

Adjustable Speed, AC Motor Controllers 1 through 75 HP

- 1-75HP
- 3 Selectable Control Modes
 - Space Vector Drive
 - Encoderless Vector Drive
 - Flux Vector Drive
- 208/230/460 Volt 3 Phase
- PID Outer Loop Control
- IGBT Power Section
- Plain English Word Messages, Faults, Etc.
- NEMA 1 Enclosures
- RS485 Serial Port standard
- Isolated Regulator
- UL/cUL Listed, CE Marked
- Output Fault Protected – Line to Line –
Line to Ground
- Metasys N2 Standard
LONworks Optional



FIGURE 1. 6500 SERIES

GENERAL

Fincor Series 6500 controllers are general purpose, microprocessor based, software-controlled units representing significant advances in AC drive technology. Design features include a comprehensive operator control and programming panel for digital setup, troubleshooting, and self-diagnostics. Optional capabilities include remote interrogation, digital speed input and serial communication for direct control by programmable logic controllers and computers.

The Fincor Series 6500 Controllers offer three methods of motor control:

1. Traditional Space Vector Volts per Hertz (V/F) control
2. Sensorless Torque Control (Encoderless) for improved torque control over the rated speed range.
3. Closed Loop Flux Vector Control (with the addition 1761 Encoder Feedback) for improved speed range (see Table 2).

Fincor Series 6500 controllers provide wide range adjustable speed control of conventional AC induction motors in applications exhibiting a variety of load characteristics.. The unit converts the fixed frequency and voltage of the AC line power source to a sine coded pulse width modulated (PWM) adjustable voltage and frequency output that will control induction motors over a wide speed range.

This is efficiently accomplished by a constant potential link coupled inverter system that maintains a uniformly high displacement power factor throughout the speed range without inducing undesirable voltage notch distortion back to the power source.

The power section uses insulated-gate bipolar transistors (IGBT's) operating at carrier frequencies up to 10 KHZ which provide low motor noise, high starting torque, and cool motor operation. The design features of the basic units shown in Figure 1, and available options allow application of the 6500 controllers to numerous industrial applications requiring constant horsepower, constant torque, or variable torque.

1. Electrical Codes:

Fincor 6500 controllers are designed and manufactured to comply with applicable standards established by the National Electric Code, and NEMA for industrial motor and control equipment. They are UL and Canadian UL listed and CE compliant (See design features & functions #50).

TABLE 1: SERIES 6500 MODEL MATRIX

HP	3-Phase	4-Phase	5-Phase	Model	Efficiency	Speed	Speed
1	.746	4.6	4.2	6501S00125A	8.56	7.25	7.51
1 1/2	1.12	6.6	6.0	6501S001525A	8.56	7.25	7.51
2	1.49	7.5	6.8	6501S00225A	8.56	7.25	7.51
3	2.24	10.6	9.6	6501S00325A	8.56	7.25	7.51
5	3.73	16.7	15.2	6501S00525A	8.56	7.25	7.51
7.5	5.60	24.2	22	6502S00725A	13.88	7.25	8.12
10	7.46	30.8	28	6502S01025A	13.88	7.25	7.50
15	11.19	46.2	42	6503S01525A	19.13	7.25	10.38
20	14.92	59.4	54	6503S02025A	19.13	7.25	10.38
25	18.65	74.8	68	6504S02525A	28.31	7.25	10.38
30	22.38	88	80	6504S03025A	28.31	7.25	10.38

HP	3-Phase	4-Phase	5-Phase	Model	Efficiency	Speed	Speed
1	.746	2.1		6501S0013A	7.48	7.25	7.51
1 1/2	1.12	3.0		6501S00153A	7.48	7.25	7.51
2	1.49	3.4		6501S0023A	7.48	7.25	7.51
3	2.24	4.8		6501S0033A	7.48	7.25	7.51
5	3.73	7.6		6501S0053A	7.48	7.25	7.50
7.5	5.6	11.0		6502S0073A	13.88	7.25	8.12
10	7.46	14.0		6502S0103A	13.88	7.25	7.50
15	11.19	21.0		6503S0153A	19.13	7.25	10.38
20	14.92	27.0		6503S0203A	19.13	7.25	10.38
25	18.65	34.0		6504S0253A	22.13	7.25	10.38
30	22.38	40.0		6504S0303A	22.13	7.25	10.38
40	29.84	52.0		6505S0403A	27.00	14.28	10.38
50	37.30	65.0		6506S0503A	27.00	14.38	10.38
60	44.76	77.0		6506S0603A	27.00	14.38	10.38
75	55.95	96.0		6506S0753A	27.00	14.38	10.38

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MODEL TYPES

Series 6500 controllers are offered in 14 basic power frame configurations comprising 33 models covering the range of 3 to 400 HP as shown in TABLE 1. See TABLE 5 for dimensions and weights.

RATINGS

- Horsepower Range**..... 1 - 75 HP (see Table 1)
- Power Source (1)**..... 208/230 or 460V, 3-Phase, 50 or 60 Hz
- Output Power (Three-Phase)**
 - Voltage** 0 - 208/230, 0 - 460 V
 - Frequency (3)**..... 0 to 400 Hz. Constant Torque (Constant V/Hz) 50 to 400 Hz Constant HP (Constant V, Variable Hz)
- Service Factor**..... 1.0
- Duty**..... Industrial, Continuous
- Overload Capacity**..... 150% for 1 minute
- Linearity (Output to Input)** ± 0.1% maximum.
- Reference Power Supply**..... 10 VDC @ 5 mA
- External Reference Source (2)**..... 0 - 10 VDC 2 - 10, 4 - 20, or 10 - 50 mA (4)
- Magnetic (Pushbutton) Control Voltage** 24 VDC
- Storage Temperature** 0 - 70 ° C.
- Relative Humidity**..... 95% Non-condensing.

- NOTES**
- 190V, 380V, and 415V models are available.
 - Isolated reference, external control signal may be grounded or ungrounded.
 - Standard frequency ranges 0 - 400 Hz, (See Figure 2).
 - 2 - 10 mA and 10 - 50 mA input require an external load resistor.

PERFORMANCE CHARACTERISTICS

- Controlled Speed Range:** Minimum speed to motor base speed, constant or variable torque with NEMA B AC induction motors (see Table 2). Selectable constant HP operation is a standard capability.
- Speed Regulation (See Table 2):** Regulation percentages listed are of motor rated (base) speed under steady-state operating conditions.

