SUMITOMO
MACHINERY CORPORATION OF AMERICA

SMAC-PAC®

Adjustable Frequency Motor Controller Operating and Maintenance Manual

208/230V Input: 1/2-60 HP, Models AF502-A40 through AF502-045

400/460V Input: 2-200 HP, Models AF504-1A5 through AF504-132

380V Input: 2-150 HP, Models AF503-1A5 through AF503-132

THE AVAILABLE SOLUTION

9

Manual 10.061.60.009

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INTRODUCTION

Sumitomo AF-500 adjustable frequency motor controllers (Inverters) are sinusoidal Pulse Width Modulated (PWM) voltage source inverters using a flux linkage algorithm. The benefits are smoother low speed operation and reduced motor noise when compared with conventional PWM controllers.

The microprocessor based AF-500 has been factory programmed with default parameters which are suitable for many applications. If changes to preprogrammed parameters are desired, these can be easily accomplished using the standard digital operator interface. Refer to the Programming section for programming instructions.

1. SAFETY AND PRECAUTIONS

Please be sure that you have read and understand this manual before attempting to install, wire and operate the AF-500 inverter. Failure to do so may result in personal injury or death, damage to the AF-500 inverter or damage to driven machinery.

DANGER! HAZARDOUS AND POTENTIALLY LETHAL VOLTAGES ARE PRESENT IN THIS CONTROLLER. VOLTAGES MAY REMAIN AT DANGEROUS LEVELS FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, DISCONNECT ALL SOURCES OF POWER AND WAIT UNTIL THE CHARGED LAMP GOES OUT

1.1 INSTALLATION PRECAUTIONS

1. Insure that the controller is installed in accordance with the instructions detailed in the Installation section of this manual.
2. Insure that the AC line voltage and AF-500 inverter nameplate voltage match.

1.2 OPERATION PRECAUTIONS

1. Always insure that the controller cover or enclosure door is securely closed before applying power or attempting to start the controller.
2. If the controller is set for automatic restart upon restoration of power (Function 43 is set to 1 or 2) or if the controller is receiving a remote run command, the driven machine will restart after normal power is reestablished. The factory setting for Function 43 is 0 (no automatic restart).

1.3 APPLICATION PRECAUTIONS

1. Motors operating from inverter power tend to run warmer than motors operating from utility supplied power. The reason is twofold. First, the output current of an inverter is not purely sinusoidal and this contributes to slightly higher losses in the motor. Second, the ability to operate at reduced speeds results in reduced speed of shaft mounted fans and reduced cooling air flow. For these reasons, the application should be evaluated for operating speed range and required torque. If operation over more than a two to one speed range with constant torque is required, an inverter rated motor may be required. If operation over a speed range of less than two to one with constant torque or if the application is variable torque, a standard motor with Class F insulation and a 1.15 service factor should be sufficient.

2. The standard overload protection circuit of the AF-500 inverter and standard overload relays are current sensitive devices. A motor may experience excessive temperature rise due to long periods of low speed operation without causing current sensitive overload protective devices to trip. The best possible motor protection is afforded by a thermal switch imbedded in the motor windings. AF-500 inverters include provisions for wiring a normally closed contact which opens at high temperature to cause inverter shutdown.
3. In the event that an unloaded motor is connected to the inverter or the load inertia (WK^2) is very small, the motor may appear to be unstable in the frequency range of 5 Hz to 25 Hz. This unstable condition will self-correct when the motor becomes loaded to at least 5% of rated output torque.
4. If the application requires rapid deceleration or if the load exhibits overhauling characteristics (tends to drive the motor at a higher speed than called for by the inverter output frequency) the inverter may trip on over voltage. If so, the following action may be required:

   0.5 - 10 HP @ 200/230 V — These units are supplied with a Dynamic Braking transistor and resistor as standard. An external resistor may be necessary depending upon load inertia and deceleration time.

   15 - 60 HP @ 200/230 V — These units require a separately mounted Dynamic Braking module and separately mounted resistors.

   2 - 20 HP @ 380/400/460 V — These units are supplied with a Dynamic Braking transistor as standard but resistors must be connected and mounted external to the AF-500 controller.

   30 - 200 HP @ 380/400/460 V — These units require a separately mounted Dynamic Braking module and separately mounted resistors.
5. AF-500 inverters are capable of producing a maximum output frequency of 400 Hz. This does not mean that a particular motor or application is suited for speeds this high. Before operating a motor in excess of its nameplate rated frequency, consult the motor manufacturer and the manufacturer of the driven equipment to insure that no damage or safety hazard will result.
6. If a mechanical speed reducer (gear box) is to be installed between the motor and load, consult with the speed reducer manufacturer to insure that it is capable of operating over the speed range without damage. Some oil lubricated reducers may not lubricate properly at low speeds and most reducers have an upper speed limit.
7. If a motor to be connected to a AF-500 inverter is equipped with an electrically operated holding brake, the brake coil must be fed from a separate power source. It cannot be connected in parallel with the motor leads. Since an inverter varies the output voltage in proportion to the output frequency, there will not be sufficient voltage to release the brake. Refer to drawing No. 10.5 for typical connection.

   Brake sequencing must be set up so that the brake is released prior to or simultaneously with the AF-500 inverter receiving a run signal. The brake must also remain released during the AF-500 inverter deceleration period unless the AF-500 has been set up for free-run stop operation by shorting control terminal MBS to COM either by means of an external contact or by a jumper. Failure to follow proper sequencing will result in nuisance tripping of the inverter.

   Note: a brake relay or contactor coil should be equipped with a transient suppressor.
8. The AF-500 inverter is a current rated device. Even though the nameplate lists a Horsepower rating, the full load current of the connected motor must not exceed the current rating of the inverter. In applications where more than one motor is connected to the inverter, the inverter must be selected to carry the sum of the full load current of all connected motors.
9. Power factor correction capacitors must not be used with a motor connected to an AF-500 inverter. In addition, installation of power factor correction capacitors into a power system in close proximity to solid state motor control equipment may cause, or worsen, existing harmonic problems. A power system harmonic analysis should be completed before applying any power factor correction capacitors.

2. INSPECTION AND STORAGE

INSPECTION - upon receiving the AF-500 inverter it should be inspected to verify that no shipping damage occurred and that the proper unit was received. The shipping container should be opened and the inverter cover removed. Look for signs of rough handling such as broken components, loose wires, etc. and report any suspected damage to the freight carrier immediately. If damage is suspected, the unit should be returned to Sumitomo for inspection and repair if necessary. Contact your local Sumitomo representative or the Sumitomo distributor from which the inverter was purchased to obtain the necessary return authorization.

STORAGE - If the inverter is not to be installed immediately, it should be returned to its original shipping container and stored in a location which is free from excessive humidity, dripping or splashing liquids, extreme cold or hot temperatures (acceptable range -20°C to +55°C), large temperature swings or excessive vibration.

3. INSTALLATION - MECHANICAL

The AF-500 inverter is designed to be wall or panel mounted unless supplied in another enclosure such as NEMA 12 The standard enclosure with all covers in place is rated as drip-proof (NEMA 1). The following guidelines should be observed when selecting a location and mounting the inverter:

1. To insure proper cooling air flow, mount the inverter vertically with at least four inches clearance on all sides of the inverter.
2. The inverter must be mounted in a location where the ambient temperature remains within the limits of the inverter. These are -10°C to +40°C (+50°C when covers are removed and the unit is mounted in another enclosure).
3. Proper ventilation should be insured to prevent heat build-up in the area where the inverter is installed.
4. The inverter should not be installed in high humidity areas subject to condensation.
5. The inverter should not be installed in dusty or dirty atmospheres where dust might interfere with cooling fans or restrict air flow over the power devices. Areas with electrically conductive dust must be avoided.
6. Select a site free from splashing or falling liquids and free from corrosive gases and direct sunlight.
7. Note that some units have dynamic braking resistors either furnished as part of the inverter or for separate mounting. These resistors can reach temperatures up to 150°C during heavy duty cycle operation. These resistors must not be installed where heat build-up will raise the ambient temperature above the inverter rated temperature or where the heat might damage surrounding equipment.

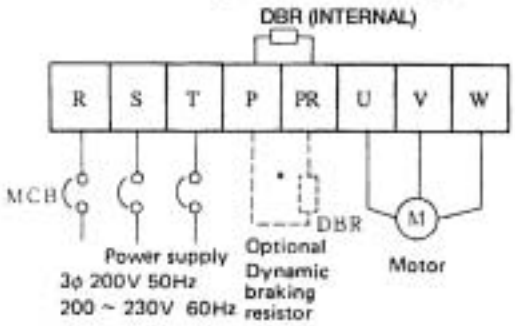
4. INSTALLATION - ELECTRICAL

DANGER! HAZARD OF ELECTRICAL SHOCK OR BURN. TURN OFF ALL POWER SUPPLIES BEFORE ATTEMPTING TO CONNECT THIS CONTROLLER INTO THE POWER SYSTEM.

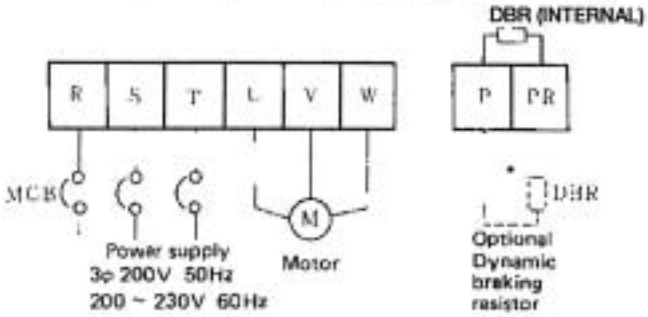
4.1 POWER WIRING - Refer to the appropriate Power Terminal Diagram.

Power Terminal Diagrams

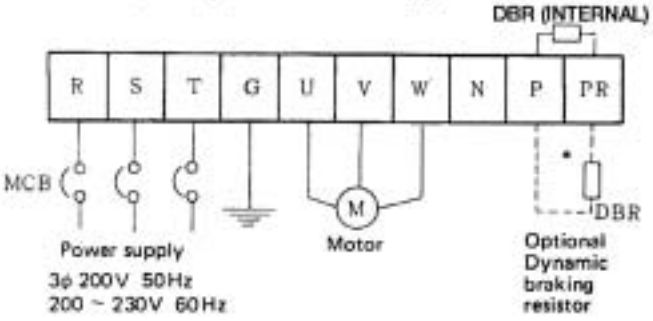
200 – 230 V
AF502-1A5 ~ 3A7 (1.5 kW – 3.7 kW) (2 HP – 5 HP)



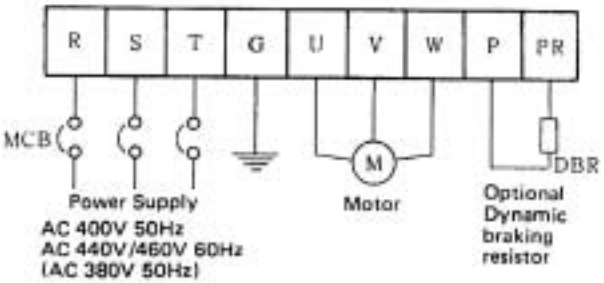
200 – 230 V
AF502-A40, A75 (0.4 kW – 0.75 kW) (0.5 HP - 1 HP)



200 – 230 V
AF502-5A5, 7A5 (5.5 kW – 7.5 kW) (7.5 HP – 10 HP)

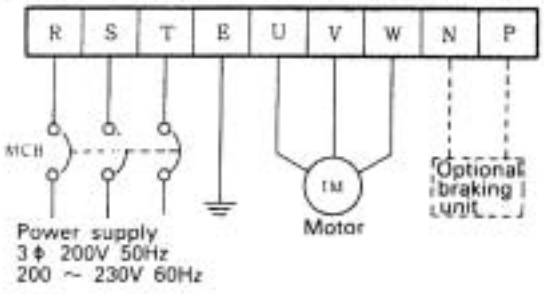


1.5 kW – 15 kW (2 - 20 HP)
380V AF503-1A5 to -015
400 – 460 V AF504-1A5 to -015

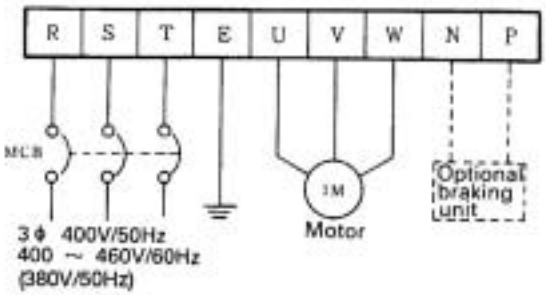


NOTE: *Terminals P and PR are for dynamic braking resistor (DBR). Built-in DB resistor is already connected. If start-stop operation is frequent or longer dynamic braking is required over heat of built-in resistor may result. Disconnect on board resistor and connect optional resistor externally. Contact Sumitomo for assistance.

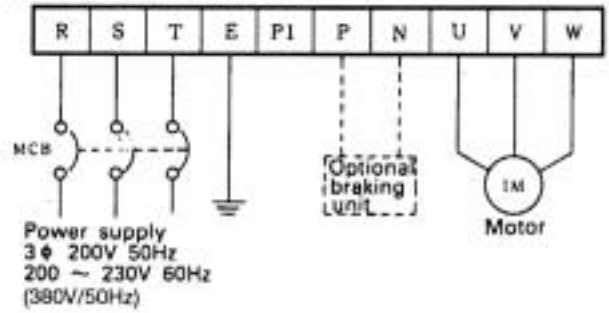
200 – 230 V
AF502-11 ~ 045 (11 kW – 45 kW) (15 HP – 60 HP)



22 kW – 110 kW (30 HP - 200 HP)
380V AF503-022 to -110
400 – 460 V AF504-022 to -110A



132 kW (200 HP)
380V AF503-132
400 – 460 V AF504-132



1. Insure that the AF-500 inverter is properly grounded in accordance with national and local electrical codes. A ground terminal is provided on the power terminal strip or on the chassis.
2. Supply input power of the proper voltage and frequency as listed on the controller nameplate. Feeder cables and branch circuit protective devices (circuit breakers or fuses) should be sized in accordance with national and local electrical codes based on the continuous current rating as listed on the controller nameplate. Suggested ampere ratings for main circuit breakers are shown in the following table.

Main circuit breaker selection

HP	0.5	1	2	3	5	7.5	10	15	20	30	40	50	60	75	100	125	150	200
AF502-200/230 V	A40	A75	1A5	2A2	3A7	5A5	7A5	011	015	022	030	037	045					
MCB RATING (AMPS)	5	10	15	20	30	40	50	75	75	125	150	200	225					
AF504-* 400/460 V			1A5	2A2	3A7	5A5	7A5	011	015	022	030	037 030A	045	055	075	090 075A	110 090A	110A 132
MCB RATING (AMPS)			10	10	15	20	30	40	50	75	75	100	125	150	200	225	250	350

* For AF503-, see equivalent AF504-.

Caution: Insure that incoming power leads are terminated on terminals R, S, T as shown on the wiring diagram. **Do Not** connect incoming power to terminals U, V, W. Doing so will **damage** the inverter and **void** the warranty.

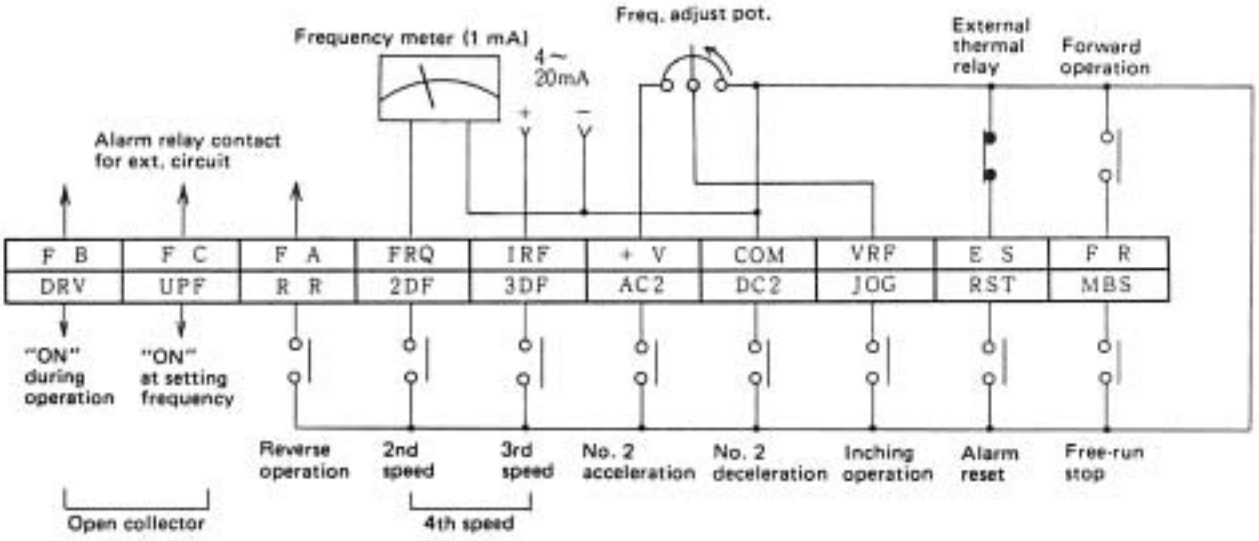
3. Connect motor feeder cables to terminals U, V, W. Cables should be sized in accordance with national and local electrical codes based on the continuous current rating listed on the AF-500 nameplate.

   Note: If a contactor or other disconnecting means is installed between the AF-500 inverter output and the motor, precautions must be taken to prevent closing the contactor or disconnect while the inverter is operating. Failure to do this may result in nuisance tripping of inverter protective circuits. If a bypass arrangement is to be used, care must be taken to avoid transferring a motor which was running across-the-line back to the inverter before the motor voltage decays. It is suggested that a minimum of one second delay be included in any transfer circuit. Failure to do this may result in damage to the inverter.
4. AF-500 inverters include over current protection suitable to protect a single motor from damage due to sustained overload. This protection may not meet the requirements of some local electrical codes. In this event, a separate overload relay or thermal switch in the motor windings will be required. Other installations requiring separate overload protection are those where a single AF-500 inverter will control more that one motor. In these cases individual overload protection must be provided for each motor and, in some cases, individual branch circuit protection must also be provided. Consult Article 430-53 of The National Electrical Code and local electrical codes to determine the required protection.

The overload protection standard with AF-500 inverters is factory programmed for 100% of the inverter rated current as shown on the nameplate. If the motor full load current is less than the inverter rated current, the overload protection must be reprogrammed. This protection level is programmable using function 07 over a range of 25% to 100% of the inverter rated current. Refer to the programming section for instructions on changing this level.

4.2 CONTROL WIRING - Refer to the Control Wiring Terminal diagram.

Control Circuit Terminal Diagram



1. All external control signals interfacing with AF-500 inverters must be connected using shielded cable. If a remote speed potentiometer is used, Belden #8771 or equal twisted, shielded, 3-conductor cable should be used. All other connections should be wired with Belden #8761 or equal twisted, shielded, 2-conductor cable. Note: If a number of remote devices are to be interfaced with an AF-500 inverter, multi-pair shielded cable may be used.

   Cable shields must be terminated only at the inverter end. A terminal (COM) is provided.

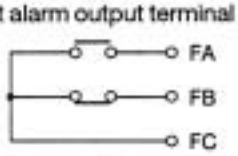
2. **Do Not** route control wiring and power wiring in the same cable tray or conduit. If control wiring is run in metallic conduit, it should be separated from power wiring run in metallic conduit by at least 18 inches. If either control wiring or power wiring are run in cable tray or non-metallic conduit, the spacing should be increased to at least 36 inches.

3. Transient suppressors must be installed on any relay, contactor, solenoid, solenoid valve or other coil of any device either controlled by an AF-500 inverter output, providing input to the AF-500 inverter or installed in close proximity to the AF-500 inverter. Failure to properly suppress coils may result in random nuisance tripping of the AF-500 inverter.

   The recommended suppressor for 115/230 VAC coils is a Marcon Electronics #DCR-10A25 or equal. A series connected 0.1 microfarad, 400 V capacitor and 500 ohm, 1/4 watt resistor connected across the coil terminals can be substituted.

   The recommended means for suppressing a DC operated coil is to place a fast recovery diode across the coil terminals with the cathode toward the positive (+) DC supply. The diode voltage should be at least 4 times the supply voltage.

4.3 TERMINAL IDENTIFICATION

POWER CIRCUIT	R, S, T	AC power terminal	AC power line
	U, V, W	Inverter output terminal	3-phase induction motor
	E or G	Ground terminal	Ground terminal of inverter chassis
	PR	Brake resistor connecting terminal	The resistor for the short-term rated brake is provided and connected when shipped from the factory. When connecting the optional long-term rated resistor, remove the wiring for the resistor mounted as standard and connect to this terminal. Change code No. 38 "0" to "1" for external resistor.
	P	DC Bus (+) output	
	PI	Precharge contactor output	Connection point for DC link reactor on AF503-132, AF504-132 only.
	N	DC link (–) output	Available only for 200/230 V, 11 – 45kW (7.5 – 60 HP) and 380/400/460 V, 22 – 132 kW (30 – 200 HP).
CONTROL CIRCUIT INPUT TERMINAL	+V	Power output terminal for frequency setting	DC 10 V for frequency adjustment potentiometer. (Should not be connected for any other purpose.)
	VRF	Signal input terminal for frequency setting by voltage	DC 0 to 10 V, with the maximum frequency at 10 V. The input impedance is 10 K , with a DC 5 V max., internally selectable.
	IRF	Frequency setting signal input terminal by 4 – 20 mA current signal	Maximum frequency at DC +4 – 20mA. Input impedance: 320
	COM	COM terminal	Common terminal for control signals.
	FR	Forward operation	F run when FR and COM connected.
	RR	Reverse operation	R run when RR and COM connected.
	2DF[1]	No. 2 frequency selector input terminal	Select the No. 2 frequency by connecting 2DF-COM.
	3DF[1]	No. 3 frequency selector input terminal	Select the No. 3 frequency by connecting 3DF-COM.
	AC2	No. 2 acceleration time mode selector input terminal	Select the No. 2 acceleration time mode by connecting AC2-COM.
	DC2	No. 2 deceleration time mode selector input terminal	Select the No. 2 deceleration time mode by connecting DC2-COM.
	JOG	Jogging operation selector input terminal	Select jog operation by connecting JOG-COM before connecting either FR or RR to COM.
	RST	Reset signal input terminal	External fault reset by connecting RST-COM for at least 0.1 sec. Must open RST-COM for operation.
	ES	External emergency stop input terminal	Keep ES-COM shorted unless the terminal is used for external emergency stop. Can be used to wire motor thermal switch or external OL relay.
	MBS	Free-run stop input terminal	Interrupts the inverter operation and brings the motor to a coasting stop.
CONTROL CIRCUIT OUTPUT TERMINAL	DRV	Inverter under operation indicator	Open collector output, +24 V 50mA max.
	UPF	Up to frequency indicator	Open collector output, +24 V 50mA max.
	FRQ	Frequency meter output terminal	DC 0 – 1 mA (full scale) 1 mA at maximum frequency.
	FC FB FA	Fault alarm output terminal 	Indicates that the inverter has detected a fault, and that operation has been interrupted by protection circuit. At normal operation: FA-FC open Fault: FA-FC close Contact rating: 250 V AC, 0.3A

[1] Select the No. 4 frequency by connecting both 2DF and 3DF to COM simultaneously.

