

## 1/6 through 3 HP Adjustable Speed DC Motor Controllers

- 1/6 - 3 HP
- 115 or 230V, Single Phase (Reconnectable)
- Isolated Regulator
- Speed & Torque Control
- AC Line Starting
- Bi-Polar DC Tach Feedback
- Run Contact
- External Signal Follower
- Configurations
  - Open Chassis
  - “Bookcase” Style
  - NEMA 4/12 Enclosed
- NEC and NEMA Compliance
- UL and cUL Listed as a Motor O/L



FIGURE 1. Series 2330 Controller

Series 2330MKII units are offered in a variety of standard models based on the four functional groups as shown in Tables 1-4. The basic, open chassis 2331 and 2332 are the nucleus of all other series 2330 models. Model numbers that include a “P” suffix identify enclosed units assembled by adding a top cover assembly to a basic chassis

unit. Top cover assemblies P1, P2 and P3 include integral operator controls. Top cover control P0 does not and is therefore intended for remote control operation. The top cover assemblies may be factory installed or, if desired, easily added to the basic chassis models as field-installed kits. All models are reconnectable for either a 115V or 230V AC power source.

TABLE 1: SERIES 2330 NEMA 4/12 ENCLOSED UNITS WITH INTEGRAL OPERATOR CONTROLS

HORSEPOWER RANGE (1)		MODEL NUMBER	FUNCTION
115V	230V		
1/6-1	1/2-2	2331P1	Run, Stop, Jog
1/6-1	1/2-2	2331P2	Run, Stop, Jog, Armature Switch Rev.
1/6-1	1/2-2	2331BP1	Run, Stop, Jog, Armature Contactor Run and DB
1/6-1	1/2-2	2331AP3	Run, Stop, Jog, Armature Contactor Reverse and DB

NOTES: (1) Units are shipped calibrated for the maximum horsepower rating. Units may be calibrated for other standard ratings by jumper selection. Standard ratings are:  
 115V Controllers: 1/6, 1/4, 1/3, 1/2, 3/4, 1, 2 HP  
 230V Controllers: 1/2, 3/4, 1, 1-1/2, 2, 3 HP  
 Units are shipped connected for 230V.  
 Units may be easily reconnected for 115V.

TABLE 2: SERIES 2330 NEMA 4/12 ENCLOSED UNITS WITHOUT OPERATOR CONTROLS

HORSEPOWER RANGE (1)		MODEL NUMBER	FUNCTION
115V	230V		
1/6-1	1/2-2	2331P0	Run-Stop
1/6-1	1/2-2	2331BP0	Run, Stop, Armature Contactor Run and DB
1/6-1	1/2-2	2331AP0	Run, Stop, Armature Contactor Reverse and DB

TABLE 3: SERIES 2330 BASIC CHASSIS UNITS WITHOUT OPERATOR CONTROLS

HORSEPOWER RANGE (1)		MODEL NUMBER	FUNCTION
115V	230V		
1/6-1	1/2-2	2331	Run-Stop
1/6-1	1/2-2	2331B	Run, Stop, Armature Contactor Run and DB
1/6-1	1/2-2	2331A	Run, Stop, Armature Contactor Reverse and DB
1/6-1	1/2-2	2332	Run-Stop
1/6-1	1/2-3	2332B	Run, Stop, Armature Contactor Run and DB
1/6-1	1/2-3	2332A	Run, Stop, Armature Contactor Run and DB

TABLE 4: SERIES 2335, 2336 CHASSIS UNITS WITHOUT OPERATOR CONTROLS

HORSEPOWER RANGE (1)		MODEL NUMBER	FUNCTION
115V	230V		
1/6-1	1/2-2	2335	Run-Stop
1/6-1	1/3-3	2336	Run-Stop
1/6-1	1/2-2	2335B	Run, Stop, Armature Contactor Run and DB
1/6-1	1/3-3	2336B	Run, Stop, Armature Contactor Run and DB
1/6-1	1/2-2	2335A	Run, Stop, Armature Contactor Reverse and DB
1/6-1	1/3-3	2335B	Run, Stop, Armature Contactor Reverse and DB

