DF， 26：RR+AD2+2DF， 27：FR+AD2+3DF， 28：RR+AD2+3DF， 29：FR+AD2+2DF+3DF， 30：RR+AD2+2DF+3DF， 31：FR+AD3+2DF， 32：RR+AD3+2DF， 33：FR+AD3+3DF， 34：RR+AD3+3DF， 35：FR+AD3+2DF+3DF， 36：RR+AD3+2DF+3DF， 37：PTR， 38：T-FCL 39：FR+5DF， 40：HD， 45：CP（Option）， 46：CCL， 47：PC， 57：P0， 58：FR+CCL， 59：FR+RCCL， 64：FR+MBS， 65：RR+MBS， 67：2DF+AD2， 68：2DF+AD3， 69：3DF+AD2， 70：3DF+AD3， 71：A×10（Option）， 72：A×100（Option）， 74：2MAX， 75：3MAX， 76：VFPID， 77：PIDLCK， 83：for factory adjustment， 84：S2， 85：PIDL， 86：PIDH， 87：RPID1， 88：PID1EX， 89：PID2EX， 91：IHOLD， 92：ICLEAR 109：RCCL， 114：1DFA， 115：1DFB， 116：1DFA+1DFB， 117：ROPE， 118: RCOM, 119：ROPE+RCOM, 120:1DFA+ROPE, 121:1DFB+RCOM, 122:1DFA+1DFB+ROPE+RCOM， 253～255：for factory adjustment，	1	1 2 3 4 5 6 7 8	
1423	effective number of bits for VRFI detection	7～10bit	1bit	10	
1424	effective number of bits for VRF/IRF detection	7～10bit	1bit	10	
1425	Reserve				
1426	Time constant of pulse train input filtering	1～500（set value1=10ms）	1	10	
1501	Internal analog output function 1	0: null 1: set frequency [Hz] 2: output frequency [Hz] 3: PID1 feedback value [Hz] 4: PID2 feedback value [Hz]	1	0	

		5: output current [A] 6: output voltage [V] 7: DC voltage [V] 8: Heat sink temperature [℃] 9: load rate [%] (electronic heat sensor accumulated value) 10: load rate [%] (for rated current) 11: VRFI analog input value [V] 12: VRF/IRF analog input value [V] 14: speed [rpm] 15: active power [kW] 16: apperant power [kVA] 17: PID1 command value [Hz] 18: PID1 input deviation value [Hz] 19: PID2 command value [Hz] 20: PID2 input deviation value [Hz] 21：for factory adjustment 22：for factory adjustment 23：for factory adjustment 24: external PID1 output value [Hz] 25: external PID2 output value [Hz] 26：for factory adjustment 35: command frequency [Hz] 36: command torque [%] 99：for factory adjustment			
1502	Internal analog output coefficient 1	0～20	0.01	1	
1503	Internal analog output bias 1	0～±10.0V	0.1V	0	
1504	Internal analog output function 2	0: null 1: set frequency [Hz] 2: output frequency [Hz] 3: PID1 feedback value [Hz] 4: PID2 feedback value [Hz] 5: output current [A] 6: output voltage [V] 7: DC voltage [V] 8: Heat sink temperature [℃] 9: load rate [%] (electronic heat sensor accumulated value) 10: load rate [%] (ratio to rated current) 11: VRFI analog input value [V] 12: VRF/IRF analog input value [V] 14: speed [rpm] 15: active power [kW] 16: apperant power [kVA] 17: PID1 command value [Hz] 18: PID1 input deviation value [Hz] 19: PID2 command value [Hz] 20: PID2 input deviation value [Hz] 21：for factory adjustment 22：for factory adjustment 23：for factory adjustment 24: external PID1 output value [Hz] 25: external PID2 output value [Hz] 26：for factory adjustment 35: command frequency [Hz] 36: command torque [%] 99：for factory adjustment	1	0	
1505	Internal analog output coefficient 2	0～20	0.01	1	
1506	Internal analog output bias 2	4～±20mA	0.1mA	0	
1507	Arrvial frequency	0～600Hz	0.01Hz	10	
1508	Range of frequency consistency	0～10Hz	0.01Hz	0	
1509 1510 1511	Output terminal DO1 Options Output terminal DO2 Options Output terminal DO3 Options	0: unused， 1: running 1 2: undervoltage， 3: termination of pattern operation cycle， 4: running 2， 5: frequency consistency (Speed 1 frequency), 6: frequency consistency (Speed 1～16 frequency), 7: frequency completion, 8: overload warning signal (value of F1704), 9: electronic heat sensor warning signal (electronic heat sensor 80%), 10: overheat warning signal of Heat sink, 13: excitation and DC braking running signal, 14: minimum frequency consistency signal, 15: maximum frequency consistency signal, 18: FR signal, 19: RR signal, 20: 2DF signal, 21: 3DF signal, 22: 5DF signal,	1	1 5 8	

		23: 9DF signal, 24: AD2 signal, 25: AD3 signal, 26: JOG signal, 27: MBS signal, 28: ES signal, 29: RST signal, 32: signal for discharging resistor connection success, 34: frequency counter (output frequency), 35: frequency counter (command frequency), 36: overload warning signal (including cases of acceleration/deceleration), 43: signal for low speed detection 47: motor speed counter 48: signal for forward movement 49: signal for reverse movement 60: malfunction output 61: in forward movement (only trilinear system) 62: in reverse movement (only trilinear system)			
1512	Output magnification of the counter	1～100time	1time	1	
1513	Relay 1 contact output options	0: Alarm contact， 1: running 1， 2: undervoltage， 3: termination of pattern operation cycle， 4: running 2， 5: frequency consistency (Speed 1 frequency), 6: frequency consistency (Speed 1～16 frequency), 7: frequency completion, 8: overload warning signal (value of F1704), 9: electronic heat sensor warning signal (electronic heat sensor 80%), 10: overheat warning signal of Heat sink, 13: excitation and DC braking running signal, 14: minimum frequency consistency signal, 15: maximum frequency consistency signal, 18: FR signal, 19: RR signal, 20: 2DF signal, 21: 3DF signal, 22: 5DF signal, 23: 9DF signal, 24: AD2 signal, 25: AD3 signal, 26: JOG signal, 27: MBS signal, 28: ES signal, 29: RST signal, 32: signal for discharging resistor connection success, 36: overload warning signal (including cases of acceleration/deceleration), 43: signal for low speed detection 48: signal for forward movement 49: signal for reverse movement	1	0	
1514	Relay 2 contact output Options	0: Alarm contact， 1: running 1， 2: undervoltage， 3: termination of pattern operation cycle， 4: running 2， 5: frequency consistency (Speed 1 frequency), 6: frequency consistency (Speed 1～16 frequency), 7: frequency completion, 8: overload warning signal (value of F1704), 9: electronic heat sensor warning signal (electronic heat sensor 80%), 10: overheat warning signal of Heat sink, 13: excitation and DC braking running signal, 14: minimum frequency consistency signal, 15: maximum frequency consistency signal, 18: FR signal, 19: RR signal, 20: 2DF signal, 21: 3DF signal, 22: 5DF signal, 23: 9DF signal, 24: AD2 signal, 25: AD3 signal,	1	0	

		26: JOG signal, 27: MBS signal, 28: ES signal, 29: RST signal, 32: signal for discharging resistor connection success, 36: overload warning signal (including cases of acceleration/deceleration), 43: signal for low speed detection 48: signal for forward movement 49: signal for reverse movement			
1515	Output magnification of Iout	0～20.00	0.01	1	
1516	Reserve				
1517	Reserve				
1518	Low speed matching level	0～2000rpm	1rpm	100	
1519	Low speed matching range	0～100rpm	1rpm	10	
1520	Reserve				
1521	Reserve				
System related functions					
1601	Copy function (optional parts)	0: null 1: Transfer the current code data to operation panel 2: Transfer the content stored in operation panel to the main body (except for motor parameter determination) 3: Transfer the content stored in operation panel to the main body (including motor parameter determination)	1	0	
1602	Changed code display function	0: null 1: display of differences against factory settings 2: display of differences against customer initial values	1	0	
1603	Function code lock	0: code data modifiable (no locking function) 1: code data unmodifiable (except for F1603) 2: code data unmodifiable, except for those related to frequency setting (except for F1603, F1021, F2101～F2116) 3: code data unmodifiable (except for F1603 and those using communication function)	1	0	
1604	Data initialization	0: null 1: Initialize to factory presets 2: Invalid parameters by auto-tuning 3: Initialize to user's data 99: Set user's initial value	1	0	
1605	Reserve				
1606	Reserve				
1607	Reserve				
1701	Output current limiting	A Mode: 0：null 50～200%	1%	150	
		B Mode: 0：null 50～150%		120	
1702	Electronic thermal setting	0：null 20～105%	1%	100	
1703	Output current limiting at constant-speed	0: null 1: Valid, V/f, (present acceleration/deceleration time) 2: Valid, V/f, (1st acceleration/deceleration time) 3: Valid, V/f, (2nd acceleration/deceleration time) 4: Valid, V/f, (3rd acceleration/deceleration time) 5: Valid, V/f, (4th acceleration/deceleration time) 6: Valid, V/f and speed control (1st acceleration/deceleration time) 7: Valid, V/f and speed control (2nd acceleration/deceleration time) 8: Valid, V/f and speed control (3rd acceleration/deceleration time) 9: Valid, V/f and speed control (4th acceleration/deceleration time)	1	0	
1704	Pre-alarm value for overload	A Mode: 20～200%	1%	150	
		B Mode: 20～150%		120	
1705	Motor type	1: general-purpose motor 2: general -purpose motor Dedicated for inverter	1	1	
1706	Switch between "OV" and "LV" alarms in STOP state	0: in STOP state, "ov" valid, "Lv" invalid 1: in STOP state, "ov" invalid, "Lv" valid 2: in STOP state, "ov" invalid, "Lv" invalid 3: in STOP state, "ov" valid, "Lv" valid	1	0	

1707	Phase lack detection	0: Input out-phase detection invalid, output-phase detection invalid 1: Input out-phase detection valid, output out-phase detection invalid 2: input out-phase detection invalid output out-phase detection valid 3: input out-phase detection valid output out-phase detection valid	1	3	
1708	Prevention of stall caused by overvoltage	0: no prevention of stall caused by overvoltage 1: function of prevention of stall caused by overvoltage exists	1	1	
1709	For feedback signal Detection time	0: only warning 0.01～119.99 seconds 120: no detection of disconnection	0.01sec	5	
1710	Carrier frequency variable by temperature drops (only effective when Method A selected)	0：null 1: function granted	1	0	
1801	Inverter host software version display	Only for reading		version	
1802	Inverter host memory version display	Only for reading		version	
1803	Operation panel software version display	Only for reading		version	
1804	Operation time display	Only for reading	1hour	---	
1805	Read alarm content	0: null 1: start reading 9: record erase	1	0	
1806	Alarm status confirmation 1	Only for reading	---	---	
1807	Alarm status confirmation 2	Only for reading	---	---	
1808	Alarm status confirmation 3	Only for reading	---	---	
1809	Alarm status confirmation 4	Only for reading	---	---	
1810	Alarm status confirmation 5	Only for reading	---	---	
Special functions					
1901	Energy-saving mode selection	0: null 1: simple energy-saving mode (V/f mode) 2: automatic energy-saving mode	1	0	
1902	Simple energy-saving rate	0～50%	1%	0	
1903	Simple energy-saving time	0～65000sec	1sec	10	
2001	V·f separation function selection	1: V·f proportional separation 2: complete separation	1	1	
2002	Command voltage for V·f seperation	0: null (command is given by VRFI) 0.01～10.23V	0.01V	0	
2003	Arbitrary V/f pattern intermediate voltage 1	0～460V	1V	0	
2004	Arbitrary V/f pattern intermediate voltage 2	0～460V	1V	0	
2005	Arbitrary V/f pattern intermediate frequency 1	0.05～400Hz	0.01Hz	20	
2006	Arbitrary V/f pattern intermediate frequency 2	0.05～400Hz	0.01Hz	40	
2007	Auto torque boost selection	0: no auto torque boost 1: voltage compensation function 2: slip frequency compensation function	1	0	
2008	Time constant of slip compensation response	0～1000（set value 1=10ms）	1	10	
2009	Slip compensation multiple	0.01～2	0.01	1	
Pattern movement functions					
2101	1st Speed frequency	0～400Hz	0.01Hz	0	
2102	2nd Speed frequency	0～400Hz	0.01Hz	10	
2103	3rd Speed frequency	0～400Hz	0.01Hz	20	
2104	4th Speed frequency	0～400Hz	0.01Hz	30	
2105	5th Speed frequency	0～400Hz	0.01Hz	40	
2106	6th Speed frequency	0～400Hz	0.01Hz	50	
2107	7th Speed frequency	0～400Hz	0.01Hz	60	
2108	8th Speed frequency	0～400Hz	0.01Hz	0	
2109	9th Speed frequency	0～400Hz	0.01Hz	0	
2110	10th Speed frequency	0～400Hz	0.01Hz	5	
2111	11th Speed frequency	0～400Hz	0.01Hz	15	
2112	12th Speed frequency	0～400Hz	0.01Hz	25	
2113	13th Speed frequency	0～400Hz	0.01Hz	35	
2114	14th Speed frequency	0～400Hz	0.01Hz	45	
2115	15th Speed frequency	0～400Hz	0.01Hz	55	
2116	16th Speed frequency	0～400Hz	0.01Hz	0	
2201	Scheduled operation function	0: Normal operation 1: Scheduled operation 2: Disturbed operation	1	0	
2202	Simple scheduled operation repetitions	0：continuous 1～250：Repetition count	1	1	
2203	Operation timer T1	0～65000sec	1sec	10	
2204	Operation timer T2	0～65000sec	1sec	10	
2205	Operation timer T3	0～65000sec	1sec	10	
2206	Operation timer T4	0～65000sec	1sec	10	
2207	Operation timer T5	0～65000sec	1sec	10	
2208	Operation timer T6	0～65000sec	1sec	10	
2209	Operation timer T7	0～65000sec	1sec	10	
2210	Operation timer T8	0～65000sec	1sec	10	

2211	Operation timer T9	0～65000sec	1sec	10	
2212	Operation timer T10	0～65000sec	1sec	10	
2213	Operation timer T11	0～65000sec	1sec	10	
2214	Operation timer T12	0～65000sec	1sec	10	
2215	Operation timer T13	0～65000sec	1sec	10	
2216	Operation timer T14	0～65000sec	1sec	10	
2217	Operation timer T15	0～65000sec	1sec	10	
2218	Operation stop timer T0	0～65000sec	1sec	10	
2219	Midway stop deceleration time	1: 1st deceleration time (value of F1016) 2: second deceleration time (value of F1017) 3: third deceleration time (value of F1018) 4: forth deceleration time (value of F1019)	1	1	
2220	Midway start acceleration time	1: 1st acceleration time (value of F1012) 2: second acceleration time (value of F1013) 3: third acceleration time (value of F1014) 4: forth acceleration time (value of F1015)	1	1	
2221	T1 Forward/reverse rotation·accelration/deceleration	X Y X…1: forward rotation 2: reverse rotation Y…1 ～ 4: specified acceleration, deceleration time	---	11	
2222	T2 Forward/reverse rotation·accelration/deceleration		---	11	
2223	T3 Forward/reverse rotation·accelration/deceleration		---	11	
2224	T4 Forward/reverse rotation·accelration/deceleration		---	11	
2225	T5 Forward/reverse rotation·accelration/deceleration		---	21	
2226	T6 Forward/reverse rotation·accelration/deceleration		---	21	
2227	T7 Forward/reverse rotation·accelration/deceleration		---	21	
2228	T8 Forward/reverse rotation·accelration/deceleration		---	11	
2229	T9 Forward/reverse rotation·accelration/deceleration		---	11	
2230	T10 Forward/reverse rotation·accelration/deceleration		---	11	
2231	T11 Forward/reverse rotation·accelration/deceleration		---	11	
2232	T12 Forward/reverse rotation·accelration/deceleration		---	21	
2233	T13 Forward/reverse rotation·accelration/deceleration		---	21	
2234	T14 Forward/reverse rotation·accelration/deceleration		---	21	
2235	T15 Forward/reverse rotation·accelration/deceleration		---	21	
2236	Analog input switch of perturbation modulation	0: no analog input 1: external analog VRFI voltage (0～5V) 2: external analog VRFI voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRF current (4～20mA)	1	0	
2237	Perturbation modulation ratio	0～50%	1%	0	
PID functions					
3001	PID1 command value input switch	1: frequency 2: external analog VRFI voltage (0～5V) 3: external analog VRFI voltage (0～10V or potentiometer) 4: external analog VRF/IRF voltage (0～5V) 5: external analog VRF/IRF voltage (0～10V or potentiometer) 9: external analog VRF/IRF current (4～20mA) 11: function code setting (F3017)	1	1	
3002	PID1 feedback input switch	0: no input 1: external analog VRFI voltage (0～5V) 2: external analog VRFI voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRF current (4～20mA) 10: communication method	1	0	
3003	PID1 control proportional gain	0～100	0.01	0.1	
3004	PID1 control integral time	0.01～100sec	0.01sec	0.1	
3005	PID1 control differential time	0～100sec	0.01sec	0	
3006	PID1 control integral separation judgement value	5～100% (maximum frequency reference)	0.1%	20	
3007	PID1 feedback signal input filter time constant	1～500（set value1=10ms）	1	10	

3008	Indirect PID1 input reference	5～100%（objective reference）	0.1%	20	
3009	PID1 deviation limit	0: no limitations 1～100% (maximum frequency reference)	0.1%	100	
3010	PID1 output limit	0: no limitations 1～100% (maximum frequency reference)	0.1%	100	
3011	PID1 operation of polarity switching	1: command value-feedback value 2: feedback value- command value	1	1	
3012	PID1 gain polarity switching	1: same gain for positive and negative deviations 2: different gain for positive and negative deviations	1	1	
3013	PID1 command value gain	0～50	0.01	1	
3014	PID1 feedback value gain	0～50	0.01	1	
3015	PID1 control proportional gain (negative: F3012=2)	0～100	0.01	0.1	
3016	PID1 control integration time (negative: F3012=2)	0.01～100sec	0.01sec	0.1	
3017	PID1 control command value	0～4000	0.1	0	
3018	PID1 control feedback value (communication function)	0～4000	0.1	0	
3019	Frequency corresponding to PID1 control maximum command value	0～400Hz	0.01Hz	60	
3101	PID2 command value input switch	1: frequency 2: external analog VRFI voltage (0～5V) 3: external analog VRFI voltage (0～10V or potentiometer) 4: external analog VRF/IRF voltage (0～5V) 5: external analog VRF/IRF voltage (0～10V or potentiometer) 9: external analog VRF/IRF current (4～20mA) 11: function code setting (F3117)	1	0	
3102	PID2 feedback input switch	0: no input 1: external analog VRFI voltage (0～5V) 2: external analog VRFI voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRF current (4～20mA) 10: communication method	1	0	
3103	PID2 control proportional gain	0～100	0.01	0.1	
3104	PID2 control integral time	0.01～100sec	0.01sec	0.1	
3105	PID2 control differentiation time	0～100sec	0.01sec	0	
3106	PID2 control judgement value integral separation	5～100% (maximum frequency reference)	0.1%	20	
3107	PID2 feedback signal input filter time constant	1～500（set value1=10ms）	1	10	
3108	Indirect PID2 input reference	5～100% (target value reference)	0.1%	20	
3109	PID2 deviation limit	0: no limitations 1～100% (maximum frequency reference)	0.1%	100	
3110	PID2 output limit	0: no limitations 1～100% (maximum frequency reference)	0.1%	100	
3111	PID2 operation polarity switch	1: command value-feedback value 2: feedback value-command value	1	1	
3112	PID2 gain polarity switch	1: same gain for positive and negative deviations 2: different gain for positive and negative deviations	1	1	
3113	PID2 command value gain	0～50	0.01	1	
3114	PID2 feedback value gain	0～50	0.01	1	
3115	PID2 control proportional gain (negative: F3012=2)	0～100	0.01	0.1	
3116	PID2 control integral time (negative: F3012=2)	0.01～100sec	0.01sec	0.1	
3117	PID2 control command value	0～4000	0.1	0	
3118	PID2 control feedback value (communication function)	0～4000	0.1	0	
3119	Frequency corresponding to PID2 control maximum command value	0～400Hz	0.01Hz	60	
3123	PID start method selection	1: Direct input mode 2: Conditional input mode	1	1	
3124	PID end method selection	1: Direct end mode 2: Conditional end mode	1	1	
3125	PID end setting value	1 - 100% (upper frequency limit standard)	0.1%	20	
3127	for factory adjustment				
3128	Upper-end baseline of PID feedback abnormality	1～100%	0.1%	100.0	
3129	lower-end baseline of PID feedback abnormality	0～100%	0.1%	0.0	
3130	PID variable gain options	0: PID variable gain invalid 1: PID variable gain valid	1	0	
3131	PID variable proportional gain	0～100	0.01	0.10	
3132	PID variable integration time	0.01～100sec	0.01sec	0.10	
3133	PID variable differentiation time	0～100sec	0.01sec	0.00	
3134	Upper-end of frequency with PID variable gain	0～240Hz	0.01Hz	10.00	

3135	lower-end of frequency with PID variable gain	0～240Hz	0.01Hz	30.00	
3201	PID control action selection	0: open-loop control 1: PID1 control 2: PID2 control 4: PID control of external terminal switching 5: PID control of timed swicthing	1	0	
3202	for factory adjustment				
3203	External PID control selection	0: no external PID control 1: PID1 external control 2: PID2 external control 4: external control of PID1 and PID2 5：for factory adjustment 6：for factory adjustment	1	0	
3204	External PID operation mode selection	1: linked running with inverter 2: PID output after power connection 3: PID output controlled by external terminal	1	1	
3205	PID combination selection	0: without command value addition calculation 1: with command value addition calculation	1	0	
3206	Command value addition calculation PID control gain	0.01～100	0.01	1	
3207	PID1/PID2 switching time	0.1～6000minutes	0.1minutes	0.1	
3301	Read PID1 command value	Only for reading	1	---	
3302	Read PID1 feedback value	Only for reading	1	---	
3303	Read PID1 input deviation	Only for reading	1	---	
3304	Read PID1 output deviation	Only for reading	1	---	
3305	Read PID2 command value	Only for reading	1	---	
3306	Read PID2 feedback value	Only for reading	1	---	
3307	Read PID2 input deviation	Only for reading	1	---	
3308	Read PID2 output value	Only for reading	1	---	
Water supply functions					
3401	Water supply mode options	0: water supply function invalid; 1: single-pump mode	1	0	
3402	Continuation time of lower limit T1	0.1～10 minutes	0.1minutes	5	
3403	Sleep/wakeup switching ratio K	30～95％	1%	50	
3404	Determination time of sleep/wakeup reset Tp	0.1～10minutes	0.1minutes	5	
3405	Pressure command Pref	0～9.999MPa	0.001MPa	0	
3406	Upper limit of pressure of analog value feedback	0～±9.999MPa	0.001MPa	1	
3407	Lower limit of pressure of analog value feedback	0～±9.999MPa	0.001MPa	0	
3408	Maximum pressure value Ph	0.001～9.999MPa	0.001MPa	1	
3409	Minimum pressure value Pl	0～9.999MPa	0.001MPa	0	
3410	Slope of pressure in acceleration and deceleration	0.001～9.999MPa	0.001MPa	0.1	
3411	Allowed deviation during motor switching	0.0-20.0%	0.1%	0.0	
Communication functions					
4001	Message checksum	0：no 1：yes	1	1	
4003	Pull up/down function selection	0：no 1：yes	1	1	
4004	communication response time	10～4000ms	1ms	10	
4005	Serial communication function	0：null 1: Dedicated protocol communication function 2: ModBus communication function	1	1	
4006	Inverter number	0～254；dedicated for Modbus (1～32；RS485 during communication)	1	1	
4007	Communication speed	1：1200bps 2：2400bps 3：4800bps 4：9600bps 5：19200bps 6：38400bps 7：57600bps	1	4	
4008	Partity bit	0：no 1: odd number 2: even number	1	1	
4009	Stop bit	1: 1 bit 2: 2 bits	1	1	
4010	Stop bit	0：CR+LF 1：CR	1	0	

4011	Selection of inverter communication return of specified commands	0: return 1: no return (return with error) 2: no return (return without error)	1	0	
4101	Timeout setting of ModBus communication	0：null 0.01～600sec	0.01sec	0	
4102	ModBus communication timeout action	0: keep the status 1: stop wth alarm	1	0	
4103	Modbus register address switching	0: register No. A 1: register No. B	1	0	
Motor parameters					
5001	Motor poles, voltage and capacity	X Y ZZZ X: number of poles Y: rated voltage Z: motor capacity	—	※ 1	
5002	Motor current rating	0.1～999.9A around 30～110% of the inverter's rated current	0.1A	※ 1	
5003	Motor frequency rating	10～400Hz	1Hz	※ 1	
5004	Motor rotation speed rating	0～24000 rpm	1rpm	※ 1	
5005	Motor insulation type	1: Type A 2: Type E 3: Type B 4: Type F 5: Type H	1	※1	
5006	Rated voltage during motor parameter auto-tuning	0: use voltage chosen in F5001 100～460V	1V	0	
5007	Rated motor slip ratio	0～50%	0.1%	2	
5008	Motor parameter auto-tuning range	0: no range 50～300%	0.1%	200	
5009	Motor stator resistance	55kWbelow 0.001～65Ω	0.001Ω	※1	
		75kWabove 0.01～650mΩ	0.01mΩ		
5010	Motor rotor Resistance	55kWbelow 0.001～65Ω	0.001Ω	※1	
		75kWabove 0.01～650mΩ	0.01mΩ		
5011	Motor stator Inductance	55kWbelow 0.1～6000mH	0.1mH	※1	
		75kWabove 0.01～600mH	0.01mH		
5012	Motor stator Inductance	55kWbelow 0.1～6000mH	0.1mH	※1	
		75kWabove 0.01～600mH	0.01mH		
5013	Motor mutual inductance	55kWbelow 0.1～6000mH	0.1mH	※1	
		75kWabove 0.01～600mH	0.01mH		
5014	Motor excitaion current	0.01～650A	0.01A	※1	
5015	Inertia of motor rotation	0～65kgm^2	0.001kgm^2	※1	
5016	Rotation inertia ratio of load	1～200time	0.01time	1	
Vector control					
6001	Torque limiter (power running)	A Mode 0～200%	0.1%	150	
		B Mode 0～150%	0.1%	120	
6002	Analog input function of torque limiter (power running)	0：F6001 1: external analog VRF voltage (0～5V) 2: external analog VRF voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRFcurrent (4～20mA)	1	0	
6003	Torque limiter (regeneration)	A Mode 0～200% B Mode 0～150%	0.1%	100	
6004	Analog input function of torque limiter (regeneration)	0: F6003 1: external analog VRF voltage (0～5V) 2: external analog VRF voltage (0～10V or potentiometer) 3: external analog VRF/IRF voltage (0～5V) 4: external analog VRF/IRF voltage (0～10V or potentiometer) 8: external analog VRF/IRF current (4～20mA)	1	0	
6005	Multiples of startup excitation current	0.1～2 times (corresponding to suitable motor)	0.01time	1	
6006	Time of startup excitation	0: no startup excitation 0.1～10 seconds	0.1sec	※1	
6007	Multiples of braking excitation current	0.1～2 times (corresponding to suitable motor)	0.01time	1	
6008	Time of braking excitation	0: no braking excitation 0.1～10 seconds	0.1sec	1	
6009	Gain compensation of current control	0.5～1.5	0.01	1	
6010	ASR proportional gain of speed control	0.01～150%	0.01%	※1	
6011	ASR integration time of speed control	0～20sec	0.001sec	※1	
6012	Cutoff frequency of detected speed fitler	0：null	0.01Hz	0	

		0.01～400Hz			
6013	Cutoff frequency of detected torque fitler	0：null 0.1～4000Hz	0.1Hz	0	
6014	Motor vibration reduction rate	0：null 1：75% 2：50% 3：25%	1	0	
6015	Lower frequency limit for motor vibration reduction function	0～240Hz	0.01Hz	0	
6016	Upper frequency limit for motor vibration reduction function	0～240Hz	0.01Hz	0	
6017	Startup torque	0～100%	0.1%	30	
6018	Lasting time of startup torque	0～6500sec	0.1sec	1	
6019	Variable second gain of speed control	0: no variable gain function 0.01～150%	0.01%	15	
6020	Frequency bottom of variable gain for speed control	0～240Hz	0.01Hz	10	
6021	Frequency top of variable gain for speed control	0～240Hz	0.01Hz	30	

During operation, the design value cannot be changed.

※1: Yes, representative parameters suitable for each model have been entered.

From ※2-1 to ※2-8, The following values have been entered for each type of inverter

Model	※2-1 F1012	※2-2 F1013	※2-3 F1014	※2-4 F1015	※2-5 F1016	※2-6 F1017	※2-7 F1018	※2-8 F1019
NS-4A061～4A152	30	60	90	120	30	60	90	120
NS-4A173～4A211	60	120	180	240	60	120	180	240
NS-4A253～4A590	75	150	225	300	75	150	225	300

※3: Data content and setting resolutions change with function codes. See 7-3 Description of Functions for details

Function Descriptions

7-3-1 Basic operation functions

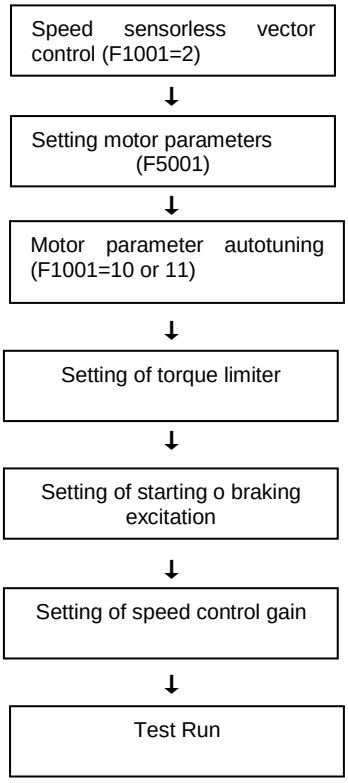
Basic function

F1001 Motor control mode selection

It is the function to select the motor control method.
This inverter only provides speed control (vector without speed sensor) mode, other control modes such as: speed vector control with sensor, torque (vector control with/without speed sensor), position control mode with speed sensor, although in the function description is reserved it is not applicable to this series of inverters.

Code No.	function name	Data content	Setting Resolution	Factory Presets
F1001	Motor control mode selection	1: V/f control mode 2: Speed control (speed sensorless vector control) 10: Auto tuning mode 1 11: Auto tuning mode 2 40: V・f separation control	1	1

F1001 = 1: the motor is controlled by the V/f graph set in V/f mode.
F1001 = 2: Speed control mode (speed sensorless vector control)
Speed control is a control mode that will maintain a constant speed regardless of what the load condition is. And, it is a control mode which allows the motor to generate high torque from the low-frequency field. In speed control, you can select speed sensorless vector control (F1001 = 2). The figure below shows the setting flow through which the vector speed control is realized.



(Related function codes)

- To carry out speed control mode selection, please refer to description of relevant parts of function code F6000.

Notes on use of speed control mode:

Note 1: When setting the control mode of speed sensorless vector control, the following conditions must be met.
1. One inverter to one motor.
2.The motor must be a Sanken designated 2, 4, 6 3-phase induction motor or a similar motor.
3.To inverter rated, motor capacity that can drive is one level lower the motor or standard applicable motor.
4. The wiring length between the inverter and the motor shall be less than 30 m. If the wiring length exceeds 30 m, conduct auto tuning of the motor parameters in advance using the auto tuning mode 2.
And, for vector control, the maximum wiring length shall be controlled within 100m.

Note 2: F5001 does not apply to the setting of 2 and 3 in Note 1, please set it correctly according to the above. And, the inverter action and control characteristics cannot be guaranteed where the F5001's setting does not match ratings of the connected motor.

Note 3: In the speed sensorless vector control mode, motor parameters, control frequency and voltage are used to drive the motor, therefore control characteristics depend on motor parameters, and the best performance may not be achieved depending

on the motor. If motor characteristics, etc. are not mastered, auto measurement of motor constant shall be carried out using auto tuning, and, the use of V/f mode of which the control characteristics do not depend on motor parameters is recommended for control.

Note 4: When setting speed sensorless vector control mode, the following function codes shall be limited.

F1004 - F1008: setting inactive

F1102 (Starting method) =3 (started by starting frequency after DC braking): setting inactive. Starting excitation shall be made by setting starting excitation time (F6006), and then the operation shall be started by starting frequency according to the setting values of operation start frequency (F1104) and starting delay time (F1105).

F1103 (starting frequency): Although the setting is active, the minimum value is 0.2Hz in speed sensorless vector control mode.

F1111 (braking method) =2: setting inactive. Braking excitation is made according to the setting of braking excitation time (F6008) when stopped. The relation between output frequency and the settings of F1104 and F1112 is handled in the same way with V/f mode.

F1113, F1114: Changed to F6007, F6008 for DC braking function.

F1701, F1703: Changed to F6001, F6003 for current limiting.

Note 5: Others

1. Upper frequency limit (**F1007**) sets the motor's rated speed as the synchronous speed, please set the frequency specified by the motor's number of poles as the maximum value of frequency setting. The operation is a weak magnetic-controlled constant power operation where the frequency setting values above rated frequency (F5003) are used to drive motor, however, do not set the upper frequency limit too much higher than the rated frequency as it may cause mechanical damage to the motor.
2. When output is stable, because the motor's speed is controlled to keep it constant, the frequency that the inverter outputs constantly changes. In contrast to the case of the V/f mode, the set frequency and the output frequency do not necessarily coincide when output is stable. Therefore, the output frequency may exceed the set frequency.
3. Frequency arrival and frequency matching set by F1509 - F1511 determine when the output frequency reaches or matches the set frequency. Therefore, for the frequency matching function, set the Range of frequency consistency (F1508) to a few Hz because of the reason described in 2.
4. All values output to the operation panel's 7-segment monitor are based on the output frequency. In the frequency display mode, the output frequency is displayed. In case of speed and no-units display, estimated speed is displayed in speed sensorless vector control; and detected speed is displayed in speed sensor vector control.

F1001=10, 11: Motor parameter auto tuning mode 1, 2

· Auto tuning is an integrated function inside the inverter, which auto detects connected motor's parameters. This function applies to the motor of which the parameters are completely unknown and is a very effective detection function for speed sensorless vector control when the wiring length between the inverter and the motor exceeds 30m.

· The auto tuning function has two modes.

1. Auto tuning mode 1 (F1001 = 10): a mode for detecting motor parameters when the motor shaft is not rotating. It is used when auto tuning mode 2 can not be executed.
2. Auto tuning mode 2 (F1001 = 11): a mode for detecting motor parameters by rotating motor shaft.

* See 6-2-6 for details and sequence of auto tuning.

● F1001=40: V•f separation control

· A function which can set the inverter 's output frequency and output voltage independently.

· The control mode is V/f mode.

· F2001: Through V•f separation selection, you can choose complete separation or V•f proportional separation.

(Related function codes)

See the following function codes for details of V•f separation function.

F2001 V•f separation function selection

F2002 V•f separation command voltage

F1002 1st speed frequency setting selection

A function for selecting the frequency setting method for the 1st speed frequency operation.

Code No.	Function Name	Data Content	Setting Resolution	Factory Presets
F1002	1st speed frequency setting selection	1: Operation panel 2: External analog VRF1 voltage (0-5V) 3: External analog VRF1 voltage (0-10V or potentiometer) 4: External analog VRF/IRF voltage (0-5V) 5: External analog VRF/IRF voltage (0-10V or potentiometer) 9：External Analog VRF/IRF current （4～20mA） 11：External Analog VRF1 voltage +VRF/IRF voltage 14：External Analog VRF1 voltage -VRF/IRF voltage 15：External Analog VRF/IRF voltage -VRF1 voltage 16：External Analog VRF1 voltage 18：External Analog VRF1 voltage + VRF/IRF current 19：External Analog VRF1 voltage -VRF/IRF current 20：External Analog VRF1 current -VRF/IRF voltage 21：Terminal block stepping 22：Communication 26：External Analog VRF1 forward/reverse operation（0～10V、5Vreference） 27：External Analog VRF/IRF forward/reverse operation （0～10V、5Vreference）	1	1

• Reading analog frequency

· A function which takes the result of calculation of the 2 channels of control circuit 's analog input terminals VRF1, VRF/IRF, VIF3 (frequency command) carried out internally by the inverter as the inverter 's command frequency. The inverter converts the input command of each channel into a frequency by adjusting the bias and gain code. The results are added or subtracted

according to the value of F1002.

- A negative result is always regarded as 0. The upper limit of the calculation result is determined using the upper frequency limit (F1007, F1316 and F1317).

- F1002 = 21: Terminal block stepping function.

  This function allows the target frequency to be increased or decreased under ON/OFF status control of the external control terminals. This function is useful when it is difficult to input an external analog frequency or to set a frequency from the operation panel.

  1) Related function codes and multifunctional input terminals

Function code	Inverter control terminal	
F1002=21	AD2	Up terminal
	AD3	Down terminal
	COM1	Digital signal common terminal
	COM2	Digital signal common terminal

- If the 1st speed frequency selection is set to terminal block stepping (F1002= 21), a frequency setting value can be entered only from external control input terminals AD2 and AD3 of the inverter host.

  Note: The frequency cannot be changed from the operation panel.

- It is a function which takes AD2 terminal as the Up terminal of the set frequency and AD3 terminal the Down terminal of the set frequency.

  Note: When F1002=21 is selected, the AD2 and AD3 terminals set using F1414-F1421 can not be used for the 2nd, 3rd, or 4th acceleration/deceleration command.

2) Increasing or decreasing the set frequency

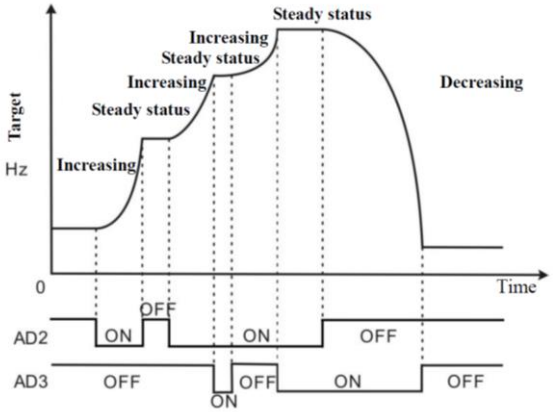
- Increasing the set frequency

Short-circuit the inverter 's external control terminal AD2 to the DCM1 or DCM2 terminal. The set frequency increases gradually from the current value.

- Decreasing the set frequency

Short-circuit the inverter 's external control terminal AD3 to the DCM1 or DCM2 terminal. The set frequency decreases gradually from the current value.

- Change of frequency display becomes rapid gradually from a low value.



Note 1: The terminal block stepping function is used not only for setting the 1st speed frequency but also for setting the frequencies for multiple speeds. For example, short-circuit the 2nd speed selection terminal 2DF (inverter control terminal) and the DCM1, if the terminal block stepping increases when setting a frequency for the 2nd speed, the set frequency for the second speed will change. But, when changing multi-segment speed during increasing or decreasing action of the terminal block, the increasing or decreasing action of segments which started before change will be stopped, and the increasing or decreasing action of segments after change will be started.

Note 2: The step function is disabled when the function lock (F1603=1, 3) is selected or at undervoltage.

Note 3: When the terminals AD2 and AD3 are both connected to either DCM1 or DCM2 in short circuit or both left open, the set frequency remains unchanged. (Maintain the current status)

Note 4: The frequency setting value for the increasing or decreasing or clearing by terminal block stepping function is determined by the current multi-speed frequency codes (F1021, F2101-F2116).

- Others

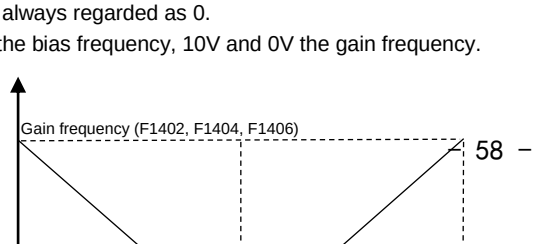
  Note: Even if F1002 = 2 - 20, 26 - 28 is selected, the frequency setting value in multi-segment speed (2nd - 8th speed) operation or JOG operation is still the value set by F2102 - F2116 or F1201.

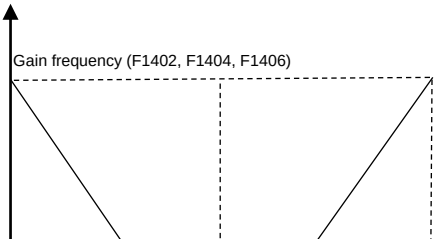
- **F1002=22: Communication**: A function which sends special commands from the PC etc. to the inverter. See Chapter 7 Communication Function for frequency setting method.
- **F1002=25: Pulse train input （option function）** The target frequency is determined with the pulse from the pulse train input by PG pulse as the 1st speed frequency command. The places for pulse input are A + and A- of the control circuit terminal. See 4-6-1 for terminal configuration.
- **F1002 = 26, 27: Analog forward / reverse runn**

• This function is a function which runs in the same direction with command direction at 5 - 10V and the opposite direction to command direction at 5 - 0V based on 5V of VRF input as the center.

• · The input of each channel shall be converted into a frequency according to its bias and gain code. A negative result is always regarded as 0.

• 5V is the bias frequency, 10V and 0V the gain frequency.





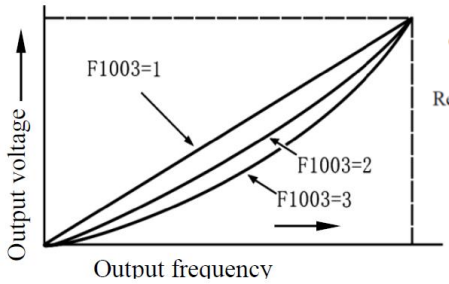
Target frequency

Target frequency

F1003 V/f pattern selection

A function for selecting linear characteristics or square-law decreasing characteristics for V/f pattern.

Code No.	Function Name	Data Content	Setting Resolution	Factory Presets
F1003	V/f pattern selection	1: Linear pattern 2: Square-law decreasing pattern (weak) 3: Square-law decreasing pattern (strong)	1	1



● Arbitrary V/f pattern can be set in linear V/f pattern. (Active when special motors are used.)

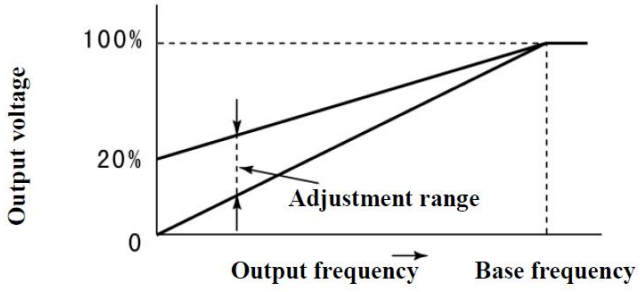
Reference parameter
F2003 (Arbitrary V/f pattern intermediate voltage 1)
F2004 (Arbitrary V/f pattern intermediate voltage 2)
F2005 (Arbitrary V/f pattern intermediate frequency 1)
F2006 (Arbitrary V/f pattern intermediate frequency 2)

F1004 **Torque boost**

A function which adjusts the V/f pattern shown in the figure below to compensate for torque deficiency of the motor in the low frequency zone.

Code No.	Function Name	Data Content	Setting Resolution	Factory Presets
F1004	Torque boost	0～20%	0.1%	※

※ The representative parameters that are suitable for various models have been input.



● An excessive increase will cause overcurrent, possibly activating output current limiting function. To avoid this, make adjustment while confirming the output current.
Note: The torque boost is active only in the V/f control mode.

F1005 Base voltage

F1006 Base frequency

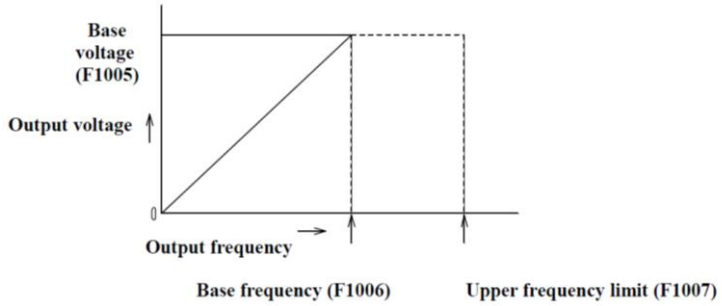
A function for determining an Arbitrary V/f pattern to match the motor 's characteristics. Set the Base voltage and Base

frequency.

Code No.	Function Name	Data content		Setting Resolution	Factory Presets
F1005	Base voltage	200Vclass	0：No AVR 50～240V	1V	※
		400Vclass	0：No AVR 50～460V		
F1006	Base frequency	0.1～400Hz		0.01Hz	※

※ The representative parameters that are suitable for various models have been input.

- **F1005=0:** The base voltage is equal to the highest possible output voltage that is determined by the input voltage. No automatic output voltage regulation will be performed.
- **F1005=50-460[V]**: base voltage. Automatic regulation of output voltage will be performed. (200V class: 50-240[V].)



Note: The inverter can not output a voltage higher than the input voltage. Therefore, the automatic regulation range specified by this function is a range of maximum possible output range determined by input voltage. For example,
F1005= 460V may be set even if used in a 400V class distribution system. However, such a setting will only serve to make the V/f pattern steeper, the actual output voltage can not reach 460V.

F1007 Upper frequency limit

F1008 Lower frequency limit

Set the upper and lower limits of the output frequency.

Code No.	Function name	Data content	Setting resolution	Factory preset
F1007	Upper frequency limit	5～400Hz	0.01Hz	60
F1008	Lower frequency limit	0.05～200Hz	0.01Hz	0.05

● Because misoperation of the operation panel or wrong actions of external frequency command signals may cause over frequency, these functions are used for protection of possible speed range required by the mechanical side.

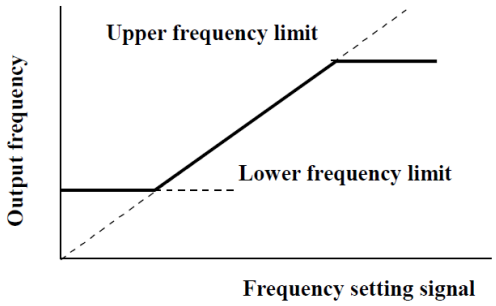
● Although a target frequency setting may exceed the upper frequency limit, the output frequency can not rise to a value higher than the upper frequency limit.

● Although a target frequency setting may be below the lower frequency limit, an output frequency lower than the lower limit is not actually output in constant speed operation.

● In case of lower frequency limit setting, please set it with a value greater than the starting frequency (F1103) and the operation start frequency (F1104).

Note 1: In vector control mode, the maximum limit of the upper frequency limit is 240Hz. (For 2-pole motor, the maximum limit is 120Hz.)

Note 2: In speed sensorless vector control mode, the minimum limit of the lower frequency limit is 0.2Hz.



F1009 Carrier frequency adjustment

A function for setting carrier frequency of the inverter.

Code No.	Function name	Data content	Setting resolution	Factory preset
F1009	Carrier frequency adjustment	0～130	1	※

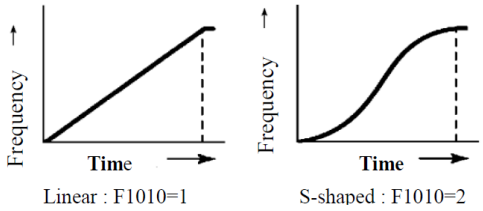
※ The representative parameters that are suitable for various models have been input.

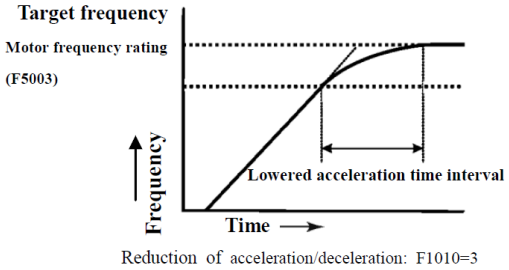
- As the value increases, the carrier frequency becomes higher. But, the maximum carrier frequency automatically varies depending on the operating status and motor capacity.
  Note 1: If the carrier frequency becomes low, the carrier noise from the motor will increase, but the leak current flowing to earth will decrease.
  Note 2: Raise the setting value of carrier frequency where the inverter is used in high frequency output applications.

F1010 Acceleration/deceleration curve

A function for selecting the frequency change mode from three modes: linear, S-Shaped and reduction of acceleration/deceleration.

Code No.	Function Name	Data Content	Resolution setting	Factory Presets
F1010	Acceleration/deceleration curve	1: Linear 2: S-Shaped 3: Reduction of acceleration / deceleration	1	1





- In linear mode, the frequency change is proportional to time.
- S-Shaped acceleration/deceleration right is effective in impact reducing at startup and shutdown. And, the shape of S-Shaped acceleration/deceleration curve can be changed according to F1022 - F1027 in the 1st S-Shaped graph, and F1028 - F1033 in the 2nd S-Shaped graph.
- The so-called Reduction of acceleration/deceleration function is a function which extends the acceleration/deceleration time as the torque decreases (If the output frequency is above the motor frequency rating, the torque will decrease).

F1011 Reference frequency for acceleration/deceleration

F1012 1st acceleration time

F1013 2nd acceleration time

F1014 3rd acceleration time

F1015 4th acceleration time

F1016 1st deceleration time

F1017 2nd deceleration time

F1018 3rd deceleration time

F1019 4th deceleration time

F1020 JOG acceleration/deceleration time

Four different acceleration slops and deceleration slops can be independently set according to four different acceleration times and deceleration times. And, F1020 is the function for setting acceleration and deceleration slopes in jog operation.