5. START-UP INSTRUCTIONS

5.1 WITHOUT POWER APPLIED

1. Check for wiring errors. Verify that the input power feeders are connected to terminals R, S, T **not** U, V, W.
2. Verify that the connected power source is the same voltage as shown on the inverter nameplate.
3. Verify that the controller and associated motor(s) are properly grounded.
4. Verify that no metal filings, wire pieces or other electrically conductive debris remains in the AF-500 inverter enclosure as a result of the installation procedure.
5. Check to insure that all terminals are securely tightened and connectors are properly mated.
6. Insure that any external contacts wired between control terminals FR - COM or RR - COM are open.

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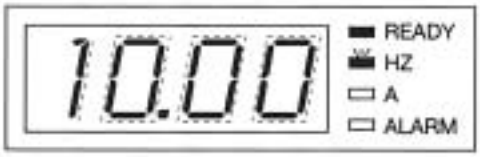
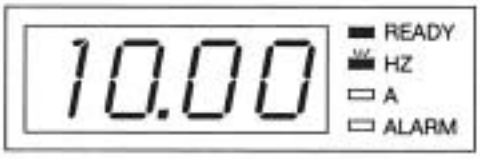
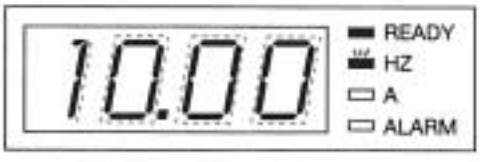
CAUTION: INSURE THAT ALL COVERS ARE SECURELY ATTACHED AND/OR ENCLOSURE DOORS ARE CLOSED BEFORE APPLYING POWER, STARTING OR STOPPING THIS CONTROLLER.

5.2 WITH POWER APPLIED

1. Close the disconnect switch or circuit breaker feeding the AF-500 controller.
2. Observe the digital operator interface panel on the front of the AF-500 (or enclosure if the optional extension cable is used). The "Ready" and "Stop" LEDs should be illuminated along with either the "Hz" or "A" LED. In addition, the digital display should be blinking showing the commanded operating frequency (10.00 Hz factory setting). Refer to Figure 5.1. If this pattern is not observed, refer to the troubleshooting section of this manual.

Figure 5.1

	OPERATION	MONITOR DISPLAY*	STATUS
1	Apply power (turn ON MCB).		Flashes 10.00 Hz
2	Operate with FWD or REV BE SURE OF RUNNING DIRECTION		Displays operation frequency
3	Stop with STOP		Displays the set frequency by flashing

* Dotted lines around digits indicate that the display is flashing.

3. Verify that a complete circuit exists between control terminals ES and COM. If the factory supplied jumper is removed, an external contact (usually an external overload relay or motor thermal switch) must be closed for the inverter to operate. If the digital display shows "OLE" this circuit is open. Once the circuit is closed, press Stop on the operator interface panel to reset the alarm.
4. The AF-500 inverter was factory programmed to operate a NEMA design B induction motor over a frequency range of 0.5 to 60 Hz. All control functions are programmed to be internal, i.e., from the digital operator panel. If operation is to be from external devices (remote start-stop, speed potentiometer, process follower signal, etc.) insure proper operation from the digital operator panel first.
5. Start the controller by pressing "FWD" on the digital operator panel. Refer to Figure 6.1 The motor should begin to rotate and accelerate to approximately 17% of rated speed. If the motor does not begin to rotate, press "STOP" on the digital operator panel, remove all power and verify that no mechanical problems exist with the motor or connected load. If no problems are found, refer to the troubleshooting section of this manual.

   If the motor begins to rotate but in the wrong direction, press "STOP" on the digital operator panel, remove all power and reverse any two motor leads at terminals U, V, W.

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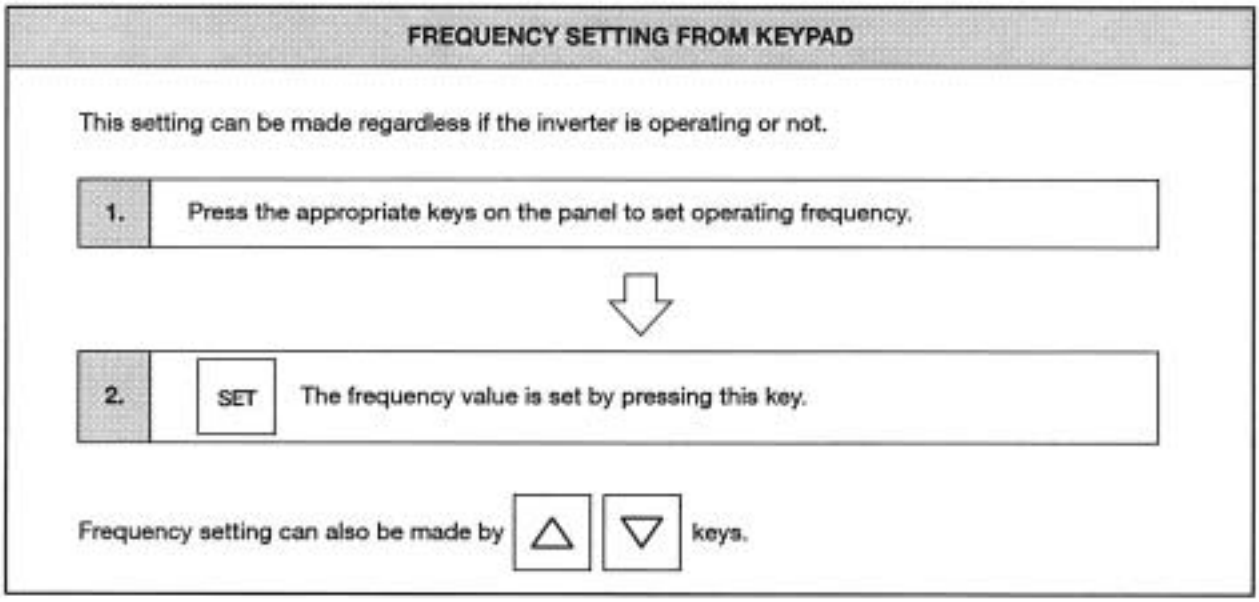
6. If the direction of rotation is correct or has been corrected and the controller restarted, set the output frequency for 60 Hz. This can be done in one of two ways. Use the Increase (up arrow) or Decrease (down arrow) keys to scroll the frequency up, or enter the desired frequency directly by pressing the numbers for the desired frequency and then pressing the "SET" key. Refer to Figure 5.2. For example, to set 60 Hz, simply press "6", "0" and press "SET". The controller will accelerate to 60 Hz at the preset ramp rate. Note: It is not necessary to enter the decimal point and trailing zeros if you are setting whole numbers.

Figure 5.2



7. As the motor and connected load are accelerating through its speed range, look for any signs of mechanical resonance problems such as excessive vibration or unusually high noise. Note: Motors will run more noisily when connected to an inverter power supply than when connected to the AC line. This is normal and is not a cause for concern. If any mechanical resonance is suspected, use the increase, decrease keys and try to isolate the frequency causing the problem. The AF-500 inverter can be programmed to skip up to five preset frequencies. Refer to the programming section of this manual for additional details.
8. Press "STOP" to stop the inverter. The motor will decelerate at the preset ramp rate. If the inverter trips during stopping, the deceleration time may be set too short for the connected load inertia. Refer to the programming section of this manual for details on how to set the deceleration rate. Note: If rapid deceleration and/or quick stop capability are required by the application, optional dynamic braking may be required. Consult your local Sumitomo Machinery Corporation of America representative or the distributor from which the AF-500 inverter was purchased.
9. If the machine driven by the AF-500 inverter is not designed to be safely operated in the reverse direction, reverse operation can be locked out by programming the appropriate function using the digital operator panel. Refer to the programming section of this manual for additional details. If reverse operation is desired, press "REV" on the digital operator panel to check reverse operation.
10. If external control devices are to be used to start, stop and/or control the frequency of the AF-500 inverter, refer to the programming section for details on setting the AF-500 for external operation. AF-500 inverters are factory set to accept 0 - 10 VDC or 4 - 20 mADC for speed control. If operation is to be from 0 - 5VDC or 0 - 7.5VDC it is necessary to reposition a jumper on the main control board. Refer to the diagram below to determine the jumper location and proper position.

J1 = 0 – 10V (Factory)
J2 = 0 – 7.5V
J3 = 0 – 5V

J1 – J3 Jumper

11. Once proper installation and operation of the AF-500 inverter has been confirmed, parameters can be changed to suit the application requirements. Refer to the programming section for detailed instructions.

6. PROGRAMMING

6.1 OPERATOR PANEL

Fig 6-1 — Operator Panel

OPERATOR PANEL FUNCTIONS

READY

Displays that the panel is ready to accept key input.

LEVEL METER

Displays percentage of the output frequency load.

7-SEGMENT MONITOR

Displays frequency, motor current, program parameters and fault codes.

OPERATION MONITOR DISPLAY

Displays forward/reverse/stop status.

OPERATION COMMAND KEYS

If external relay sequence is used and function code No. 4 is set to (1), these commands are ignored.

STOP KEY

- Stops Inverter operation.
- If external relay sequence is used, this function is ignored unless code No. 41 is set to (1).
- Clears the program under program writing
- Resets alarm indication and protection circuit.

FUNCTION SETTING KEYS

Keys used to set, change and confirm the functions.

- Changing the set values: Some of the functions can be changed even when the inverter is being operated.
- Checking the set values: This can be performed anytime.

MONITOR MODE DISPLAY

Indicates type of function

STEP KEYS

Keys used to calibrate the frequency meter and to change the frequency continuously.

Change the No. of the function code at READ mode

NUMERIC KEY PAD

6.2 FAULT CODES

If the inverter protective function activates, it stops the inverter and displays the cause on the monitor. The inverter continues to operate, while Err, bUOH, or OL is flashing.

To restart operation, reset the alarm by pressing STOP, turning OFF the power or by external reset signal (close RST-COM).

ERROR INDICATION	DESCRIPTION OF FAULT
Err	Inproper key sequence or parameter can't be changed during operation.
ErO	Missoperation of internal ROM or RAM
ErC	Missoperation of internal CPU.
OCPA	Overcurrent detected during acceleration (180% of the rated current is detected)
OCPd	Overcurrent detected during deceleration (180% of the rated current for the unit is detected)
OCPn	Overcurrent detected during normal operation (180% of the rated current for the unit is detected)
OCS	Output short circuit or ground detected.
OU	DC link overvoltage
LU	Insufficient voltage detected due to power failure, or instantaneous power loss.
OH	Overheating of the cooling fin detected
OLE	Terminal ES-COM is open
OL	Inverter overload detected (150% of the value for the electronic thermal setting detected for more than 1 minute)
bUOH	DBR overheat detected (flashes for 10 seconds)
Fb	Blown fuse (No fuse for AC200V 0.4 ~ 3.7 kW units)

Mode Indications

READY	Indicates that the respective operator panel is selected as the control device when the DOS-5 remote operator is used
Hz	Indicates that the display is showing operating frequency. The "Hz" indication will flash when the stall prevent function is operating during frequency display.
A	Indicates that the display is showing output current. The "A" indication will flash when the stall prevent function is operating during motor current display

Level meter Display

FREQUENCY RATIO MODE	Displays the output frequency in 10% steps with the maximum frequency set using the V/F pattern as 100%.
LOAD RATIO MODE	Displays the current ratio of load with the value for overload capacity 50% x 60 sec = 3000% sec. as 100%.

If you pressed PROG by mistake and a change of setting is not required, press SET to return to the original value.

If you press keys in the wrong sequence or select a function which cannot be changed during operation, Err is displayed for a few seconds. After the display returns to normal, start the procedure over.

6.3 FUNCTION PROGRAMMING

Programming any function is a simple five (5) step process:

1. Press PROG (Display shows Cd__)
2. Press function number 0 through 55 (Display CdXX where XX = function number)
3. Press READ (Display shows stored value)
4. Press numbered keys for desired value (Display shows keyed-in value)
5. Press SET (Display alternately blinks CdXX then set value, for five (5) seconds to verify correct input.

Figure 6.2 Operation Panel

NOTES ON PROGRAMMING:

1. To return to the normal operation mode while programming, press the "STOP" key if stopped, the "FWD" or "REV" key if running. These keys will return the display to the normal meter display, as selected, without affecting any preset program or the operation. Theses keys will function in this manner even when the Operation Command (Function No. 04) is from external devices.
2. Except as noted in Figure 6.5, some functions may be read or reprogrammed while running: all functions may be read or reprogrammed while stopped. Pressing the "FWD, "REV", or "STOP" keys, or having the external forward or reverse contacts opened or closed while programming will return the AF-500 from the program mode to the normal mode.
3. Program code numbers 00 through 09 may be input as two digits or a singΩle digit, for example, "09" or "9."
4. The standard adjustment will operate a standard 1200 RPM, 1800 RPM, or 3600 RPM induction motor of the same nameplate HP as the inverter. It is suitable for constant torque applications which do not require high performance response or high torque. In the standard set up, all starting, stopping, and speed commands are input directly to the AF-500 using the Operation Command digital keypad.

   Changing any set up parameter on the AF-500 is very easy, using the simple five step process described above.

PROGRAMMING EXAMPLE (Typical of All)

Change No. 1 acceleration time from the factory setting of 5 seconds (to reach 50 Hz) to 15 seconds.

Example 1 – Changing 1st Accel Time

OPERATION	MONITOR DISPLAY	REMARKS
[PROG] [8]	Cd 8	Displays Code No.
[READ]	5.0	Displays the present setting.
[1] [5]	15	Displays new setting (Max. 9999)
[SET]	Cd08 15.0	Alternates for 5 seconds.
[SET] If this key is pressed before a entering a new value, display returns to the original operating values immediately.	50.00	Returns to display before programming.

Note: At least one zero (0) must be input when entering a decimal value less than one.
Ex. If you put in 0.5, operate the key as [0] [·] [5]

- If a wrong number was accidentally put in, enter 0 until the number scrolls off the display, then enter in the correct number.

Example 2 – Correcting Improper Data Entry

OPERATION	MONITOR DISPLAY	REMARKS
[2] (Wrong number)	2	
[0] [0] (Input required number of 0s.)	200	
[1] ↓ [5]	2001 0015	Input the correct numerals.

- Displayed data is cleared by [STOP] key when inverter is stopped.
- If wrong function code No. is put in, press the correct number and ignore wrong number.

6.4 CONFIRMATION OF SETTINGS

1. STEP PROCEDURE

Example 3 - Check setting of 1st acceleration time (Cd08)

OPERATION	MONITOR DISPLAY	REMARKS
READ	Cd00	Displays Cd00
△ ▽ Up to code No. to check	Cd01 Cd08	
READ	15.0	Displays setting.
READ READ Pressing this key displays code No. and setting alternately.	Cd08 15.0	
△	5.0	Displays the data of code No. 09.
SET	50.00	Returns to the original display.

△ ▽ keys scroll up/down displaying either the Code Number or data depending upon the last press of the READ key.

2. DIRECT PROCEDURE

Settings can be checked by pressing PROG → (Code Number) → READ.

SET returns to the original display without changing any data.

Note: Confirmation of settings can be made regardless of whether the inverter is operating or stopped.

6.5 PROGRAM FUNCTION OVERVIEW

FUNCTION NUMBER	FUNCTION	SETTING RANGE	FACTORY SETTING	CUSTOMER SETTING	COMMENTS
00	Auxiliary Frequency Setting	0.5 to 400.0 Hz	10		Use when function #2 is set to display current or speed.
*01	Frequency Setting Method	0: From keypad 1: External signal 2: Binary signal 3: BCD signal	0		Does not change operation command, see function #4
02	Meter Display	0: Frequency (Hz) 1: Current Amps (A) 2: Speed 3: Actual motor speed	0		Use step key for speed change when metering frequency or speed. Speed, see function 44. Actual motor speed determined by feedback. See function #52.
03	Bar Graph Display	0: Frequency % 1: Overcurrent %	0		Current % display is only excess of preset motor overload protection, see function #7.
*04	Operation Command	0: From keypad 1: External devices	0		Does not change frequency setting method, see function #1.
*05	Volts per Hz Pattern	1 – 28	2		Select using volts per Hz graphs. Use #2 for 60 Hz maximum, #4 for 120 Hz maximum with constant HP above 60 Hz.
*06	Voltage Boost Pattern	0: Auto boost 1 – 25: manual boost	5		Select using boost graphs. Auto boost is in accel only. Settings 3-13 for constant torque applications.
07	Motor Electronic Thermal Overload Protection	25 – 100%	100		Current level at which the overload shut-down timer is activated.
08	#1 Acceleration	0.1 to 9999 seconds per 50 Hz change	5		Functional when operation command function #4 is from the keypad or from external devices.
09	#1 Deceleration	0.1 to 9999 seconds per 50 Hz change	5		Functional when operation command function #4 is from the keypad or from external devices.
10	#2 Acceleration	0.1 to 9999 seconds per 50 Hz change	10		Functional when operation command function #4 is from external devices.†
11	#2 Deceleration	0.1 to 9999 seconds per 50 Hz change	10		Functional when operation command function #4 is from external devices.†
12	#2 Preset Frequency	0.50 to 400.0 Hz	20		Functional when operation command function #4 is from external devices.†
13	#3 Preset Frequency	0.50 to 400.0 Hz	30		
14	#4 Preset Frequency	0.50 to 400.0 Hz	40		
15	Jogging Frequency	0.50 to 400.0 Hz	5		Functional when operation command function #4 is from external devices.†
16	Starting Frequency	0.50 to 50.0 Hz	0.5		Frequency output begins at selected value. No operation until speed command is at or above selected value.
17	Maximum Frequency Limit	0.50 to 400.0 Hz	60		Volts per Hz pattern (function #5) will also limit the maximum frequency. Frequency output beyond 120 Hz requires reset of function #27.
18	Minimum Frequency Limit	0 to 400.0 Hz	0		Frequency output begins at selected value. Output remains at selected value until the speed command is above the selected value.
19	Frequency Bias	0 to 400.0 Hz	0		For adjustment of external signal at the minimum signal level (4mA or 0VDC).
20	#1 Frequency Avoidance	0 to 400.0 Hz	0		Prevents operation from 0.50 Hz below the set frequency to 0.50 Hz above the set frequency.
21	#2 Frequency Avoidance	0 to 400.0 Hz	0		
22	#3 Frequency Avoidance	0 to 400.0 Hz	0		
23	#4 Frequency Avoidance	0 to 400.0 Hz	0		
24	#5 Frequency Avoidance	0 to 400.0 Hz	0		
25	DC Injection Braking Voltage Setting	0: No injection braking 1 – 7: Braking rate	0		
26	DC Injection Braking Braking Time	1 – 60 seconds	1		Braking time begins when frequency reduces to starting frequency function #16.

* May only be set when not in the run mode.
† Externally activated ACCEL, DECEL, preset speed, jog function require maintained device.

FUNCTION NUMBER	FUNCTION	SETTING RANGE	FACTORY SETTING	CUSTOMER SETTING	COMMENTS
*27	Maximum Frequency Limit	0: No limit 1: Limit 120 Hz	1		
28	Current Limit A: Acceleration – Functional at 150% current B: Running – Functional at 100% current	0: No limits 1: Slow response 2: Moderate response 3: Quick response	0		Functional in both accel. phase and run phases. Response rates are a factor of accel. and decel. rates and C.L. setting.
29	Stall Prevention (Selector of current limit application)	0: During accel. only 1: During run only 2: Both accel. and run	0		Selects when current limit is applied to prevent stall. See function #28.
30	Coasting Motor Restart	0: Normal mode 1: Restart mode	0		When set for setting 1, inverter will begin operation at frequency equivalent to coasting speed of AC motor.
31	Calibrate External Frequency Meter	0: Normal mode 1: Calibrate	0		To calibrate, increase/decrease keys will increase or decrease the signal to an external frequency meter (0 – 1 mA).
32	Motor Restart After Trip	0: No restart 1: Auto restart	0		Auto restart will reset and restart after trip. If 3 trips in 20 seconds will not restart.
33	Alarm Signal on Power Outage	0: No signal 1: With signal	0		
*34	Acceleration/Deceleration	0: Linear	0		
*35	Remote Digital Keypad Continuous Operation	0: Remote keypad 1: Faceplate keypad	1		Activates DOS-5 option
*36	Reset to Factory Settings	0: No reset 1: Reset	0		When reset is selected, all adjustments return to the original factory settings.
37	Motor Overload Selection	0: Standard motor 1: Inverter motor	1		Setting #0 does not allow full current at reduced frequency. Setting #1 allows full current at all frequencies.
38	Dynamic Braking Selection	0: Standard 1: External resistor	0 1		Factory setting for 230 V is #0, 460 V is #1.
*39	Motor Rotation	0: Forward or reverse 1: Forward only 2: Reverse only	0		
40	Keypad Lockout	0: Standard 1: Locked	0		Locked setting prevents the changing of internal adjustments.
41	Keypad Stop	0: No keypad stop 1: Keypad stop available	1		Provides keypad stop when function #4 is set for external operation.
42	Frequency Gain	20 – 200%	100		For adjustment of external signal at the maximum signal level (20mA or 10VDC).
43	Motor Restart After Power Outage	0: No auto restart 1: Coasting restart 2: Zero Hz restart	0		Set at "0" to prevent auto restart after power outage. Note: Must use relay when operating with external devices.
44	Speed Display	0.01 – 500	1		Provides output display as multiple of set frequency.
45	Bias Polarity	0: Positive Bias 1: Negative Bias	0		Function #01 set external. For setting polarity only, refer to function #19.
46 47 48 49	Fourth Fault Occurrence Third Fault Occurrence Second Fault Occurrence First Fault Occurrence	Cause of Fault OCPA OCS OH OCPd OU OLE OCPn OL *LU bUOH Fb	none		Fault data memory is maintained with power off. Reset only by function #50. See fault annunciation in catalog for fault description. *LU function only during inverter operation.
50	Clear Fault Data	1: Clear Data	—		Will not clear automatically.
51	Alarm Signal on Fault Trip	0: No signal 1: With signal	0		Signal is reset by auto restart.
*52	Speed, Setting Method Feedback Signal	0: No feedback 1: From keypad 2: External signal	0		Use to select speed setting method when operating with optional OPG feedback card.
53	Speed Setting	0 – 3600 RPM	0		Use to set speed in RPM from keypad when function #52 is set to keypad.
54	Feedback Gain	0 – 9999	100		Sets proportional gain.
55	Offset Constant	0 – 9999	250		Sets integral gain.