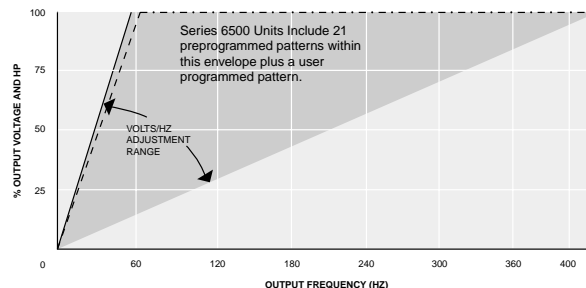
TABLE 2: SPEED REGULATION

Regulation Method	Motor Type		Load Change 95%	Line Voltage +/- 10% (1)	Motor Heating Cold to Normal	Temperature +/-10 C (Controller and Motor)	Speed Range
	Induction	Synchronous					
Normal Volts per Hertz (2)	X	----	3.00%	0.50%	1.00%	0.25%	30:1
	----	X	0.00%	0.00%	0.00%	0.25%	60:1
Slip Comp Volts per Hertz (2)	X	----	1.00%	0.50%	0.50%	0.25%	30:1
	----	X	0.00%	0.00%	0.00%	0.00%	60:1
Normal Sensorless Torque Control (2)	X	----	0.50%	0.50%	0.50%	0.25%	100:1
	----	N/A	----	----	----	----	----
Option 1761 Encoder Feedback (3)	X	----	0.02%	0.02%	0.02%	0.25%	1000:1
	----	N/A	----	----	----	----	----

- NOTES:**
- (1) Shown at full load, full speed.
 - (2) Listed are average, expected values when using a wide range of standard motors. Results may vary with some makes.
 - (3) 1000 PPR (Minimum) encoder.
- Frequency Resolution (at 60 Hz)**
 - Analog Input 0.0146 Hz
 - Digital Input 0.0060 Hz
 - Frequency Stability**..... 0.005 %
 - Switching Frequency (Selectable)**..... 4-20 KHz
 - Efficiency (at rated speed, rated load @ the specified carrier frequency)**

Carrier Frequency (KHz)	2	3	4	5	6	7	8	9	10
Controller	97.0%	96.8%	96.6%	96.4%	96.2%	96.0%	95.8%	95.6%	95.4%
Controller with 93% Efficient Motor	90.2%	90.0%	89.8%	89.7%	89.5%	89.3%	89.1%	88.9%	88.7%

- Displacement Power Factor**.....95% or better



- ADJUSTMENT RANGE FOR CONSTANT TORQUE APPLICATIONS.
- - - - - ADJUSTMENT RANGE FOR CONSTANT HP APPLICATIONS.
- ADJUSTMENT RANGE FOR 60 HZ CONSTANT TORQUE APPLICATIONS. FINCOR SERIES 6500 UNITS ARE ADJUSTED FOR THIS PATTERN AS SHIPPED.

FIGURE 2: VOLTS/HERTZ ADJUSTMENT RANGE

ADJUSTMENTS

All adjustments are programmed digitally via the standard integral operator panel or the standard serial port. Basic adjustments include:

1. **Acceleration (Linear)**0.1 - 1900.0 Seconds
(S Curve)3.0 - 120.0 Seconds
2. **Deceleration (Linear)**0.1 - 1900.0 Seconds
(S Curve)3.0 - 120.0 Seconds
3. **Minimum Speed (6)**0 - 75.00 %
4. **Maximum Speed (6)**50.00 - 100.00 %
5. **Torque Limit (7)**20.00 - 200.00 %
6. **Jog Speed (6)**0 - 100.00 %
7. **Torque Boost (8)**0 - 200.00 %
8. **Slip Compensation**0 - 100.00 %
9. **Volts/Hz Trim**±20.00 % of Nominal Setting
10. **Preset Speeds, 7 Provided (6)**0 - 100.00 %
11. **Field Trim (9)**50.00 - 200.00 %

- NOTES:** (6) % of Maximum Frequency.
 (7) Motor design typically limits available torque to 200%.
 (8) % of Rated Torque. Applicable only in Volts/Hz mode.
 (9) % of Rated Current. Applicable only in Vector Control mode.

OPERATING CONDITIONS

1. **Line Voltage Variation**±10% of rated
2. **Line Frequency Variation**50 or 60 Hz ±5 %
3. **Ambient Temperature**0 - 40 °C (32 - 104 °F)
4. **Altitude (Standard)**3300 feet (1000 meters) maximum
5. **Relative Humidity** 95% Non-condensing

DESIGN FEATURES AND FUNCTIONS

1. **Construction** - Compact, high density, dead back configuration. Standard Series 6500 units are furnished in a ventilated NEMA type 1 (IP 20) enclosure. Most units include an external fan to force cooling air over fins on the back of the enclosure to aid dissipation of internal heat.
2. **Microprocessor Design** - Series 6500 units use a powerful 16-bit microprocessor for logic, communications, regulator functions, and generation of the PWM waveform to control the motor.
3. **Power Devices** - Series 6500 controllers use state of the art Insulated Gate Bipolar Transistor (IGBT) power switches. IGBT's require less gate drive power, which reduces internal controller temperatures. Their extremely high speed switching capability provides a superior waveform for greater starting torque, cooler and virtually inaudible motor operation. Fast turn-off prevents damage in the event of an output short circuit.
4. **PWM Modulation Technique** - Series 6500 controllers use modified voltage vector modulation for smooth, quiet motor operation. Asynchronous modulation eliminates undesirable "Gear Shifting" sounds produced by earlier designs. Sensorless Torque Control is selectable and Closed Loop Flux Vector control is available with the addition of option 1761.



FIGURE 3. OPERATOR PANEL FOR SERIES 6500 CONTROLLERS

5. **Operator Panel** - Series 6500 units include a versatile, digital operator control panel mounted on the front cover of the unit. The panel includes a membrane keypad, and an LCD display that enables its use for set-up and monitoring of all controller functions, operating parameters, self-diagnostics, and also as a local operator control station. The operator panel is a smooth, unbroken surface, which is easy to keep clean and is sealed to prevent the penetration of liquids and dust.
 - A. **Display** - LCD super twist type provides two lines of 16 alphanumeric characters each. Display is backlit, enabling viewing in extremes of lighting conditions including total darkness and is temperature compensated for reliable viewing. Displays motor speed, motor load, and power, and indicates all programmable functions and faults in English language word messages, no cryptic fault codes are used.
 - B. **Visual Indicators** - LED's are provided to indicate power on, direction, run/jog, manual/auto, and "at speed".
 - C. **Keypad** - 10 buttons are provided for local operator control and programming. The buttons include a raised perimeter, which defines the operating area, and tactile feedback, which provides confidence that the command has been entered. The keypad is logically designed with two operating areas, one for local operator control, and the other for programming:
 1. **Local Operator Control** - Buttons and their functions:
 - a. **Stop (controlled)** - Oversized button, easy to locate in an emergency.
 - b. **Forward (FWD)** - Provides forward run/jog function. Includes an LED indicator.
 - c. **Reverse (REV)** - When enabled (at start-up) will provide reverse run function. Includes an LED indicator.
 - d. **Jog** - Alternate presses activate and deactivate the Jog mode. An LED indicator is illuminated when Jog mode is selected. Jog mode makes the operation of the Forward and Reverse buttons momentary.
 - e. **Alternate presses** activate and deactivate the Auto mode. An LED indicator is illuminated when Auto mode is selected. Auto mode allows speed and/or torque control commands to be accepted from alternate or external sources.
 - f. **Faster** - When the "Faster" indicator is illuminated, pressing the up arrow key will increase the local run speed command.
 - g. **Slower** - When the "Slower" indicator is illuminated, pressing the down arrow key will decrease the local run speed command.