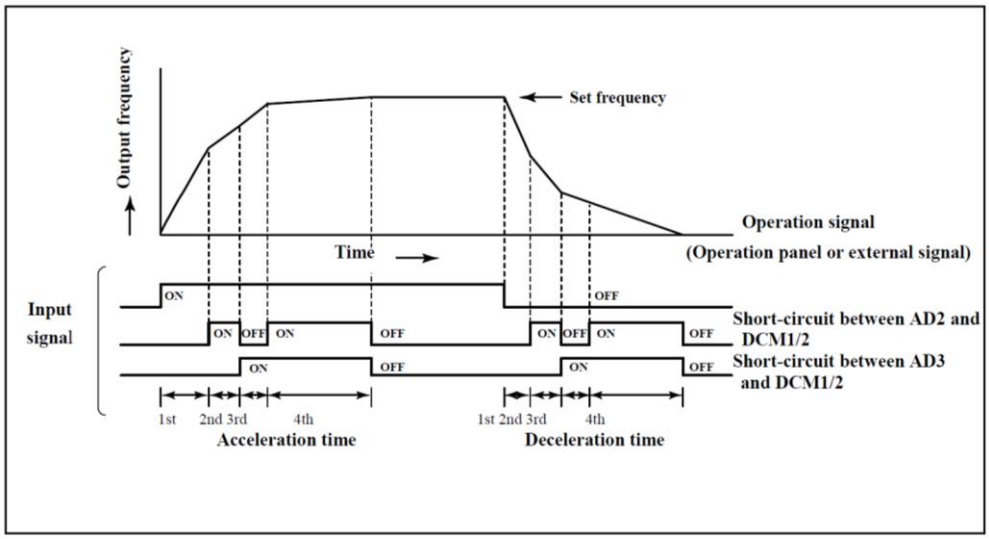
Code No.	Function name	Data content	Resolution setting	Factory preset
F1011	Reference frequency for acceleration/deceleration	1～120Hz	0.01 Hz	※
F1012	1st acceleration time	0～6500sec	0.1sec	※
F1013	2nd acceleration time	0～6500sec	0.1sec	
F1014	3rd acceleration time	0～6500sec	0.1sec	
F1015	4th acceleration time	0～6500sec	0.1sec	
F1016	1st deceleration time	0～6500sec	0.1sec	※
F1017	2nd deceleration time	0～6500sec	0.1sec	
F1018	3rd deceleration time	0～6500sec	0.1sec	
F1019	4th deceleration time	0～6500sec	0.1sec	
F1020	JOG acceleration/deceleration time	0～20sec	0.1sec	0.1sec

※ The representative parameters that are suitable for various models have been input.

Example) When F1011 = 50 Hz, F1012 = 5 seconds, the acceleration slope is set to 10Hz / s.

● In the V/f mode, even if the acceleration/deceleration time is set to 0 s, the actual value will still be 0.1 s.

● From the 2nd to the 4th acceleration/deceleration times are selected by the combination of signals input to control input terminals AD2 and AD3.



F1021	JOG frequency

A function for setting frequency in JOG operation.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1021	JOG freqeuncy	0～60Hz	0.01 Hz	5

- Selection of the jog operation mode (control input terminals JOG-DCM1 or JOG-DCM2 are short-circuited) allows the JOG frequency to be specified jointly by the operation panel 's quick knob and stepping mode.
  Note: As long as the JOG operation mode is selected, this mode takes precedence and cannot be changed to any other multi-speed frequency.

F1022	1st Start of S-shaped acceleration
F1023	1st End of S-shaped acceleration
F1024	Gradient of middle of 1st S-shaped Acceleration
F1025	1st Start of S-shaped deceleration
F1026	1st End of S-shaped deceleration
F1027	Gradient of middle of 1st S-shaped deceleration
F1028	2nd Start of S-shaped acceleration
F1029	2nd End of S-shaped acceleration
F1030	Gradient of middle of 2nd S-shaped Acceleration
F1031	2nd Start of S-shaped deceleration
F1032	2nd End of S-shaped deceleration
F1033	Gradient of middle of 2nd S-shaped deceleration

A function which provides variable shape of acceleration/deceleration curve when S-shaped acceleration/deceleration (F1010 = 2) is set in the acceleration / deceleration mode. Set F1414-F1421=84, and if the terminal is put at ON, the 2nd S shape is selected, and OFF the 1st S shape.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1022	1st Start S-shaped acceleration	0～200%	1%	50
F1023	1st End S-shaped acceleration	0～200%	1%	50
F1024	Gradient of middle of 1st S-shaped Acceleration	0～100%	1%	0
F1025	1st Start of S-shaped deceleration	0～200%	1%	50
F1026	1st End of S-shaped deceleration	0～200%	1%	50
F1027	Gradient of middle of 1st S-shaped Deceleration	0～100%	1%	0
F1028	2nd Start of S-shaped acceleration	0～200%	1%	50

F1029	2nd End of S-shaped acceleration	0～200%	1%	50
F1030	Gradient of middle of 2nd S-shaped Acceleration	0～100%	1%	0
F1031	2nd Start of S-shaped deceleration	0～200%	1%	50
F1032	2nd End of S-shaped deceleration	0～200%	1%	50
F1033	Gradient of middle of 2nd S-shaped Deceleration	0～100%	1%	0

● The acceleration, deceleration can be independently set by the shape of S-shaped acceleration/deceleration curve. And, the curvature of curves of S shape start part and arrival part and slope of middle of the S shape can be configured one by one.

F1022 - F1024, F1028 - F1030 are set for the acceleration, while the F1025 - F1033, F1031 - F1033 are set for the deceleration time.

The setting method is described as follows. Only the setting method for acceleration is illustrated since the same method is used for both acceleration and deceleration.

F1022=0-200%: Specify the curvature of curve of S-shaped acceleration start part.

(1% stepping) If set to 0, then the start part is linear acceleration, if set to 200, then the curvature becomes maximum.

F1023=0-200%: Specify the curvature of curve of S-shaped acceleration arrival part.

(1% stepping) If set to 0, then the arrival part is linear acceleration, if set to 200, then the curvature becomes maximum.

F1024=0-100%: Set slope of middle of S-shaped acceleration.

(1% stepping) If set to 0, then the slope set by F1011 - F1015 is selected, if set to 100, the slope two times the value set by F1011 - F1015 is selected.

● If the setting value of S-shaped acceleration/deceleration is changed, the new setting value will become active from the next acceleration/deceleration.

● In S-shaped acceleration/deceleration mode, the frequency arrival time changes depending on the setting values of F1022 - F1027. The calculation formula of arrival time is shown as follows.

$$Ts = \frac{T}{2} \times \left(\frac{200}{100 + \text{slope of middle of S shape}} + \frac{\text{S} - \text{shaped start curve} + \text{S} - \text{shaped arrival curve}}{200} \right)$$

Ts: Arrival time for S-shaped acceleration/deceleration mode (in seconds).
T: Arrival time for the setting value of F1011-F1019 in linear acceleration/deceleration mode (in seconds).
S-shaped start curve: Setting values (%) of F1022, F1025, F1028 and F1031.
S-shaped arrival curve: Setting values (%) of F1023, F1026, F1029 and F1032.
Slope of middle of S shape: Setting values (%) of F1024, F1027, F1030 and F1033

(Example) In case of change from 20Hz to 50Hz acceleration in 1st acceleration/deceleration,
F1011=50[Hz]: The setting value of acceleration/deceleration reference time.
F1012=5[s]: The setting value of acceleration time.
F1022=50[%]: S-shaped curve with medium-curvature start.
F1023=50[%]: S-shaped curve with medium-curvature arrival.
F1024=0[%]: The slope of middle part is the same with that in linear acceleration.

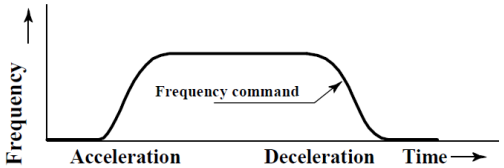
$$① \ T = \frac{5s}{50Hz} \times (50Hz - 20Hz) = 3s$$

$$② \ Ts = \frac{3s}{2} \times \left(\frac{200}{100 + 0} + \frac{50 + 50}{200} \right) = 3.75s$$

● Examples of S-shaped curves combined according to the set values are shown below. In each of these examples, acceleration/deceleration reference time and acceleration/deceleration time settings are set to the same value. F1011=50[Hz] / F1012=5[s] / F1016=5[s]

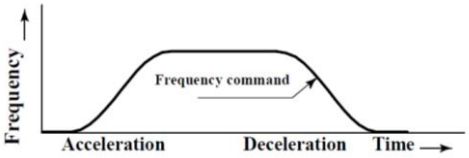
Example 1) F1022=100 F1023=100 F1024=100 F1025=100 F1026=100 F1027=100

- The arrival time is equal to that in linear acceleration / deceleration. However, since the slope of the middle portion is twice as that in linear acceleration/deceleration mode, the current limiting function may operate depending on the magnitude of the load inertia.

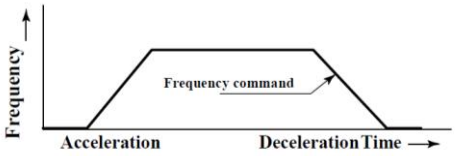


Example 2) F1022=100 F1023=100 F1024=100 F1025=100 F1026=100 F1027=100.

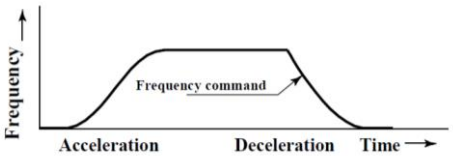
- The curvature of the S-shaped acceleration/deceleration's start portion and end portion become maximum, and the slope of the S-shaped acceleration/deceleration ‘s middle portion becomes the same as that in the linear acceleration/deceleration mode.



Example 3) F1022=0 F1023=0 F1024=0 F1025=0 F1026=0 F1027=0.
The result is the same with that in the linear acceleration/deceleration mode.



Example 4) F1022=100 F1023=100 F1024=0 F1025=0 F1026=0 F1027=100.
This setting value applies to the acceleration/deceleration of loads with square-law decreasing torque (such as fan



Note: Notes on use of S-shaped acceleration/deceleration

1. In case of frequency setting change in S-shaped acceleration/deceleration, S-shaped acceleration/deceleration shall be restarted from its starting point under new frequency setting. Therefore, the change in actual output frequency is not a smooth curve at the starting point of frequency change.

2. If F1002 is set to 2-20, and frequency is set through the external analog signal, the analog signal will constantly change due to influence overlap of interference component and the ripple component etc. Therefore, in this case, the possibility that the change of actual output frequency can not form a smooth curve exists because of the reason described in 1. At this point, please increase the analog signal filter time constant of F1407 - F1409 and detect effective number of bits by further adjusting the VIF of F1423 - F1425 to achieve stable analog signal.

3. In case of frequency locking (forward run signal and reverse run signal are input at the same time in operation of external terminals), if acceleration / deceleration is interrupted at a time point, the output frequency value will remain fixed. At the frequency unlocking time point, it will return to the original S-shaped acceleration/deceleration for the remaining frequency change.
Example) If the frequency is locked at 20Hz during acceleration from 10Hz to 50Hz, stable operation will be kept at the locked frequency 20Hz, and S-shaped acceleration will restart from 20Hz to 50Hz when the frequency is unlocked.

4. In the S-shaped acceleration/deceleration, the change of acceleration/deceleration time (F1011- F1019) becomes active from the next acceleration/deceleration. Similarly, when switched to other acceleration/deceleration mode controlled by external control terminals in acceleration/deceleration (2nd acceleration/deceleration, etc.), it also becomes active from the next acceleration/deceleration

5. In case of current limiting function in S-shaped acceleration/deceleration, the remaining acceleration/deceleration is temporarily changed to linear acceleration/deceleration to carry out acceleration/deceleration.

6. The acceleration/deceleration is carried out according to linear acceleration/deceleration curve when current limiting function works in stable condition.

7. The acceleration/deceleration is also carried out according to S-shaped acceleration/deceleration curve in JOG operation.

F1034	1st Speed frequency selection A

F1035	1st Speed frequency selection B

F1036	1st Speed frequency selection C

Through configuring this function, the setting method of 1st speed frequency can be selected using the terminal block.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1034 F1035 F1036	1st Speed frequency Selection A 1st Speed frequency Selection B 1st Speed frequency Selection C	1：Operation panel 2：External Analog VRF1 voltage （0～5V） 3：External Analog VRF1 voltage （0～10Vor potentiometer) 4：External Analog VRF/IRF voltage （0～5V） 5：External Analog VRF/IRF voltage （0～10Vor potentiometer) 9：External Analog VRF/IRF current （4～20mA） 21：Terminal block stepping 22：Communication 25：Pulse train input 26：External analog VRF1 forward / reverse run operation (0 - 10V, 5V reference) 27: External analog VRF/IRF forward / reverse run operation (0 - 10V, 5V reference)	1	1

- This function is a function for switching the setting methods of 1st speed frequency by use of 1DFA and 1DFB terminals. Depending on the status of 1DFA and 1DFB terminals, the setting methods of 1st speed frequency can be changed as the table below. 1DFA 1DFB

1DFA	1DFB	1st speed frequency action
OFF	OFF	Determine the 1st speed frequency according to the method selected by F1002
ON	OFF	Determine the 1st speed frequency according to the method selected by F1034
OFF	ON	Determine the 1st speed frequency according to the method selected by F1035
ON	ON	Determine the 1st speed frequency according to the method selected by F1036

●See items of F1002 for input modes.
●Even if 1DFA and 1DFB are ON, the frequency setting value in multi-segment speed (2nd - 16th speed) operation or JOG operation is still the value set by F1021 or F2102 - F2116.
●The same VIF input can be specified by F1002, F1034, F1035, and F1036.
●When any one code of F1034 - F1036 is set to VIF current input, the input resistance of VIF terminal changes as the switching of 1DFA and 1DFB. Please note this when using VIF current input.

F1037	Terminal block step set

This function is valid when the setting mode of the 1st speed frequency is selected as the terminal block stepping function (F1002=21). At this time, the setting value of F1037 is the frequency change per second during stepping. When using this function, please follow the instructions when F1002=21.
About the operation panel display frequency when using the step function: During operation, if AD2 or AD3 is ON, the panel will display the set frequency; when AD2 or AD3 are both OFF, the current output frequency will be displayed after 1 second. When stopped, the panel displays the set frequency.

F1038	Keep or clear frequency

This function is valid when the setting mode of the 1st speed frequency is selected as the terminal block stepping function (F1002=21). At this time, F1038 has three modes to choose from, but they can only be modified when the inverter is stopped and cannot be modified during operation.

・When F1038=0, the set frequency remains uncleared. Even if the converter is shut down or the power is OFF

・When F1038=1, the set frequency is cleared after the power is turned off. The inverter is powered on again, and the setting rate is 0.
When F1038≠1, keep the original set frequency unchanged after the inverter power is OFF

・When F1038=2, the set frequency is cleared after the inverter stops.
Regardless of whether it is a normal machine or an alarm shutdown, the set frequency will be cleared. Note: When F1038=2 is set, the instantaneous power failure restart function (F1108=1, 2) is invalid because the set frequency is cleared.

Starting·braking function

F1101 Operation command selection

A function for selecting whether the operation/stop command of inverter is sent through operation panel or through external signals.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1101	Operation command selection	1: Operation panel 2: External terminal 3: Communication 4：External terminal (three-wire type)	1	1

- When F1101=2 (external terminal), the input signals of control terminals FR and RR are active. Other control terminal inputs are always active because they are not related to F1101 data.
- The operation control authorization can be set using external terminals POPE and RCOM. When using external terminals, the operation control authorization is as shown in the table below.

ROPE	RCOM	Operation Control Authorization
OFF	OFF	The operation command under the mode selected by F1101 is active.
ON	OFF	The operation command from operation panel is active.
OFF	ON	The operation command from communication is active.
ON	ON	The operation command from terminal block (FR terminal or RR terminal) is active.

Note 1: When ROPE=OFF and RCOM=OFF, the operation control authorization of F1101 is active. When any one terminal of ROPE and RCOM is ON, the operation control authorization depends on the terminal status of ROPE and RCOM regardless of what the set status of F1101 is.

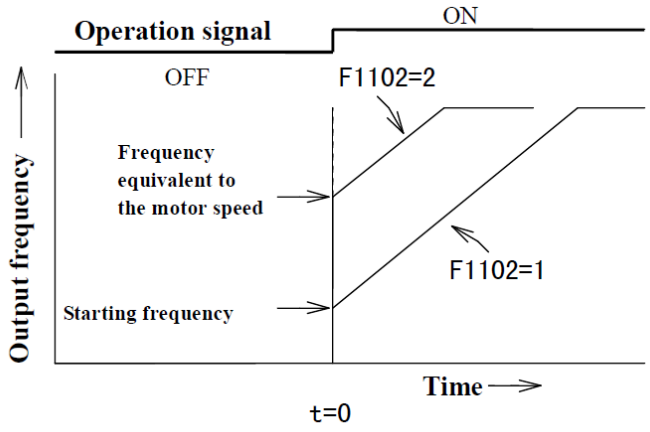
Note 2: Shutdown by『STOP』key on operation panel is always active regardless of the status of ROPE and RCOM terminals.

F1102 Starting method

A function for selecting the starting method.

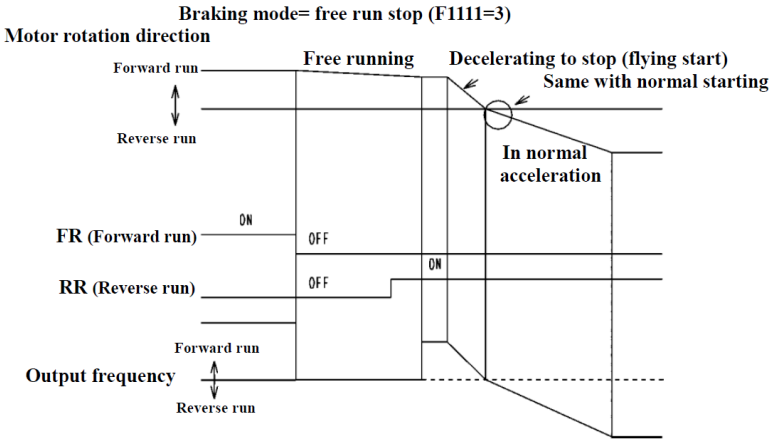
Code No.	Function name	Data content	Resolution setting	Factory preset
F1102	Starting method	1: Starting frequency 2: Flying start 3: Starting frequency after DC braking 4：External terminal (three-wire type)	1	1

- The so-called "flying start" is a method for starting from the frequency corresponding to the motor speed detected so as to reduce the impact at startup when the motor starts from idling condition. However, in this case, if there is an electromagnetic contactor between the motor and the inverter, please set the electromagnetic contactor ON in advance, and then input operation signal.
- The so-called "started by starting frequency after DC braking" means the motor is stopped by DC braking before being started in applications such as reverse run of fan against wind, in which the inverter is stopped while the motor is rotating due to other factors. This is an effective method to reduce the impact at startup. See F1112- F1114 for DC braking setting.
- Flying start is executed when the alarm is automatically reset and restarted after momentary power failure regardless of the setting



Note 1: The flying start function may not be effective when the capacity of the inverter is much larger than that of the motor or when the free-running speed of the motor is very low or in an environment tends to be disturbed.

Note 2: If the inverter starts a free-running motor with a low frequency, an excessive current may be generated and trip the circuit breakers. Thus, by detecting the rotational direction together not only the rotational speed, the motor is now possible to start a shock less than ever before. This function can start the motor in a predetermined rotation direction without any shock even when the motor is free-running in reverse, for example due to a back wind.



Note 3: In feedback control such as PID control etc., it is possible that the flying start does not happen when configuring the gain setting value or when affected by response speed of the system.

F1103 Starting frequency

The inverter starts to operate with this frequency. If the set frequency is lower than starting frequency, the inverter does not start.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1103	Starting frequency	0.05～60Hz	0.01Hz	1

Example 1) When setting F1103=20Hz for 50Hz operation, if operation signal is turned on, the inverter outputs 20Hz as the output frequency, and then goes up to 50Hz according to the specified acceleration slope.

Example 2) When setting F1103=20Hz for 15Hz operation, if operation signal is turned on, the inverter remains in standby and does not output.

- Once the inverter starts, it continues to run even if a frequency lower than the starting frequency (but higher than operation start frequency) is set..
- When inputting a stop signal, if the output frequency is below starting frequency, the inverter will stop outputting. (When DC braking function is disabled).

F1104 Operation start frequency

This frequency value is used to determine whether the inverter can operate or not.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1104	Operation start frequency	0～20Hz	0.01Hz	1

- If the set frequency equals or exceeds the levels of the operation start frequency and the starting frequency, the inverter starts operating at the starting frequency. And, if a frequency below the operation start frequency is set during operation, the inverter enters a standby state. And the output frequency drops to the starting frequency and then output stops. In this case, the operation mode indicator on the operation panel flashes, indicating the standby state. This function is useful for starting or stopping the inverter using only an external frequency command.

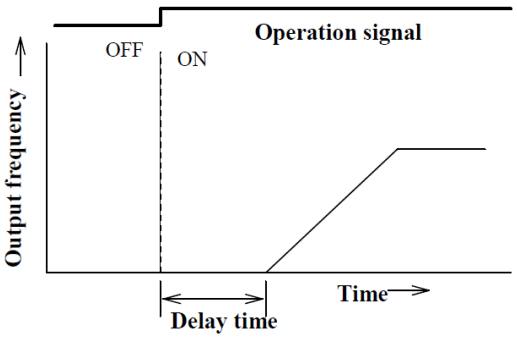
Example) F1104=20Hz, F1002=1 for the frequency setting using the operation panel. By using number button, the output starts when the command frequency is 20Hz or higher. At a frequency lower than 20Hz, the output frequency goes down to the starting frequency, and output stops.

F1105 Start delay time

This function is used to set the time until the inverter starts operation after inputting an operation signal.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1105	Start delay time	0～5sec	0.1	0

- This function is useful for setting the delay time with a sequence circuit for changeover between inverter/mains power, etc.
- When a switch between the motor and the inverter turns on at the same time as input of the operation signal, set F1105 to approximately 0.5 sec.



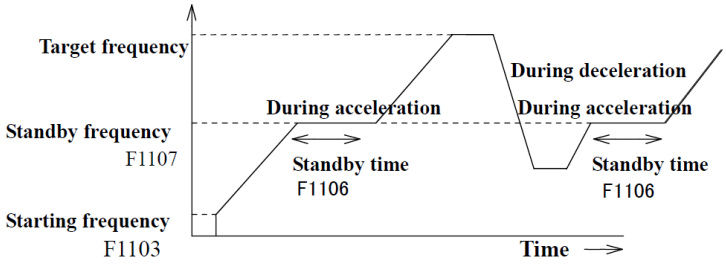
F1106 Start standby time

F1107 Start standby frequency

Through the use of output frequency standby function, this function is used to keep the big inertia load in temporary standby by increasing the frequency when starting and to increase frequency when the speed goes up, so as to facilitate a smooth acceleration.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1106	Start standby time	0.0～120.0sec	0.1sec	0
F1107	Start standby frequency	0.05～60.0Hz	0.01Hz	5

- In the F1106, if a value other than 0 is set, when the frequency set by F1107 is reached by acceleration, the frequency increase can be locked only by using the time set by F1106 (output frequency standby)
  Note 1: This function is inactive when the acceleration/deceleration curve is S-shaped curve (F1010 = 2).
  Note 2: If the starting frequency setting is higher than standby frequency, use the starting frequency to realize standby.
  Note 3: If target frequency is lower than the standby frequency, standby action will not be executed.
  Note 4: Standby action will not be executed during deceleration.



F1108 Restart after momentary power failure

Whether the inverter resumes operation after it stops due to a momentary power failure can be specified using this function. This function works properly only after a momentary power failure. If the duration of the power failure is longer, correct action can not be made as the control power supply is lost, as shown in the following table.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1108	Restart after momentary power failure	0: Do not restart 1: Restart 2: Compensation for momentary power failure	1	0

F1108	Short time power failure (momentary failure)			Long power failure (Re-start of the inverter)		
	Operation panel	External terminals		Operation panel	External terminals	
		Operation signal	No operation signal		Operation signal	No operation signal
0: No restart	No Restart	No Restart	No Restart	No Restart	Restart	No Restart
1: Restart	Restart※1	Restart※1	No Restart	No Restart	Restart	No Restart
2: Restart	Restart※1	Restart※1	No Restart	No Restart	Restart	No Restart

The restart marked with ※1 means that the inverter starts in the flying start mode after a momentary power failure.

- When F1108=2 is selected, the Momentary Power Failure Compensation function is enabled to prolong the operation time of the inverter even in the event of a power failure. The Momentary Power Failure Compensation function detects a drop in the input voltage and reduces the output frequency and voltage of the inverter before any alarm trip, and uses the energy regenerated from the motor to keep it operating for longer.
  Note 1: The Momentary Power Failure Compensation function works when F1001: the motor control mode is V/f control or speed control (F1001=1, 2, 3).
  Note 2: While the Momentary Power Failure Compensation function is working, the output frequency of the inverter is reduced. Use this function for loads, of which the frequency reduction is allowable.
  Note 3: Restart after momentary power failure for F1108 = 2 has the same restart effect as for F1108 = 1.
  Note 4: In the PID control, sometimes the Momentary Power Failure Compensation function can not be fully functional as a result of the effects of PID gain setting value and the system response speed.
  Note 5: Output voltage AVR function is needed to execute the Momentary Power Failure Compensation function in V/f control mode. Therefore, to use this function, please set the base voltage to F1005≠0.

F1109 Direction of motor rotation

This function is used to restrict the rotation of the motor to a fixed direction for safety reasons etc.

CodeNo	Function name	Data content	Resolution setting	Factory preset
F1109	Direction of motor rotation	1: Forward reverse run 2: Forward run only 3: Reverse run only	1	1

Note 1: The terms "forward run" and "reverse run" and the actual motor shaft rotation direction changes depending on the motor structure and inverter connection method. For the inverter, when the "forward run" or "reverse run" command is given, the user should confirm it directly during test run.
Note 2: The rotation direction of [DRIVE] button on the operation panel is determined by F1110.

F1110 Direction of motor rotation (Operation panel)

Set the rotation direction at the [DRIVE] button on operation panel.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1110	Direction of motor rotation (Operation panel)	1: Forward run 2: Reverse run	1	1

Note: Use F1109 to fix the motor rotation direction.

F1111 Braking method

A function for selecting the stop mode when a stop signal is input.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1111	Braking method	1: Deceleration to stop 2: Deceleration to stop + DC braking 3: Free run stop	1	1

- Deceleration to stop
  A normal stop method for reducing output frequency according to the settings of acceleration/deceleration curve (F1010) and the deceleration time (F1016 - F1019).
- Deceleration to stop + DC braking
  Similar to the case of F1111 = 1, this method is used to reduce the output frequency to the time point below DC braking start frequency (F1112); DC braking quickly stops the motor which is working. The DC braking time and DC braking force are determined according to F1113 and F1114.
- Free run stop
  Turn OFF all drive signals of the switching device at the time when a stop signal is sent to put the motor in free run state.

F1112 DC braking start frequency

F1113 DC braking time

F1114 DC braking force

A function for setting DC braking start frequency and action time and braking force when braking.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1112	DC braking start frequency	0.05～20Hz	0.01Hz	0.5
F1113	DC braking time	0.1～10sec	0.1sec	2
F1114	DC braking force	1～10	1	5

- If F1111 = 2, the output frequency drops as the stop signal is input, DC braking starts at the time point where the value is below the frequency set by F1112.
- When F1111=2, the starting frequency (F1103) is inactive during braking. When output frequency drops to the DC braking start frequency (F1112), the DC braking starts.
- For DC braking action at starting means that the DC braking starts after the operation signal has met the starting conditions, and then the motor will be started by starting frequency. In this case, the action time and braking force are the setting values of F1113 and F1114. See also F1102 for Dc braking action at starting.
- After the operation signal has been input, if the set frequency is below the operation start frequency or DC braking start frequency, the following actions will be executed according to the magnitude relation between operation start frequency and DC braking start frequency.

  ① Operation start frequency ≥ DC braking start frequency.

  If the set frequency is lower than the DC braking start frequency, even if it is higher than DC braking start frequency, the output frequency will be decreased to DC braking start frequency, and then DC braking starts.

  ② Operation start frequency ＜ DC braking start frequency.

  • Even if the set frequency is lower than DC braking start frequency, as long as it is greater than the operation start frequency, the operation will continue.

  • When the output frequency is higher than DC braking start frequency, even if the set frequency is lower than the operation start frequency, like in ①, the output frequency will be decreased to DC braking start frequency, and then DC braking starts.

  • When the output frequency is lower than DC braking start frequency, if the set frequency is lower than the operation start frequency, then DC braking will start immediately.

  - During DC braking, if the [STOP] button is pressed again, the DC braking will be released.
  - During DC braking in stopped state, if the operation signal is input, then the operation will be restarted in the normal operation order.

Note 1: F1113 and F1114 are active only in V/f mode (F1001=1, 40). In speed control mode (F1001=2, 3, 10, 11), the setting of F6005-F6008 is equivalent to this setting.

Note 2: During DC braking, the motor tends to be over-heated as there is no self-cooling effect caused by motor rotation. Therefore, the DC braking force should be set to a smaller value, and it is recommended to set the value within the range in which the motor does not overheat or to install a temperature limiting relay on the motor.

Note 3: If the increase in DC braking force is ineffective, the possible reason is that current limiting function is activated by overcurrent caused by some reason.

F1115 Duty cycle of brake resistor

A function for setting utilization rate of a brake resistor. The value shall be set within the allowable utilization rate of the brake resistor.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1115	Duty cycle of brake resistor	0: No brake resistor 2-25%ED 98: No discharge resistor protection (with discharge *1) 99: External brake unit	1%ED	※2

Note: In case of braking through an external circuit, please set F1115 = 99.

***1 Since the protection actions will not be executed when F1115 = 98, the discharge resistor and the device may be damaged. Please note this when setting.**

***2 The representative parameters that are suitable for various models have been input.**

When setting F1115 = 2-25, if it is judged that excessive current will flow in the brake resistor for a long time, in order to prevent the brake resistor connected

F1116 Discharge resistor on signal output time

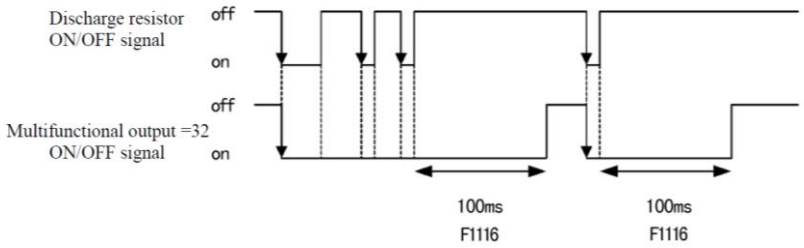
This function is used to output signals from a multifunctional output terminal for the time set with F1116 when the discharge resistor for regenerated power discharge is turned on.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1116	Discharge resistor on signal output time	0.01～10sec	0.01sec	0.1

● Set one of F1509-F1511 to 32 for the multifunctional output terminal setting. The discharge resistor on signal is output from the terminal which is set to 32.

● During regenerated energy discharge, the discharge resistor switches between ON and OFF very quickly and repeatedly. The Discharge Resistor on Signal function facilitates the measurement of this high-speed on/off operation with a narrow pulse width in external equipment. The narrow pulse width of the on/off operation is expanded by the time set with F1116 and output by a multifunctional output terminal.

Example) When the Discharge Resistor on Time F1116=0.1 [s].



LED display function

F1201 Monitor display selection

A function for switching the display contents of operation panel.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1201	Monitor display selection	1: Frequency [Hz] 2: Output current [A] 3: Speed [rpm] 4: Load rate [%] 5: Pressure [MPa] 6：No unit display	1	1

● The change of the display value and display method in stopped state, standby state as well as operating state is shown in the following table.

F1201	Stopped	Standby/Operating
1	Flashing setting frequency	Normally-on output frequency
2	Flashing 0 [A]	Normally-on output current
3	Flashing speed (*1)	Normally-on speed (*1)
4	Flashing 0 [%]	Normally-on Load rate
5	Flashing display 0.000 three decimal places MPa	
6	The output monitor can be changed using F1202.	

(*1) The display contents may vary depending the motor control mode. The display contents are as shown in the table below.

Motor control mode	In operation (operating)	Stopped
Sensorless vector control	Estimated speed of motor	0
Others (V/f·vector)	-	-

Note: By using F1603, this code can be set even when the operation function is locked.

F1202 State display selection

This function is used to select output data displayed on the 7-segment monitor on the operation panel in No-Units Display mode.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1202	State display selection	1: No unit (multiple of F1203) 2: Output voltage [V] 3: DC voltage [V] 4: Active power [kW] 5: Apparent power [kVA] 6: Heat sink temperature [℃] 7: Command speed [rpm] 8: PID1 feedback value [Hz] 9: PID2 feedback value [Hz] 10: VRF1 analog input value [Hz] 11: VRF/IRF analog input value [Hz] 14: Excitation partial current [A] 15: Torque partial current [A] 17: Set pressure [MPa] 18: Instructed pressure [MPa] 19: Feedback pressure [MPa] 29: Command frequency [Hz]	1	1

		35: Detection rotation [rpm] 44: Target frequency [Hz] 45: Output frequency [Hz]		

- Output voltage: the output voltage of inverter.
- DC voltage: the value of DC voltage applied to the inverter.
- Active power: the actual power consumed on load.
- Apparent power: the apparent power is used for displaying inverter output.
- Heat sink temperature: internal Heat sink temperature.
- Command speed: the speed given by a command.
- PID feedback value: the feedback value of PID control.
- VRF analog input value: an analog signal value generated by voltage or current.
- Command frequency: the frequency given by a command.
- Excitation sub-current: it is the current value for the excitation of the motor.
- Torque sub-current: the current value that gives the motor torque.

※ When three detecting positions are selected, even if the positioning is finished, " 2Ero " will not be displayed.

F1203 Multiple for no-units display

This function is used when No-Units Display mode is displayed on the 7-segment monitor on the operation panel. This function is used for setting the multiple which is multiplied with output frequency when F1202 = 1 (no-units display).

Code No.	Function name	Data content	Resolution setting	Factory preset
F1203	Multiple for no-units display	0～100	0.01	1

- This function is used in applications where linear velocity etc. is displayed in a simple way.

Auxiliary function

F1301 1st jump bottom frequency

F1302 1st jump top frequency

F1303 2nd jump bottom frequency

F1304 2nd jump top frequency

F1305 3rd jump bottom frequency

F1306 3rd jump top frequency

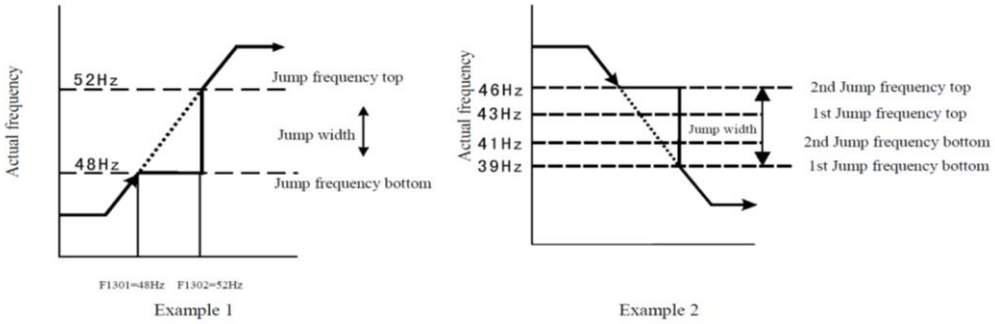
For the inverter-driven motor, resonance generated in the co-ordination between output frequency (speed) and the mechanical system produce larger vibration and noise, and the power frequency hopping sometimes cause the change in output voltage. In this case, the frequency which generates mechanical vibration and voltage change will be jumped during operation.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1301	1st jump bottom requency	0～400Hz	0.01Hz	0
F1302	1st jump top frequency	0～400Hz	0.01Hz	0
F1303	2nd jump bottom frequency	0～400Hz	0.01Hz	0
F1304	2nd jump top frequency	0～400Hz	0.01Hz	0
F1305	3rd jump bottom frequency	0～400Hz	0.01Hz	0
F1306	3rd jump top frequency	0～400Hz	0.01Hz	0

- Three different frequencies to skip can be specified.
  The frequency jumps between the top frequency and bottom frequency set by F1301-F1306. However, no jump occurs during acceleration/deceleration.
  Example 1) F1301=48Hz and F1302=52Hz.

  1) If the target frequency is set to 51Hz: the inverter continues to operate at 48Hz.
  2) If the target frequency is set to 53Hz: normal acceleration skips 48-52Hz and reaches 53Hz at which the inverter continues to operate.

Example 2) F1301=39Hz, F1302=43Hz, F1303=41Hz and F1304=46Hz.
Jump frequencies are combined, and the range from 39-46Hz is skipped.



- The 1st, 2nd and 3rd jump frequencies can be set independently, for example, 2nd jump frequency> 1st jump frequency> 3rd jump frequency.
- The top value and the bottom value of a jump frequency can not be reversely set. Therefore, when setting the top value or the bottom value, set the values in the correct order so that the top and bottom values are not reversed. (Because in the initial settings, both the top and bottom values are specified as 0, setting the bottom value 1st will cause an error, such setting is prohibited.)
- When the upper frequency limit (F1007) or the lower frequency limit (F1008) is set within the jump frequency band, the frequency will jump within the range of the upper frequency limit and lower frequency limit.
- Setting a jump frequency band that includes both the upper frequency limit (F1007) or highest frequency and the lower frequency limit (F1008) is prohibited for safety reasons.

F1307 Auto alarm recovery

This function code automatically specifies whether the inverter restarts after the inverter is tripped by protection function due to overcurrent or overvoltage.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1307	Auto alarm recovery	0: No auto reset function 1: Auto reset function	1	0

- The inverter restarts in the flying start mode. And, the alarm relay does not work when the inverter is restarted.
- If three consecutive trips occur in 10 seconds, the status of 3rd trip alarm will be kept, and the alarm relay works.
- When an alarm for which auto reset is possible occurs during standby and then is released, the reset method depends on the status at that time.
  Standby: Keeps standby.
  If operation conditions are established: Setting of starting frequency is inactivated by flying start.
- When an alarm for which auto reset is possible occurs during deceleration caused by the stop signal and then is released, auto reset is performed in the alarm stop status. But operation is not restarted.
- Auto reset is possible with the following alarms:

oCH	Abnormal main switching device temperature
oCA	Overcurrent during acceleration
oCn	Overcurrent during constant speed
oCd	Overcurrent during deceleration
oCPA	Short-time overload during acceleration
oCPn	Short-time overload during constant speed
oCPd	Short-time overload during deceleration
ouA	Overvoltage during acceleration
oun	Overvoltage during constant speed
oud	Overvoltage during deceleration

F1308 Instability elimination

When the inverter is used to drive a motor, the dead time to protect a switching device from a short circuit may make the current unstable. If the current becomes unstable, the motor may generate vibration or abnormal noises. In addition, compared with the stable current, the current value may become greater. The instability elimination function is used to avoid this problem.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1308	Instability elimination	0～20	1	0

- The larger the value specified, the greater the compensation. Therefore, increase the value gradually to set the value at which instability is eliminated.

F1309 Operation direction switching under V/f control mode

This function specifies the action for operation direction switching under V/f control mode.

Code No.	Function name	Data content	Resolution setting	Factory preset
1309	Operation direction switching under V/f control mode	0: Start from the direction opposite to current direction after a stop 1: Continuous operation	1	0

- When F1309 = 0, the start and stop-related functions are executed in accordance with the values of the function codes. The operation stops according to the function code. Then, the operation immediately starts from the direction opposite to current direction in accordance with the setting value of the function code. However, when switching the direction of operation, neither the DC braking in

stopped state nor the DC braking at start works.

- When F1309 =1, regardless of function codes related to start or stop, acceleration will be executed consecutively in opposite direction after deceleration. When switching the direction of operation, the output frequency is continuously variable and the rotation direction can be switched smoothly.

Note 1: When F1309=0, the stop or start is executed in the mode specified by the function code. Therefore, the output frequency near 0Hz is not continuously variable. And, because DC braking is executed, if the starting frequency or DC braking start frequency is set with a too big value, motor vibration and overcurrent alarm may occur.

Note 2: When reverse run flying start function is set, regardless of the setting of F1309, rotation direction switching is a continuous action.

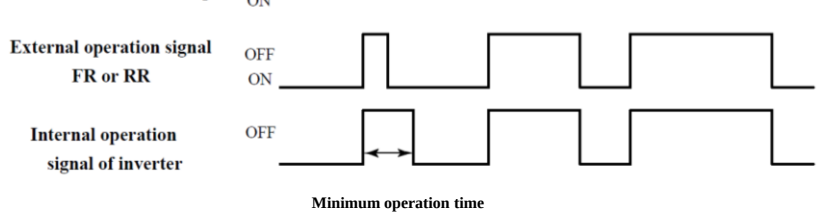
Note 3: In speed control mode, regardless of the setting of F1309, rotation direction switching is a continuous action.

F1315 Minimum operation time function

Even when a brief operation signal is input via an external control terminal, this function holds the operation command for the time set by the Minimum operation time function.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1315	Minimum operation time function	0～99.99sec	0.1sec	0

- During operation by the external control terminal, the function defines the minimum ON width for the input signal of multifunctional input terminal FR or RR. In other words, the function starts counting when the input signal turns on, and the signal is assumed to remain on for the duration of the count even if the multifunctional input terminal FR or RR is set to off. After the time set by F1315, the inverter operates again according to the current status of multifunctional input terminal FR or RR.



F1316 2nd Upper frequency limit

F1317 3rd Upper frequency limit

A function for setting the upper limit of output frequency. If 2MAX is set to ON using multifunctional input terminals (F1414 - F1421), then the 2nd Upper frequency limit will be used to limit frequency, if 3MAX is set to ON, then 3rd Upper frequency limit will be used. If both of them are set to ON, then the upper frequency limit of F1007 will be used for limiting frequency.

Gain frequency (F1402, F1404, F1406)

Code No.	Function name	Data content	Resolution setting	Factory preset
F1316	2nd Upper frequency limit	5～400Hz	0.01Hz	60
F1317	3rd Upper frequency limit	5～400Hz	0.01Hz	60

F1318 Cooling fan ON/OFF control

This function is used to select the action of cooling fan for cooling inverter.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1318	Cooling fan ON/OFF control	0: ON/OFF control 1: Normally ON	1	1

- When ON/OFF control is selected, fan ON/OFF control will be automatically executed according to the Heat sink temperature.
- Note: In power-on test after the fan has been replaced, check that the fan is set to normally ON.

F1319 Functions for high altitude areas

In high altitude areas, due to the unit cooling capacity, the current derating rate of parts and other reasons, it is recommended to use larger inverters by one rank. However, when used in high-altitude areas of more than 1,000m above sea level, the rated current can be derated, and this function should be used for selecting suitable altitude where applicable.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1319	Functions for high altitude areas	1：1000mbelow 2：1000～1500mbelow 3：1500～2000mbelow 4：2000～2500mbelow 5：2500～3000m	1	1

- The current derating rate of inverter for each altitude range is as shown below.

Content	Current derating rate
1000m below	1
1000～1500m below	0.966
1500～2000m below	0.925
2000～2500m below	0.900
2500～3000m	0.876

F1320	Rating selection

A function which changes the rating to mode A for heavy overload or mode B for light overload.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1320	Rating selection	1: Mode A (heavy overload) 2: Mode B (light overload)	1	2

- Mode A (heavy overload) allows an overload capacity of 150% per minute.
- Mode B (light overload) allows an overload capacity of 120% per minute.

Note: If the mode is switched by specification selection, then the relevant function codes shall be initialized.
e.g.） F1009,F1701,F1704,F5001,F6001,F6102.

7-3-2 Input output functions

Input/Output-Related Function

The function blocks of input and output terminals of the inverter control circuit are described as follows.

F1401	Bias frequency (VRF1)

F1402	Gain frequency (VRF1)

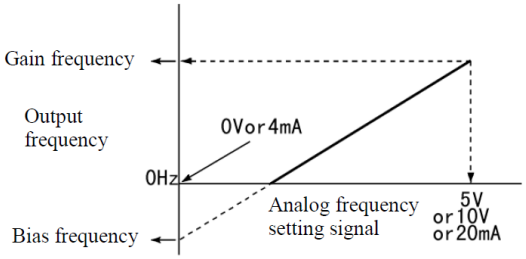
F1403	Bias frequency (VRF/IRF)

F1404	Gain frequency (VRF/IRF)

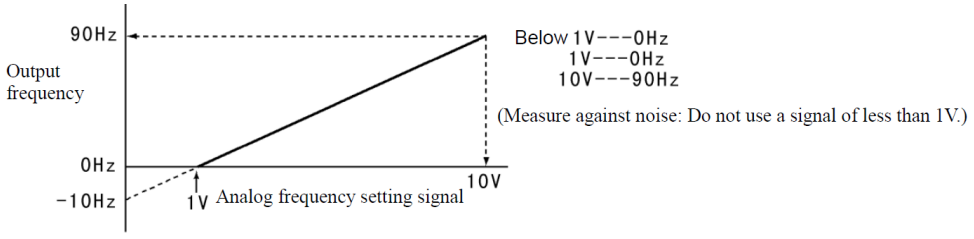
In case of setting output frequency using the analog signal, these functions are used to set a frequency (bias frequency) corresponding to minimum analog signal value (0V or 4mA) and a frequency (gain frequency) corresponding to maximum value (5V or 10V and 20mA).

Code No.	Function name	Data content	Resolution setting	Factory preset
F1401 F1403	Bias freqeuncy（VRF1） Bias freqeuncy（VRF/IRF）	0～±400Hz (frequency at 0V or 4mA) In case of negative value, -XXX.X will be displayed.	0.1Hz	0
F1402 F1404	Gain freqeuncy（VRF1） Gain freqeuncy（VRF/IRF）	0～±400Hz (frequency at 5V or 10V or 20 m) In case of negative value, -XXXX will be displayed.	0.1Hz	60

The relation between the analog frequency setting signal (VRF1，VRF/IRF) and the inverter output frequency is shown as follows.



Setting example: When F1401 =- 10.0 (-10Hz), F1402 = 90.0 (90 Hz), and F1002 = 3 (frequency setting VRF1: 0 - 10V), the output frequency is as shown below.



- By taking advantage of bias and gain frequencies, a common analog signal for frequency commands can be input to more than one inverter for proportional operation.

- Example) Input 0 - 10V analog signals to two inverters, so that 1st and 2nd inverters deliver output frequencies with a ratio of 1:2 for the purpose of proportional operation.

  Setting of 1st inverter: F1401=0.0(0Hz),
  F1402=50.0(50Hz)
  Setting of 2nd inverter: F1401=0.0(0Hz),
  F1402=100.0(100Hz)
  (Adjust the acceleration/deceleration time as required.)

Note 1: In negative setting frequency field, the output frequency is 0Hz.

Note 2: For PID control, the bias and gain frequencies apply to the feedback signal.

F1407 **Filter time constant of external analog input (VRF1)**

F1408 **Filter time constant of external analog input (VRF/IRF)**

Functions for setting the filter time constant of external analog signal input.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1407 F1408	Filter time constant of external analog input（VRF1） Filter time constant of external analog input（VRF/IRF）	1～500 （set value1=10ms）	1 （10ms）	10

If interference is detected in external analog signals, adjust the external analog input filter time constant.
Set the time constant to N × 10 ms (N = 1 to 500), the setting range is 10 to 5,000 ms.
Filters can be assigned to VRF1, VRF/IRF independently.

F1410 **Set frequency gain**

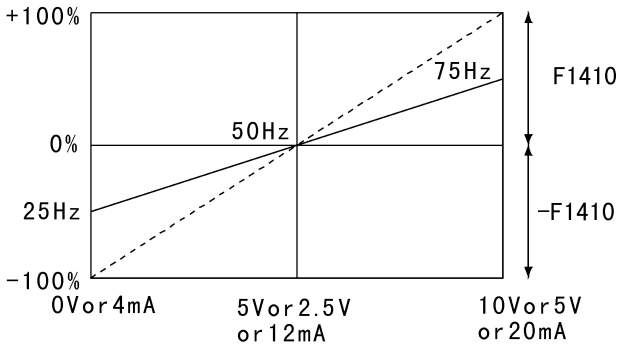
F1411 **Analog input switching for set frequency gain**

Using an external analog input terminal, the gain is adjustable when setting frequency.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1410	Set frequency gain	0～100%	1%	0
F1411	Analog input switching for set frequency gain	0：No analog input 1：External Analog VRF1 voltage （0～5V） 2：External Analog VRF1 voltage （0～10Vor potentiometer） 3：External Analog VRF/IRF voltage （0～5V） 4：External Analog VRF/IRF voltage （0～10Vor potentiometer） 8：External Analog VRF/IRF current （4～20mA）	1	0

- When several inverters are used for proportional operation, this function is useful for fine adjustment of the command frequencies of the inverters from the master to the slave.
- The external analog input terminal is switched with F1411 (Analog input switching for set frequency gain).
- Use F1410 as the set frequency value for proportional operation.

  Example 2) When the set frequency is 50Hz, F1410 = 50%, if the external analog input is 0 - 10V



VRF1or VRF/IRFinput

- 0V:50Hz－（50Hz×50%）=25Hz.
- 5V:50Hz－（50Hz×0%）=50Hz.
- 10V:50Hz＋（50Hz×50%）=75Hz.

F1412 **Input mode for MBS terminal**

This function is used to select the input signal action of multifunction input terminal MBS.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1412	Input mode for MBS terminal	1: Level triggered 2: Edge triggered	1	1

Edge operation will accept MBS input once between OFF and ON

F1413 **ES input signal options**

This function can be used for switching the function of control input terminal ‘ES’.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1413	ES input signal options	1: NO external thermistor signal 2: NC external thermistor signal	1	1

The function shall be switched according to the contact type.
F1413=1: ES terminal (external thermistor input terminal) is connected with a NO (normally open) contact.
F1413=2: ES terminal (external thermistor input terminal) is connected with an NC (normally closed) contact.