* May only be set when not in the run mode.

6.6 PROGRAM FUNCTION DETAILS

Cd00 SET FREQUENCY

- The function to set operating frequency. Especially, when the monitor displays current (Cd02 = 1).
- Settable range of frequency is 0.5 - 400Hz.
  Note: Not functional when Cd01 = 1 (external)

Cd01 SELECT SETTING PROCEDURE OF FREQUENCY

- This is the function to select operation panel or external analog signal to set the output frequency of inverter.
  Cd01 = 0: Set frequency on operation panel.
  Cd01 = 1: Set frequency by external analog signal (4-20mA, 0-10V, etc.)
  Cd01 = 2: Set frequency by binary signal (Requires ODI card)
  Cd01 = 3: Set frequency by BCD signal (Requires ODI card)

Cd02 SELECT MONITOR DISPLAY DATA

- The function to select the monitor display data
  Cd02 = 0: Display the frequency (Hz).
  Cd02 = 1: Display the current (A).
  Cd02 = 2: Display process units (RPM, FPM, etc.). See Function 44.
  Cd02 = 3: Display actual motor speed (Requires OPG card). See Function 52.

Cd03 SELECT DISPLAY DATA OF LEVEL METER

- The function to select the display data of level meter.
  Cd03 = 0: Display the ratio (%) of output frequency to maximum frequency of the selected V/F pattern.
  Cd03 = 1: Display the overload factor (%). (It displays the rate of present overload 50% x 60 sec. = 3000% . sec. as 100%.)

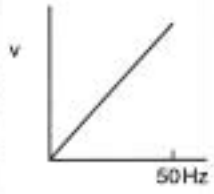
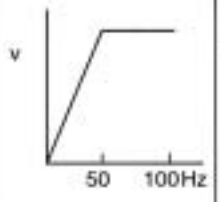
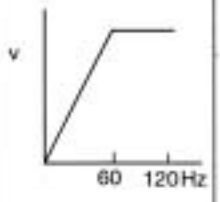
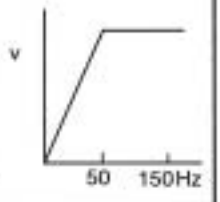
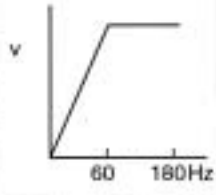
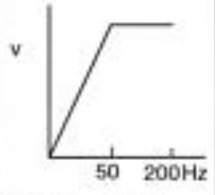
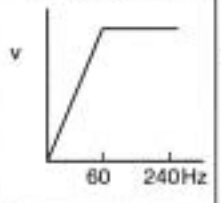
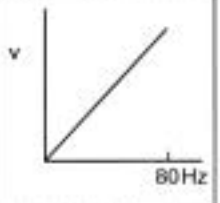
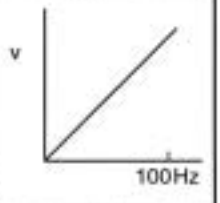
Cd04 SELECT OPERATION COMMAND

- The function to select operation panel or external signal to perform the inverter run-stop operation.
  Cd04 = 0: Operation on operation panel
  Cd04 = 1: Operation by external signal

  Note: This parameter cannot be programmed if an external contact shorts FR-COM or RR-COM. These contacts must be open to change parameter.

CdO5 SELECT V/F PATTERN

- Select any one from the following 28 patterns.

No.	1	2	3	4	5
V/F Pattern					
No.	**6**	**7**	**8**	**9**	**10**
V/F Pattern					
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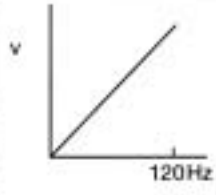
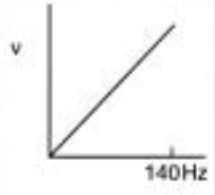
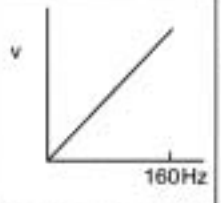
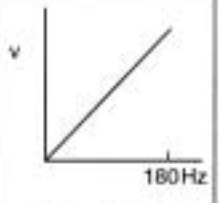
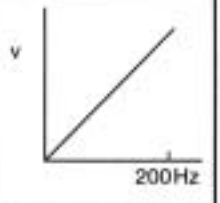
V/F Pattern					
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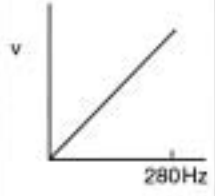
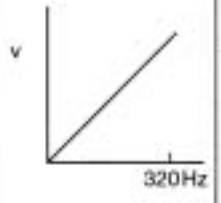
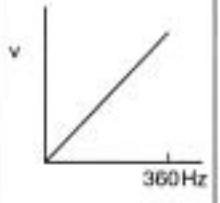
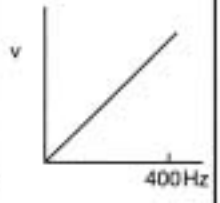
V/F Pattern					
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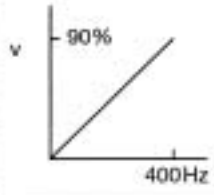
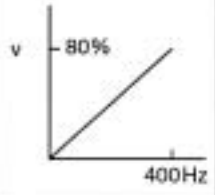
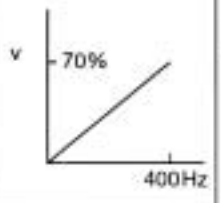
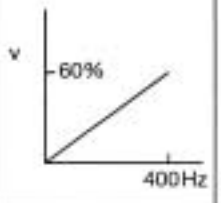
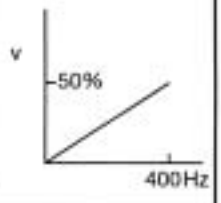
V/F Pattern					
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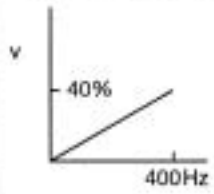
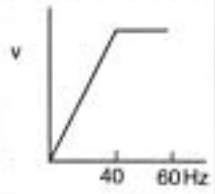
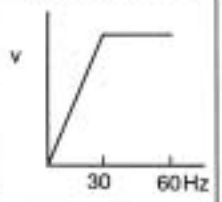
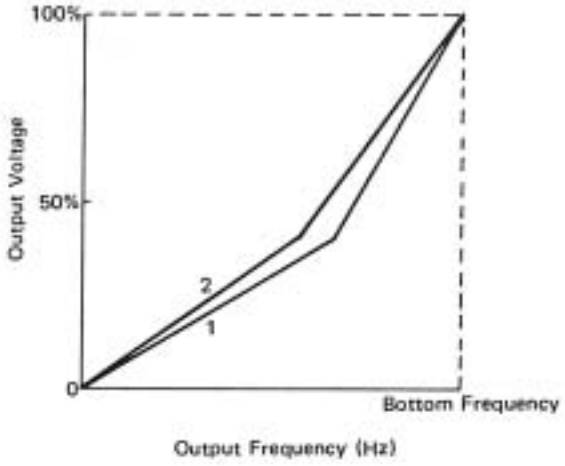
V/F Pattern					

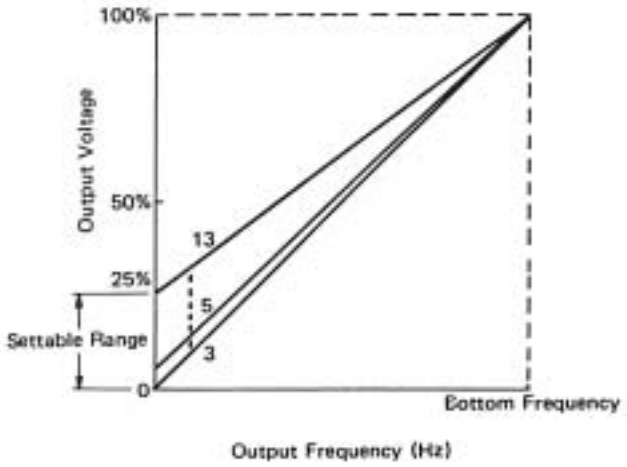
CdOb SELECT TORQUE BOOST

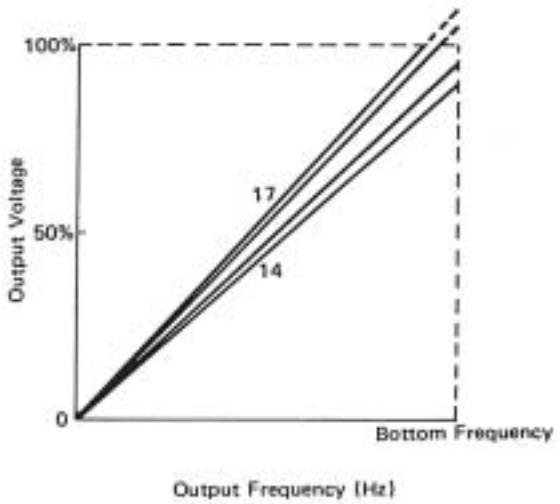
- Select any one from 0 ~ 25 patterns

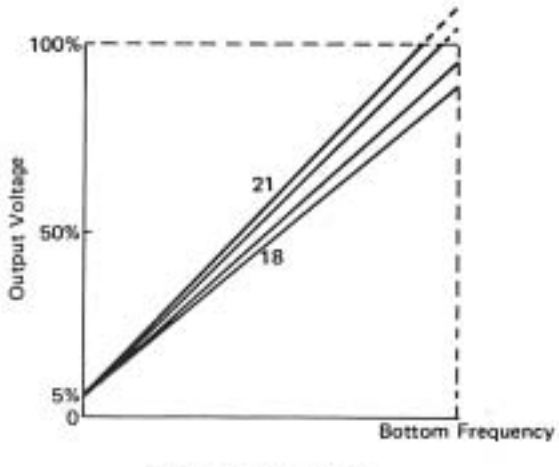
DATA NO.	DESCRIPTION
0	Auto boost
1,2	For variable torque load
3 – 13	Voltage boost at lower frequency
14 ~ 25	For voltage change to compensate for long motor feeder cables.

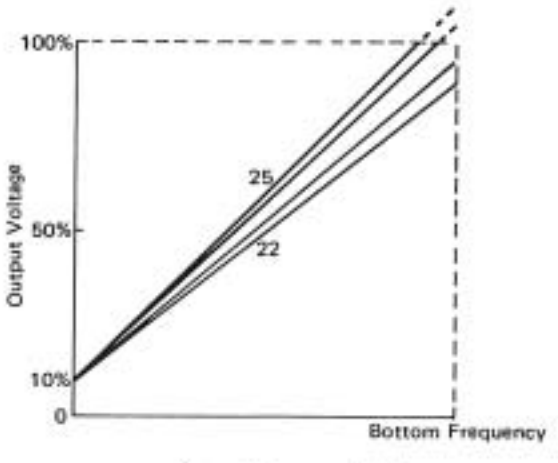
Note: Auto boost raises the voltage automatically during acceleration and increases the starting torque. This operation functions only at the time of acceleration.





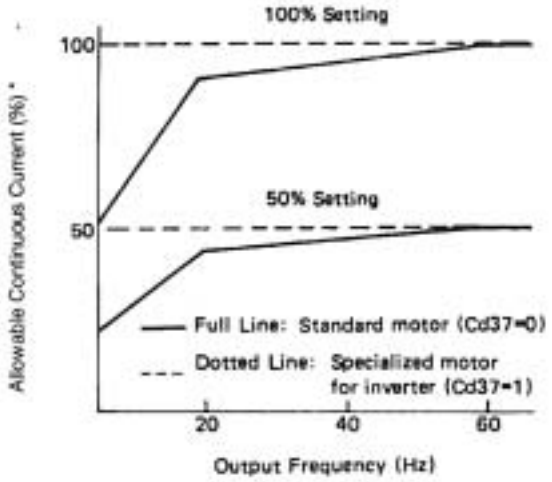


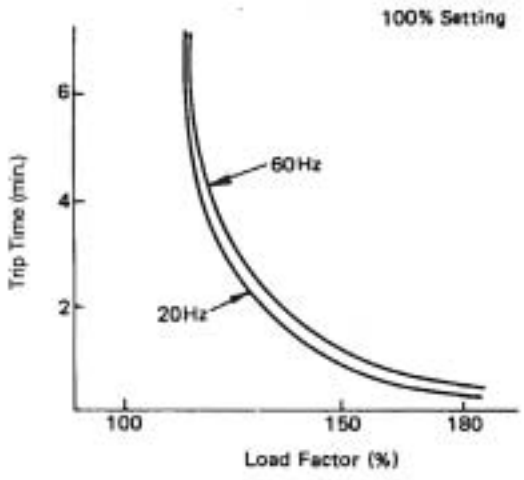




Cd07 ELECTRONIC OVERLOAD RELAY

- If the overload relay trips, the inverter stops operation to protect the motor from heating.
- It can be set in the range 25-100% of inverter rated current.
- If the electronic overload relay is not required, set Cd07 = 0.





*The allowable continuous current of a non-inverter duty motor is reduced at reduced output frequency.

Note: 1. If more than one motor is connected to the inverter, each motor must have overload protection. Motor thermal switches or external overload relays are suitable. Normally closed contacts can be wired between terminals ES-COM to stop the inverter

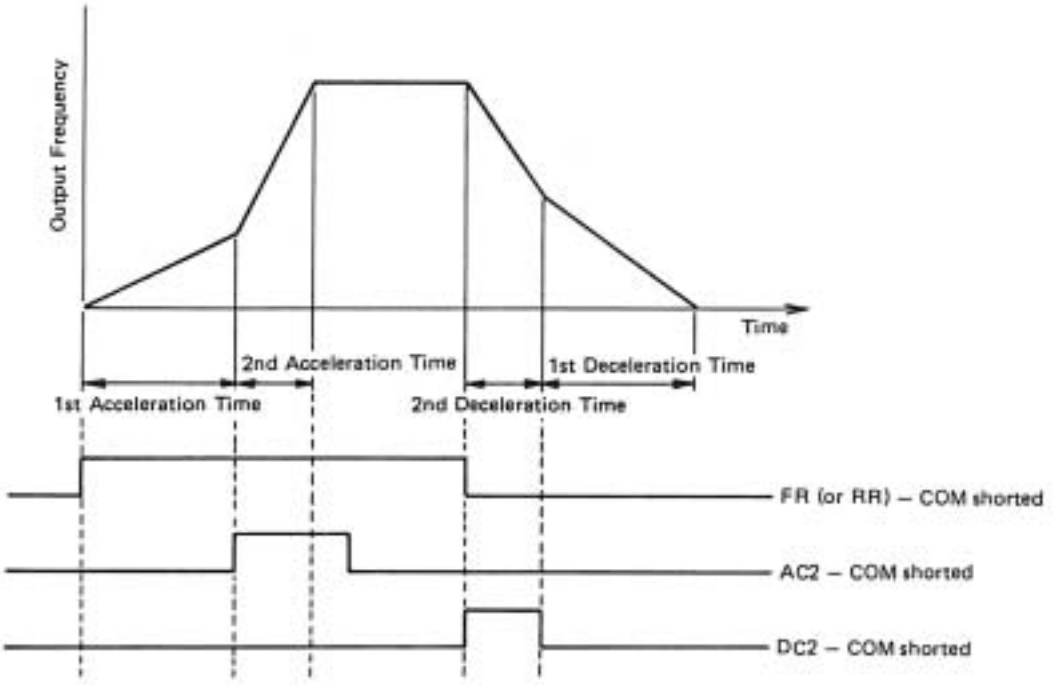
2. Note that electronic overload relay is not accurate under 5 Hz.
3. The factory setting is 100%

PROG ⇨ NO. ⇨ READ ⇨ DATA ⇨ SET

Cd08	SET 1ST ACCELERATION TIME
Cd09	SET 1ST DECELERATION TIME
Cd10	SET 2ND ACCELERATION TIME
Cd11	SET 2ND DECELERATION TIME

* 2nd acceleration time and 2nd deceleration time are available only when operation command selects the external signal mode (Cd04 = 1). They are activated by external contacts wired between terminals AC2-COM and DC2-COM.

- Acceleration time and deceleration time are the times required for 50Hz change of frequency and the settable range is 0.1 -9999 sec.
- Each of the 2 modes are individually settable for acceleration and deceleration time.



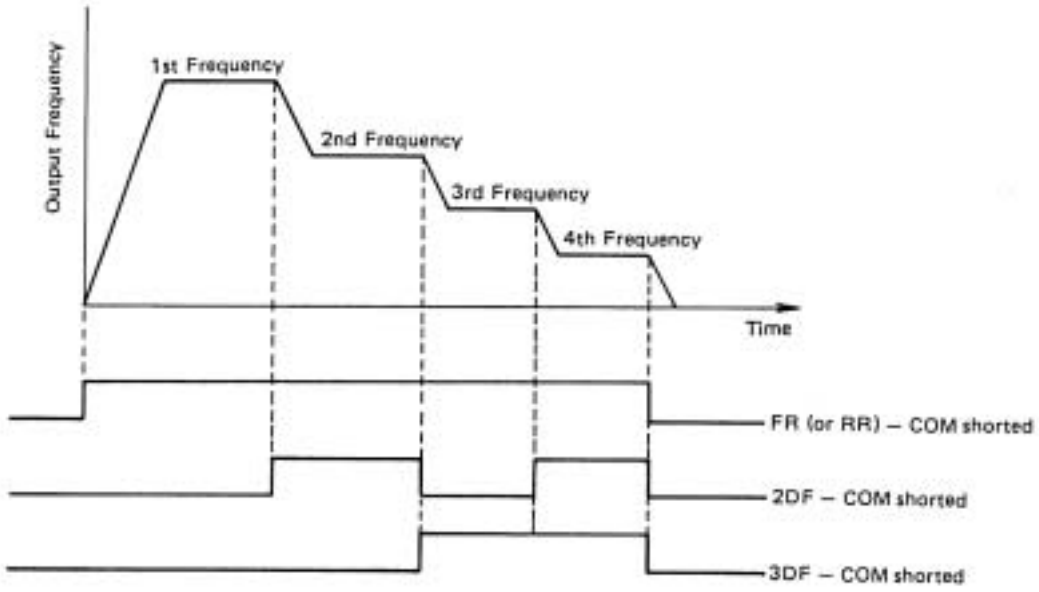
Cd12 SET 2ND FREQUENCY

Cd13 SET 3RD FREQUENCY

Cd14 SET 4TH FREQUENCY

* 2nd – 4th frequency operation is available only when the setting procedure of frequency selects operation panel (Cd01 = 1). and the operation command selects external operation signal mode (Cd04 = 1).

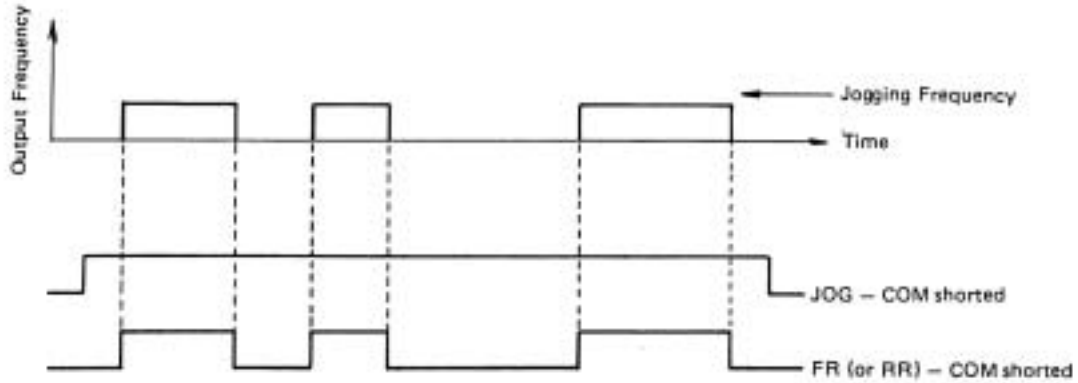
- Operation at 4th speed is obtained by shorting both 2DF-COM and 3DF-COM.
- The frequency is settable in the range 0.5 – 400Hz. however, Cd05, 17, and 27 take priority.



Cd15 SET JOGGING FREQUENCY

* Jogging operation is available only when operation command selects the external operation signal mode (Cd04 = 1).

- Short JOG to COM terminals, then, short FR -COM (or RR - COM) or short JOG-COM simultaneously with FR-COM or RR-com.



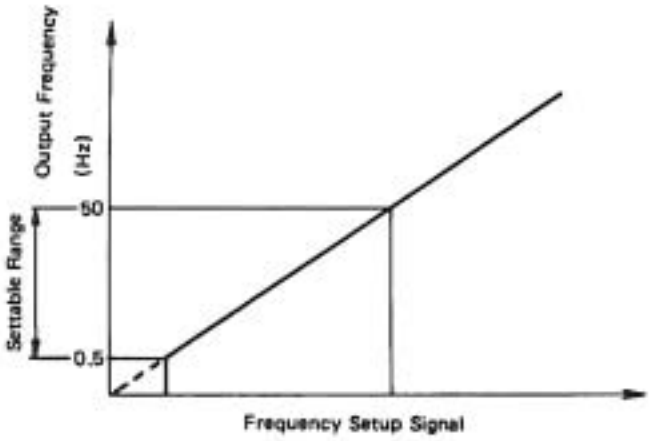
Note 1. JOG-COM must be shorted prior to or simultaneously with FR-COM or RR-COM. If JOG-COM is shorted after FR-COM or RR-COM, the jog command will be ignored.

2. Acceleration/deceleration times are fixed at 0.1 sec./50 Hz.

PROG ⇨ NO. ⇨ READ ⇨ DATA ⇨ SET

Cd16 SET START FREQUENCY

- Start frequency is the point at which the inverter will begin operating. It can be set in increments of 0.01 Hz between 0.5 -50 Hz.

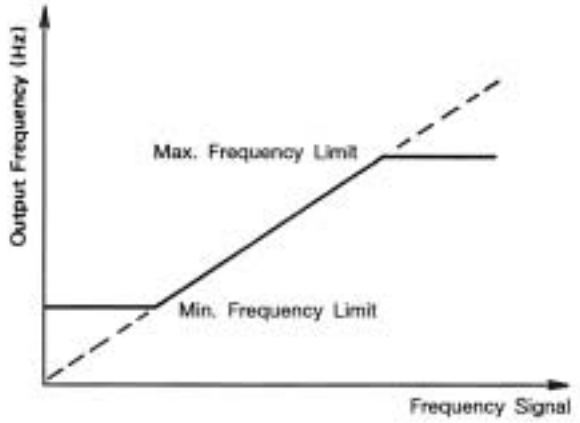


Note 1. The inverter will not start if the start frequency is set higher than operating frequency.
2. Once started, the inverter will continue to operate even if the commanded frequency is lower than the start frequency.

Cd17 SET MAXIMUM FREQUENCY LIMIT

Cd18 SET MINIMUM FREQUENCY LIMIT

- These limits take priority over inputs from the panel keys or external signal.