- h. Optional Potentiometer - Space is provided to mount an optional speed setting potentiometer. Option 1120K provides a single turn speed setting potentiometer and the dial face for mounting in a dedicated area on the operator panel. The potentiometer is used instead of the faster-slower buttons to set motor speed.
- 2. Programming Buttons and their functions:
 - a. Menu - Selects adjustable drive parameters, which can then be set with the arrow buttons.
 - b. Arrow Buttons - Arrow up, arrow down, arrow right, and arrow left buttons are provided to select, program, and monitor all operating parameters.

Optionally, Series 6500 units may be provided without the standard, integral, digital operator panel as enabled by options 1710 and 1711. The 6500 in this configuration is then programmed and monitored by a personal computer via the standard serial port.

- D. Programming - The 6500 controller provides three levels of user programmability.

Level One - Without entering a password or entering the menu operating system, the user may change the motor speed and the display configuration for monitoring purposes.

Level Two - Upon entering the menu system by pressing the Menu button, the user may adjust any of the most commonly adjusted parameters without entering a password. These parameters are listed as adjustments under ADJUSTMENTS - Page 3 (excludes preset speeds and field trim).

Level Three - Upon entering the menu system and entering a password, the operator has access to all programmable features of the 6500. This level is intended for complex or nonstandard control applications. A partial list of available functions includes:

- | | |
|---------------------------------|----------------------------------|
| a. Line Starting | j. Torque Boost |
| b. Operating Patterns | k. Regeneration Limit |
| c. Volts/Hertz | l. Dwell |
| d. Resonant Frequency Avoidance | m. Torque Taper |
| e. Carrier Frequency Select | n. Auto Restart |
| f. Static Braking | o. PID Control |
| g. DC Injection Braking | p. Digital Input Selection |
| h. Start into Rotating Motor | q. Digital Signal Output |
| i. Inv. Time Overload | r. Analog Signal Input Selection |
| | s. Analog Output |
| | t. Operating Mode Selection |

- E. Security Code - All 6500 adjustments may be protected by a "password" access scheme. Once the password has been entered, the user may remove password protection from commonly adjusted parameters that need not be restricted.

- 6. **Keypad Operator Disable** - The Operator control functions described above can be disabled if desired by changing a parameter in the 6500 AC Drive.
- 7. **Operating Modes** - Series 6500 controllers provide three basic operating modes selectable via the operator panel.
 - A. Control Mode - Permits Run-Stop-Jog-Reverse-Manual/Auto functions and speed control from the integral operator panel, a remote control station, or an external signal source such as a process controller.
 - B. Monitor Mode - In monitor mode the operating state of the 6500 may be observed. English language messages and/or a parameter number inform the operator of the parameter being displayed. The unit may be programmed so any two of the following parameters may be displayed simultaneously.

- | | |
|---------------------------------|-----------------------------|
| 1. Drive Legend (Assigned Name) | 9. Output Voltage |
| 2. Custom Parameter | 10. Ratio |
| 3. Speed Reference | 11. Status |
| 4. Motor Speed | 12. Operating Hours |
| 5. Output Power | 13. None (Display Not Used) |
| 6. Torque Limit Set-point | 14. Motor Current |
| 7. Motor Load | 15. Extended Monitor |
| 8. Output Frequency | 16. Date and Time |
- C. Programming Mode - Allows monitoring and adjustment of all 6500 parameters. Parameters are grouped logically into menus using descriptive English names and a companion identification number for ease of location. Parameters are grouped in descending order from those most general to those more specific for operational simplicity and quick selection.

- 8. **Control Power Supply** - A 24 VDC power supply isolates all magnetic control for pushbuttons and external Run-Stop logic from the AC power source for operator protection and equipment reliability.
- 9. **Over voltage and Under voltage Protection** - Electronic shutdown when line voltage exceeds approximately +10 % of rated or -30% of rated line voltage.
- 10. **Power Loss Ride Through** - The controller has sufficient energy storage to maintain control of the motor for at least 1 second whenever the AC power source is interrupted. Upon reapplication of AC line power within 1 second, the motor will resume its set speed with a minimum of disturbance. The amount of speed droop during the power outage will be determined by the actual motor loading and other mechanical time constants.
- 11. **Power Loss Shutdown** - During power interruption, if power is lost for longer than 1 second, a power loss fault is registered. If a phase of the AC Input is missing for more than 1 second, a phase loss fault will be issued if the drive is running.
- 12. **Automatic Restart** - Series 6500 units may be programmed for automatic restart after any or all of the faults listed under STANDARD DIAGNOSTIC FEATURES, item 3, Faults (Page 7). This feature allows the user to program the number of tries as well as the retry time. Units in the restart mode will display "Restarting".
- 13. **Start into Rotating Motor** - The unit can be programmed to start into a spinning motor. When programmed for this mode of operation, the 6500 can start while the motor is still spinning. The drive will not trip and the motor will not necessarily be brought to zero speed.
- 14. **Line Starting Capability** - The unit can be programmed to start when the main AC power is applied to its input terminals.
- 15. **Visual Indicators** - LED indicators are provided to monitor circuit operation and aid in troubleshooting. Included are individual red LED's showing FWD, REV, JOG, AUTO, POWER, and AT SPEED status.
- 16. **Multiple PWM Switching Frequencies** - The user can program carrier frequencies of 4-20 KHZ. The most efficient operation is produced at the lower carrier frequencies. Series 6500 units through 75 HP are shipped programmed for 5 KHz.
- 17. **AC Line Voltage Calibration** - Holds output voltage constant with rated line variations when output voltage is less than line voltage (10% line voltage variation causes 1% output voltage variation).
- 18. **Volts/Hertz, Sensorless Torque, or Closed Loop Flux Vector Control Operation** - In the Volts/Hertz mode the Volts/Hertz ratio may be trimmed $\pm 20\%$ of nominal. In the Sensorless Torque Control or Closed Loop Flux Vector mode the Motor Torque may be adjusted from 50 to 200% of nominal.
- 19. **Run/Stop Control** - Series 6500 controllers can be remotely started and stopped by:
 - 1. 2 wire control (maintained dry contact)
 - 2. 3 wire control
 - 3. Application of AC Line power
- 20. **Jog Control** - The 6500 features a separate jog function with

- unique directional acceleration/deceleration rates. This feature allows hard or ramp acceleration on jog without affecting run operation.
21. **Isolated Regulator** - Internal logic and control circuits are isolated from the AC power source and internal DC power circuitry for operator and equipment safety and for simplified application. Isolation eliminates the common condition of line voltage to ground potentials being present on the speed control potentiometer.
 22. **PID Control** - A built in Proportional Integral Derivative type control is standard in the 6500. Provides outer loop control of speed, flow, pressure, fluid level, or other process variables. The PID loop may be programmed to accept set-point/feedback input or error input. A flexible configuration scheme allows PID inputs to be either analog or digital with PID gains being separately adjustable.
 23. **Dwell Feature** - The Standard Series 6500 units incorporate this feature providing an adjustable Dwell time and Dwell Speed. This feature is commonly used in pumping HVAC applications. The dwell feature halts acceleration for a period of time at a programmed Dwell Speed.
 24. **Resonant Frequency Avoidance** -The 6500 controller can be programmed to accelerate or decelerate through, but not continuously run at certain frequencies that may cause mechanical and or acoustic resonance. These frequencies are determined by setting a center point and width. Three programmable frequency bands are offered.
 25. **Multiple Motor Operation** - All motors will track the common output frequency of the Series 6500 controller. Synchronous motors are ideal for this purpose since they will provide identical motor-to-motor shaft speeds. For multiple motor operation, only Volts/Hertz operation is recommended.
 26. **Torque Boost** - Provides improved torque capacity at lower speeds to produce up to 200% starting torque with most standard motors. 6500 Torque Boost provides programmable boost level as well as a programmable frequency where maximum boost is obtained. This feature is disabled in sensorless torque or flux vector mode of operation.
 27. **DC Injection Braking** - Provides effective low speed braking by injecting DC current into two motor windings. The braking time period programmable to 25.5 seconds and is engaged under programmable control at start, stop, or both.
 28. **Volts/Hertz Patterns** - 21 preprogrammed and one user programmable pattern is included as standard as shown in the following table. They provide constant horsepower and/or constant torque patterns for a wide range of applications. Additionally, the unit may be programmed for any desired pattern within the frequency and voltage range of the unit as shown by Table 3.