F1414	Input terminal DI1 definition
F1415	Input terminal DI2 definition
F1416	Input terminal DI3 definition
F1417	Input terminal DI4 definition
F1418	Input terminal DI5 definition
F1419	Input terminal DI6 definition
F1420	Input terminal DI7 definition
F1421	Input terminal DI8 definition

These functions are used to assign functions to the digital multifunctional input terminals DI1 - DI8 arbitrarily through data selection.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1414	Input terminal DI1 definition	0: Unused 1: FR 2: RR 3: 2DF 4: 3DF 5: MBS 6: ES 7: RST 8: AD2 9: AD3	1	1
F1415	Input terminal DI2 definition	10: JOG 11: 5DF 12: 9DF 13: FR+JOG 14: RR+JOG 15: FR+AD2		2
F1416	Input terminal DI3 definition	16: RR+AD2 17: FR+AD3 18: RR+AD3 19: FR+2DF 20: RR+2DF 21: FR+3DF		3
F1417	Input terminal DI4 definition	22: RR+3DF 23: FR+2DF+3DF 24: RR+2DF+3DF 25: FR+AD2+2DF 26: RR+AD2+2DF 27: FR+AD2+3DF		4
F1418	Input terminal DI5 definition	28: RR+AD2+3DF 29: FR+AD2+2DF+3DF 30: RR+AD2+2DF+3DF		5
F1419	Input terminal DI6 definition	31: FR+AD3+2DF 32: RR+AD3+2DF 33: FR+AD3+3DF 34: RR+AD3+3DF 35: FR+AD3+2DF+3DF		6
F1420	Input terminal DI7 definition	36: RR+AD3+2DF+3DF 37: PTR 39: FR+5DF 40: HD 45: CP(Option) 46: CCL		7
F1421	Input terminal DI8 definition	47: PC(Option) 57: P0 58: FR+CCL 59: FR+RCCL 64: FR+MBS 65: RR+MBS 67: 2DF+AD2 68: 2DF+AD3 69: 3DF+AD2 70: 3DF+AD3 71: A×10(Option) 72: A×100 (Option) 74: 2MAX 75: 3MAX 76: VFPID 77: PIDLCK 83: for factory adjustment 84: S2 85: PIDL 86: PIDH 87: RPID1 88: PID1EX 89: PID2EX 91: IHOLD 92: ICLEAR 109: RCCL 114: 1DFA 115: 1DFB 116: 1DFA+1DFB 117: ROPE 118: RCOM 119: ROPE+RCOM 120: 1DFA+ROPE 121: 1DFB+RCOM 122: 1DFA+1DFB+ROPE+RCOM 253～255: for factory adjustment		8

Digital multifunctional input terminals DI1 - DI8 can be set into any one of the functions by using the corresponding function codes F1414 - F1421.

Also, for multiplexed terminal, several functions can be input to one terminal.

For example, if F1414=13, Jog operation can be realized by connecting DI1 terminal.

Table 7-1 Multifunctional input codes

Function code No.	Input terminal name	Data range	Initial value (symbol)
F1414	DI1	0～255	1 (FR)
F1415	DI2		2 (RR)
F1416	DI3		3 (2DF)
F1417	DI4		4 (3DF)

F1418	DI5		5 (MBS)
F1419	DI6		6 (ES)
F1420	DI7		7 (RST)
F1421	DI8		8 (AD2)

Table 7-2 Multifunctional input signals

Data No.	Symbol	Function	Data No.	Symbol	Function
0	—	Unused terminal	40	HD	Operation signal hold command
1	FR	Forward run command	45	CP	Command pulse blocking signal (option)
2	RR	Reverse run command	46	CCL	Deviation counter clear signal
3	2DF	Multi-speed command 1	47	PC	P control signal
4	3DF	Multi-speed command 2	57	P0	Zero speed command
5	MBS	Free run command	58	Multiplexed terminal	FR+CCL
6	ES	External abnormal stop command	59	Multiplexed terminal	RR+CCL
7	RST	Alarm reset command	64	Multiplexed terminal	FR+MBS
8	AD2	2nd, 4th acceleration/deceleration command or up terminal	65	Multiplexed terminal	RR+MBS
9	AD3	2nd, 4th acceleration/deceleration command or down terminal	67	Multiplexed terminal	2DF+AD2
10	JOG	Jog operation command	68	Multiplexed terminal	2DF+AD3
11	5DF	Multi-speed command 3	69	Multiplexed terminal	3DF+AD2
12	9DF	Multi-speed command 4	70	Multiplexed terminal	3DF+AD3
13	Multiplexed terminal	FR+JOG	71	A×10	Electric gear ×10 (option)
14	Multiplexed terminal	RR+JOG	72	A×100	Electric gear ×100 (option)
15	Multiplexed terminal	FR+AD2	74	2MAX	2nd Upper frequency limit selection *1
16	Multiplexed terminal	RR+AD2	75	3MAX	3rd Upper frequency limit selection *2
17	Multiplexed terminal	FR+AD3	76	VFPID	V/f-PID control switching terminal
18	Multiplexed terminal	RR+AD3	77	PIDLCK	PID control locking terminal
19	Multiplexed terminal	FR+2DF	83		for factory adjustment
20	Multiplexed terminal	RR+2DF	84	S2	2nd S-shaped acceleration / deceleration time command
21	Multiplexed terminal	FR+3DF	85	PIDL	PID switching terminal (PIDL)
22	Multiplexed terminal	RR+3DF	86	PIDH	PID switching terminal (PIDH)
23	Multiplexed terminal	FR+2DF+3DF	87	RPID1	PID1 reset terminal
24	Multiplexed terminal	RR+2DF+3DF	88	PID1EX	PID1 External terminal selection
25	Multiplexed terminal	FR+AD2+2DF	89	PID2EX	PID2 External terminal selection
26	Multiplexed terminal	RR+AD2+2DF	91	IHOLD	PID integral value hold terminal
27	Multiplexed terminal	FR+AD2+3DF	92	ICLEAR	PID integral value clear terminal
28	Multiplexed terminal	RR+AD2+3DF	109	RCCL	Deviation counter reverse run clear signal
29	Multiplexed terminal	FR+AD2+2DF+3DF	114	1DFA	1st speed frequency selection 1
30	Multiplexed terminal	RR+AD2+2DF+3DF	115	1DFB	1st speed frequency selection 2
31	Multiplexed terminal	FR+AD3+2DF	116	Multiplexed terminal	1DFA+1DFB
32	Multiplexed terminal	RR+AD3+2DF	117	ROPE	Control authorization selection 1
33	Multiplexed terminal	FR+AD3+3DF	118	RCOM	Control authorization selection 2
34	Multiplexed terminal	RR+AD3+3DF	119	Multiplexed terminal	ROPE+RCOM
35	Multiplexed terminal	FR+AD3+2DF+3DF	120	Multiplexed terminal	1DFA+ROPE
36	Multiplexed terminal	RR+AD3+2DF+3DF	121	Multiplexed terminal	1DFB+RCOM
37	PTR multiplexed terminal	Simple scheduled operation counter reset signal	122	Multiplexed terminal	1DFA+1DFB+ROPE+RCOM
38	T-FCL	Keep or clear frequency	253～255	for factory adjustment	
39	Multiplexed terminal	FR+5DF			

※1 When the terminal is set to ON, F1316: limits the frequency with the 2nd upper frequency limit.

※2 When the terminal is set to ON, F1317: limits the frequency with the 3rd upper frequency limit.

F1423 Effective number of bits for VRF1 detection

F1424 Effective number of bits for VRF/IRF detection

Functions for setting the resolution (effective number of bits) of external analog signal reading.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1423 F1424	Effective number of bits for VRF1 detection Effective number of bits for VRF/IRF detection	7～10bit	1bit	10bit

This function is used to make the detection value of external analog signal stable and effective where interference exists in the external analog signal. And, if the effective number of bits is reduced, then the action in S-shaped acceleration/deceleration curve becomes more stable.

Effective number of bits for VRF1, VRF/IRF detection =8, when this value is set, 4 lower bits are inactive.
=9, when this value is set, 3 lower bits are inactive.
=10, when this value is set, 2 lower bits are inactive.
=11, when this value is set, 1 lower bit is inactive.
=12, when this value is set, no inactive bit.

Effective number of bits can be assigned to VRF1, VRF/IRF independently.

F1501	Internal analog output function 1

F1502	Internal analog output coefficient 1

F1503	Internal analog output bias 1

F1504	Internal analog output function 2

F1505	Internal analog output coefficient 2

F1506	Internal analog output bias 2

Analog output functions of a variety of internal states of the inverter between the control circuit terminals VOUT (0-10V) or IOUT (4~20mA) and the analog signal common terminal ACM are as follows:

Code No.	Function name	Data content	Resolution setting	Factory preset
F1501 F1504	Internal analog output function 1 Internal analog output function 2	0：Inactive 1: Set frequency [Hz] 2: Output frequency [Hz] 3: PID1 feedback value [Hz] 4: PID2 feedback value [Hz] 5: Output current [A] 6: Output voltage [V] 7: DC voltage [V] 8: Heat sink temperature [℃] 9: Load rate [%] (accumulated value of the electric thermistor) 10: Load rate [%] (ratio to rated current) 11：VRF1 analog input value [V] 12：VRF/IRFanalog input value [V] 14：Speed [rpm] 15: Active power [kW] 16: Apparent power [kVA] 17: PID1 command value [Hz] 18: PID1 input deviation value [Hz] 19: PID2 command value [Hz] 20: PID2 input deviation value [Hz] 21～23：for factory adjustment 24: External PID1 output value [Hz] 25: External PID2 output value [Hz] 26: For factory adjustment 35: Command frequency [Hz] 36: Command torque [%]	1	0
F1502 F1505	Internal analog output coefficient 1 Internal analog output coefficient 2	0～20time	0.01time	1
F1503 F1506	Internal analog output bias 1 Internal analog output bias 2	0～±10V	0.1V	0

The methods of conversion between output values of possible output analog signal from VOUT terminal and actual values are shown in the table below.

F1501 set value	Output signal content	Conversion method
0	Null	
1	Set frequency [Hz]	120Hz/10V
2	Output frequency [Hz]	120Hz/10V
3	PID1 feedback value [Hz]	120Hz/10V
4	PID2 feedback value [Hz]	120Hz/10V
5	Output current [A]	*1
6	Output voltage [V]	500V/10V
7	DC voltage [V]	500V/5V
8	Heat sink temperature [℃]	100℃/8V
9	Load rate [%] (integral value of the electric thermistor)	100%/5V
10	Load rate [%] (ratio to rated current)	100%/5V
11	VRF1 analog input value [V]	4～20mA current input，20mA/10V 0～5V voltage input，5V/5V 0～10V voltage input，10V/10V
12	VRF/IRFanalog input value [V]	
13	Reserve	
14	Speed [rpm]	1800rpm/5V
15	Active power [kW]	10kW/10V
16	Apparent power [kVA]	10kVA/10V
17	PID1 command value [Hz]	120Hz/10V
18	PID1 input deviation value [Hz]	120Hz/10V
19	PID2 command value [Hz]	120Hz/10V
20	PID2 input deviation value [Hz]	120Hz/10V
24	External PID1 output value [Hz]	120Hz/10V
25	External PID2 output value [Hz]	120Hz/10V
35	Command frequency [Hz]	120Hz/10V
36	Command torque [%]	400%/10V（※1）

※1 The positive and negative values of torque are output with 5V as the center.
(0V=-200%, 5V=0%, and 10V=200%)

The methods of conversion between output values of possible output analog signal from IOUT terminal and actual values are shown in the table below.

F1504 set value	Output signal content	Conversion method
0	Null	
1	Set frequency [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
2	Output frequency [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
3	PID1 feedback value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
4	PID2 feedback value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
5	Output current [A]	*1
6	Output voltage [V]	500V/16mA(500V:20mA,0V:4mA)
7	DC voltage [V]	500V/8mA(1000V:20mA,0V:4mA)
8	Heat sink temperature [℃]	100℃/12.8mA(125℃:20mA,0℃:4mA)
9	Load rate [%] (integral value of the electric thermistor)	100%/8mA(200%:20mA,0%:4mA)
10	Load rate [%] (ratio to rated current)	100%/8mA(200%:20mA,0%:4mA)
11	VRF1 analog input value [V]	4～20mA current input，16mA/16mA(20mA:20mA,0mA:0mA)
12	VRF/IRFanalog input value [V]	0～5V voltage input，5V/8mA(5V:12mA,0V:4mA)
13	Reserve	0～10V voltage input，10V/16mA(10V:20mA,0V:4mA)
14	Speed [rpm]	1800rpm/12mA(3600rpm:20mA,0rpm:4mA)
15	Active power [kW]	10kW/16mA
16	Apparent power [kVA]	10kVA/16mA
17	PID1 command value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
18	PID1 input deviation value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
19	PID2 command value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
20	PID2 input deviation value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
24	External PID1 output value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
25	External PID2 output value [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
35	Command frequency [Hz]	120Hz/16mA(120Hz:20mA,0Hz:4mA)
36	Command torque [%]	400%/16mA（+200%:20mA,0%:12mA,-200%:4mA）(*1)

Note 1: Maximum allowable current: 15mA.
(But the converted value is no-load output voltage. If the output current increases, the output voltage will decrease. In this case, the signal output can be adjusted using output coefficient.)

***1) Inverter capacity and output current conversion methods**

Model	Output current signal conversion method	
	A Mode	B Mode
NS-4A061-B**	100A/10V（16mA）	250A/10V（16mA）
NS-4A076-B**	250A/10V（16mA）	250A/10V（16mA）
NS-4A092-B**		
NS-4A115-B**		
NS-4A152-B**	250A/10V（16mA）	500A/10V（16mA）
NS-4A173-B**	500A/10V（16mA）	500A/10V（16mA）
NS-4A211-B**		
NS-4A253-B**	500A/10V（16mA）	750A/10V（16mA）
NS-4A304-B**	750A/10V（16mA）	750A/10V（16mA）
NS-4A386-B**		
NS-4A426-B**		
NS-4A472-B**	750A/10V（16mA）	1000A/10V（16mA）
NS-4A540-B**		
NS-4A590-B**	1000A/10V（16mA）	1000A/10V（16mA）

Output signals can be increased or decreased by the internal analog output coefficients F1502 and F1506. If the output signal from the VOUT or IOUT terminal is not of an adequate level, the signal level can be adjusted by setting the internal analog output coefficient.

F1502: Coefficient for F1501 (Internal Analog Output Function 1)
F1505: Coefficient for F1504 (Internal Analog Output Function 2)

Note 2: If the coefficients of F1502 and F1505 are smaller than 1, the output signals are decreased.
Bias voltage can be set for each output signal using F1503 or F1506 (internal analog output bias).
Although the negative bias voltage setting is possible, the output signal voltage will be 0V where the output signal voltage is negative.

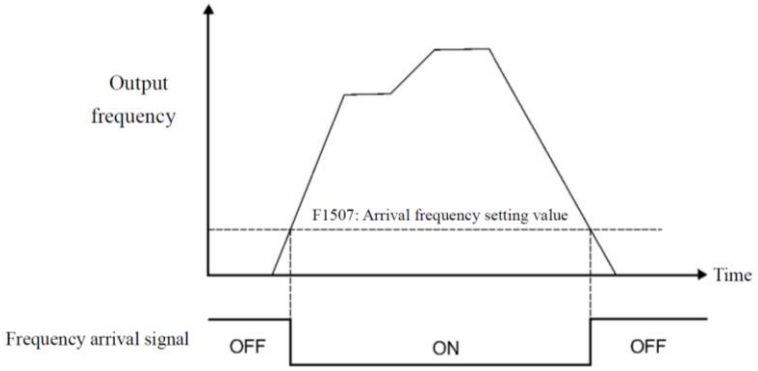
Note 3: The PID controlled variables are output in the form of absolute value. In case of negative value, the output will be positive.

F1507 Arrival frequency

This function specifies the frequency at which a frequency arrival signal is output.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1507	Arrival frequency	0～400Hz	0.01Hz	10

If the value of any one of F1509 – F1511 is 7 (frequency arrival), the signal is output from control circuit output terminals DO1 to DO3 when the output frequency exceeds the value of F1507.
Similarly, If the value of F1513 is 7 (frequency arrival), the signal is output from control circuit relay output terminals FA1, FB1 or FC1 when the output frequency exceeds the value of F1507.



F1508 Range of frequency consistency

This function specifies the out-frequency band corresponding to the frequency matching signal.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1508	Range of frequency consistency	0～10Hz	0.01Hz	0

If the value of any one of F1509 – F1511 is 5, 6, 14 or 15, the signal is output from control circuit terminals DO1 to DO3 when the output frequency falls within the value range between ±F1508.
Similarly, for F1513, the signal is output from control circuit relay output terminals FA1, FB1 or FC1.

Note: When the frequency is specified using an analog signal, an appropriate setting should be specified using F1508 to prevent frequency matching signal from chattering. When the vector control is active, the output frequency constantly changes. Set F1508 to several Hz.

F1509 Output terminal DO1 options

F1510 Output terminal DO2 options

F1511 Output terminal DO3 options

This function is used to select the required function from the multifunctional output terminals DO1-DO3 of control circuit terminals to execute open-collector output.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1509	Output terminal DO1 options	0 0: Unused 1: In operation 1 2: Undervoltage 3: End of simple scheduled operation 4: In operation 2 5: Frequency matching (1st speed frequency) 6: Frequency matching (1st to 16th speed frequencies) 7: Frequency arrival 8: Overload alarm level setting signal (the value of F1704) 9: Electric thermistor pre-alarm signal (80% of electric thermistor) 10: Heat sink overheat pre-alarm signal 13：Excitation and DC braking signals 14：Lower frequency limit matching signal 15：Upper frequency limit matching sign 18：FR signal 19：RR signal 20：2DF signal 21：3DF signal 22：5DF signal 23：9DF signal 24：AD2 signal 25：AD3 signal 26：JOG signal 27：MBS signal 28：ES signal 29：RST signal 32: Discharge resistor on signal 34: Frequency counter (output frequency) (*1) 35: Frequency counter (command frequency) (*1) 36: Overload alarm level setting signal (Including when in acceleration/deceleration) 42: Torque matching signal 43: Low speed detection signal 47: Motor speed counter (*1) 48: Forward run detection signal 49: Reverse run detection signal	1	1
F1510	Output terminal DO2 options			5
F1511	Output terminal DO3 options			8

※1 Can not be used together with the current output function. When outputting frequency counter, set F1515 = 0 to disable the current output function.

Table 7-3 Multifunctional output signals

Data No.	Function	Action
0		Unused terminal.
1	In operation 1	On when Inverter is in operation (gate signal on)
2	Undervoltage	Undervoltage alarming ON.
3	End of simple scheduled operation	On when simple scheduled operation ends
4	In operation 2	Inverter in operation (except DC braking and exciting) is (gate signal on) on
5	Frequency matching (1st speed frequency) (*3)	ON when the output frequency is equal to target frequency during 1st speed operation.
6	Frequency matching (1st-16th speed frequencies) (*3)	ON when the output frequency is equal to target frequency during 1st-16th speed operations.
7	Frequency arrival (*3)	Output frequency is F1507: On when the arrival frequency is exceeded.
8	Overload alarm level setting signal (the value of F1704)	Load status during normal operation is F1704: On when the overload pre-alarm value is exceeded.
9	Electric thermistor pre-alarm signal (80% of electric thermistor)	ON when the electric thermistor integral value is more than 80% of protection stop value.
10	Heat sink overheat pre-alarm signal	ON when Heat sink overheat protection alarm occurs
13	Excitation and DC braking signals	ON during DC braking or excitation.
14	Lower frequency limit matching（※3）	When output frequency is F1008: ON when the lower frequency limit and F1508 are the same within the Range of frequency consistency.
15	Upper frequency limit matching（※3）	When output frequency is F1007: ON when the upper frequency limit and F1508 are the same within the Range of frequency consistency.
18	FRsignal	ON if the multifunctional input terminal FR is on.
19	RRsignal	ON if the multifunctional input terminal RR is on.
20	2DFsignal	ON if the multifunctional input terminal 2DF is on.
21	3DFsignal	ON if the multifunctional input terminal 3DF is on.
22	5DFsignal	ON if the multifunctional input terminal 5DF is on.
23	9DFsignal	ON if the multifunctional input terminal 9DF is on.
24	AD2signal	ON if the multifunctional input terminal AD2 is on.
25	AD3signal	ON if the multifunctional input terminal AD3 is on.
26	JOGsignal	ON if the multifunctional input terminal JOG is on.
27	MBSsignal	ON if the multifunctional input terminal MBS is on.
28	ESsignal	ON if the multifunctional input terminal ES is on.
29	RSTsignal	ON if the multifunctional input terminal RST is on.
32	Discharge resistor on signal	ON if the discharge resistor is on.
34	Frequency counter (output frequency)（※1）	F1512: the output frequency calculated with counter output multiple.
35	Frequency counter (command frequency)（※1）	F1512: the command frequency calculated with counter output multiple.
36	Overload alarm level setting signal (Including when in acceleration/deceleration)	On when the load condition is F1704: above overload pre-alarm value.
43	Low speed detection signal	ON when the motor torque is within the range specified by F1518: low speed matching level and F1519: low speed matching range.
47	Motor speed counter (※1)	Motor speed is output by the multiple specified by F1512: counter output multiple.
48	Forward run detection signal (※2)	ON when the motor speed is greater than F1518: low speed matching range in forward run direction.
49	Reverse run detection signal（※2）	ON when the motor speed is greater than F1518: low speed matching range in reverse run direction.

*1 Can not be used together with the current output function. When outputting frequency counter or motor speed counter, set F1515 = 0 to disable the current output function.
*2 If only single-phase pulse is input to PG input terminal, it can not detect the direction of rotation. Therefore, the rotation direction signal can not be correctly output.
*3 No output in torque control or position control.

F1512 Output magnification of the counter

This function specifies the output multiple when the inverter 's output frequency, command frequency and motor speed are countered and output to the control circuit output terminals (DO1-DO3).

Code No.	Function name	Data content	Resolution setting	Factory preset
F1512	Output magnification of the counter	1～100time	1time	1

The output multiple can be set where the inverter's frequency and command frequency counter and motor speed counter (which can be set with F1509 - F1511) are output from multifunctional output terminals DO1 - DO3. When motor speed counter multiple in F1512 is 1, 1 rpm indicates 0.1Hz, and the motor rotation direction is output to the forward run detection signal and reverse run detection signal.

Example 1) When F1512 = 1, the frequency will be output from the control signal output terminals at 1 time the output frequency and command frequency of the inverter. When the inverter output frequency = 60Hz, the frequency counter output = 60Hz.

Example 2) When F1512 = 10, the frequency will be output from the control signal output terminals at 10 times the output frequency and command frequency of the inverter. When the inverter output frequency = 60Hz, the frequency counter output = 600Hz.

Example 3) When F1512 = 10, the motor speed counter outputs 1500Hz with 1500rpm. (1rpm indicates 1Hz)

● Related functions

F1509-F1511=34: Frequency counter output (output frequency)
F1509-F1511=35: Frequency counter output (command frequency)
F1509-F1511=47: Motor speed counter

Note 1: The output range of frequency counter output is 1.5-1,500Hz. When the coefficient calculation result of frequency counter output multiple is below 1.5Hz, the output is always OFF. And, 1,500 Hz is the limit when the frequency is above 1,500 Hz.

Note 2: Output frequency is the actual frequency output by the inverter and may be different from command frequency according to the load condition in vector control mode. Even in constant speed operation under the vector control mode, if a certain frequency counter output is required, set F1509 - F1511 = 35 (command frequency).

Note 3: Depending on the impedance of peripheral device connected to, output waveform of the frequency counter may be delayed, and uneven duty cycle may be occurred. In order to reduce uneven duty cycle, please adjust the impedance of the peripheral device to be 2kΩ or below in the range below 50mA to be flowed into open-collector.

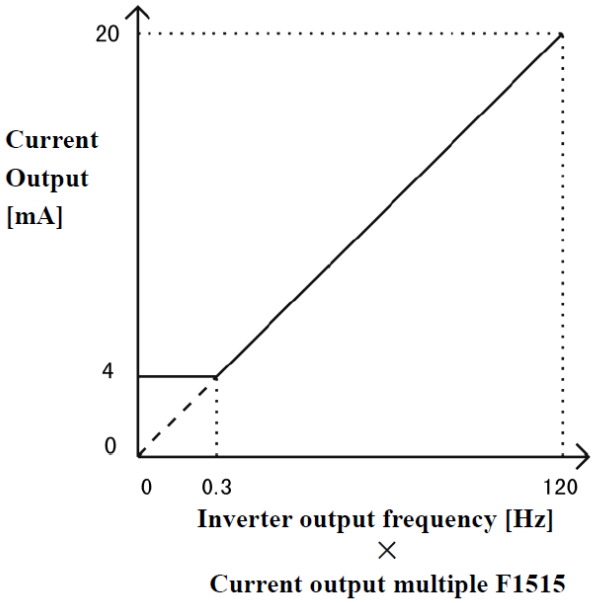
F1513 **Relay 1 contact output options**

F1514 **Relay 2 contact output options**

This function is used to select and output control circuit output terminals FA1, FB1, and FC1 relay contacts.。

Code No.	Function name	Data content	Resolution setting	Factory preset
F1513 F1514	Relay 1 contact output options Relay 2 contact output options	0: Alarming 1: In operation 1 2: Undervoltage 3: End of simple scheduled operation 4: In operation 2 5: Frequency matching (1st speed frequency) 6: Frequency matching (1st to 16th speed frequencies) 7: Frequency arrival 8: Overload alarm level setting signal (the value of F1704) 9: Electric thermistor pre-alarm signal (80% of electric thermistor) 10: overheat warming signal of heat sink 13：Excitation and DC braking signals 14：Lower frequency limit matching signal 15：Upper frequency limit matching signal 18：FRsignal 19：RRsignal 20：2DFsignal 21：3DFsignal 22：5DFsignal 23：9DFsignal 24：AD2signal 25：AD3signal 26：JOGsignal 27：MBSsignal 28：ESsignal 29：RSTsignal 32: Discharge resistor on signal 36: Overload alarm level setting signal (Including when in acceleration/deceleration) 43: Low speed detection signal 48: Forward run detection signal 49: Reverse run detection signal	1	0

For the operation description of the function, please refer to Table 7-3 of the multi-function output terminal.
The converted value of the inverter's output frequency and current output is as follows:
When the output frequency of the inverter × F1515 (current output magnification) = 3Hz or less, the current output = 4mA.
When the output frequency of the inverter × F1515 (current output ratio) = 120Hz, the current output = 20mA.



Current output multiple may be changed in function code F1515, please make appropriate adjustment based on service condition.

※ Adjust the maximum output frequency to 20mA or below.

Adjust the impedance of current output load side to 250Ω or below. In case of large impedance, the current output shall be 20mA or below.
When the current output makes output frequency=0 Hz, multiple=0, please output the minimum value 4mA.
Make sure that there is no wiring short-circuit and open circuit at load side before current output.
The signal wire may not work correctly due to short-circuit or open circuit.

F1518 **Low speed matching level**

F1519 **Low speed matching range**

These functions are used to set torque level and torque matching range output by the torque matching signal.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1518	Low speed matching level	0～2000rpm	1rpm	100

Code No.	Function name	Data content	Resolution setting	Factory preset
F1519	Low speed matching range	0～100rpm	1rpm	10

If any one of F1509 – F1511 is 43 (low speed detection signal), the signal is output from control circuit output terminals DO1 to DO3 when the detected speed matches the value set by F1518. The matching width is specified with the set value of F1519. Similarly, for F1513, the signal can also be output from control circuit relay output terminals FA1, FB1 or FC1.
The low speed matching range is also used in forward run detection signal or reverse run detection signal for multifunctional output.

7-3-3 System related functions

System function

The inverter system, repair and maintenance functions as well as function blocks for operation setting of the control panel are described as follows.

F1601 **Copy function**

This function transfers the function code data from the host side to the operation panel side or other hosts.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1601	Copy function	0：Null 1: Transfer the current code data to the operation panel 2: Transfer the contents stored by operation panel to the inverter host (excluding the motor parameters measured) 3: Transfer the contents stored by operation panel to the inverter host (including the motor parameters measured)	1	0

- Transfer the current function code data to the operation panel, and then to the host of copying side.
  When copying, SEnd or a flashing rEAd will be displayed on 7-segment monitor.
- To transfer data to the host of copying side, turn the power OFF before transmission in order to re-close the inverter to reset.
- When the motor parameters are set by F5001 - F5016, the copy function can not be used. Because during replication, if the motor parameters conflicts with the set value of other function code(s), the motor parameters or the conflicted function code(s) will be initialized. When motor parameters are set by F5009 - F5014, set F1601 = 3 to transfer data to the host.

(Steps) Sequence for copying to other inverter(s).

1 Transfer the current function code data to the operation panel with F1601=1. Refer to the sequence of 5-5-1.

2 During transmission of data, the flashing SEnd is displayed. Please wait for the display of SEnd until it disappears.

3 Turn the power OFF, remove the operation panel and install it to another host. Please also turn OFF the power of other hosts before work.

4 Turn ON the power of other hosts.

5 Transfer data from the operation panel to other hosts with F1601 = 2

6 During transmission of data, the flashing rEAd is displayed. Please wait for the display of rEAd until it disappears.

7 After the transmission of data to the copy side and before operation, turn the power OFF to reset inverter.

- As an exception, the active codes and data of F1320, F1601, F1602, F1604, all of F18XX blocks, all of F33XX blocks, F5001 - F5008, F5015 - 5016, F6010 - F6016, F6117, F6118, as well as optional functions can not be copied. And, in case of copy between different inverter capacities and rated voltages, the data may not be copied depending on its contents. (e.g.: F1005)
- The copy function can not be used during operation of the inverter. Please stop the inverter before copying.

Note 1: Since copy function is subject to software version, data may not be copied due to compatibility of the software version. In addition, due to different versions, copying from an inverter with additional functions to an inverter without additional functions may cause unpredictable actions such as alarms, so before proceeding, please confirm that both versions are up to date and that the presence of both functions are the same.
*For upgrade, please contact the sales shops.

Note 2: In the event of an error during data transmission to operation panel, please do not transfer data to the same or any other inverter.

Note 3: During action of copy function, the monitor's display flashes. When the monitor's display is flashing, do not pull out or insert the operation panel nor turn off the power.

Note 4: During action of copy function, no part of the operation panel can be operated.

Note 5: This code can not be written using communication function. The undefined response shall be returned.

Note 6: When the inverter host capacity of the copying side is different and F1601 = 3, conflict and interference errors may occur if the data is transferred from the panel to the host. When using F1601 = 3 for a copy of motor parameters, check if the inverter capacities of the copying source and copying side are the same.

F1602 Changed code display function

This function compares the factory presets, user's initial value, and current function code data and displays the function codes for which data values have changed.

This is an effective function for finding out the difference between the current function code and the factory presets or the user's initial value. Repair and maintenance functions such as confirmation of codes etc. can be easily executed.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1602	Changed code display function	0: Inactive 1: Display differences from factory preset 2: Display differences from the user's initial value	1	0

As an exception, even if F1601, F1602, F1604, F1805, and the read only function code are changed, they shall not be displayed by this function. (Operation method)

1 Through F1602 = 1, search the code number of function codes of which the factory presets have changed.

2 When searching the changed function code number, a flashing " F ind " is displayed. Please wait for the display of F ind until it disappears.

3 When the changed function code number is found, it will be displayed (flashing). See 5-5-2 Changed Code Display Operation for detailed operation methods.

Note 1: When F1604 = 99 and the user's initial value is not determined, " Er d " will be displayed if F1602=2 is executed.

Note 2: When the associated code page changes accordingly if the rated initial values of motor and inverter are different, even the codes which are not changed by the user will be displayed as changed codes.

Note 3: This code can not be written using communication function. The undefined response shall be returned.

Reference parameter

F1604 (Data initialization)

F1603 Function code lock

This function is used to disable the operation panel 's function code data setting in order to prevent misoperation.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1603	Function code lock	0: Code data changeable (No lock function) 1: Code data unchangeable (except F1603) 2: Code data unchangeable (except frequency setting-related) (excluding F1603, F1021, F2101 - F2116) 3: Code data unchangeable	1	0

		(excluding F1603 and the data change by use of the communication function)		

● The function code data can be viewed even if the operation locking is active. When the locked code data settings are confirmed, " Er n " will be displayed.
● When F1603 = 1, the frequency setting value is also unchangeable.
● When F1603 = 2, the frequency setting value is changeable.
● Reading dedicated function code is possible even in locked state.
● F1201 as an object other than the locked object.

F1604 Data initialization

This function initializes function code data to the factory presets or user 's initial value.
Not only the factory presets but also the value determined by user (user 's initial value) can be fixed as the initial value of the inverter. And, data initialization can be selected from either the factory presets or user 's initial value.
By fixing the user's initial value, the function code data can be initialized to the user's initial value even if it is overwritten for some reason, allowing for resetting the function code within a minimum range.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1604	Data initialization	0：Null 1：Initialize to factory presets 2: Invalid parameters by auto tuning 3: Initialize to user's data 99: Set user's initial value	1	0

● F1604=1: Initialize to factory presets
Function codes are initialized to factory presets.
● F1604=2: Motor parameters measured by auto tuning are invalid.
Return to the motor's initial value of the parameters measured by auto tuning selected by F5001.
If the motor's initial value can not be stored in the inverter, the parameters measured by auto tuning will be initialized to factory presets.
Parameters measured by auto tuning: F5009-F5014.
● F1604 = 3, 99: user data related
User data initialization and data confirmation shall be carried out in accordance with the following operation sequences.
(Sequence 1) Setting the initial value of user data
1 Set the required function code.
2 Confirm the user 's initial value with F1604=99.
3 Check that" rEAdY "is displayed and that the set value is flashing, press【UP】 key to confirm.
4 ' dEC id keeps flashing while the user's initialization value is being stored. Wait until ' dEC id disappears.
5 "dEC id" Once has disappeared, the function code data can be initialized to the user's initial value with F1604=3.
(Sequence 2) Initialization of the user data
1. Set F1604=3 to initialize the data determined by F1604=99.
2 Check that " rEAdY " is displayed and that it is alternately displayed with the set value, press 【UP】key to confirm.
3 " in itY "keeps flashing while the user's data is being initialized. Wait until " in itY "disappears.
4 When" in itY " disappears, the user's data initialization is completed.
Note 1: In operations where the initial value is used, " rEAdY " is displayed for confirmation. Now, the【UP】 key is used for this
Note 2: As an exception, F1804 and F1805 can not be initialized.
Note 3: When the user's initial value is not determined, " Er d " will be displayed if F1604 = 3 (the user's data initialization) is executed.
Note 4: In serial communication function, dEC id in it in itY are not displayed.

Protection Function

The function blocks related to inverter protection function setting are described as follows.

F1701 Output current limiting

The current at which the output current limiting function begins to work can be specified. This is useful for driving a motor with a small capacity compared with that of the inverter, or to make the best use of the inverter capacity to achieve the speediest acceleration.

Code No.	Function name	Data content		Resolution setting	Factory preset
F1701	Output current limiting	A Mode	0：null 50～200%	1%	150
		B Mode	0：null 50～150%		120

- The value is set with the ratio to rated current.
- The so-called output current limiting function is used to limit the inverter's output current to prevent overload during acceleration/deceleration or during normal operation. Use of this function enables the inverter to temporarily operate in the ways described below:
  1) During acceleration/deceleration: Reduce the acceleration/deceleration slope. This extends the time until the set frequency is reached. The extended time varies depending on the magnitude of this setting and the inertia of the load. Generally, accelerating or deceleration of a load with a large inertia requires a considerable current, requiring a relatively high setting.
  Example 1) When F1701=200% (Mode A).
  Maximum use of the inverter capacity to minimize the acceleration/deceleration time.
  (In mode B, the maximum value of F1701 is 150%)
  Example 2) Set current limit to the same value as the rated current of a motor with small capacity:
  F1701 = (rated motor current/rated inverter current) × 100[%].

However, the drive frequency can only be specified within a range of 50 - 200% of the rated current of the inverter. (in mode A)

(Possible range of setting is 50-150% in mode B）

2) During constant speed operation: When the inverter 's output current exceeds this setting; the output frequency is automatically reduced. The output frequency is reduced with the acceleration/deceleration slope specified by F1703.

Note 1: The current limiting function during normal operation is generally useful for loads with a reduced torque such as fans and pumps. However, this function has an adverse effect on overloads during constant speed operation with loads with normal and constant torque. The factory preset, therefore, of F1703 (Output current limiting at constant speed) = 0 disables the output current limiting function during operation. When driving reduced torque load, if the F1703 ≠ 0, it is recommended to effectively use the output current limiting function during constant speed operation.

Note 2: During the acceleration/deceleration caused by the output current limiting function in constant speed operation, the output current limiting function during acceleration/deceleration described in 1) and overvoltage stalling prevention function do not work.

● In vector control mode (speed control mode), because the torque limiter function is used to limit current, this function may not work.

Reference parameter

F1003 (V/f pattern selection)
F1320 (Rating selection)
F1703 (Output current limiting at constant speed)

F1702 Electric thermal setting

The current at which the electric thermal begins to work (electric thermal overload setting) is specified as a ratio to the rated inverter current. Rated current is the base of the ratio.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1702	Electric thermal setting	0：Inactive 20～105%	1%	100

● When a motor with a small capacity is driven, F1702 should be set to a small value which matches the rated motor current. (Refer to Example 1)

● For general-purpose motors, due to low cooling efficiency of the motor in the low speed zone, the electric thermal works faster as the frequency decreases. When using an inverter-driven motor, current can not be compensated according to the frequency value. Refer to F1705 (motor types).

● The electric thermal overload function also works during DC braking.

Note 1: The so-called overload protection caused by thermal works by monitoring the output current of the inverter to prevent the motor from overloading. It can only be used when one inverter is allocated to one motor. When many small capacity motors are connected with one inverter, each motor should be equipped with a thermal, and each motor shall be protected by inputting thermal relay contact to the control terminal ES (external thermal relay).

Example 1) To drive a 22kW motor using mode A of NS-4A061:

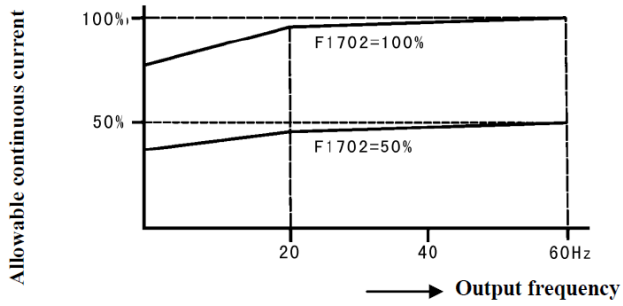
Set F1702 = (rated current of 22kW motor)/ (rated current in mode A of NS-4A061 is 46A) × 100%

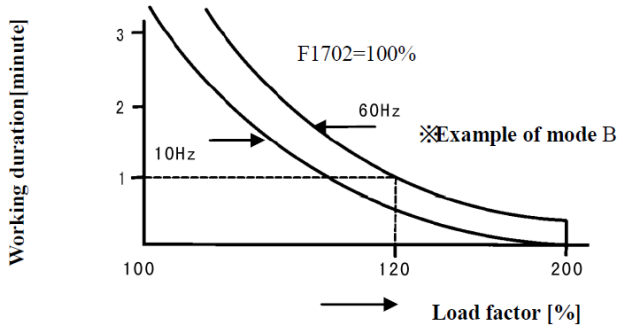
Example 2) When set to F1702=50%:

50% of the rated inverter current specified is equivalent to 100% of the Load rate in the electric thermal function. Accordingly, 75% of the rated inverter current is equivalent to 150% of the Load rate in the electric thermal function.

Reference parameter

F1414 - F1421 (select the input terminals DI1- DI8)
F1705 (Motor type)





F1703 Output current limiting at constant speed

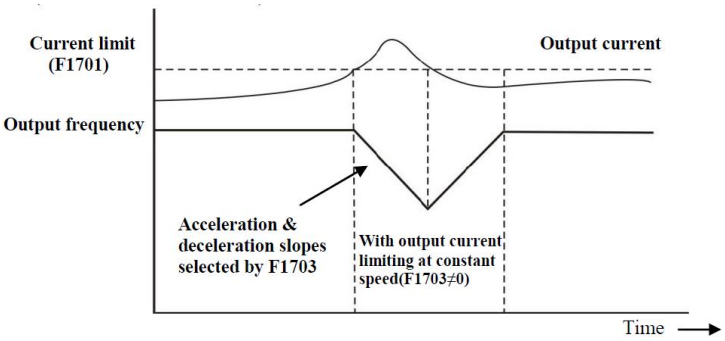
During constant-speed running, the action of output current limiting can be selected to be ON or OFF.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1703	Output current limiting at constant speed	0: Null 1: Valid V/f (current acceleration / deceleration time) 2: Valid V/f (1st acceleration / deceleration time) 3: Valid V/f (2nd acceleration / deceleration time) 4: Valid V/f (3rd acceleration / deceleration time) 5: Valid V/f (4th acceleration / deceleration time) 6: Valid V/f and speed control mode (1st acceleration / deceleration time) 7: Valid V/f and speed control mode (2nd acceleration / deceleration time) 8: Valid V/f and speed control mode (3rd acceleration / deceleration time) 9: Valid V/f and speed control mode (4th acceleration / deceleration time)	1	0

- The motor control mode and acceleration / deceleration time can be selected separately. The acceleration / deceleration time is the time set in F1012-F1021. (no external signal is required)
- With the speed control mode (F1001=2), the output current can still be limited by the torque limiter even the function of output current limiting at constant speed is OFF. Also, even if the function of output current limiting at constant speed has been set (F1703=1-9), when the limit value on the torque limiter is low, the situation of using a current limit lower than the values set in F1701 can still happen.

Note 1: The code for limiting actions of output current at constant speed and the code for selecting of normal 1st - 4th acceleration/deceleration time share the same code.
Note 2: The situation that the output current is limited by speed control through the torque limiter may be used in case that the values set in F1012-F1021 don't decelerate.
Note 3: Use torque control mode, this function won't work since the control methods are different.

Reference parameter
F1701 (output current limiting function)
F1012-F1015 (1st - 4th acceleration time)
F1016-F1021 (1st - 4th deceleration time)



F1704 Pre-alarm value for overload

The function to output an overload pre-alarm signal for the current from the control signal output terminal (set by F1509-F1511) or multi-function relay (set by F1513) when the inverter is powered off because of overload or there is an abnormal situation at the side of the loading device.

Code No.	Function name	Data content		Resolution setting	Factory preset
F1704	Pre-alarm value for overload	Mode A	20～200%	1%	150
		Mode B	20～150%		120

● The setting values are set according to the ratio with the rated current.
● When the output current from the inverter exceeds the values set in F1704, the overload pre-alarm signal will be output.
Reference parameter
F1509-F1511 (Selection of output terminal D01 - D03)
F1513 (Relay 1 contact output selection)

F1705 Motor type

The function to select the type of the motor connected to the inverter.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1705	Motor type	1: General-purpose motor 2: Dedicated motor specifically for inverter	1	1

● Change the actions of the electric thermistor according to the motor types. Refer to F1702 (Electric thermistor setting)
Reference parameter
F1702 (Electric thermistor setting)

F1706 Switch between "OV" & "LV" alarms in stop state

Select the alarms of "OV" (overvoltage) and "LV" (lowvoltage) when the inverter is stopped.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1706	Switch between 'OV' & "LV" alarms in stop state	0: "OV" enabled, "LV" disabled 1: "OV" disabled, "LV" enabled 2: "OV" disabled, "LV" disabled 3. "OV" enabled, "LV" enabled	1	0

● In the seven-segment monitor on the operation panel, overvoltage is shown as OU, lowvoltage is shown as Lu
Note 1: With this function, even when the alarm is disabled, the protecting action is still effective. But the alarm will not be displayed on the operation panel, the alarm relay will neither output, therefore the reason of the alarm can not be detected.
Note 2: When the display of OU & Lu as well as the relay output influence other logic actions, please set this function.

F1707 Phase lack detection

The function to select the detections of out-phase at input & output.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1707	Phase lack detection	0: input out-phase detection invalid, output out-phase detection invalid 1: input out-phase detection valid, output out-phase detection invalid 2: input out-phase detection invalid, output out-phase detection valid 3. input out-phase detection valid, output out-phase detection valid	1	3

● When an input out-phase is detected, the alarm display is " oPn I.
● When an output out-phase is detected, the alarm display is " oPn O.

Note 1: When leaving the factory, both detection functions of input & output out-phase are enabled. However, please disable these functions with consideration of the errors caused by peripherals and interference. Furthermore, in order to decrease the false detection ratio of input out-phase, the detection function should be carried out according to the load ratio during normal running with stable load.

F1708 Prevention of stall caused by overvoltage

The function of overvoltage stalling prevention is selected to control the deceleration slope, therefore prevent the overvoltage trip in regeneration caused by sudden deceleration of the motor and other reasons.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1708	Prevention of stall caused by overvoltage	0: without overvoltage stalling prevention 1: with overvoltage stalling prevention	1	1

Note 1: When this function is set with the overvoltage stalling prevention disabled, it is effective when the deceleration is finished within the deceleration time. However, since the DC voltage of the inverter will rise, enough discharging units must be equipped.

Reference parameter F1115 (Duty cycle of brake resistor)

F1709 Detection time of feedback signal disconnection

This Function is used to set the detection time of feedback signal of the PID or PG when the feedback is disconnected.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1709	Detection time of feedback signal disconnection	0: Only warning 0.01-119.9s 120: Without disconnecting detection	0.01sec	5

● Though F1709=0 is used to detect the disconnection, there is only warning but without stop alarm.
● Use F1709=120, never detect the disconnection.

F1710 Carrier frequency variable by temperature

The function to change carrier frequency automatically according to the Heat sink fin temperature of the inverter.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1710	Carrier frequency variable by temperature	0: disabled 1: enabled	1	0

● In case of F1710=1, in order to prevent the inverter from stopping caused by overheating alarm, the carrier frequency will be changed automatically.
● The values of F1710 are available only when F1320=1 (mode A). When F1320=2 (mode B), the carrier frequency will be changed automatically without referring to values of F1710.

Information function

The functional blocks representing the inverter will be illustrated as follows.

F1801 Inverter host software version display

Show software version of the inverter host.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1801	Inverter host software version display	Inverter host software version	—	—

● This is a read only function code.
● Show the software version of the inverter as. " UXXXX ". XXXX represents the software version.
(Example) When the software version of the inverter host is "1.00", the seven-segment monitor displays " U0100 ".

F1802 Inverter host memory version display

Show memory version of the inverter host.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1802	Inverter host memory version display	Inverter host memory version	—	—

● This is a read only function code.
● Show the memory version of the inverter as " tXXXX ". XXXX represents the memory version.

F1803 Operation panel software version display

Show the software version of operation panel.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1803	Operation panel software version display	Operation panel Software version	—	—

● This is a read only function code.
● Show the software version of currently connected operation panel as " PXXXX". XXXX represents the software version.

F1804 Operation time display

The inverter displays the accumulated time of operation by the unit of time.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1804	Operation time display	Inverter operation time	1hour	—

● This is a read only function code.

F1805	Read alarm data content

The function to read the five alarms stored by time sequence.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1805	Read alarm data content	0: Null 1: Start reading 9: Record erase	1	0

- The function to read the alarms displayed on the inverter. Read the last five alarms.
- In case that the alarm will not be recorded, it will display "End" when F1805=1 is set.
- The record will be erased when F1805=9. Meanwhile, the data of F1806 - F1810 will also be erased.
- Please refer to —5-5-4 Reading operations of alarm datall for details.

Note 1: This code cannot be written with the communication function; otherwise, the undefined response will be replied.

F1806	Alarm status confirmation 1

F1807	Alarm status confirmation 2

F1808	Alarm status confirmation 3

F1809	Alarm status confirmation 4

F1810	Alarm status confirmation 5

The function of the inverter to read output frequency, output current and other data when the alarm stops.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1806 F1807 F1808 F1809 F1810	Alarm status confirmation 1 Alarm status confirmation 2 Alarm status confirmation 3 Alarm status confirmation 4 Alarm status confirmation 5	Inverter status in case of an alarm (alarm name, output frequency, output current, output voltage, DC voltage, output power, Heat sink fin temperature)	—	—

- This is a read only function code.
- In case that the alarm will not be recorded when F1805=1 is set, it will display "End".
- When F1805=9 is set, the data recorded in F1806 - F1810 will be erased.
- Please refer to 5-5-5 Alarm status confirmation operation for detailed operation method and display content.

Note 1: This code cannot be written with the communication function; otherwise, the undefined response will be replied.

Note 2: The motor parameters will automatically test the alarm status in 1 and 2, but only the alarm name will be displayed, other status will be displayed as 0 and will not be recorded.

7-3-4 Special function

Energy-saving function

F1901	Energy-saving mode selection

F1902	Simple energy saving rate

F1903	Simple energy saving time

Decrease the output voltage and realize an energy-saving operation. Simple energy saving is an arbitrarily set function, it is the mode to automatically decrease the output voltage and control the highest efficiency.

Code No.	Function name	Data content	Resolution setting	Factory preset
F1901	Energy-saving mode selection	0: Null 1: Simple energy-saving mode (V/f mode) 2: Auto energy-saving mode	1	0
F1902	Simple energy saving rate	0～50%	1%	0
F1903	Simple energy saving time	0～65000sec	1sec	10

(1)F1901=1: Simple energy saving (V/f)

- With the V/f mode and after the specified time during the constant speed running after the acceleration, the voltage will be decreased by a certain ratio, therefore realizing the function of energy saving.
- For loads of general fans and pumps, the input current is decreased by reducing the output voltage of the inverter in the V/f constant mode, therefore realizing the energy saving. Simple energy saving is adjusted manually to form a voltage-frequency relationship which matches with the load and torque characteristics and realizing the energy saving.

1) Related functional code

F1901=1 Simple energy saving mode (V/f)

F1902=0-50% Simple energy saving rate

F1903=0-65000s Simple energy saving timer T1

2） Actions of simple energy-saving mode

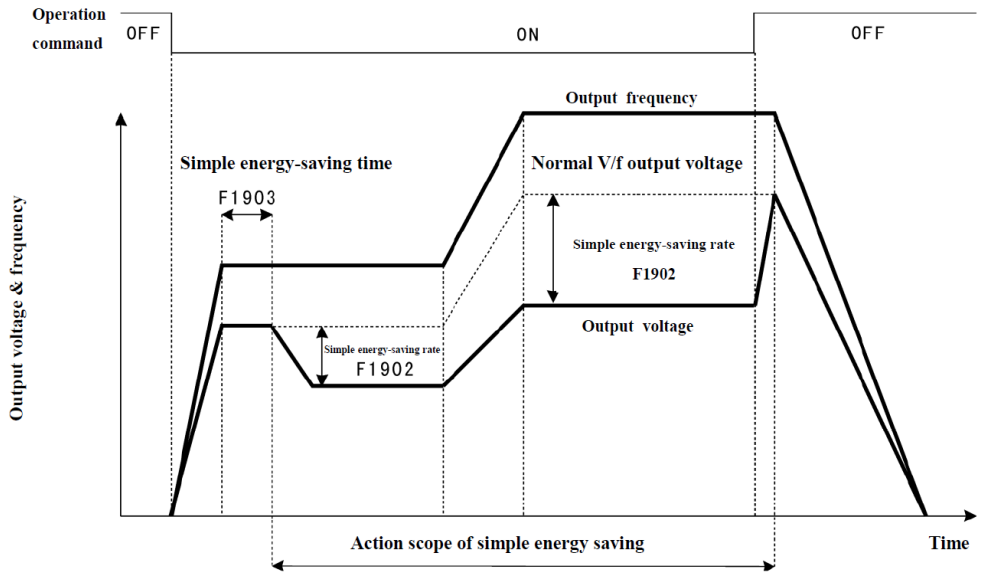
- If operation command is input into the inverter, normal acceleration will start and then enter the constant speed running status.
  When simple energy saving mode (F1901=1) can be selected, after certain time specified by the timer T1 (F1903) during constant speed running, the simple energy saving function will be enabled. For the output voltage of currently output signal, the simple energy saving is the action to decrease the output voltage by the ratio specified by F1902. Before energy saving and when the output voltage is about 200V, set F1902=50%, the output voltage will be decreased to about 100V after the time period specified by timer T1.
- Since energy saving rate (F1902) can be adjusted even when the inverter is running, please set the values which are compliant with the load characteristics.
  When simple energy saving is enabled, the afterwards output voltage will maintain the decreasing ratio to realize the V/f control even when the command frequency is modified. However, when the stoppage command of the inverter is enabled, the voltage will be recovered to the original value slowly, deceleration will be carried out when the voltage is fully recovered.