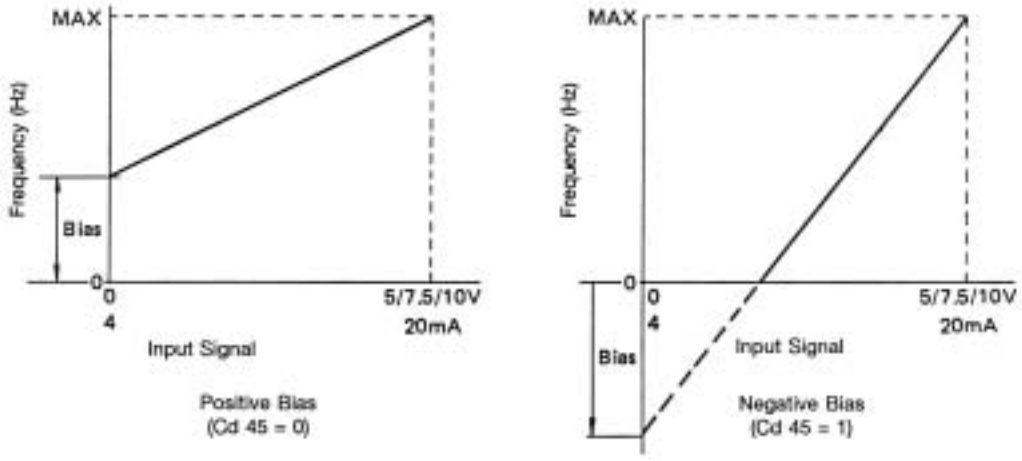
Note: Be sure to set the max. limit higher than min. limit and max. limit higher than starting frequency.

Cd19 FREQUENCY BIAS

The Frequency Bias parameter is used to shift the point at which the inverter begins producing output when the frequency setting signal is set for external (Cd01=1). Frequency bias can be set positive or negative using function 45. Positive and negative bias have different effects as described below and shown in the respective graphs.

Positive bias - has an effect similar to the minimum frequency limit setting except that 1) it only functions in the external mode and 2) the output frequency begins to increase immediately with increasing input signal unlike minimum frequency where the output frequency does not begin to increase until the input signal exceeds the level which would have resulted in that operating frequency. In addition, setting the frequency bias to be equal or greater than the start frequency, will result in the inverter starting as soon as a start command is received instead of waiting for the input signal to reach a level which would have resulted in that operating frequency.

Negative bias - effectively shifts the point where the inverter will begin operation, and frequency will begin to increase along the X axis as shown on the Negative Bias graph. This is accomplished by programming a frequency below zero (negative) that the input signal level must overcome before the output frequency begins to increase. Since the inverter obviously cannot output negative frequency, the result is a clamp on the output until the appropriate input signal level is reached. Refer to the example below for a typical procedure for setting negative bias. Note that once the inverter begins to produce output, the minimum frequency is controlled by function 18, Minimum Frequency Limit, and the inverter will continue to run at or above this point until the stop command is received or an external run contact opens.



EXAMPLE OF NEGATIVE BIAS:

Suppose the inverter is to be controlled from a 4 to 20 mA signal and the application requires that the output frequency not begin to increase until the input signal reaches 10 mA. This can be accomplished by programming the appropriate negative bias frequency as follows.

First, for calculation purposes, the input signal must be referenced to zero which, for a 4-20 mA input means that 4 must be subtracted yielding a 0-16 mA range. Then, determine the slope (m) of the Frequency vs Input signal by dividing the maximum frequency (usually 60 Hz) by the difference between maximum input signal (16 mA) and the desired input (10 mA) where output frequency is to begin (16 mA - 10 mA = 6 mA). The slope (m) = 60 / 6 = 10.

Using the calculated value for m, solve the standard linear equation y = mx + b where:

y = the output frequency at the x axis = 0 m = calculated slope from above = 10

x = the input signal value where increasing output is to begin referenced to zero = 10 mA

b = the y axis crossing point and the bias frequency which must be programmed.

Using the above and solving the equation for b we find that

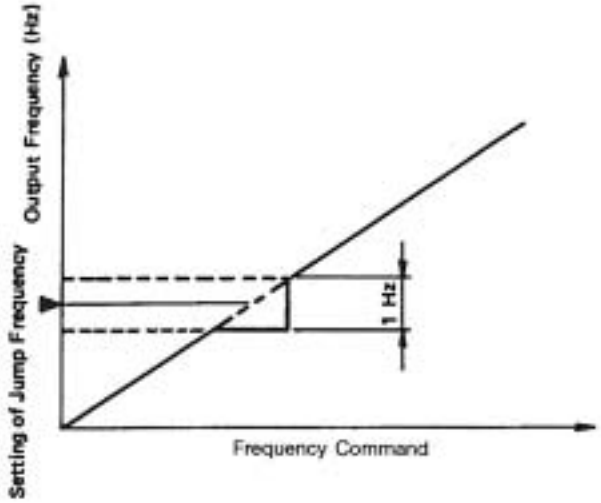
b = y - mx = 0 - 100 = -100 Hz

To program this frequency, first be sure function 45 is set to 1 to select negative bias (Cd45=1). Then program function 19 to equal the required bias frequency (100).

PROG ⇨ NO. ⇨ READ ⇨ DATA ⇨ SET

Cd20	SET JUMP FREQUENCY 1
Cd21	SET JUMP FREQUENCY 2
Cd22	SET JUMP FREQUENCY 3
Cd23	SET JUMP FREQUENCY 4
Cd24	SET JUMP FREQUENCY 5

- Up to 5 jump points can be set. The inverter will not produce output from - 0.5 Hz to +0.5 Hz from set jump frequency.
- If wider jump ranges are required, 2 or more jump points can be programmed in 1 Hz increments.

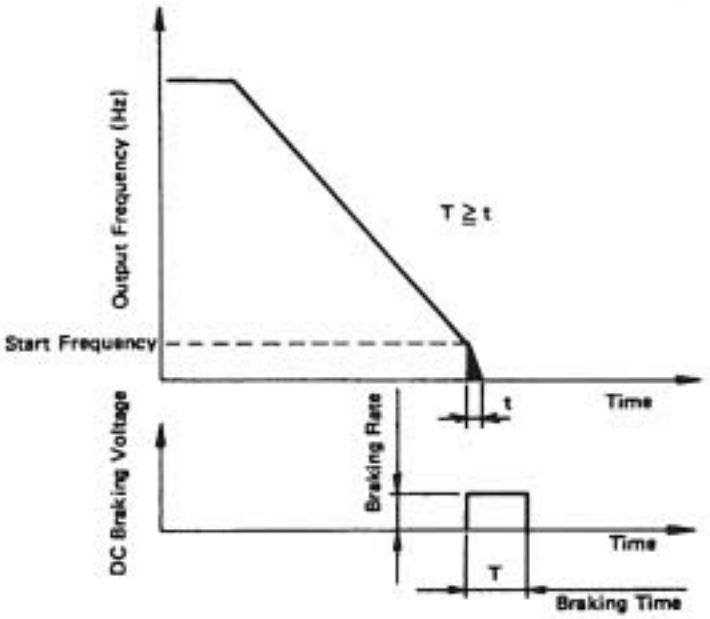


Note: Min/Max frequency limit takes priority if jump frequency is outside the limits.

Cd25 SET BRAKING RATE

Cd26 SET DC BRAKING TIME

- The DC braking rate (Cd25) is programmable over the range of Cd25=0 (zero), No DC braking to Cd25 = 7 maximum braking. DC braking current is applied after the deceleration ramp reaches the programmed start frequency.
- DC braking time (Cd26) is programmable over the range 1 – 60 sec.



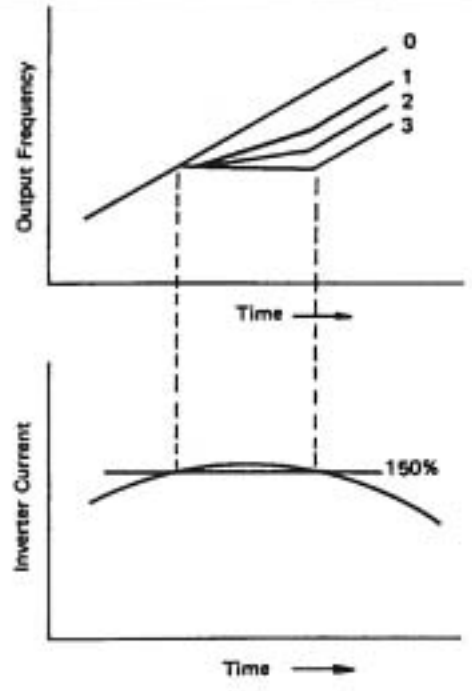
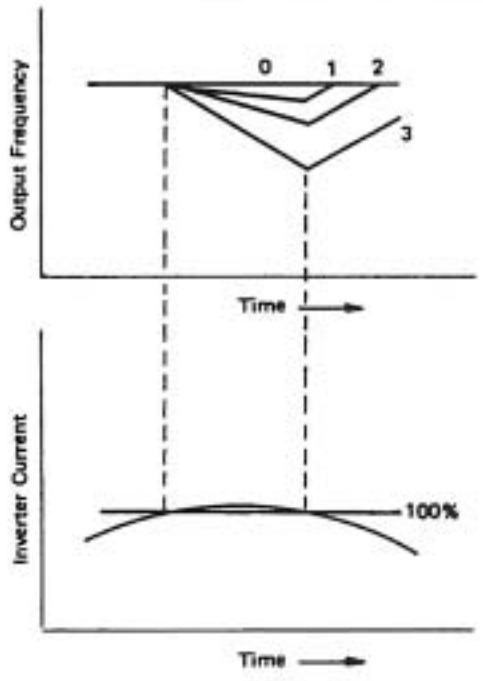
Cd27 MAX. FREQUENCY CLAMP

- Factory programmed to limit output frequency to 120Hz for safety (Cd27=1)
- If a V/F pattern above 120Hz is selected, remove the clamp by programming Cd27=0.

CAUTION: Consult motor and machine manufacturer before operating above 60Hz.

Cd28 SELECT OVERCURRENT STALL MODE

- Operation is affected by the setting of Cd29.
- During acceleration, the acceleration time is increased if inverter output current exceeds 150%.
- During steady state, if inverter output current exceeds 100%, the output frequency is reduced.
- Refer to the table below and program 0-3 corresponding to the desired effect.

DATA VALUE	DURING ACCELERATION	AT STEADY STATE
0	No stall protective function	
	EFFECT DURING ACCEL	EFFECT DURING STEADY STATE
1	Double Accel Time F / T = 1/2	Frequency lowers at 4 times deceleration time.
2	Quadruple Accel Time F / T = 1/4	Frequency lowers at 2 times deceleration time.
3	Stop Accel Until Current is Reduced F / T = 0	Frequency lowers at deceleration time.
		

Note: Hz or A lamp flashes when stall preventive function is activated.

Cd29 SELECT STALL PREVENTIVE FUNCTION

- This is the function to select overcurrent stall prevention to be active during acceleration, steady state or both.

  Cd29 = 0: Operate only during acceleration time.

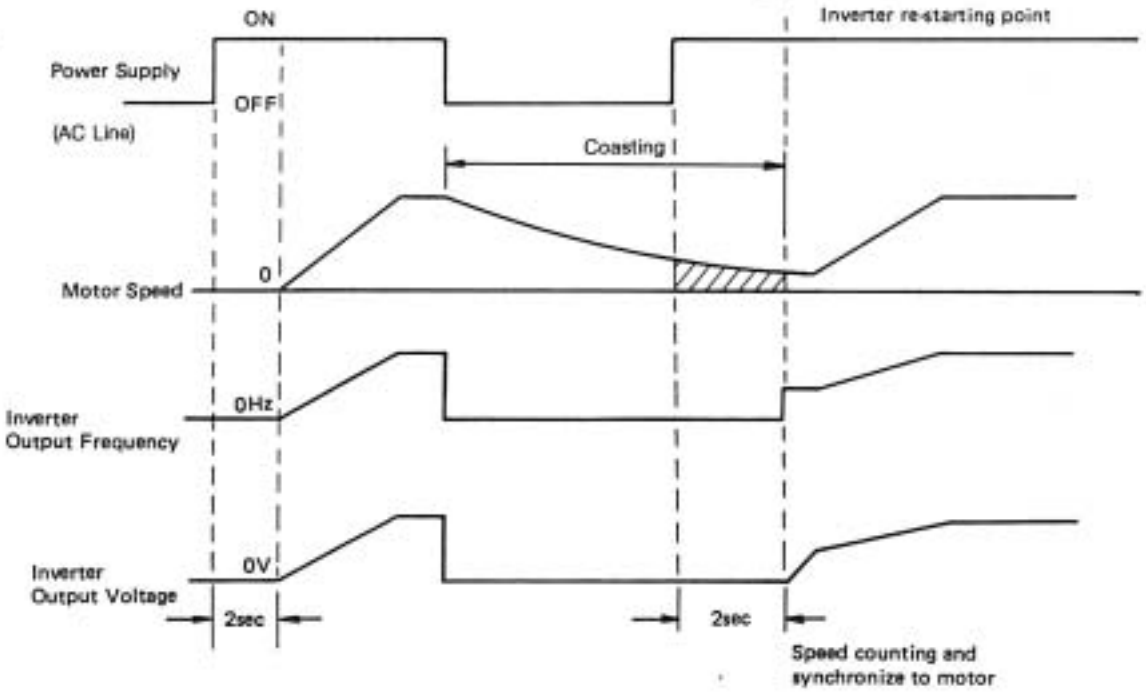
  Cd29 = 1: Operate only during steady state.

  Cd29 = 2: Operate both during acceleration and at steady state.

Cd30 COASTING MOTOR RESTART

- Also refer to Cd43. Allows the inverter to restart and match output frequency to motor coasting speed before applying voltage.

  Cd30 = 0: No restart. Cd30 = 1: Restart at motor coasting frequency.



Note 1. Direction of motor rotation during coasting should agree with the "FR or "RR" command.
2. Cd04 must be "1" and FR-COM or RR-COM must be maintained.
3. There is an approx. 2 seconds delay after power supply recovers.
4. This function differs from function 43 in that function 43 causes a restart only if the power was not off long enough to cause a control power loss (approx 2 sec.). There is no 2 second delay.
5. Also, Cd32 = 1

Cd31 CALIBRATE EXTERNAL FREQUENCY METER

1. Operate inverter at maximum output frequency
2. Set Cd31=1 and adjust the meter indication to 100% with △ ▽ keys.
3. Press SET key after completing calibration. Cd 31 will automatically return to 0.

Cd32 AUTOMATIC ALARM RESET FUNCTION

- If Cd32 = 1, overcurrent and overvoltage trip will be reset automatically and the inverter will restart automatically if Cd30 = 1. If the inverter trips 3 times in 20 seconds, it must be reset manually. Otherwise, the motor coasts to a stop and the inverter must be restarted manually.

Cd33 ALARM AT POWER INTERRUPTION

- Cd33 = 0 No alarm output
- If Cd33 = 1, alarm relay will pick up when inverter is tripped by protective functions (ALARM). Note that during loss of power, the alarm relay only maintains for approx. 1 second. It is automatically reset when the power is reapplied.

  Note: The alarm relay (function) does not work during under voltage "LU" if the inverter is not operating.

Cd34 SELECT ACCELERATION DECELERATION MODE

- Cd34 = 0: Ramp mode only (other mode is not available at present)

Cd35 SELECT REMOTE-LOCAL CONTROL OF INPUT FUNCTION FOR OPERATION PANEL

- If optional remote digital operation panel is installed (DOS-5), this function is used to transfer the function from the local panel to the remote panel. The ready lamp lights on the selected operation panel:

  Cd35 = 0 remote panel Cd35 = 1 local panel

  Note: Control transfers back to the local panel if the remote panel is disconnected or if Cd35 is set to "0" on the remote panel.

Cd36 INITIAL FACTORY SETTING

- If Cd36 = 1 is selected, all function code data is reset to original factory settings.

Cd37 ELECTRONIC OVERLOAD RELAY RESPONSE CHARACTERISTICS

- This function selects motor derating for continuous operation at low frequencies. (See Cd07.)

  Cd37 = 0: Standard motor (not suitable for constant torque at low frequencies without overheating).

  Cd37 = 1: Specialized motor for inverter - 10:1 constant torque range.

Cd38 DYNAMIC BRAKING RESISTOR SELECTION

- The function to select the built-in braking resistor or external resistor (optional).

  Cd38 = 0: Using built-in DB resistor (Only for AC-200V input 0.4 ~ 7.5kW units)

  Cd38 = 1: Using External resistor (optional).

- Only when the data us set to "0", "bUOH" alarm indication on AF-500 display is available, when DC link voltage reaches DC360V (or DC 720V for AC 400V line) by regeneration, and deceleration time is extended by 2 times the original setting.

Cd39 MOTOR ROTATION DIRECTION

- This function selects allowable motor rotation direction.

  Cd39 = 0: Both forward and reverse operations are possible.

  Cd39 = 1: Only forward operation is available.

  Cd39 = 2: Only reverse operation is available.

  Note: External FR or RR contacts must be open to allow changes to this parameter.

Cd40 KEYPAD LOCK

- Prevents unauthorized data entry from keypad.

  Cd40 = 0: Data changeable. Cd40 = 1: Data not changeable.

  Note 1: If Cd40 = 1, Err is displayed when an attempt is made to change programmed parameters.

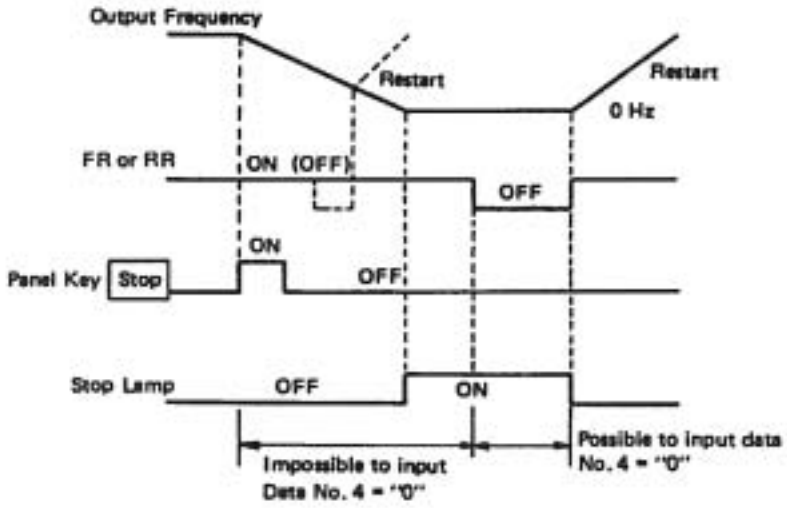
  2: The output frequency can be changed by direct setting or step setting.

Cd41 STOP BY PANEL KEY

- This function enables the inverter to be stopped by the "STOP" key on the operator panel even when the inverter is operated by external FR or RR contacts.

  Note 1: This function is activated only when Code No. 04 = "1" is selected.

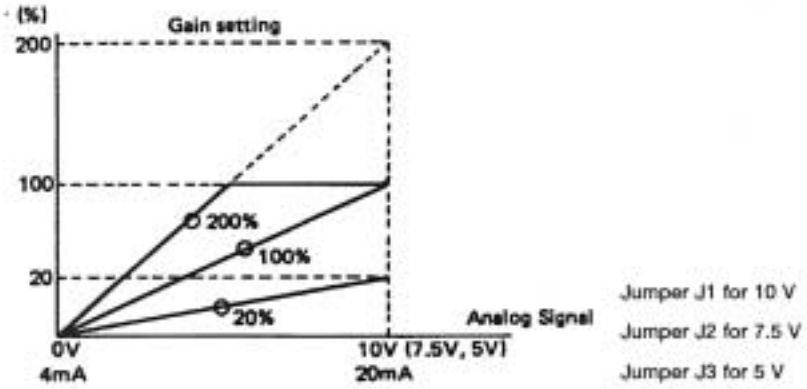
  Note 2: When Code No. 41 = "1", restart of inverter will not occur until the initiating contact opens and recloses.



Note: If remote control panel is used, this function is not activated when the panel lamp "READY" is off.

C d 42 FREQUENCY GAIN SETTING

- Sets the gain of external analog signals.
- Setting a gain of 100% results in the inverter reaching set maximum frequency when the input reaches 100% of its nominal value.



Note 1: This function is available only when Code No. 1 = "1".

Note 2: 100% corresponds to the maximum frequency of the selected V/F pattern.

Note 3: Level meter indicates the ratio of the 100% as Max. frequency of V/F pattern of Code No. 5.

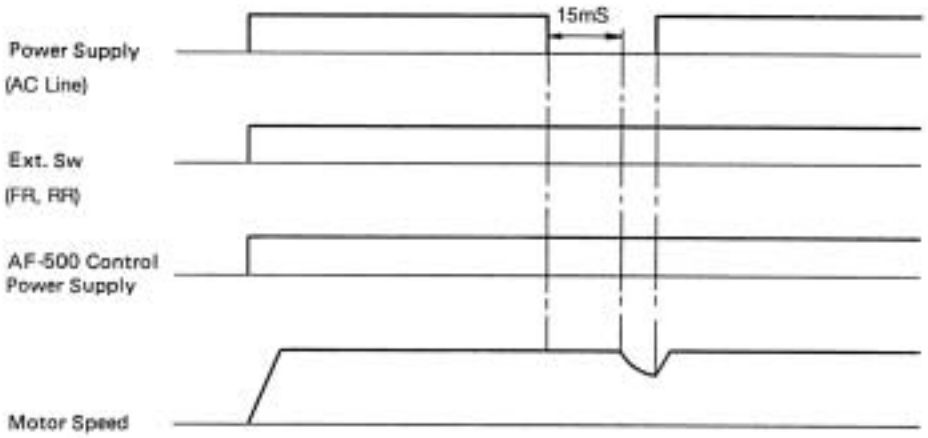
Note 4: In case of Bias > Gain, frequency is clamped at 0Hz.

Note 5: If the maximum frequency of V/F pattern exceeds 120Hz, gain setting of larger than 100% is ignored and fixed at 100% and input data of Code No. 42 will not be changed.

Cd43 AUTO RESTART AFTER POWER FAILURE

- Also refer to Cd30. Cd43 sets the inverter response to a brief (less than 2 second) interruption in input power.

Cd43 = 0	No restart
Cd43 = 1	Auto restart at coasting motor frequency
Cd43 = 2	Auto restart but from initial start frequency. (Will be used when motor stops immediately.)



Note 1: If auto-start is required for longer power failure, Cd = 30 should also be set.
Note 2: For auto restart to function in external control mode, "FR" or "RR" to common must be maintained.

Cd44 SPEED MULTIPLIER

- This function enables the digital indicator to be used as speed meter display. Calculate the required multiplier by dividing the maximum units to be displayed by the frequency which produces maximum units. Ex: for 1750 RPM at 60HZ, 1750 divided by 60 = 29.17.