Table 3

Pattern Number	1	2	3	4	5	6	7	8	9	10	11
Frequency at Full Output Voltage	50	60	90	120	180	240	400	50	60	60	60
Maximum Frequency	50	60	90	120	180	240	400	55	66	90	120

Pattern Number	12	13	14	15	16	17	18	19	20	21
Frequency at Full Output Voltage	60	60	60	90	90	90	90	120	120	120
Maximum Frequency	180	240	400	120	180	240	400	180	240	400

The unit is shipped programmed for pattern number 2. Patterns, which permit operation above 60 Hz, may require a special high speed motor. Patterns 3 through 7 produce constant torque from special motors wound for the design operating voltage at the pattern frequency, e.g.: when Pattern 7 is selected for a 460V unit the motor must be wound for 460V at 400Hz.

Pattern 22 shows the range over which the 6500 units may be individually programmed for constant torque or constant HP. Patterns 8 and 9 are for variable torque applications where it may be desirable to trim the pump or fan speed by $\pm 10\%$.

Both Linear and Non-Linear Volts per Hertz curves can be selected. The Non-Linear Volts per Hertz curve offers additional power savings for variable torque loads.

29. **Output Protection** - Line-to-Line and Line-to-Ground output fault protection is provided. Also programmable is output phase loss protection to protect the motor from single-phase operation.
30. **Phase Loss Protection** - The controller detects phase loss and inhibits normal operation as necessary to prevent drive malfunction. If the phase loss is of short duration (less than 1 second), the drive will continue to operate normally until the phase is missing for more than 1 second. When the phase is missing for longer than 1 second a phase loss fault will be generated if the motor is running.
31. **Over Temperature Protection** - A thermal switch on the controller heatsink will shut down the controller in the event of a cooling fan failure or other causes for overheating.
32. **Analog Output⁽¹⁾** - One Analog Output rated 0 - 10 VDC @ 2mA is provided as standard. Two additional analog outputs are available as an option and may be programmed to one of the following parameters:

a) Actual Speed	k) Acceleration Ramp
b) Analog Input #1	l) Analog Input #2
c) Analog Input #3	m) Motor Current
d) Motor Load	n) Motor Voltage
e) None	o) Output Frequency
f) PID Error	p) PID Feedback
g) PID Output	q) PID Reference
h) Power	r) Remote Digital
i) Spd. Command	s) Speed Ratio
j) Speed Trim	t) Torque Reference

This output may be programmed for offset, scaling, and inversion. The output could be used for external meters or as a speed reference for other drive units in a system.
33. **Output Contacts** - One set of form C output contacts rated 30 VDC @ 2.0 Amps or 115 VAC @ 0.5 Amps for fault annunciation.
34. **Digital Control Outputs** - Four buffered open collector outputs, rated 24 VDC @ 50 mA, are available for external alarms or monitoring. One of these outputs is dedicated for a pulse train at the drive output frequency. The three remaining outputs are user programmable to be any of the following parameters:

a) Acceleration	m) Motor Overload
b) Alarm	n) None
c) Auto	o) Regeneration Limit
d) At Speed	p) Reverse Direction
e) Bus Voltage Limit	q) Run
f) Bypass	r) Speed Avoidance
g) DC Braking	s) Speed Search
h) Deceleration	t) Taper #1 Speed
i) Drive Enabled	u) Taper #2 Speed
j) Dwelling	v) Torque Limit
k) Forward Direction	w) Zero Speed
l) Jog	x) Proof of Torque
35. **Slip Compensation** - Programmable slip compensation is provided to correct for induction motor speed droop or slip and thereby improve speed regulation in the Volts/Hertz operating mode (see Table 2, Page 2).
36. **Electronic Inverse Time Motor Overload Protection** - Inverse time motor overload protection provides a programmable threshold and time to trip to reduce the potential of costly motor damage. NOTE: To insure motor protection, a motor thermal switch is suggested.
37. **Static Reversing Control** - Contactorless reversing is a standard capability. Requires only the selection of an operator station with reversing controls or direction may be selected by external control contacts. NOTE: The drive must also be programmed to enable reverse operation by changing a parameter.

⁽¹⁾ Three analog outputs to become standard with REV 2 Control Board

38. Protective Features -

- a. Inverter Trip - Due to over voltage, over current, under voltage, controller over temperature, ground fault, motor overload, and CPU error. The unit will announce the fault with an English language word.
- b. Trip Avoidance - Series 6500 units include sophisticated torque control circuitry to minimize nuisance tripping under conditions of rapid deceleration and/or overhauling loads, or when encountering high peak torque loads. Under these abnormal torque conditions, the circuits function much like the current limiter in a DC drive extending the programmed acceleration or deceleration times to hold motor currents within set limits without tripping.
- c. Output Fault Protection - Unit is protected from phase-to-phase and phase-to-ground output short circuits and can be programmed for output phase loss.

39. Regeneration Limit - Designed to eliminate trips when excessive braking energy is transferred from the motor to the control, regeneration limit will perform in the following fashion:

- a. Will extend the deceleration time to prevent bus over voltage trip with high inertia loads.
- b. Will increase output frequency to user programmed maximum frequency range during overhauling loads.

40. Fault Trip Reset - Should a fault trip occur, the 6500 offers two reset modes.

- a. Disconnect and reapply power.
- b. Reset by STOP pushbutton command by operator.

41. Static Braking Control - Provides adjustable linear rate electronic braking for the three-phase AC induction motor. The braking rate is determined by the setting of the deceleration control, which is adjustable.

Braking is effective under the following conditions:

- a. Speed Reference Change - Whenever the speed reference is changed to command a reduction in speed. The speed reference change can originate from a manually adjusted speed setting potentiometer, an external DC analog signal or a change in the digital speed reference. This permits the drive to rapidly follow a reduced speed command otherwise impossible except with a heavy friction load.
- b. Stop Function - When selected, the motor will brake following the deceleration ramp to zero speed. The stop command can originate from a pushbutton or external logic. A selectable alternate method of operation allows un-powered coast to stop.

The standard unit provides a typical braking torque of 20% (dependent on motor efficiency) of rated motor torque. This is the limit of the standard drive to dissipate the regenerative energy produced by the kinetic energy of the motor and connected machine load.