### DESIGN FEATURES AND FUNCTIONS

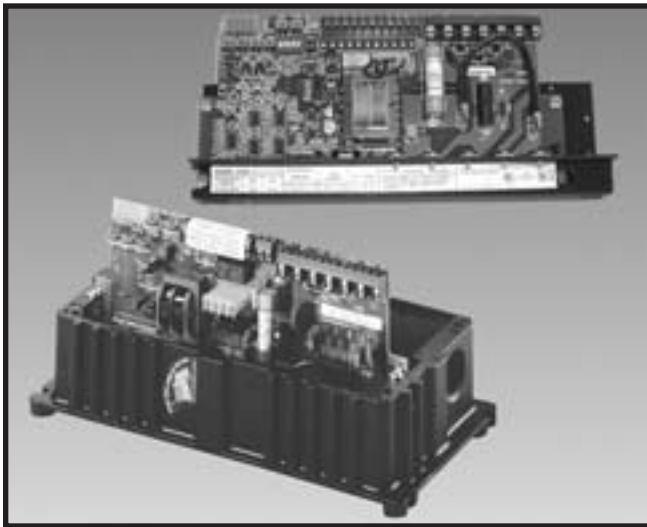


FIGURE 2. 2331 Chassis and 2335 Chassis

- 1. Enclosure** — Totally enclosed, nonventilated, constructed of rugged die-cast aluminum alloy. Gasketed, screw fixed cover excludes contaminants. The cover includes a recessed area to guard local operator controls from accidental operation. Provision for conduit entry is included top and bottom by two 3/4-14 NPSC tapped holes. Standard unit meets provisions for NEMA Type 4 and 12 making them suitable for a wide range of wet and dirty industrial environments. See Figure 3 for dimensions. All models with integral operator controls also include flexible boots to seal the operator control switches, and a seal for the motor speed potentiometer.
- 2. Full-Wave Power Conversion** — NEMA Code K converter configuration consisting of 4 SCR's, and a free-wheeling diode provide optimum form factor for best motor performance and long service. Units have 600 PIV devices. The control enclosure forms an integral heatsink with the power control devices electrically isolated from the enclosure.
- 3. Voltage Transient Protection** — Metal oxide suppressor across the AC line minimizes the effect of high voltage spikes from the AC power source.
- 4. AC Line Protection** — AC line fuse provides instantaneous protection from peak loads and fault currents. Fuse holder is mounted on the control circuit board within base assembly
- 5. Motor Contactor** —
  - (a) Bidirectional Models — Model numbers which have an "A" suffix such as 2331A, 2331AP3, 2335A, etc. include DC magnetic armature reversing contactors. This provides a positive, two-pole disconnection of the motor armature from the rectified power source. Action of the contactor is sequenced with the SCR regulator to ensure that the DC power circuit is "phased-off" before the contactor is opened. This results in "dry-switching" for improved contactor longevity. The standard contactor circuit board permits both unidirectional and selectable bidirectional operation when desired. To facilitate this, anti-plug protection is also provided to prevent armature reversal until a safe minimum speed is reached.
  - (b) Unidirectional Models — Model numbers which include a "B" suffix such as 2331B, 2331BP3, 2335B, etc. include a DC magnetic armature contactor. This provides a positive, two-pole disconnection of the motor armature from the rectified power source. Action of the contactor is sequenced with the SCR regulator to ensure that the DC power circuit is "phased-off" before the contactor is opened. This results in "dry-switching" for improved contactor longevity. The contactor circuit board permits unidirectional operation only.
- 6. Dynamic Braking** — Standard feature of model numbers with an "A" or "B" suffix. Dynamic braking provides exponential rate braking of the DC motor armature. Included is a DB resistor with an anti-plug circuit to prevent restarting the controller until the braking cycle is complete, thereby preventing a potentially damaging electrical surge and mechanical stress.