Note 1: Hz and A lamp will be OFF.

Note 2: Input a multiplier against the frequency. (A unit can not be displayed.)
Indication = multiplier x frequency

Note 3: Range can be set from 0.02 to 9998.

Note 4: If the result of counting is more than 4-digits, the display shows "9999".

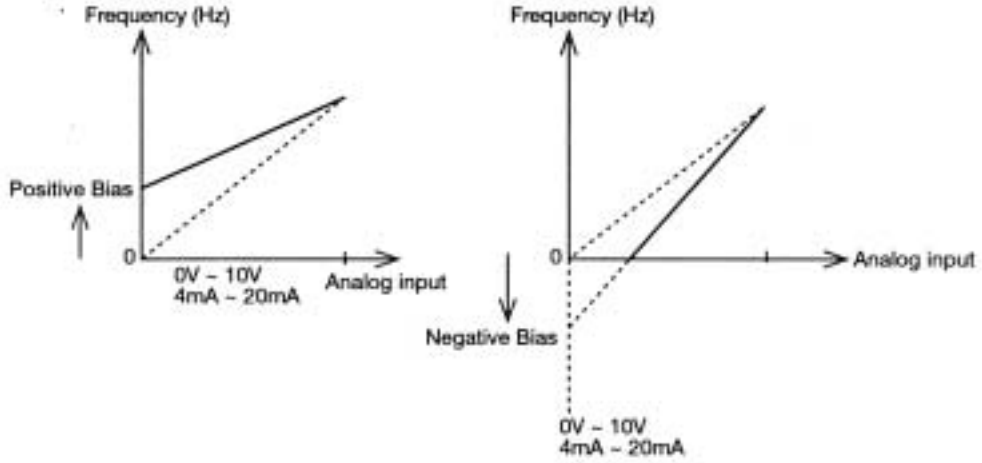
Note 5: When the display is set for speed, frequency can be changed from the operator panel by Code No. 00, or by using step keys.

Note 6: Display indicates "0.00" when motor is at a stop.

Cd45 BIAS POLARITY

- Sets polarity of the bias frequency set by Code No. 19. Set Cd45 = 0 for positive bias and Cd = 1 for negative bias.

  Note 1: Activated only when Code No. 1 = "1"



  Note 2: Negative bias setting is an imaginary value, and does not produce output frequency.

  Note ⁻: This code cannot be changed during inverter operation.

  Note 4: If the maximum frequency of V/F is greater than 120Hz, negative bias will be fixed at 0 bias, but is effective for positive bias.

Cd46 FAULT INDICATION

Cd47 Cd48 Cd49

- This function allows inspection of the type of fault, even if power has been interrupted.

  Note 1: Error indication [Err], [Er0], [ErC] and [bUOH] are not stored.

  Note 2: Can not be cleared by Code No. 36 = 1. (Ref. Cd50)

  Note 3: The most recent 4 faults are stored.

  Note 4: [LU] (Low Voltage) while the inverter is stopped is not stored.

  Note 5: Fault is stored even if the auto restart function (Cd32 = 1) is selected.

Cd50 MEMORY CLEAR

- Clears fault memory

  Note 1: The data of Code No. 50 is always "0". (On reading.)

  Note 2: All of the contents of data Code No. 46-49 will display [nOnE] after setting Code No. 50 = 1.

CdS1 ALARM SIGNAL OUTPUT SELECTION

- The alarm relay contacts change state whenever a protective circuit causes the inverter to trip off-line. The alarm relay resets when the controller is reset.
- If the controller is set for automatic reset of an over voltage or overcurrent trip, function Code 32 is set to "1". The alarm relay can be set to ignore this momentary trip. This is the factory setting.

  Cd51 = 0 Ignore momentary trip. Cd51 = 1 Alarm on each trip.

Note 1: If Cd 51 = 1 and Cd 32 = 1, the alarm contacts will change state for about 250 ms.
Note 2: Regardless of the setting of Cd51, a fault which does not automatically reset will cause the alarm relay to operate.

CdS2 OPTIONAL PULSE GENERATOR CARD SPEED SETTING METHOD

- When the optional pulse generator card is used with a motor mounted encoder, there are three choices for a means of speed setting. These are made by appropriate programming of Cd52 as described below

  Cd52 = 0: Pulse generator board is not used. Speed control means is determined by function code 1.

  Cd52 = 1: Speed control is from the digital panel as described in function code 53.

  Cd52 = 2: Speed control from an external analog signal.

CdS3 SPEED INPUT

- When the optional pulse generator board is used for feedback from a motor mounted pulse tachometer, speed control from the operator panel can only be achieved by entering the desired RPM using function code 53.
- Allowable range is 0-3600.

Note: If the desired speed requires operation above 60Hz, the appropriate V/F pattern must be programmed and the maximum frequency limit function code 17 must be set accordingly.

CdS4 FEEDBACK GAIN

- This function controls the gain of the proportional plus integral controller comparing the feedback from the motor mounted encoder with the set speed. Higher gain settings improve the response time and accuracy of regulation but setting the gain too high causes instability.
- Allowable values are 0 to 9999 with a factory setting of 100.

CdS5 OFFSET CONSTANT

- This parameter allows improvement in steady-state operation.
- Allowable values are 0 - 9999 with a factory setting of 250.

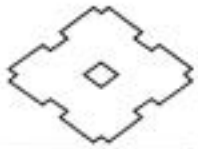
7. MAINTENANCE AND TROUBLESHOOTING

DANGER! HAZARDOUS AND POTENTIALLY LETHAL VOLTAGES ARE PRESENT IN THIS CONTROLLER. VOLTAGES MAY REMAIN AT DANGEROUS LEVELS FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, DISCONNECT ALL SOURCES OF POWER AND WAIT UNTIL THE CHARGED LAMP GOES OUT

7.1 PERIODIC INSPECTION & MAINTENANCE

Remove all power and check the following.

INSPECTION CYCLE	INSPECTION ITEM
Every Six (6) Months	1. Check tightness of terminal and installation bolts. 2. Inspect terminals for corrosion or signs of overheating
Once a Year	1. Clean surface of circuit board, heat sinks, and cooling fan by blowing with clean and dry air. 2. Check for signs of cracked or discolored components. 3. Inspect cooling fans if present. Verify that they rotate freely and do not exhibit excessive lateral shaft movement which indicates excessive bearing wear.



7.2 TROUBLE SHOOTING

DANGER! HAZARDOUS AND POTENTIALLY LETHAL VOLTAGES ARE PRESENT IN THIS CONTROLLER. VOLTAGES MAY REMAIN AT DANGEROUS LEVELS FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, DISCONNECT ALL SOURCES OF POWER AND WAIT UNTIL THE CHARGED LAMP GOES OUT

7.2.1 MOTOR WILL NOT START

POSSIBLE CAUSE	CORRECTIVE ACTION
Displays fault code	• Refer to Inverter Trips and displays fault code (7.2.2)
Loss of Power	• Check status of operator panel. If no LEDs are illuminated, check line voltage.
Blown Fuse on Main Circuit Board	• If line power is OK, remove power and check the control fuse in the main circuit board. Replace if necessary.
Improper set-up of Program Parameters	• If Code Cd04 is set for external operation, terminal FR or RR must be connected to terminal COM to start the inverter.
Insufficient Starting Torque	• Verify that the motor shaft is free to rotate. If not, correct the mechanical problem. • Start the inverter and measure motor current with a clamp – on ammeter. If the current is not balanced within 5%, contact the factory. • If currents are balanced, increase starting torque by adjusting Function Cd06. If motor will not start with maximum torque boost, the controller and/or motor may be undersized for the application.

7.2.2 INVERTER TRIPS AND DISPLAY FAULT CODE (Part 1)

POSSIBLE CAUSE	CORRECTIVE ACTION
Display shows OCPA	• Refer to Inverter Trips when Attempting to Start (7.2.3)
Display shows OCPd	• Refer to Inverter Trips during decel. (7.2.4)
Display shows OCS	• Phase to phase or phase to ground short at the inverter output. Check for short in wiring or motor. • Improperly switched motor contactor. A contactor or safety switch between the inverter and motor cannot be closed during inverter operation. • Shorted output transistor. Disconnect motor wiring from U, V, W. If trip still occurs, transistor is shorted.
Display shows OU	• If trip occurred during decel, see Inverter Trips During Decel. (7.2.4) • Check for plant or utility switching of capacitors, especially if the trip occurs with regularity at about the same time. • Verify that the AC line voltage is within limits.
Display Shows OCPn	• Check for sudden load or motor being connected to inverter during operation

7.2.2 INVERTER TRIPS AND DISPLAY FAULT CODE (Part 2)

POSSIBLE CAUSE	CORRECTIVE ACTION
Display shows OL	• Restart the inverter and check output current. If higher than nameplate, correct overload.
Display shows OLE	• Terminal ES to COM has opened. Check for external OL relay, motor thermal switch or other device open.
Display shows OH	• Check for proper operation of cooling fans or clogged air input. If OK, check for excessive ambient.
Display shows Fb	• Replace blown DC bus fuse. Check for shorted DC bus capacitor, welded contacts on precharge contactor, or shorted transistor module.
Display Shows bUOH	• Refer to Inverter Trips during Decel. (7.2.4)
Display Shows LU	• Low input voltage. Check for low voltage at inverter input terminals R, S, T. Correct if voltage is more than 10% below nameplate rating.
Display Shows Ero	• Internal memory error. Turn off power, wait one minute, then reapply power. If fault does not clear, contact Sumitomo.
Display Shows ErC	• CPU error. Turn off power, wait one minute, then reapply power. If fault does not clear, contact Sumitomo. If trip occurs frequently, look for unsuppressed coils or other sources of electrical noise.

7.2.3 INVERTER TRIPS WHEN ATTEMPTING TO START

POSSIBLE CAUSE	CORRECTIVE ACTION
Display shows OCPA	• Torque boost Function code Cd06 set too high. Reduce if possible • Acceleration time too short. Lengthen accel time. See Function code Cd08 and Cd10. • Starting frequency set too high. For maximum starting torque, the inverter starting frequency must be set below the motor slip frequency. See Function code Cd16. • Inverter is started while the motor is coasting and Function code Cd43 = 2 (restart from 0 Hz). If restart is required, try Cd43 = 1, (Restart at motor coasting frequency.) • Wrong motor connection. Verify that the motor is properly connected. Verify the motor is connected for 460 V when used with a 460 V inverter. • If a motor brake is used the brake coil cannot be fed from the inverter.
Display shows OCS	• Phase-to-phase or phase-to-ground short at the inverter output. Check for short in wiring or motor. • Improperly switched motor contactor. A contactor installed between the inverter and motor must close before the inverter starts. • Shorted output transistor. Disconnect motor leads from U, V, W and try to start, if OCS still appears a transistor module is shorted.

7.2.4 INVERTER TRIPS DURING DECEL

POSSIBLE CAUSE	CORRECTIVE ACTION
Display shows OU	• Deceleration time set too fast for load inertia. Install optional Dynamic Braking or increase DB resistor capacity. Lengthen deceleration time. See Function code Cd09 and CD11. • Overhauling load. The load is attempting to drive the motor faster than the called for speed. Eliminate the overhauling condition or add (or increase the capacity of) Dynamic Braking.
Display shows OCPd	• Dynamic braking is installed and excessive braking torque is being developed. The current must be reduced by increasing the deceleration time. See Function code Cd09 or Cd11. Note: if the application is such that decel time cannot be increased, a larger inverter must be installed.
Display shows bUOH	• The dynamic braking duty cycle is too severe. Too frequent Start-Stop, too rapid Deceleration for load or overhauling load. Increase Decel time or increase capacity of dynamic braking.

8. OPTIONS

The following sections describe options which may have been supplied with the AF-500 or as kits for separate mounting.

8.1 DYNAMIC BRAKING

All AF-500 inverters will allow approximately 15% - 20% of rated motor torque for stopping or slowing a load. This regenerated energy is dissipated as losses (heat) in the motor and controller. Additional braking torque is available in 0.5 HP - 10 HP, 200/230 V controllers. These units have a dynamic braking transistor and resistor furnished and mounted on the controller heat sink. Approximate braking torque is shown in Table 8-1. When additional capacity is required, the internal resistor can be disconnected and an external resistor connected to the provided terminals.

In addition, 2 HP - 20 HP, 400/460 V controllers include a dynamic braking transistor and terminals for connecting an external resistor. All other controllers include terminal provisions for the connection of external dynamic braking modules and resistors. Refer to Table 8-1 and the appropriate diagrams for additional details.

One symptom indicating a possible need for dynamic braking is an inverter over voltage trip during deceleration. If this happens there are two possible solutions. First, if the application does not require quick stops or rapid deceleration, simply increase the deceleration time. Second, add dynamic braking or, in the case of 0.5 HP - 10 HP, 200/230 V units, increase braking capacity by adding an external braking resistor.

Your local Sumitomo Machinery Corporation of America representative or distributor will be happy to assist or, if you prefer, contact Sumitomo headquarters in Chesapeake, VA and ask for the electrical group.

The following information provides details concerning the installation and wiring of optional dynamic braking resistors and modules.

DANGER! HAZARDOUS AND POTENTIALLY LETHAL VOLTAGES ARE PRESENT IN THIS CONTROLLER. VOLTAGES MAY REMAIN AT DANGEROUS LEVELS FOR SEVERAL MINUTES AFTER POWER IS REMOVED. BEFORE ATTEMPTING TO SERVICE THIS CONTROLLER, DISCONNECT ALL SOURCES OF POWER AND WAIT UNTIL THE CHARGED LAMP GOES OUT

INSTALLATION

1. Mount the resistors, in a well ventilated area a safe distance away from combustible materials or other materials which may be damaged by heat.

DANGER! DYNAMIC BRAKING RESISTORS OPERATE AT HIGH VOLTAGES. RESISTORS WHICH ARE NOT ENCLOSED IN PROTECTIVE COVERS MUST BE MOUNTED IN A LOCATION WHERE PERSONNEL WILL NOT ACCIDENTALLY COME IN CONTACT WITH LIVE TERMINALS.

2. If dynamic braking modules are required, remember that these are electronic devices and must be treated accordingly. They should be mounted in an environment similar to the AF-500.
3. If the AF-500 inverter includes a braking transistor (refer to Table 8-1) the resistor is connected to terminals P and PR on the AF-500 power terminal strip. Polarity is not important. Insure that the connecting wire enters the resistor bank from the bottom and does not come close to individual resistor elements. Size wire according to Table 8-2.

TABLE 8-1 DYNAMIC BRAKING CONFIGURATION

MODEL	VOLTS	KW	HP	TR	RES	OHMS	WATTS	% TORQUE	FIG. 8-5
AF502-A40	200/230	0.4	0.5	I	I	120	80	150	*
AF502-A75	200/230	0.75	1	I	I	120	80	150	*
AF502-1A5	200/230	1.5	2	I	I	60	120	100	*
AF502-2A2	200/230	2.2	3	I	I	60	120	100	*
AF502-3A7	200/230	3.7	5	I	I	40	120	90	*
AF502-5A5	200/230	5.5	7.5	I	I	40	120	60	*
AF502-7A5	200/230	7.5	10	I	I	40	120	40	*
AF502-011	200/230	11	15	E	E	15	2400	125	30
AF502-015	200/230	15	20	E	E	11	3000	125	31
AF502-022	200/230	22	30	E	E	8	4800	125	32
AF502-030	200/230	30	40	E	E	2-11**	3000	125	31
AF502-037	200/230	37	50	E	E	2-11**	3000	100	31
AF502-045	200/230	45	60	E	E	2-8**	4800	120	32
AF504-1A5	400/460	1.5	2	I	E	240	400	145	11
AF504-2A2	400/460	2.2	3	I	E	240	400	100	11
AF504-3A7	400/460	3.7	5	I	E	120	800	117	12
AF504-5A5	400/460	5.5	7.5	I	E	120	800	80	12
AF504-7A5	400/460	7.5	10	I	E	50	2000	140	13
AF504-011	400/460	11	15	I	E	50	2000	95	13
AF504-015	400/460	15	20	I	E	32	2400	90	14
AF504-022	400/460	22	30	E	E	28	5250	125	21
AF504-030	400/460	30	40	E	E	20	6000	125	22
AF504-037	400/460	37	50	E	E	16	9600	125	23
AF504-045	400/460	45	60	E	E	14	10500	125	24
AF504-055	400/460	55	75	E	E	2-20**	12000	135	25
AF504-075	400/460	75	100	E	E	2-14**	21000	145	26
AF504-090	400/460	90	125	E	E	2-14**	21000	120	26
AF504-110	400/460	110	150	E	E	3-20**	18000	100	27

I = INTERNAL E = EXTERNAL

* Indicates that the resistor is internal to the unit. If more braking torque or a longer duty cycle are required, an external resistor can be used. Contact your local Sumitomo representative or distributor for assistance.

** Indicates that multiple resistor units and external transistor modules are placed in parallel to achieve this rating.

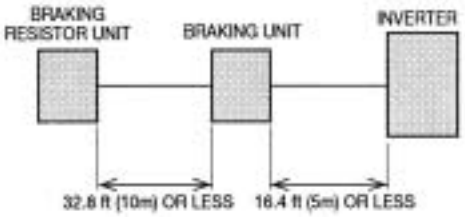
TABLE 8-2 WIRING GUIDE

CIRCUIT	TERMINALS	WIRE SIZE*	WIRE TYPE
Power	P, PR, PO, N, B	See NEC Table 430-29. Use 5/75 Duty Cycle	600 V, 90° C
Control	1 – 6	AWG 18 – 14	600 V, 90° C

*If a higher duty cycle is required, consult Sumitomo.

4. If the AF-500 inverter does not include a braking transistor (refer to Table 8-1) an external braking module or modules will be required. Terminals N and P on the module should be connected to terminals N and P on the AF-500. This connection is polarity sensitive. N must be connected to N and P to P. Size wire according to Table 8-2. Refer to Figure 8-1 for maximum recommended distances. Be sure that the braking module is properly grounded. A ground terminal is provided at the bottom of the enclosure.

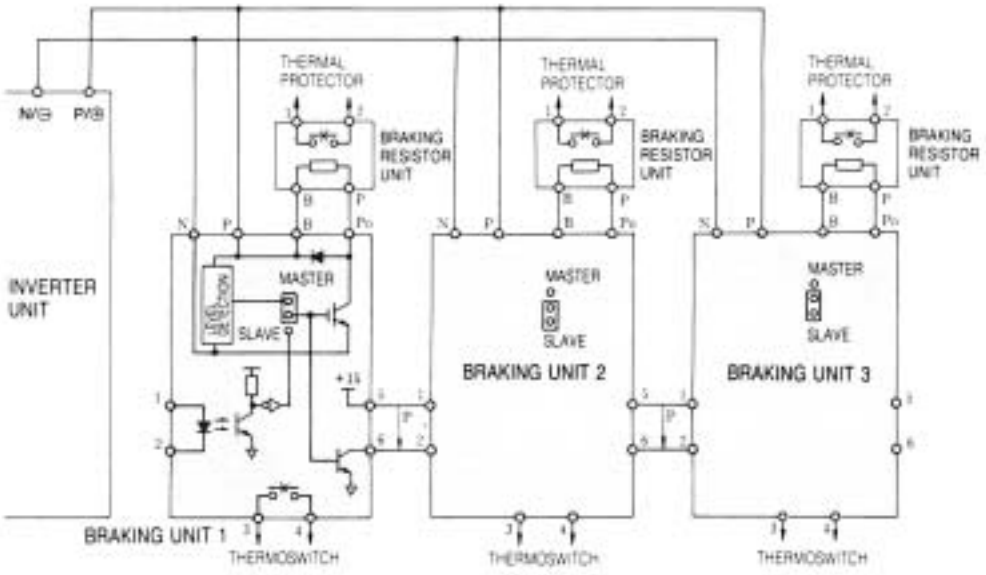
Figure 8-1 Wiring Distances



Connect the external resistor to terminals B and PO on the braking module. This connection is not polarity sensitive. Size wire according to Table 8-2.

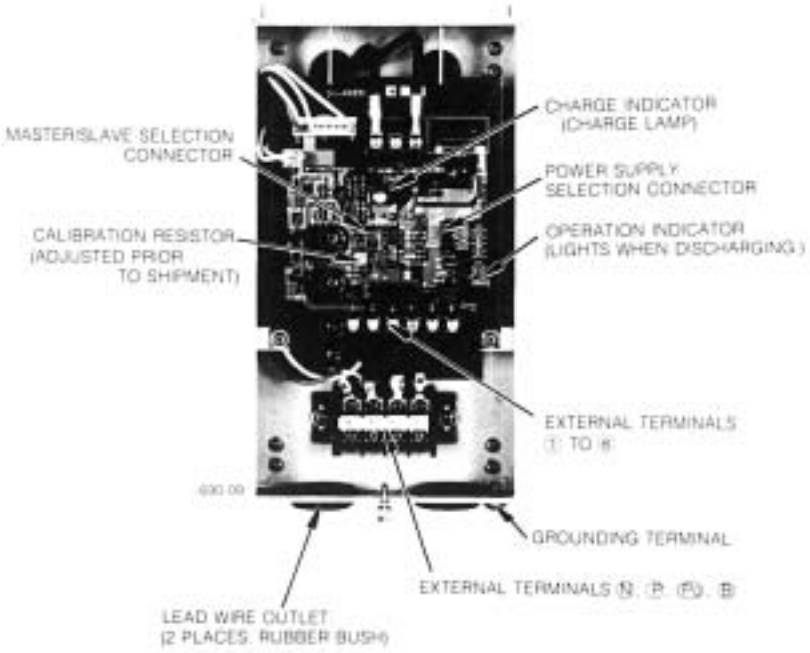
5. If multiple braking modules and transistors are required, they should be connected as shown in Figure 8-2. Connect the Master/Slave terminals for each unit as shown in the diagram. The Master/Slave jumper (refer to Figure 8-3 for the location) must also be positioned if the unit is a slave. Only one unit can be selected as Master. Note: separate the control wiring between Master/Slave terminals from the power wiring. DO NOT run control and power wires in the same conduit or raceway.

Figure 8-2 Multiple Units



6. If an external braking module is required, insure that the voltage selector jumper on the external braking module (refer to Figure 8-4 for the location and position) is correctly positioned before applying power to the AF-500 inverter.

Figure 8.3



7. Insure that any covers that were removed during installation are replaced.
8. After applying power to the AF-500, refer to the programming instructions to set the controller for external dynamic braking.

Figure 8.4 Voltage Selection

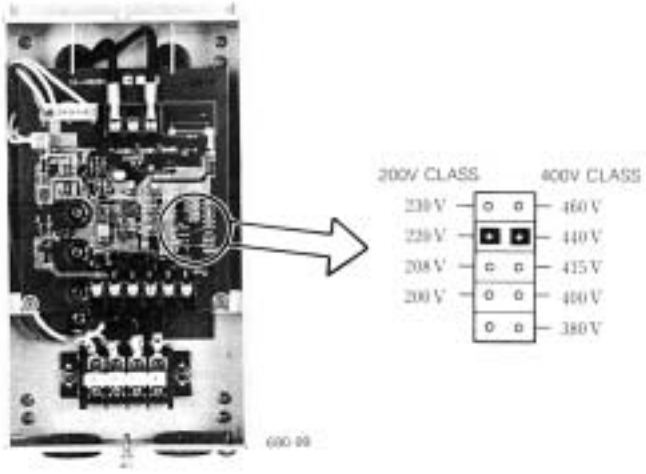
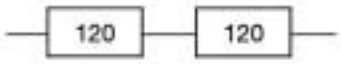
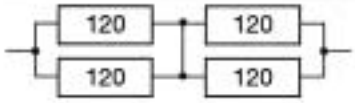
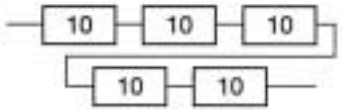
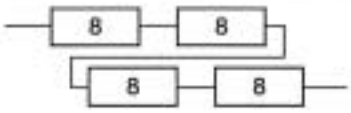
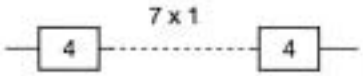
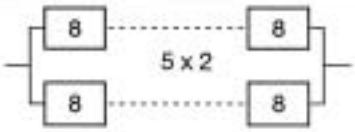
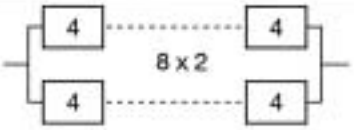
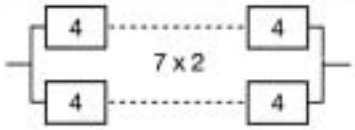
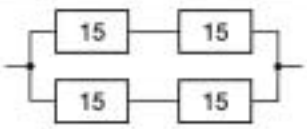
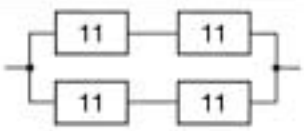
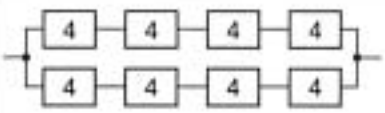


Figure 8-5 Connection of DBR

11	12	13
		
240 , 400W 120 , 200W x 2 TH: 1.0A	120 , 800W 120 , 200W x 4 TH: 2.0A	50 , 2KW 10 , 400W x 5 TH: 5.0A
14	**21**	**22**
		
32 , 2.4KW 8 , 600W x 4 TH: 6.0A	28 , 5250W 4 , 750W x 7 (DB CDBR 4030)	20 , 6000W 8 , 600W x 10 (DB CDBR 4030)
23	**24**	**25**
		FIG. 8-5-22 x 2 (10 , 12,000W) w/2 – DB Units (CDBR 4030)
16 , 9600W 4 , 600W x 16 (DB CDBR 4045)	14 , 10,500W 4 , 750W x 14 (DB CDBR 4045)	
26	**27**	
FIG. 8-5-24 x 2 (7 , 21,000W) w/2 – DB Units (CDBR 4045)	FIG. 8-5-22 x 3 (6.7 , 18,000W) w/3 – DB Units (CDBR 4045)	
30	**31**	**32**
		
15 , 2400W 15 , 600W x 4	11 , 3000W 11 , 750W x 4	8 , 4800W 4 , 600W x 8

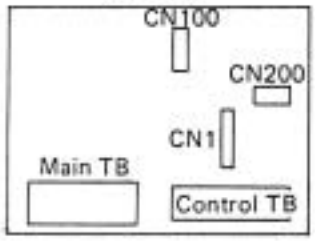
TH: These amperages are to be set as thermal trip current value.

8.2 OPTION CARDS

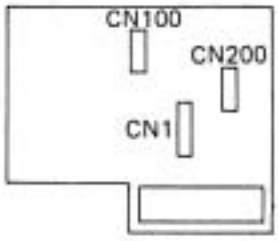
OPTION / MODEL NO.	RELAY CIRCUIT CARD	DIGITAL INTERFACE CIRCUIT CARD	INTERFACE CARD FOR REMOTE CONTROL STATION	PULSE GENERATOR INTERFACE CARD
AF502 A40	ORU – 1	ODI – 1	DOS – 1	OPG – 1
AF502 A75				
AF502 1A5	ORU – 2	ODI – 2	DOS – 2	OPG – 2
AF502 2A2				
AF502 3A7				
AF502 5A5	ORU – 1	ODI – 1	DOS – 1	OPG – 1
AF502 7A5				
AF502 011				
AF502 015				
AF502 022				
AF502 030				
AF502 037				
AF502 045				
AF504 1A5	ORU – 1	ODI – 1	DOS – 1	OPG – 1
AF504 2A2				
AF504 3A7				
AF504 7A5				
AF504 015				
AF504 022				
AF504 030				
AF504 037				
AF504 045				
AF504 055				
AF504 075				
AF504 090				
AF504 110				

Locations of connectors and terminal boards of main card for each ratings.

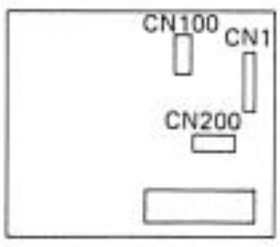
AF502-A40, A75, 5A5, 7A5, 011 - 045



AF502-1A5, 2A2, 3A7



AF504-1A5 – 110

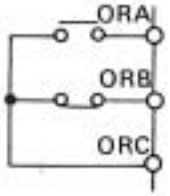
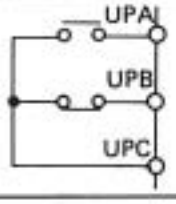


NOTE: Only one option card can be mounted on main card.

8.2.1 RELAY KIT (ORU)

Except for alarm indication (form C contacts) the AF-500 has open collector outputs. ORU is an option card to change this open collector output to dry. Once the option card is installed, relay contacts are available for inverter run (DRV) and operation at set frequency (UPF).

1. Specification

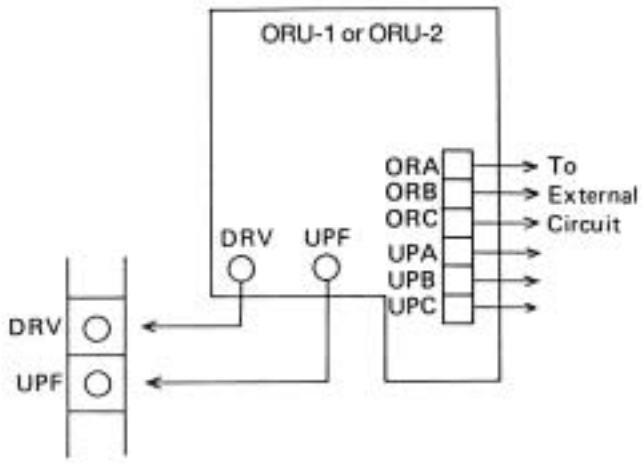
Inverter		AF502 -A40	AF502 -A75	AF502 -1A5	AF502 -2A2	AF502 -3A7	AF502 5A5 thru 045	AF504 ALL
MODEL		ORU-1		ORU-2			ORU-1	
Contact rating		AC250V/3.5A•DC30V/3.5A						
Relay contacts	DRV						"ON" during inverter operation	
	UPF						"ON" at up to set frequency	

2. Installation and wiring

WARNING NOTE: Installation and wiring should be made after confirming power supply and charge lamp are "OFF".

1. Verify that the proper ORU card number (ORU-1 or ORU-2) is selected for the inverter above.
2. Open the enclosure of AF-500 unit and disconnect the connector (CN1) which connects cover (panel) and inverter unit.
3. The installation of ORU should be made as follows: Connect the connectors (Connector No. CN100, CN200) of option card (ORU-1 or ORU-2) to the connector on main card. Then, connect two wires of option card to the terminal of AF-500 unit (DRV, UPF).

Figure 8.6 - ORU Connection

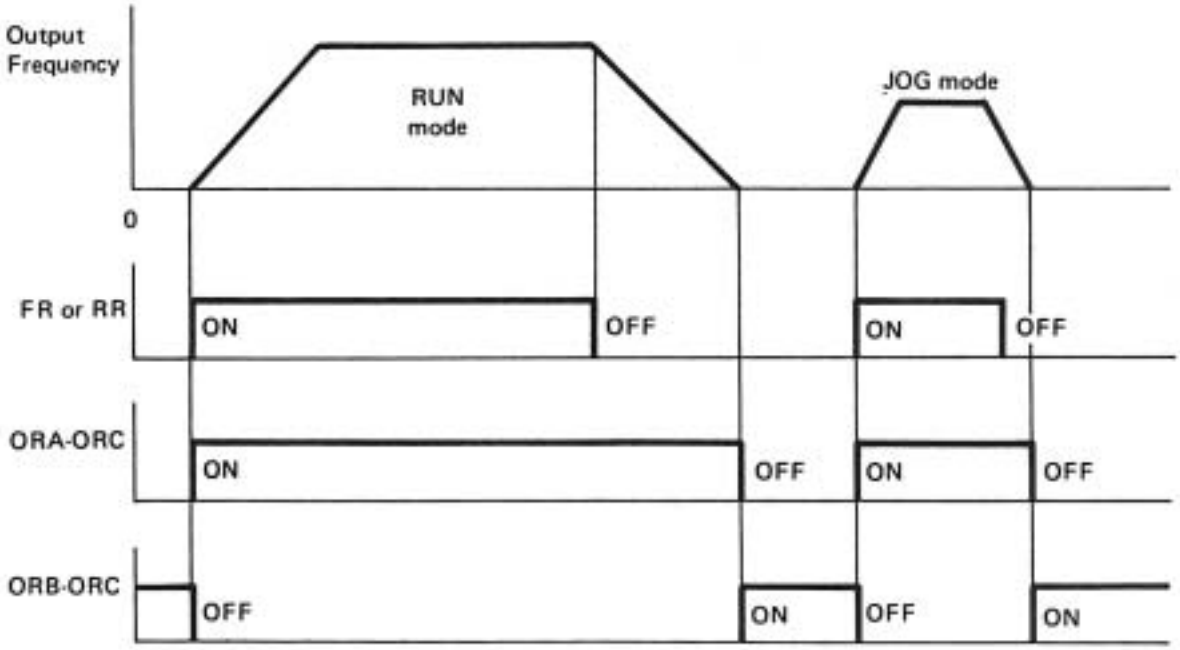


Connect wires to option card terminal boards for external circuit as required.

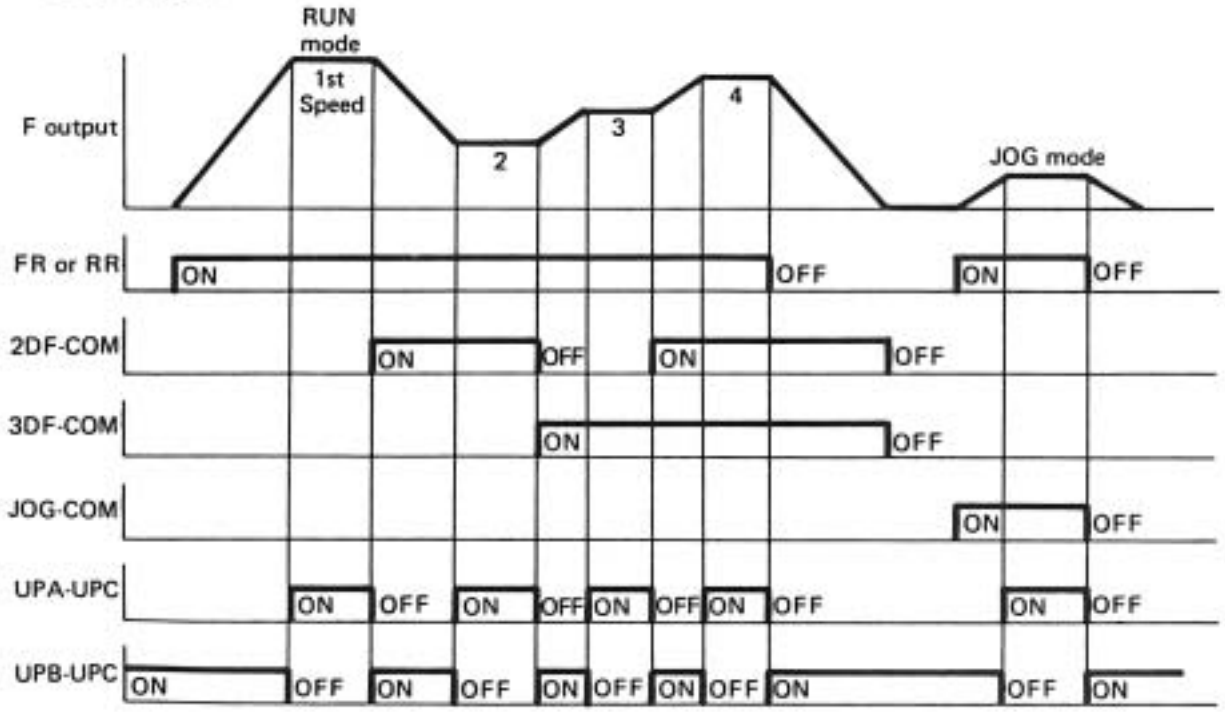
4. Re-connect the connector (CN1) which connects cover (panel) and main card of AF-500 unit.
5. Mount front cover.

3. Relay Contact Sequence

1. DRV signal



2. UPF signal



8.2.2 DIGITAL INTERFACE CARD (ODI)

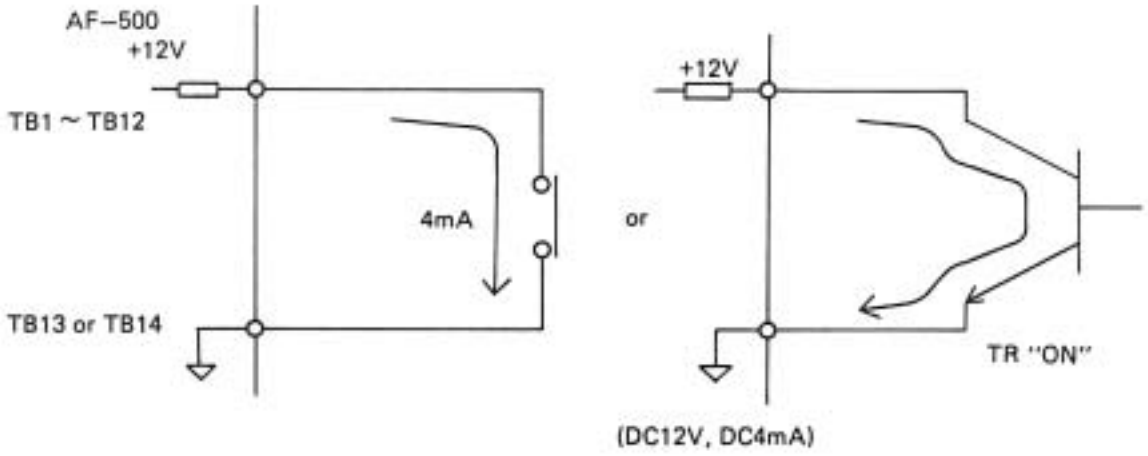
Installing the Digital Interface Card (ODI) to AF-500 unit, permits speed control from a computer or programmable controller using a 12-bit binary or 3-digit BCD signal.

1. Specifications

INVERTER		AF-502 A40	AF-502 A75	AF-502 1A5	AF-502 2A2	AF-502 3A7	AF-502 5A5 thru 045	AF-504 ALL
ODI CARD		ODI - 1		ODI - 2			ODI - 1	
INPUT CIRCUIT		Dry relay contact or by Open collector transistor						
		Rated DC 12V @ DC 4mA						
Frequency Setting Resolution	Binary Code (12 bit)	[Function Code No.05] (Max Frequency of V/F data) ≤ 100Hz : 0.05Hz (Max. Frequency of V/F data) ≥ 120Hz : 0.1Hz						
	BCD Code (3 Digits)	[Function Code No.05] (Max Frequency of V/F data) ≤ 80Hz : 0.1Hz (Max. Frequency of V/F data) ≥ 100Hz : 1Hz						
SET FREQUENCY RANGE		0.5 ~ 400Hz						
SAMPLING TIME		20 msec						

2. Functions of Terminal

1. 12 bit signal to each terminal is parallel signal. The reading of the terminal signal is made every 20 msec. by AF-500 unit, so it is necessary to provide the frequency setting signal continuously.
2. Input signal of each terminal is logical 1 (true) when the terminal is pulled low by external relay contacts or external open collector transistors.



3. Application

A. Installation and wiring.

WARNING: Installation and wiring should be made after confirming power supply and charge lamp of AF-500 unit is "OFF".

1. Parts Check – Verify that the proper ODI card model number (ODI-1 or ODI-2) is selected for the inverter.
2. Open the enclosure of AF-500 and disconnect the connector which connects between cover (panel) and inverter unit.
3. The Card is connected by two connectors. Connect connectors of Option Card (ODI-1 or ODI-2) and Main Card (Connector No. CN100, CN200) firmly. During maintenance avoid touching parts on the printed circuit board.
4. Terminate the signal wiring (TB1-TB14) at Digital interface card. Make sure the wiring agrees with the diagram.
5. Re-connect the connectors and the cover (panel) which were disconnected in step 2.
6. Mount front cover.

B. Setting of Operation Frequency by Digital Interface Card.

1. After completing the procedure of item 3-A Installation and wiring, apply the power to AF-500.
2. Program function code CD01 for the appropriate code as shown in the table below.

Code No. 01

DATA	SOURCE OF FREQUENCY COMMAND
0	Panel key setting
1	External analog setting
2	Binary code signal
3	BCD code signal

	No.	Functions								
			Binary Setting		BCD setting					
			V/F pattern		0.1Hz ~ 80Hz			1Hz ~ 400Hz		
	TB		Under 100Hz	Over 120Hz						
Terminals for Control Signal input	1	2^0 (LSB)	0.05 Hz	0.1 Hz	10^{-1}	2^0	0.1Hz	10^0	2^0	1Hz
	2	2^1	0.1	0.2		2^1	0.2		2^1	2
	3	2^2	0.2	0.4		2^2	0.4		2^2	4
	4	2^3	0.4	0.8		2^3	0.8		2^3	8
	5	2^4	0.8	1.6	10^0	2^0	1	10^1	2^0	10
	6	2^5	1.6	3.2		2^1	2		2^1	20
	7	2^6	3.2	6.4		2^2	4		2^2	40
	8	2^7	6.4	12.8		2^3	8		2^3	80
	9	2^8	12.8	25.6	10^1	2^0	10	10^2	2^0	100
	10	2^9	25.6	51.6		2^1	20		2^1	200
	11	2^{10}	51.6	102.4		2^2	40		2^2	400
	12	2^{11} (MSB)	102.4	204.8		2^3	80		2^3	800
	13	COM terminal (for all control signal)								
	14	"								

*10^{-1} designates number to the right of the decimal point, i.e. 10ths of a hert.

4. Resolution of setting frequency depends on selection of Function Code No. 05 Max. Frequency of V/F data.

MAX. FREQUENCY OF V/F DATE	30 ~ 80	100	120 ~ 400
Binary Code Setting	0.05 Hz		0.1 Hz
BCD Code Setting	0.1 Hz	1 Hz	

5. Example of input signal

a. Binary code setting (Code No. 01 = "2")
Code No. 05 = 2 (Max. frequency of V/F data: 60 Hz*)

	2048	1024	512	256	125	64	32	16	8	4	2	1	
Terminal (TB)	12	11	10	9	8	7	6	5	4	3	2	1	Setting Frequency
Input signal	0	0	0	1	0	0	0	0	1	0	0	1	13.25
ON = 1	0	0	1	1	0	0	1	0	1	1	0	1	40.65
OFF = 0	0	1	0	0	1	0	1	1	0	0	0	0	60.00

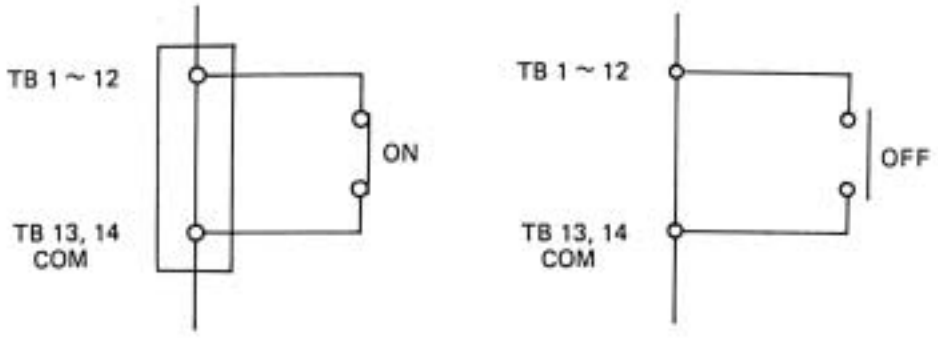
*Output frequency = decimal equivalent of binary number times frequency resolution (.05 Hz or 0.1 Hz)

b. BCD code setting (Code No. 01 = "3")
Code No. 05 = 2 (Max. frequency of V/F data: 60Hz**)

2x	8	4	2	1	8	4	2	1	8	4	2	1	
Terminal (TB)	12	11	10	9	8	7	6	5	4	3	2	1	Setting Frequency
Input signal	0	0	0	1	0	0	1	0	0	1	0	1	12.5
ON = 1	0	0	1	1	0	1	1	1	0	1	1	0	37.6
OFF = 0	0	1	1	0	0	0	0	0	0	0	0	0	60.0

** Frequency is entered directly to 1 decimal place.

Note: Input signal "ON" means a short circuit between terminal (1 - 12) and common terminal (13,14).
Input signal "OFF" means a circuit.



Note 1. In case the frequency set by digital interface is lower than starting frequency set by Code No. 16 panel display of AF-500 shows "0.0".

Note 2. Maximum frequency set by code no. 17 takes priority.

8.2.3 DIGITAL OPERATOR STATION (D0S.5)

Digital Operator Station is used for the purpose of remote control of AF-500 unit. All of the functions of the operator panel mounted on the AF-500 inverter unit are duplicated.

1. Specification

ENCLOSURE	TOTALLY ENCLOSED TYPE
Max. length of wire	30 m (100 ft. shielded wire)
Function	Same as to operation panel
Connection	By terminal board

1. DOS-5 shall be used together with card for installation (DOS-1 or DOS-2) which will be mounted inside of AF-500 unit. Check the type of inverter unit and select the proper card from the table below.

TYPE OF CARD FOR INSTALLATION	TYPE OF INVERTER UNIT
DOS – 1	AF502-A40, AF502-A75, AF502-5A5 thru AF502-045, AF504 all models
DOS – 2	AF502-1A5, AF502-2A2, AF502-3A7

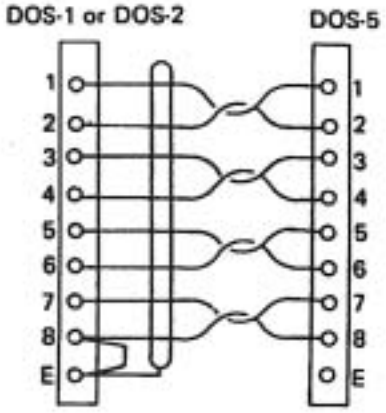
2. Local to remote, This is set on the local panel function Cd 35.
3. Other option cards can not be installed while the DOS-1 or DOS-2 is installed.
4. DOS-5 can be mounted in the furnished enclosure or in a panel by detaching the enclosure.

2. Installation and wiring

WARNING: Installation and wiring should be made after confirming the power supply and charge lamp of AF-500 units are "OFF".

1. Check the parts
   (a) DOS-5 (Remote control panel box)
   (b) Card for installation (DOS-1 or DOS-2)
2. Open the enclosure of AF-500 unit and disconnect the connector (CD1) which connects between operation panel and inverter unit.
3. The card for installation should be connected by two connectors. Line up connectors of option card and main card of AF-500 (CN100 to CN100, CN200 to CN200) and press firmly.
4. Make connections between DOS-5 interface card (DOS-1 or DOS-2).
   Cable: 4 pair of shielded wires. Only one panel (local or remote) can be in control.

3. Control is transferred from the local to the remote by setting function code 35=0. To transfer control back to the local panel, set function code 35=1 from the remote panel.



1. Connect the shielded wire and jumper between 8 and E as shown.
2. Shield should connect only at the DOS-1 or 2 board.
3. Run wires in separate conduit and separate from power wires.
4. Re-connect the local operator panel.
5. Mount front cover and apply power.
6. Program the AF-500 to operate from the DOS-5.

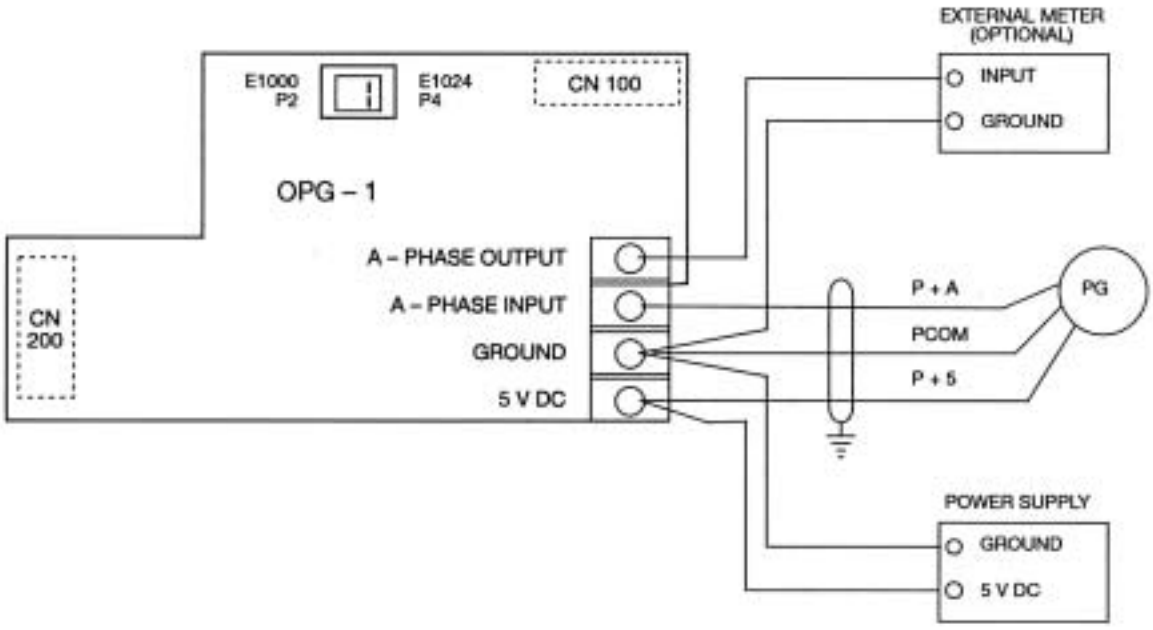
NOTES: 1. The "ready" light will illuminate on the panel which has control.
2: If the DOS-1 or 2 card or wiring to the DOS-5 is disconnected, control will return to local panel.

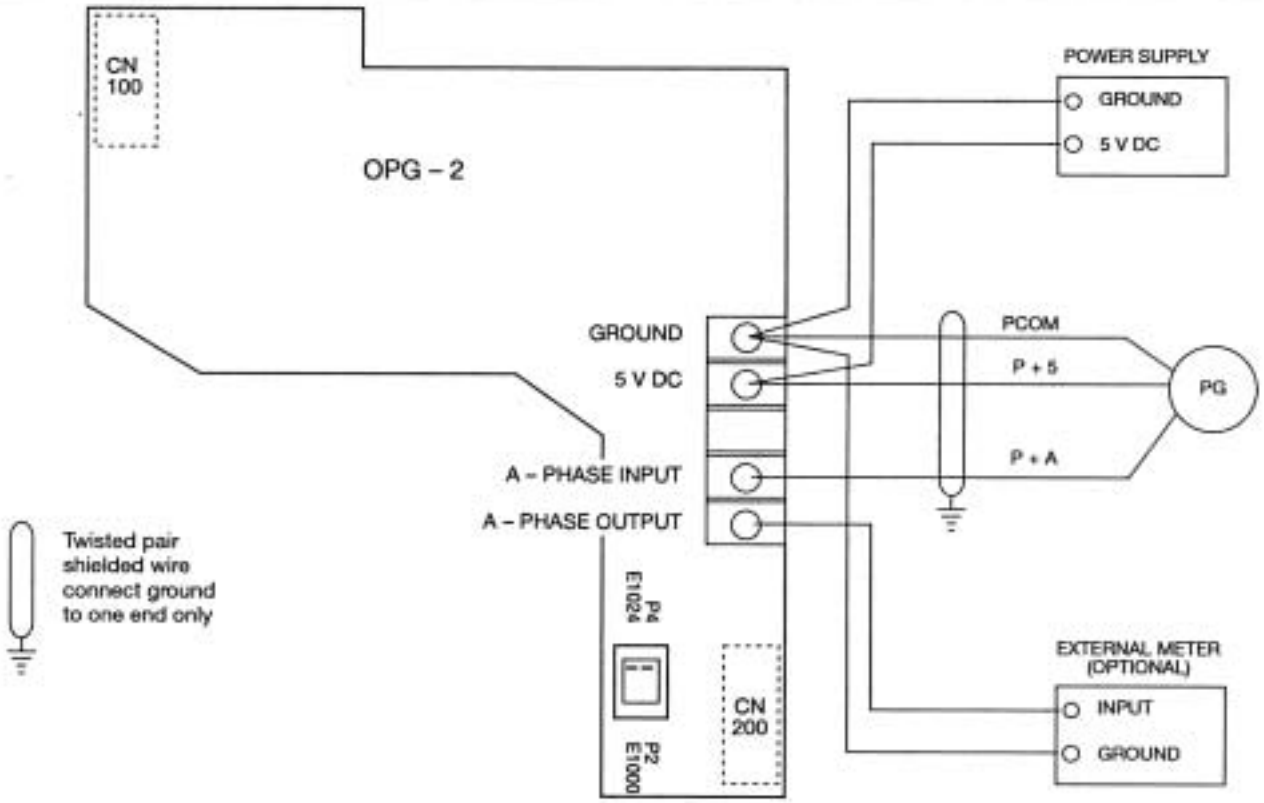
8.2.4 PULSE GENERATOR CARD (OPG)

The pulse generator card is a plug-in option card allowing closed-loop speed regulation to be accomplished with AF–500 inverters and a meter equipped with a 1000 or 1024 pulses per revolution shaft encoder. Field installation of this operation into an existing AF–500 inverter requires replacement of the existing EPROM (Erasable Programmable Read Only Memory) chip. Contact your local Sumitomo Representative or the factory for assistance.

1. Wiring

Connect the shaft encoder to the appropriate terminals on the OPG card as shown in one of the following diagrams. Only one phase is used





NOTE: The OPG card does not provide a source of +5 or +12VDC required by the encoder. This power must be provided from an external source.

A connection to the output terminal on the OPG card is not required. If needed, a remote speed meter (frequency counter with appropriate scaling) can be connected to terminals output and GND.

2. Start Up

A. Position the miniature switches on the OPG card as shown above to select the proper number of PPR (1000 or 1024) for the encoder and the number of poles of the motor (2 or 4).

B. Program function codes 52 through 55 for the desired operation. Refer to Section 6, Programming, for details.

9. SPECIFICATIONS

9.1 RATINGS

380/400/460V RATED CONTROLLERS

RATED OUTPUT CURRENT	3 PHASE INPUT VOLTAGE							
	400V ± 10%, 50HZ ± 5% 400-460V ± 10%, 60HZ ±5%				380V ± 10%, 50HZ ± 5%			
	kW*	HP*	kVA	MODEL NO.	kW*	HP*	kVA	MODEL NO.
4.0A	1.5	2	3.2	AF504-1A5	1.5	2	2.6	AF503-1A5
6.0A	2.2	3	4.6	AF504-2A2	2.2	3	3.9	AF503-2A2
8.7A	3.7	5	6.6	AF504-3A7	3.7	5	5.7	AF503-3A7
13.0A	5.5	7.5	10.4	AF504-5A5	5.5	7.5	8.6	AF503-5A5
17.0A	7.5	10	13.5	AF504-7A5	7.5	10	11.2	AF503-7A5
24.0A	11.0	15	19.0	AF504-011	11.0	15	16.0	AF503-011
33.0A	15.0	20	25.0	AF504-015	15.0	20	22.0	AF503-015
44.0A	22.0	30	36.0	AF504-022	22.0	30	31.0	AF503-022
62.0A	30.0	40	47.0	AF504-030	30.0	40	41.0	AF503-030
62.0A		50	54.1	AF504-030A				
76.0A	37.0	50	58.0	AF504-037	37.0	50	50.0	AF503-037
93.0A	45.0	60	71.0	AF504-045	45.0	60	61.0	AF503-045
117.0A	55.0	75	87.0	AF504-055	55.0	75	75.0	AF503-055
152.0A	75.0	100	116.0	AF504-075	75.0	100	100.0	AF503-075
152.0A		125	133.4	AF504-075A				
186.0A	90.0	125	142.0	AF504-090	90.0	125	122.0	AF503-090
186.0A		150	163.6	AF504-090A				
228.0A	110.0	150	174.0	AF504-110	110.0	150	150.0	AF503-110
228.0A		200	214.0	AF504-110A				
260.0A	132.0	200	225.0	AF504-132	132.0	175	185.0	AF503-132

* Select controller based on motor full load amperes not kW or HP.

200/230V RATED CONTROLLERS

RATED OUTPUT CURRENT	3 PHASE INPUT VOLTAGE			
	200V ± 10%, 50HZ ± 5% 200-230V ± 10%, 60HZ ±5%			
	kW*	HP*	kVA	MODEL NO.
3.2A	0.4	0.5	1.3	AF502-A40
4.8A	0.75	1	1.9	AF502-A75
8.0A	1.5	2	3.2	AF502-1A5
11.1A	2.2	3	4.4	AF502-2A2
17.4A	3.7	5	6.9	AF502-3A7
26.0A	5.5	7.5	10.4	AF502-5A5
34.0A	7.5	10	13.5	AF502-7A5
48.0A	11.0	15	19.0	AF502-011
65.0A	15.0	20	26.0	AF502-015
93.0A	22.0	30	37.0	AF502-022
124.0A	30.0	40	49.0	AF502-030
152.0A	37.0	50	60.0	AF502-037
186.0A	45.0	60	74.0	AF502-045

* Select controller based on motor full load amperes not kW or HP.

9.2 GENERAL

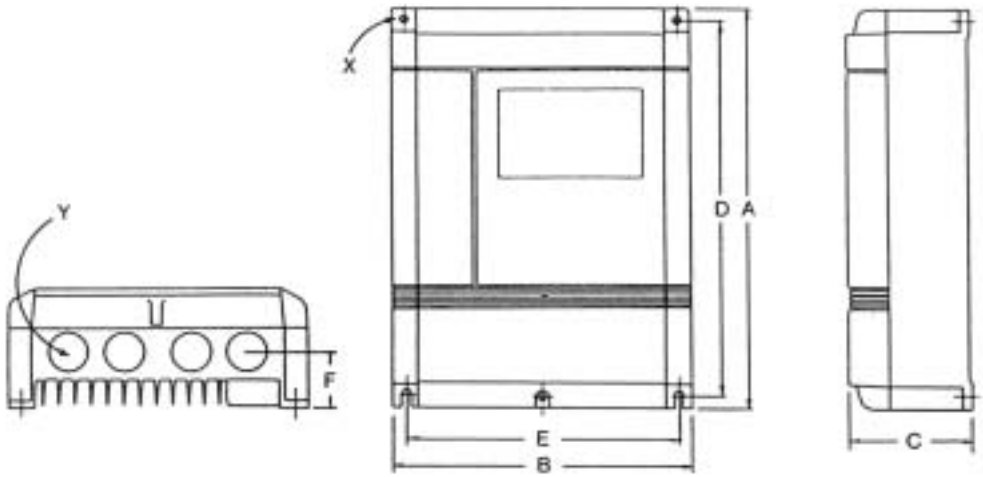
Control System	Flux Linkage Pulse Width Modulated				
Frequency Accuracy	Digital Setting: ±0.01% Analog Setting: ±0.5% (25°C ± 10°C)				
Frequency Range	0.5 – 400 Hz User Programmable				
Volts/Hz Ratio	28 Pre-programmed Patterns				
Voltage Boost	25 Patterns manual boost plus automatic boost				
Acceleration or Deceleration Rate	0.1 sec to 9999 sec per 50Hz change				
Programmable Features	DC Injection Braking, start into coasting motor, minimum and maximum speed limits, preset jogging speed, frequency avoidance, auto restart after electronic trip... Refer to the program functions for a complete list.				
Signal for Setting Freq.	Digital setting by keypad or external analog signal 0-5 VDC, 0-7.5 VDC, 0-10 VDC, or 4-20 mADC				
Protection Functions	Instantaneous Electronic Trip for: • Overcurrent • Output Short Circuit • Sustained Overload • Overvoltage • Overheat • Emergency Stop • Undervoltage • DB Resistor Overheat Current limit will reduce rate of acceleration or deceleration to avoid tripping.				
Operating Display	4-digit 7-segment LED displays operating frequency (Hz) or current (A), fault code, and programming information. 10-segment LED bar chart displays operating frequency (%). LED indication of READY, ALARM, STOP, FWD, REV, Hz, and A.				
Overload Capacity	150% for 60 seconds				
Mounting Location	Indoors. Ambient temperature – 10 to 40°C (50°C with the covers removed). Relative humidity less than 90%, non-condensing. Vibration less than 0.5G. Atmosphere not exposed to steam, electrically conductive dusts, or corrosive gasses.				
Enclosure	Drip Proof (NEMA 1)				
Motor Braking	DC Braking, 1 – 60 Seconds (All Controllers)				
		Model	Transistor	Resistor	Torque
	Dynamic Braking	AF502-A40 thru AF502-A75	Standard	Standard	150%
		AF502-1A5 thru AF502-3A7	Standard	Standard	100% [1]
		AF502-5A5 thru AF502-7A5	Standard	Standard	40% [1]
		AF502-011 thru AF502-045	Optional	Optional	20% [2]
		AF504-1A5 thru AF504-015	Standard	Optional	20% [2]
		AF504-022 thru AF504-110	Optional	Optional	20% [2]
		AF503-All	See AF504	See AF504	

[1] Torque with standard resistor. Can be increased with selection of optional resistor.
[2] Value listed is developed by motor and controller losses. Proper resistor selection can increase this value up to 150%. Consult factory for assistance.

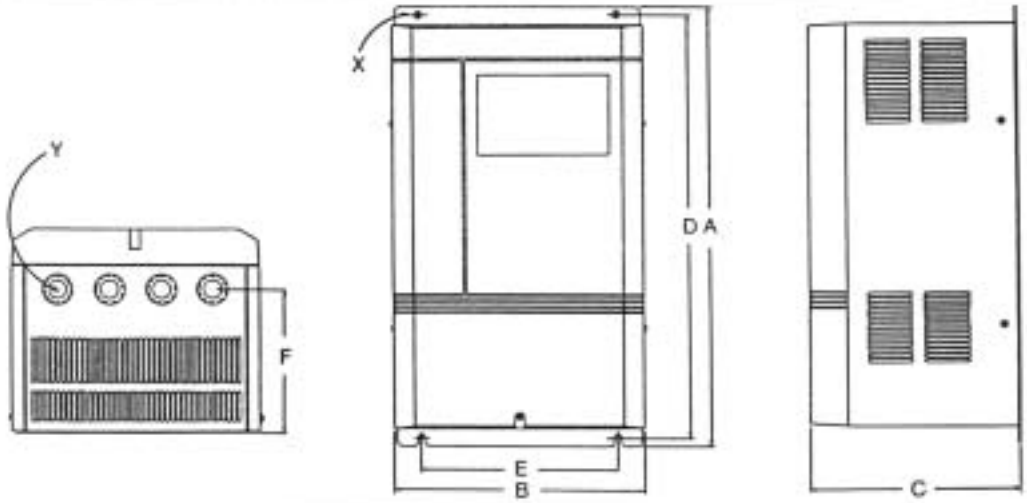
10. DRAWINGS

10.1 AF-500 DIMENSIONS

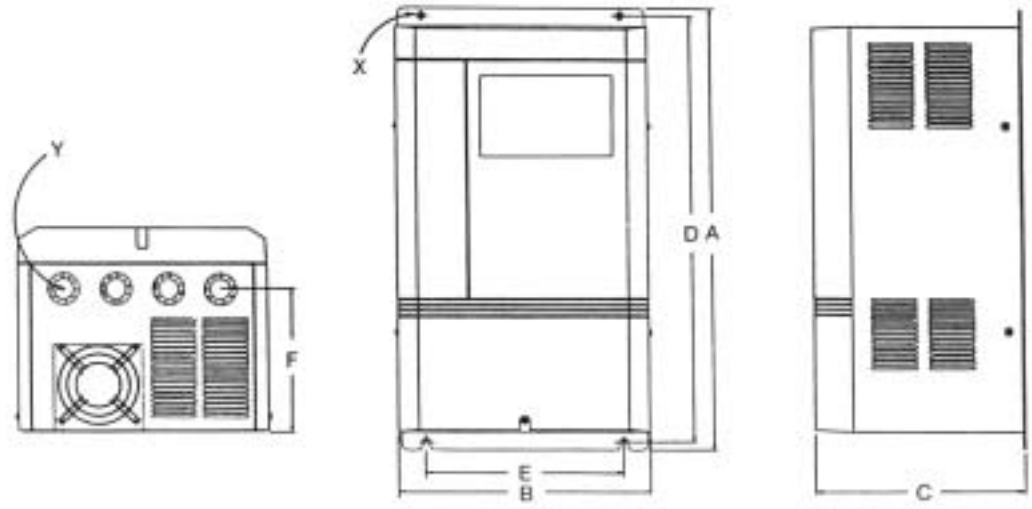
TYPE 1

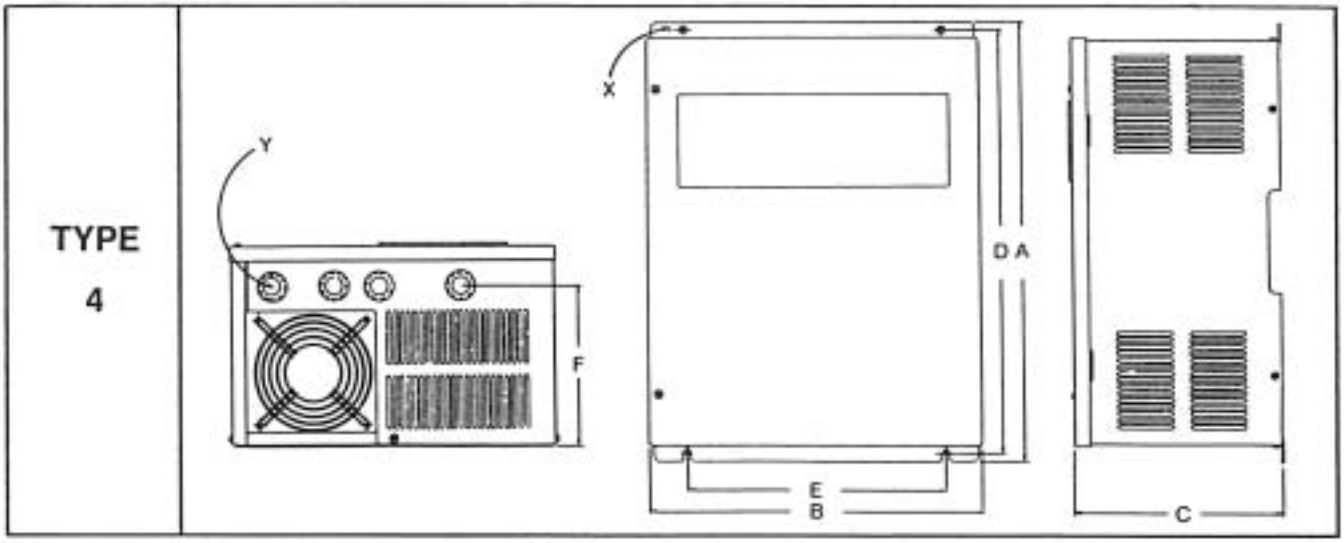


TYPE 2



TYPE 3



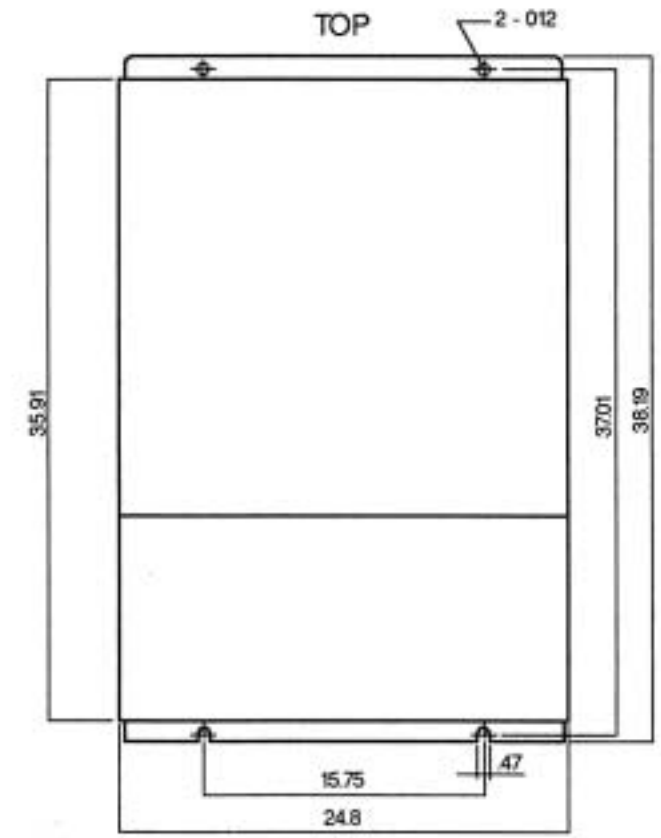


DIMENSIONS NEMA-1 ENCLOSURE (AF504-132, AF503-132 See Page 60)