Where the inertia of the load is such that the desired minimum braking time cannot be achieved with the standard unit, an optional high torque braking circuit is also offered. See Electronic Braking Option 1045A/1045C.

42. Analog Signal Inputs - Three analog signal inputs are provided. The Analog to Digital conversion resolution is 12 bit plus sign. The associated external signals may be grounded or ungrounded. However all three analog inputs share the same common connection. These inputs are programmable for the following functions:

- | | |
|-----------------------|---------------------------|
| a) Run Speed Command | g) PID Error |
| b) Jog Speed Command | h) PID Feedback |
| c) Torque Reference | i) Speed Ratio |
| d) Auto Speed Command | j) Speed Trim |
| e) Auto Torque Limit | k) Speed Feedback |
| f) PID Reference | l) None (input is unused) |

The Analog Input may be programmed for Scaling, Offset, Inversion. Signal Filtering are available for all Analog Inputs!

43. Digital Control Inputs - A total of 5 predefined and 3 programmable digital inputs are provided, these provide the following functions.

Predefined Digital Inputs:

- Forward Run
- Reverse Run
- Forward Jog
- Stop
- Emergency Stop

Programmable Digital Inputs:

- Faster
- Jog Reverse
- Slower
- Preset Speed

All inputs are designed for use with the 24V control voltage supplied by the 6500 controller. The predefined Digital Inputs can be disabled if desired.

44. Torque Limit - State of the art electronics allow the 6500 to provide good torque control over a programmable range of 20 - 200% of rated torque.

45. Torque Taper - Torque Limit slope and threshold are adjustable providing a programmable torque taper range of 0.1:1 to 3:1

46. Adjustments - The adjustments listed in ADJUSTMENTS on page 3 and most other adjustments can be changed while the drive is in operation. This feature simplifies fine-tuning since the drive does not need to be stopped, then restarted after each adjustment. See Series 6500 Equipment Manual for a complete list of adjustable parameters.

47. Standard Serial Port - An RS-485 compatible serial port is standard on the 6500. This port provides read/write access to all parameters available in the 6500. Up to 31 6500 drives can be connected to a host computer with an RS-485 Serial Port.

The 6500 has the capability of communicating serially with a host computer or PLC. Any parameter may be read or written via the serial port. Full communication is allowed during motor operation as well as at stop. The only exceptions to this are, configuration parameters that may not be adjusted from the keypad during operation, cannot be adjusted through the serial port during operation. When the drive is faulted, no parameters may be changed through the serial port. All parameters may be read under any condition.

Transmission rates up to 9600 baud and an optimized machine to machine protocol, make the 6500 suitable for low to moderate performance real time communication tasks by providing a single parameter communications bandwidth of better than 5 Hertz.

48. Speed Regulator -The 6500 AC Drive controls motor speed via a Proportional Integral Derivative (PID) Speed Regulator. Speed Feedback to this PID Speed Regulator can be selected from one of the following sources:

1. Sensorless (Motor Speed is determined from Applied Stator Voltage and measured stator currents).
2. DC Tachometer Feedback (Requires external scaling resistor if Tachometer voltage exceeds $\pm 10VDC$).
3. Encoder or Pulse Tachometer Feedback (Option 1761).

49. Analog Input Loss - This feature detects the loss of a 4-20 mA analog input by determining if the input current drops below a user programmable level. The user has the option of generating a fault, replacing the analog input with a fixed reference, or turning on a programmable digital alarm output when the input is lost.

50. CE Marking

- HP 208/230V units are available with CE
- 2-5HP 208/230V units are CE
- 1-10HP 460V units are CE
- others pending certification

STANDARD DIAGNOSTIC FEATURES:

1. Over current
Current Limit
Overload
Short Circuit
Ground Fault
2. **Test Mode select** - Normal self-test on power-up is always performed.
3. **Fault Parameter Values** - All operating parameters are frozen on fault, providing extensive information on the conditions present at the time of fault. One of the following English language 15 character fault codes will be displayed:

Fault Code Number	Fault Description
0	None
1	External Fault
2	Over temperature Fault
3	Rating Mismatch Fault
4	Bus Over voltage Fault
5	Bus Over current Fault
6	No Encoder Option Fault
7	Ground Fault
8	Power Loss Fault
9	Frequency Range Fault
10	Voltage Knee Fault
11	Precharge Fault
12	Motor Configuration Fault
13	Motor Overload Fault
14	EEPROM Write Fault
15	EEPROM Read Fault
16	EEPROM Missing Fault
17	EEPROM Acknowledge Fault
18	User Memory Fault
19	Unknown Fault
20	Phase Loss Fault
21	Carrier Frequency Fault
22	Analog / Digital Converter Fault
23	Feedback Loss Fault
24	Analog Input #1 Fault
25	Analog Input #2 Fault
26	Analog Input #3 Fault
27	Output Phase Loss
28	10 VDC Power Supply Loss
29	24 VDC Power Supply Loss
30	Motor Current Fault
31	Phase Imbalance Fault

4. Fault Clearing

Faults are cleared on the 6500 AC drive by the following actions:

- Stop button press
- Remote Stop Button Press
- Removing and Re-applying power

TABLE 4. TYPICAL APPLICATION DATA STANDARD SERIES 6500 MODELS

Component			Ratings												
Rated Horsepower (HP)			1	1 1/2	2	3	5	7.5	10	15	20	25	30	40	50
Rated Kilowatts (KW)			.746	1.12	1.49	2.24	3.73	5.60	7.46	11.2	14.9	18.7	22.4	29.8	37.3
3-Phase AC Output (Full Load)(1)	Amps 460V		2.1	3.0	3.4	4.8	7.6	11.0	14.0	21.0	27.0	34.0	40.0	52.0	65.0
	Amps 230V		4.2	6.0	6.8	9.6	15.2	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0
	Amps 208V		4.6	6.6	7.5	10.6	16.7	24.2	30.8	46.2	59.4	74.8	88.0	114.4	143.0
	KVA		1.7	2.4	2.7	3.8	6.0	8.7	11.1	16.6	21.4	26.9	31.7	41.2	51.5
Motor Torque (lb-ft)(2)	Motor Speed	3500	1.5	2.2	3	4.50	7.50	11.3	15.0	22.5	30.0	37.5	45.0	60.0	75.0
		1750	3	4.5	6	9.00	15.0	22.5	30.0	45.0	60.0	75.0	90.0	120	150
		1150	4.5	6.9	9	13.7	22.8	34.3	45.7	68.5	91.3	114	137	183	228
Minimum Transformer KVA for Voltage Matching or Isolation (1)			2	3	3	5	7.5	11	15	20	27	27	34	40	51

Component		Ratings		
Rated Horsepower (HP)		60	75	
Rated Kilowatts (KW)		44.8	56.0	
3-Phase AC Output (Full Load)(1)	Amps 460V		77.0	96.0
	Amps 230V		154.0	192.0
	Amps 208V		169.4	211.2
	KVA		61.0	76.1
Motor Torque (lb-ft)(2)	Motor Speed	3500	90.0	113
		1750	180	225
		1150	274	343
Minimum Transformer KVA for Voltage Matching or Isolation (1)		63	75	

NOTES:

- (1) For voltage matching on isolation, see Specification 7300 for suitable transformers with rating of K-4 or greater.
- (2) Data listed is rated torque over a 10:1 speed range. See AC Motor Specification 9700.