The DB resistor is rated for stopping a typical load, when the external machine inertia does not exceed that of the motor armature, as shown in Table 7. The DB resistor may be disconnected with braking is not desired.
- 7. Operator Controls** — All enclosed models with integral operator controls include a speed setting potentiometer and other control elements as listed in Table 9.
- 8. Control Transformer** — All models include a 24VDC control transformer which provides internal reference and power supply voltages, and a low voltage source for the magnetic controls ("A" suffix models only), control logic and operator controls.
- 9. Counter EMF Voltage Feedback with IR Compensation** — Adjustable to suit individual motor characteristics.
- 10. Trigger Circuit** — Fast rise, hard firing to ensure reliable conduction and minimizes di/dt degradation of SCR's.
- 11. Field Supply** — Transient protected. Reconnectable for half-wave or full-wave output.
- 12. Paint Finish** — Durable silicone reinforced enamel in an attractive two color finish. Cover is Fincor "Dyna Orange" (to OSHA color code standards) with a "Thermo-Black" base.
- 13. Customer Use Run Relay Contact** — Form A normally open contact rated one amp at 115 VAC or 30 VDC coordinated with run command. May be used for external control and indicating devices. May be applied as a pushbutton seal-in or a drive OK contact.
- 14. Motor Overload** — UL Listed as a motor O/L device
- 15. Isolated Regulator** — Internal DC circuits are isolated from the AC power source for operator and equipment safety and for simplified application. The control reference input common may be grounded or connected without additional isolation to other drive units or grounded external signal sources. Isolation eliminates the common condition of line voltage to ground potentials being present on the speed control potentiometer.
- 16. Selectable Capabilities** —
  - (a) DC Tachometer Feedback — Provided is impedance matching, voltage scaling and terminals for accepting a signal from a DC tachometer generator mechanically coupled to the drive motor armature. The tachometer feedback signal makes the controller directly sensitive to motor speed. This results in expanded speed range, improved speed regulation with load changes and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor field heating and other operating variables. The controller will automatically transfer to counter EMF voltage feedback to prevent run away if the tachometer circuit is opened. Tachometers producing 7 VDC to 150 VDC (polarity insensitive) at maximum motor speed may be used.
  - (b) AC Line Starting — Provision is included to defeat the no-restart-on-power failure feature to permit run-stop control of unidirectional models by an external AC line contactor. Included is circuitry to assure smooth starting.
  - (c) Torque Regulator — Series 2330MKII units may be easily reconfigured to function as torque regulators. In this mode, the speed setting potentiometer is used to set and regulate the motor maximum armature current over a range of 0-150% of rated. Accordingly, motor speed is unregulated and will go to a level of 0-100% of rated, depending upon the application load torque.
  - (d) External DC Signal Follower — Series 2330MKII units include isolation and impedance matching circuitry to interface an externally supplied grounded or ungrounded, isolated or nonisolated 0-5 VDC, 0-10 VDC or 4-20 mA DC signal source with the motor controller reference input. This provides a linear transfer of the external signal to motor speed.
- 17. Mechanical Flexibility** — Series 2330MKII units offer outstanding application flexibility. The same basic unit can be used as an open chassis or enclosed package controller. Enclosed units may also be mounted under or through a console surface.
- 18. Safety Features** — UL and cUL Listed. Low Voltage Operator Control. Requires mandatory restart after power interruption. High visibility paint finish. TENV enclosure. Recessed operator controls.
- 19. Quality Features** — Rugged aluminum alloy enclosure — no plastic parts to burn or break. Conservatively rated components selected for long service life. Full-wave power conversion.

### RATINGS AND CHARACTERISTICS

#### RATINGS

1. Service Factor ..... 1.0
2. Duty ..... Continuous
3. Overload Capacity (armature circuit) ..... 150% for 1 minute
4. Operating Voltages ..... See Table 5
5. Run Speed Potentiometer ..... 5K ohms, 1/2W
6. Horsepower Range ..... See Tables 1-4
7. Reference Power Supply ..... 10 VDC
8. AC Line Fuse, Interrupting Capacity ..... 100,000 Amps

#### ADJUSTMENTS

Potentiometer adjustments are provided for:

1. Current Limit ..... 0-150% full-load torque (typical)
2. Maximum Speed ..... 50-100% of motor base speed
3. Minimum Speed ..... 0-40% of motor base speed
4. IR (load) Compensation ..... 0-100% of rated load
5. Acceleration (linear) ..... 0.2 to 40 seconds
6. Deceleration (linear) ..... 0.2 to 40 seconds

#### PERFORMANCE CHARACTERISTICS

1. **Controlled Speed Range** – Zero to motor base speed. Speed range with respect to specified regulation is as listed in Table 6. See DC Motor Catalog Section for continuous duty application limitations of DC Motors.
2. **Speed Regulation** – (See Table 6) - Regulation percentages listed are of motor base speed under steady-state conditions. Normal operation will result in performance equal to or better than specified.
3. **Efficiency** (rated speed/rated load)
  - (a) Controller SCR regulator ..... 99%
  - (b) Complete drive with motor (typical) ..... 85%

#### OPERATING CONDITIONS

1. Line Voltage Variation ..... ±10% of rated (1)
2. Line Frequency Variation ..... ±2 Hz
3. Ambient Temperature (2) ..... 0°C to 40°C (32°F to 104°F)
4. Altitude (standard) ..... 3300 feet(1000 meters) maximum
5. Relative Humidity ..... 95% noncondensing

NOTES: (1) Unit will operate down to – 15% of rated voltage although this may prevent rated speed with rated load.  
 (2) 55°C (131°F) maximum in enclosed areas where open chassis units are mounted. 3HP, 230V bookcase and 5HP, 230V chassis units are rated for 50°C maximum.