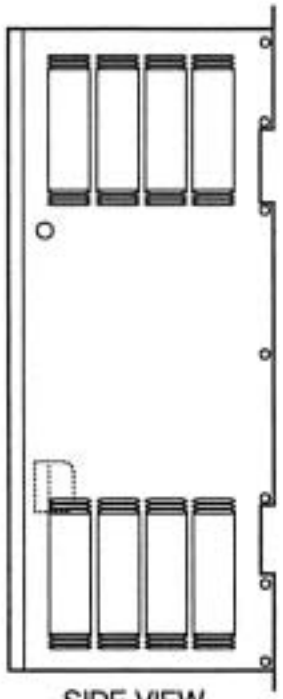
VOLTAGE	MODEL NO.	ENCL. TYPE	DIMENSIONS (INCHES)								NO. FANS	WT (LBS)
			PHYSICAL				MOUNTING					
			A	B	C	D	E	F	X	Y		
230	AF502-A40 AF502-A75	1	11.81	8.66	3.54	11.02	7.87	1.61	0.28	0.87	— —	7 7
	AF502-1A5 AF502-2A2 AF502-3A7	1	11.81	8.66	6.5	11.02	7.87	5.51	0.28	1.1	— 1 1	12 14 14
	AF502-5A5 AF502-7A5	3	16.93	9.45	7.48	16.34	7.48	5.51	0.28	1.02	1 1	24 24
	AF502-011 AF502-015	4	19.5	11.02	8.66	18.9	7.87	6.5	0.28	1.02	1 1	37 37
	AF502-022	4	23.23	11.81	9.05	22.44	8.27	7.2	0.39	1.02	1	57
	AF502-030	4	23.82	13.38	11.02	23.03	9.84	8.8	0.39	1.62	2	75
	AF502-037 AF502-045	4	26.97	18.11	11.81	26.18	12.6	9.45	0.39	1.62	2 2	116 116
380* 400 460	AF504-1A5 AF504-2A2 AF504-3A7	2	16.93	9.45	7.87	16.34	7.48	5.51	0.28	1.02	—	21 21 21
	AF504-5A5 AF504-75	3	16.93	9.45	7.87	16.34	7.48	5.51	0.28	1.02	1 1	24 24
	AF504-011 AF504-015	4	16.93	12.6	7.87	16.34	9.84	6.3	0.28	1.02	1 1	34 34
	AF504-022	4	22.05	12.6	8.27	21.26	9.84	6.5	0.28	1.38	1	46
	AF504-030 AF504-030A	4	23.82	12.99	11.81	23.03	9.84	9.64	0.39	1.38	1 1	73 73
	AF504-037 AF504-045	4	25.59	14.96	11.81	24.8	10.36	9.17	0.39	2.00	2 2	88 88
	AF504-055 AF504-075 AF504-075A	4	31.5	20.47	13.78	30.71	15.75	10.62	0.47	2.48	2 2 2	147 147 147
	AF504-090 AF504-090A AF504-110 AF504-110A	4	38.19	24.02	14.96	37.01	15.75	12.51	0.47	2.48	4 4 4 4	220 220 220 220

* Note: For 380V units, substitute AF503- for AF504-. All dimensions are the same.

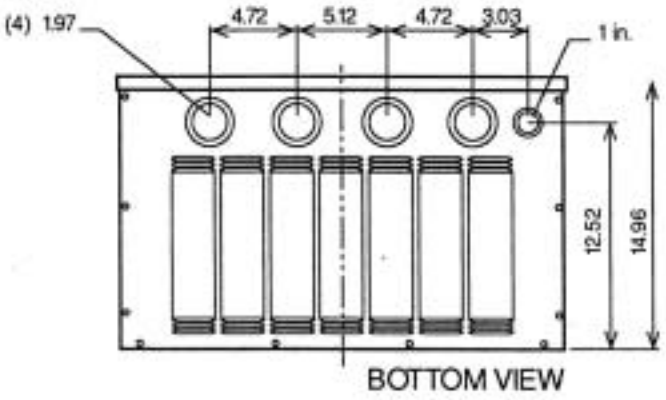
DIMENSIONS & WEIGHT AF504-132, AF503-132



FRONT VIEW

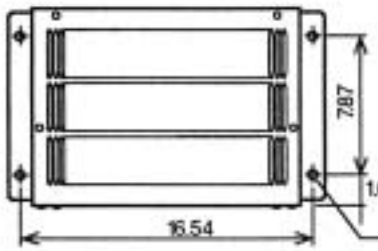


SIDE VIEW

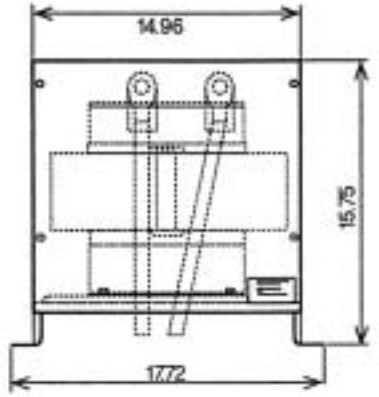


BOTTOM VIEW

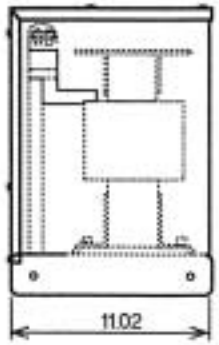
DC LINK REACTOR



TOP VIEW



FRONT VIEW



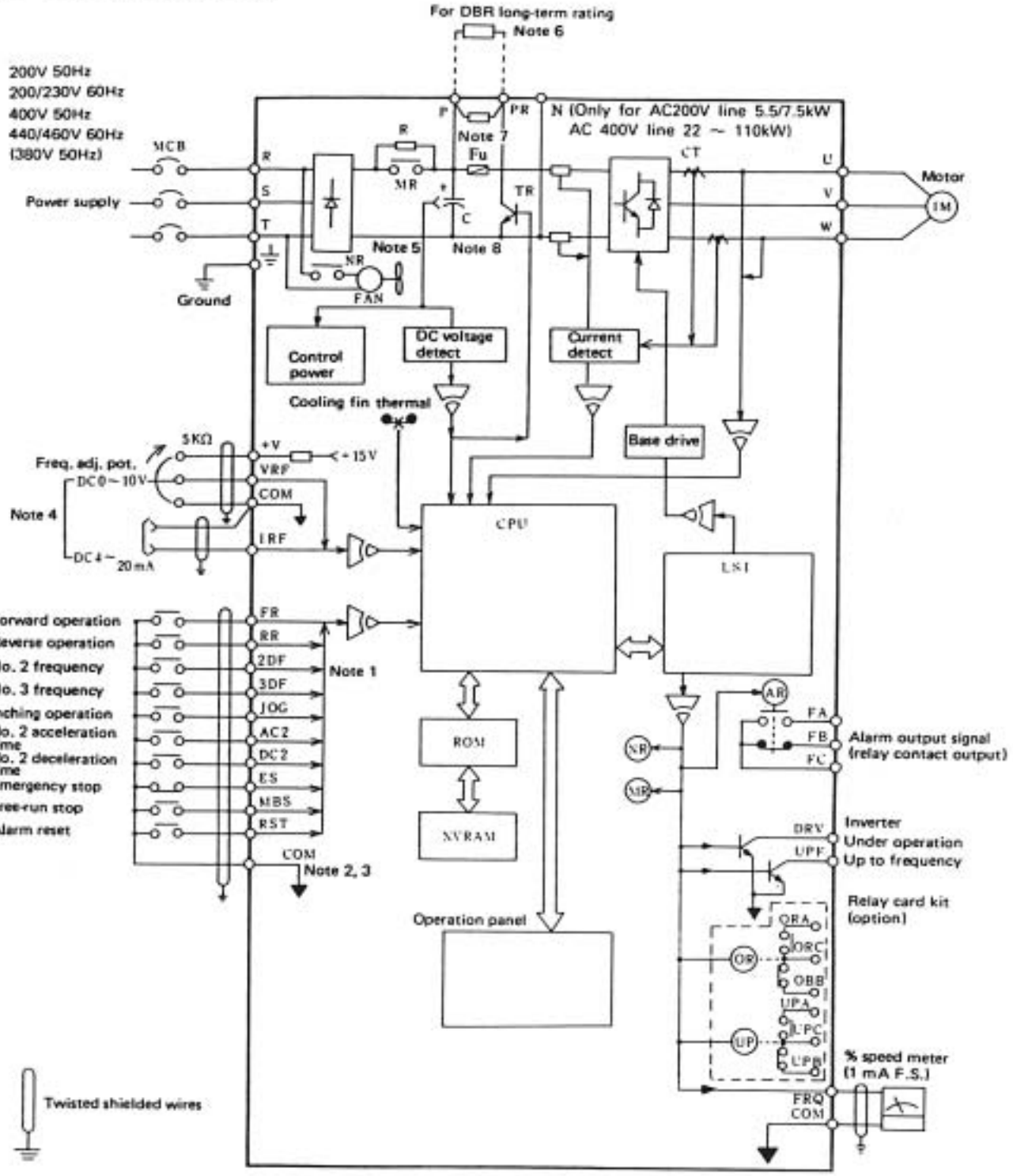
SIDE VIEW

WEIGHT:

CONTROLLER: 265 lbs.

DC LINK REACTOR: 90 lbs.

10.2 BLOCK DIAGRAM



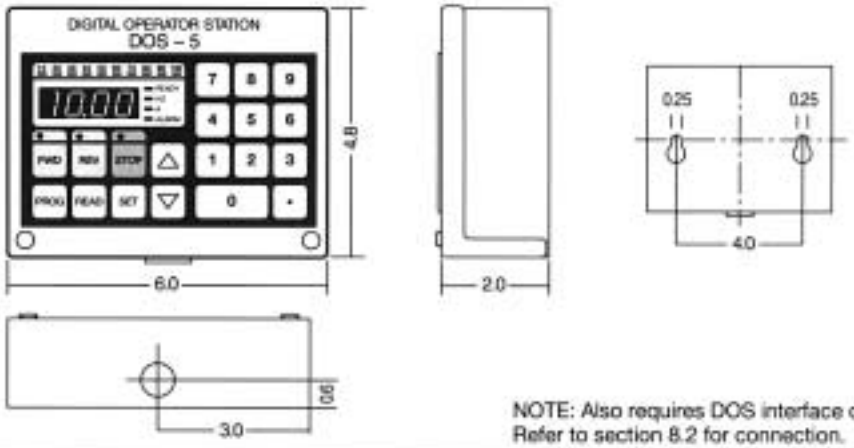
NOTE:
1. When 4th freq. is required both, 2DF and 3DF are to be closed at the same time.
2. The COM is the common terminal.
3. Only one COM terminal available for all common signal wires.
4. When the speed signal is input externally.
5. FAN and NR is not used for 200/230V, 0.4 ~ 7.5kW (0.5-2HP) and 400/460V 1.5kW ~ 3.7kW (2-5HP).
6. DBR resistor is already internally connected for 200/230V 0.4 ~ 7.5kW (0.5-10HP).
7. Fu is not used for 200/230V 0.4 ~ 3.7kW (0.5-5HP).
8. DB T_R is not installed for 200/230V 11 ~ 45kW (15-60HP) and 400/460V 22 ~ 110kW (30-150HP), use optional DB unit(s) and DBR resistors.
9. All contacts must be maintained during performance of the desired function.

10.3 REMOTE OPERATOR STATION OUTLINE & CONNECTION DIAGRAMS

DIGITAL OPERATOR STATION

DOS-5

(NEMA 1)

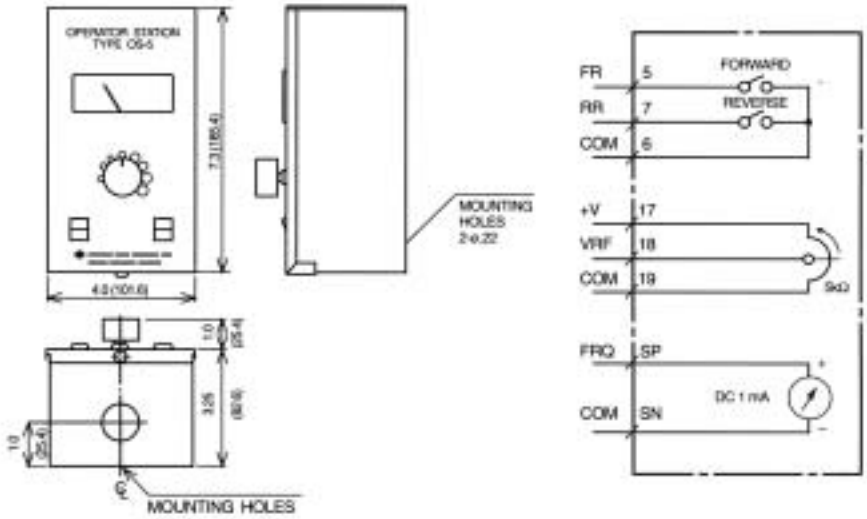


NOTE: Also requires DOS interface card
Refer to section 8.2 for connection.

REMOTE OPERATOR STATION

0S-5

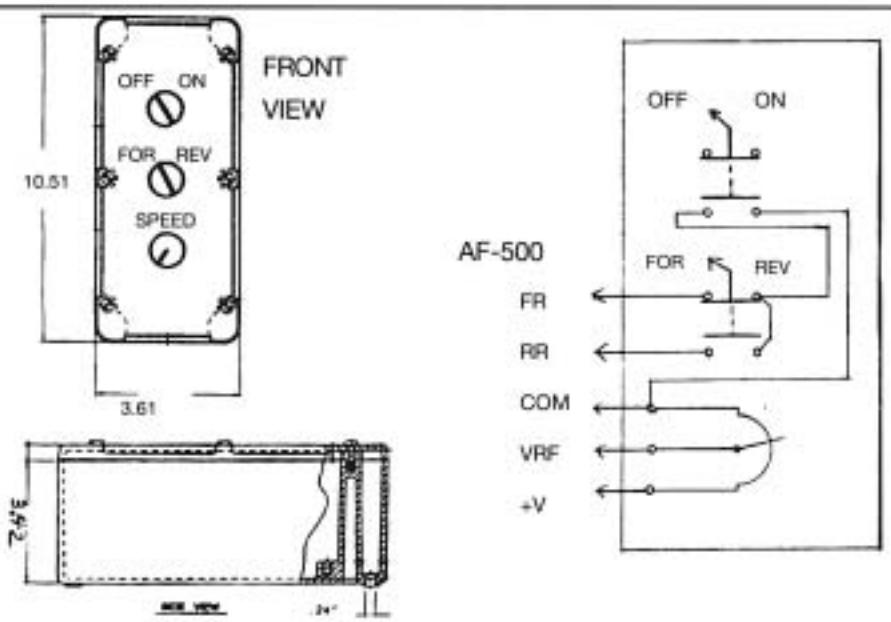
(NEMA 1)



REMOTE OPERATOR STATION

0S-4

(NEMA 4/12)



10.4 THREE-WIRE CONTROL USING THE ORU BOARD

When operation command for the AF500 is set for external (Cd04 = 1), a maintained contact on terminal FR (for forward operation) or RR (for reverse operation) is required for the inverter to operate. If this contact remains closed during a power outage, restoration of power will result in the AF500 and its connected motor restarting. In some applications this could be a safety hazard.

The optional relay board (ORU – 1 or ORU – 2) can be used to provide 3-wire control as shown in Figure 1 or Figure 2 below. Using either of these circuits will require the Start push-button to be pressed before the AF500 will operate. Loss of power will cause the relay to open insuring that the AF500 will not automatically restart when power is restored.

Note: The ORU board includes 2 relays. It is suggested that the relay labeled UPF (Up to Frequency) be used. This leaves the other relay free for Run indication if required.

Figure 1 – Single Direction Control

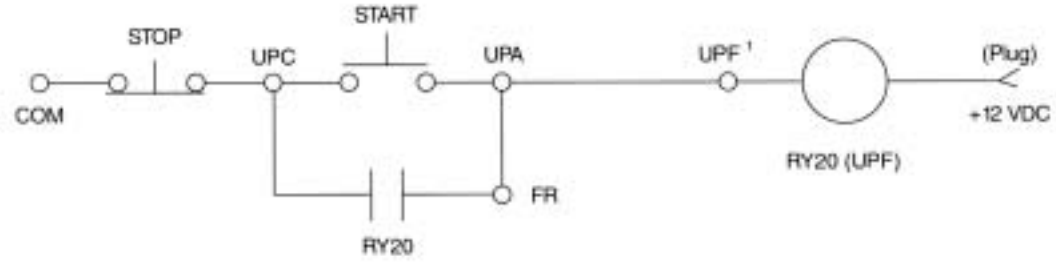
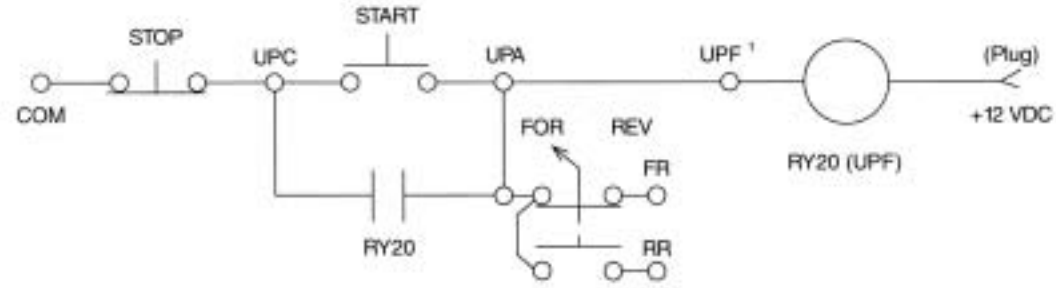


Figure 2 – Bi-directional Control

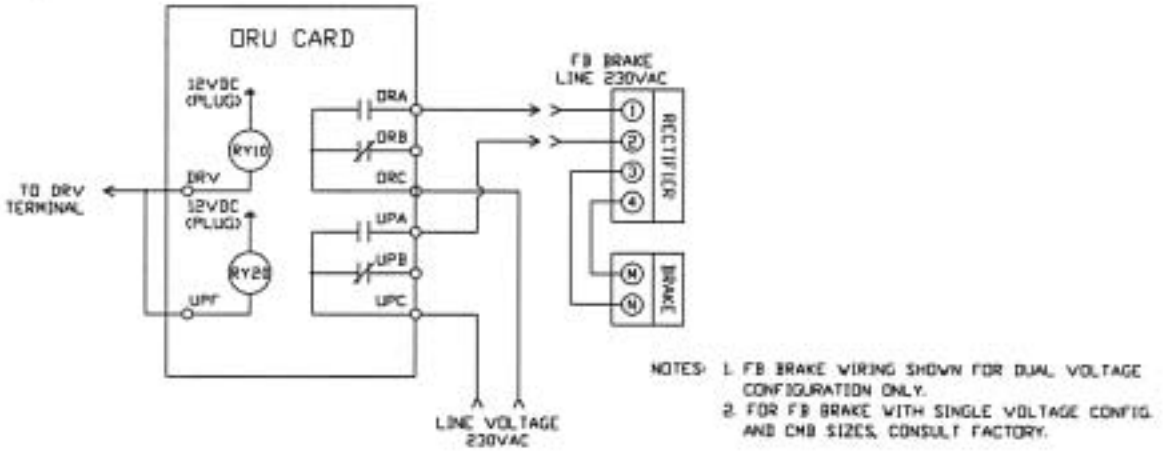


NOTE: [1] UPF Terminal is the brown wire with the ring tongue lug.

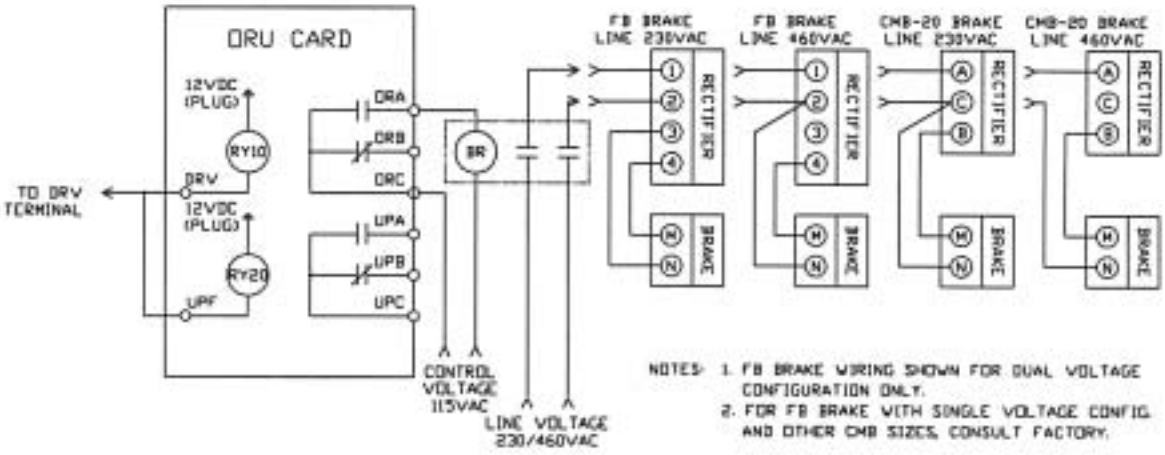
10.5 TYPICAL MOTOR BRAKE CONNECTIONS (SUMITOMO BRAKE MOTORS)

Inverter operation of a brakemotor requires the brake to be powered from line voltage and not from the inverter. For the AF500, ORU-1 Card is available to control the brake in conjunction with the inverter operation. Typical wiring for standard SUMITOMO brakemotors is shown below.

1. 230V Wiring (ORU CARD only)



2. 230/460V Wiring (ORU Card and Customer-supplied Relay)



3. Standard Configuration

FB Dual Voltage Brake is the standard brake through 15HP and can be identified by the rectifier, 25FW-4FB. The brake coil is rated for 200VDC. Standard CMB-20 brake uses SB25F-3HS rectifier and 200VDC rated coil.

4. Non-standard Configuration and ORU Card Only Wiring

Voltage rating of the ORU contacts limit the applied voltage to a maximum of 250VAC. Amperage rating of the ORU Card contacts limit the size of the brake thru FB-3A for 100VDC FB brake and thru CMB-5 for 200VDC CMB brake. All 200VDC (i.e. Std.) FB brake can be wired through the ORU card without the additional relay.

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