TABLE 5. DIMENSIONS AND WEIGHTS

HP RANGE		DIMENSIONS inches (mm)					WEIGHT lbs
		ENCLOSURE			MOUNTING		
(208/230V)	(460V)	H	W	D	H	W	
1 - 5	1 - 5	7.48 (190)	7.25 (184)	7.51 (191)	7.00 (178)	4.63 (118)	6.5
7.5 - 10	7.5 - 10	11.88 (302)	7.25 (184)	8.12 (206)	11.31 (287)	4.63 (118)	14.6
15 - 20	15 - 20	19.13 (486)	7.25 (184)	10.38 (264)	16.63 (422)	4.63 (118)	29
25 - 30	NA	28.31 (719)	7.25 (184)	10.38 (264)	24.88 (632)	4.63 (118)	42.5
NA	25 - 30	22.13 (562)	7.25 (184)	10.38 (264)	19.63 (499)	4.63 (118)	34.5
NA	40 - 75	27.00 (686)	14.38 (365)	10.38 (264)	26.25 (667)	11.75 (298)	63.3

FIGURE 4-1. 6500 CONTROLLER MOUNTING DIMENSIONS, 1 - 5HP, 230/460V

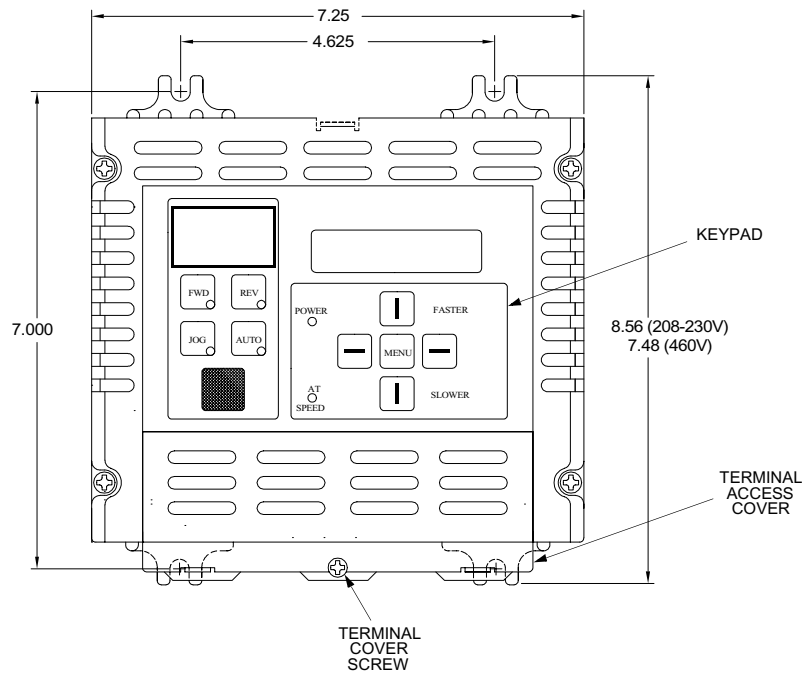
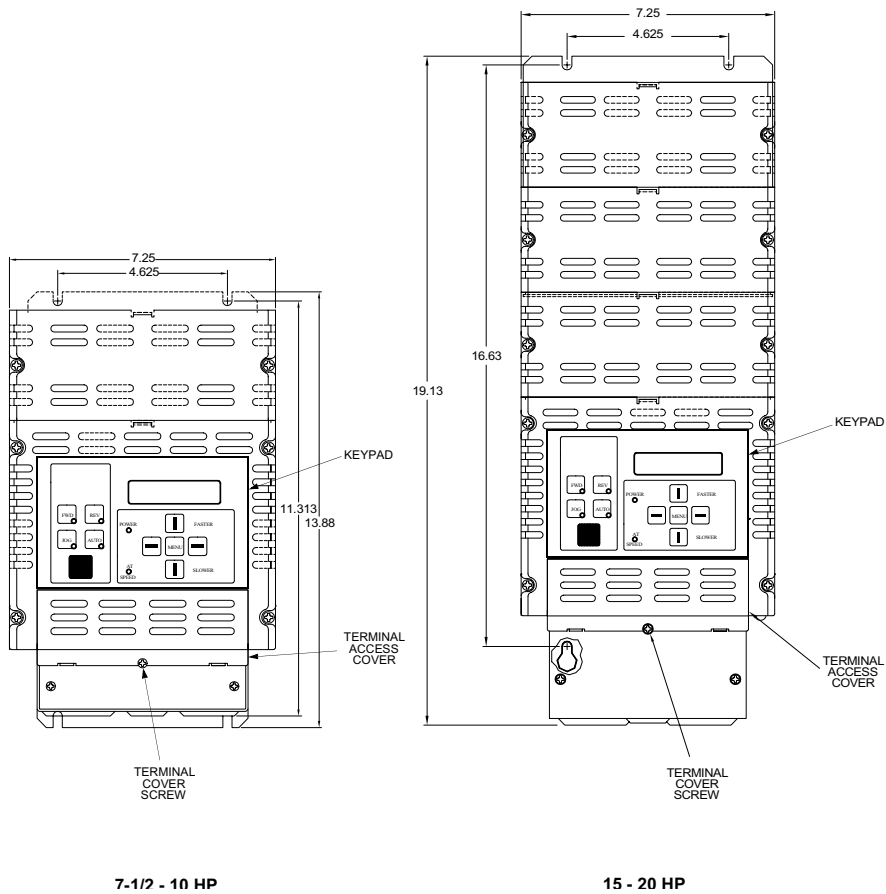