TABLE 5. OPERATING VOLTAGES

POWER SOURCE (Single-Phase)	OUTPUT VDC		CONTROL REFERENCE VOLTAGE	MAGNETIC CONTROL VOLTAGE
	Armature	Field		
115V, 50 or 60 Hz	0-90	50/100	0-5 VDC OR 4-20mA	24 VDC
230V, 50 or 60 Hz	0-180	100/200		

TABLE 6. SPEED REGULATION CHARACTERISTICS

REGULATION METHOD	Load Change 95%	Line Voltage ±10%	Field Heating Cold/Normal	Temperature ±10°C	Speed Range
Standard Voltage Feedback with IR Compensation	2%	±1%	5-12%	±2%	50:1
Optional Speed (Tach) Feedback (1)	.5%	±1%	0.2%	±2%	200:1

(1) Unidirectional Models Only

TABLE 7. DB RESISTOR RATINGS

MODEL	COMPONENT	UNIT	RATED HORSEPOWER								
			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
2331	Braking Torque%	115V	180	129	103	66	44	34	—	—	—
		230V	—	—	—	278	190	130	88	62	—
2335	Stops Per Minute	115V	15	12	11	8	6	2	—	—	—
		230V	—	—	—	8	6	1	1	1	—
2332	Braking Torque%	115V	300	215	170	110	75	60	—	—	—
		230V	—	—	—	400	320	220	145	105	85
2236	Stops Per Minute	115V	9	6	5	5	4	4	—	—	—
		230V	—	—	—	5	4	4	3	3	2

TABLE 8. TYPICAL APPLICATION DATA

COMPONENT			RATINGS								
RATED HORSEPOWER (HP)			1/6	1/4	1/3	1/2	3/4	1	1-1/2	2	3
RATED KILOWATTS (kW)			0.124	0.187	0.249	0.373	0.560	0.746	1.120	1.492	2.238
1-PHASE AC INPUT (FULL-LOAD)	LINE Amps	115V Unit	3.9	5.0	6.0	8.7	12.4	15.8	—	—	—
		230V Unit	—	—	—	4.2	5.9	8.8	12.6	15.8	22.0
	KVA	0.48	0.58	0.71	1.00	1.40	2.00	3.00	4.00	5.00	
DC OUTPUT (FULL-LOAD)	Motor Armature Amps	90V	2.0	2.8	3.5	5.4	8.1	10.5	—	—	—
		180V	—	—	—	2.7	4.0	5.5	8.2	11.6	15.1
	Motor Field Amps (1)	50V	1.0	1.0	1.0	1.0	1.0	1.0	—	—	—
		100V	—	—	—	1.0	1.0	1.0	1.0	1.0	1.0
		200V	—	—	—	1.0	1.0	1.0	1.0	1.0	1.0
FULL-LOAD TORQUE (lb-ft) with 1750 RPM Base Speed Motors			0.5	0.75	1.0	1.5	2.2	3.0	4.5	6.0	9.0
WEIGHT lbs. (Kg)	2331, 2332, 2335B		3 (1.56)			2336B			4 (1.82)		
	2331A, 2332A		3.5 (1.59)			2335A			1.5 (0.68)		
	2331PO, 2331P1, 2331P2		5 (2.27)			2336A			2.5 (1.14)		
	2331APO, 2331AP3		5.5 (2.5)								
	2335		1 (0.45)								
	2336		2 (0.91)								

NOTE: (1) Does not apply to Permanent Magnet Motors.