3) Decrease output voltage and recovery time

- When simple energy saving is enabled, in order to avoid large changes of loaded torque, the voltage should drop slowly, a slope of about ten seconds is required for maximum output voltage value.
  Example 1) When maximum output voltage is 440V, an output voltage of 200V will be run. If the rate is 50%, about 2.3 seconds is required to decrease the voltage to about 100V.
- In case that the energy saving is disabled through stopping command, in order to avoid the poor control caused by inadequate torque, the voltage recovery should be carried more quickly. For maximum voltage output, the slope is about one second.
  Example 2) For simple energy saving in example 1, about 0.23 second is required to recover to original voltage through the stopping command. A deceleration will be carried out after the recovery.

4) Attentions

- Simple energy saving function only decreases the output voltage of the inverter. Therefore, since the load conditions are different, the voltage drop may result in the slow down of the speed. In devices with low speed forbidden, the energy saving, and rotating speed should be compensated by the combination of auto energy saving mode (speed control) and PID control.
- For loads without energy saving even when the output voltage is decreased, never use this method.
- When restarting by the functions of flying start, alarm auto resetting, instantaneous stop restarting and etc., the simple energy saving function should be started from the beginning. (flying start can be added)
- Since the stopping action in simple energy saving is used for deceleration after the output voltage is recovered to the original value, the actual stopping time will change according to the recovering time of the voltage. When time sequence control is adopted, please take consideration of this recovery time.



(2) About auto energy saving function

The auto energy saving function is based on the V/f control method and speed control method.
Please make a selection with a motor control mode of F1001.

① F1001=1 (V/f mode)

● Based on V/f mode, the energy saving function is realized by supplying high-frequency voltage to the torque required by the load.

● Different from the simple energy saving function with manual adjusting of optimal voltage, this function can automatically calculate the high-frequency voltage value even when the load is changed, therefore realizing a stable energy saving.

● When energy saving, motor speed control and other feedback controls are operated synchronously, they can be used together with PID controlling function when a sensor is installed on the system. (Please set F3002 for PID feedback input)

1) Actions of auto energy saving mode (V/f mode)

- The auto energy saving mode can be used for the starting of inverter operation and the control of auto energy saving mode. During energy saving, the output voltage for high-efficient operation will be calculated and the voltage will be changed slowly. Whereas, in case that the acceleration / deceleration time is very short, the energy saving mode will be enabled after constant-speed operation is entered.
- Auto energy saving remains continuous operation, even when the torque is changed very slowly. Furthermore, for the changes of frequency and quick torque alteration, the inverter will disable the energy saving operation quickly, therefore preventing the inadequate torque caused by loaded torque alteration.

2) Attentions

· This function only controls the output voltage of the inverter. Therefore, the speed may decrease because of the pressure rise/drop according to the load situation. When it is used on the devices with a problem when the speed is reducing, the combination of an auto energy saving mode (speed control) and the use of PID control system with a speed sensor can make a compensation to the energy saving and the speed. Refer to F30xx - F33xx for PID functions.

· The time required for voltage rising to realize a high-efficient voltage value will be changed according to the actual load condition.

· For changes of pre-set frequency, stopping command and rapid load alteration, in order to avoid the reducing of driving power caused by inadequate loading torque, the decreased or increased output voltage will be recovered to the original voltage within several milliseconds.

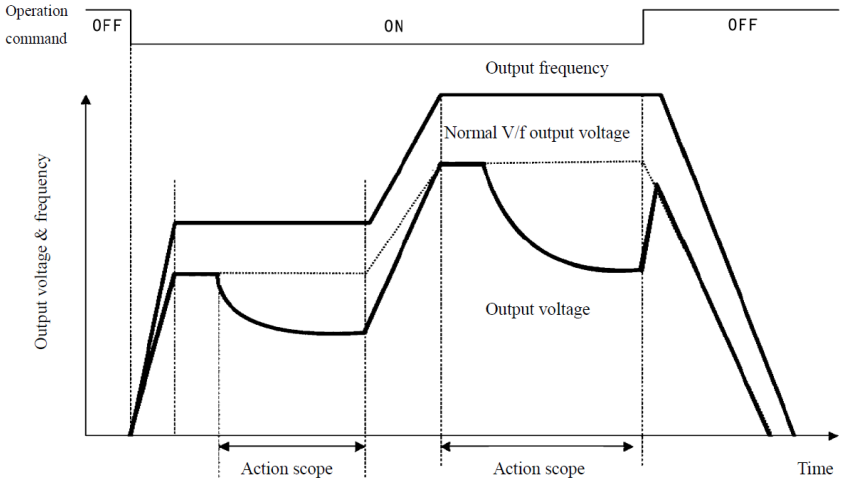
· Different from the actions in simple energy saving, the deceleration will be enabled simultaneously when the stopping command is carried out, therefore it equals to the normal stopping time. But, when the regenerating energy cannot be used fully, the deceleration time will be prolonged through the protective function.

· For fans and pumps, it is effective for the square torque during light loading, but it may be noneffective for the constant torque during heavy loading.

· When restarting by the functions of flying start, alarm auto resetting, instantaneous stop restarting and etc., the simple energy saving function should be set from the beginning. (Flying start can be added.)

· Energy saving action functions only when the loaded torque alteration is stable during constant speed running. Therefore, when the frequencies are changed by analog frequency input and other methods, the energy can also be saved by increasing the Range of frequency consistency (F1508) in case the frequency is changed very slowly.

· Linear Graphic is used for the V/f figure of auto energy saving mode.



② F1001=2 (speed control mode)

● The function of energy saving is realized by increasing motor frequency for arbitrary load torque, basing on the speed control mode (F1001=2: speed sensorless vector control).

● Different from manually adjusting of optimum voltage in simple energy saving, this function is used to reduce the motor consumption under normal operation; even the load has been changed, this function is still available for high-efficient operation under arbitrary load torque.

● Since this function is based on the speed controlling, the speed should also be compensated during energy saving.

1) Actions of auto energy saving mode

- This function will be enabled by only setting the auto energy saving mode (F1901=2).
- Start the running of the inverter with this auto energy saving mode, after stable & normal operation is reached, the control of auto energy saving will be started.
- Auto energy saving function works continuously under the energy saving actions, therefore, it is still effective even when the torque is changed very slowly. Also, for the frequency changes and fast torque changes, it can recover to normal operation from energy saving mode and eliminate the inadequate torque caused by load torque changes.

2) Attentions

・Even though the auto energy saving mode is set, normal control actions will be used during the acceleration/deceleration.

・Different from the stopping actions in simple energy saving, since this function enters the deceleration together with stopping command, the stopping time equals to the time of normal stopping actions. However, when the regenerated energy cannot be used fully and a torque limiter is required, the deceleration time will be prolonged according to the protective function.

・Auto energy saving control is effective during constant-torque operation. When rated speed has been exceeded during constant-power operation, a weak magnetic control will be adopted as normal modes.

・The function of auto energy saving is more obvious under light loads.

V·f separation function

F2001	V•f separation function selection

F2002	Command voltage for V•f separation

V•f separation function is based on V/f control mode, it can separately control the output frequency and output voltage of the switcher. A complete separation and proportional separation can be selected by the function codes.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2001	V•f separation function selection	1：V•f proportional separation 2：complete separation	1	1
F2002	Command voltage for V•f separation	0：null (command is given by VRF1） 0.01～40.95V	0.01V	0

By setting the V•f separation control F1001=40, the "V•f separation function" is effective.

1） Related control terminals on the inverter

Mark	Control terminals on inverter
VRF1	Voltage command input terminal
+V	Potentiometer connecting terminal
ACM	Analog signal common terminal

2) Input method of frequency & voltage command

・The frequency command (F1002) is selected according to speed 1, the setting can be made on the operation panel and from external.

Note: If frequency command F1002 is iteratively set with VRF1 external analog, it will conflict with the output voltage command during V•f separation. Therefore, the iterative setting of the VRF1 terminal should be avoided.

・The output voltage command can input the DC voltage (0-10V) into the external control terminals VRF1 and ACM1 or ACM2 on the inverter and input voltage into VRF1 from internal power supply +V and external potentiometer. For the external potentiometer, please refer to the connection and correct installation of control circuit terminals.
(Parameters of external potentiometer: resistance =5kΩ, capacity= ≥ 0.3W.)

・The output voltage command can input the 0-10V voltage into VRF1 and set the V•f separation command voltage: correspond to VRF1 command voltage in F2002. When the command voltage is set by function code, please set the V/f separation command voltage: F2002≠0.

3) The gain of output voltage command

① V•f proportional separation (F1001=40 & F2001=1)

- In normal V/f pattern, the voltage command Vin for current frequency is gained through the external control terminal VRF1 inputs (0-10V), and the output voltage command is sent to the inverter. There is a proportion between the frequency command and the voltage command. However, the proportion is changed with the changes of VRF1 inputs.

The relationships between VRF1 voltage input and gain coefficient are as follows:

The gain coefficient

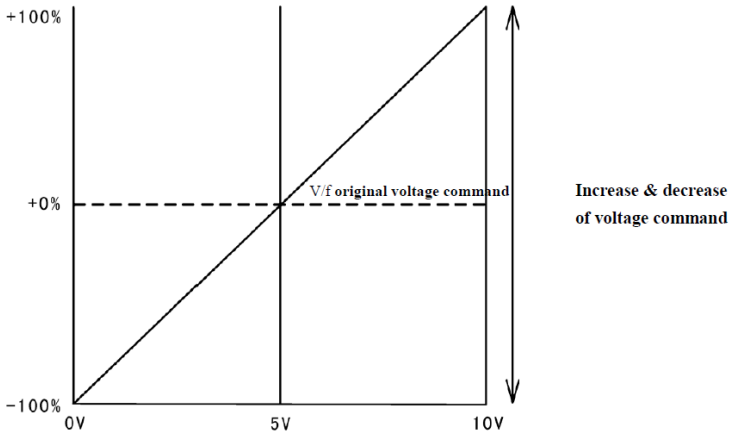
VRF1=0V input, Vout = Vin – (Vin×100%) = 0[v]

=5V input, Vout = Vin + (Vin×0%) = Vin[v]

=10V input, Vout = Vin + (Vin×100%) = 2Vin[v]

Vin= Current voltage command

Vout= Voltage command after processing



Note: output voltage is set by base voltage (F1005). When the voltage command is too large while the potentiometer is at maximum limit, please decrease the F1005.

② Complete separation (F1001=40 & F2001=2)

・ Use the base voltage (F1005) in V/f pattern as the maximum value, gain this voltage command through the external controlterminal VRF1 inputs (0-10V) and use it as the output voltage command of the inverter. The frequency command and voltage command are totally separated from each other.

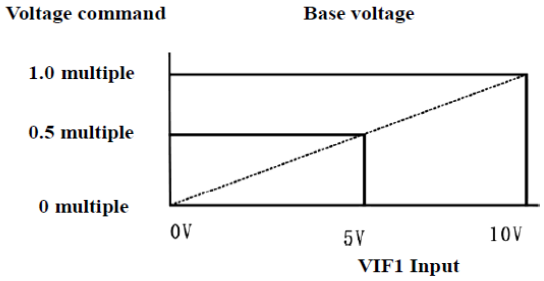
The relationships between VRF1 voltage input and gain coefficient are as follows:

The gain coefficient (linear function)

VRF1=0V input，Output voltage is 0 multiple of base voltage.

VRF1=5V input，Output voltage is 0.5 multiple of base voltage.

VRF1=10V input，Output voltage is 1.0 multiple of base voltage.



Note 1: this function is noneffective during DC braking.
Note 2: AVR functions which are accorded to base voltage (F1005 data) are effective.
Note 3: Even though the settings of instability elimination (F1308) are effective, the performance of frequency and voltage commands from this function are reduced.
Note 4: The bias and gain of VRF1 voltage coefficient are set to be noneffective.
Note 5: The frequency and voltage commands are unattached, therefore, for the output frequency, the motor may over-excited when the voltage command is too large, and the inverter may trip off because of over current. Please pay attention to the settings of frequency and voltage commands. (Especially during the acceleration/ deceleration actions)

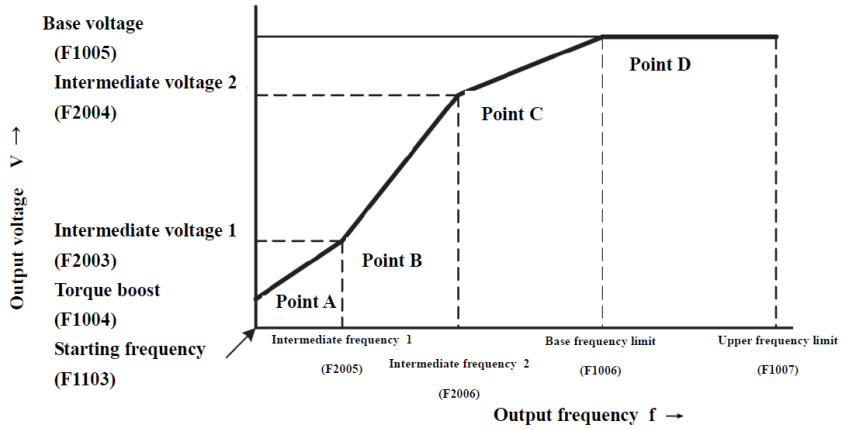
Arbitrary V/f pattern function

F2003	**Arbitrary V/f pattern intermediate voltage 1**
F2004	**Arbitrary V/f pattern intermediate voltage 2**
F2005	**Arbitrary V/f pattern intermediate frequency 1**
F2006	**Arbitrary V/f pattern intermediate frequency 2**

Arbitrary V/f pattern can be set when linear V/f pattern is selected as the V/f pattern of F1003.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2003	Arbitrary V/f pattern intermediate voltage 1	0～460V	1V	0
F2004	Arbitrary V/f pattern intermediate voltage 2	0～460V	1V	0
F2005	Arbitrary V/f pattern intermediate frequency 1	0.05～400Hz	0.01Hz	20
F2006	Arbitrary V/f pattern intermediate frequency 2	0.05～400Hz	0.01Hz	40

Set intermediate voltage 1 & 2 and intermediate frequency 1 & 2 as follows.



- When intermediate voltage 1 & 2 are smaller than the voltage command determined by F1004 (torque boost), a voltage command determined by torque boost will be for limitation.
- When intermediate voltage 1 & 2 are larger than the voltage command determined by F1005 (base voltage), the base voltage will be used for limitation.
- When intermediate frequency 1 & 2 are smaller than F1103 (starting frequency), the starting frequency will be used for limitation.
- When intermediate frequency 1 & 2 are larger than F1006 (base frequency), the base frequency will be used for limitation.

Note 1: Trip operation may happen when the output command changes fast, so more attention must be paid to the changes of settings during operation.
Note 2: Please set F2003=F2004 and F2005=F2006 when only an intermediate point is required.

Auto torque boost function

F2007	**Auto torque boost selection**
F2008	**Time constant of slip compensation response**
F2009	**Slip compensation multiple**

The function of auto torque boost based on V/f control code. It can select voltage compensation and slip compensation. However, since the motor parameters are required to be set, please carry out this function after the auto tuning 2 of the motor parameters have been finished (when the motor parameters are not clear).

Code No.	Function name	Data content	Resolution setting	Factory preset
F2007	Auto torque boost selection	0: No auto torque boost 1: Voltage compensation function 2: Slip frequency compensation function	1	0
F2008	Time constant of slip compensation response	0-1000(Setting 1=10ms)	1	10
F2009	Slip compensation multiple	0.01～2	0.01	1

① F2007=1 Auto torque boost function (voltage compensation function)
The function to automatically adjust the voltage according to the load condition.
When the load is heavy (large current), the output voltage will be increased to output torque.

② F2007=2 Auto torque boost function (slip frequency compensation function)
If the load becomes heavier, the motor speed will decrease, and the motor slip will become larger. The auto slip compensation will increase the precision of the speed.

Note 1: In order to cooperate with the control of motor characteristics, please carry out the auto tuning of motor parameters (F1001=11: motor parameter auto tuning 2).
Note 2: When a special motor is used and the output is unstable, the auto torque boost can not be selected. Please select torque boost (F1004).
Note 3: When F1005 is 0, the auto torque boost is invalid.
Note 4: Not effective during DC braking actions.
Note 5: When V/f pattern F1003=2 & 3 (low speed & deceleration mode) is set, it is invalid.
Note 6: V•f separation control is invalid.
Note 7: Energy saving function (F1901=1 & 2) is invalid.
Note 8: When the settings of special motor and auto tuning conflict, the auto tuning will not be carried out. Please set the motor parameters manually.

③ F2008 Time constant of slip compensation response.
The function to set the slip compensation response time.
Note 1: When the speed is unstable, please increase this time constant.
Note 2: The large loading inertia will result in a voltage alarm, please make an adjustment.

④ F2009 Slip compensation multiple
The function to set the speed precision of slip frequency compensation.
Normally is '1', no setting is required. When it is higher than command frequency, please set it to be smaller than 1.

7-3-5 Multi-speed function

Multi-speed function

F2101	**1st Speed frequency**
F2102	**2nd Speed frequency**
F2103	**3rd Speed frequency**
F2104	**4th Speed frequency**
F2105	**5th Speed frequency**
F2106	**6th Speed frequency**
F2107	**7th Speed frequency**
F2108	**8th Speed frequency**
F2109	**9th Speed frequency**
F2110	**10th Speed frequency**
F2111	**11th Speed frequency**
F2112	**12th Speed frequency**
F2113	**13th Speed frequency**
F2114	**14th Speed frequency**
F2115	**15th Speed frequency**
F2116	**16th Speed frequency**

The function to set the frequency during multi-speed operation.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2101	1st Speed frequency	0～400Hz	0.01Hz	0
F2102	2nd Speed frequency			10
F2103	3rd Speed frequency			20
F2104	4th Speed frequency			30
F2105	5th Speed frequency			40
F2106	6th Speed frequency			50
F2107	7th Speed frequency			60
F2108	8th Speed frequency			0
F2109	9th Speed frequency			0
F2110	10th Speed frequency			5
F2111	11th Speed frequency			15
F2112	12th Speed frequency			25
F2113	13th Speed frequency			35
F2114	14th Speed frequency			45
F2115	15th Speed frequency			55
F2116	16th Speed frequency			0

- The frequency during multi-speed operation can be selected from 1st speed to 16th speed through the combination of control terminals 2DF, 3DF, 5DF and 9DF. According to the input status of the terminals, the inverter will run with the selected frequency.

- 2DF, 3DF, 5DF and 9DF can be set to be an arbitrary terminal of DI1-DI8 through the settings of F1414-F1421.

- For frequency during multi-speed operation, the new frequency can be set through the operation panel.

Example 1) When 3rd speed is selected, the frequency set by operation panel will be stored in F2103.

Example 2) During the halfway of changing the frequency of 3rd speed operation, the output frequency of the inverter with the speed switched to 5th speed will change to 5th speed. However, the set frequency is 3rd speed frequency (F2103).

- External terminals are other functions and multiplexed functions.
  Example) 67：2DF＋AD2
  For these multiplexed terminals, the information for multi-speed operation will be only used as the terminal status of 2DF, AD2 status has no relationship with the multi-speed operation. For multi-speed switching of external terminals and the operation status of inverter as well as F1101: when the content selected by operation command has no relationship, it is effective.

Function code	Freqeuncy	2DF	3DF	5DF	9DF
F2101	1st speed	OFF	OFF	OFF	OFF
F2102	2nd speed	ON	OFF	OFF	OFF
F2103	3rd speed	OFF	ON	OFF	OFF
F2104	4th speed	ON	ON	OFF	OFF
F2105	5th speed	OFF	OFF	ON	OFF
F2106	6th speed	ON	OFF	ON	OFF
F2107	7th speed	OFF	ON	ON	OFF
F2108	8th speed	ON	ON	ON	OFF
F2109	9th speed	OFF	OFF	OFF	ON
F2110	10th speed	ON	OFF	OFF	ON
F2111	11th speed	OFF	ON	OFF	ON
F2112	12th speed	ON	ON	OFF	ON
F2113	13th speed	OFF	OFF	ON	ON
F2114	14th speed	ON	OFF	ON	ON
F2115	15th speed	OFF	ON	ON	ON
F2116	16th speed	ON	ON	ON	ON

Scheduled operation function

Simple scheduled operation function (F2201=1)

F2201	Scheduled operation function

F2202	Simple scheduled operation repetitions

The function to select an operation mode.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2201	Scheduled operation function	0：Normal operation 1：Simple scheduled operation 2：Disturbed operation	1	0
F2202	Simple scheduled operation repetitions	0：Continuous 1-250：Repetition count	1	1

- The function to establish a graph with the function codes for auto operation of running direction, set frequency, operation time, acceleration/ deceleration time and so on. This can be used effectively during setting the operating schedule of auto operation.
- The operating schedule including stopping timer can be set into 16 graphs. Furthermore, the total 16 graphs can be operated as one cycle, also it can be operated repeatedly within the specified times. Since the operating status will be stored in the memory during power failure, the inverter will continue the interrupted schedule when it is returned to normal operation.

1) Use control terminals on inverter

Control Terminal	Content	Function Code Setting	
DI1～DI8※	Timer reset function	F1414～F1421	37
DO1～DO3※	Cycle completion signal	F1509～F1511	3
COM1、COM2	Digital signal common terminal		

※ Please select the terminals through the function codes and set the contents.

2) Startup of simple scheduled operation

- Please set F2201=1 (simple scheduled operation). When motor control mode is V/f or speed control, the simple scheduled operation is effective.
- The operating command is only effective for operation panel, external control circuit terminal and other forward run, so please input forward run command which has no relationship with the operation direction.
- The operation direction and acceleration/deceleration time can be set by the 16 timers from T1 to T16.

3) Setting method

- Enter 2-digit value into the forward/reverse run and acceleration/deceleration (F2221-F2235) in T1-T15.

F2221	T1 Forward/reverse rotation and accelration/deceleration

F2222	T2 Forward/reverse rotation and accelration/deceleration

F2223	T3 Forward/reverse rotation and accelration/deceleration

F2224	T4 Forward/reverse rotation and accelration/deceleration

F2225	T5 Forward/reverse rotation and accelration/deceleration

F2226	T6 Forward/reverse rotation and accelration/deceleration

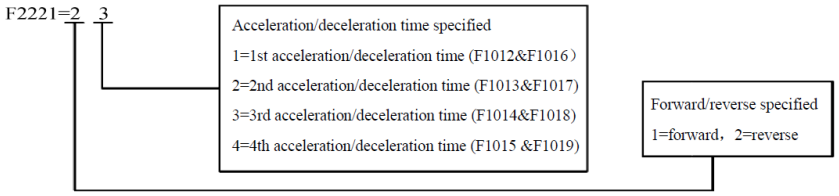
F2227	T7 Forward/reverse rotation and accelration/deceleration

F2228	T8 Forward/reverse rotation and accelration/deceleration

F2229	**T9 Forward/reverse rotation and accelration/deceleration**
F2230	**T10 Forward/reverse rotation and accelration/deceleration**
F2231	**T11 Forward/reverse rotation and accelration/deceleration**
F2232	**T12 Forward/reverse rotation and accelration/deceleration**
F2233	**T13 Forward/reverse rotation and accelration/deceleration**
F2234	**T14 Forward/reverse rotation and accelration/deceleration**
F2235	**T15 Forward/reverse rotation and accelration/deceleration**

Code No.	Function name	Data content	Resolution setting	Factory preset
F2221	T1 Forward/reverse rotation and accelration/deceleration	X Y	—	11
F2222	T2 Forward/reverse rotation and accelration/deceleration	X…1 ： forward rotation, 2：reverse rotation		11
F2223	T3 Forward/reverse rotation and accelration/deceleration	Y…1 ～ 4 ： acceleration/deceleration time specified		11
F2224	T4 Forward/reverse rotation and accelration/deceleration			11
F2225	T5 Forward/reverse rotation and accelration/deceleration			21
F2226	T6 Forward/reverse rotation and accelration/deceleration			21
F2227	T7 Forward/reverse rotation and accelration/deceleration			21
F2228	T8 Forward/reverse rotation and accelration/deceleration			11
F2229	T9 Forward/reverse rotation and accelration/deceleration			11
F2230	T10 Forward/reverse rotation and accelration/deceleration			11
F2231	T11 Forward/reverse rotation and accelration/deceleration			11
F2232	T12 Forward/reverse rotation and accelration/deceleration			21
F2233	T13 Forward/reverse rotation and accelration/deceleration			21
F2234	T14 Forward/reverse rotation and accelration/deceleration			21
F2235	T15 Forward/reverse rotation and accelration/deceleration			21

Example: set the operation direction and acceleration/deceleration time in T1 into the third acceleration/deceleration time with reverse run



Note 1： The inching operation before startup of simple scheduled operation should be as normal. (Forward & reverse)
For the occasions of half stop during simple scheduled operation, the inching operation should also be as normal.

Note 2: Use the startup, braking and other conditions of the simple scheduled operation, operate as normal unless special instructions have been shown.

Note 3: For operating direction specified in T1-T15, when the rotation direction is fixed according to the allowable direction of the motor, the use of an operation timer with an unallowed direction will lead the inverter into standby and wait for the startup of the next timer.

Note 4: During simple scheduled operation, since the acceleration/deceleration time is specified by each timer, the switching of acceleration/deceleration time by multi-functional input terminals AD2 and AD3 are invalid.

4) Each timer operated with simple scheduled operation

- When the simple scheduled operation is started with rotation direction specified by function codes and acceleration/deceleration time according to the forward run command, T1-T15 as well as T0 will start to count by sequence. After a specified time period, it will move to the next timer. This operation timer will start from T1 and continue to T2, T3…T15, T0 by sequence. However, when the time of the operation timer is 0s, the current timer will be skipped and continue to the next timer.
-

F2203	**Operation timer T1**
F2204	**Operation timer T2**
F2205	**Operation timer T3**
F2206	**Operation timer T4**
F2207	**Operation timer T5**
F2208	**Operation timer T6**

F2209	**Operation timer T7**
F2210	**Operation timer T8**
F2211	**Operation timer T9**
F2212	**Operation timer T10**
F2213	**Operation timer T11**
F2214	**Operation timer T12**
F2215	**Operation timer T13**
F2216	**Operation timer T14**
F2217	**Operation timer T15**

Please set each expected time in the following function codes.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2203	Operation timer T1	0～65000sec	1sec	10
F2204	Operation timer T2			
F2205	Operation timer T3			
F2206	Operation timer T4			
F2207	Operation timer T5			
F2208	Operation timer T6			
F2209	Operation timer T7			
F2210	Operation timer T8			
F2211	Operation timer T9			
F2212	Operation timer T10			
F2213	Operation timer T11			
F2214	Operation timer T12			
F2215	Operation timer T13			
F2216	Operation timer T14			
F2217	Operation timer T15			

Note: When a timer is changed during operation, the value will be effective from the next cycle. If the change is made after the operation, the value will become effective since the cycle is started.

F2218	**Operation stop timer T0**

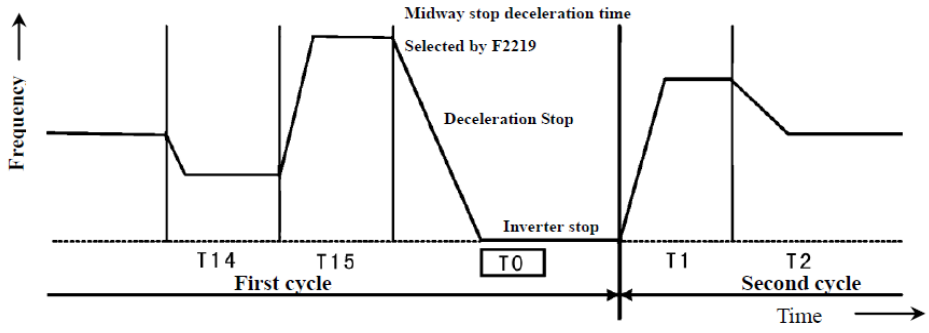
5) About the operation stop timer T0

During simple scheduled operation, besides the above-mentioned T1-T15, there is an operation stop time T0 (F2218).

Each timer in simple scheduled operation is used as a cycle, but the cycle switching (i.e. moving from T15 to T1) after one complete operation is stopped will be used when trying to move to the next cycle.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2218	Operation stop timer T0	0～65000sec	1sec	10

Note 1: The frequency cannot be specified during the operation stop time T0. Usually under the status of stopping deceleration.
Note 2: The deceleration time in stopping action will decelerate from 1st deceleration time to fourth deceleration time specified by midway stop deceleration time (F2219).
Note 3: When the operation stop time T0 is finished and the inverter is still stopping deceleration, it will last until the inverter is fully stopped, otherwise, it will not enter the next cycle. Therefore, the stop time of T0 should be set longer than the time from T15 to deceleration stopping.
Note 4: The braking mode is the same as usual operation. (DC braking, braking excitation, free run stop are effective)
Note 5: When operation stop time is not required, please set F2218=0. When the cycle moves from T15 to T1, the inverter will operate continuously.



6) Use of frequency value for each timer

- The frequency of each timer is set by function codes of multi-speed frequency (1st - 15th speed frequency) with standard functions. However, for the frequency set for T1, when 1st speed frequency (F1002) selects 1, 21 and 22, the 1st speed frequency (F2101) is the set frequency; for occasions other than 1, 21 and 22, the set frequency is the frequency set for specified function.

・ Setting method

Operation timer	Content
Operation timer T1	F1002=1, 21, 22 1st speed frequency (F2101) F1002=2～20→Analog freqeuncyinput（VRF1、VRF/IRF terminal） F1002=25 →Pulse train input F1002=26～28→ Absolute value of analog input frequency（VRF1、VRF/IRFterminal） （Rotation direction as specified by F2221）
Operation timer T2～T15	Decided by contents of F2102-F2115 =0～400Hz

Note 1：During actions of each operation timer (T1-T15), if the frequency is changed by multi-speed frequency code (F2102-F2115), direct step setting or terminal stepping functions, the frequency in current operation timer will also change. Furthermore, the changed frequency will be shown in the function codes of multi-speed frequency.

Example) When operation timer T2 is running and the frequency is changed on the operation panel, make an acceleration/deceleration according to the changed frequency, enter the changed frequency values in to F1202.

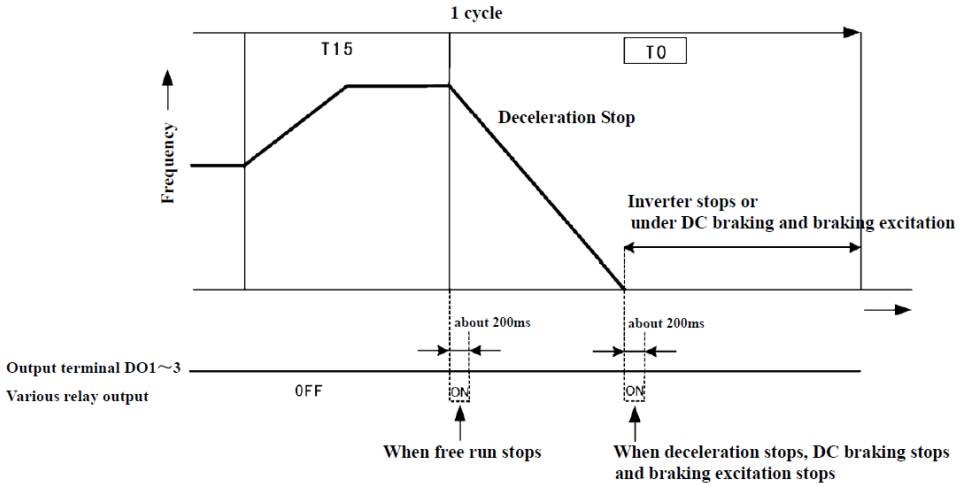
Note 2: Since the simple scheduled operation will specify multi-speed frequency in each timer, the multi-speed changes made for control circuit input terminals will be noneffective.

7) Cycle completion signal of simple scheduled operation

- If a control terminal output function is set in cycle completion of simple scheduled operation (any one of F1509-F1511 is 3), before the operation timer T0 stops the inverter or enters into DC braking and braking excitation, the open-circuit output of collector between control circuit output terminal and DCM1 & 2 is set to ON and is about 200ms. Please put the external action command to OFF after one cycle is completed or use it when peripheral equipments and the programs are required to be synchronized.

Note 1: There is an output when the cycle completion signal of simple scheduled operation passes the T0. When an output is not wanted, make a setting beyond F1509-F1511=3, or set the operation timer T0 to 0.0s.

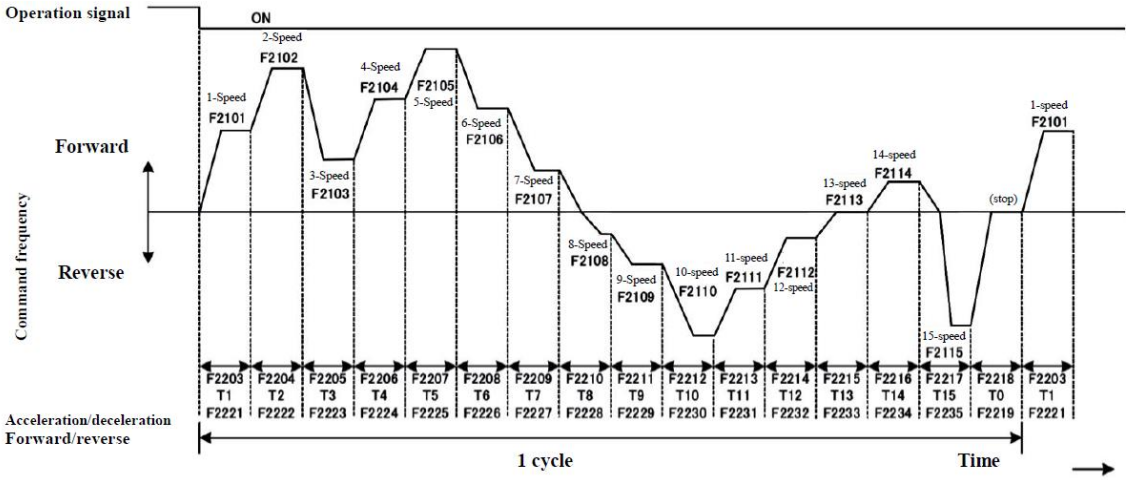
Note 2: On the last operation timer when the total cycle (simple scheduled operation repetition count) is completed, when the inverter stops or starts DC braking and braking excitation, the cycle completion signal which has no relationship with the timer status will be ON.



8) Figure of simple scheduled operation and function code setting

・ The following figure summarizes the correspondence between the actions of simple scheduled operation and the function codes.

Operation timing T0-T15: F2203-F2217=0-65000s
Multi-speed frequency 1-15: F2101-F2115=0-400Hz
Forward/reverse, acceleration/deceleration time: F2221-F2235
Repetition count: F2202=0-250 (0: without limit)



9) Midway stop and midway start of simple scheduled operation

- During simple scheduled operation, when the inverter must be stopped because of some undiscovered reason, the deceleration time during this period can be set independently and separated from the operation timer.

- When stop command between operation timers T1-T15 (including alarms) are entered into the inverter, the inverter will stop deceleration or free run, and stay at the midway stop status during simple scheduled operation. The stop deceleration time should be accorded to the deceleration time of midway stop deceleration time (F2219). F2219 will make a choice from 1st deceleration time to 4th deceleration time of F1016-F1019.

F2219	**Midway stop deceleration time**

F2220	**Midway start acceleration time**

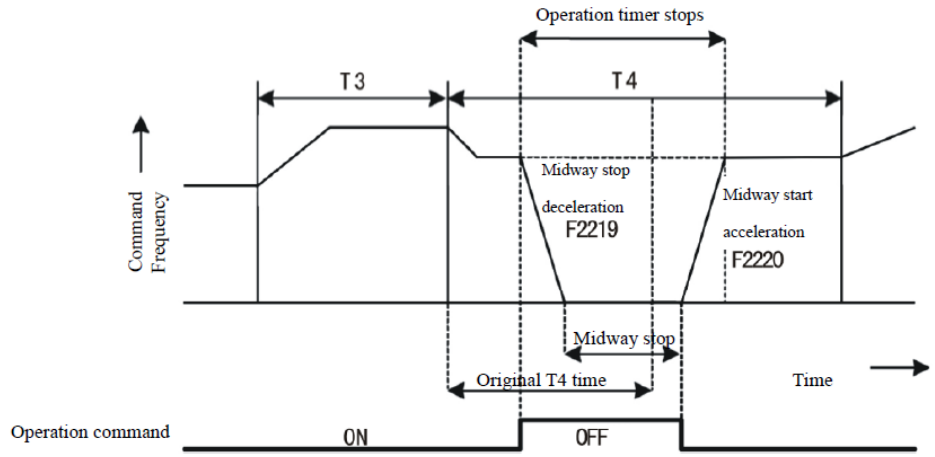
Code No.	Function name	Data content	Resolution setting	Factory preset
F2219	Midway stop deceleration time	1: 1st deceleration time (value of F1016) 2: 2nd deceleration time (value of F1017) 3: 3rd deceleration time (value of F1018) 4: 4th deceleration time (value of F1019)	1	1
F2220	Midway start acceleration time	1: 1st acceleration time (value of F1012) 2: 2nd acceleration time (value of F1013) 3: 3rd acceleration time (value of F1014) 4: 4th acceleration time (value of F1015)	1	1

Note: When stop command (or free run) enters into the inverter, the current operation timer will be maintained, and prepared for the next operation. When the operation command enters again, the operation timer will continue to work if original frequency is reached.

· During midway stop, if the conditions for another start are satisfied, the inverter will start acceleration to the original frequency set in the operation timer and enters into the midway start status. The acceleration time of this period is accorded to the acceleration time of midway start acceleration time (F2220).

· F2220 can make a choice from 1st deceleration time to 4th deceleration time of F1012-F1015. When the pre-set frequency is reached, the operation timer will work again.

Reference: During midway stop, even if the power supply is cut off, it still can record the last status of operation timer, therefore, when daily operation is finished and the inverter is stopped or the power supply is cut off, the operation on the next day will continue with the last operation.



10) Resetting of simple scheduled operation timer during midway stop

· Keep the timer running during midway stop. Therefore, when conditions for another start are satisfied, the inverter will start acceleration to the original frequency set in the operation timer and continues with the remaining simple scheduled operation. If the maintained status of the operation timer is not used, please use the reset functions on the control circuit terminals to reset the operation timer.

· Since the reset function has reset the total timers in simple scheduled operation, the next operation will start the cycle from timer 1.

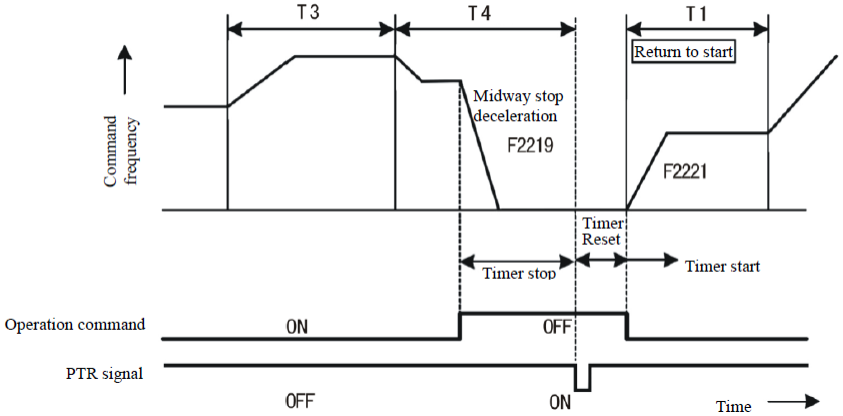
11) Setting & resetting method

· Please use the resetting of simple scheduled operation timers (any one of F1414-F1421 equals to 37) to set the multi-functional input terminals.

· If the inverter stays in stop status because of midway stop, please short-circuit the control circuit terminal and DCM1 or DCM2 for over 100msec. Therefore, rest the simple scheduled operation timer.

· When the inverter is fully stopped because of midway stop, please reset the operation timer before the input of the next operation signal. When inverter is during running, standby and start acceleration, even the reset of the timer is noneffective.

Note: If reset command of operation timer is input continuously, even when the next status is in midway stop state, the timer can still reset. Please input reset command only when necessary.



Disturbed operation function（F2201=2）

Disturbed operation function (F2201=2)

F2236	Disturb modulation analog input switching

F2237	Disturb modulation rate

● The function to periodically set the frequency change and repeat the actions through the pre-set acceleration/deceleration time. According to the difference between the shaft diameters of front end and terminal end, it is effective for the system desiring to change the rotating speed.

● For the frequency set in disturbed operation, since it is freely modulated according to external analog command, the setting value of repeated frequency can be adjusted in conjunction with load status.

Code No.	Function name	Data content	Resolution setting	Factory preset
F2236	Disturb modulation analog input switching	0: No analog input 1：External Analog VRF1 voltage （0～5V） 2：External Analog VRF1 voltage （0～10Vor potentiometer） 3：External Analog VRF/IRF voltage （0～5V） 4：External Analog VRF/IRF voltage （0～10Vor potentiometer） 8：External Analog VRF/IRF current （4～20mA）	1	0
F2237	Disturb modulation rate	0～50%	1%	0

1) Use of inverter terminal

Control terminal	Content	Function code setting
VRF1 ， VRF/IRF	Modulation signal input	F2236
ACM	Analog signal common terminal	

2) Basic actions of disturbed operation

● Please set F2201=2 (disturbed operation). No matter what the control mode of the motor is, the disturbed operation is always effective.

● Since there are two settings of frequency value, it must be set according to 1st speed frequency (F2101) and 2nd speed frequency (F2102).

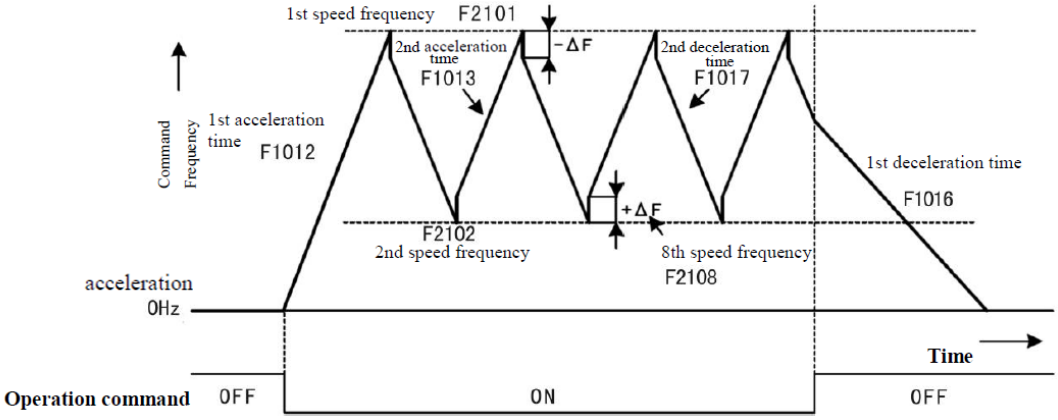
● When an operation command is input, the both frequencies will be repeated with a sequence of 1st speed frequency→2nd speed frequency→1st speed frequency…Also, when output frequency reaches the preset frequency, in order to prevent twining, an increase/decrease (△F) will be made to the instantaneously set frequency. When 1st speed frequency is reached, 8th speed frequency (F2108) will be used to subtract the preset frequency from 1st speed frequency; when 2nd speed frequency is reached, this value will be added to act as the set frequency.

The next set frequency when 1st speed frequency is reached→1st speed frequency – 8th speed frequency (△F).

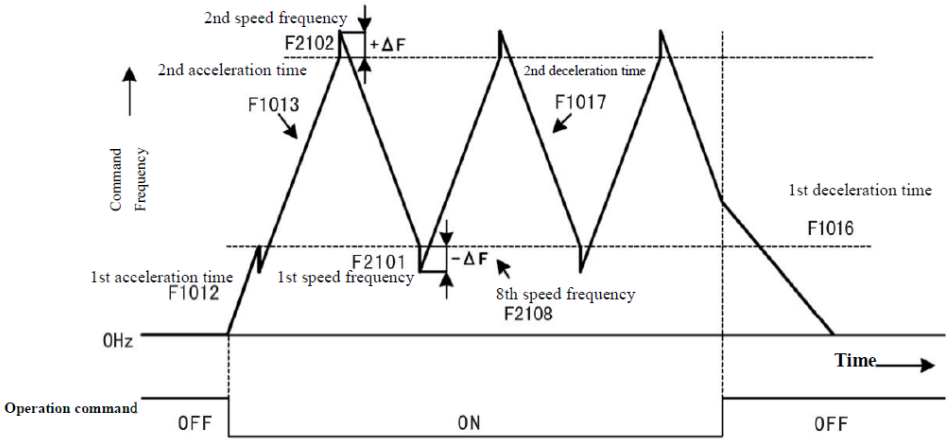
The next set frequency when 2nd speed frequency is reached→2nd speed frequency + 8th speed frequency (△F).

- For start (from operation command ON to the 1st speed frequency is reached) and stop (from stop command ON to stop) of the acceleration and deceleration time during disturbed operation, the frequency is changed through 1st acceleration/deceleration time, furthermore, it can also be changed through 2nd acceleration/deceleration time.

■ **When 1st speed frequency ＞ 2nd speed frequency**



■ **When 2nd speed frequency ＞ 1st speed frequency**



Note 1: The 1st speed frequency in disturbed operation is set by F2101. Therefore, the 1st speed frequency will not be set through external analog & digital (option) or terminal step. Please use F1002=1, 21.

Note 2: The inching operation before disturbed operation is as normal.

Note 3: During disturbed operation, since the acceleration/deceleration time can be set by 1st and 2nd, the switching of acceleration/deceleration time through control circuit input terminal AD2 and AD3 are noneffective. However, when AD2 and AD3 are set by terminal stepping function, the terminal stepping function is effective.
When control circuit input terminal is selected by operation signal holding function (F1414-F1421=38), its function is available.

Note 4: Since the multi-speed in disturbed operation mode is set by 1st speed and 2nd speed, the multi-speed set by control circuit input terminal 2DF and 3DF are noneffective.

Note 5: When restart the operation with the functions of flying start, alarm auto reset and instantaneous-stop restart, it will be restarted toward the 1st speed frequency.

3) Modulation of disturbed operation

- The 1st speed frequency and 2nd speed frequency in disturbed operation can be modulated by external analog command. When analog input is switched to be non-zero, the corresponding analog input will be modulation command. The maximum gain (frequency) of analog command will be set by gain frequency (F1402 or F1404 or F1406). However, since the polarity of analog input is positive, in order to modulate larger and smaller the frequency, a disturb modulation rate (F2237) can be used to adjust the offset of modulation rate.

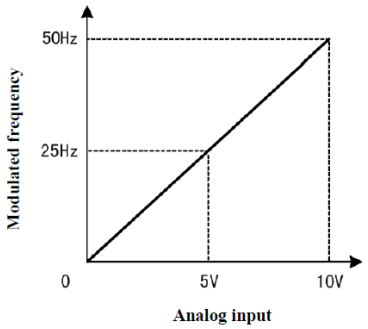
2-1) Setting and modulating method

· Use F2236 (analog input switching) to specify the modulation input.
· Use F1402 or F1404 or F1406 (setting of gain frequency) to set a maximum analog input.

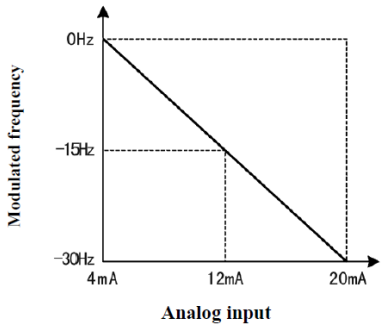
Gain frequency implies the switched frequency (modulated frequency) when a maximum analog input is specified by F2236, i.e. the switching gain corresponding to modulated frequency of analog input. When gain frequency is decided, the input analog signal will be switched into modulated frequency. This frequency is added by the two frequencies (1st & 2nd speed frequency) in disturbed operation to be modulated as a new frequency.

However, the function codes of 1st speed frequency and 2nd speed frequency will not change directly. The gain frequency can also be negative. I.e. the switched modulation frequency of analog input command tends to be negative or is already negative. The negative modulation frequency in disturb modulation will be calculated by subtraction.

Example 1 **Analog input VIF1=0-10V**
Gain frequency F1402=50Hz



Example 2 **Analog input VIF1=4-20 mA**
Gain frequency F1402=-30Hz



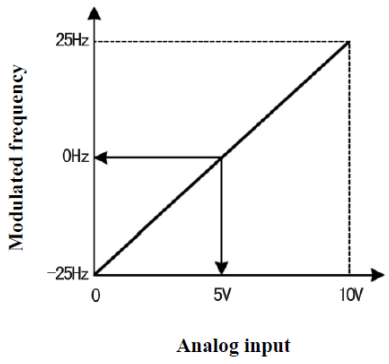
2-2) Offset of modulation frequency

After adjustment of modulation frequency is finished by analog input, the input modulation frequency is the two frequencies (1st speed frequency and 2nd speed frequency) in disturbed operation, they are the new values calculated by addition for modulation. However, as shown in example 1 and 2, through the polarity of gain frequency (F1402 or F1404), any side set in the addition calculation or subtraction calculation will be modulated.

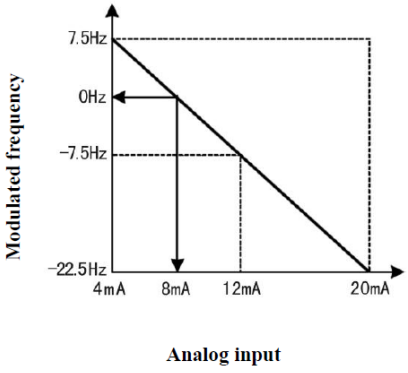
In this way, when the original frequency (1st speed frequency and 2nd speed frequency) is modulated larger or smaller, the disturb modulation rate (F2237) can be modulated by setting an offset. The offset is set according to the proportion of F2237=0-50%.

The above-mentioned proportion refers to be position of 0Hz (modulation frequency) specified by analog input. Even though the specified analog modulation input and the gain of modulation frequency through the 0Hz are totally changed, the change scope of modulation frequency is set by the settings in gain frequency (F1402 or F1404).

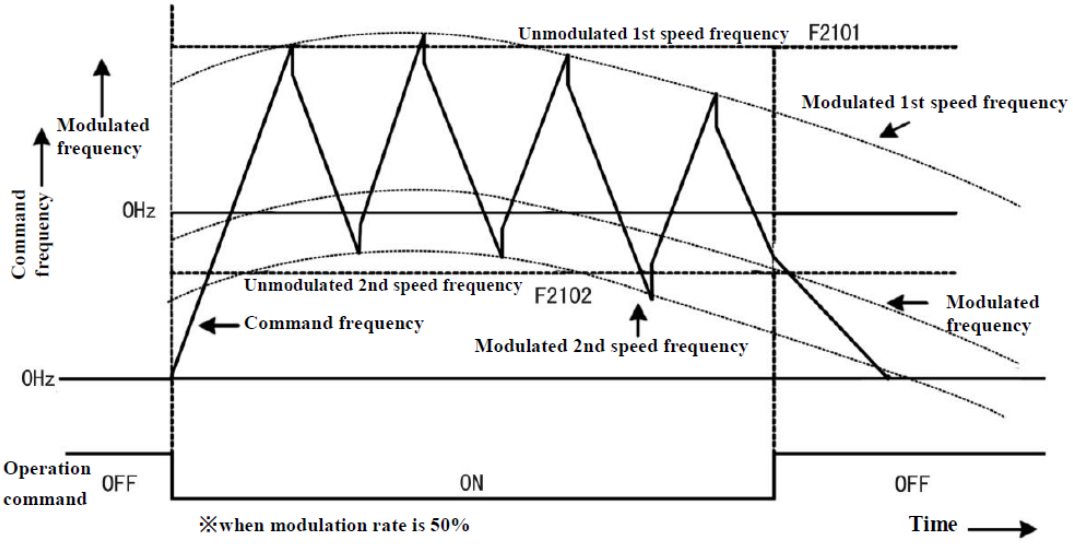
Example 1 **Analog input VIF1=0-10V**
Gain frequency F1402=＋50Hz
Disturb modulation rate F2237=50%



Example2 **Analog input VIF1=4-20 mA**
Gain frequency F1402=-30Hz
Disturb modulation rate F2237=25%



Examples of total actions are as follows.

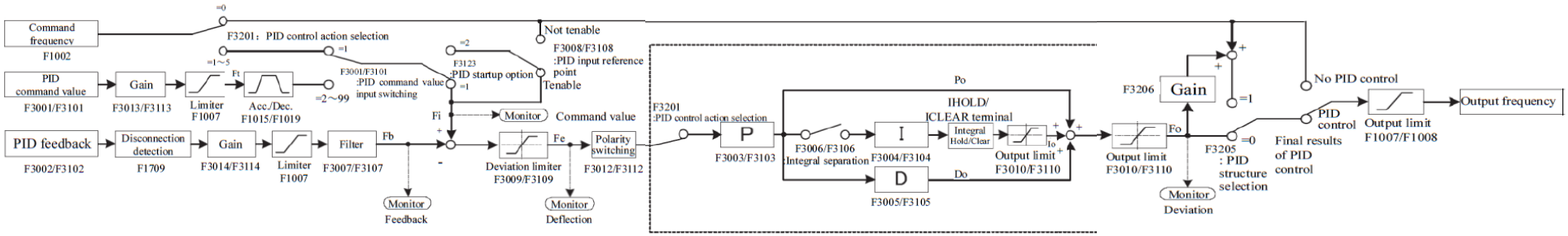


Note 1: For modulation input during disturbed operation, bias frequency (F1401) is invalid.

7-3-6 PID function

PID function

The followings are descriptions of PID control function blocks.
Multiple PID controls have been installed in this product. Each PID control is used to set the equipment status and can be used commutatively.
Also, there are multiple options for PID command and feedback values, which are used in each system.
The next page shows the basic formation of PID control.



PID Operation

Figure 7-1

The follows are function codes related to PID control.

Code No.	Function name	Data content	Resolution setting	Factory preset
1709	Detection time for feedback signal disconnection	0：only warning 0.01-199.99 second(s) 120：No detection of disconnection	0.01sec	5
3001	PID1 command value input switch	1: Frequency 2: External analog VRF1 voltage (0-5V) 3: External analog VRF1 voltage (0-10V or potentiometer) 4: External analog VRF/IRF voltage (0-5V) 5: External analog VRF/IRF voltage (0-10V or potentiometer） 9：External Analog VRF/IRF current （4～20mA） 11: Function code setting (by F3017) 99: Pulse train input	1	1
3002	PID1 feedback input switch	0: No input 1: External analog VRF1 voltage (0-5V) 2: External analog VRF1 voltage (0-10V or potentiometer) 3: External analog VRF/IRF voltage (0-5V) 4: External analog VRF/IRF voltage (0-10V or potentiometer) 8：External Analog VRF/IRF current （4～20mA） 10: Communication mode 99: PG feedback PID	1	0
3003	PID1 control proportional gain	0～100	0.01	0.1
3004	PID1 control integral time	0.01～100sec	0.01sec	0.1
3005	PID1 control differential time	0～100sec	0.01sec	0
3006	PID1 control integral separation judgment value	5～100%（upper frequency limit reference)	0.1%	20
3007	PID1 feedback signal input filter time constant	1～500（set value1=10ms）	1	10
3008	Indirect PID1 input reference	5～100%（target value reference）	0.1%	20
3009	PID1 deviation limit	0：No limit 1～100%（upper frequency limit reference）	0.1%	100
3010	PID1 output limit value	0：No limit 1～100%（upper frequency limit reference）	0.1%	100
3011	PID1 operation polarity switch	1: command value - feedback value 2: feedback value - command value	1	1
3012	PID1 gain polarity switch	1: The positive or negative deviation indicates the same gain 2: The positive or negative deviation indicates different gain	1	1
3013	PID1 command value gain	0～50	0.01	1
3014	PID1 feedback value gain	0～50	0.01	1
3015	PID1 control proportional gain (negative：F3012=2)	0～100	0.01	0.1
3016	PID1 control integral time (negative：F3012=2)	0.01～100sec	0.01sec	0.1
3017	PID1 control command value	0～4000	0.1	0

Code No.	Function name	Data content	Resolution setting	Factory preset
3018	PID1 control feedback value (communication function)	0～4000	0.1	0
3019	Frequency corresponding to PID1 control maximum command value	0～400Hz	0.01Hz	60
3101	PID2 command value input switch	1：freqeuncy 2：External Analog VRF1 voltage （0～5V） 3：External Analog VRF1 voltage （0～10Vor potentiometer） 4：External Analog VRF/IRF voltage （0～5V） 5：External Analog VRF/IRF voltage （0～10Vorpotentiometer） 9：External Analog VRF/IRF current （4～20mA） 11：Function code setting (by F3017)	1	1
3102	PID2 feedback input switch	0：No input 1：External Analog VRF1 voltage （0～5V） 2：External Analog VRF1 voltage （0～10Vor potentiometer） 3：External Analog VRF/IRF voltage （0～5V） 4：External Analog VRF/IRF voltage （0～10Vor potentiometer） 8：External Analog VRF/IRF current （4～20mA） 10：Communication mode 99：PG feedback PID	1	0
3103	PID2 control proportional gain	0～100	0.01	0.1
3104	PID2 control integral time	0.01～100sec	0.01sec	0.1
3105	PID2 control differential time	0～100sec	0.01sec	0
3106	PID2 control integral separation judgment value	5～100%（上限 freqeuncyreference）	0.1%	20
3107	PID2 feedback signal input filter time constant	1～500（set value1=10ms）	1	10
3108	Indirect PID2 input reference	5～100%（target value reference）	0.1%	20
3109	PID2 deviation limit	0：Nolimit 1～100%（upper frequency limit reference）	0.1%	100
3110	PID2 output limit	0：No limit	0.1%	100

		1～100%（upper frequency limit reference）		
3111	PID2 operation polarity switch	1：command value - feedback value 2：feedback value - command value	1	1
3112	PID2 gain polarity switch	1：The positive or negative deviation indicates the same gain 2：The positive or negative deviation indicates different gains	1	1
3113	PID2 command value gain	0～50	0.01	1
3114	PID2 feedback value gain	0～50	0.01	1
3115	PID2 control proportional gain (negative：F3012=2)	0～100	0.01	0.1
3116	PID2 control integral time (negative：F3012=2)	0.01～100sec	0.01sec	0.1
3117	PID2 control command value	0～4000	0.1	0
3118	PID2 control feedback value (communication function)	0～4000	0.1	0

Code No.	Function name	Data content	Resolution setting	Factory preset
3119	Frequency corresponding to PID2 control maximum command value	0～400Hz	0.01Hz	60
3123	PID start mode selection	1: Direct input mode 2: Conditional input mode	1	1
3124	PID end mode selection	1: Direct input mode 2: Conditional input mode	1	1
3125	PID end setting value	1-100% (upper frequency limit reference)	0.1%	20
3201	PID control action selection	0: Open loop control 1: PID1 control 2: PID2 control 3: For factory adjustment 4: External terminal switching PID control 5: Timing switch PID control	1	0
3203	External PID control selection	0: No external PID control 1: PID1 external control 2: PID2 external control 3: For factory adjustment 4: PID1, PID2 external control 5: For factory adjustment 6: For factory adjustment	1	0
3204	External PID operation mode selection	1: Linked running with inverter 2: PID output after power connection 3: PID output controlled by external terminals	1	1
3205	PID combination selection	0: Without command value addition calculation 1: With command value addition calculation	1	0
3206	Command value addition calculation PID control gain	0.01～100	0.01	1
3207	PID1/PID2 switching time	0.1～6000minutes	0.1minutes	1

【PID Control Action Selection】

F3201	**PID control action selection**

The function to select PID action.

- When setting F3201≠0, the following PID controls can be selected.
  ·F3201=0: Normal operation mode without PID control
  ·F3201=1: PID1 control mode
  ·F3201=2: PID2 control mode
  ·F3201=3: For factory adjustment
  ·F3201=4: PID control mode switched by external terminals
  ·F3201=5: PID control mode switched by timing
- PID control is effective in V/f control and speed control mode-based vector control.
- The basic formation of PID1 and PID2 are the same, therefore they can be used separately or combinedly.
- Details of each PID control mode is sorted according to the category of each function.

Note: During the operation status of inverter stopping, DC braking, excitation and so on, the PID control will not be used.

【Command Value of PID Control】

F3001	**PID1 command value input switch**

F3101	**PID2 command value input switch**

F3013	**PID1 command value gain**

F3113	**PID2 command value gain**

F3019	**Frequency corresponding to PID1 control maximum command value**

F3119	**Frequency corresponding to PID2 control maximum command value**

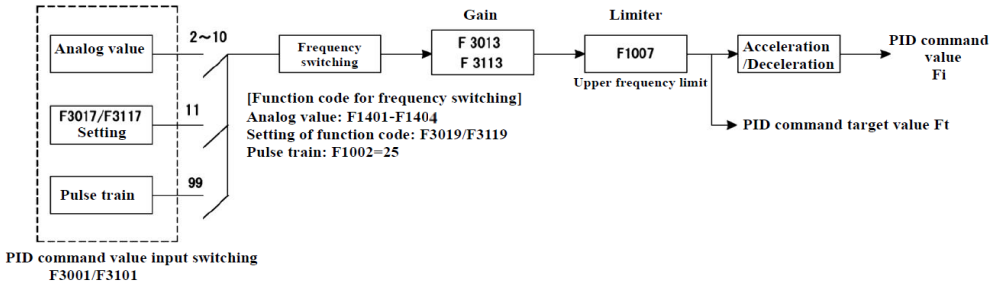
The function to select the command value of PID control.
The function to select control command value, F3001 for PID1 and F3101 for PID2.

- Select the following PID command value in the setting of F3001/F3101.
  - F3001/F3101=1：freqeuncy
    The 1st speed frequency selected by F1002 and the frequency according to multi-speed command are the command values.
  - F3001/F3101=2～10：various analog input values（VRF1，VRF/IRF）.
    The settings of various analog input values（VRF1，VRF/IRF）are the command values.
    Analog input is the same as normal frequency, the input value will be switched into frequency by gain frequency and bias frequency of F1401-F1404, this frequency will be the command value used for PID control.
  - F3001/F3101=11：use setting values of F3017（PID1）/F3117（PID2）as the command values.
    The setting values of F3017（PID1）/F3117（PID2）will be switched into frequency by the setting values of F3019（PID1）/F3119（PID2）.
    The maximum value（6000）of F3017（PID1）/F3117（PID2），will be switched into the frequency set by F3019（PID1）/F3119（PID2）.
    Example）When F3017=3000，F3019=60Hz，the command value of PID will be30Hz。
  - F3001=99：pulse train input (Option function)
    F1002=25：same as pulse train, the pulse train input from external is the command value.
    About the pulse train input, please refer to the pulse train function of F1002.
- Each PID command value can be gained by F3013 (PID1)/F3113 (PID2).
- Each PID command value will be limited according to the upper frequency limit after the gain, then acceleration/deceleration will be processed.
  When PID command value is beyond the frequency setting, the acceleration/deceleration time will be based on reference frequency for acceleration/deceleration: F1011 is the reference, run the operation according to 3rd acceleration time: F1014, 3rd deceleration time: F1018.

Note 1: The PID control of acceleration/deceleration (beyond the frequency setting) will share the 3rd acceleration/deceleration time used in normal operation, this is a fixed use.

Note 2: During the 3rd acceleration time: F1014, when any one of F1018 during 3rd deceleration time =0, the acceleration/deceleration will not be carried, the PID command target value will be directly used as PID command value.

The following shows the formation of PID command value.



Note 3: The judgment of inverter startup condition is not the command values of PID, like the normal operation, it is determined by the status of target frequency, starting frequency and operation start frequency.
Therefore, when the setting is beyond the frequency of F3001/F3101≠1, the input switching of PID command value during operation startup is required to set the multi-speed target frequency larger than starting frequency and operation start frequency.

Note 4: PID command value input switching: when the setting is beyond the frequency of F3001/F3101≠1, since the control value is different from normal frequency command, the functions based on normal frequency will not work, such as acceleration/deceleration characteristics, constant-speed protection, flying start and so on. Please pay attention to this.

【Feedback Value of PID Control】

F3002	**PID1 feedback input switch**
F3102	**PID2 feedback input switch**
F3014	**PID1 feedback value gain**
F3114	**PID2 feedback value gain**
F3007	**PID1 feedback signal input filter time constant**
F3107	**PID2 feedback signal input filter time**

	constant

The function to select the feedback value of PID control.
The function to select feedback input, F3002 for PID1 and F3102 for PID2.

● Select the following PID feedback value in the settings of F3002/F3012.

· F3002/F3012=0: no input

When the feedback input is not selected, the PID control selected by PID1 and PID2 will be noneffective. The normal open loop operation will be carried out.

· F3002/F3012=1-9: various analog feedback input values (VIF1，VRF/IRF)

Input feedback value through various analog inputs (VIF1, VRF/IRF).

Analog input is the same as normal frequency command, the input value will be switched into frequency by gain frequency and bias frequency of F1401-F1404, this frequency will be used as feedback value for PID control.

· F3002/F3012=10: the values set by F3018 (PID1)/F3118 (PID2) are the feedback values.

When feedback value is input by communication function, please enter the data in F3018 (PID1)/F3118 (PID2).

The values set by F3018 (PID1)/F3118 (PID2) are switched into frequency by the frequency set by F3019 (PID1)/F3119 (PID2).

The maximum value (6000) of F3018 (PID1)/F3118 (PID2) will be switched into the frequency set by F3019 (PID1)/F3119 (PID2).

Example) When F3118=1200 and F3119=100Hz, the feedback value of PID2 is 20Hz.

· F3002/F3012=99: The speed is switched into frequency by PG feedback pulse input (A+, A-/B+, B- terminals), the frequency will be used as feedback value input.

For PG feedback pulse input and setting method, please refer to Chapter 4 “Connection of PG Sensor” and “Function description of PG sensor (F8110/F8122/F8125)”.

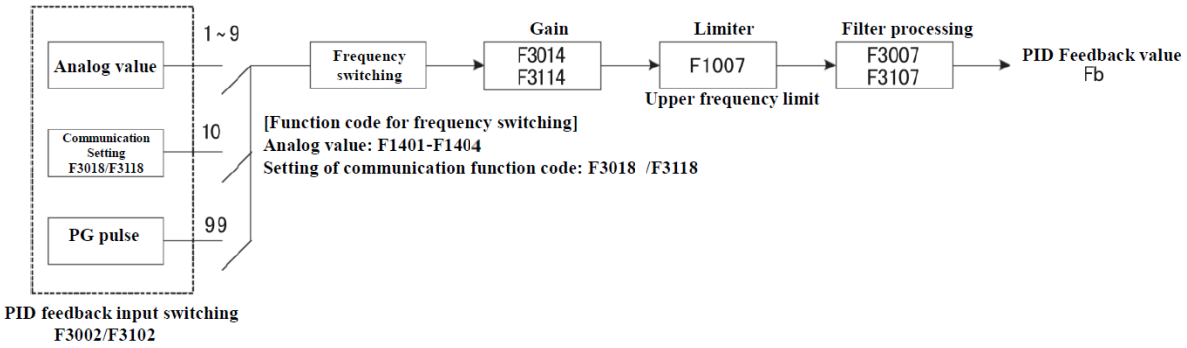
● Each PID feedback value can be gained by F3014 (PID1)/F3114 (PID2).

● After each PID feedback value is gained, F3007 (PID1)/F3107 (PID2) can be used for filter. The setting value=1 of F3007 (PID1)/F3107 (PID2) is the time constant for 10ms filter.

Example) When F3007=10, the filter time constant =100ms.

Note: When there is a speed control by PG sensor, the PG feedback will be processed internally. Therefore, never use PG feedback PID function (F3002=99 or F3102=99). If the functions of PG sensor speed control and PG feedback PID are used together, a correct control cannot be realized.

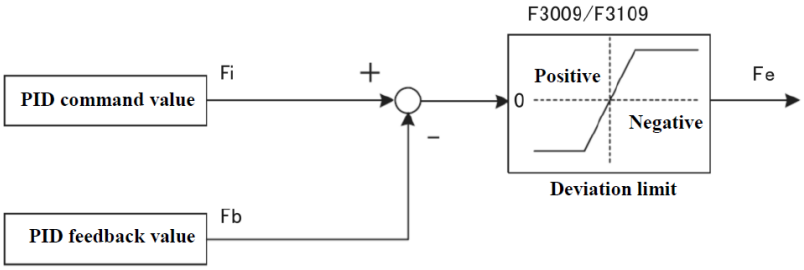
The following shows the formation of PID feedback value.



【Deviation Limit of PID Control】

F3009	**PID1 deviation limit**
F3109	**PID2 deviation limit**

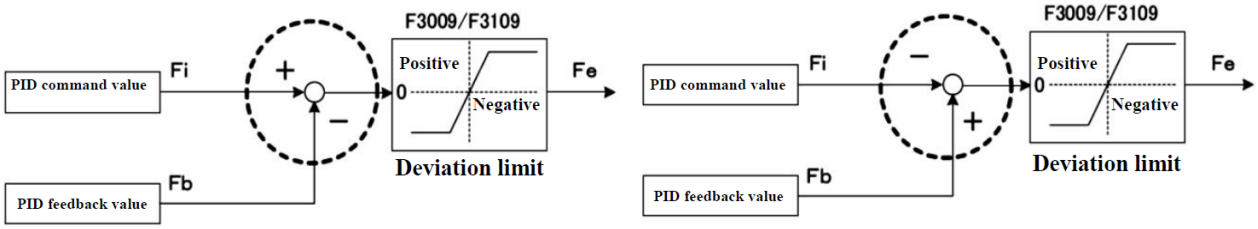
The function to make a positive/negative limit for the deviation of command value and feedback value in PID control.
● Upper frequency limit: For frequency of F1007, the rate set by F3009/F3109 will be used as the limit value.
· F3009/F3109=0: no limit
· F3009/F3109=1-100%: Use the rate to upper frequency limit for control.
Example) When F1007=50Hz and F3009=20%, ±10Hz will be used to control the deviation of PID1 control.



【PID Operation Polarity Switch】

F3011	**PID1 operation polarity switch**
F3111	**PID2 operation polarity switch**

The function to switch the deviation operation results of command value and feedback value in PID control.
● For PID deviation of Fe, the polarity will be switched according to the settings of F3011/F3111.
· F3011/F3111=1: command value – feedback value.
The polarity of deviation Fe will not be changed.
· F3011/F3111=2: feedback value – command value.
The symbol of deviation Fe will be reversed. (Polarity reversion)



Note 1: Since deviation Fe is calculated by command value – feedback value, the polarity reversion will not be carried out when F3011/F3111=1. When deviation operation is used for reversed polarity, set F3011/F3111=2.
Note 2: When F3011/F3111=2, the PID control output will be made towards increase by inverter stop action. When the system cannot be stopped, set F3124: PID end mode selection=1: direct end mode for stop action.

【PID Operation】

F3003	**PID1 control proportional gain**
F3103	**PID2 control proportional gain**
F3004	**PID1 control integral time**
F3104	**PID2 control integral time**
F3005	**PID1 control differential time**
F3105	**PID2 control differential time**

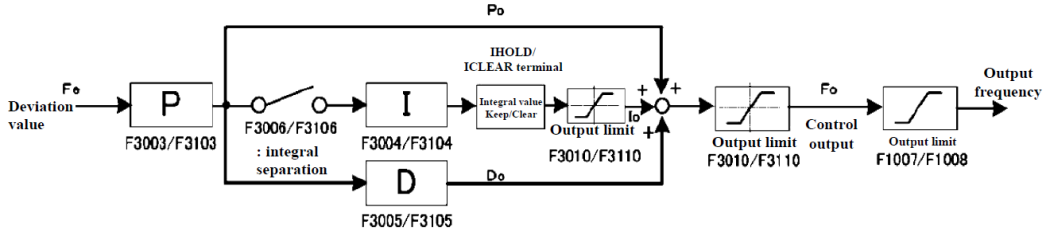
The function to make a PID operation for deviation value of command value and feedback value.
● Adjustment of PID control proportional gain
· F3003/F3103=0-100: used when adjusting the proportional gain.
To output a control value which is proportional to the deviation value. However, the deviation cannot be cleared by only P control. Please make an adjustment within a stable scope and make sure there is no vibration during the control.
● Adjustment of PID control integral time
· F3004/F3104=0.01-100 second(s): used when adjusting the integral time.
After an integral action, the deviation value will be output as the control value, it is effective for deviation clearing. However, the response to fast changes will be slowed down.
Since static difference only exists in P control, it will be used together with integral control.
In order to make a fast stabilization, the integral time should be set short. When there is an over-adjustment, the time must be set much longer.

● Adjustment of PID control differential time

· F3005/F3105=0.01-100 second(s): used when adjusting the differential time.

After a differential action, the deviation value will be output as the control value. It can be used for fast changes when the response is improved. When there is an over-adjustment, the time must be set much shorter.

The following shows the basic formation of PID control.



F3010	PID1 output limit

F3110	PID2 output limit

The function to make output limit for output of integral operation output and PID operation output.

● For integral and PID operation output, F1007: a positive/negative limit will be made by the rate to upper frequency limit.

· F3010/F3110=0: no limit

· F3010/F3110=1-100%: make a limit by the rate to upper frequency limit.

Example) When F1007=60Hz and F3010=90%, ±54Hz will be used to limit the deviation of PID control.

Note: Even though output Fo is controlled for positive/negative limit of F3010/F3110, the actual output frequency of the inverter is controlled by the upper frequency limit F1007 and lower frequency limit F1008.

F3012	PID1 gain polarity switch

F3112	PID2 gain polarity switch

F3015	PID1 control proportional gain (negative)

F3115	PID2 control proportional gain (negative)

F3016	PID1 control integral time (negative)

F3116	PID2 control integral time (negative)

The function to switch positive/negative proportional gain and integral time through the polarity of deviation.

● With the polarity of deviation, the switching of positive/negative proportional gain and integral time can be selected.

· F3012/F3112=1： The positive or negative deviation indicates the same gain

When deviation has no relationship with polarity, use F3003/F3103: proportional gain and F3004/F3104: integral time for PID operation.

· F3012/F3112=2： The positive or negative deviation indicates different gains

The proportional gain and integral time used for operation are different according to the polarity of deviation.

When deviation ≧ 0 (positive)

Use F3003/F3103: proportional gain and F3004/F3104: integral time for PID operation.

When deviation < 0 (negative)

Use F3015/F3115: proportional gain (negative) and F3016/F3116: integral time (negative) for PID operation.

Note: In normal control system, same proportional gain and integral time will be normally used. But for system with an obvious result of gain by positive/negative polarity, please try this function.

F3006	PID1 control integral separation judgment value

F3106	PID2 control integral separation judgment value

The function to invalid the integral according to the deviation value.

When the status change of the control system is large and large vibration or unstable has been caused by sharp increase of integral output, please adjust this function.

● Set the judgment value for PID control integral separation

· F3006/F3106=5-100%: the rate to upper frequency limit.

Deviation between PID command value and PID feedback value: when the conditions specified by Fe have been satisfied, the integral control is noneffective (separation).

Separation conditions are F3006/F3106: integral separation judgment value and upper frequency limit and deviation: absolute value of Fe. The judgment will be as follows.

Conditions of integral separation: |Fe| > upper frequency limit×F3006/F3106

【Start Mode of PID Control】

F3008	**Indirect PID1 input reference**
F3108	**Indirect PID2 input reference**
F3123	**PID start mode selection**

The function to select the input mode for PID control.

● The direct input mode and indirect input mode can be selected by selecting the function code.

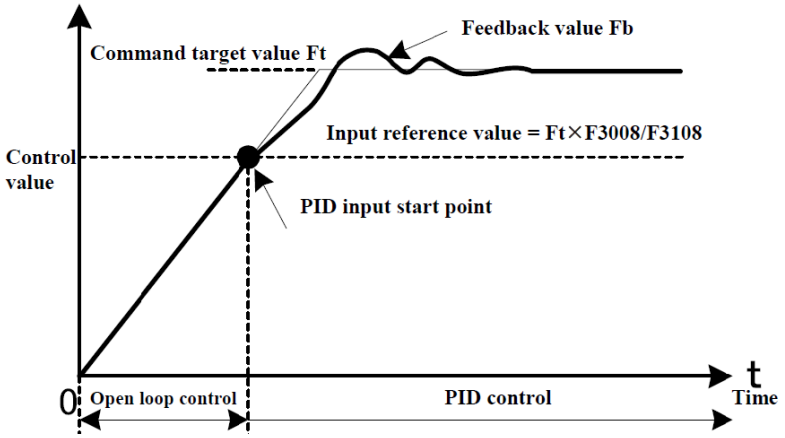
· F3123=1: direct input mode…Normal PID control.

· F3123=2: Conditional input mode.

When the conditions specified by PID command value and PID feedback value are satisfied, the PID action will be started by switching open loop control into PID control.

Start conditions are F3008/F3108: input reference and PID command target value: Ft and feedback value: Fb. The judgment will be as follows.

PID start condition: Fb≥Ft×F3008/F3108



Note 1: When PID control is started once the PID start conditions are satisfied, the PID control will continue even the second start conditions are not satisfied. However, once the inverter is in stop status and other conditions will not carry out PID control, the start operation of PID control will be carried out again according to the PID conditions.

Note 2: When PID command value input switching is F3001/F3101=1, the frequency will be target frequency Ft under normal mode.

【Formation of PID Control】

F3205	**PID combination selection**
F3206	**Command value addition calculation PID control gain**

The function to select the output formation of PID control.

● You can use PID control output directly as the frequency output, you can also add command frequency and PID control output and use the summation as the frequency output.

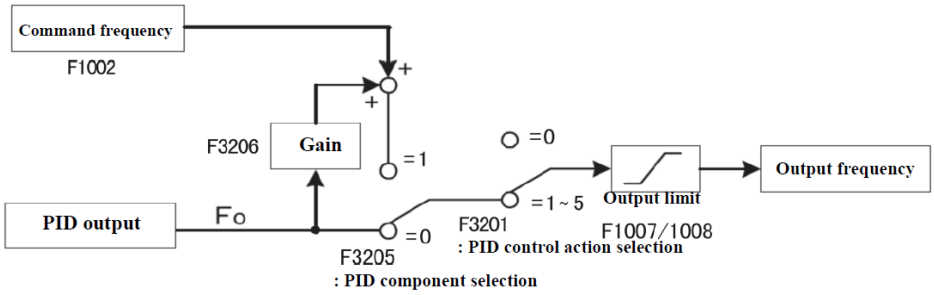
● When command frequency is added to PID control output for the frequency output, you can gain the PID control output and then make an addition calculation.

· F3205=0: Without command value addition calculation

Use the PID control output directly as the frequency output.

· F3205=1: With command value addition calculation

When PID control output is gained by F3206: After command value addition calculation is added to command frequency, it will be used as the frequency output.



【End Mode of PID Control】

F3124	PID end mode selection

F3125	PID end setting value

The function to select PID control end mode when inverter stops the acceleration/deceleration.

● When selecting stop deceleration with the following function code, i.e. make a stop without a PID control open loop mode, or the specified conditions have been satisfied, a open loop mode will be used to stop the deceleration.

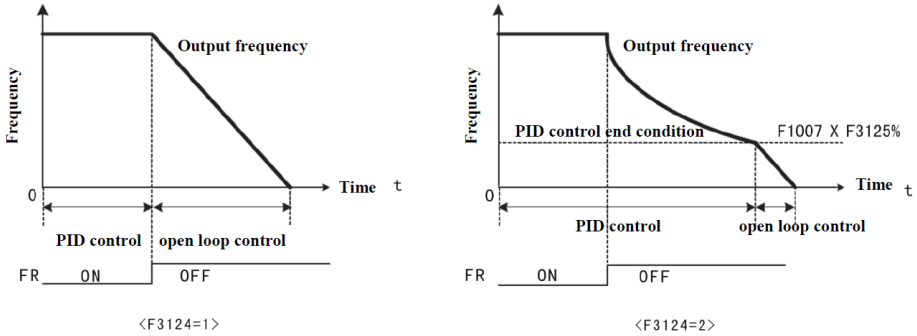
· F3124=1: direct end mode.

At the same time of stopping the deceleration, end the PID control forcibly by the open loop mode.

· F3124=2: conditional end mode.

When it starts to stop deceleration and the output frequency of the inverter becomes to be the PID end setting value: frequency operated by F3125, the PID control will be ended forcibly by the open loop mode.

The conditions of PID control are to make a judgment of the output frequency with the PID end setting value: frequency set by F3125 comparing to the upper frequency limit: F1007.



<F3124=1> <F3124=2>

Note 1: PID operation polarity switching function: when F3011/F3111=2, the PID control output tends to increase because of the stop action, when the system cannot be stopped, please set F3124: PID end mode selection = 1: direct end mode to stop the action.

Note 2: When zero servo action is effective in PID control, end the PID control and start the open loop zero servo action.

【Feedback Signal Disconnection Detection】

F1709	Detection time for feedback signal disconnection

The function to set the disconnection detection of feedback signal and the detection time.

● Detect the relationship between PID control command value and feedback value, when there is an abnormal situation, it will be judged as disconnection, warning or alarm for shutdown.

· F1709=0: only warning (the inverter will continue to run).

During disconnection detection, even when it is judged as disconnection, the inverter will continue to run, a warning of " FbEr " will be displayed.

If it stops during warning display, the inverter will also stop the free run.

· F1709=0.01-119.99: set the detection time of disconnection judgment. (Initialization=5s)

During disconnection detection, when it is judged as disconnection, " GAL 1 " will be displayed and an alarm for shutdown will be output.

When the system response speed is very slow and a false detection may happen, please prolong the detection time.

· F1709=120: no disconnection detection.

No action of disconnection detection, warning or alarm for shutdown.

【PID Various Variables Output】

F1501	Internal analog output function 1

F1504	Internal analog output function 2

The function to output (0-10V) the various variables in PID control from the analog output VOUT/IOUT.
- F1501 will output signal through VOUT, F1504 will output signal through IOUT. Refer to the following table for output variable and setting.
- The output format of each PID variable is 120Hz/10V.
- Please adjust the coefficient and offset of output signal according to F1502 (VOUT)/F1505 (IOUT) and F1503 (VOUT)/F1506 (IOUT).

Code No.	Function name	Data content	Resolution setting	Factory preset
1501 1504	Internal analog output function 1 Internal analog output function 2	3: PID1 feedback value [Hz] 4: PID2 feedback value [Hz] 17: PID1 command value [Hz] 18: PID1 input deviation value [Hz] 19: PID2 command value [Hz] 20: PID2 input deviation value [Hz] 24: External PID1 output value [Hz] 25: External PID2 output value [Hz]	1	0 0

Note: The variable of PID control will be output with an absolute value. When it is negative, it will be positive during output.

Besides analog output, the internal variables in PID control can also be displayed on operation panel timely.
● The follows are function code and variable as well as the setting value displayed on the operation panel.

Code No.	Function name	Data content	Resolution setting	Factory preset
3301	Read PID1 command value	Only for reading	1	—
3302	Read PID1 feedback value	Only for reading	1	—
3303	Read PID1 input deviation value	Only for reading	1	—
3304	Read PID1 output value	Only for reading	1	—
3305	Read PID2 command value	Only for reading	1	—
3306	Read PID2 feedback value	Only for reading	1	—
3307	Read PID2 input deviation value	Only for reading	1	—
3308	Read PID2 output value	Only for reading	1	—

Note 2: The variable of PID control will be output with an absolute value without a symbol.

【Control Switching by External Terminals】

The function to switch various control actions in PID control with the signal input by external multi-function terminal (DI1-DI8).
- The following is the table of multi-function input terminal signal in PID control.

Code No.	Function name	Data content	Resolution setting	Factory preset
1414 1415 1416 1417 1418 1419 1420 1421	Input terminal DI1 definition Input terminal DI2 definition Input terminal DI3 defintion Input terminal DI4 definition Input terminal DI5 definition Input terminal DI6 definition Input terminal DI7 definition Input terminal DI8 definition	76：V/f-PID control switching terminal/VFPID 77：PID control locking terminal/PIDLCK 85：PID switching terminal/PIDL 86：PID switching terminal /PIDH 87：PID1 resetting terminal/RPID1 88：PID1 external terminal selection/PID1EX 89：PID2 external terminal selection/PID2EX 91：PID integral value holding terminal/IHOLD 92：PID integral value eliminating terminal/ICLEAR	1	1 2 3 4 5 6 7 8

- VFPID Signal

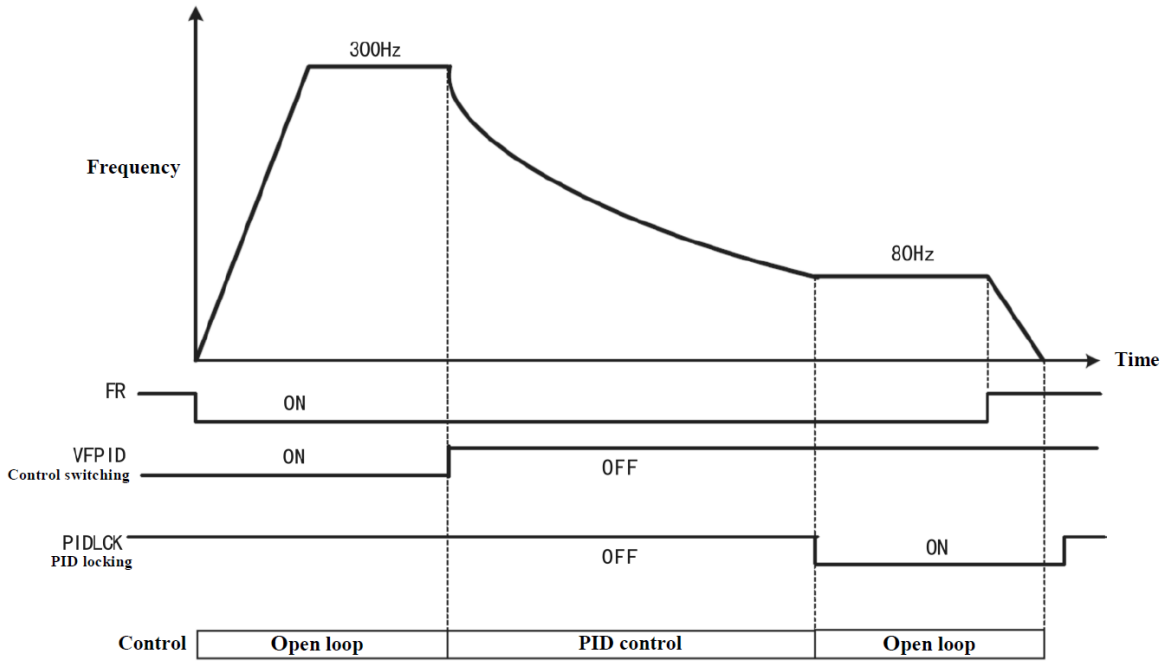
Used to switch from open loop control to PID control.
ON: Open loop control. (No PID feedback control)
Use PID command value directly as the PID output.
OFF: Switch from Open loop control to PID control.

Note: When start PID control with ON→OFF and return the VFPID signal to open loop control by another OFF→ON, since the PID command value is directly used as the PID output, the output frequency will change greatly in case that the integral output is large before ON, it may also cause an over-current alarm.
When return from OFF to ON, please send a stop command during inverter stoppage or after PID control is locked by PIDLCK signal, it must be used with a stop action.

- PIDLCK Signal

Hold control output in PID control, use it when stop action is carried under that status.
ON： Lock the PID control output (hold). (no PID feedback control)
The PID control output changes with a proportion to PID command value.
OFF： Carry out PID control.

The followings are application examples of VFPID signal and PIDLCK signal.
Example) Start = open loop control
Constant-speed = switch to PID control and start operation.
End = Lock PID control, open loop control deceleration stops.



● IHOLD Signal:
The terminal to lock the integral operation of PID control and hold the integral value.
ON： Lock the integral operation of PID control and hold the integral value.
Don ‘t clear integral value in ON, hold the previous value.
OFF： Carry out normal PID control.

● ICLEAR Signal:
The terminal to stop the integral operation of PID control and clear the integral value.
ON： Stop the integral operation of PID control and clear the integral value.
OFF：Carry out normal PID control.
Note: When clearing the integral output, sometimes the current output frequency may change rapidly.

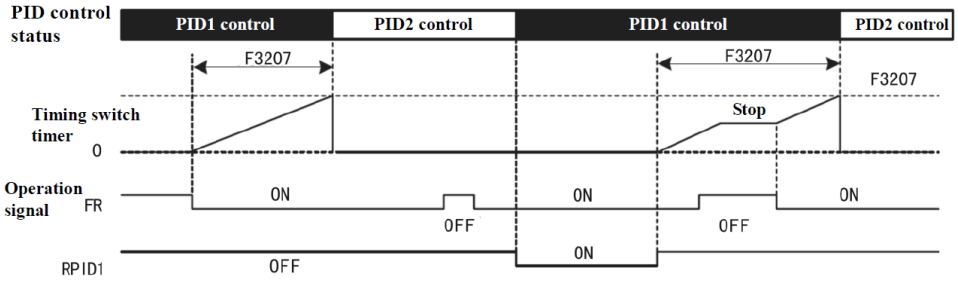
【Timing Switch of PID Control】

The function to automatically switch from PID1 control to PID2 control within the preset time period.
● Use the following function code and input signals of external multi-function input terminals (DI1-DI8).
Selection of PID control action
· F3201=5: switch the PID function timely.
PID1/PID2 switching time
· F3207=0.1-6000 minute(s): set the switching time.

RPID1 Signal
The terminal to forcibly switch the control into PID1 control after switching to PID2 control.
ON： Switch the control in PID2 control to PID1 control.
During this period, the time count of timing switch will be stopped.
OFF： Continue the time count for timing switch

● When set F3201=5, the switch will be carried out automatically through PID1 and PID2 controls set by F3207.
The control will start from PID1 control, when setting time is reached, it will switch to PID2 control.
In PID2 control, if RPID1 signal is connected, it will return to PID1 control again.
If RPID1 signal is OFF, the timer for timing switch will continue to count and carry out the same action.
Note 1: During stop, the timer for timing switch will stop (hold). When power is OFF, the time on the timer will also be recorded.
Note 2: After startup of the timer for timing switch, the timer will work.
Note 3: During operation of the timer for timing switch, when the setting of F3207 is changed, it will be switched into the change.

The followings are examples of actions



【External Terminal Switching PID Control】

The external terminal switching PID control is the function to coordinate various PID controls and system status, and then make a switch through the external terminals. It can be applied in the following systems.

(1) When the motor load is changed and the control by the same PID control is difficult.

(2) When switching motor or load according to the status of the system.

Each PID control is selected by the selection of function code or external multi-function input terminal signal (DI1-DI8).
Use inverter as the component of the PID controller, this can control the external peripheral devices.

● Use the following function codes and external multi-function input terminal signals (DI1-DI8).

PID control action selection

·F3201=4: external terminal switching PID control

PIDH/PIDL Signal: PID switching terminal

With the status of the two terminals, the PID control will be switched as follows.

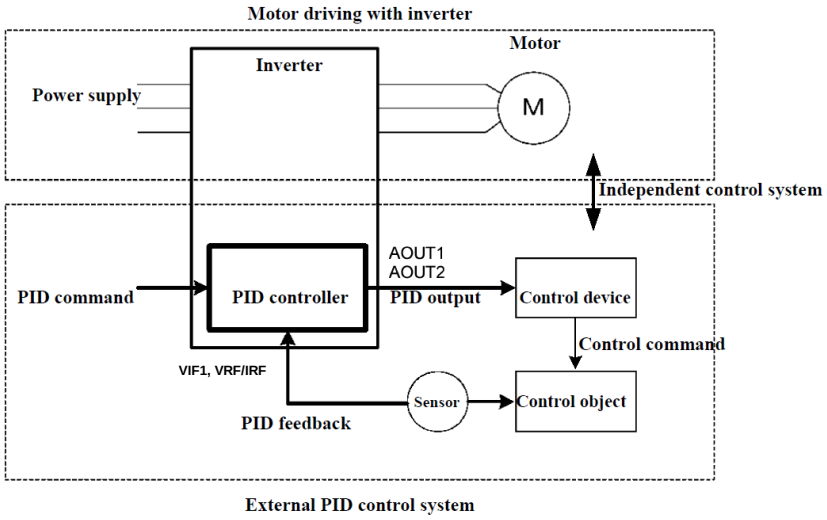
External multi-function input terminal signal (DI1-DI8)		
=86: PIDH	=85: PIDL	PID switching terminal
OFF	OFF	Open loop control
OFF	ON	PID1 control
ON	ON	PID2 control
ON	OFF	Open loop control

Note: When switching the PID control through external terminals, the PID control output may change rapidly according to the system control status; there may also be the protective actions for over-current, over-voltage and so on.

When adjusting switching time and each PID control parameter, please make an adjustment upon fully consideration of the changes to the actions of the control system.

【External PID Control】

The external PID control doesn ‘t means to use PID control output as the control for output frequency of the inverter, it means to use inverter as an independent PID controller and use it to control the external peripheral devices.
The formation and action of each PID control is set and selected together with the normal PID control function of the inverter output frequency.



F3203	External PID control selection

F3204	External PID operation mode selection

● The function to select external PID actions.
- · F3203=0: no external PID control
- · F3203=1: PID1 external control is effective
- · F3203=2: PID2 external control is effective
- · F3203=3: For factory adjustment
- · F3203=4: Both PID1 and PID2 external controls are effective
- · F3203=5: For factory adjustment
- · F3203=6: For factory adjustment

Matching to the selection of external PID, select the operation mode of external PID control. This function is used to decide the start and stop of the external PID control.
● Select the operation mode of external PID control
- · F3204=1: Operation interlocked with inverter operation
  Start operation interlocked with inverter operation and start the external PID control. When the inverter is stopped, stop PID control.
- · F3204=2: PID output after power input
  Start operation interlocked with inverter power supply and start the external PID control. When detecting the undervoltage during inverter power supply OFF, stop the PID control.
- · F3204=3: PID output controlled by external terminals
  Start the operation of external PID control through the external multi-function input terminal (DI1-DI8).

PID1EX Signal
The terminal to operate or stop the PID1 control.
ON： Operate PID1 control
OFF： Stop PID1 control
PID2EX Signal
The terminal to operate or stop the PID2 control.
ON： Operate PID2 control
OFF： Stop PID2 control

Note 1: During external PID control, the PID component selection: F3205 is noneffective, it will not make an addition calculation for the frequency command value of the inverter.
Note 2: During external PID control, stop PID control and reset/clear the operation results of PID control.
Note 3: When trying to stop the external PID control, please use PID control selection in inverter stoppage: F3203=0.

● External PID control is output through the VOUT/IOUT analog output terminal.
External PID1 output: please set F1501 (VOUT) or F1504 (IOUT)=24.
External PID2 output: please set F1501 (VOUT) or F1504 (IOUT)=25.

For analog output terminal functions related to PID control, please refer to【various variables output】internal analog output function: content of F1501/F1504.

● After gaining by external PID command value, it will be limited by upper frequency limit and then carry out acceleration/deceleration.
When PID command value is beyond the frequency setting, the acceleration/deceleration time will be based on acceleration/deceleration standard frequency: F1011 and set the actions according to 4th acceleration time: F1015 and 4th deceleration time: F1019.
Note 1: The acceleration/deceleration for external PID control with off-set frequency will share a same time with 4th acceleration/deceleration time in normal operation, this is a fixed application.
Note 2: When any one of 4th acceleration time: F1015 and the 4th deceleration time: F1019 is set to 0, the acceleration/deceleration will not be carried, and the PID command target value will be directly used as the PID command value.

7-3-7 Water supply function

Water supply function

Description and use of single pump water supply function:

This drive supports single pump water supply control function.

Related code function are listed below，for water supply function please follow the F34xx setting list.

Code No.	Function name	Setting resolution	Content
1001	Motor control mode selection	1～40 (1)	Set1 for single pump function
1101	Operation command selection	1～3 （1）	Specify instruction of command operation method
1111	Braking method	1～3 （1）	When using single pump function 2 is non effective
1202	State display selection	1～99 （1）	17: Set pressure 18: Pressure command 19: Pressure feedback
3001	PID1 command value input switch	1～99 (1)	Set to 1
3002	PID1 feedback input switch	1～99 (0)	For setting the feedback signal
3003	PID1 control proportional gain	0～100（0.1）	P gain
3004	PID1 control integral time	0.01～100sec（0.1）	I gain
3005	PID1 control differential time	0～100sec（0）	D gain
3201	PID control action selection	0～5（0）	Select 1（PID1 control）

mark means:

Set value cannot be changed during operation

Enter the F34xx code for the corresponding water supply function：

Water supply function F34xx				
Code	Function name	Data content	Minimum unit	Factory preset
3401	Water supply mode options	0: water supply function invalid; 1: single-pump mode	1	0
3402	Continuation time of lower limit T1	0.1～10minutes	0.1minutes	5
3403	Sleep/wakeup switching ratio K	30～95%	1%	50
3404	Determination time of sleep/wakeup reset Tp	0.1～10minutes	0.1minutes	5
3405	Pressure command Pref	0～9.999MPa	0.001MPa	0
3406	Upper limit of pressure of analog value feedback	0～±9.999MPa	0.001MPa	1
3407	Lower limit of pressure of analog value feedback	0～±9.999MPa	0.001MPa	0
3408	Maximum pressure value Ph	0.001～9.999MPa	0.001MPa	1
3409	Minimum pressure value Pl	0～9.999MPa	0.001MPa	0
3410	Slope of pressure in acceleration and deceleration	0.001～9.999MPa	0.001MPa	0.1
3411	Allowed deviation during motor switching	0.0-20.0%	0.1%	0.0

■ Function code setting description for single pump water supply function.

F1001 Motor control mode selection

◆ Please set F1001=1: V/F control mode, when using single-pump water supply function.

F1101 Operation command selection

◆ Please set to 1 when using the operation panel for operation command, and set it to 2 when using an external terminal. additionally, 3 is the communication function operation command.

F1111 Braking method

◆ When the single pump function is used, setting 2 (deceleration stop + DC braking) becomes invalid.
Set F1111=2 to perform the same action as F1111=1.

F1202 State display selection

◆ In the operation panel monitor, use F1202 to select the display content.

F1202=17: set pressure [MPa]

F1202=18: Command pressure [MPa]

F1202=19: Feedback pressure [MPa]

F3002 PID1 feedback input switching

◆ Set pressure feedback signal according to function code. Set F3002=0 for invalid.

Please be sure to set F3002=1, 2, 3, 4, 8.

F3002=1: Input 0～5V from the VRFI terminal, 0V corresponds to F3407, and 5V corresponds to F3406.

F3002=2: Input 0～10V from the VRFI terminal, 0V corresponds to F3407, and 10V corresponds to F3406.

F3002=3: Input 0～5V from the VRF/IRF terminal, 0V corresponds to F3407, and 5V corresponds to F3406.

F3002=4: Input 0～10V from the VRF/IRF terminal, 0V corresponds to F3407, and 10V corresponds to F3406.

F3002=8: Input 4-20mA from the VRF/IRF terminal, 4mA corresponds to F3407, and 20mA corresponds to F3406.

F3201 PID control action selection

◆ Use the single pump water supply function, and the constant pressure water supply control will be performed only when F3201=1 is selected;

Note: For single pump water supply, only PID1 control can be selected, others wil be invalid.

F3201=0: open loop control;

F3201=1: PID1 control.

7-3-8 Communication function

Communication function

The followings are descriptions of function blocks in communication function.
For details of communication function, please refer to section 7-4.

F4001 Message checksum

The function to select or deselect the checksum in the communication message.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4001	Message checksum	0：no 1：yes	1	1

F4003 Pull up/down function selection

The function to select pull up/down of RS485 communication circuit.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4003	Pull up/down function selection	0：no 1：yes	1	0

F4004 Communication response time

The function to set response time from inverter.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4004	Communication response time	10～4000ms	1ms	10

F4005 Serial communication function

The function to select communication function.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4005	Serial communication function	0: Null 1: Dedicated protocol communication function (SANKEN communication protocol) 2: Modbus communication function	1	0

F4006 Inverter number

The function to set inverter number.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4006	Inverter number	0～254：ModBus dedicated （1～32：RS485 communication）	1	1

Please set the value with 1～254. Pay attention not to repeat with other inverter numbers. It is not required to set the number sequentially; a loss of number is allowable.

Note 1: When setting a repetitive number, it cannot ensure a normal communication.
Note 2: In dedicated protocol (SANKEN protocol) communication, number 1-32 is effective.

F4007 Communication speed

The function to set communication speed.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4007	Communication speed	1: 1200bps 2: 2400bps 3: 4800bps 4: 9600bps 5: 19200bps 6: 38400bps 7: 57600bps	1	4

F4008 Parity bit

The function to set the parity bit.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4008	Parity bit	0: No 1: Odd 2: Even	1	1

F4009 Stop bit

The function to set the stop bit.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4009	Stop bit	1: 1 bit 2: 2 bits	1	1

F4010 End bit

The function to set the end code for dedicated protocol communication function (SANKEN communication protocol).

Code No.	Function name	Data content	Resolution setting	Factory preset
F4010	End bit	0：CR+LF 1：CR	1	0

F4011 Selection of inverter communication return of specified commands

The function to limit the response message sent from the inverter to specify command, therefore increase the communication speed.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4011	Selection of inverter communication return of specified commands	0: return 1: no return (return with error) 2: no return (return without error)	1	0

F4101 **Timeout setting of modbus communication**

The function to set Modbus communication timeouts time.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4101	Timeout setting of modbus communication	0：null 0.01～600sec	0.01sec	

During Modbus communication, if no message has been received within the time period set by F4101, it will be considered as communication timeouts.

F4102 **Modbus communication timeout action**

The function to select Modbus communication timeout action.

Code No.	Function name	Data content	Resolution setting	Factory preset
F4102	Modbus communication timeout action	0: Keep the status 1: Stop with alarm	1	0

During Modbus communication, if no message has been received within the time period set by F4101, it will be considered as communication timeouts. When F4102=1 is selected, the inverter will stop with an alarm.

F4103 **Modbus register address switching**

It is a function which chooses the register address of Modbus communication.

4103	Modbus register address switching	0: register number A 1: register number B	1	0	

The address of the register used by Modbus communication is chosen. Please refer to Section 7-4 for a register address.

7-3-9 Motor parameters

Motor parameters

F5001 **Motor poles, voltage and capacity**

Set the poles, voltage and capacity of the motor connected to the inverter.

Code No.	Function name	Data content	Resolution setting	Factory preset
F5001	Motor poles, voltage and capacity	XYZZZ X: Poles Y: Rated voltage Z: Motor capacity		※

※ Typical values have been entered for each motor model.

- The followings are applicable values and displaying contents.
  1) Poles: 4 kinds of 2-8 poles.

2	4	6	8

  2) Rated voltage: show the setting range of rated voltage by serial number.

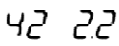
Serial No.	1	2	3	4	5	6	7	8
Rated voltage	200	220	230	380	400	415	440	460

  3) Motor capacity: the following table shows the setting scope of the motor capacity.
  Unit: [kW]

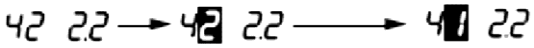
0. 37	△0. 4	0. 55	0. 75	△1. 1	△1. 5	△2. 2
△3. 0	△3. 7	△4. 0	△5. 5	△7. 5	11. 0	15. 0
18. 5	22. 0	30. 0	37. 0	45. 0	55. 0	75. 0
90. 0	110	132	160	185	200	220
250	280	315	355			

Symbol △ means that there is a blank.

Display example) When using a motor of 4 poles, 220V and 2.2kW, the 7-segment monitor will display:



Display example) When change the rated voltage for the motor of 4 poles, 200V and 2.2kW.



Note: In V/f mode (F1001=1), in order to display the speed, only pole data is used.
In the modes of speed control, torque control and position control (F1001=2), determine the standard values of all control constants according to the setting value of corresponding function codes. Therefore, this function code must be set correctly when used in the modes of speed control, torque control and position control. For setting method for special motor used in these modes, please contact with us.
Rated voltage: three or less for 200V class inverters.
four or more for 380V class inverters.
Motor capacity: The same level or 1 level smaller than the inverter class.
When motor is not selectable, it may display " " or "  "

F5002 **Motor current rating**

F5003 **Motor frequency rating**

F5004 **Motor speed rating**

F5005 **Motor insulation type**

Set the rated current, frequency and speed as well as insulation type for the motor.

Code No.	Function name	Data content	Resolution setting	Factory preset
F5002	Motor current rating	0.1～999.9 About 30 - 110% of the inverter current rating	0.1A	※
F5003	Motor frequency rating	10～400Hz	1Hz	※
F5004	Motor rotation speed rating	0～24000 rpm	1rpm	※
F5005	Motor insulation type	1: Type A 2: Type E 3: Type B 4: Type F 5: Type H	1	※

※ Typical values have been entered for each motor model.

● Normally, please set the motor rated values. When these values cannot be set, the auto tuning results and the controls of speed, torque and position will become worse.
Note 1: the setting values are interlocked with the settings of motor poles, voltage and capacity (F5001). Therefore, when F5001 is changed, F5002-F5005 will automatically set the standard values according to F5001.
Note 2: The above setting values cannot be used in V/f mode (F1001=1, 40).
Note 3: In speed control mode, when operating speed exceeds the rated speed, it will be flux-weakening control.

F5006 **Rated voltage during motor parameters auto-tuning**

The function code used for special motor and in other occasions during auto tuning of motor parameters.

Code No.	Function name	Data content	Resolution setting	Factory preset
F5006	Rated voltage during motor parameters auto-tuning	0: Use voltage selected by F5001 100-460V (voltage of F5001 is noneffective)	1V	0

When the rated voltage of F5001 is used, the setting is not required. (F5006=0)

F5007 **Rated motor slip ratio**

Set the rated slip ratio of the motor in use.
The standard for addition and correction of slip ratio in auto torque increase (F2007=2).
When the motor is loaded, add and correct the slip ratio to control the speed decrease.

Code No.	Function name	Data content	Resolution setting	Factory preset
F5007	Rated motor slip ratio	0～50%	0.1%	2

Please calculate with the following formula.

$$\text{Synchronized speed} = \frac{120\times \text{Base freqeuncy（F1006）}}{\text{Motor poles P (poles in F5001)}}$$

$$\text{Rated motor slip ratio} = \frac{\text{Synchronized speed} - \text{Rated speed (F5004)}}{\text{Synchronized speed}} \times 100\%$$

F5008 Motor parameter auto tuning range

The function to set the range of valid tuning constant according to the factory presets during motor parameter auto tuning (F1001=10, 11).

Code No.	Function name	Data content	Resolution setting	Factory preset
F5008	Motor parameter auto tuning range	0：No range 50～300%	0.1%	200

Note: When the range of motor parameter auto tuning results is extended, the controls of speed, torque and position and auto torque increase may become worse. Please change the setting range value, if there is an error during auto-tuning for a special motor.

F5009 Motor stator resistance

F5010 Motor rotator resistance

F5011 Motor stator inductance

F5012 Motor rotator inductance

F5013 Motor mutual inductance

F5014 Motor excitation current

The function code to set parameters for the motor in use.

Code No.	Function name	Data content		Resolution setting	Factory preset
F5009	Motor stator resistance	55kW below	0.001～65Ω	0.001Ω	※
		75kW above	0.01～650Ω	0.01Ω	
F5010	Motor rotator resistance	55kW below	0.001～65Ω	0.001Ω	※
		75kW above	0.01～650Ω	0.01Ω	
F5011	Motor stator inductance	55kW below	0.1～6000mH	0.1mH	※
		75kW above	0.01～600mH	0.01mH	
F5012	Motor rotator inductance	55kW below	0.1～6000mH	0.1mH	※
		75kW above	0.01～600mH	0.01mH	
F5013	Motor mutual inductance	55kW below	0.1～6000mH	0.1mH	※
		75kW above	0.01～600mH	0.01mH	
F5014	Motor excitation current	0.01～650A		0.01A	※

※ Typical values have been entered for each motor model.

- The setting scope of F5009-F5013 and the minimum values will be changed with the changes of motor capacity set by F5001.
- When motor test report and other documents with motor constant are used, please enter into the above-mentioned function code.
- Save the motor constant detected by motor parameter auto tuning (F1001=10, 11) into F5009-F5014
- In vector control, when the inverter output

Note: When the auto tuning cannot be finished correctly, the tuning results should not be saved into the function codes. Only results during correct finish can be stored into the function codes.

F5015 Inertia of motor rotation

F5016 Rotation inertia ratio of load

Set the motor inertia moment and the load inertia moment ratio.

Code No.	Function name	Data content	Resolution setting	Factory preset
F5015	Inertia of motor rotation	0～65kgm2	0.001k gm2	※
F5016	Rotation inertia ratio of load	1～200time	0.01time	1

※ Typical values have been entered for each motor model.

- An effective function during vector control (speed control, torque control and position control).
- After the setting of load inertia ratio, the command can be controlled.
- Mechanical vibration may happen in case that the load inertia ratio is large; therefore, an optimum gain should be adjusted.
- Please set motor unit value for motor rotation inertia.
- When load inertia can be ignored, there is no need to set the load inertia ratio.
- When driving cylinder and other loads with larger inertia, please set the load inertia ratio.

7-3-10 Vector control

Vector speed control function

The following describes the speed control function codes of vector control (with speed sensor, without speed sensor).
Note 1: Only for inverters with power below 75kW.
Note 2: This inverter only provides F1001=2: speed control (vector control without speed sensor), other functions are invalid

F6001 Torque limiter (power running)

F6003 Torque limiter (regeneration)

The function to limit torque generated by motor during the speed control of vector control (speed sensor and speed sensorless). The torque limiter in power running and regeneration running can be set separately. Even though corresponding to the output current limit (F1701) in V/f mode, the motor torque can be directly limited by vector control mode.

Code No.	Function name	Data content	Resolution setting	Factory preset
F6001	Torque limiter (power running)	Mode A: 0-200% Mode B: 0-150%	0.1%	150% 120%
F6003	Torque limiter (regeneration)	Mode A: 0-200% Mode B: 0-150%	0.1%	100%

- The setting if a ratio of rated torque.
- The motor rated torque is calculated automatically according to motor capacity (set by F5001) and rated speed.
- The torque limiter (power running) will limit the torque with a same direction to the braking direction.
- The torque limiter (regeneration) will limit the torque with a reverse direction to the braking direction.
- The setting ranges of torque limiter (power running) are different when selected by mode A (F1320=1) and mode B (F1320=2). (Refer to the above table.)

Note:

- **According to the load difference, it may not be able to accelerate or decelerate when the setting of torque limiter is too small, please pay attention to this.**

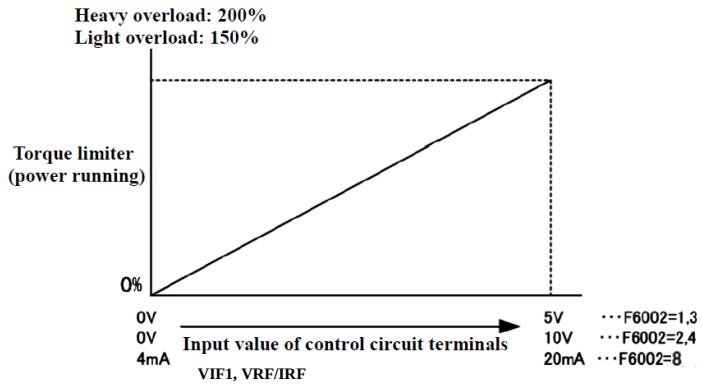
Reference parameter
F1001 (motor control mode selection)
F1320 (Rating selection)
F5001 (motor poles, voltage and capacity)
F5004 (motor speed rating)
F6002 (Analog input function of torque limiter (power running))
F6004 (Analog input function of torque limiter (regeneration))

F6002 Torque limiter Analog input function (power running)

The function to change the torque limiter values in power running status with the analog input command of control circuit terminals VRF1, VRF/IRF

Code No.	Function name	Data content	Resolution setting	Factory preset
F6002	Analog input function of torque limiter (power running)	0：F6001 1：External Analog VRF1 voltage （0～5V） 2：External Analog VRF1 voltage （0～10V or potentiometer） 3：External Analog VRF/IRF voltage （0～5V） 4：External Analog VRF/IRF voltage （0～10V or potentiometer） 8：External Analog VRF/IRF current （4～20mA）	1	0

- When F6002=0, the torque limiter during power running will use the value set by F6001.
- When F6002=1, 3 the torque limiter values in power running status are determined by input values of control circuit terminals VRF1、VRF/IRF 0～5V.
- When F6002=2, 4 the torque limiter values in power running status are determined by input values of control circuit terminals VRF1、VRF/IRF 0～10V or potentiometer
- When F6002= 8 the torque limiter values in power running status are determined by input values of control circuit terminals VRF/IRF 4～20mA.



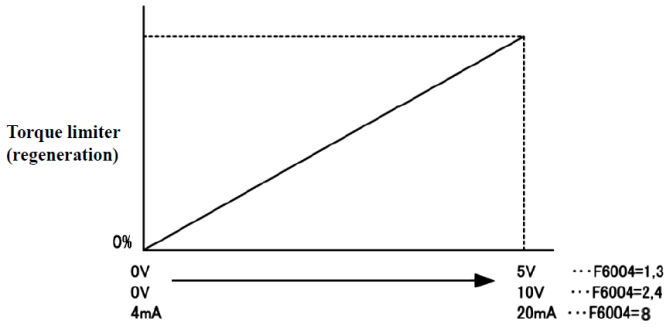
Note 1: For torque limiter (power running) values corresponding to control circuit terminal input signal, the changable range of mode A is 0-200%, the changable range of mode B is 0-150%.
Note 2: This function is effective only when selected by the speed control of vector control (F1001=2 or 3).
Reference parameter
F1001 (motor control mode selection)
F6001 (torque limiter (power running))

F6004 Analog input function of torque limiter (regeneration)

The function to change the torque limiter values in regenerated status with the analog input command of control circuit terminals VRF1, VRF/IRF

Code No.	Function name	Data content	Resolution setting	Factory preset
F6004	Analog input function of torque limiter (regeneration)	0：F6003 1：External Analog VRF1 voltage （0～5V） 2：External Analog VRF1 voltage （0～10V or potentiometer） 3：External Analog VRF/IRF voltage （0～5V） 4：External Analog VRF/IRF voltage （0～10V or potentiometer） 8：External Analog VRF/IRF current （4～20mA）	1	0

● When F6004=0, the torque limiter during regeneration will use the value set by F6003.
● When F6004=1, 3 the torque limiter values in regenerated status are set by input values of control circuit terminals VRF1, VRF/IRF (0-5V).
● When F6004=2, 4 the torque limiter values in regenerated status are set by input values of control circuit terminals VRF1, VRF/IRF (0-10V) or potentiometer.
● When F6004=8 the torque limiter values in regenerated status are set by input values of control circuit terminals VRF1, VRF/IRF (4-20mA).



Input value of control circuit terminal VRF1, VRF/IRF

Note 1: The torque limit value during braking changes within the range of 0-100% for the input signal of the control circuit terminal.
Note 2: This function is only valid when the speed control selection of vector control is used (F1001=2 or 3).

Reference parameter
F1001 (motor control mode selection)
F6003 (torque limiter (regeneration))

F6005 Multiples of startup excitation current

The function to set the startup excitation current in vector control mode (speed sensor and speed sensorless).
Correspond to DC braking force in V/f mode during startup (F1114).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6005	Multiples of startup excitation current	0.1-2 multiple(s) (for applicable motor)	0.01time	1

● The factory presetting values are set to be equal to (1.0 multiple) the excitation current of corresponding motor.
● When setting this function, please input the ratio value related to the motor excitation current. (Maximum of 2 multiples)
Note 1: If excitation current is over-increased, there may be a shutdown because of over-current.
Note 2: When the braking force is not changed and the excitation current ratio is enlarged, the current limiting function will be enabled because of the over-current caused by some reason.

Reference parameter
F1001 (motor control mode selection)

F6006 Time of startup excitation

The function to set the time of startup excitation time in vector control mode (speed sensor and speed sensorless).
Correspond to DC braking time in V/f mode during startup (F1113).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6006	Time of startup excitation	0-10 second(s) (0 means no startup excitation)	0.1sec	※

※ Typical values have been entered for each motor model.

● Set the connecting time for excitation current by F6005.
● When 0 is set, the braking function during startup will be disabled.
● Excitation will not be carried out during the startup of alarm auto resetting and restart after instantaneous-stop, it will be changed into flying start.
Note: The setting value is interlocked with the settings of motor poles, voltage and capacity (F5001). Therefore, when F5001 is changed, F6006 will be automatically set to standard values according to F5001.

Reference parameter
F1001 (motor control mode selection)
F5001 (motor poles, voltage and capacity)

F6007 Multiples of braking excitation current

The function to set the braking excitation current in vector control mode (speed sensor and speed sensorless).
Correspond to DC braking force in V/f mode during shutdown (F1114).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6007	Multiples of braking excitation current	0.1-2 multiple(s) (for applicable motor)	0.01 multiple	1

● The factory presetting values are set to be equal to (1.0 multiple) the excitation current of corresponding motor.
● When setting this function, please input the ratio value related to the motor excitation current. (Maximum of 2 multiples)
Note 1: If excitation current is over-increased, there may be a shutdown because of over-current.
Note 2: When the braking force is not changed and the excitation current ratio is enlarged, the current limiting function will be enabled because of the over-current caused by some reason.

Reference parameter
F1001 (motor control mode selection)

F6008 Time of braking excitation

The function to set the braking excitation time in vector control mode (speed sensor and speed sensorless).
Correspond to DC braking time in V/f mode during startup (F1113).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6008	Time of braking excitation	0-10 second(s) (0 means no starting excitation)	0.1sec	※

※ Typical values have been entered for each motor model.

● Set the connecting time for excitation current by F6006.
● When 0 is set, the braking function during startup will be disabled.
Note: The setting value is interlocked with the settings of motor poles, voltage and capacity (F5001). Therefore, when F5001 is changed, F6008 will be automatically set to standard values according to F5001.

Reference parameter
F1001 (motor control mode selection)
F5001 (motor poles, voltage and capacity)

F6009 Gain compensation of current control

This function is to compensate the setting values of current control gain during the speed control in the vector control mode (speed sensor and speed sensorless). The function not only can be used to adjust speed control gain, but also can be used when the motor vibration cannot be eliminated.

Code No.	Function name	Data content	Minimum setting unit	Factory preset
F6009	Gain compensation of current control	0.5～1.5	0.01	1

- The initial value of gain compensation current control (F6009) is 1. The gain will be controlled with the current preset according to various motors.
- The current control gain is adjustable according to the settings in gain compensation current control. The variable range is 0.5-1.5 multiples.
- During adjusting control gain and before using this function, please 1stly make an adjustment with speed control gain (F6010 & F6011). When the adjustment of speed control gain cannot improve the control performance, please adjust this function.

Note 1: Optimum values have been set for current control gain according to different motors, the users cannot make a direct change.
Note 2: When the limit value of current control gain compensation has been increased or decreased, the control performance may become worse.

Reference parameter
F6010 (ASR proportional gain of speed control)
F6011 (ASR integral time of speed control)

F6010 ASR proportional gain of speed control

The function to set the proportional gain of speed control (ASR) in vector control mode (speed sensor and speed sensorless).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6010	ASR proportional gain of speed control	0.01～150%	0.01%	※

※ Typical values have been entered for each motor model.

- Typical values applicable for the motor should be set for factory presets.
- As the target for adjustment, please set 100% for motor response 200rad/s.

Note 1: Besides this function code, the proportional gain of speed control will change according to the settings of motor inertia (F5015) and load inertia ratio. Therefore, when adjusting the motor response by this function, please set motor inertia to be equal to actual load.
Note 2: When using the function of motor vibration reduction rate (F6014), the proportional gain of speed control will automatically change according to the setting and load conditions.

Reference parameter
F1001 (motor control mode selection)
F5015 (motor inertia)
F5016 (load inertia ratio)
F6014 (motor vibration reduction rate)

F6011 ASR integral time of speed control

The function to set integral time of speed control (ASR) in vector control mode (speed sensor and speed sensorless).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6011	ASR integral time of speed control	0～20sec	0.001sec	※

※ Typical values have been entered for each motor model.

- When there is proportional control, motor speed may generate static difference comparing to speed command value, therefore, please set this function code and add the integral control.
- As the target for adjustment, increase the value by 10ms by stage, then make sure the motor speed is the same as the command speed.
- When PC (P control signal) of multi-function input terminal is ON, the integral time will be disabled, and only proportional gain is controlled.

F6014 Motor vibration reduction rate

F6015 Lower frequency limit for motor vibration reduction function

F6016 Upper frequency limit for motor vibration reduction function

The function to reduce motor vibration under the occasions of vibration caused by mechanical sympathetic vibration in vector control mode (speed sensor and speed sensorless).

Code No.	Function name	Data content	Resolution setting	Factory preset
F6014	Motor vibration reduction rate	0：null 1：75% 2：50% 3：25%	1	0
F6015	Lower frequency limit for motor vibration reduction function	0～240Hz	0.01Hz	0

F6016	Upper frequency limit for motor vibration reduction function	0～240Hz	0.01Hz	0

- The factory preset is F6014=0 (null).
- When F6014 is set beyond 0, decrease the proportional gain of speed control within the range of 1st speed command frequency set in lower frequency limit for motor vibration reduction function (F6015) and upper frequency limit for motor vibration reduction function (F6016).
- Motor vibration reduction rate is the reduction rate related to speed control ASR proportional gain (F6009). The motor vibration cannot be eliminated even when the rate is set to be 25%, please decrease the setting of speed control ASR proportional gain.
- Besides this function, the speed detection filter cut-off frequency (F6012) or Torque detection filter cut-off frequency (F6013) can also be used to adjust and reduce the motor vibration.

Examples of setting
When command frequency is 15Hz-25Hz mechanical sympathetic vibration,
F6014=1(75%)
F6015=15.00Hz
F6016=25.00Hz
Note: The setting of lower frequency limit for motor vibration reduction function must be carried out referring to the settings of upper frequency limit for motor vibration reduction function. (When the setting exceeds the setting in upper frequency limit, the setting will be invalid because of the inconsistent detection.)

Reference parameter
F1001 (motor control mode selection)
F6010 (speed control ASR proportional gain)

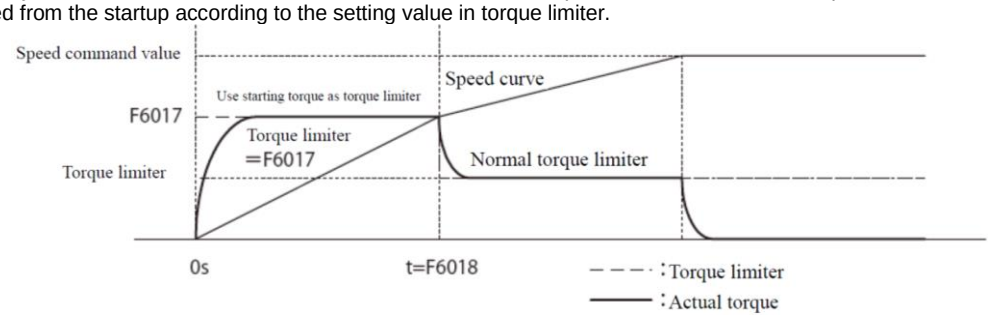
F6017 Starting torque

F6018 Starting torque duration time

The function to separately set the starting torque limiting value during speed control in vector control mode (speed sensor and speed sensorless). This function is used when the motor cannot start because of the setting of torque limiting value is low.

Code No.	Function name	Data content	Resolution setting	Factory preset
F6017	Startup torque	0～100%	0.1%	30
F6018	Lasting time of starting torque	0～6500sec	0.1sec	1

- The setting value of startup torque (F6017) is a ratio to rated torque.
- The torque limiting of startup torque is effective from startup to the startup torque lasting time (F6018).
- When startup torque duration time ends, the torque will be limited according to the setting value in torque limiter.
- When any one function code of F6017 or F6018 is set to 0, the torque limiter is invalid. The torque will be limited from the startup according to the setting value in torque limiter.



Note: If the startup torque is set too large, the motor may accelerate rapidly. Therefore, please carefully set the startup torque.

Reference parameter
F1001 (motor control mode selection)
F6001 (torque limiter (power running))
F6003 (torque limiter (regeneration))

F6019 Variable second gain of speed control

F6020 Frequency bottom of variable gain for speed control

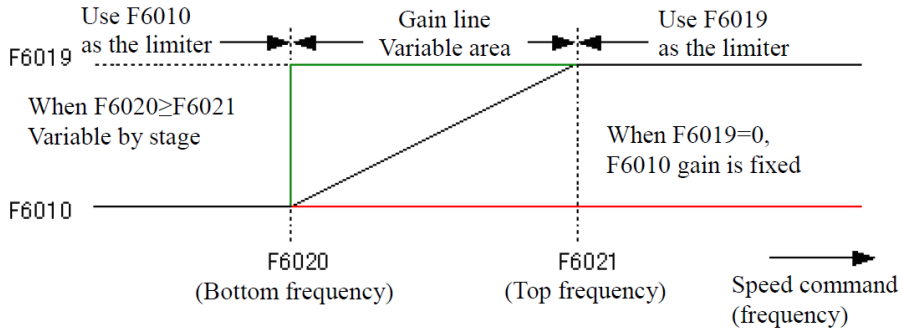
F6021 Frequency top of variable gain for speed control

The function to vary speed control proportional gain according to speed command (frequency) during the speed control in vector control mode (speed sensor and speed sensorless). When making a speed control with a large range from low speed to high speed, different speed control gains are required within low speed zone and high-speed zone, at this time this function can be used.

Code No.	Function name	Data content	Resolution setting	Factory preset
F6019	Variable second gain for speed control	0: No variable gain function 0.01-150%	0.01%	15
F6020	Frequency bottom of variable gain for speed	0～240Hz	0.01Hz	10

	control			
F6021	Frequency top of variable gain for speed control	0～240Hz	0.01Hz	30

- When variable secondd gain (F6019) for speed control is set to 0, the speed control proportional gain for the whole speed area is the setting value of speed control ASR proportional gain (F6010) and this value is fixed.
- When variable second gain for speed control is not 0, the variable function of speed control proportional gain is effective.
- The speed command at the low speed side of variable speed control proportional gain is set by frequency bottom of variable gain for speed control (F6020).
- The speed command at the high-speed side of variable speed control proportional gain is set by frequency top of variable gain for speed control (F6021).
- When speed command (frequency) is smaller than the inner limiter in the speed area of F6020, the speed control proportional gain will be set by F6010; it will be set by F6019 when the peed command (frequency) is larger than inner limiter in the speed area of F6021.
- When command frequency is within the area of F6020 and F6021, the speed control proportional gain will be changed according to slope determined by the setting values and frequency range of F6010 and F6019 to the change linear of speed command (frequency).
- Variable 2nd gain for speed control (F6019) can set large or small speed control ASR proportional gain (F6010).
- When the setting of frequency top of variable gain for speed control (F6021) is smaller than the setting of frequency bottom of variable gain for speed control (F6020) (F6020≥F6021), the speed control proportional gain will be changed by stage with F6020 as the threshold value.
- The initial setting of speed control proportional gain function is F6019=15%, F6020=10Hz and F6021=30Hz. During initial status, the speed control proportional gain function is effective.



Note: Speed control integral gain has no relationship with this function, it is fixed to be the setting value of F6011.

Reference parameter

F6010 (ASR proportional gain of speed control)
F6011 (ASR integral time of speed control)

7-4 Serial Communication Function

7-4-1 Outline

● The serial communication function is an interface function that controls the inverter using serial signals from a computer. It can control inverter start/stop, frequency setting, operation status monitoring and function code reading & setting.
● An RS485 communication interface is embedded in the inverter. With this interface, the computer can control multiple inverters.
● The communication mode is RS485, SANKEN protocol and Modbus-RTU protocol can be used for RS485.
● The Modbus communication is composed with a master computer (PLC or PC) and up to 254 lower computers. (248-254 are reserved.)
● In SANKEN protocol of RS485, one master computer and up to 32 inverters can be connected.
● The followings are communication specifications.

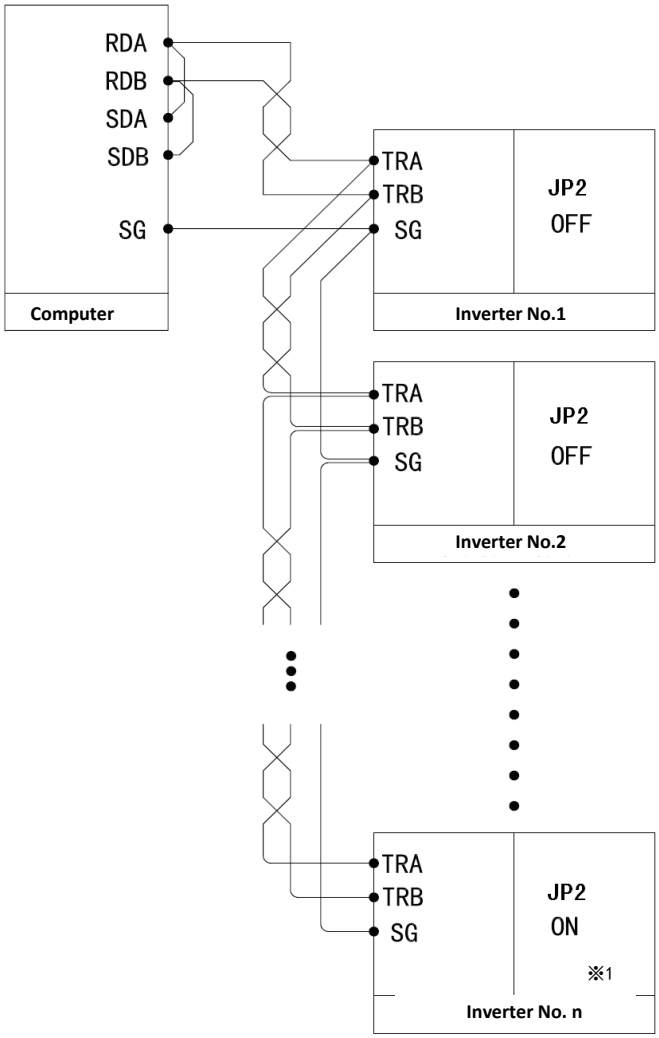
Electrical characteristic		RS485 Communication	
Communication provision		SANKEN protocol	Modbus-RTU protocol
Communication form		Bus form of 2-wire (RS485 standard)	
Transmission distance		Total extension 500m Terminal resistance must be connected	
Number of connections		Up to 32	Up to 247*Note
Connection cable		Shielded Twisted-Pair is recommended	
Communication mode		Half duplex communication	
Communication speed [bps]		Selectable 57600/38400/19200/9600/4800/2400/1200	
Synchronization mode		Synchronization of start/stop	
Data form		ASCII or BINARY	BINARY
Data length		8bit	
Stop digit		Selectable 1bit or 2bit	
Parity check		Yes (even, odd), No (Selectable)	
Error correction		Data and correction	CRC correction
Message end code	ASCⅡ	Selectable CR＋LF/CR	no
	BINARY	no	

Note: SANKEN protocol is the dedicated protocol used by our company (F4005=1).
※ Note: When the number exceeds 32, a relay must be installed.

7-4-2 Terminal Functions and Wiring

(1) Terminal functions

RS485 communication interface (one inverter)



※1 For the farthest inverter from the computer, the terminal resistance switch JP2 should be set to ON.

7-4-3 Inverter Operation and Related Function Code Setting by Serial Communication

(1) Setting of serial communication use

Serial communication F4005 setting	Operation of operation panel	Serial communication						Description
		Function code		Operation		Freqeuncy		
		Reference	Set	Start	Stop	Display	Set	
0：Null	Enabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Serial communication cannot be used.
1: Communication of dedicated protocol	Enabled	Enabled	Enabled	Enabled※1	Enabled	Enabled	Enabled※2	Operation panel can be used at the same time.
2: Modbus-RTU protocol	Enabled	Enabled	Enabled	Enabled※1	Enabled	Enabled	Enabled※2	

※1: Set F1101=3 for operation by serial communication.

※2：Set F1002=22 for frequency setting by serial communication.

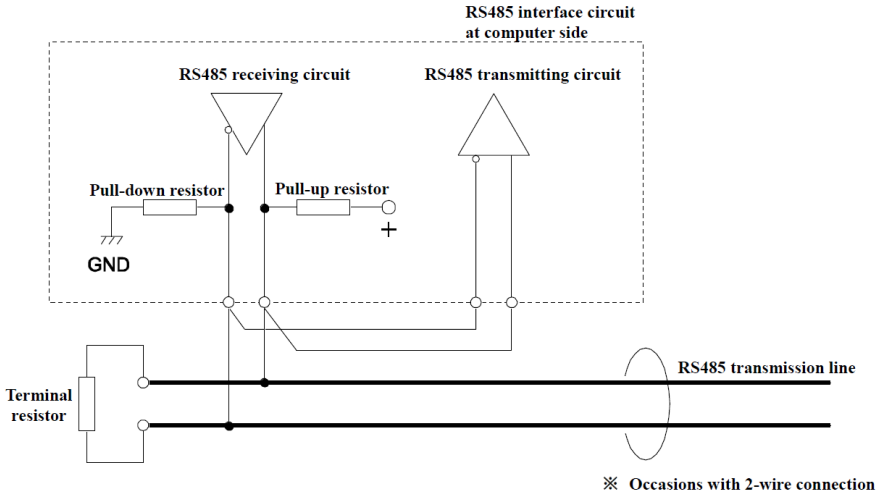
(2) Setting of function codes related to the computer and serial communication

Code	Description
F4001	Message checksum Select whether to add a checksum to a communication message. 0: No 1: Yes (Factory preset)

F4003	Pull-up/down function selection ※1 Select pull-up/down for the RS485 communication circuit. 0: No (Factory preset) 1: Yes
F4004	Communication response time Set a communication response time. 1-6000ms (Factory preset =10ms)
F4005	Serial communication function Select a serial communication. 0: Null (Factory preset) 1: Communication with dedicated protocol (SANKEN communication protocol) 2: Modbus communication
F4006	Inverter number Set the inverter number (Factory preset = 1) ・ Please set value of 1-32 by a communication with the dedicated protocol (SANKEN protocol). ・ Please set value 0-247 by a Modbus communication. Please set a number which is not the same with other numbers, otherwise, the inverter may not work normally. The inverters need not be numbered sequentially.
F4007	Communication speed Set a communication speed 1: 1200bps 2: 2400bps 3: 4800bps 4: 9600bps (Factory preset) 5: 19200bps 6: 38400bps 7: 57600bps
F4008	Parity bit Set a parity bit. 0: None 1: Odd (Factory preset) 2: Even
F4009	Stop bit Set a stop bit. 1: 1 bit (Factory preset) 2: 2 bits
F4010	End code Set an end code. 0: CR＋LF (Factory preset) 1: CR ※ No end code for BINARY and Modbus communication
F4011	Selection of inverter communication return of specified commands Prevent the inverter from sending response message to the specified command message at PC side. 0: Sent (Factory preset) 1: Not sent (Error response sent) 2: Not sent (Error response not sent)
F4101	Timeout setting of modbus communication Set a Modbus communication timeout 0: Null (Factory preset) 0.01-600s
F4102	Modbus communication timeout action Set a Modbus communication timeout action. 0: keep the status (Factory preset) 1: Stop alarm
F4103	Modbus register address switching It is a function which chooses the register address of Modbus communication. 0: register number A (Factory preset) 1: register number B

Note: Do not set a communication-related function code during communication, otherwise, the function may be noneffective.

※1: Set the output of the RS485 communication interface to high impedance when not used for data transmission. To prevent unstable output or malfunctioning, please set the pull-up/down function code (F4003=1) when no pull-up/down is embedded in the RS485 communication interface circuit to maintain a safe circuit at low impedance.



7-4-4 Communication with Dedicated Protocol (SANKEN Communication Protocol)

(1) List of command code (OP)

The followings are command codes in communication (ASCII).

Command Type	Command	Processing
Data reading	"A"	Alarm No.
	"B"	Function code data
	"C"	Output frequency
	"D"	Output current
	"E"	DC voltage
	"F"	Heat sink fin temperature
	"G"	Load rate
	"H"	Operation status 1
	"I"	Operation status 2
	"J"	Control terminal input status
	"K"	Output voltage
	"L"	VRF/IRFcontrol circuit terminal input
	"M"	VRF1control circuit terminal input
	"T"	Reserved
Data writing	"N"	Function code data
	"O"	Frequency setting ※1
Operation control	"P"	Forward run ※2
	"Q"	Reverse run ※2
	"R"	Stop ※2
	"S"	Alarm reset
Automatic alarm	"X"	Automatic alarm permitted
	"Y"	Automatic alarm prohibited
	"Z"	Automatic alarm notification
Batch operation	"a"	Select inverters for batch control
	"b"	Specify direction of rotation for batch inverter control
	"c"	Release batch inverter control
	"d"	Batch start ※2
	"e"	Batch stop ※2
Error	"?"	Error response

※1：Effective only when 1st speed frequency setting selection F1002=22 (communication) is selected

※2：Effective only when operation command F1101=3 (communication) is selected

(2) Frequency setting command

- The frequency setting (O) command provides a function for setting the frequency from a computer, equivalent to directly setting the frequency from the panel. The set frequency is written into an appropriate frequency-related function code (F1021, F2101-F2116) depending on the status of signal input into the control circuit terminals (2DF, 3DF and JOG) at that time.

  Example) If control circuit terminals 2DF and DCM1 are connected when the inverter has received command O, the set frequency is written to function code F2102 as the 2nd speed frequency.

  Note: Set F1002=22 before setting a frequency using command O or writing data to a frequency-related function code (F1021, F2101-F2116) using the function code data write (N) command.

(3) Batch operation function

- The batch operation function allows selected inverters or all inverters connected through a communication line to be started and stopped simultaneously by a computer.

1) Batch operation of selected inverters

① Select inverters for batch operation using command a

② Specify the direction of rotating for inverters using command b for batch operation

③ Transmit command d with inverter number 33 to simultaneously start the inverters selected using command a. The inverters return no response to command d.

④ Transmit command e with inverter number 33 to simultaneously start the inverters selected using command a. The inverters return no response to command e.

2) Connect the batch operation of all inverters. The operation direction will be preset by command b.

① Preset the operation direction using command b.

② Transmit command d with inverter number 34 and simultaneously start all the connected inverters. The inverters return no response to command d.

③ Transmit command e with inverter number 34 and simultaneously start all the connected inverters. The inverters return no response to command e.

3) Release of batch operation

① Transmit command c with inverter number 35 to release the inverters selected using command a from batch control.

Note: During batch operation, keep in mind the followings:

1) Inverters return no response to command c, d or e.

2) If command c, d or e sent from a computer is not received normally for some reason, the connected inverter cannot execute the command. Therefore, the computer should transmit an Operation Status 1 (H) command to each inverter to confirm that whether the inverter is now executing the received command correctly.

3) For the meanings of inverter numbers 33, 34 and 35, please refer to Message format. Different numbers from 1 to 32 are given to inverters connected using a communication line to identify them as message destinations. 33 to 35 are special inverter numbers indicating that the messages are addressed to all inverters connected for batch operation.

(4) Automatic alarm function

- If an alarm occurs, the automatic alarm function automatically issues an Automatic Alarm (Z) command to notify the computer of the alarm. This function enables the computer to detect an inverter alarm immediately.
- An inverter can issue command Z automatically only if an Automatic Alarm Permitted (X) command is received from the computer. However, if the Automatic Alarm Prohibited (Y) command is received after command X, the inverter cannot issue command Z.

Note: If automatic alarm is enabled, the inverter automatically issues an Automatic Alarm command in case of an alarm. Consequently, message collision may occur on a communication line. The causes of message collision and preventive actions are as follows:

(1) If the computer transmits a command to an inverter and the inverter in which an alarm has occurred issues command Z simultaneously

① The computer detects the message collision. Transmit the message again.

② If the computer cannot detect the message collision, the messages cannot be sent to their destinations correctly. Therefore, a normal response from the destination cannot be expected.

(2) If an alarm occurs simultaneously in several inverters permitted to issue command Z

① Since a message collision destroys the messages, the computer will discard the received abnormal message.

- An alarm permitted inverter automatically issues command Z about every two seconds in case of an alarm. The automatic transmission stops if an Alarm Reading (A) command is received. If command Z is received, the computer must transmit command A immediately to the inverter issuing command Z.

Note: If command A is received, the inverter issuing command Z will stop automatic alarm transmission. Command Z cannot be issued again even if the cause of the alarm has not yet been solved (for example, the fin temperature is too high and the overheat protection function has been activated) or the alarm status has not been reset.

7-4-5 Programming Design

(1) Message Format

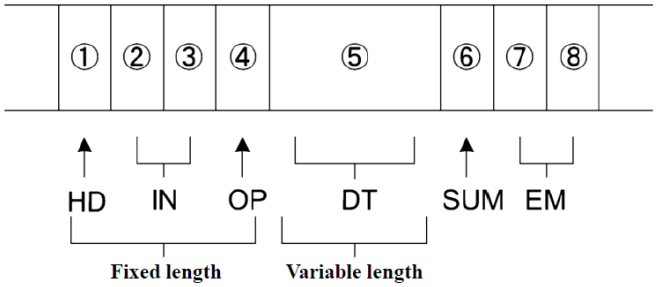
● Messages have the following two formats:

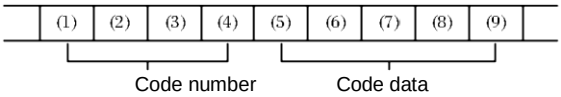
① ASCII format: consisting of character codes only

② BINARY format: consisting of an inverter number and data in hexadecimal. Since message of this format is shorter than the ASCII-format message, the communication time for one message is shorter. This format is available only for the frequency setting (O), forward run (P), reverse run (Q), stop (R) and alarm reset (S) commands.

If the message checksum function is disabled (F4001=0), SUM is not necessary for messages in ASCII or BINARY format.

1) Message from computer to inverter (ASCII format)



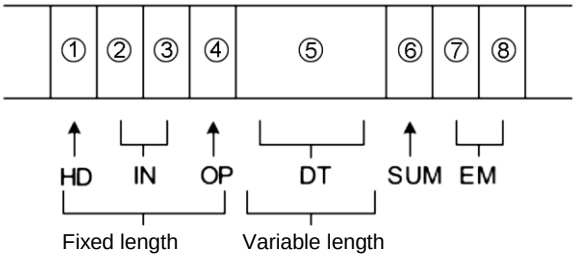
Item		Name	Content
①	HD	Start code	Message transmission start code (“*”：ASCII code 2AH)
②③	IN	Inverter No.	Inverter number. Data format: 2 bytes fixed The inverter number is set by function code F4006 Example: Inverter number 20 ②→ “2”,③→ “0”
④	OP	Command code	Inverter command code
⑤	DT	Data	Example: Function code data read/write contents 1） Function code number section (Data length: 4 bytes fixed) Example: code number F2103 (1) ➞ “2” (2)→ “1” (3)→ “0” (4)→ “3” 2） Function code data section (Data format: 5 bytes fixed) Example: code data 123 (5)→“0”(6)→“0”(7)→“1”(8)→“2”(9)→“3”  ©The data length and format are determined by each command. For details, please refer to Details of message formation.
⑥	SUM	Checksum	Obtain the 2‘s complement of the lowest byte of the binary sum of data ①-⑤. Change bit 7 to 0 and bit 6 to 1. (See reference 1.)
⑦⑧or ⑦	EM	End code	The code to end data transmission. Please determine it according to function code F4010. ASCII code 0DH(“CR”) and 0AH(“LF”) or 0DH(“CR”)

Reference 1: As an example of checksum calculation for ASCII format, set the function code F2101 of the 1st inverter to 50.00Hz.

Item		Name	Content
①	Start code	*	(1) 2AH “*”
② ③	Inverter No.	01	(2) 30H “0” (3) 31H “1”
④	Command code	N	(4) 4EH “N”
⑤	Data	Function code number F2101	(5) 32H “2” (6) 31H “1” (7) 30H “0” (8) 31H “1”
		Function code data 50.00 Hz※	(9) 30H “0” (10) 35H “5” (11) 30H “0” (12) 30H “0” (13) 30H “0”
Sum of ASCII codes ⑪-(3)			292H Lower byte: 92H
2‘s complement of the lower byte of the sum			6EH
⑥	Change bit 7 to 0 and change bit 6 to 1.		6EH=01101110B→01101110B=6EH Checksum: 6EH

※ Frequency data consists of a 3-digit integer part and a 2-digit decimal part.

2) Message from inverter to computer (ASCII format)



Item		Name	Content
①	HD	Start code	Message transmission start code (“*”：ASCII code 2AH)
②③	IN	Inverter No.	Inverter number. Data format: 2 bytes fixed The inverter number is set by function code F4006 Example: inverter number 20 ②→ “2”, ③→ “0”
④	OP	Command code	Same as command code from computer “?” for error response
⑤	DT	Data	Example: Function code data read 1） When reading a positive, the data is 5 bytes long (fixed). Example: when reading data 123 (1) →“0”(2)→“0”(3)→“1”(4)→“2” (5)→“3” Example: When no data is read, normal end code will be (1) →“e”(2)→“F”(3)→“F”(4)→“F” (5)→“0” 2) During response error, an error code or interference code of 5 bytes long (fixed) is returned.  ⑤ Data area ◎The data length and format are determined by each command. For details, please refer to Details of message formation.
⑥	SUM	Checksum	Obtain the 2‘s complement of the lowest byte of the binary sum of data ①-⑤. Change bit 7 to 0 and bit 6 to 1. (See reference 1.)
⑦⑧ or⑦	EM	End code	The code to end data transmission. Please determine it according to function code F4010. ASCII code 0DH(“CR”) and 0AH(“LF”) or 0DH(“CR”)

※ The following messages are used for commands N and B for signed function codes:

In F1402: gain frequency (VIF1) with signed 10 multiples data format, the example is as follows:

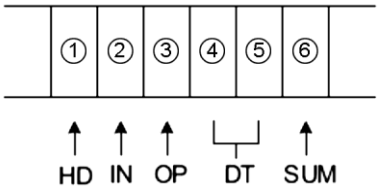
〈Command N〉 Example 1) When setting +50.00Hz for F1402
The data (DT) written is: 00500 or +0500

Example 2) When setting -50.00Hz for F1402
The data (DT) written is: -0500

〈Command B〉 Example 3) When setting +50.00Hz for F1402
The data (DT) read is: 00500

Example 4) When setting -50.00Hz for F1402
The data (DT) read is: -0500

3) Message from computer to inverter (BINARY format)



Item		Name	Content
①	HD	Start code	Message transmission start code ("@"：ASCII code 40H)
②	IN	Inverter No.	Inverter number Example: 14H for inverter number 20
③	OP	Command code	Inverter command code
④⑤	DT	Setting data	Data sent to inverter Example: For data 123 ④→00H ⑤→7BH ※Added only to a command code when there is applicable setting data.
⑥	SUM	Checksum	Add the two 's complement of the lower byte of the BINARY sum of data ①-⑤. (See Reference 2)

Reference 2: As an example of checksum calculation for BINARY format, set 50.00 Hz on the 1st inverter

① Start code =40H ： "@"

② Inverter No. =01H

③ Command =4FH ： "O"

④ Data (upper byte) =13H ： 50.00Hz→5000D→1388H

⑤ Data (lower byte) =88H ：

⑥ Sum of ①-⑤ =12BH： 40H＋01H＋4FH＋13H＋88H=12BH

⑦ Lower byte of 12BH =2BH ：

⑧ Two's complement of 2BH =D5H ： Checksum

(2) Details of message formation

① ASCII-format message

<table>
<tr><th>OP—CD</th><th colspan="2">Example of communication data (when inverter number is 1)</th></tr>
<tr><th></th><th>Transmission from computer to inverter</th><th>Transmission from inverter to computer</th></tr>
<tr><td>A</td><td>· Reading of alarm number
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>1</td><td>A</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table></td><td>· External thermal alarm (14)
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th colspan="5">DT</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>1</td><td>A</td><td>0</td><td>0</td><td>0</td><td>1</td><td>4</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table>
·The response is 0 if no alarm is detected.
·Refer to list of alarm codes for details of alarm numbers.</td></tr>
<tr><td>B</td><td>· Reading of function code
· F4006 Inverter number
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th colspan="4">DT</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>1</td><td>B</td><td>4</td><td>0</td><td>0</td><td>6</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table></td><td>· F4006=1
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th colspan="5">DT</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>0</td><td>B</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table>
·The read data is a fixed floating-point value, with a same format as the display on the operation panel of the inverter.
· If a read error occurs, "eXXXX" is returned as an error code. See list of alarm codes for details of the error codes.
· Refer to "Note" for the read data format of F5001 (motor poles, voltage and capacity).</td></tr>
<tr><td>C</td><td>· Reading of output frequency
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>1</td><td>C</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table></td><td>· Output frequency: 50 Hz
<table>
<tr><th>HD</th><th colspan="2">IN</th><th>OP</th><th colspan="5">DT</th><th>SUM</th><th>EM</th></tr>
<tr><td>*</td><td>0</td><td>1</td><td>C</td><td>0</td><td>5</td><td>0</td><td>0</td><td>0</td><td>SUM</td><td>CR or CR+LF</td></tr>
</table>
· The frequency data is multiplied by 100.</td></tr>
</table>

D

· Reading of output current

HD	IN		OP	SUM	EM
*	0	1	D	SUM	CR or CR+LF

· Output current: 12[A]

HD	IN		OP	DT					SUM	EM
*	0	1	D	0	0	1	2	0	SUM	CR or CR+LF

· The current data is multiplied by 10.

E

· Reading of DC voltage

HD	IN		OP	SUM	EM
*	0	1	E	SUM	CR or CR+LF

· DC voltage: 600V

HD	IN		OP	DT					SUM	EM
*	0	1	E	0	6	0	0	0	SUM	CR or CR+LF

· The voltage data is multiplied by 10.

F

· Reading of fin temperature

HD	IN		OP	SUM	EM
*	0	1	F	SUM	CR or CR+LF

· Fin temperature: 50[℃]

HD	IN		OP	DT					SUM	EM
*	0	1	F	0	0	0	5	0	SUM	CR or CR+LF

· The fin temperature data is multiplied by 1.

G

· Reading of Load rate

HD	IN		OP	SUM	EM
*	0	1	G	SUM	CR or CR+LF

· Load rate: [40%]

HD	IN		OP	DT					SUM	EM
*	0	1	G	0	0	0	4	0	SUM	CR or CR+LF

· The Load rate data is multiplied by 1

OP—CD	Example of communication data (when inverter number is 1)	
	Transmission from computer to inverter	Transmission from inverter to computer

H

· Reading of operation status 1

HD	IN		OP	SUM	EM
*	0	1	H	SUM	CR or CR+LF

· The operation status is returned as bit data

HD	IN		OP	DT					SUM	EM
*	0	1	H	0	0	0	X	X	SUM	CR or CR+LF

· The data has a 2-byte formation.

· See Operation Status 1 data for the bit correspondence of data X.

I

· Reading of operation status 2

HD	IN		OP	SUM	EM
*	0	1	I	SUM	CR or CR+LF

· The operation status is returned as bit data

HD	IN		OP	DT					SUM	EM
*	0	1	I	0	X	X	X	X	SUM	CR or CR+LF

· The data has a 4-byte formation.

· See Operation Status 2 data for the bit correspondence of data X.

J

· Reading of control terminal input status

HD	IN		OP	SUM	EM
*	0	1	J	SUM	CR or CR+LF

· The terminal status is returned as bit data

HD	IN		OP	DT					SUM	EM
*	0	1	J	0	X	X	X	X	SUM	CR or CR+LF

· The data has a 4-byte formation.

· See control terminal input data for the bit correspondence of data X.

K

· Reading of output voltage

HD	IN		OP	SUM	EM
*	0	1	K	SUM	CR or CR+LF

· Output voltage: 400[V]

HD	IN		OP	DT					SUM	EM
*	0	1	K	0	4	0	0	0	SUM	CR or CR+LF

· The output voltage data is multiplied by 10.

L

· Reading of VRF/IRF control terminal input value

HD	IN		OP	SUM	EM
*	0	1	L	SUM	CR or CR+LF

· The VRF/IRF control terminal input value is returned.

HD	IN		OP	DT					SUM	EM
*	0	1	L	0	4	0	9	5	SUM	CR or CR+LF

· Up to 4095 (12 bit) are returned for the maximum input (10V).

M

· Reading of VRF1 control terminal input

HD	IN		OP	SUM	EM
*	0	1	M	SUM	CR or CR+LF

· The VRF1 control terminal input value is returned.

HD	IN		OP	DT					SUM	EM
*	0	1	M	0	4	0	9	5	SUM	CR or CR+LF

· Up to 4095 (12 bit) are returned for the maximum input (10V).

T

·Reserved

OP—CD	Example of communication data (when inverter number is 1)	
	Transmission from computer to inverter	Transmission from inverter to computer

N

· Writing of function code data

· Writing 50Hz to F1008 —lower frequency limitll

HD	IN		OP	DT								SUM	EM
*	0	1	N	1	0	0	8	0	5	0	0	SUM	CR or CR+LF

· Writing of OK

HD	IN		OP	DT					SUM	EM
*	0	1	N	e	F	F	F	0	SUM	CR or CR+LF

· Interference error (Example: interference with F4007)

HD	IN		OP	DT				SUM	EM
*	0	1	N	e	4	0	0	7	SUM	CR or CR+LF

· Setting error(error code)

HD	IN		OP	DT					SUM	EM
*	0	1	N	e	F	F	F	5	SUM	CR or CR+LF

· See list of error codes for details of error code.

· See “Note” for the written data format of F5001 (motor poles, voltage and capacity).

O

· Setting of the frequency

· Set the target frequency to 55Hz

HD	IN		OP	DT					SUM	EM
*	0	1	O	0	5	5	0	0	SUM	CR or CR+LF

· Set the frequency data by a multiple of 100

· Same as for code data write

HD	IN		OP	ST					SUM	EM
*	0	1	O	e	F	F	F	0	SUM	CR or CR+LF

· “eFFFA” is returned if the frequency setting is not permitted.

P

· Forward run command

HD	IN		OP	SUM	EM
*	0	1	P	SUM	CR or CR+LF

HD	IN		OP	ST	SUM	EM
*	0	1	P	ST	SUM	CR or CR+LF

* ST：”0”：Normal
“1”：Operation control is not permitted
“2”：No operation in alarm status

Q

· Reverse run command

HD	IN		OP	SUM	EM
*	0	1	Q	SUM	CR or CR+LF

HD	IN		OP	ST	SUM	EM
*	0	1	Q	ST	SUM	CR or CR+LF

* ST：”0”：Normal
“1”：Operation control is not permitted
“2”：No operation in alarm status

R

· Stop command

HD	IN		OP	SUM	EM
*	0	1	R	SUM	CR or CR+LF

HD	IN		OP	ST	SUM	EM
*	0	1	R	ST	SUM	CR or CR+LF

* ST：”0”：Normal
“1”：Operation control is not permitted

S

· Stop command

HD	IN		OP	SUM	EM
*	0	1	S	SUM	CR or CR+LF

HD	IN		OP	SUM	EM
*	0	1	S	SUM	CR or CR+LF

OP—CD	Example of communication data (when inverter number is 1)	
	Transmission from computer to inverter	Transmission from inverter to computer
X	· Automatic Alarm Permitted HD: * | IN: 0 1 | OP: X | SUM: SUM | EM: CR or CR+LF	HD: * | IN: 0 1 | OP: X | SUM: SUM | EM: CR or CR+LF
Y	· Automatic Alarm Prohibited HD: * | IN: 0 1 | OP: Y | SUM: SUM | EM: CR or CR+LF	HD: * | IN: 0 1 | OP: Y | SUM: SUM | EM: CR or CR+LF
Z	· Command A (reading of alarm number) is transmitted when automatic alarm is received to obtain the alarm number.	· Automatic alarm HD: * | IN: 0 1 | OP: Z | SUM: SUM | EM: CR or CR+LF
a	· Selecting inverters for batch operation · Selecting inverter number 1 HD: * | IN: 0 1 | OP: a | SUM: SUM | EM: CR or CR+LF	HD: * | IN: 0 1 | OP: a | ST: ST | SUM: SUM | EM: CR or CR+LF * ST："0"：Normal "1"：Operation control is not permitted "2"：No operation in alarm status
b	· Selecting the direction of rotation of batch-operation inverters · Selecting inverter number 1 HD: * | IN: 0 1 | OP: b | DT: DT | SUM: SUM | EM: CR or CR+LF * DT："0"：Forward run "1"：Reverse run	HD: * | IN: 0 1 | OP: b | ST: ST | SUM: SUM | EM: CR or CR+LF * ST："0"：Normal "1"：Operation control is not permitted "2"：No operation in alarm status
c	· Releasing of inverters in batch operation HD: * | IN: 3 5 | OP: c | SUM: SUM | EM: CR or CR+LF · Send with inverter number 35	· No response is returned. · The command can be ignored if operation control is not permitted.
d	· Batch start command · The selected inverters are started simultaneously. HD: * | IN: 3 3 | OP: d | SUM: SUM | EM: CR or CR+LF · Send with inverter number 33	· No response is returned. · The command can be ignored if operation control is not permitted.
	· Batch start command · The selected inverters are started simultaneously. HD: * | IN: 3 4 | OP: d | SUM: SUM | EM: CR or CR+LF · Send with inverter number 34	

OP—CD	Example of communication data (when inverter number is 1)	
	Transmission from computer to inverter	Transmission from inverter to computer
e	· Batch stop command · The selected inverters are stopped simultaneously. HD: * | IN: 3 3 | OP: e | SUM: SUM | EM: CR or CR+LF · Send with inverter number 33	· No response is returned. · The command can be ignored if operation control is not permitted.

	· Batch stop command · All connected inverters are stopped simultaneously. HD | IN | OP | SUM | EM * | 3 | 4 | e | SUM | CR or CR+LF · Send with inverter number 34	
?	· Error response (Response of parity, SUM error and command code undefined)	HD | IN | OP | DT | SUM | EM * | 0 | 1 | ? | DT | SUM | CR or CR+LF * DT："p"：Parity error "s"：Checksum error "u"：Command code undefined "d"：Data length, format abnormal

Note: The data formats for reading of F5001 (poles, voltage and capacity) and the F5001 data format have a 5-digit formation.

X Y ZZZ

— — ———

Ⓐ Ⓑ Ⓒ

Ⓐ Number of poles
Examples) 4 poles→"4"

Ⓑ Rated voltage
Set the rated voltage using the corresponding setting number as follows:

Setting No.	1	2	3	4	5	6	7	8
Rated voltage	200	220	230	380	400	415	440	460

Example) 380V→"4"。

Ⓒ Rated capacity
Set the rated capacity using the corresponding setting number as follows:

Rated capacity	0.37kW	0.4kW	0.55kW	0.75kW	1.1kW	1.5kW	2.2kW
Setting No.	1	2	3	4	5	6	7
Rated capacity	3.0kW	3.7kW	4.0kW	5.5kW	7.5kW	11.0kW	15.0kW
Setting No.	8	9	10	11	12	13	14
Rated capacity	18.5kW	22.0kW	30.0kW	37.0kW	45.0kW	55.0kW	75.0kW
Setting No.	15	16	17	18	19	20	21

Example） When writing 4.0kW→"010"or"_10"
When reading 4.0kW→"_10"
Where "_" is ASCII code 5FH.

② BINARY format

Note: A BINARY-format message can be transmitted for the following commands only.

OP—CD	Example of communication data (when inverter number is 1)	
	Transmission from computer to inverter	Transmission from inverter to computer
O	· Setting of frequency · Setting target frequency to 55Hz HD | IN | OP | DT | SUM @ | 01h | O | 15h 7Ch | SUM · Set the frequency data by a multiple of 100	HD | IN | OP | ST | SUM @ | 01h | O | ST | SUM · ST returns the contents of the error code.
P	· Forward run command HD | IN | OP | SUM @ | 01h | P | SUM	HD | IN | OP | ST | SUM @ | 01h | P | ST | SUM * ST："00h"：Normal "01h"：Operation control is not permitted "02h"：No operation in alarm status
Q	· Reverse run command HD | IN | OP | SUM @ | 01h | Q | SUM	HD | IN | OP | ST | SUM @ | 01h | Q | ST | SUM *ST："00h"：Normal "01h"：Operation control is not permitted "02h"：No operation in alarm status

<table>
<tr>
<td>R</td>
<td>· Stop command
<table>
<tr><th>HD</th><th>IN</th><th>OP</th><th>SUM</th></tr>
<tr><td>@</td><td>01h</td><td>R</td><td>SUM</td></tr>
</table>
</td>
<td>
<table>
<tr><th>HD</th><th>IN</th><th>OP</th><th>ST</th><th>SUM</th></tr>
<tr><td>@</td><td>01h</td><td>R</td><td>ST</td><td>SUM</td></tr>
</table>
* ST：”00h”：Normal
“01h”：Operation control is not permitted
</td>
</tr>
<tr>
<td>S</td>
<td>Alarm reset
<table>
<tr><th>HD</th><th>IN</th><th>OP</th><th>SUM</th></tr>
<tr><td>@</td><td>01h</td><td>S</td><td>SUM</td></tr>
</table>
</td>
<td></td>
</tr>
<tr>
<td>?</td>
<td>· Error response
(Response of parity, SUM error and command code undefined)</td>
<td>
<table>
<tr><th>HD</th><th>IN</th><th>OP</th><th>ST</th><th>SUM</th></tr>
<tr><td>@</td><td>01h</td><td>?</td><td>01h</td><td>SUM</td></tr>
</table>
*ST：01h Fixed
</td>
</tr>
</table>

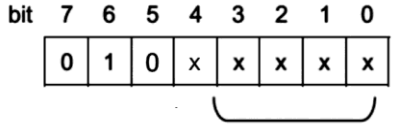
(3) Inverter operation and control terminal board input status data

Data read by from Operation Status 1 (H), Operation Status 2 (I) and Control Terminal Board Input Status (J) commands are as follows:

① Operation Status 1

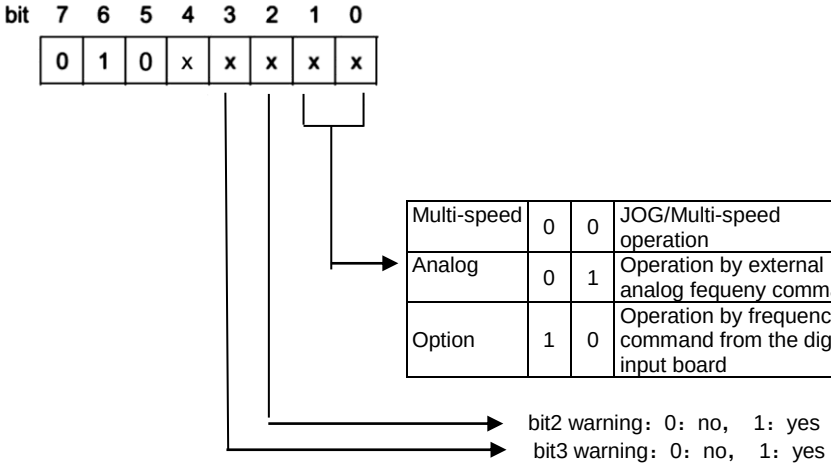
Operation Status 1 data is returned in two bytes

1st byte



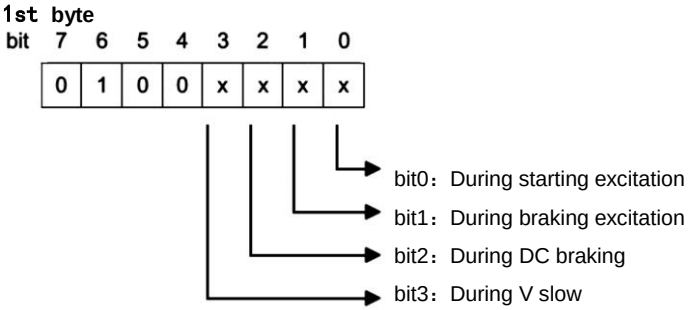
bit	4	3	2	1	0	
JOG	0	0	0	0	0	JOG operation
Stage1	0	0	0	0	1	Current number of stages in multi-speed operation
Stage2	0	0	0	1	0	
Stage3	0	0	0	1	1	
Stage4	0	0	1	0	0	
Stage5	0	0	1	0	1	
Stage6	0	0	1	1	0	
Stage7	0	0	1	1	1	
Stage8	0	1	0	0	0	
Stage9	0	1	0	0	1	
Stage10	0	1	0	1	0	
Stage11	0	1	0	1	1	
Stage12	0	1	1	0	0	
Stage13	0	1	1	0	1	
Stage14	0	1	1	1	0	
Stage15	0	1	1	1	1	
Stage16	1	0	0	0	0	

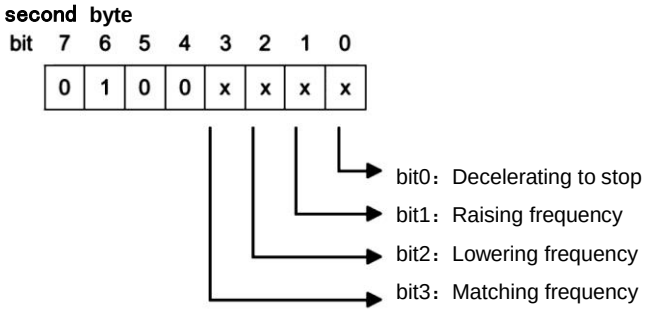
second byte

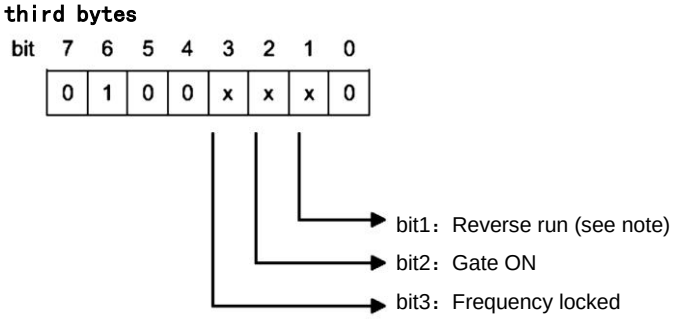


② Operation Status 2

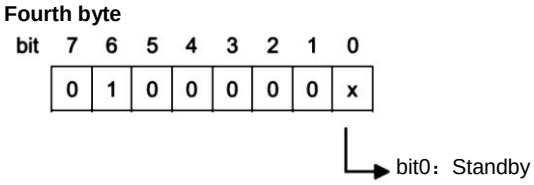
Operation Status 2 data is returned in four bytes



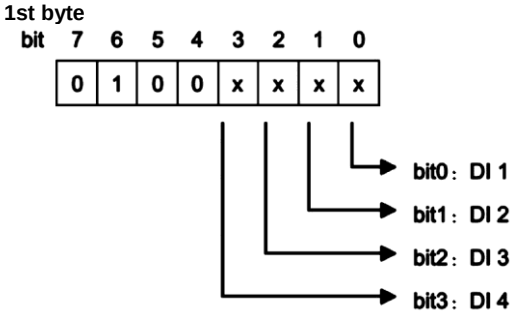


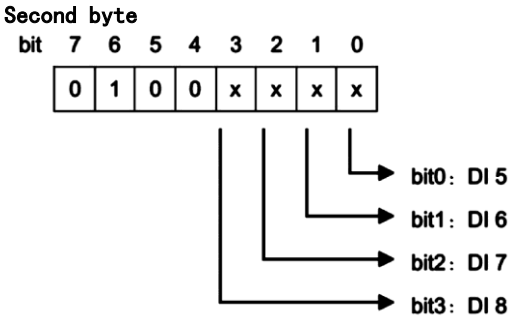


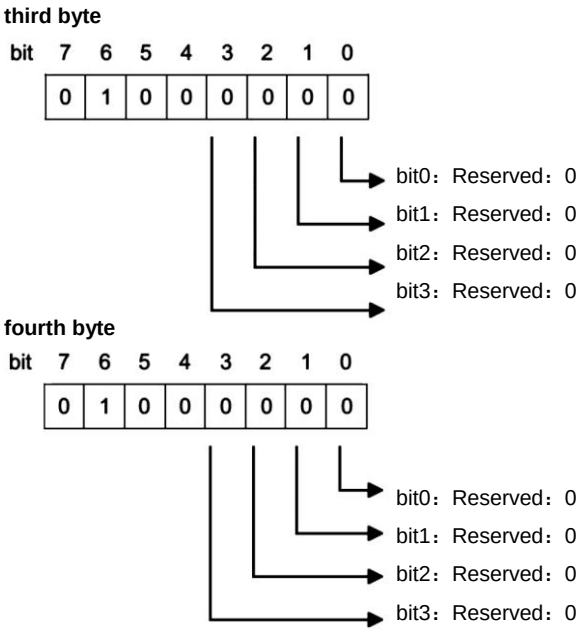
Note: The "Reverse run" bit during stop is changed through the last operation status. When it is necessary to confirm forward or reverse run, please also confirm the status of "Gate ON" bit.



③ Control terminal board data
Control terminal board data is returned in four bytes.







(4) List of error codes during function setting

ASCII	BIN	Error description
“exxxx”		Setting value conflicts with function code number Fxxxx
“eFFF0”	F0H	Normal setting
“eFFF1”	F1H	Function code value is out of range, user ‘s initial value is not determined, or motor constant is not registered.
“eFFF2”	F2H	Function code setting conflicts with mounted optional board
“eFFF3”	F3H	Function code setting conflicts with mounted options
“eFFF4”	F4H	Unable to change function code during inverter operation
“eFFF5”	F5H	Unable to change function code with operation function locked
“eFFF9”	F9H	Unable to change function code during LV
“eFFFA”	FAH	Frequency setting is not permitted (check the setting values of F1002)
“eFFFB”	FBH	Inverter control microcomputer busy (send the message again)
“eFFFC”	FCH	Reserved
“eFFFE”	FEH	Access to undefined code (access the code which cannot be accessed in serial communication function)

ASCII：ASCII-format message communication
BIN：BINARY-format message communication

(5) List of inverter alarm codes

Alarm No.	Alarm code	Description
1	AL1	Memory abnormality
2	AL2	System abnormality
3	AL3	System abnormality
4	AL4	System abnormality
5	AL5	System abnormality
9	AL9	System abnormality
10	AL10	System abnormality
11	ACER	Overload protection during acceleration
12	CNER	Overload protection during constant speed
13	DCER	Overload protection during deceleration
14	ES	External thermal abnormality
15	OH	Heat sink temperature abnormality
16	LVA	Undervoltage during acceleration
17	LVN	Undervoltage during constant speed
18	LVD	Undervoltage during deceleration
19	OCH	Main switch element temperature abnormality
20	OCA	Overcurrent during acceleration
21	OCN	Overcurrent during constant speed
22	OCD	Overcurrent during deceleration
23	OCPA	Momentary overload during acceleration
24	OCPN	Momentary overload during constant speed
25	OCPD	Momentary overload during deceleration
26	OLA	Overload during acceleration
27	OLN	Overload during constant speed
28	OLD	Overload during deceleration
29	OVA	Overload during acceleration
30	OVN	Overload during constant speed

31	OVD	Overload during deceleration
32	OVP	Braking resistor overvoltage protection
33	GAL1	Disconnection of feedback signal cable (PID control)
34	GAL2	Overspeed
35	GAL3	Modbus Communication timeout
39	PONG	24V Power supply abnormality
40	FANL	Cooling fan abnormality
41	PGER	Disconnection of PG feedback signal, abnormality of position deviation counter
42	OPNI	Missing input phase
43	OPNO	Missing output phase
44	GNDF	Grounding output overcurrent alarm
45	RYOFF	Main relay abnormality

Note: According to the inverter software edition, there may be some alarm numbers beyond the above list of alarm codes.

(6) Communication processing by the inverter

If an error is detected in a message from the computer, the inverter executes the following processing:

1) ASCII-format message

① Parity error, SUM error, or undefined command code
The inverter returns an error message with the command code "?" and a one-byte communication error code for DT.
Example) When inverter number is "1"

*	0	1	?	DT	SUM	EM

② DT data too long or short, or data cannot be interpreted

The same error processing as ① is executed if a message in data defined by a code is too long or short, or the received message data cannot be interpreted.

③ Timeout processing
The receive status is terminated forcibly if the entire message cannot be received within 150ms after receiving start code. The inverter returns communication error code "d".

④ Start code not detected
If data is being received without a correct start code, the above error is reported after a correct start code is detected.

⑤ List of communication error codes
"s": Checksum error
"u": Command code not defined
"d": Abnormality of data length and format

⑥ Other errors
The timeout processing applies to other errors related to message reception from a computer. The computer returns no response.

2) BINARY-format message
When an error is detected in a received message, the inverter returns an error message to the computer with OP set to "?" and ST set to 1 (BINARY).

① Abnormality detection item
Parity error, SUM error, undefined command code, or message data too short (receive timeout)
Example) BINARY format

@	IN	?	ST	SUM

(7) **Message transmission and reception between inverter and computer**

1) Basics

① The serial communication protocol is based on a procedure for an inverter to respond to a computer command. Whenever a command is received from a computer, the inverter returns a response. If the computer sends more commands to the inverter without waiting for a response from the inverter, the inverter may not work normally.

② Due to an inverter or communication line fault, however, the computer may not be able to receive a response from the inverter. To prevent the response, wait status from locking the communication sequence, the computer should use a receiver timeout of two seconds or longer.

③ The following commands are exceptions:

1) Command Z: The command to automatically notify the computer of an alarm, the transmission of this command is not influenced by computer command.

2) Command c, d and e: The inverter cannot return a response to these batch control commands.

④ When sending commands c, d and e with no response from the inverter, the computer should insert an interval of about 10 ms between two commands.

2) Message transmission and receive timings on the RS485 communication interface

3) Specified command inverter 's response selection

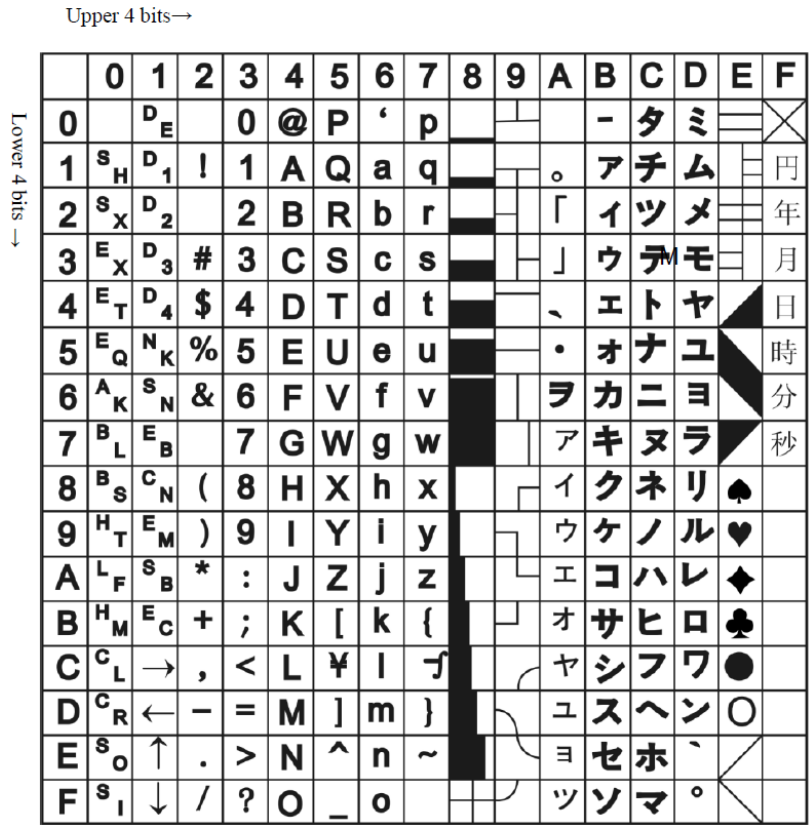
In order to improve communication speed, the response sent by inverter can be selected. The communication formats of ASCII and BINARY will not return a response from an inverter to the following commands. The error response can also be selected.

F4011=0: Sent
=1: Not sent (error response sent)
=2: Not sent (error response not sent)

① ASCII-supported commands
N, O, P, Q, R, S, a, b

② BINARY-supported commands
O, P, Q, R

(8) List of character code

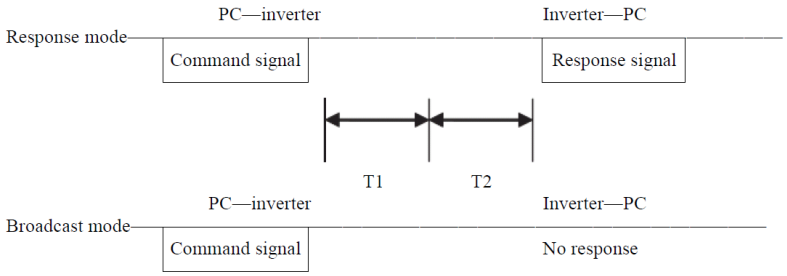


	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
0		D_E		0	@	P	‘	p				ｰ	タ	ミ		
1	S_H	D_1	!	1	A	Q	a	q			。	ｱ	ﾁ	ﾑ		円
2	S_X	D_2		2	B	R	b	r			「	ｲ	ﾂ	ﾒ		年
3	E_X	D_3	#	3	C	S	c	s			」	ｳ	ﾃ	ﾓ		月
4	E_T	D_4	$	4	D	T	d	t			、	ｴ	ﾄ	ﾔ		日
5	E_Q	N_K	%	5	E	U	e	u			・	ｵ	ﾅ	ﾕ		時
6	A_K	S_N	&	6	F	V	f	v			ヲ	ｶ	ﾆ	ﾖ		分
7	B_L	E_B		7	G	W	g	w			ｧ	ｷ	ﾇ	ﾗ		秒
8	B_S	C_N	(	8	H	X	h	x			ｨ	ｸ	ﾈ	ﾘ	♠	
9	H_T	E_M	)	9	I	Y	i	y			ｩ	ｹ	ﾉ	ﾙ	♥	
A	L_F	S_B	*	:	J	Z	j	z			ｪ	ｺ	ﾊ	ﾚ	✦	
B	H_M	E_C	+	;	K	[	k	{			ｫ	ｻ	ﾋ	ﾛ	♣	
C	C_L	→	,	<	L	¥	l	ｺﾞ			ｬ	ｼ	ﾌ	ﾜ	●	
D	C_R	←	−	=	M	]	m	}			ｭ	ｽ	ﾍ	ﾝ	○	
E	S_O	↑	.	>	N	^	n	~			ｮ	ｾ	ﾎ	ﾞ		
F	S_I	↓	/	?	O	_	o				ｯ	ｿ	ﾏ	ﾟ		

7-4-6 Modbus-RTU Communication

The followings are descriptions of Modbus-RTU communication.

(1) Message transmission and receive timings between inverter and computer
The transmission and receive timings of RTU message are as follows:

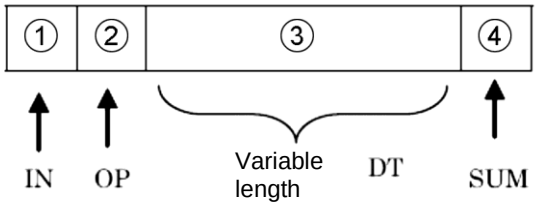


T1: Data receive complete time
The maximum time for judging 1-frame data complete by message receive cycle is the time needed to transmit 3.5-bit data with current baud rate. Therefore, the response signal must be within the time of T1.
T2: Communication response time (F4004)
By changing the communication time, the response interval sent by inverter can also be changed.

The response mode is a normal or error response sent by inverter to the command from the PC.
No response is sent in broadcast mode.

〈Communication timeout function〉
In Modbus communication, the setting of function code F4101: Modbus communication timeout can be used to set the response timeout during communication.
When exceeding the time period set by F4101, the inverter will act according to the setting of function code F4102:Modbus communication timeout actions.
F4102=0 Status keeping
F4102=1 Alarm and stop (GAL3 alarm)

(2) Message format
The message format is as follows. The RTU format is consisted with data in hexadecimal.



IN： Address (inverter number)
The 1byte length for IN is selectable from 0-247, 0 refers to broadcast mode (batch operation).
OP： Operation code (command code)
Used as a command code
The 1byte length for OP is defined as the following table from 0-255. Blanks with shading are used by OP.

OP	Description
0～2	Not used
3 (03H)	Register reading
4～5	Not used
6 (06H)	One register writing
7～15	Not used
16 (10H)	Continuous register writing (max. one data)
17～127	Not used
128～255	Saved as exceptional response

DT： Data
DT contains all information (register, data and etc.)

SUM： CRC (checksum)
SUM is the 2byte length of CRC check mode.

The followings are examples of messages (computer → inverter, inverter → computer (normal & abnormal response)).

1）Message from computer to inverter (RTU)

Item		Name	Description
①	IN	Inverter number	0: broadcast mode 1-254: termination inverter number Data format is fixed as 1byte Inverter number, the data set by function code F4006 Example: inverter number 2 ①→ “02”
②	OP	Command code	Command code (1byte fixed) (03H, 06H, 10H)
③	DT	Data	Example ①: Data content read from register(03H) 1） Register number (2-byte fixed) Example: register number 07D0H (1) → “07” (2) ➞ “D0” 2） Number of registers (2-byte fixed) Example: two registers (3) ➞ “00” (4)→ “02” ·Data (DT) (4byte)） (1) (2) (3) (4) Example ② the contents of data when writing data in one register (06H) 1) Register number (2-byte fixed) Example: register number 03E8H (1) → “03” (2) → “E8” 2) Data content (2-byte fixed) Example: Setting register 0001H (3) → “00” (4) → “01” · Data(DT) (4byte) (1) (2) (3) (4) Example ③ Data content written into the register (10H) 1） Register number (2-byte fixed) Example: register number 03E8H (1) → “03” (2)→ “E8” 2）Setting of number of registers (2-byte fixed) Example: setting register (3)→‘00’ (4)→‘01’ 3）Number of data (1-byte fixed) Example: setting data (5)→‘02’ 4）Data content (variable, byte = number of data (5)) Example: Setting register 0001H (6)→‘00’(7)→‘01’ ·Data (DT) (7byte) (1) (2) (3) (4) (5) (6) (7)
④	SUM	Checksum	CRC check (2 byte fixed)

2） Message from inverter to computer (RTU) (normal response)

Item		Name	Description
①	IN	Inverter number	0: Broadcast mode 1-254: inverter number of senders Data format is fixed as 1byte Inverter number, the data set by function code F4006 Example: inverter number 2 ①→ “02”
②	OP	Command code	same as the code sent from computer to inverter
③	DT	Data	Example ①: Data content read from register(03H) 1） Register number (2-byte fixed) Example: register number 07D0H (1)→‘02’（2）→‘F3’ 2） Number of registers（2 byte fixed） Example：setting 2 registers (3) → ‘00’ (4) ➞‘02’ 3) Number of data（1 byte fixed） Example: 4 data are read (5) → ‘04’ 4) Data content (variable, byte = number of data (1)) Example: 4 data are read (6) → ‘00’ (7)→‘00’ (8)→‘13’ (9)→‘88’ (1) (2) (3) (4) (5) (6) (7) (8) (9) Example ② the contents of data when writing data in one register (06H) 1) Register number (2-byte fixed) Example: register number 03E8H (1)→ “03” (2)→ “E8” 2) Data content (2-byte fixed) Example: Setting register 0001H (3)→ “00” (4)→ “01” ・Data (DT) (4byte) (1) (2) (3) (4) Example ③ Data content written into the register (10H) 1） Register number (2-byte fixed) Example: register number 03E8H (1)→‘03’（2）→‘E8’ 2） Setting number of registers (2-byte fixed) Example: writing in two registers (3)→‘00’ (4)→‘02’ ·Data（DT）（4byte） (1) (2) (3) (4)
④	SUM	Checksum	CRC check (2-byte fixed)

3） Message from inverter to computer (RTU) (abnormal response)

Item		Name	Description
①	IN	Inverter number	0: Broadcast mode 1-254: termination inverter number Data format is fixed as 1byte Inverter number is the data set by function code F4006 Example: inverter number 2 ①→ “02”
②	OP	Command code	Computer-sent command code +80H; Top digit 1 means abnormal.
③	DT	Data	Abnormality response data format is fixed as 1-byte For alarm contents, see list of alarms for dedicated protocol.

④	SUM	Checksum	CRC check (2-byte fixed)

(2) Types of OP

In OP in RTU format, 03H: register reading, 06H: One register writing and 10H: Continuous register writing are existed. The followings are descriptions for registers used in batch operation.

1) Register reading

- OP=03H
- During register reading, the data listed in the following table can be read.
  For the register address of various data, please refer to "(6) Register address" described later. Up to 5 data can be read simultaneously.
  For setting errors of function codes, please refer to list of error codes.

2) Continuous register writing

- OP = 06H (single register writes) / OP = 10H (continuous register write)
- By register writing, various data can be written and changed.
  For the register address of various data, please refer to "(6) Register address" described later.
  With continuous register writing, the data listed in the following table can be written.
  For setting errors of function codes, please refer to list of error codes.

Note: The data format of all function codes is the same with dedicated communication protocol.
However, F5001 (poles, voltage and capacity) is consisted by the following data.
Data length: 16bit
bit15-bit8: capacity
bit7-bit4: voltage
bit3-bit0: number of poles

3) Batch operation

By setting the address (inverter number) to 0, batch operation shown in the following table can be carried out.

- IN=0 (broadcast mode)
- During batch operation, the inverter returns no response.

(4) Processing of inverter communication error

- The following error processing will be carried out when an error is detected in the message received from the computer. According to error content, it can be divided into error response not sent and error response sent.

1) Error response not sent

- Serial communication error
  In case of parity error and other errors in serial communication
- Error of received data frame length
  When received data length is longer than maximum data length of 256-byte or shorter than the minimum data length (address 1-byte + command code 1-byte + CRC 2-byte) of 4-byte
- CRC Error
  Error during receiving CRC checksum of data frame
- Broadcast mode
  In broadcast mode, no response is returned.

2) Error response sent

- Command code not defined
  When a command code is except 03H, 06H or 10H, error detection will be carried out and an error code will be returned.
- PDU Error
  When number of data for communication message has an error, an error code will be returned.
- Address error
  When starting address or starting address + number of registers is beyond the following range of valid address, an error code will be returned.
  (at F4103=0: the time of register number A) Reading command 2000-2019
  Writing command 1000-1002
  (at F4103=1: the time of register number B) Reading command 9600-9619
  Writing command 9500-9502
- Error of specified execution
  When setting the register with a value beyond the setting values listed in the data sheet [for frequency setting of register number (1000 at F4103=0: the time of register number A, 9500 at F4103=1: the time of register number B), the range of 0-60000 is valid], or no control is permitted when setting the start command for register number [1001 at F4103=0: the time of register number A, 9501 at F4103=1: the time of register number B], an error code will be returned.

(5) List of error codes during function code setting

Error code	Description
01H	Command code not defined
02H	Address error
03H	PDU error
04H	Specified execution error
F0H	Inconsistency between function code number XXXX and setting value

F1H	Function code value setting too large, undefined user initialization, or an un-registered inverter number
F2H	Inconsistency between function code setting value and optional board
F3H	Inconsistency between function code setting value and option
F4H	Inverter operation, function code cannot be changed
F5H	Operation locked, function code cannot be changed
F9H	Function code cannot be changed in LV
FAH	Frequency setting is not allowed, please enter F1002 setting value
FBH	Inverter busy, please send message again
FCH	System reserved
FEH	Selection of undefined code (access the code with serial communication function)

(6) Function code register address

The address of the register can be selected from 2 types of addresses through the function code "F4103: Modbus register address switching".。

A function code register address is as in the following tables.

■Read register address (F4103=0: when register serial number A)

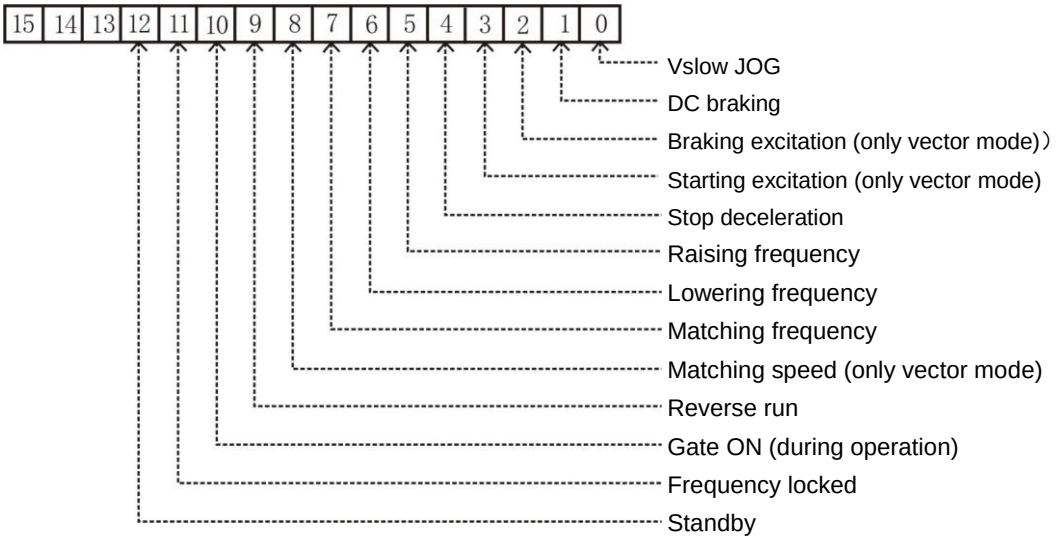
Process method	Register No		Description	
	DEC	HEX		
Reading	2000	7D0H	Alarm content	
			0= no alarm; others=list of alarm codes※1	
	2001	7D1H	Command frequency	
	2002	7D2H	Reading of Output freqeuncy	
	2003	7D3H	Reading of Output current	
	2004	7D4H	Reading of DC voltage	
	2005	7D5H	Reading of Heat sink temperature	
	2006	7D6H	Load rate reading	
	2007	7D7H	Reading of Operation Status 1	
			BIT0～BIT4	JOG＋16th speed operation (operation status)
				0000：speed segment 0, JOG operation
				00001：1st speed operation
				00010：2nd speed operation
				……
				10000：16th speed operation
			BIT5	Operation by external analog input frequency (operation status)
			BIT6	Operation by option input frequency (operation status)
			BIT7	1 = warning; 0 = no warning
			BIT8	1 = alarm; 0 = no alarm
			BIT9 above	System reserved
	2008～2009	7D8H～7D9H	Reading of Operation Status 2	
			STATUS FLAG（32bit） ※2	
			BIT17 above	System reserved
	2010	7DAH	Reading of Operation Status 3	System reserved
	2011	7DBH	Reading of Operation Status 4	System reserved
	2012	7DCH	Reading of external terminal input status 1	
			BIT0～BIT7	DI1～DI8 (ON/OFF)
				1=ON; 0=OFF
			BIT8 above	System reserved
	2013	7DDH	Reading of external terminal input status 1	
			BIT0～BIT2	DO1～DO3 (HIGH/LOW)
				1=LOW; 0=HIGH
			BIT3～BIT4	RY1～RY2 (HIGH/LOW)
				1=HIGH; 0=LOW
			BIT5 above	System reserved
	2014	7DEH	Reading of output voltage	
	2015	7DFH	Reading of VRF/IRF control terminal input value	
	2016	7EOH	Reading of VRF1 control terminal input value	
	2017	7E1H	Reserved	
	2018	7E2H	Reading of VOUT output value	
	2019	7E3H	Reading of IOUToutput value	
	2020～2029	7E4H～7EDH	System reserved	

※1 Please refer to list of alarm codes for communication with dedicated protocol.

※2 STATUSFLAG(status flag)

In RAM bit status, the status flags are shown as follows.
And, the —only vector modell bit is reset and cleared only in vector mode; all the bits will be cleared in V/f mode. (Clear = 0, Reset = 1)

FL-STFLG bit formation



※ **b13-b31 is system reserved.**

■Write in register address (at F4103=0: the time of register number A)

Process method	Register No.		Description			
	DEC	HEX				
Write in	1000	3E8H	Freqeuncy command	Setting of target frequency (1st speed)		
	1001	3E9H	Operation command			
			BIT 0	Not used		
			BIT 1	Forward run	1=Enabled	0=Disabled
			BIT 2	Reverse run	1=Enabled	0=Disabled
			BIT 3	Stop	1=Enabled	0=Disabled
			BIT4 above	Not used		
	1002	3EAH	Rest command			
			BIT 0	Alarm reset	1=Enabled	0=Disabled
			BIT1 above	Not used		
	1003～1009	3EBH～3F1H	System reserved			

■Batch operation register address (at F4103=0: the time of register number A)

Process method	Register No.		Description		
	DEC	HEX			
Batch operation	3000	BB8H	Selecting inverters for batch operation		
	3001～3002	BB9H～BBAH	Specifying direction of rotation for inverters in batch control		
			3001	Selecting inverters for batch control	
			3002	Direction of rotation	1=Forward, 2=Reverse
	3003	BBBH	Releasing inverters in batch operation		
	3004	BBCH	Batch start		1=Start
	3005	BBDH	Batch stop		1=Stop
	3006～3009	BBEH～BC1H	System reserved		

■ Function code register address (at F4103=0: the time of register number A)
Register No. should set the value of the "function code number + 8000H(HEX)".

Process method	Register No.		Description
	DEC	HEX	
Reading Write in	9001	2329H	Function code F1001
	9002	232AH	Function code F1002
	…	…	…
	16999	4267H	Function code F8999

■ Read register address (F4103=1: when register number B)

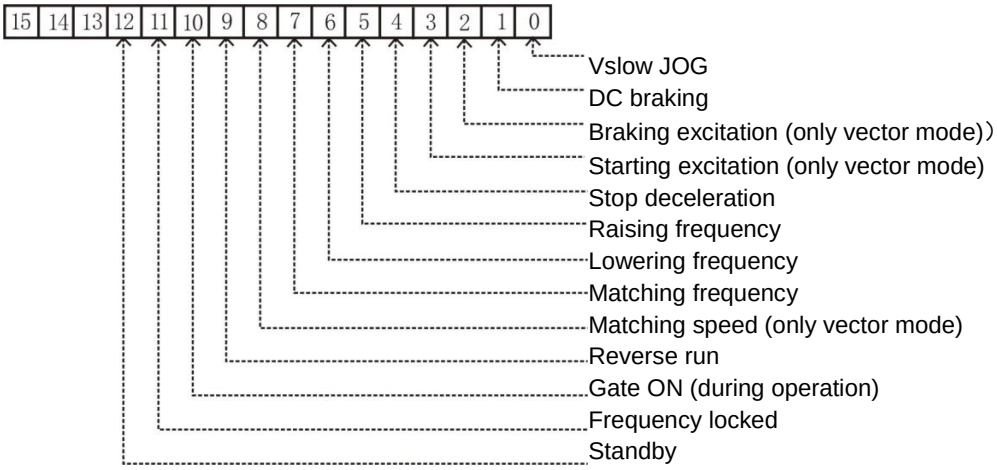
Process method	Register No.		Description		
	DEC	HEX			
Reading Write in	9600	2580H	Alarm content		
			0 = No alarm; Other = list of alarm codes ※1		
	9601	2581H	Reading of command frequency		
	9602	2582H	Reading of output frequency		
	9603	2583H	Reading of output current		
	9604	2584H	Reading of DC voltage		
	9605	2585H	Reading of Heat sink temperature		
	9606	2586H	Reading of Load rate		
	9607	2587H	Reading of Operation Status 1		
			BIT0～BIT4	JOG＋16th speed operation (operation status)	
				0000：speed segment 0, JOG operation	
				00001：1st speed operation	
				00010：2nd speed operation	
				……	
				10000：16th speed operation	
			BIT5	Operation by external analog input frequency (operation status)	
			BIT6	Operation by option input frequency (operation status)	
			BIT7	1 = warning; 0 = no warning	
			BIT8	1 = alarm; 0 = no alarm	
			BIT9 above	System reserved	
	9608～9609	2588H～2589H	Reading of Operation Status 2		
			STATUS FLAG（32bit） ※2		
			BIT17 above	System reserved	
	9610	258AH	Reading of Operation Status 3	System reserved	
	9611	258BH	Reading of Operation Status 4	System reserved	
	9612	258CH	Reading of external terminal input status 1		
			BIT0～BIT7	DI1～DI8 (ON/OFF)	
				1=ON; 0=OFF	
			BIT8 above	System reserved	
	9613	258DH	Reading of external terminal input status 1		
			BIT0～BIT2	DO1～DO3 (HIGH/LOW)	
				1=LOW; 0=HIGH	
			BIT3～BIT4	RY1～RY2 (HIGH/LOW)	
				1=HIGH; 0=LOW	
			BIT5 above	System reserved	
	9614	258EH	Reading of output voltage		
	9615	258FH	Reading of VRF/IRF control terminal input value		
	9616	2590H	Reading of VRF1 control terminal input value		
	9617	2591H	Reserved		
	9618	2592H	Reading of VOUT output value		
	9619	2593H	Reading of IOUT output value		
	9620～9629	2594H～259DH	System reserved		

※1 Please refer to list of alarm codes for communication with dedicated protocol.

※2 STATUSFLAG(status flag)

In RAM bit status, the status flags are shown as follows.
And, the “only vector mode” bit is reset and cleared only in vector mode; all the bits will be cleared in V/f mode. (Clear = 0, Reset = 1)

FL-STFLG bit formation



※ **b13-b31 is system reserved.**

■Write in register address (at F4103=1: the time of register number B)

Process method	Register No.		Description			
	DEC	HEX				
Write in	9500	251CH	Frequency command	Setting of target frequency (1st speed)		
	9501	251DH	Operation command			
			BIT 0	Not used		
			BIT 1	Forward run	1=Enabled	0=Disabled
			BIT 2	Reverse run	1=Enabled	0=Disabled
			BIT 3	Stop	1=Enabled	0=Disabled
			BIT4above	Not used		
	9502	251EH	Rest command			
			BIT 0	Alarm reset	1=Enabled	0=Disabled
			BIT1above	Not used		
	9503～9509	251FH～2525H	System reserved			

■Batch operation register address (at F4103=1: the time of register number B)

Process method	Register No.		Description		
	DEC	HEX			
Batch operation	9700	25E4H	Selecting inverters for batch operation		
	9701～9702	25E5H～25E6H	Specifying direction of rotation for inverters in batch control		
			9701	Selecting inverters for batch control	
			9702	Direction of rotation	1=Forward, 2=Reverse
	9703	25E7H	Releasing inverters in batch operation		
	9704	25E8H	Batch start	1=Start	
	9705	25E9H	Batch stop	1=Stop	
	9706～9709	25EAH～25EDH	System reserved		

■Function code register address (F4103=1: when register number B)
The register number is used to set the value of "function code number".

Process method	Register No.		Description
	DEC	HEX	
Reading Write in	1001	03E9H	Function code F1001
	1002	03EAH	Function code F1002
	…	…	…
	8999	2327H	Function code F8999

8. Protection & Error Function

8-1 Operation Error

- The operation error is displayed in the operation of operation panel (key, quick-turn knob), or some unallowed operations or code inputs in function code data inputting (operation, code input).

  When an operation error is displayed, the operation and code input are noneffective.

- The operation error can be displayed either in operation state or stop state. The display will automatically disappear after 3 seconds, and the inverter will return to the status before the operation error.

- During display of operation error, inverter will keep running (*1). The control from external terminals or communication is still effective. But, only the stop key [STOP] on the operation panel is effective.
  *1 It can also be displayed in stop status.

8-1-1 List of Error Operation

Table 8-1 List of error operation

Monitor display	Description
Er A	The frequency cannot be set on the operation panel.
Er b	Specify the undefined function code number. (not displayed on standard operation panel)
Er C	The entered values exceed the allowable range. Or the motor parameters of F5001 (motor poles, voltage and capacity) are not registered.
Er d	User initialization data is not registered. Please use F1604=99 to set the initial user data definition.
Er E	Cannot start with the operation panel.
Er H	The entered setting value conflicts with the optional board.
Er J	The entered setting value conflicts with the optional board.
Er L	Since the inverter is in operation, the function code data cannot be changed.
Er n	Since the operation panel is locked, the function code data cannot be changed.
Er o	Since software editions are different, the data cannot be transmitted. (copy function)
Er P	A password is required, please confirm with the sellers.
Er r	The memory content on operation panel cannot be sent to the master computer. (copy function)
Er S	Automatic testing of motor parameters cannot be carried out for the connected motor.
Er t	The current function code data cannot be sent to the operation panel. (copy function)
Er u	The function code cannot be changed because of undervoltage.
Er 10	No communication between operation panel and inverter computer. Please disconnect the power supply and confirm the connection of operation panel and optional board. Consult the seller when the error is displayed repeatedly.
oFF L	No communication between operation panel and inverter computer. Please disconnect the power supply and confirm the connection of operation panel and optional board. Consult the seller when the error is displayed repeatedly.

8-2 Conflict & Interference Error

- During function code entering, a conflict & interference error will be displayed when the entered data conflicts with the settings of other function codes. The displayed 4-digit number is the number of conflict & interference function code.

- The entered data is invalid when a conflict & interference error is displayed. Please correct it to a value without a conflict or change the values of the conflict & interference function code.

- For function code and error display related to conflict and interference, please refer to Table 8.2.

8-2-1 List of Conflict & Interference Error

Table 8.2 List of conflict & interference error

Setting function code			Error code	Description
No.	Name	Setting		
1001	Motor control mode selection	All (exclude 1 and 40)	E5001	The setting motor cannot be used in vector control
			E1007/E1316/E1317	Exceed the upper frequency limit
		2	E1901	Simple energy-saving function (only in V/f mode) cannot be used in vector control mode
		3	E1002	Cannot set PG input repeatedly
			E1901	Simple energy-saving (only in V/f mode), cannot be used in vector control mode
		4	E1901	Energy-saving mode cannot be used in torque control
			E2201	Pattern, disturbed operation cannot be used in torque control
			E3201	PID control action cannot be used in torque control
		5	E1002	Cannot set PG input repeatedly
			E1901	Energy-saving mode cannot be used in torque control
			E2201	Pattern, disturbed operation cannot be used in torque control
			E3201	PID control action cannot be used in position control
		6	E1002	Cannot set PG input repeatedly
			E1101	Position control mode is only effective when operation command is external terminal
			E1901	Energy-saving mode cannot be used in position control
			E2201	Pattern, disturbed operation cannot be used in position control
			E3201	PID control action cannot be used in torque control
		10,11	E1901	Energy-saving mode cannot be set when motor parameter are measured automatically
			E2201	Pattern, disturbed operation cannot be set during automatic measurement
			E3201	PID control action cannot be set during automatic measurement
		40	E1901	Energy-saving mode cannot be set during V•f separation control
			E2201	Pattern, disturbed operation cannot be set in V•f separation mode
			E3201	PID control action cannot be set in V•f separation mode
		All	Exxxx	Cannot set analog input repeatedly
1002	1st speed frequency setting	2～20 26～28	Exxxx	Cannot set analog input repeatedly
		25	E1001	When 1st speed frequency is pulse train input, the required PG sensor control mode cannot be used
1003	V/f pattern	2, 3	E2007	Automatic torque boost and square ratio lowing mode cannot be used together
1007	Upper frequency limit	All	E1008	Upper frequency limit cannot be smaller than lower frequency limit
			E1001	Exceed the possible upper frequency limit
1008	Lower frequency limit	All	E1007/E1316/E1317	Lower frequency limit cannot be larger than upper frequency limit
1010	Acceleration / deceleration curve	2, 3	E2007	Automatic torque boost and S acceleration / deceleration degression cannot be used together
1101	Operation command selection	1, 3	E1001	During position control (F1001=6), only terminal board command (F1101=2) can be used
1301	1st jump bottom frequency	All	E1302	No larger than the value of 1st jump top frequency
1302	1st jump top frequency	All	E1301	No smaller than the value of 1st jump bottom frequency
1303	2nd jump bottom	All	E1304	No larger than the value of 2nd jump top frequency

	frequency			
1304	2nd jump top frequency	All	E1303	No smaller than the value of 2nd jump bottom frequency
1305	3rd jump bottom frequency	All	E1306	No larger than the value of 3rd jump top frequency
1306	3rd jump top frequency	All	E1305	No smaller than the value of 3rd jump bottom frequency
1316	2nd upper frequency limit	All	E1008	Upper frequency limit cannot be smaller than lower frequency
			E1001	Exceed the possible upper frequency limit/motor parameter sheet error
1317	3rd upper frequency limit	All	E1008	Upper frequency limit cannot be smaller than lower frequency
			E1001	Exceed the possible upper frequency limit/motor parameter sheet error
1411	Analog input switching for set frequency gain	All	Exxxx	Cannot set analog input repeatedly
1901	Energy-saving mode selection	1	E1001	Only V/f control can use simple energy-saving mode
			E2007	Automatic torque boost and simple energy-saving mode cannot be used together
			E3201	PID control action and simple energy-saving mode cannot be used together
		2	E1001	Only V/f control speed control can use simple energy-saving mode
			E2007	Automatic torque boost and auto energy-saving mode cannot be used together
2002	V•f separation command voltage	0	Exxxx	Cannot set analog input repeatedly
2007	Auto torque boost selection	Beyond 0	E1003	Automatic torque boost, cannot be used unless V/f mode is linear
			E1010	Automatic torque boost, cannot be used unless acceleration / deceleration curve is linear
			E1901	Automatic torque boost and energy-saving mode cannot be used together
2201	Scheduled operation selection	1,2	E1001	In current control mode, scheduled or disturbed operation cannot be used
		All	Exxxx	Cannot set analog input repeatedly
2236	Disturb modulation analog input switching	All	Exxxx	Cannot set analog input repeatedly
3001	PID1 command value input switching	All	Exxxx	Cannot set analog input repeatedly
3002	PID1 feedback input switching	All	Exxxx	Cannot set analog input repeatedly
3101	PID2 command value input switching	All	Exxxx	Cannot set analog input repeatedly
3102	PID2 feedback input switching	All	Exxxx	Cannot set analog input repeatedly
3201	PID control action selection	Beyond 0	E1001	PID control action can only be used in V/f control or speed control
			E1901	Simple energy-saving mode and PID control operation cannot be used together
		1	E3203	Same PID control cannot be used both internally and externally
		2	E3203	Same PID control cannot be used both internally and externally
		4, 5	E3203	Same PID control cannot be used both internally and externally
		All	Exxxx	Cannot set analog input repeatedly
3203	External PID control selection	1	E3203	Same PID control cannot be used both internally and externally
		2	E3203	Same PID control cannot be used both internally and externally
		4, 5	E3203	Same PID control cannot be used both internally and externally
		All	Exxxx	Cannot set analog input repeatedly
5001	Motor poles, voltage and capacity	All	Exxxx	The motor is not applicable when its capacity has a large difference with inverter capacity

			Exxxx	Vector control mode is only applicable to 2-, 4-, and 6 pole motors
			E1007/E1316/E1317	Exceed the possible upper frequency limit
5011	Motor primary inductance	All	E5013	Mutual inductance should be smaller than primary inductance
5012	Motor secondary inductance	All	E5013	Mutual inductance should be smaller than secondary inductance
5013	Motor mutual inductance	All	E5011	Mutual inductance should be smaller than primary inductance
			E5012	Mutual inductance should be smaller than secondary inductance
6002	Torque limiter analog input function (power running)	All	Exxxx	Cannot set analog input repeatedly
6004	Torque limiter analog input function (regeneration)	All	Exxxx	Cannot set analog input repeatedly
6015	Lower frequency limit for motor vibration reduction function	All	E6016	Cannot exceed the upper frequency limit
6016	Upper frequency limit for motor vibration reduction function	All	E6015	Cannot exceed the lower frequency limit
6101	Torque command selection	All	Exxxx	Cannot set analog input repeatedly
6103	Positive upper value of torque command	All	E6104	Cannot exceed the lower limit value
6104	Positive lower value of torque command	All	E6103	Cannot exceed the upper limit value
6105	Negative upper value of torque command	All	E6106	Cannot exceed the lower limit value
6106	Negative lower value of torque command	All	E6105	Cannot exceed the upper limit value

※Exxxx represents analog input repetition function code.

8-3 Warning Status

- This warning status alerts you that the protection function of the inverter has been activated. However, the inverter keeps on running. If the inverter runs for a long time in this status, the inverter may enter the alarm status and stop running.
- In the status display mode, details of the warning and the status indication alternate on the display when a warning has occurred. When the status display mode is not selected, the alternating display appears on the display if the warning is still active after the status display mode is resumed.
- All keys are valid during the warning status because the inverter continues to run.

8-3-1 List of Warnings

table 8-3 List of warnings

Warning display	Warning content	Description
SC	Current limiting during acceleration / deceleration	acceleration (deceleration） time too short
SCn	Current limiting during constant speed operation	Load too heavy, output frequency too high
Su	During overvoltage prevention	Deceleration time too short
oL	Overload warning	Load too heave, continuous operation will cause an inverter shutdown.。
tH	Heat sink temperature warning	Temperature of the Heat sink is rising. Check the ambient temperature and operation of the cooling fan. The warning is issued at a temperature 10℃ below the abnormal Heat sink fin temperature (OH) (The abnormal Heat sink fin temperature differs depending upon the output frequency, output current and other factors)
dboH	Overheating of brake resistor	Brake resistor capacity too low. (%ED is small) Brake resistor stops to prevent heat damage.
FbEr	Disconnection of feedback cable	A feedback is abnormal. Please check feedback value and feedback signal.
CtLEr	Disallowance of the motor rotation direction	Since an operation command unallowed by the specified rotation direction has been input, please confirm the setting of motor rotation direction.
u iEr	Conflict warning for analog input setting	For the same analog input channels, input current and voltage input is set at the same time. Please confirm the function code selected by analog input.
PGnG	PG line error detection	A reverse direction is detected by PG feedback. Please confirm the phase of PG pulse.

8-4 Alarm Status

- The alarm status occurs when the protection function stops the inverter.
- During alarm status, all values on the display (Hz, A, rpm, %, M) flash indicating the alarm status.
- When Status Display mode is selected, details of the alarm are indicated on the 7-segment display. If the Status Display mode is not selected, details of the alarm are indicated on the 7-segment display if the alarm status continues after the Status Display mode is resumed. Details of the alarm cannot be deleted.

8-4-1 List of Alarms

Table 8-4-1 List of alarms

7-segment monitor display	Alarm description	Check points	Actions
AL 1 ※2	Memory abnormality	Turn off the power and wait until the CHARGE lamp turns off, turn the power on again and check the alarm.	Contact your supplier.
AL 2 ※1 AL 3 ※1	System abnormality	Excessive external noise? Are signal and power lines separated far enough?	Install a noise collector or filter Keep the signal line far away from the power line
AL 4 ※2	System abnormality	Abrupt capacitor discharge? Turn off the power so the CHARGE lamp turns off, turn the power on again and check the alarm.	Reconfirm the modified code data. Turn the power on and off several times. If the alarm cannot be cancelled, reset the system using F1604=1 and then turn the power off and on again. All the function data is initialized to the factory presets.
AL 5 ※2 AL 9 ※2	System abnormality	Excessive external noise? Are signal and power lines separated far enough?	Install a noise collector or filter Keep the signal line far away from the power line
AL 10	System abnormality	Abrupt capacitor discharge? Turn off the power so the CHARGE lamp turns off, turn the power on again and check the alarm.	Contact your supplier.
ACEr	Overload prevention during acceleration	Setting for output current limiting function (F1701) too small?	Increase the setting value of F1701 Prolong acceleration and deceleration time
CnEr	Overload prevention during constant speed		
dCEr	Overload prevention during deceleration		
ES	External thermal alarm	Motor overheated? Function settings are correct?	Reduce the load Re-set the function codes correctly (F1413)

7-segment monitor display	Alarm description	Check points	Actions
oH	Heat sink temperature abnormality	Fan stopped? Ambient temperature too high?	Check fan operation Increase the ventilation
LuA	Undervoltage during acceleration	Does power supply satisfy conditions? Has the voltage dropped?	Examine/improve power supply conditions.
Lun	Undervoltage during constant speed		
Lud	Undervoltage during deceleration		
oCH	Main switch element temperature abnormality	Fan stopped? Ambient temperature too high?	Check fan operation Increase the ventilation
oCA ※3	Overcurrent during acceleration	Abrupt acceleration / deceleration rate? Output short-circuited or ground fault? Main switch elements abnormality?	Prolong acceleration and deceleration time. Correct short-circuit or ground fault. Contact your supplier when alarms are issued repeatedly.
oCn ※3	Overcurrent during constant speed		
oCd ※3	Overcurrent during deceleration		
oCPA	Momentary overload during acceleration	Excessive acceleration rate? Setting for current limiting function (F1701) too high?	Prolong acceleration time Decrease the setting value
oCPn	Momentary overload during constant speed	Abrupt change (increase) in load? Setting for current limiting function (F1701) too high?	Eliminate the abrupt change (increase) Decrease the setting value

oCPd	Momentary overload during deceleration	Excessive deceleration rate with a GD^2? Setting for current limiting function (F1701) too high?	Prolong acceleration time Decrease the setting value
oLA	Overload during acceleration	Motor operated with an excessive load? Electrothermal level set properly? Load GD^2 too large?	Reduce the load Increase the capacity of the inverter and motor
oLn	Overload during constant speed		
oLd	Overload during deceleration		
ouA	Overvoltage during acceleration	Did start-up occur during free run?	Flying start.
oun	Overvoltage during constant speed	Is motor being turned by other force?	Redesign the system so that the motor is not driven by external force. Use a brake resistor with a larger capacity.
oud	Overvoltage during deceleration	Excessive deceleration?	Prolong the deceleration time (so that GD2 of the load is met)
ouP	Brake resistor overvoltage protection	Braking frequency too high?	Reduce the braking frequency Increase the brake resistor capacity
GAL 1	Disconnection of feedback signal cable (during PID control action)	Feedback signal cable disconnected? Feedback signal correct? Gain frequency correct? (F1402, F1404)	Check feedback signal cable and connect securely. Set gain frequency properly (F1402, F1404)

7-segment monitor display	Alarm description	Check points	Actions
GAL 2	Overspeed	Over-shoot or under-shoot happened?	Confirm speed command value or torque command value
GAL 3	Modbus communication timeout	Communication cable disconnected?	Confirm communication cables are connected securely
PonG ※2	Power supply abnormality	+24V power supply output from the control circuit overloaded or shorted?	Check the +24V output power supply for load conditions
oPn o	Missing output phase	Missing an output phase?	Connect the output cables securely
oPn i	Missing input phase	Missing an input phase?	Check and improve the input current
Gnd F	Check grounding short-circuit current	Short-circuited when grounding?	Confirm output cable and motor insulation performance
PGEr	Disconnection of PG pulse feedback signal cable Position deviation counter abnormality	Feedback signal cables are well connected? Is motor being driven by other force?	Connect the feedback signal cable securely Redesign the system so that the motor is not driven by external force.
FAn L	Cooling fan abnormality	Cooling fan is working?	Check the fan performance
rYoFF	Main relay abnormality	Turn off the power and wait until the CHARGE lamp turns off, turn the power on again and check the alarm.	Contact the supplier

※1: Since all function data are initialized to the factory presets, settings will need to be input again.

※2: After several times of power on/off, contact your supplier if the alarm is displayed again.

※3: Even though a protective function against short-circuit of the main switch element is installed, repeated short-circuiting may cause deterioration of the elements and lead to damages to the inverter. Therefore the inverter can only be restarted after checking and removing the cause of the problem.
* If the display on the operation panel goes out for some reason, turn off power supply to the inverter to check the wiring; then turn the power on after CHARGE lamp has gone out. (Short-circuiting caused by improper connection of control terminals and so on)

9. Fault Analysis

Problem		Check points
Motor does not rotate	Main circuit	• Voltages at input terminals R, S and T are normal? • Is the motor wired correctly?
	Load side	• Load too heavy? • Motor locked?
	Operation panel	• Starting frequency setting too high (F1103)? • Operation start frequency (F1104) setting too high? • Is operation command selected for control by external signal (F1102=2)? • Upper frequency limit set too low (F1007)? • 2nd upper frequency limit (F1316) and 3rd upper frequency limit selected by multi-function input signal are setting too low? • Check if no setting is specified for the direction of rotation of motor (F1109)?
	Input signal	• Are operation signals (FR, RR) being input? • FR and RR signals are input simultaneously? • Free run stop signal input (MBS)? • Analog signal for frequency setting is zero?
Rotation direction different from what it should be	Wrong wiring of output terminals U, V and W? Is the wiring for forward and reverse run mixed up?	
Rotation speed does not increase	• Upper frequency limit (F1007) activated? • Output current limiting function activated? → Is setting of F1701 too low? • Load too heavy? → Torque boost (F1004) too high? • PG sensor connected correctly?	
Rotation is not constant	• Load fluctuating? • Frequency setting (analog) signal fluctuating? • Are the capacity and number of poles appropriate for the inverter capacity specified for use in the sensorless vector control mode? • PG sensor set correctly?	
Acceleration / deceleration is not constant	• Acceleration / deceleration time too short? • Output current limiting function activated? • Load too heavy?	
Motor heating up	• Wrong setting for V/f mode? • Torque boost too high?	
Rotation speed changes abnormally during operation	• Is the load fluctuating? • Output current limiting function activated? Is setting of F1701 too low?	
No display on the interface of operation panel	• Voltages at input terminals R, S and T are normal? • Connection between inverter and operation panel satisfies the standard?	

10. Maintenance & Inspection

■ Never touch the internal parts.
Failure to obey may result in electrical shock, personal injury and other dangers

In order to enable the inverter to be used for a long time under normal conditions, it is necessary to carry out good maintenance and regular inspections on it

10-1 Precautions on Checking and Maintenance

- Capacitors retain a high voltage charge for a while after the power is turned off. Before carrying out inspection, please 1stly make sure that the CHARGE lamp is off, then make sure that the voltage across terminals P and X is lower than DC30V using a circuit tester.

10-2 Inspection Items

- The motor works as expected;
- The cooling system is free from any problems (such as abnormal heating);
- There is no abnormality at the location of installation; and
- There is no abnormal vibration or noise.

Table 10-1 Inspection must be carried out following the periodic inspection list.

Table 10-1 Periodic inspection list

Inspection item		Inspection details	Method & Instrument	Criteria
General	Ambient environment	• Ambient temperature, relative humidity • Confirm operating environment	• Visual inspection, measuring instrument • Thermometer & hygrometer	• Satisfy standard specifications
	Power supply voltage	• Power supply voltage of the inverter is normal.	• Measure interphase voltage of R, S and T input terminals. • Use tester and multimeter	• Satisfy standard specifications of input
	Appearance Structural parts	• No abnormal vibration or noise • No loosening of bolts • No deformation or breakage • No adhesion of dust or dirt	• Tighten bolts • Visual inspection	• No abnormal
Main Circuit	General	• Megger check • No loosening of bolts • No adhesion of dust or dirt	• Tighten bolts • Visual inspection	• No abnormal
	Connection conductors and wires	• No deformation or dirt • No discoloration because of overheating	• Visual inspection	• No abnormal
	Main module	• Check resistance between terminals	• Disconnect the main wiring of the inverter and measure each terminal with tester (x1 range) • Use analog tester	• Refer to Table 10-2 Main circuit power module checklist

Inspection item		Inspection details	Method & Instrument	Criteria
Main Circuit	Terminal board	• No burning or breakage	• Visual inspection	• No abnormal
	Main electrolytic capacitor	• No liquid leakage • No loosening of safety valve	• Visual inspection	• No leakage, deformation or crack • No action of the safety valve
	Relay electromagnetic contactor	• No chatter during operation • No rough surface on the contact • No abnormal noise when the switch is ON	• Visual and hearing inspection	• No abnormal
	Resistor	• No disconnection • No odor or crack because of overheating	• Odor and visual inspection • Remove one-end and check with tester • Use tester or multimeter	• No abnormal • Within ±10% of indicated resistance value
	Transformer	• No abnormal beat sound or odor	• Odor, visual and hearing inspection	• No abnormal
Control circuit display	Connector	• No loosening of connectors • No crack, breakage or deformation	• Visual inspection	• No abnormal
	Capacitor	• No leakage, breakage or deformation	• Visual inspection	• No abnormal
	Board	• No discoloration or dirt	• Visual inspection	• No abnormal
	Display	• No break in the LED lamp on operation panel • No abnormality in key operation • Favorable display of characters on LCD panel	• Visual inspection	• Make sure the lamp lights up. • Make sure operations.
Cooling system	Fan	• No abnormal vibration or noise • No OH alarm • No loosening of bolts, wiring or connectors	• Visual and hearing inspection • Tighten bolts, wiring and connectors.	• No abnormal

	Ventilation flue	• No blockage in cooling fan inlet and outlet or contamination adhesion of foreign objects.	• Visual inspection • Tactile inspection	• No abnormal
	Fin	• No abnormal heating	• Tactile inspection or check the temperature • Use thermometer	• No abnormal
Motor	General	• No abnormal vibration or noise	• Visual and hearing inspection	• No abnormal
	Insulation resistance	• Megger check	• Disconnect the inverter output wiring U, V and W, then make an inspection • Use megger tester	• Higher than 5MΩ

Table 10-2 Main circuit power module checklist

Input/Output	Terminals		Measured value
	Multimeter +	Multimeter -	
Input (R, S, T)	P	R、S 、T	conducted
	R 、S、 T	P	Not conducted
	X	R、 S 、T	Not conducted
	R 、S 、T	X	conducted
Output (U, V, W)	P	U、 V、 W	conducted
	U 、V 、W	P	Not conducted
	X	U、 V、 W	Not conducted
	U 、V 、W	X	conducted

10-3 Part Replacement

When replacing a part, please contact your supplier or our sales department.

10-3-2 Smoothing Capacitors

Aluminum electrolytic capacitors for smoothing deteriorate over time. It must be replaced approximate every five years. Since the service life varies greatly depending on the ambient temperature, load and using frequency, this time period is only an approximate limit rather than a guaranteed limit.

When used continuously in a high temperature (averagely 40℃ and above), the service life will be shortened.

The inverter must receive transmitted electricity at least once a year when it is stored and not energized.

The capacitors must be inspected at least once a year, and once in 6 months when they are near the end of their lifetime.

10-4 Megger Test

- When performing a megger test on the motor and the sequential circuit, be careful not to apply the test voltage to the inverter.
- For the inverter itself, perform the megger test only on the main circuit as shown below. Do not conduct a megger test on the control circuit.

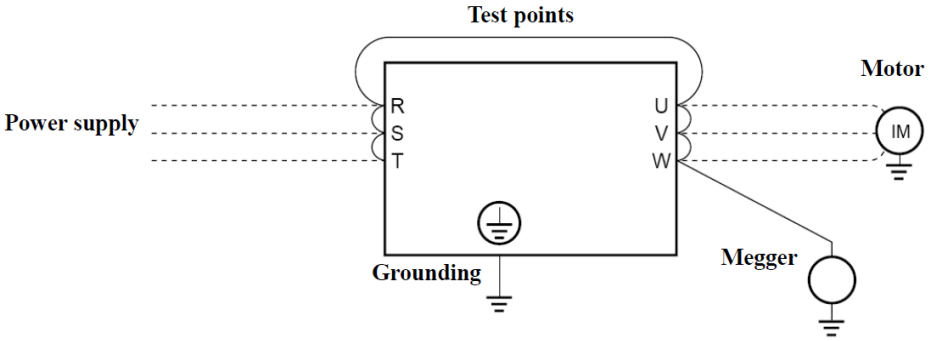


Figure 10-3 Circuit diagram for megger test

Use a multimeter (high resistance range) for continuity testing of the control circuit. Do not use the testing instruments such as megger or buzzer.

Note: Use a megger for measurement when the connector status is OFF (in 4-7 About EMC filter).

10-5 Electrical Measurement of Main Circuit

- Since the voltages and currents of the main inverter circuit at the input (power supply) and output (motor)contain harmonic components, measured values may differ depending on the meter used. When using a commercial frequency meter, select one of the types listed in the table below.
- The power factor cannot be measured with a commercial power-factor meter that measures the phase difference between voltage and current. Measure the voltage, current and power separately at input/output and calculate the power factor using the following formula:

$$\text{Power factor [\%]} = \frac{\text{Power [W]}}{\sqrt{3} \times \text{Voltage [V]} \times \text{Current [A]}} \times 100$$

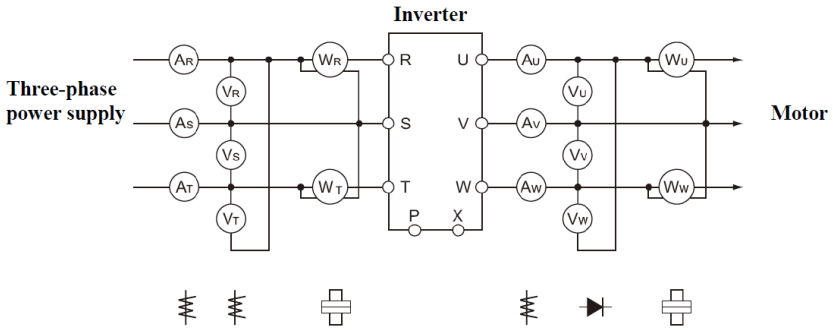


Figure 10-5 Power measurement circuit for main circuit

Table 10-5 Main circuit measuring instruments

Symbol	Item	Measuring instruments
	Power supply current	Moving-iron type AC ammeter
	Power supply voltage	Moving-iron type AC voltmeter
	Power supply power	Electrodynamic single-phase power meter or Digital power meter
	Power supply power factor	Digital power meter (can be calculated with the measured power supply voltage, current and power)
	Output voltage	Rectifier type AC voltmeter or digital power meter
	Output current	Moving-iron type AC ammeter or digital power meter
	Output power	Electrodynamic single-phase power meter or Digital power meter
	Output power factor	Digital power meter (can be calculated with the measured power supply voltage, current and power)

11. Specification

11-1 Standard Specification

Item			Specification						
Model（NS-4A□□□-XX）			61	76	92	115	152	173	211
Output specification	B Mode	Standard applicable motor [kW]	30	37	45	55	75	90	110
		Rated capacity [kVA] ※1	41	53	64	80	105	120	146
		Rated current [A] ※2	61	76	92	115	152	173	211
		Overload current rating ※3	120%-1min						
		Output frequency range ※4	0.05～240Hz（Starting frequency 0.05-60Hz variable）						
	A Mode	Standard applicable motor [kW]	22	30	37	45	55	75	90
		Rated capacity [kVA] ※1	34	41	53	64	80	105	120
		Rated current [A] ※2	46	61	76	92	115	152	173
		Overload current rating ※3	150%-1min						
		Output frequency range ※4	0.05～400Hz（Starting frequency 0.05-60Hz variable）						
	Rated output voltage ※5		3Φ 380V～460V						
Input power supply	voltage and freqeuncy		3Φ 380V～460V 、 50/60Hz						
	Allowable fluctuation		Voltage: -15%, +10% Frequency: ±5% Voltage unbalance: within 3%						
	Power supply impedance		1% and above (Use optional reactor if less than 1%)						
Protective structure			Totally enclosed (IP20)						
Cooling method			Forced air cooling						
Approximate weight ※6			12kg	15kg	25kg	35kg		45kg	
Carrier freqeuncy ※7			Sine wave PWM (carrier freqeuncy1k～8kHz）						
DC reactor			Option						

Item			Specification						
Model（NS-4A□□□-XX）			253	304	386	426	472	540	590
Output specification	B Mode	Standard applicable motor[kW]	132	160	200	220	250	280	315
		Rated capacity [kVA] ※1	180	211	267	295	327	374	409
		Rated current [A] ※2	253	304	386	426	472	540	590
		Overload current rating ※3	120%-1min						
		Output frequency range ※4	0.05～240Hz（Starting frequency 0.05-60Hz variable)						
	A Mode	Standard applicable motor [kW]	110	132	160	185	200	220	250
		Rated capacity [kVA] ※1	146	175	211	249	267	295	327
		Rated current [A] ※2	211	253	304	360	386	426	472
		Overload current rating ※3	150%-1min						
		Output frequency range ※4	0.05～400Hz（Starting frequency 0.05～60Hz variable）						
	Rated output voltage ※5		3Φ 380V～460V						
Input power supply	Voltage and freqeuncy		3Φ 380V～460V 、 50/60Hz						
	Allowable fluctuation		voltage ：-15%、+10% freqeuncy：±5% voltage unbalance: within 3%						
	Power supply impedance		1% and above (Use optional reactor if less than 1%)						
Protective structure			Totally enclosed (IP20)						
Cooling method			Forced air cooling						
Approximate weight ※6			65kg		100kg		125kg		
Carrier freqeuncy ※7			Sine wave PWM（carrierfreqeuncy1k～8kHz）						
DC reactor			Standard (external)						

※1 Rated capacity at the output voltage of 400V
※2 When input voltage is 400VAC and above, the rated current will be decreased according to the output power
※3 One minute is allowed every 10 minutes
※4 The output frequency range will be reduced during vector control, see "General Specifications of Inverters" for details
※5 Output voltage cannot exceed power supply voltage
※6 Approximate weight including packaging
※7 Carrier frequency varies with capacity and load conditions

11-2 Inverter General Specification

Control mode			Vector control／sensorless vector control／V/f control※4
Driving performance※1	Control range	Without PG sensor	0.25～240Hz（1：200/50Hzreference） ※2
	Response/Precision	Without PG sensor	Response characteristic：100rad/sec Precision：±0.5%
Control specification	Freqeuncy Setting resolution	Digital setting	0.01Hz
		Analog setting	0.05%（12bit 0～10V，4～20mA）、0.1%（11bit 0～5V）of the maximum output frequency
	Frequency precision	Digital setting	±0.01% of output frequency（at -10℃～40℃）
		Analog setting	±0.2% of the maximum output frequency（at 25±10℃） ※3
	DC braking		Starting frequency（0.05～20Hz）, operation time（0.1～10sec）, braking force（1～10 grade）
	Additional functions		Restart after momentary power failure, flying start, multi-speed operation, frequency jump, auto alarm recovery, PID control operation, simple scheduled operation, energy-saving operation and others
Operation specification	Start/stop setting		Operation panel, serial communication (RS485, Modbus), control circuit terminals
	Frequency command setting	Digital setting	Operation panel, serial communication (RS485, Modbus), step setting from terminal board
		Analog setting	2 channels, 0～5V, 0～10V,4～20mA, potentiometer（5kΩ 、0.3Wabove）
	Input signal		Frequency command, forward run command, reverse run command, acceleration/deceleration time setting, free run stop, alarm reset, emergency stop, [Digital input: 8 channels can be arbitrarily set and distributed], [Analog input: 1 channel for voltage, 1 channel for both current and voltage]
	Output signal	Contact output	Various alarm signals and multi-function contact output 2 channels (2C contact, AC250V, 0.3A)
		Monitor signal	Operating, frequency matching, overload alarm, undervoltge, frequency approach and etc.
		Digital output	Open collector output 3 channels can be set and distributed arbitrarily
		Analog output	Analog output: 2 channels [1 channel voltage 0～10V; 1 channel current 4～20mA]
LED Dsiplay			Frequency, output current, speed, Load rate, no unit: (output voltage, power and etc.), operating, alarm
Communication I/F			RS485、Modbus-RTU
External power supply output			DC24V、150mA（control terminal board）
Protection function			Current limiting, overcurrent shutoff, motor overload, external thermal alarm, undervoltage, overvoltage, momentary power failure, fin overheat, open phase
Warning function			Overvoltage prevention, current limiting during acceleration/deceleration, brake resistor overheats, overload, overheating of Heat sink fins
Environment	Ambient temperature		-10℃-+50℃ (no frost): heavy overload, -10℃-+40℃(no frost):light overload
	Storage temperature		-20℃-+65℃ (short-term storage during transportation)
	Relative humidity		95%RH or less (no condensation)
	Elevation		3000m or lower (Decrease the current when higher than 1000m)
	Vibration		5.9m/s2(0.6G）or less (JIS C 60068-2-6 standard; IEC60068-2-6)
	Gas medium		Indoor (no corrosive or inflammable gases, oil mist, or dust)

※1 Vary with the environment, condition, motor in use or sensor.

※2 When 2-pole motor is set, the maximum value of frequency setting range is 120Hz.

※3 The maximum output frequency is at 5V, 10V, and 20mA.

※4 Only for 400V series, 75kW below inverter

NS series inverters comply with below directives and standards：

Command	Command name	Standards compliant
Low voltage command	Low Voltage Directive 2006/95/EC	EN61800-5-1（2003）
EMC command	Electromagnetic Compatibility Directive 2004/108/EC	EN61800-3（2004）

Note: The EMC directive requires a filter to be configured, and when the installation conditions are met, it conforms to category C3.

11-3 Communication Function Specification

Electrical characteristics		RS485 communication	
Communication protocol		SANKEN protocol	Modbus-RTU communication protocol
Communication form		2-wire bus type (RS485 standard)	
Transmission distance		Total 500m, terminal resistor is required	
Number of units connected		Max. 32	Max. 247 ※Note
Connection cable		Shielded twisted-pair cable recommended	
Communication type		Half-duplex communication method	
Communication speed [bps]		57600/38400/19200/9600/4800/2400/1200 selectable	
Synchronization		Start-stop synchronization method	
Data format		ASCⅡ code or BINARY	BINARY
Data length		8bit	
Stop bit length		1bit or 2bit selectable	
Parity check		yes（odd, even） no (selectable)	
Error check		SUM check	CRC code check
Message end code	ASCⅡ	CR+LF/CR selectable	no
	BINARY	no	

※ Note: A relay is required when exceeding 32

11-4 Storage Environment

As follows

Item	Content	Remark
Storage temperature	-20℃～+65℃	Short term during transportation
Relative humidity	95% RH or below	
Gas medium	No corrosive, gases, oil mist, dripping, dust or direct sunlight	
Atmospheric pressure	86～106 kPa	

(1) Temporary storage

①Never place it directly on the ground.

②If equipment is stored in an environment which is worse than above mentioned, pack and seal the equipment with polyvinyl resin plastic film, add an internal desiccant to prevent humidity.

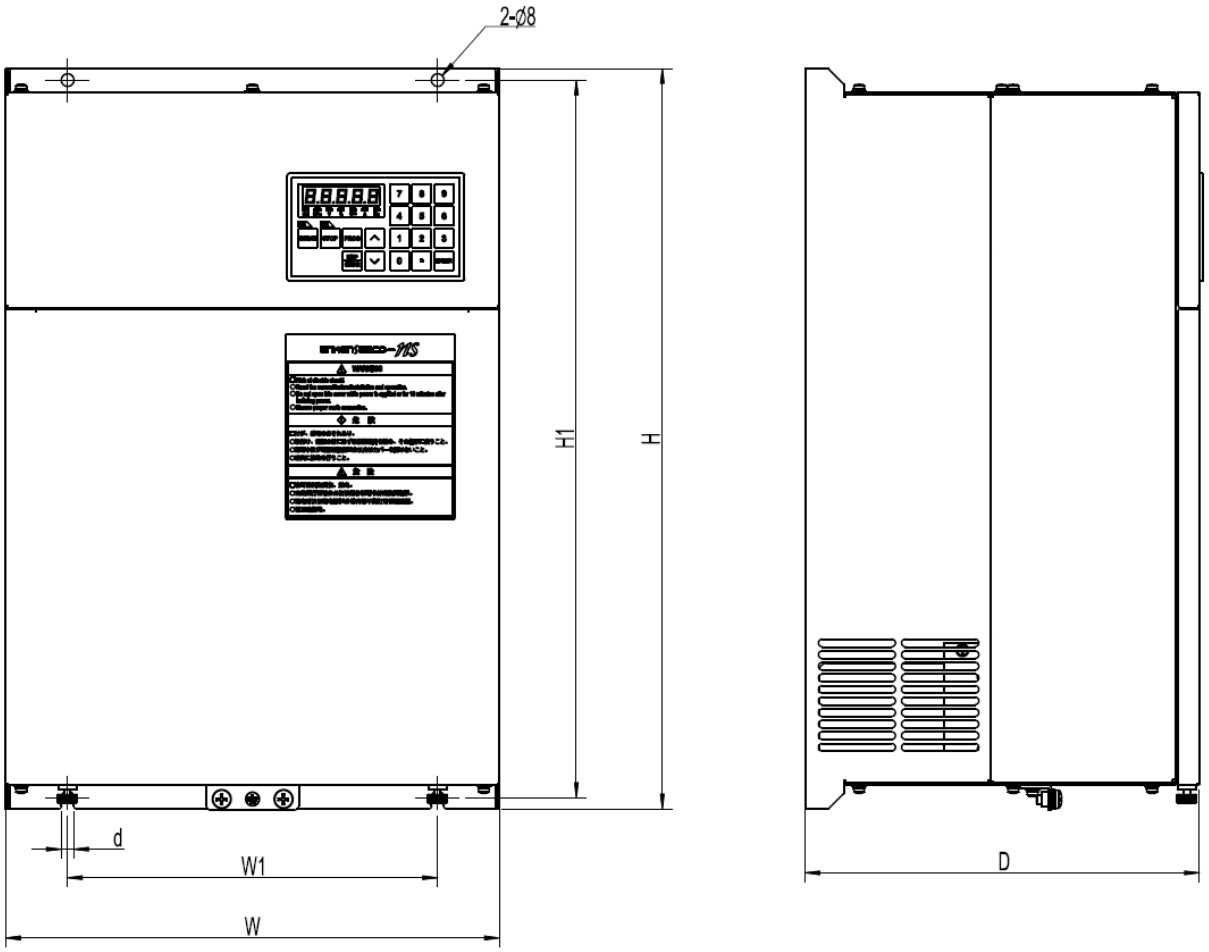
(2) Long-term storage

① When storage time exceeds 3 months, in order to prevent the deterioration of the electrolytic capacitors caused by temperature, please adjust the ambient temperature to-10℃～+35℃。

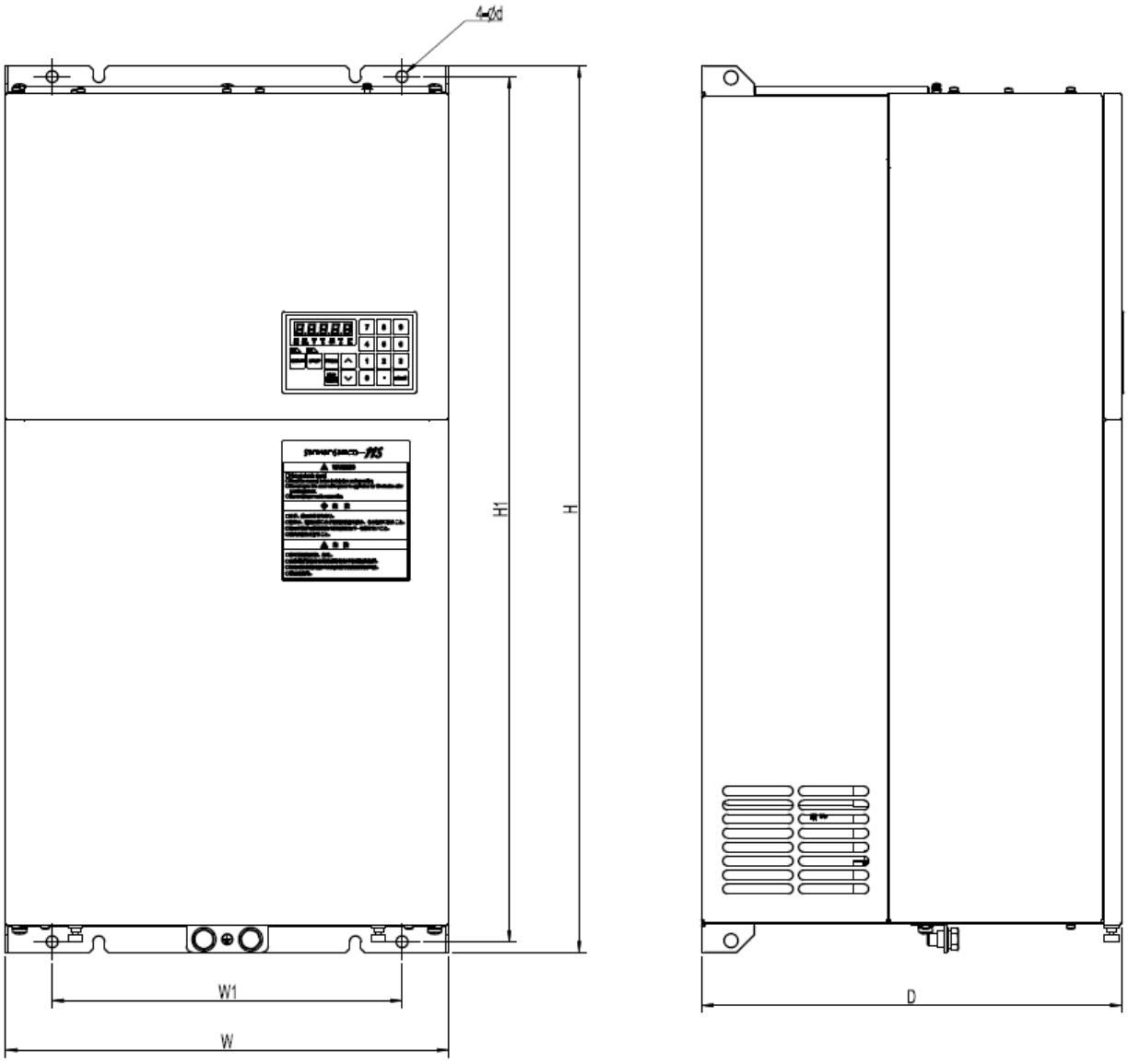
② Use desiccant, and keep the relative humidity in the package lower than 70%.

12. External Dimension

12-1 Master Dimension



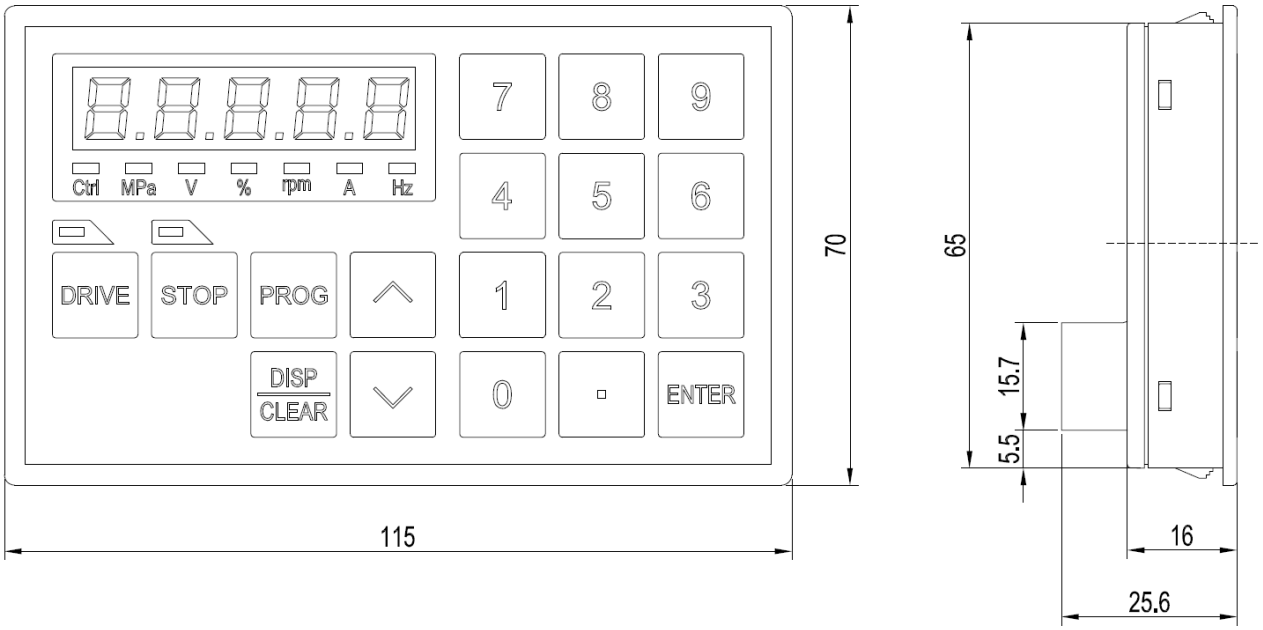
Specification	H	H1	W	W1	D	d
NS-4A061-B**	370	356	240	200	200	7
NS-4A076-B**	390	376	280	240	200	7
NS-4A092-B**	480	465	320	240	260	8
NS-4A115-B**	600	582	320	240	270	10
NS-4A152-B**						
NS-4A173-B**	680	660	340	260	330	10
NS-4A211-B**						

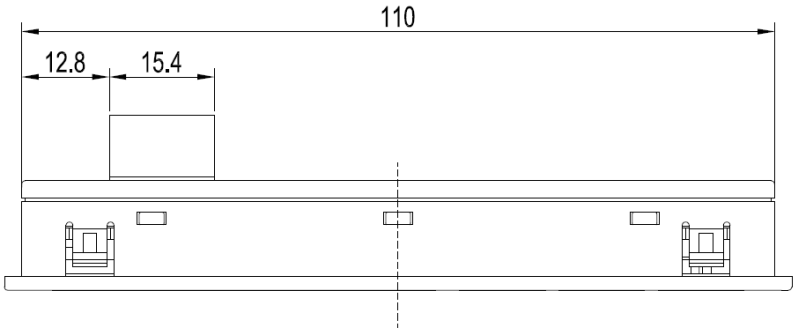


Specifiation	H	H1	W	W1	D	d
NS-4A253-B**	760	742	380	300	360	10
NS-4A304-B**						
NS-4A386-B**	940	915	460	400	360	12
NS-4A426-B**						
NS-4A472-B**	960	935	540	460	390	14
NS-4A540-B**						
NS-4A590-B**						

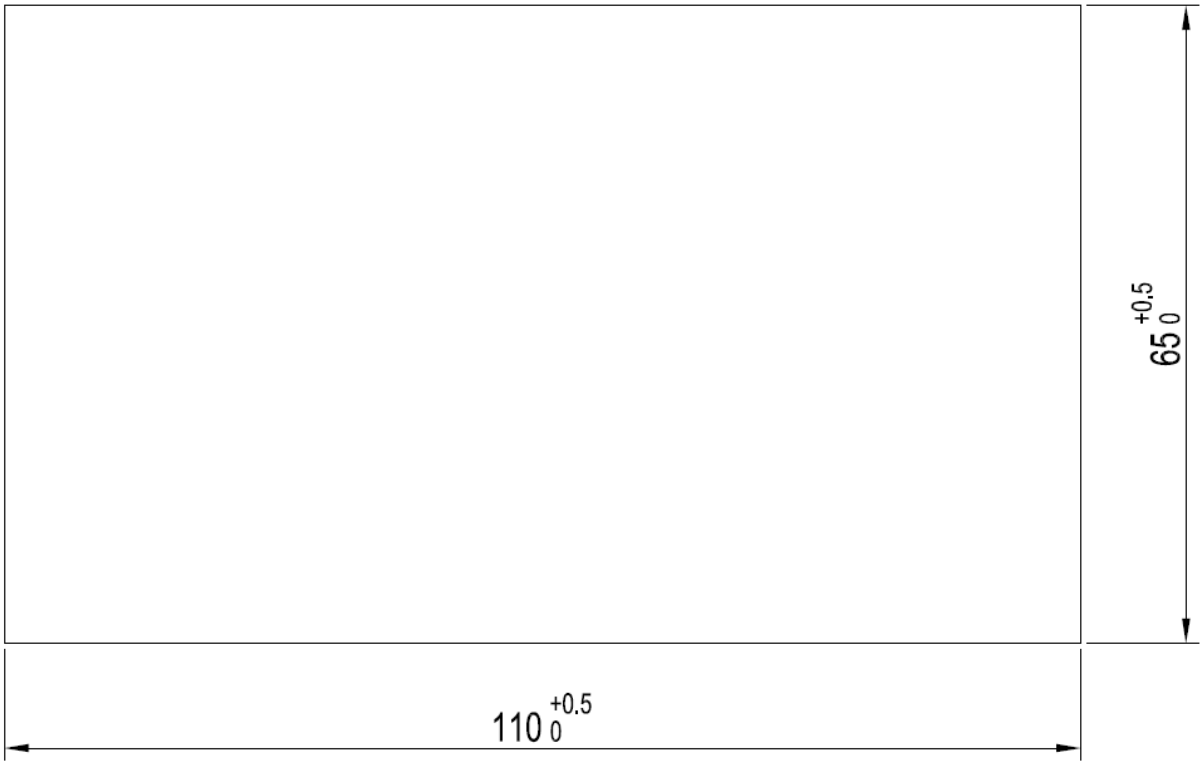
12-2 Operation Panel Dimension

（1） Operation panel





（2） External installation of operation panel: Dimensional diagram of opening hole


65 +0.5 0
110 +0.5 0

13. Peripheral equipments and Options

■ Please work on the equipment only when the safety precautions are confirmed.
Failure to observe may result in personal injury and fire.

The options of this series are as follows. Please set up peripheral equipment including Option according to the situation and usage

Table 13-1 Options of peripheral mechanical equipments

Name	Details of purposes
① AC reactor / DC reactor	Purposes include: • to improve the input power factor of the inverter • to reduce the influence of interphase unbalance for power supply voltage • to prevent the inverter trip caused by open/close action of phase-lead compensating capacitor in the system • Large power supply capacity (500kVA or above) ■ Model name • AC reactor S□-ACL-●●k • DC reactor S□-DCL-●●k □：400 class F, 200V class T
② zero-sequence reactor Transmission interference filter	Reduce the cable interference influence caused by wiring into the inverter power supply system. We recommend that these elements are installed near the inverter as possible. ■ Model name RC5078 RC5096 [SOSHIN ELECTRIC CO.,LTD. product]
③ Radio noise filter	Used to restrain the radiation of radio noise to the inverter power supply. ■ Model name 200V class: 3XYEB-105.104 400V class: 3XYHB-105.104 [OKAYA ELECTRIC INDUSTRIES CO.,LTD. product]
④ Noise filter *Note 1	Reduce the cable interference influence caused by wiring into the inverter power supply system. We recommend that these elements are installed near the inverter as possible. ■ EMC filter recommended (consult separately)
⑤ Braking resistance	P-PR terminal used to connect inverter; it will consume the regenerated energy by a resistor. ■ Please consult separately.

※1 Input power supply / transformer

When system power voltage and inverter rated input voltage are required to be suited, please set according to the requirements.
When several inverters are used simultaneously, it must be configured to reduce the influence of higher harmonic current to other loaded equipments.

※2 Molded case circuit breaker or earth leakage circuit breaker

Please connect it with the protection or overload protection circuit of power supply system.
When an earth leakage circuit breaker protection switch is required, please select corresponding higher harmonic products.

※3 Electromagnetic contactor

A surge absorber must be configured on the winding.
Please install a surge absorber to restrain the surge caused by open/close actions of electromagnetic contactor or controlling relay.

*** Note 1: When an internal EMC filter is used, please set the selector switch to ON.**

SANKEN L.D. ELECTRIC CO.,LTD.

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