FIGURE 4-2. 6500 CONTROLLER MOUNTING DIMENSIONS, 7.5 - 20HP, 230/460V



7-1/2 - 10 HP

15 - 20 HP

FIGURE 4-3. 6500 CONTROLLER MOUNTING DIMENSIONS, 25 - 30HP, 230/460V

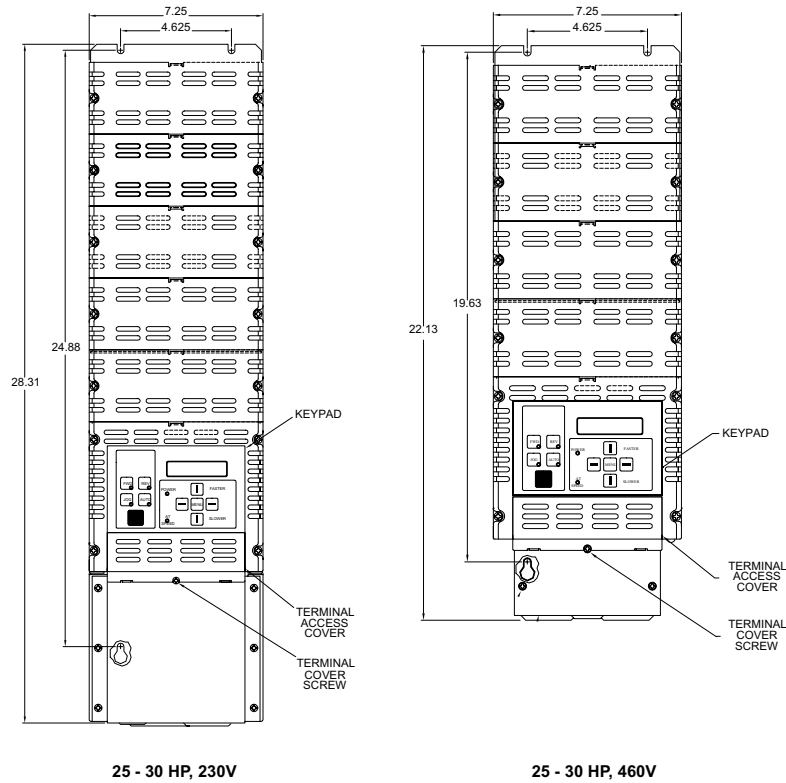
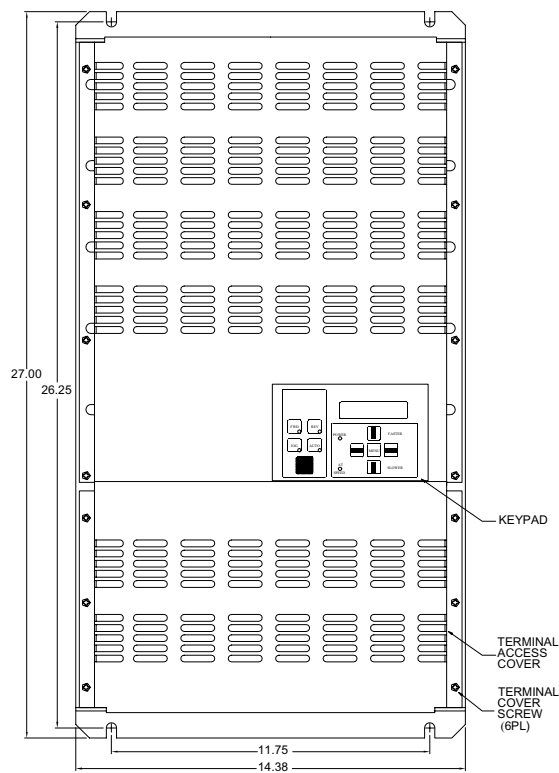


FIGURE 4-4. 6500 CONTROLLER MOUNTING DIMENSIONS, 40 - 75HP, 460V



OPTIONS

ORDER BY OPTION NUMBER AND PRODUCT SERIES

Option Number	Description
1002 ⁽¹⁾	<p>MOTOR CONTACTOR Provides an AC output contactor that is coordinated with controller's electronics to ensure a safe, reliable shut-down and a positive disconnection of the motor from the controller.</p>
1010A ⁽¹⁾	<p>AC LINE CIRCUIT BREAKER WITH HANDLE This option provides a three pole magnetic fast trip breaker as a means of manually disconnecting the drive from the AC line. The handle for the option is cover mounted.</p>
1015 ⁽²⁾	<p>MAGNETIC CONTROL INTERFACE (115V) The standard magnetic control run logic excitation in the Series 6500 is 24 VDC, obtained from a self-contained power supply in the controller. This option provides a means of interfacing the controller with contacts in pushbuttons or external logic powered by a 115 VAC excitation source. The interface circuit includes five control relays with 115 VAC coils for use in both unidirectional and reversing applications, and three or more preset speeds, or other functions.</p>
1018 ⁽¹⁾	<p>FUSES, CURRENT LIMITING Provides 3-pole current limiting fuses with a clearing capacity of at least 100,000 symmetrical amperes. This option limits the energy between the plant power bus and the drive during fault conditions.</p>
1024C ⁽²⁾	<p>CRANE CONTROL INTERFACE (JOYSTICK CONTROL) This option facilitates the application of standard Series 6500 controllers to new or existing material handling systems where individual preset motor speeds, and the direction of rotation are commonly determined by 115 VAC input signals selected by external control contacts such as pushbuttons, joysticks or drum switches.</p> <p>The option accepts up to six 115 VAC inputs from external contact closures which typically provide:</p> <ol style="list-style-type: none"> Two (2) inputs provide directional commands: Forward, Reverse, or Up, Down and Preset Speed Step number 1. Four (4) inputs provide preset speed steps 2 through 5 in either forward or reverse directions. <p>The speed steps can be adjusted to produce motor speeds anywhere between zero and maximum as required by the application. Additionally, Option 1024C can also be used where forward and reverse run commands are selected as previously described, but the speed command is infinitely adjustable by a speed setting potentiometer or external signal.</p> <p>The option also coordinates the operation of a fallsafe holding brake. (To enable this capability Analog Output Option 1701 must be added to the drive.) Included is a provision to assure the brake will not release until sufficient torque is produced by the motor (Typically 10-30% torque). This is factory set for 20% but can be reset in the field to optimize performance. The brake will not reset until a stop command is given, AND the 6500 controller senses the preset low speed setpoint. The low speed setpoint is separately adjustable for both forward and reverse directions. A fault condition (External or Internal) will set the brake immediately.</p>
1045A&C ⁽¹⁾	<p>ELECTRONIC BRAKING This option is furnished in a ventilated NEMA 1 enclosure and includes an electronic braking module and a resistor assembly. The brake circuit is rated for stopping a typical load a maximum number of two stops per minute from motor base speed. A typical load is defined as:</p> <ol style="list-style-type: none"> Not exceeding rated-load torque. External load inertia (beyond the motor shaft) not exceeding that of the motor rotor. <p><i>High inertia loads may extend braking times beyond the wattage rating of the power dissipation resistor. The braking circuit is not rated for continuous regeneration and should be used only where intermittent control of overhauling loads is required. The braking circuit is not a holding brake; it will not prevent a motor at rest from rotating.</i></p>

Continues on next page

OPTIONS (Continued)