# 2330MKII

SINGLE-PHASE DC SERIES



## DIMENSIONS

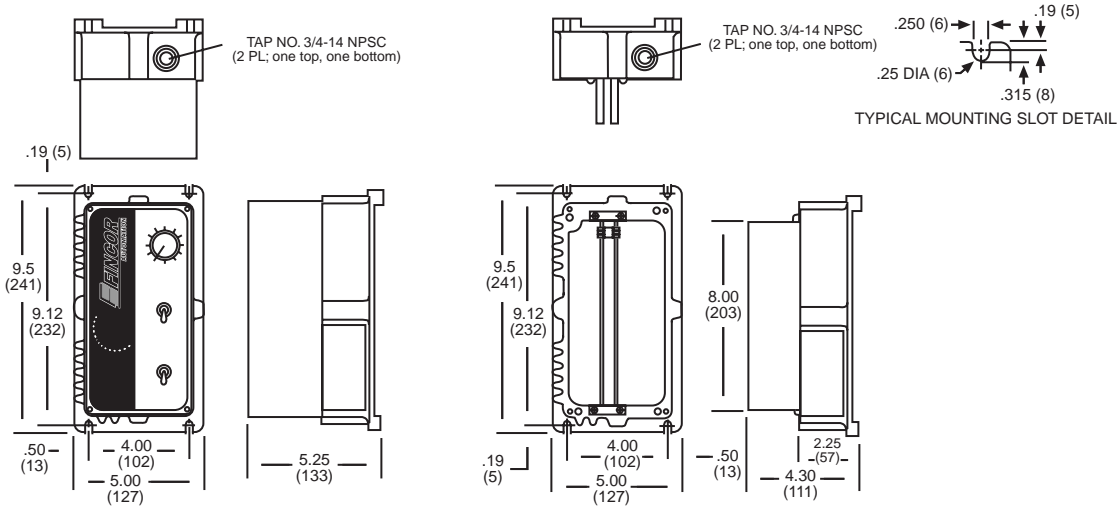


FIGURE 3. Series 2330 Dimensions

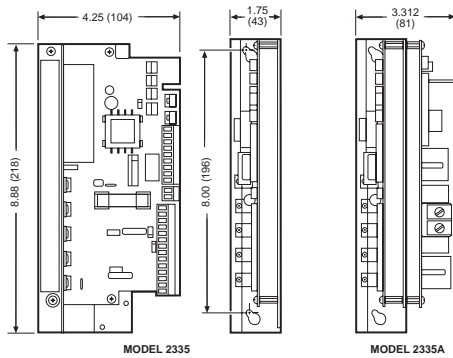


FIGURE 4. Series 2335, 2336 Dimensions

TABLE 9. COVER ASSEMBLIES WITH LOCAL OPERATOR CONTROLS

Cover Model Number	Control Elements		Use with Controller Models
	Toggle Switches	Potentiometer	
P0	None	None	2331AP0, 2331BP0, 2331P0
P1	Run-Stop-Jog (4), (5)	Motor Speed	2331BP1, 2331P1
P2	Run-Stop-Jog (1), (4) Fwd-Rev (2)	Motor Speed	2331P2
P3	Run-Stop-Jog (1), (4) Fwd-Rev (3)	Motor Speed	2331AP3

NOTES: (1) Maintained in RUN and JOG positions.  
 (2) Maintained in FORWARD or REVERSE positions. Armature power switch includes a center position detent for anti-plug protection.  
 (3) Momentary contact switch with spring return to center position.  
 (4) JOG speed is set by the RUN speed potentiometer.  
 (5) Maintained in RUN position. JOG position is momentary with a spring return to STOP.

## OPERATOR CONTROLS

Table 10 lists the standard operator stations for use with the Series 2330 controllers. All remote control stations are NEMA Type 1 TENV with industrial rated components. The dimensions are shown in Figure 5.

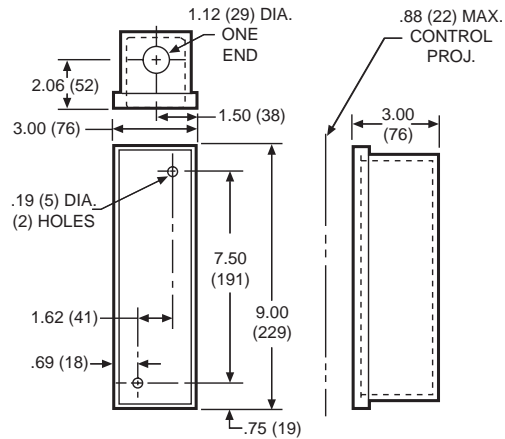


FIGURE 5. Remote Control Station Dimensions

TABLE 10. REMOTE OPERATOR CONTROL STATIONS

Model Number	Control Elements			Use With Controller Models
	Push-button	Toggle Switch	Potentiometer	
SCS153	-	Run-Stop-Jog	Motor Speed	2331, 2331B, 2331BP0, 2331P0, 2332, 2332B, 2335, 2335B, 2336, 2336B
SCS154	-	Run-Stop-Jog Fwd-Rev	Motor Speed	2331A, 2331AP0, 2332A, 2335A, 2336A