ORDER BY OPTION NUMBER AND PRODUCT SERIES

Option Number	Description
1058B	HAND-OFF-AUTO SWITCH Provides a 3 position switch and legend plate to select between user supplied manual speed pot and an automatic speed reference. Option 1261E3 also required.
1058C	SELECTOR SWITCH HAND-OFF-AUTO WITH MANUAL POT Same as Option 1058B except includes a manual speed pot.
1071	BLOWER MOTOR CONTROL Includes a 3-pole AC motor starter with 3-leg overload protection and integral circuit breaker to control and protect an AC force-ventilation blower mounted on the main drive motor. The blower is energized whenever power is applied to the controller and the optional AC line switch or circuit breaker is closed <i>Motor blower is not included with this option.</i>
1071A	BLOWER MOTOR FUSES Includes 3-pole line fuses to protect an AC force ventilation blower, mounted on the main drive motor. The blower is energized whenever power is applied to the controller and the optional AC line switch or circuit breaker is closed. <i>Motor blower is not included with this option.</i>
1074 ⁽¹⁾	INPUT LINE CHOKES (ENCLOSED) Same as 1074A but furnished in a NEMA 1 enclosure. <i>This option should not normally be used in combination with Option 1788A/1788 Output Line Filter.</i>
1074A ⁽¹⁾	INPUT LINE CHOKES (OPEN) Includes an assembly with three AC line reactors (chokes rated 3% impedance) connected in series with the AC supply line. These reactors oppose rapid current changes and surges and help protect the unit from transients. This option is not normally needed when a controller connected to the AC supply through an isolation transformer. However, option is suggested whenever: 1. The KVA of the AC power supply is greater than three times the horsepower rating of the controller. 2. Additional transient voltage surge protection is desirable. 3. It is desirable to isolate inverter ripple currents from the AC line. 4. Harmonic distortion must be reduced. <i>This option should not normally be used in combination with Option 1788A/1788 Output Line Filter.</i>
1083 ⁽¹⁾	OVERLOAD RELAY This option includes a three pole overload relay. Motor full load current must match listed adjustment range.
1120K	LOCAL SPEED POTENTIOMETER This option provides local analog motor speed control (1/2 watt, 5K ohm, single turn).
1139H	ENCLOSURE, AUXILIARY This option consists of a separate sheet metal NEMA 1 enclosure. It has ample space to allow for mounting various options.
1257A ⁽²⁾	RELAY OUTPUT OPTION This option provides four relays with Form C contacts rated 5 amps @ 250 VAC or 30 VDC for customer use to annunciate the digital control outputs provided by the standard open collector transistors. Option allows these outputs to be used with warning devices such as bells, buzzers and indicator lights or other monitoring devices.

Continues on next page

OPTIONS (Continued)

ORDER BY OPTION NUMBER AND PRODUCT SERIES

Option Number	Description																
1261E3 ⁽¹⁾	<p>COMPLETE MAGNETIC BYPASS With this option, the 6500 is bypassed and the motor is directly connected to the AC line. Three contactors, motor overload and AC line disconnect with fuses are included in a NEMA 1 enclosure. The drive is isolated in the bypass mode.</p>																
1701 ⁽³⁾	<p>ANALOG OUTPUTS The standard Series 6500 controller has one 0-10 VDC analog output rated 2 mA which may be programmed to follow any one of the listed parameters:</p> <table border="0" data-bbox="285 562 1055 793"> <tr> <td>a. Speed Command</td> <td>i. Actual Speed</td> </tr> <tr> <td>b. Motor Voltage</td> <td>j. Accel/Decel Ramp</td> </tr> <tr> <td>c. Motor Current</td> <td>k. Motor Load</td> </tr> <tr> <td>d. Frequency</td> <td>l. P.I.D. Error</td> </tr> <tr> <td>e. RPM</td> <td>m. P.I.D. Feedback</td> </tr> <tr> <td>f. Output Power</td> <td>n. P.I.D. Reference</td> </tr> <tr> <td colspan="2">g. Remote Digital (a parameter set through the serial port)</td> </tr> <tr> <td colspan="2">h. P.I.D. Output</td> </tr> </table> <p>Option 1701 provides the capability to follow two additional parameters of those listed. This option may be useful for external analog monitoring devices or as a speed or torque reference for other drives in a system.</p>	a. Speed Command	i. Actual Speed	b. Motor Voltage	j. Accel/Decel Ramp	c. Motor Current	k. Motor Load	d. Frequency	l. P.I.D. Error	e. RPM	m. P.I.D. Feedback	f. Output Power	n. P.I.D. Reference	g. Remote Digital (a parameter set through the serial port)		h. P.I.D. Output	
a. Speed Command	i. Actual Speed																
b. Motor Voltage	j. Accel/Decel Ramp																
c. Motor Current	k. Motor Load																
d. Frequency	l. P.I.D. Error																
e. RPM	m. P.I.D. Feedback																
f. Output Power	n. P.I.D. Reference																
g. Remote Digital (a parameter set through the serial port)																	
h. P.I.D. Output																	
1713	<p>DIGITAL OPERATOR PANEL (UNENCLOSED, SEPARATE MOUNTING) This option provides the standard operator panel furnished with an 10' cable and connector for plug-in connection to the Series 6500 controller. The operator panel would normally be mounted in the door of a larger enclosure within which the Series 6500 enclosure is mounted.</p>																
1727A ⁽²⁾	<p>LONWORKS NETWORK INTERFACE This circuit board provides a LonWorks port, which conforms to the LonMark Profile for Variable Speed Motor Drives. An external LonMark compliant device can then control the 6500. Additional access, beyond the LonMark profile, is provided to all 6500 parameters.</p>																
1761 ⁽³⁾	<p>CLOSE LOOP FLUX VECTOR (ENCODER FEEDBACK) Provides terminals and circuitry for accepting a digital feedback signal from a photo-optic encoder mechanically coupled to the drive motor rotor. The feedback signal replaces the slip compensation circuitry in the Series 6500 controller, making the unit directly sensitive to the motor speed.</p> <p>This option results in improved speed regulation with load changes and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor heating, and other variables as shown in Table 2.</p> <p>Encoder Specifications</p> <ol data-bbox="285 1346 1485 1585" style="list-style-type: none"> Electrical: LED/Optical type Supply Voltage: +5 VDC power supply is provided in the Series 6500 controller, Channel Arrangement: Quadrature, Differential, Bi-directional Differential line drivers (TTL) are required for applications where greater than 50 feet of wiring distance separate the motor and controller. Marker Pulse: Not required. Number of Lines, Pulses Per Revolution (PPR): 1000 or 1024 PPR is standard. A performance reduction will result when lower frequency encoders are applied. <p><i>This option does not include the encoder which may be selected from catalog Section 7400.</i></p>																

Continues on next page

OPTIONS (Continued)

ORDER BY OPTION NUMBER AND PRODUCT SERIES

Option Number	Description
1788 ⁽¹⁾	<p>OUTPUT FILTER (ENCLOSED) Same as 1788A but furnished in a NEMA 1 enclosure. <i>Since this option represents a 3% output impedance, it may not be acceptable in applications characterized by low line voltage, heavy loading, and high speeds, or in combination with Input Line Chokes.</i></p>
1788A ⁽¹⁾	<p>OUTPUT FILTER (OPEN) This option filters the AC output to provide the following benefits:</p> <ul style="list-style-type: none"> a. Quiet motor operation at low carrier frequencies. b. Elimination of ground fault due to DV/DT. c. Reduced DV/DT stress on motor windings at higher carrier frequencies. d. Reduced electrical interference. <p><i>Since this option represents a 3% output impedance, it may not be acceptable in applications characterized by low line voltage, heavy loading, and high speeds, or in combination with Input Line Chokes.</i></p>

Notes: ⁽¹⁾ Supplied loose for customer mounting • ⁽²⁾ Requires option 1139H auxiliary enclosure • ⁽³⁾ To be standard with REV 2 Control Board

ADDITIONAL AC MOTOR CONTROLLERS AVAILABLE FROM FINCOR:



1/2 – 50 HP
208/230, 460, 575 VAC
Basic Operation



5300
1/6 – 5 HP
115, 208/230, 460 VAC
Basic Operation



5600
1/6 – 75 HP
115, 208/230, 460 VAC
Basic Operation
Programmable



5600-WD
1/6 – 30 HP
208/230, 460 VAC
Programmable
Washdown



6600
100 – 600 HP
460 V
Full Featured
Flux Vector

For additional information, or to place an order, please contact us at: