BOOK 0430
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SERIES 5100

SINGLE-PHASE

ADJUSTABLE-FREQUENCY

AC MOTOR CONTROLLERS

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GENERAL INFORMATION

INTRODUCTION

This manual contains installation, operation, theory of operation, and maintenance instructions for the Fincor Series 5100 Single-Phase Adjustable-Frequency AC Motor Controllers. A parts list, spare parts list, and illustrations are also included.

GENERAL DESCRIPTION

Series 5100 AC Motor Controllers are adjustable-frequency adjustable-speed transistorized inverters, which provide speed control of conventional three-phase AC motors. These controllers statically convert the fixed frequency and voltage of a single-phase AC supply to adjustable frequency and voltage that controls induction or synchronous reluctance motors over a wide speed range.

Series 5100 Controllers comply with applicable standards established by the National Electrical Code, California Electrical Code, and NEMA for industrial motor and control equipment.

MODEL TYPES

Series 5100 Controllers are supplied in one of two basic model types, as shown in table 1.

1. Models 5100S are open, chassis-mount controllers for user installation in an enclosure along with special logic and/or auxiliary control devices.

2. Models 5100P are enclosed packaged controllers supplied in a rugged sheet steel oiltight enclosure.

Each model controller is a complete functional unit, requiring only a motor and operator controls.

TABLE 1. SERIES 5100 MODEL MATRIX

MODEL	HP (1) RANGE	THREE-PHASE OUTPUT		CONFIGURATION	
		MAX. CURRENT	MAX. KVA	Open Chassis	Enclosed
5101S	1/4-1 HP	4.0A	1.6	X	
5101P					X
5102S	1/4-2 HP	6.8A	2.7	X	
5102P					X
5103S	3	10.0A	4.0	X	
5103P					X
5105S	3-5	15.2A	6.0	X	
5105P					X

(1) Horsepower ratings are for reference only. The maximum currents required must not exceed those shown per model.

CONTROLLER IDENTIFICATION

Each 5100 Controller contains a data label, which specifies the model and serial numbers, ratings, and a listing of options that are installed.

MOTOR SELECTION

Either one of the following two basic motor types can be used with 5100 Controllers:

1. Any standard three-phase AC motor designed for fixed speed operation at standard line frequency, provided the following is considered:

   a. A slight increase in motor losses occurs with inverter power.

   b. The motor thermal capacity must be rated as a function of the minimum continuous operating speed in accordance with figure 1, due to the reduced ventilation of the internal motor fan. Where applications require 100% rated torque at speeds below 50% of the synchronous speed, a separately powered ventilation blower, a non-ventilated motor, or next higher motor rating should be used. When a separately powered ventilation blower is used, an internal thermostat should be built into the motor to prevent damage which may result from a failure in the ventilation system.

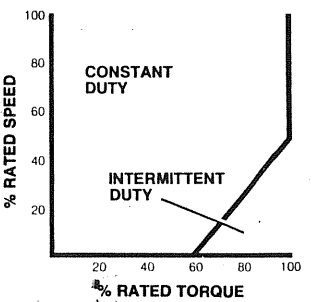


FIGURE 1. STANDARD AC MOTORS-ADJUSTABLE SPEED OPERATION

2. Any three-phase synchronous or induction AC motor designed for adjustable speed operation by inverter control.

OPERATOR CONTROLS

The operator controls may be user supplied or supplied by Fincor as a companion to the controller.

Table 2 lists Fincor Series SCS160 companion remote operator control stations for use with Series 5100 Controllers.

TABLE 2. REMOTE CONTROL STATIONS

MODEL NO.	CONTROL ELEMENTS		
	Pushbuttons	Toggle Switch	Potentiometer
SCS 161	Run, Stop	—	Motor Speed
SCS 162	Run, Stop	Fwd-Rev	Motor Speed
SCS 163	Run, Stop	Run-Jog	Motor Speed, Jog Speed
SCS 164	Run, Stop	Run-Jog, Fwd-Rev	Motor Speed, Jog Speed
104200001	Operator station housing with blank cover for converting local control models to remote control.		

NOTE: NEMA Type 1 Enclosure with TENV industrial rated components.

RATINGS

1. Horsepower Range - 1/4 to 5 HP
2. Power Source - 230V, 1Ø, 50 or 60 Hz
3. Output Power (Three-Phase)

   a. Voltage - 0 to 230 VAC
   b. Frequency (standard range) - 0 to 60 Hz

4. Service Factor - 1.0

5. Duty - Continuous

6. Overload Capacity (rated torque) - 120% for 1 minute

7. Reference Power Supply - +10 VDC

8. Motor Speed Potentiometer - 5K Ohm, 1/2W

TABLE 3. TYPICAL APPLICATION DATA

COMPONENT		RATINGS							
Rated Horsepower (HP)		1/4	1/2	3/4	1	1-½	2	3	5
Rated Kilowatts (kW)		0.187	0.373	0.560	0.746	1.120	1.492	2.238	3.730
1-PHASE 230V INPUT (FULL LOAD)	Line Amps (2)	4.1	5.8	7.2	8.6	11.1	15.1	18.5	28.2
	KVA (1)	1.0	1.3	1.7	2.0	2.6	3.5	4.3	6.5
3-PHASE 230V OUTPUT (FULL LOAD)	Motor Amps (2)	1.5	2.4	3.2	4.0	5.0	6.8	10.0	15.2
	KVA	.6	.96	1.3	1.6	2.0	2.7	4.0	6.0
MINIMUM TRANSFORMER KVA FOR VOLTAGE MATCHING OR ISOLATION		1.0	1.5	2.0	3.0	5.0	5.0	10.0	10.0
FULL LOAD TORQUE (lb.-ft.) with 1750 RPM Base Speed Motors (1)		0.75	1.5	2.2	3.0	4.5	6.0	9.0	15.0
CONTROLLER WT. IN LBS. (kgs.)	5100P	28 (13)				30 (14)		49 (22)	50 (23)
	5100S	20 (9)				22 (10)		35 (16)	37 (17)

NOTES: [1] Data listed is rated torque at or below base speed. Continuous duty application of these motors is typically limited to 100% rated torque down to 50% of base speed or 60% of rated torque over a 10:1 speed range.

[2] Currents listed are typical and should be used when sizing wire and circuit protection devices.

OPERATION CONDITIONS

1. Line Voltage Variation - +10%, -5% of rated

2. Line Frequency Variation - ±2 Hz of rated

3. Ambient Temperature

   a. Model 5100P Controller - 0 to 40°C (32 to 104°F)
   b. Model 5100S Controller - 0 to 55°C (32 to 131°F)*

4. Altitude (standard) - 1000 meters (3300 feet) maximum

Note: * Temperature within the enclosure in which the controller is mounted.

PERFORMANCE CHARACTERISTICS

1. Controller Speed Range - Zero to motor base speed at 60 Hz, constant torque with standard NEMA Design B motors. Constant horsepower from base speed to maximum speed with optional personality modules. See Option Group C in table 9. Speed range with respect to the specified speed regulation is 6 to 60 Hz or 10 to 1.

2. Speed Regulation (see table 4) - Regulation percentages are of motor rated (base) speed under steady-state operating conditions.

3. Efficiency (rated speed, rated load)

   a. Controller - 94%
   b. Controller with motor - 70 to 80%

4. Displacement Power Factor (maximum speed, rated load) - 95%

TABLE 4. TYPICAL SPEED REGULATION CHARACTERISTICS

REGULATION METHOD	MOTOR TYPE		VARIABLES			
	NEMA B	Synchronous Reluctance	95% Load Change	±10% Line Voltage	±10° C Temp	Motor (1) Cold/Hot
Standard	X	–	3.0%	±1.0%	±2.0%	1.0%
	–	X	0%	±1.0%	±2.0%	0%
Precision Reference Option 1059	X	–	3.0%	±0.1%	±0.5%	1.0%
	–	X	0%	±0.1%	±0.5%	0%
Slip Compensation Option 1060A with Precision Reference Option 1059	X	NA	1.0%	±0.1%	±0.5%	1.0%
Tach Feedback Option 1061C	X	NA	0.2%	±1.0%	±2.0%	0.2%
Tach Feedback (1061C) with Precision Reference (1059)	X	NA	0.2%	±0.1%	±0.5%	0.2%

(1) Average expected values dependent upon individual motor characteristics.

STANDARD FEATURES

1. AC Line Protection - Two fuses, one in series with each AC line, provide protection from peak load and short circuit.

2. Instantaneous Overload Protection - Immediate shutdown of the controller by solid-state circuitry whenever DC bus current exceeds 150% of rated or DC bus voltage exceeds 110% of rated. This circuitry also prevents a phase-to-phase output short from damaging the controller.

3. Motor Overload Protection - Positive motor protection by a solid-state current monitor, which shuts down the controller when the DC bus current exceeds 120% of rated for 60 seconds.

4. Undervoltage Protection - Provided by dropout of the controller run relay. Involuntary restart is prevented after power interruption.

5. Voltage Transient Protection - Metal oxide suppressor (varistor) and an RC network across the AC line minimize effects of high voltage spikes from the AC power source.

6. Isolated Regulator - Internal DC circuits are isolated from the AC power circuitry for operator and equipment safety and simplified application. The control reference input common may be grounded or connected without additional isolation to other drive controllers or grounded output process controllers. Isolation eliminates line voltage to ground potentials on the motor speed potentiometer.

7. Static Braking Control - Adjustable linear rate dynamic braking of the motor. Maximum braking torque of the standard controller is 20% of rated load torque. Braking occurs when one of the following events occurs:

   a. The speed reference is decreased to reduce motor speed.
   b. A Stop function is initiated.
   c. An overhauling load is connected to the motor.

   Optional electronic braking (Option 1045A) is available which increases the braking capability of the controller from 20 to 150% of rated load torque.

8. Static Reversing Control - Provides contactorless reversing when appropriate external contacts are used.

9. Control Transformer - A 24-volt secondary isolates operator controls and magnetic control logic from the AC power source for operator protection.

10. Base Drive Indicators - Light emitting diodes (LED's) illuminate to indicate when base driving signals are applied to the output transistors.

11. Bus Voltage Indicator - An LED illuminates when voltage is applied to the bus.

12. Fault Indicator - An LED illuminates after an automatic shutdown, which may be caused by an instantaneous or timed overload or overvoltage on the DC bus.

13. Auxiliary Outputs

    a. Auxiliary Contact - Run relay provides one normally-open and one normally-closed form C contact for external use. Each contact is rated 1 ampere, 120 VAC and 2 amperes, 28 VDC resistive load.

    b. Fault Trip - An open collector transistor, rated 24 VDC at 100 milliamperes maximum, provides a fault trip indication for an external fault indicator.

    c. Motor Frequency - An open collector transistor, rated 24 VDC at 100 milliamperes maximum, switches directly proportional to motor frequency, thereby providing a signal for an external frequency counter.

    d. Speed Meter - A 0 to -8.0 VDC signal provides an indication of 0 to maximum motor speed for an external speed indicator.

    e. Zero Speed - An open collector transistor, rated 24 VDC at 100 milliamperes maximum, provides a zero speed indication for activating external logic.

ADJUSTMENTS

The following adjustments are provided on the standard control board in the controller.

1. Acceleration - 2 to 20 seconds
2. Deceleration[1] - 2 to 20 seconds
3. Low Frequency Voltage Boost[2] - 0 to 60 volts
4. Maximum Speed - 60 to 100%
5. Minimum Frequency[2] - 0 to 5%
6. Minimum Speed - 0 to 30%
7. Volts/Hz - ±10%

Notes: [1] Setting determines rate of dynamic braking. See "Static Braking Control" on page 5.

[2] Setting determines starting torque, typically adjustable from 150 to 200%.

OPTIONS

Standardized pre-engineered optional equipment can be supplied with Series 5100 Controllers at additional cost. See the option selection table in Section VII. Each option is supplied with an instruction sheet. Therefore, option descriptions are not included with this manual.

SECTION II

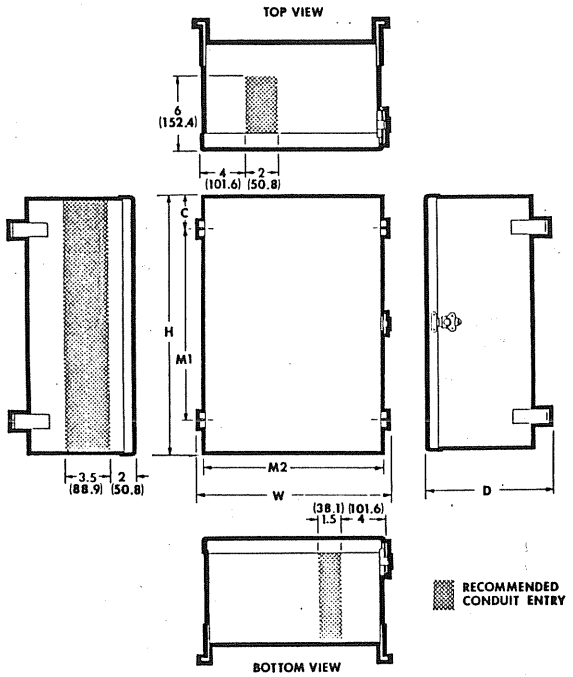
INSTALLATION

MOUNTING INSTRUCTIONS

1. Surface mount the controller in a vertical position with the mounting tabs provided. The standard enclosure (Series 5100P) should not be used where a watertight, weatherproof, or explosion proof enclosure is required. See figure 2 or 3 for mounting dimensions.

[CAUTION]

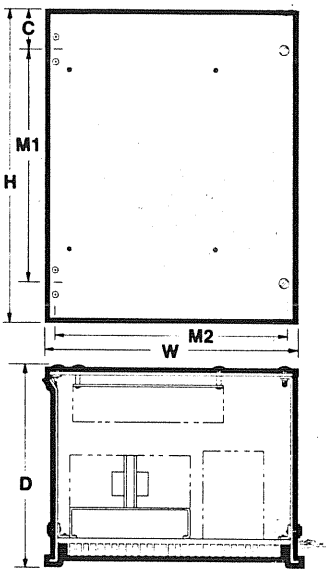
NEVER MOUNT THE CONTROLLER IMMEDIATELY BESIDE OR ABOVE HEAT-GENERATING EQUIPMENT, OR DIRECTLY BELOW WATER AND STEAM PIPES.



HP (kW)	DIMENSIONS, inches (mm)						DOOR SWING
	H	W	D	M1(1)	M2(1)	C	
1/4-2 (0.187-1.492)	12.25 (311)	11.75 (298)	8.75 (222)	7.75 (197)	11.125 (283)	2.25 (57)	165°
3-5 (2.238-3.730)	18.50 (457)	14.12 (361)	8.75 (222)	14.0 (356)	13.50 (343)	2.25 (57)	165°

NOTE: (1) Mounting Dimensions

FIGURE 2. 5100P ENCLOSED PACKAGE DIMENSIONS



HP (kW)	DIMENSIONS, inches (mm)					
	H	W	D	M1(1)	M2(1)	C
1/4-2 (0.187-1.492)	11.75 (298)	11.68 (296)	8.75 (222)	7.75 (197)	11.125 (283)	2.0 (51)
3-5 (2.238-3.730)	18.0 (457)	14.2 (361)	8.75 (222)	14.0 (356)	13.50 (343)	2.0 (51)

NOTE: (1) Mounting Dimensions

FIGURE 3. 5100S CHASSIS-MOUNT DIMENSIONS

2. Allow for free air circulation around the controller. Provide 4 inches minimum clearance on all sides for maximum cooling efficiency. If the controller is user mounted in an enclosure, allow for adequate ventilation. Air passages into the bottom, with exit openings near the top, form an adequate configuration. If a small enclosure is used, a ventilation fan may be required. Temperature within an enclosure should not exceed 55°C (131°F) or controller damage may occur.

3. Shock-mount the controller if it is subjected to external vibrations. Shock and excessive vibrations are detrimental to controller performance and life. Vibration can cause general deterioration of connections and component damage.

4. Fincor's Series SCS160 standard operator control station can be wall-mounted using the two holes in the back of the enclosure. See figure 4 for mounting dimensions.

5. If the motor is to be foot-mounted, bolt the motor to a firm, flat foundation. If the foundation is not flat, use shims to prevent strain when tightening the bolts. If the motor is to be connected directly to a machine, be sure of correct alignment. Pulleys and couplings must slip freely onto the motor shaft.

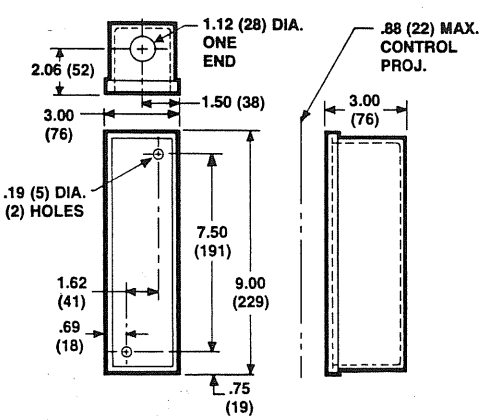


FIGURE 4. REMOTE CONTROL STATION DIMENSIONS

[CAUTION]

NEVER HAMMER THE PULLEY, COUPLING, OR MOTOR SHAFT, NOR OVERTIGHTEN DRIVE BELTS OR TIMING CHAINS. Bearing damage may occur.

WIRING INSTRUCTIONS

1. Interconnection wiring is required between the controller, AC input supply, operator controls, and applicable optional equipment.

[CAUTION]

SEPARATE OVERCURRENT PROTECTION IS REQUIRED BY THE NATIONAL ELECTRICAL CODE. THE USER IS RESPONSIBLE FOR CONFORMING WITH THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE LOCAL CODES WHICH GOVERN SUCH PRACTICES AS WIRING PROTECTION, GROUNDING, DISCONNECTS, AND OTHER CURRENT PROTECTION.

2. The controller is protected from normal line transients and surges. However, to prevent problems from high-energy transients and large surges, observe the following:

   a. Place the controller on a feeder line separate from that supplying large inductive loads.

   b. If the input supply to the controller comes directly from a transformer, always switch power ON and OFF between the transformer secondary and the controller. See table 3 (page 3) for minimum transformer KVA.

[CAUTION]

1. NEVER MAKE OR BREAK POWER IN THE TRANSFORMER PRIMARY. Transients may be generated which can damage the controller.

2. THE AVAILABLE SHORT-CIRCUIT CURRENT OF THE INPUT SUPPLY MUST BE LESS THAN 10,000 AMPERES SYMMETRICAL OR CONTROLLER DAMAGE MAY OCCUR.

Short-circuit current can be limited by sizing the input supply transformer at 100 KVA or less, or by using correctly sized current-limiting fuses in the input supply to the controller. Do not size the transformer less than the minimum transformer KVA listed in table 3 (page 3).

   c. If the controller must be fed from an AC feeder which also feeds highly inductive loads, supply additional suppression to limit transients or surges to 150% of peak line voltage.

[CAUTION]

NEVER USE POWER FACTOR CORRECTION CAPACITORS ON THE INPUT LINES TO THE CONTROLLER OR ON THE WIRING TO THE MOTOR WITHOUT CONSULTING FINCOR. These capacitors may damage the solid-state components.

3. The wire size of the power wiring (input supply and motor) can be determined from table 3 and the controller data label. Use stranded wire for all external wiring. For 1/4 through 2 HP controllers, do not use wire larger than #12 AWG. For 3 and 5 HP controllers, do not use input supply wiring larger than #8 AWG nor motor wiring larger than #12 AWG. Use stranded wire for all external wiring.

[CAUTION]

1. NEVER USE SOLID WIRE. Intermittent and broken connections may occur if solid wire is used.

2. OVERSIZED OR SOLID WIRE, AS WELL AS THE USE OF LARGE SCREWDRIVERS FOR ELECTRICAL CONNECTIONS, CAN BREAK TERMINAL BOARD BARRIERS.

4. All external wiring for low voltage signal sources, e.g., wiring for potentiometers, tachometer generators, operator controls, and transducers, should be run in conduit separate from all other wiring. Use shielded cable such as Alpha 2423 (3-conductor) and Alpha 2424 (4-conductor). Connect the shield only to common Terminal 14 or 11 on the controller Control Board (1043905). Tape the opposite end of the shield. Maintain the separation of power and signal wiring by at least 2 inches.

[CAUTION]

PICKUP FROM UNWANTED SIGNALS CAN CAUSE ERRATIC OPERATION AND/OR CONTROLLER DAMAGE.

5. Since the DC circuits are isolated from the AC input supply, the reference input common can be grounded, or connected without additional isolation to other drive controllers or grounded output process transducers.

6. Figure 2 shows recommended areas for conduit entry. Conduit entry into areas other than those shown can damage the controller.

[CAUTION]

BE SURE METAL CHIPS FROM CONDUIT OPENINGS DO NOT ENTER THE CONTROLLER. Metal chips can cause short circuits and grounds which can damage the controller.

AC POWER CONNECTIONS

Connect the 230 volt single-phase AC input supply to the controller, as follows:

1. 1/4 - 2 HP Controllers - Terminals L1 and L2 on the power board Terminal Board (TB2). See figure 29.

2. 3 & 5 HP Controllers - The line terminals on the Line Fuses (F1 and F2). See figure 30.

If an isolation transformer is used for isolation or voltage matching, be sure the transformer KVA rating is not less than the minimum transformer KVA listed in table 3 (page 3).

Connect the controller to an earth ground according to applicable electrical codes. A Ground Connection Screw (GND) is provided for this purpose on the controller heat-sink base. (See figure 29 or 30.)

MOTOR CONNECTIONS

The motor can be connected directly to the controller at Terminals ØA-ØB-ØC on the power board Terminal Board (TB2). If a motor overload relay is used, connect it as shown on figure 5. (See figure 29 or 30 for terminal location.) The motor wiring may be bundled with the input power wiring.

[CAUTION]

DO NOT GROUND THE MOTOR WIRING. Grounded wiring can cause controller damage.

If the motor has a thermoguard, connect it to Terminals 1 and 2 on the control board Terminal Board (TB1) as shown on figure 5. (Also see figure 29 or 30.)

If an overload relay and/or motor thermoguard is used, remove the jumper wire from Terminals 1 and 2 as shown on figure 5. Use shielded cable for the thermoguard and overload relay contact wiring.

If, during startup, motor rotation is opposite to that desired,

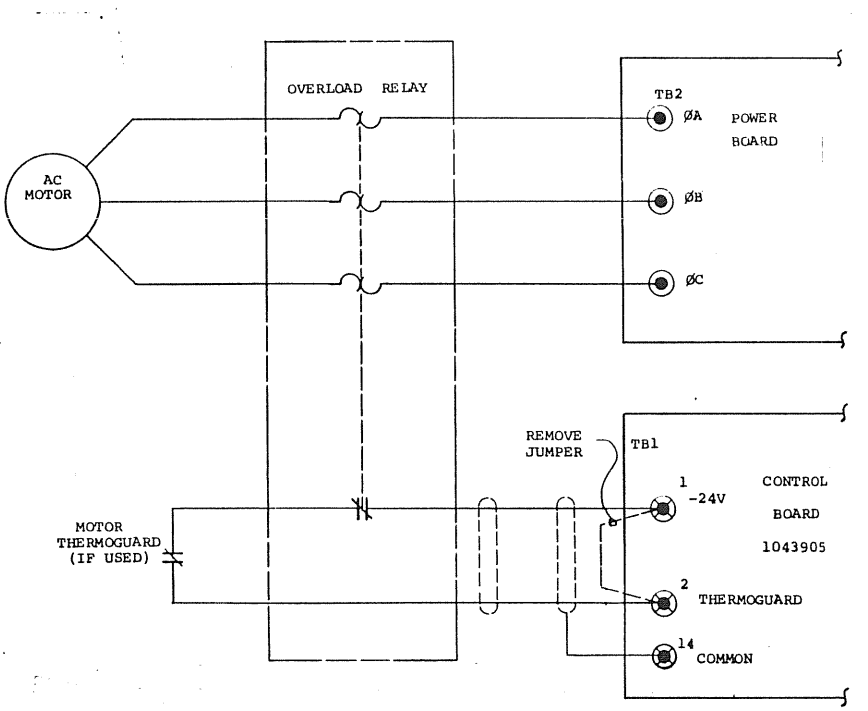


FIGURE 5. MOTOR CONNECTIONS

turn-off the AC supply and interchange any two of the three motor leads at Terminals ØA-ØB-ØC.

OPERATOR CONTROL STATION CONNECTIONS

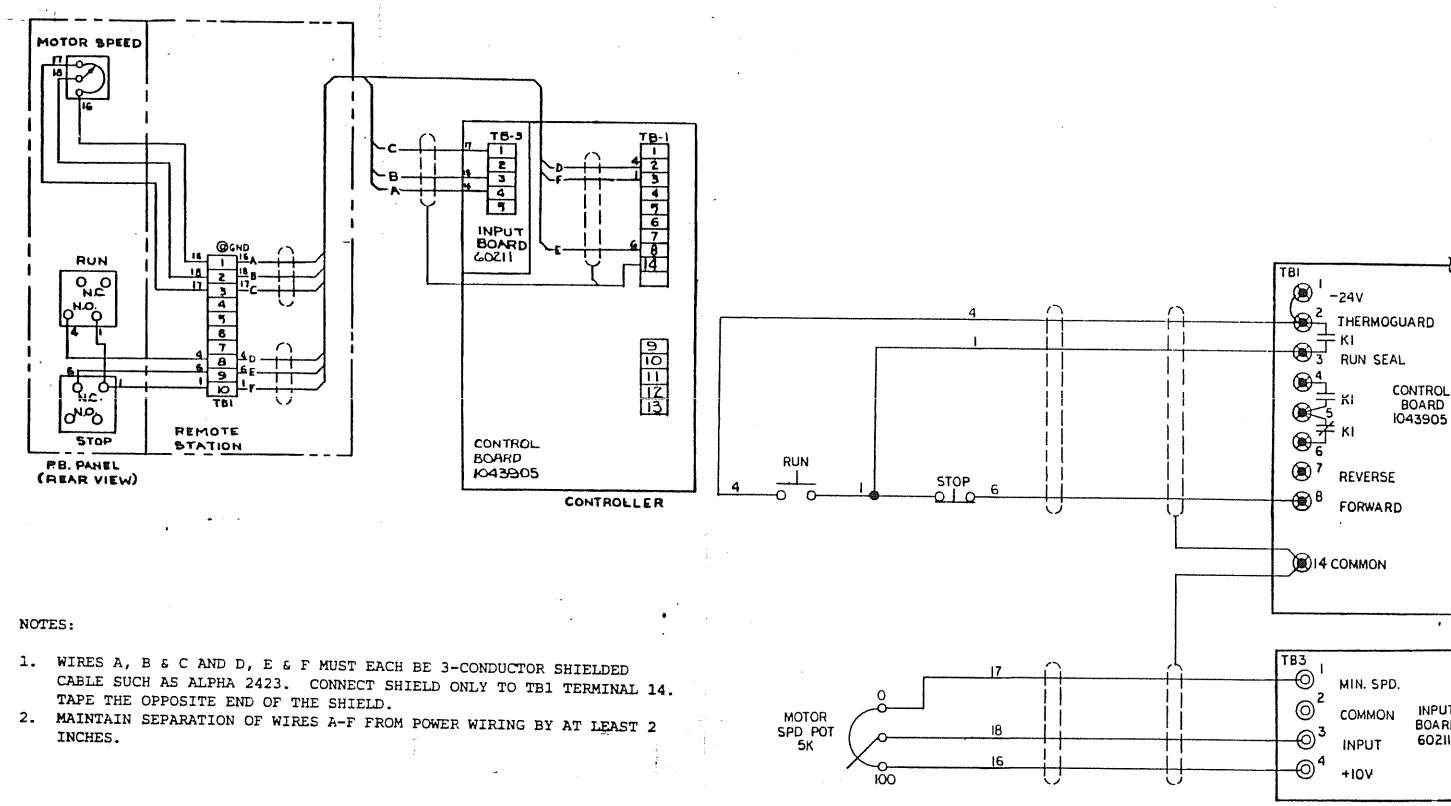
Connect the operator controls to the controller control board and input board, as follows:

1. For basic operation functions, or if a Fincor Series SCS160 remote operator control station is used, see figure 6, 7, 8 or 9, as applicable.

2. For operation functions with external relay logic (user supplied), see figure 10, 11, 12, 13 or 14, as applicable.

[CAUTION]

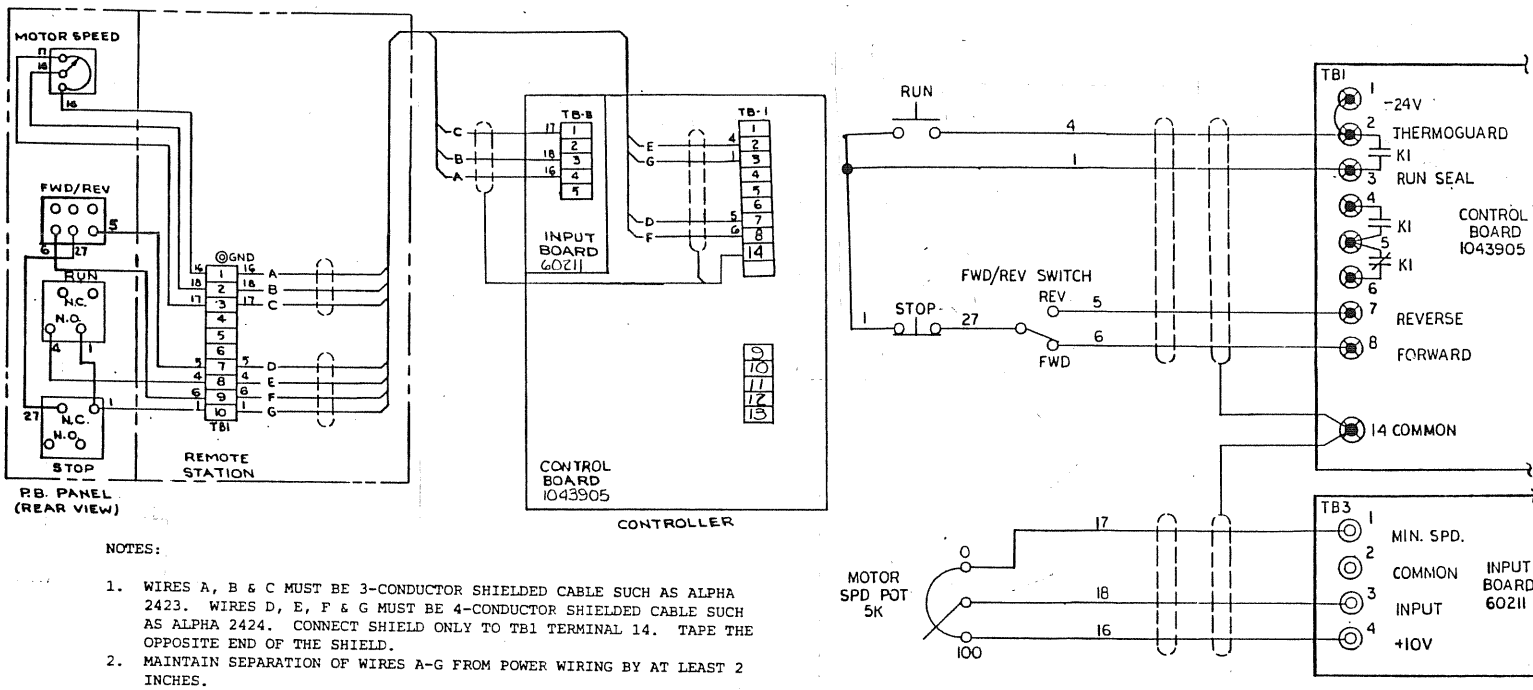
IF MAINTAINED CONTACTS ARE USED FOR RUN FUNCTIONS, THEY SHOULD OPEN IF THE AC SUPPLY IS INTERRUPTED TO THE CONTROLLER SO THAT POWER CANNOT BE REAPPLIED TO THE MOTOR WHILE IT IS ROTATING. IF RESTARTING OCCURS WHILE THE MOTOR IS ROTATING, A CONTROLLER FAULT OR SYSTEM MALFUNCTION MAY OCCUR.



NOTES:

1. WIRES A, B & C AND D, E & F MUST EACH BE 3-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2423. CONNECT SHIELD ONLY TO TB1 TERMINAL 14. TAPE THE OPPOSITE END OF THE SHIELD.
2. MAINTAIN SEPARATION OF WIRES A-F FROM POWER WIRING BY AT LEAST 2 INCHES.

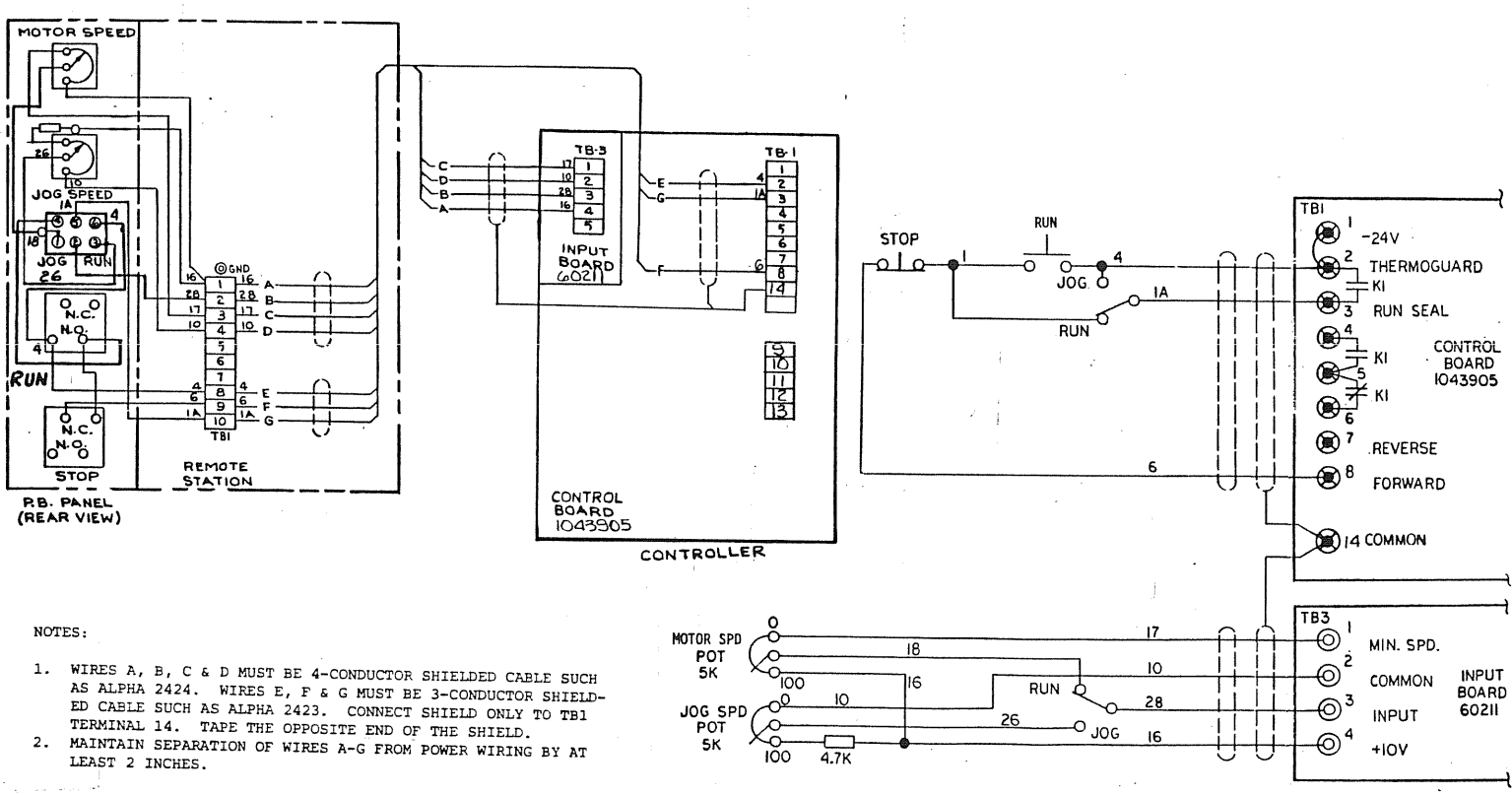
FIGURE 6. CONNECTION DIAGRAM, RUN/STOP W/SCS 161 REMOTE STATION



NOTES:

1. WIRES A, B & C MUST BE 3-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2423. WIRES D, E, F & G MUST BE 4-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2424. CONNECT SHIELD ONLY TO TB1 TERMINAL 14. TAPE THE OPPOSITE END OF THE SHIELD.
2. MAINTAIN SEPARATION OF WIRES A-G FROM POWER WIRING BY AT LEAST 2 INCHES.

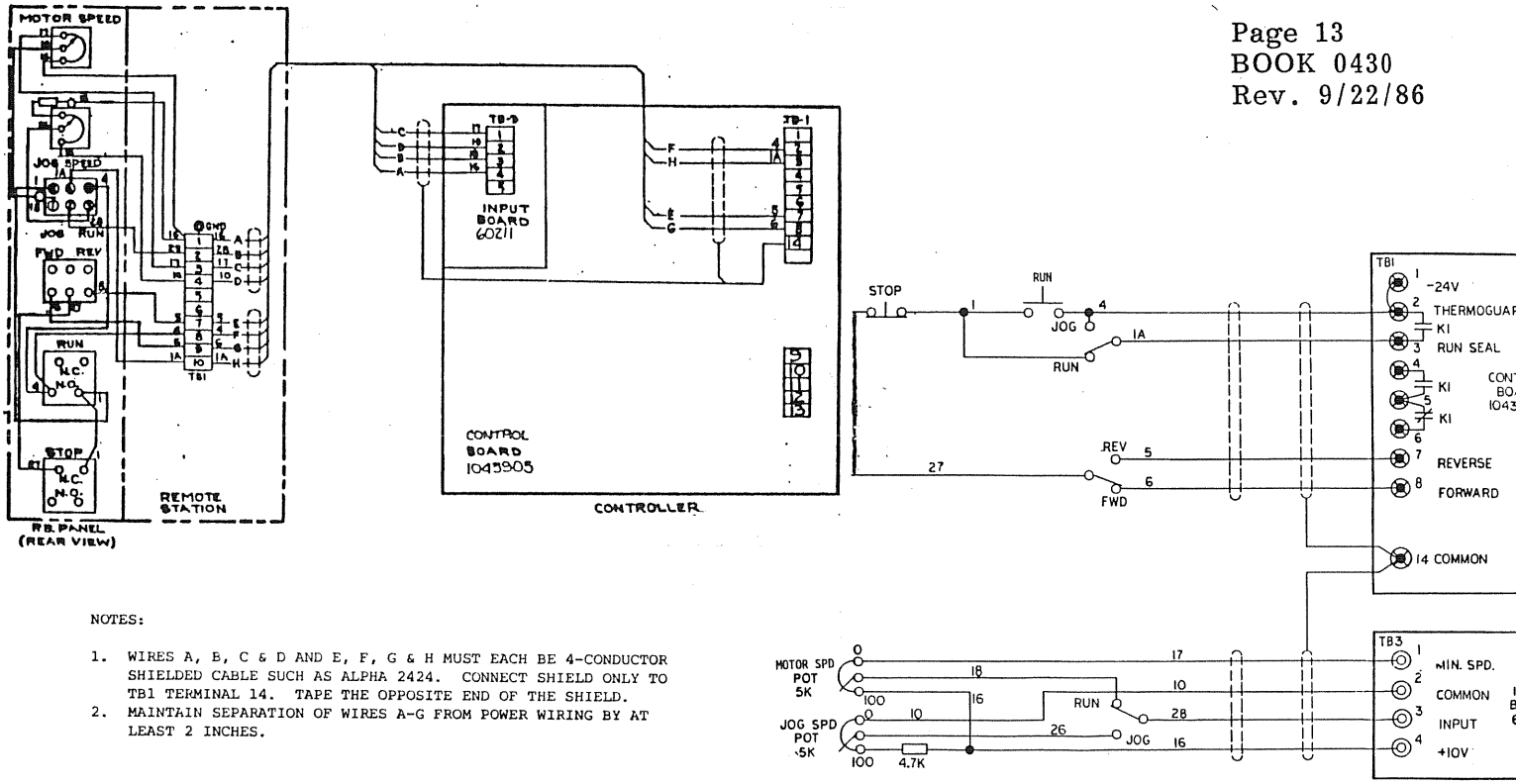
FIGURE 7. CONNECTION DIAGRAM, FWD/STOP/REV W/SCS 162 REMOTE STATION



NOTES:

1. WIRES A, B, C & D MUST BE 4-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2424. WIRES E, F & G MUST BE 3-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2423. CONNECT SHIELD ONLY TO TB1 TERMINAL 14. TAPE THE OPPOSITE END OF THE SHIELD.
2. MAINTAIN SEPARATION OF WIRES A-G FROM POWER WIRING BY AT LEAST 2 INCHES.

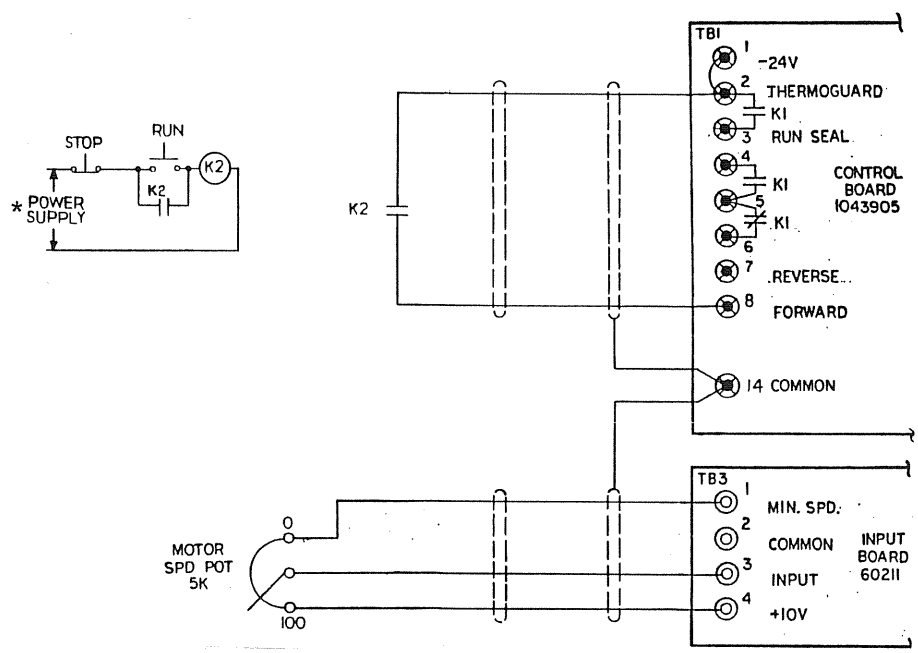
FIGURE 8. CONNECTION DIAGRAM, RUN/STOP/JOG W/SCS 163 REMOTE STATION



NOTES:

1. WIRES A, B, C & D AND E, F, G & H MUST EACH BE 4-CONDUCTOR SHIELDED CABLE SUCH AS ALPHA 2424. CONNECT SHIELD ONLY TO TB1 TERMINAL 14. TAPE THE OPPOSITE END OF THE SHIELD.
2. MAINTAIN SEPARATION OF WIRES A-G FROM POWER WIRING BY AT LEAST 2 INCHES.

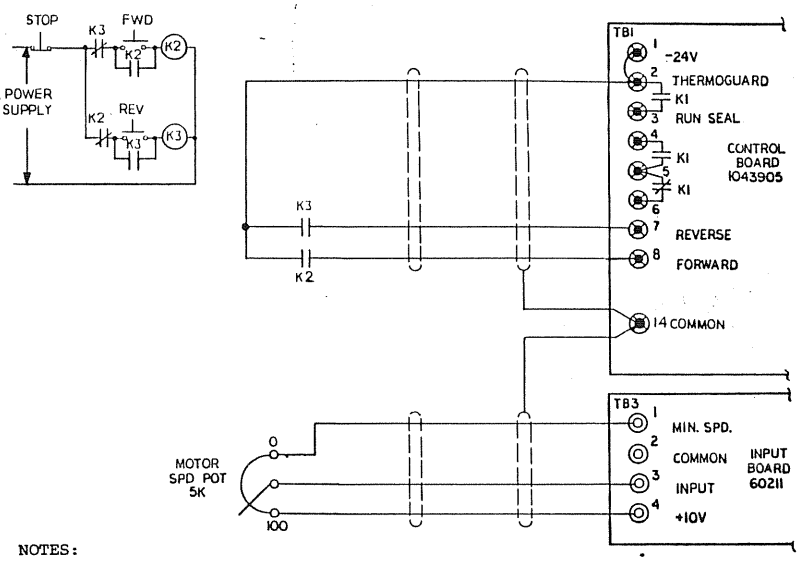
FIGURE 9. CONNECTION DIAGRAM, FWD/STOP/REV/JOG W/SCS 164 REMOTE STATION



NOTES:

1. RELAY K2, RUN-STOP BUTTONS, AND MOTOR SPD POT ARE USER SUPPLIED.
2. SUGGESTED RELAY (K2) - P & B TYPE KHU.
3. ALL WIRING CONNECTED TO TB1 AND TB3 MUST BE SHIELDED CABLE, SUCH AS:
   2-CONDUCTOR - ALPHA 2422
   3-CONDUCTOR - ALPHA 2423
   4-CONDUCTOR - ALPHA 2424
   CONNECT SHIELD ONLY TO TB1 TERMINAL 14. TAPE THE OPPOSITE END OF THE SHIELD.
4. MAINTAIN SEPARATION OF SHIELDED CABLES AND POWER WIRING BY AT LEAST 2 INCHES.
5. * REFER TO THE CAUTION ON PAGE 11.

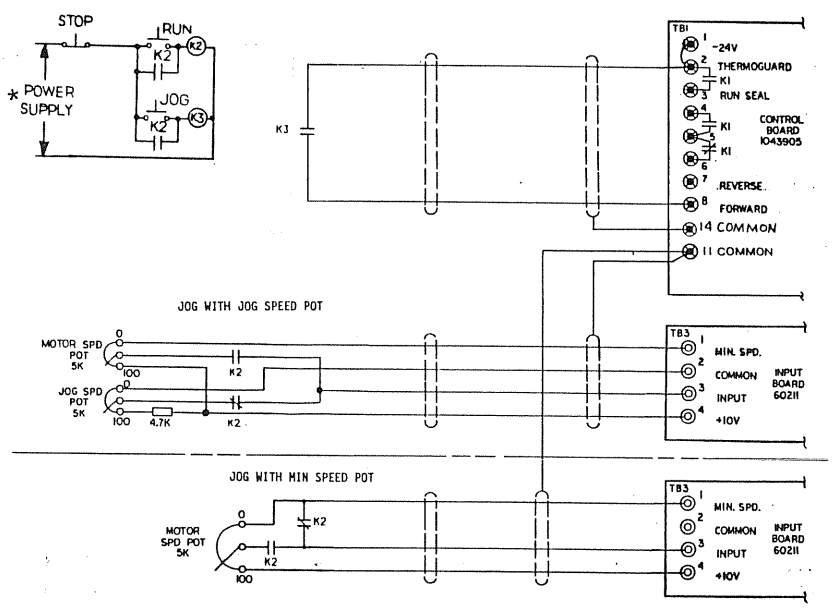
FIGURE 10. SUGGESTED CONNECTION DIAGRAM, RUN/STOP W/EXTERNAL RELAY LOGIC



NOTES:

1. RELAYS K2 AND K3, FWD-STOP-REV BUTTONS, AND MOTOR SPD POT ARE USER SUPPLIED.
2. SUGGESTED RELAYS (K2, K3) - P & B TYPE KHU.
3. ALL WIRING CONNECTED TO TB1 AND TB3 MUST BE SHIELDED CABLE, SUCH AS:
   2-CONDUCTOR - ALPHA 2422
   3-CONDUCTOR - ALPHA 2423
   4-CONDUCTOR - ALPHA 2424
4. MAINTAIN SEPARATION OF SHIELDED CABLES AND POWER WIRING BY AT LEAST 2 INCHES.
5. * REFER TO THE CAUTION ON PAGE 11.

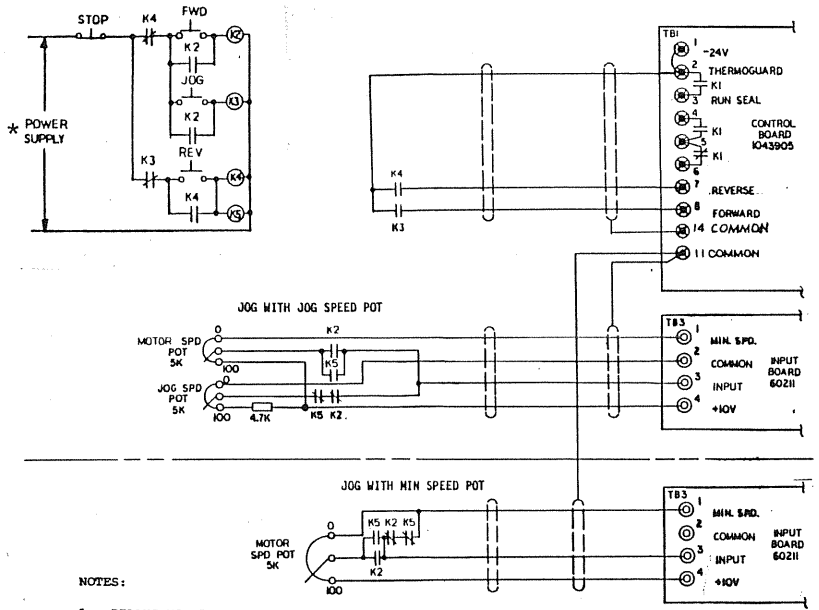
FIGURE 11. SUGGESTED CONNECTION DIAGRAM, FWD/STOP/REV W/EXTERNAL RELAY LOGIC



NOTES:

1. RELAYS K2 AND K3, RUN-STOP-JOG BUTTONS, AND MOTOR SPD AND JOG SPD POTS ARE USER SUPPLIED.
2. SUGGESTED RELAYS (K2,K3) - P & B TYPE KHU.
3. ALL WIRING CONNECTED TO TB1 AND TB3 MUST BE SHIELDED CABLE, SUCH AS:
   2-CONDUCTOR - ALPHA 2422
   3-CONDUCTOR - ALPHA 2423
   4-CONDUCTOR - ALPHA 2424
4. MAINTAIN SEPARATION OF SHIELDED CABLES AND POWER WIRING BY AT LEAST 2 INCHES.
5. * REFER TO THE CAUTION ON PAGE 11.

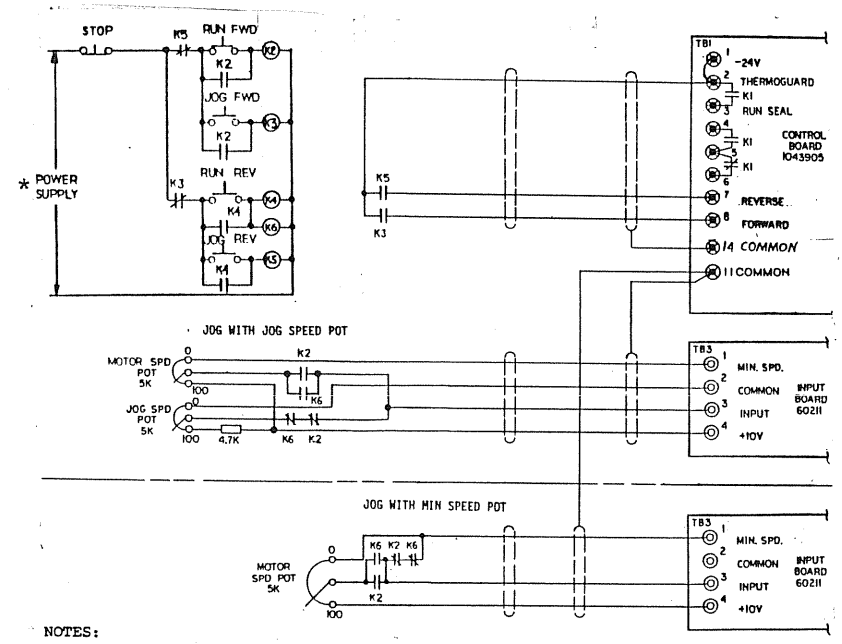
FIGURE 12. SUGGESTED CONNECTION DIAGRAM, RUN/STOP/JOG W/EXTERNAL RELAY LOGIC



NOTES:

1. RELAYS K2-K5, FWD-STOP-REV-JOG BUTTONS, AND MOTOR SPD AND JOG SPD POTS ARE USER SUPPLIED.
2. SUGGESTED RELAYS (K2-K5) - P & B TYPE KHU.
3. ALL WIRING CONNECTED TO TB1 AND TB3 MUST BE SHIELDED CABLE, SUCH AS:
   2-CONDUCTOR - ALPHA 2422
   3-CONDUCTOR - ALPHA 24223
   4-CONDUCTOR - ALPHA 2424
4. MAINTAIN SEPARATION OF SHIELDED CABLES AND POWER WIRING BY AT LEAST 2 INCHES.
5. * REFER TO THE CAUTION ON PAGE 11.

FIGURE 13. SUGGESTED CONNECTION DIAGRAM, FWD/STOP/REV/JOG FWD W/EXTERNAL RELAY LOGIC



NOTES:

1. RELAYS K2-K6, FWD-STOP-REV-JOG FWD-JOG REV BUTTONS, AND MOTOR SPD AND JOG SPD POTS ARE USER SUPPLIED.
2. SUGGESTED RELAYS (K2-K6) - P & B TYPE KHU.
3. ALL WIRING CONNECTED TO TB1 AND TB3 MUST BE SHIELDED CABLE, SUCH AS:
   2-CONDUCTOR - ALPHA 2422
   3-CONDUCTOR - ALPHA 2423
   4-CONDUCTOR - ALPHA 2424
4. MAINTAIN SEPARATION OF SHIELDED CABLES AND POWER WIRING BY AT LEAST 2 INCHES.
5. * REFER TO THE CAUTION ON PAGE 11.

FIGURE 14. SUGGESTED CONNECTION DIAGRAM, FWD/STOP/REV/JOG FWD/JOG REV W/EXTERNAL RELAY LOGIC

If multiple motor speed potentiometers are required, connect them as shown on figure 15.

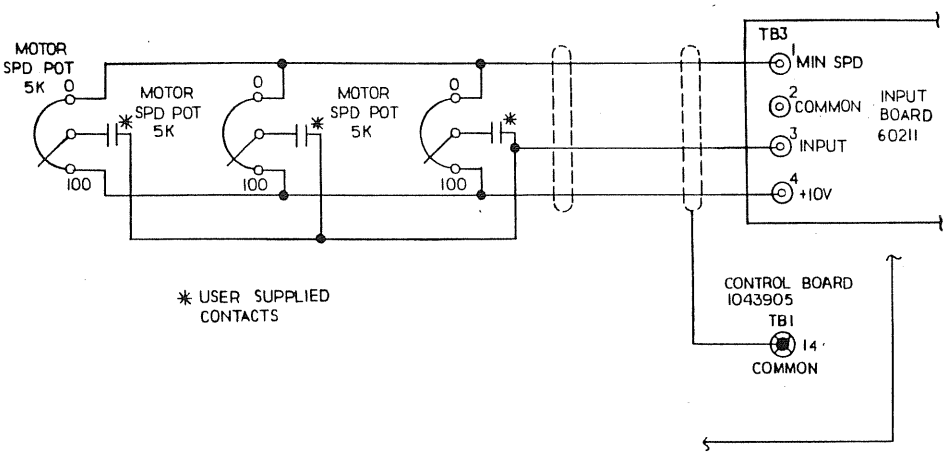


FIGURE 15. MULTIPLE POTENTIOMETER CONNECTIONS

If more than three 5000 ohm motor speed potentiometers are required, use switching to ensure that no more than three potentiometers connect to the controller input board (Terminal TB3-4) at a time.

[CAUTION]

CONNECTING MORE THAN THREE 5K OHM MOTOR SPEED POTENTIOMETERS DIRECTLY TO THE INPUT BOARD WILL OVERLOAD THE CONTROLLER REFERENCE POWER SUPPLY.

If multiple controller operation from a single motor speed potentiometer is required, refer to figure 16.

[CAUTION]

1. NEVER CONNECT MORE THAN 10 CONTROLLERS TO ONE MOTOR SPEED POTENTIOMETER.

2. ISOLATED START AND STOP CONTACTS ARE REQUIRED FOR EACH CONTROLLER.

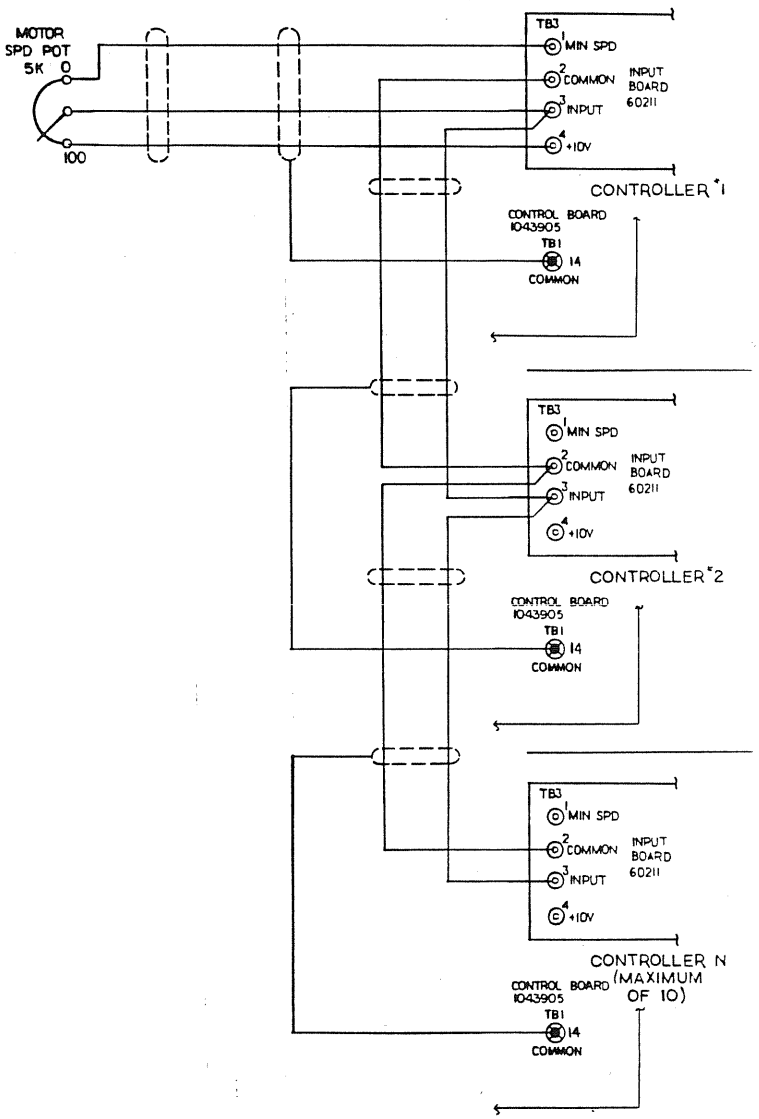


FIGURE 16. MULTIPLE CONTROLLER CONNECTIONS

AUXILIARY EQUIPMENT CONNECTIONS

Various auxiliary outputs are available in the controller, which are listed on page 5. Refer to the following diagrams for typical auxiliary output connections.

Starter Interface

If a motor starter (or contactor) is required for safety, motor selection or line voltage bypass. The starter (or contactor) must be interlocked so that it will not pull in while the motor is rotating or while the controller is in a Run function, unless the drive is sized for line starting.

If a motor starter (or contactor) is required, connect it as shown on figure 17.

When a Run function is initiated, Transistor Q5 conducts from collector to emitter, which energizes Starter M1. When a Stop function is initiated and the motor decelerates to zero speed, Q5 turns-off and drops out M1.

If the starter (or contactor) coil draws more than 100 milliamperes, use an auxiliary relay to operate the starter.

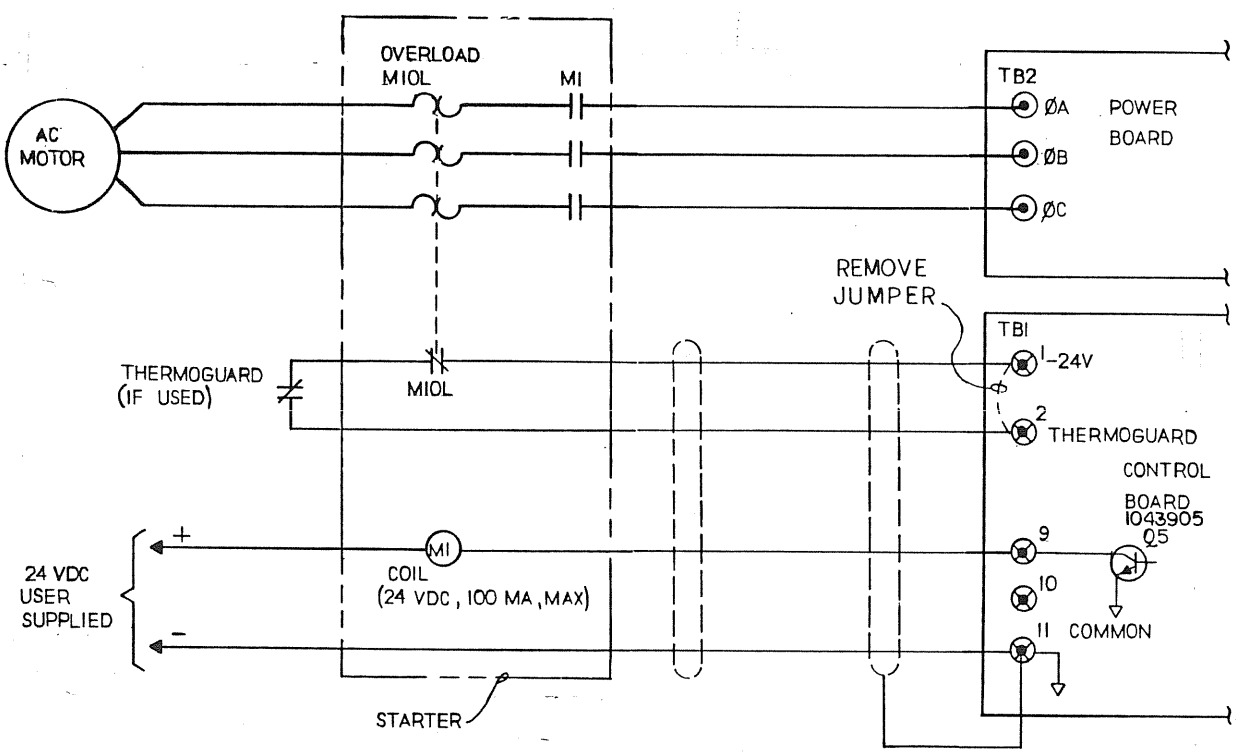


FIGURE 17. STARTER CONNECTIONS

Multiple Motor Operation

When more than one motor is to be connected to a single controller, an overload relay should be used to protect each motor. Figure 18 shows a typical two motor connection scheme.

Transistor Q5 operates Relay K2 which, in turn, operates Starters M1 and M2.

Be sure the K2 relay coil draws less than 100 milliamperes.

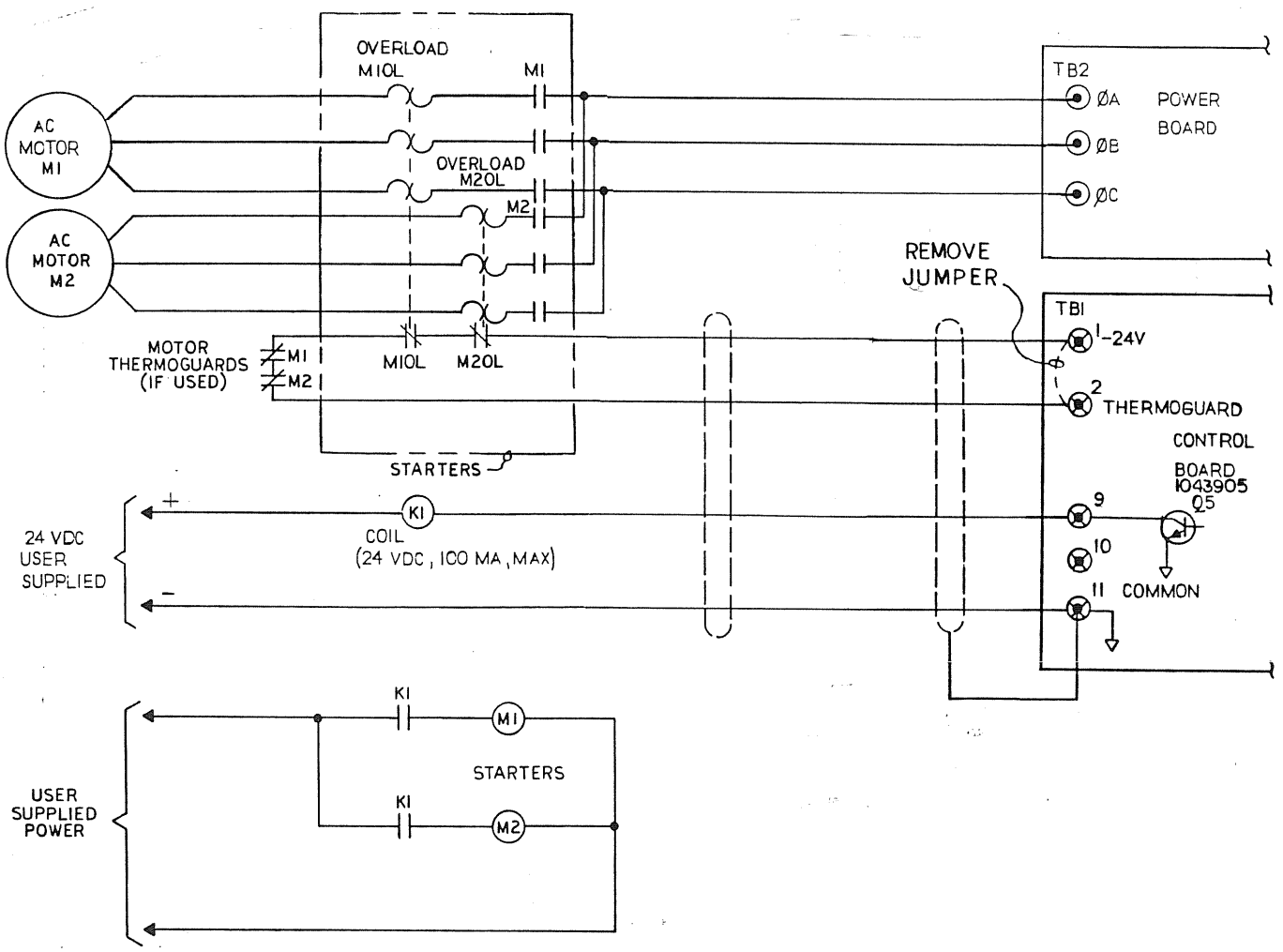


FIGURE 18. TWO-MOTOR CONNECTIONS

Fault Indicator

The controller contains a light emiiting diode (LED) which illuminates to indicate a fault. A fault can be a motor overload, instantaneous overload, or a DC bus overvoltage. See "Standard Features" on page 4. If an external fault indicator (light or relay) is desired, connect it as shown on figure 19.

Be sure the external fault indicator draws less than 100 milliamperes.

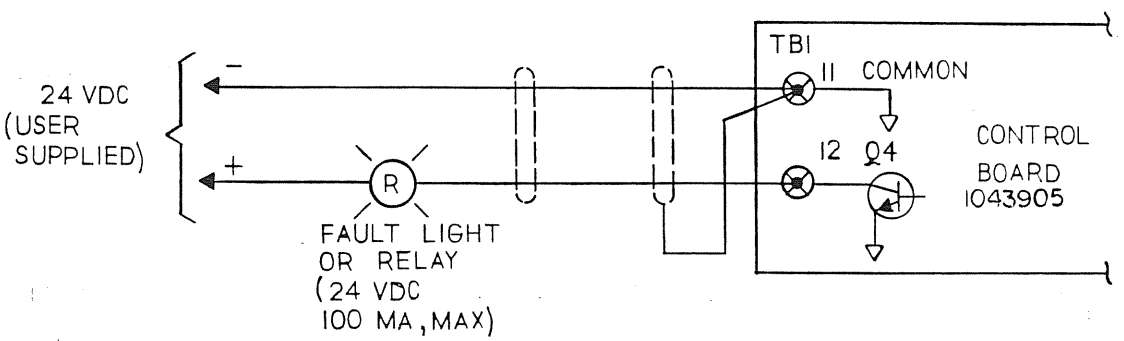


FIGURE 19. FAULT INDICATOR CONNECTIONS

Speed Indicator

Figure 20 shows the connections of a Fincor Model SCM201 Digital Speed Indicator and a Fincor Model SCM101 Analog Speed Indicator. Other speed indicators that operate from a 0 to -8 VDC input can also be used. The speed indicator may be either grounded or ungrounded.

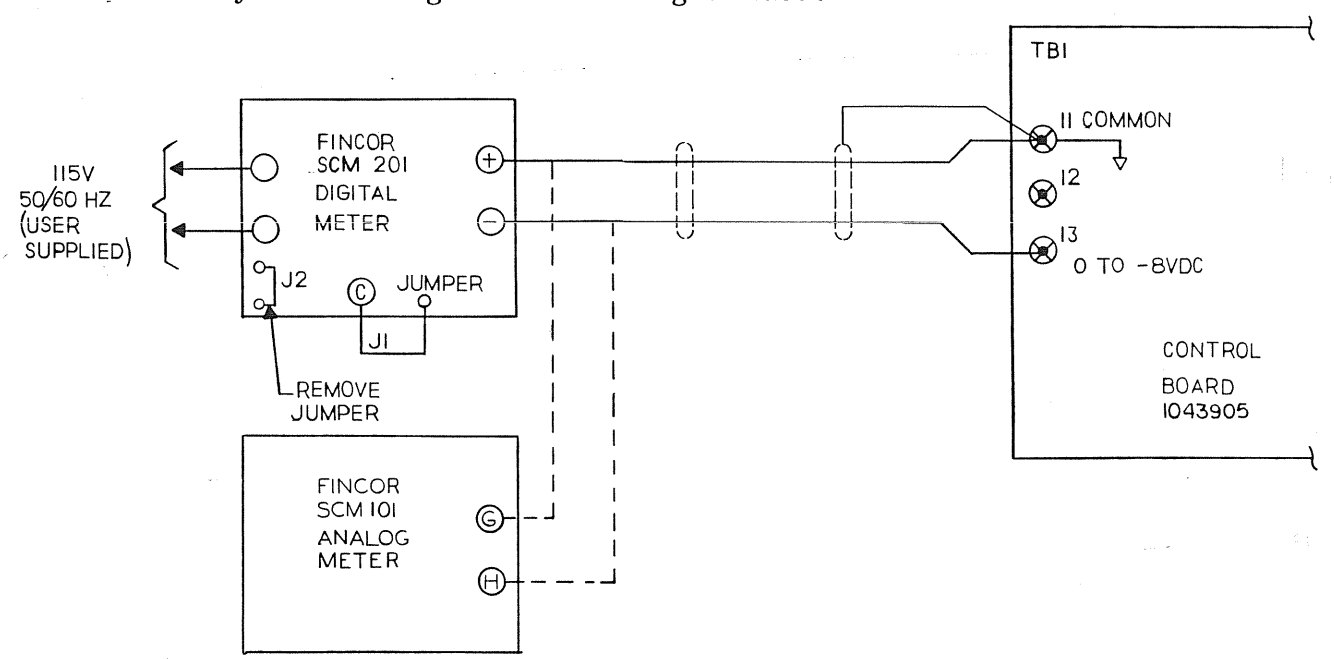


FIGURE 20. SPEED INDICATOR CONNECTIONS

INITIAL STARTUP

Before energizing the controller for the first time, be familiar with all applicable options. See the option selection table in Section VII and the instruction sheet supplied with the option.

The controller has been factory tested and adjusted with a motor under simulated operating conditions. Therefore, startup adjustments may not be needed. However, the following startup procedure should be performed for proper operation, system compatibility and safety.

STARTUP PROCEDURE

1. Be sure all interconnection wiring is correct, and all wiring terminations are tightened securely. Wiring errors, loose connections or accidental grounds can cause controller and motor damage.

2. Be sure the Receptacle (J1) on the control board contains circuit board(s). Unless optional circuit boards have been selected, Receptacle J1 must contain an Input Board (60211) and a Feedback Board (1043910). All feedback boards for use in 5100 Controllers are labeled "5100." (See figure 29 or 30 for circuit board locations.)

[CAUTION]

DO NOT SUBSTITUTE FEEDBACK BOARDS. Substitute feedback boards can cause controller damage.

3. Be sure a personality module is plugged into Socket A1 on the control board. (See figure 29 or 30 for module location.)

4. For 50 Hertz operation, be sure the 60 Hz jumper wire is removed (cut out) from the control board. (See figure 29 or 30 for jumper location.)

5. Be sure the correct resistor wires are removed (cut out) from the power board. See table 5 and figure 29 or 30.

   Note: Do not remove resistor wires from 2 and 5 HP controllers.

6. Turn the motor speed potentiometer fully counterclockwise.

7. Couple the motor to the machine (load).

8. Turn-on the AC input power to the controller.

TABLE 5. RESISTOR WIRES

HP RATING	RESISTOR WIRE TO REMOVE
1/4	R2 thru R8
1/3	R3 thru R8
1/2	R3 thru R8
3/4	R4 thru R8
1	R5 thru R8
1-1/2	R7 & R8
2	NONE
3	R10 thru R15
5	NONE

9. Initiate a Run function and slowly turn the motor speed potentiometer clockwise until the motor rotates. If motor rotation is opposite to that desired, stop the motor, turn-off the AC input power, and interchange any two of the three motor leads.

   Note: Three base drive indicators (LED's) should be illuminated on the driver boards. This is normal and is not cause for concern.

10. Check that motor speed changes in proportion to the motor speed potentiometer setting.

11. Turn the motor speed potentiometer fully counterclockwise and check minimum speed. Minimum speed is typically factory adjusted for zero speed. If desired, minimum speed can be increased to 30% of motor base speed. To readjust minimum speed, turn the MIN SPD Potentiometer (R1), located on the input board, clockwise for desired minimum speed. (See figure 29 or 30 for R1 location.)

12. Turn the motor speed potentiometer fully clockwise and check maximum speed. Maximum speed is typically factory adjusted for motor base (rated) speed. If desired, maximum speed can be decreased to 60% of motor base speed. To readjust maximum speed, turn the MAX SPD Potentiometer (R9), located on the control board, counterclockwise for desired maximum speed. (See figure 29 or 30 for R9 location.)

13. If necessary, adjust the rates of acceleration and/or deceleration as desired with the ACCEL (R10) and DECEL (R12) potentiometers, respectively. Full clockwise rotation provides minimum time and full counterclockwise rotation, maximum time. (See figure 29 or 30 for R10 and R12 locations.)

    Notes: 1. When adjusting acceleration, be sure the rate of acceleration is not too rapid and the motor is not overloaded. Too rapid acceleration and/or excessive load will cause an instantaneous overload fault and shut down the controller. See "Inoperative Motor," page 23.

    2. When adjusting deceleration, be sure the rate of deceleration is not too rapid and the motor and load coasting time is not longer than the desired deceleration time. Too rapid deceleration and/or an overhauling load may cause a DC bus overvoltage fault and shut down the controller. (See "Inoperative Motor," page 23.)

14. Since the controller has been factory tested and adjusted, additional adjustments are not normally necessary. If readjustments are required, see "Adjustment Instructions" in Section V.

15. Turn the motor speed potentiometer fully counterclockwise and initiate a Stop function.

16. Close the controller cover.

SECTION III

OPERATION

GENERAL

Basic Series 5100 Controllers provide the following operation functions: Run, Stop, Speed Control, and Reversing. The actual operator controls and control location will vary according to the model controller and the options selected.

POWER ON/OFF

Series 5100 Controllers are energized when the AC input power is applied to the controller. Normally, this occurs when the user supplied input line disconnect or circuit breaker is turned-on.

RUN

To start the motor, initiate a Run function, and the motor will accelerate to the setting of the motor speed potentiometer. The rate of acceleration is set by the ACCEL Potentiometer (R10).

SPEED CONTROL

Motor speed is directly proportional to the setting of the motor speed potentiometer. This potentiometer may be adjusted while the motor runs or may be preset at any position before the motor is started. Clockwise rotation increases motor speed and counterclockwise rotation decreases speed.

REVERSE

If reversing operator controls are used, initiate a Reverse function to reverse motor rotation, and the motor will accelerate to the setting of the motor speed potentiometer. When a Reverse function is initiated while the motor is running, the motor will decelerate to a stop at the rate set by the DECEL

Potentiometer (R12) and then accelerate in the opposite direction at the rate set by the ACCEL Potentiometer (R10).

STOP

To stop the motor, initiate a Stop function, and the motor will decelerate to a stop at the rate set by the DECEL Potentiometer (R12).

If the controller contains electronic braking (Option 1045A), the braking capability of the controller is increased from 20% to 150% of rated load torque at motor base speed. When a braking function is initiated with Option 1045A, a resistor module connects across the DC bus and dissipates the energy regenerated by the motor.

The resistor module is rated for stopping a typical load a maximum number of stops per minute from motor base speed as shown in table 6.

TABLE 6. ELECTRONIC BRAKING CHARACTERISTICS

COMPONENT	RATED HORSEPOWER							
	1/4	1/2	3/4	1	1-1/2	2	3	5
Stops per Minute	6	5	4	4	3	3	2	2
Braking Torque	150% ALL MODELS							

[CAUTION]

1. OVERHAULING LOADS SHOULD NOT EXCEED RATED LOAD TORQUE.

2. HIGH INERTIA LOADS MAY EXTEND BRAKING TIME BEYOND THE WATTAGE RATING OF THE RESISTOR MODULE.

JOG

To jog the motor on controllers with Jog Option 1022, place the RUN/JOG switch in JOG position and jog the motor with the RUN button. Jog is momentary, causing motor rotation only while the button is depressed. Release the button to stop the motor.

Option 1022 provides a separate JOG SPEED potentiometer, adjustable from 0 to about 50% of motor base speed.

If reversing operator controls are used, Option 1022 provides identical forward and reverse jog speeds.

INOPERATIVE MOTOR

If the motor stops and/or won't start, check if the FAULT indicator is illuminated on the control board. (See figure 29 or 30 for indicator location.) The FAULT indicator illuminates when the internal current monitor shuts off the controller, which can be caused by one or more of the following events:

1. Motor current exceeds 120% of rated for 60 seconds.

2. DC bus current exceeds 150% of rated.

3. DC bus voltage exceeds 110% of rated.

4. Phase-to-phase short or phase-to-ground short of the controller output.

To reset the controller after a fault condition, initiate a Stop function, remove the overload, and then initiate a Run function to restart. Repeated shutoff indicates a continual overload (mechanical or electrical) which must be removed. See the troubleshooting table in Section V.

If the fault indicator is not illuminated, turn-off the AC input power and check the two Line Fuses (F1, F2). (See figure 29 or 30 for fuse location.) If a fuse is blown, replace it with an exact replacement.

[CAUTION]

DO NOT SUBSTITUTE FUSES. Substitute fuses can cause controller damage.

If the replacement fuse blows, turn-off the AC input power and refer to the troubleshooting table in Section V.

BASE DRIVE INDICATORS

The base drive indicators monitor the base driving signals to the output transistors. When the motor runs slowly, these indicators blink slowly. As motor speed increases, the blinking increases until at fast speed, the indicators glow continuously. If the indicator operation isn't as stated, refer to the troubleshooting table in Section V.

SECTION IV

THEORY OF OPERATION

GENERAL DESCRIPTION

Series 5100 Controllers change the constant frequency and voltage of the AC input power to an adjustable frequency and voltage output.

The controller rectifies the AC power source to an adjustable DC voltage proportional to the input speed reference (motor speed potentiometer setting). This DC is coupled to a six-step transistorized inverter, which converts the DC to AC at a frequency proportional to the speed reference. Output voltage and

frequency are simultaneously regulated to maintain a constant volts/Hertz ratio throughout the normal speed range.

The voltage waveform applied to the motor is a stepped wave approximation of a true sinsusoidal waveform, as shown by figure 21. This is commonly known as a six-step waveform because of the characteristic six steps/cycle.

The synchronous speed of an AC induction motor is directly proportional to the power source frequency, as follows:

$$\text{Speed} = \frac{120 \times \text{Frequency}}{\text{No. of Motor Poles}}$$

This synchronous speed is the speed of the rotating electrical field, not the actual rotor speed. The difference between the synchronous speed and the full-load motor speed is called slip, which is normally expressed as a percent. The percentage of slip is determined by the design of the motor, primarily the rotor resistance. NEMA has assigned code letters (A, B, C, D, etc.) to standardize motor characteristics including slip. The type most commonly used is NEMA Design B with 3% slip at rated operating conditions. Figure 22 shows typical speed/torque curves for NEMA Design B and D motors.

As the power source frequency is changed, the motor will run faster or slower, as shown by figure 23. The actual full-load motor speed (rated or slip speed) varies in inverse proportion to the frequency, where a 3% slip motor at 60 Hz, for example, would have 6% slip at 30 Hz or 1½% slip at 120 Hz. Motor speed is limited only by the maximum inverter output frequency and the mechanical integrity of the motor.

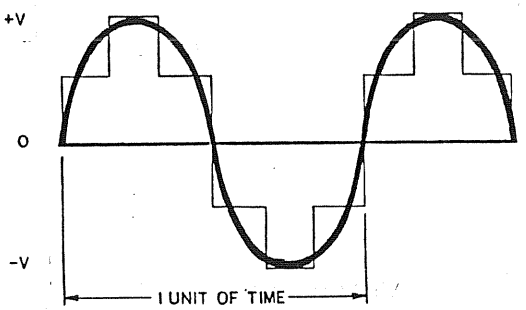


FIGURE 21. OUTPUT VOLTAGE WAVEFORM

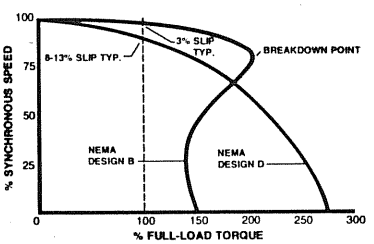


FIGURE 22. TYPICAL SPEED-TORQUE CHARACTERISTICS AT RATED VOLTAGE & FREQUENCY

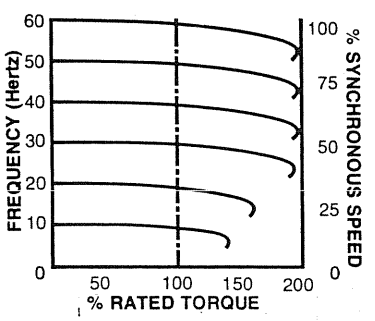


FIGURE 23. TYPICAL SPEED-TORQUE CURVES FOR A NEMA DESIGN B MOTOR (WITHOUT VOLTAGE BOOST)

CONSTANT TORQUE OPERATION

The ability of the 5100 Controller to maintain a constant volts/Hz relationship allows motor operation at rated torque from near zero speed to rated speed.

Figure 24 represents the relationship between torque, horsepower, and speed with a maintained volts/Hz ratio. A standard 230 volt 4-pole motor can be controlled by this method to its synchronous speed of 1800 RPM. Since the controller output voltage is limited by the 230 VAC power source, the ideal volts/Hz ratio cannot be maintained above this voltage. If the same motor was wound for 115 volts, it could be controlled in the constant torque mode to double the normal rated speed and horsepower. The motor would not be overvoltaged because the volt/Hz ratio of 115V/60 Hz is the same as 230V/120 Hz. The horsepower would also double since the same torque would be developed at twice the normal rated speed. When the motor horsepower doubles, the controller horsepower rating must also be doubled.

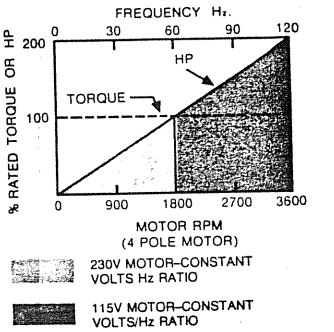


FIGURE 24. CONSTANT TORQUE OPERATION

[CAUTION]

1. THE MOTOR'S SELF-COOLING CAPABILITY IS REDUCED CONSIDERABLY AT LOW OPERATING SPEEDS.

2. OPERATION AT FREQUENCIES BELOW 6 HERTZ MAY PRODUCE COGGING - A DISCONTINUOUS FORM OF MOTOR ROTATION.

CONSTANT HORSEPOWER OPERATION

Series 5100 Controllers are also capable of constant horsepower operation, as shown by figure 25.

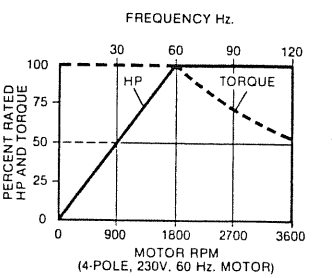


FIGURE 25. CONSTANT HP OPERATION

In this mode of operation, the volts/Hz ratio is maintained at a specified frequency, normally 60 Hz. At this point, the voltage is "clamped" at a constant level while the frequency is increased to achieve the desired maximum speed. Since the controller maximum output voltage is limited to the 230 VAC input power source, the volts/Hz ratio decreases beyond this point as the frequency increases. The motor becomes "voltage starved" above the clamping point and torque decreases as speed increases, resulting in constant horsepower operation.

As shown in figure 25, the controller provides conventional constant torque/variable horsepower operation up to the 1800 RPM base speed of the 60 Hz motor. Between 1800 and 3600 RPM, a 2:1 speed range, the controller provides constant rated horsepower/variable torque operation. If constant horsepower is required over a 4:1 speed range (900 to 3600 RPM), the controller and motor rated horsepower must be increased, since 900 RPM intersects the horsepower curve at a point which is only 50% of rated horsepower (see figure 25). Therefore, using an 1800 RPM motor, if one horsepower is required over a 900 to 3600 RPM speed range (4:1) it would be necessary to use a two horsepower controller and motor.

[CAUTION]

ONLY INDUCTION MOTORS CAN BE USED FOR CONSTANT HORSEPOWER OPERATION ABOVE SYNCHRONOUS SPEED. SYNCHRONOUS RELUCTANCE MOTOR CHARACTERISTICS PREVENT OPERATION IN THIS MODE.

MULTIPLE MOTOR OPERATION

A 5100 Controller can simultaneously control multiple motors in process line applications, provided the total KVA required by all the motors which are started and stopped simultaneously does not exceed the controller's ratings. (See table 3.) Since all motors are operated at a common frequency they are therefore synchronized at a common speed.

Tracking accuracy between motors varies only by the difference in their loads, typically 0.5% to 3.0% with standard NEMA Design B motors and 0.0% with synchronous reluctance types.

SECTION V

MAINTENANCE

****
WARNING
****

1. SERIES 5100 CONTROLLERS CONTAIN HIGH VOLTAGE WHICH CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.
2. BE SURE ALL AC POWER IS REMOVED (TURNED-OFF) FROM THE CONTROLLER BEFORE CLEANING OR REPAIRING THE CONTROLLER.
3. WAIT 2 MINUTES AFTER TURNING-OFF THE AC POWER FOR THE FILTER CAPACITORS TO DISCHARGE. IF THE FILTER CAPACITOR DISCHARGE CIRCUIT FAILS, HIGH VOLTAGE CAN REMAIN IN THE CONTROLLER FOR A LONG TIME AFTER THE AC POWER IS TURNED-OFF. BE SURE THE VOLTAGE ACROSS THE FILTER CAPACITOR TERMINALS IS LESS THAN 10 VOLTS BEFORE TOUCHING ANY COMPONENT, WIRING, TERMINAL OR ELECTRICAL CONNECTION. FAILURE TO OBSERVE THIS WARNING CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.

   Note: The filter capacitors can be discharged rapidly by connecting a 50 to 100 ohm, 50 watt or greater resistor across the filter capacitor terminals for at least 15 seconds. Then, disconnect the resistor, and check that the voltage across the filter capacitor terminals is less than 10 volts before proceeding.

GENERAL

Séries 5100 Controllers require very little maintenance, other than occasional visual inspections and, if necessary, external cleaning. They must be kept dry and reasonably free from dust, dirt, and debris. No parts require periodical replacement.

Maintain the motor according to maintenance instructions supplied by the motor manufacturer.

VISUAL INSPECTIONS

1. Be sure all wires are fastened securely.
2. Check components for damage due to overheating or breakage. All damaged and/or faulty components must be replaced for satisfactory operation.

ADJUSTMENT INSTRUCTIONS

Series 5100 Controllers are factory adjusted with a motor under simulated operating conditions. Therefore, except for initial startup adjustments (see Section II), readjustments should not normally be needed. However, if necessary, the following adjustments can be made. All adjustments must be made in strict conformance to the following instructions.

Refer to figure 29 or 30 when performing these adjustment instructions.

PRELIMINARY

1. Initiate a Run function and turn the motor speed potentiometer fully clockwise.
2. Connect the probe of an ungrounded or isolated oscilloscope (or digital voltmeter) to Test Point TP1 (+) and the negative to Terminal 11 (common) on Terminal Board TB1, and adjust the MAX SPD Potentiometer (R9) until the oscilloscope records -8.0 VDC, ±40 millivolts.
3. Connect the oscilloscope probe to the node of Resistor R42 and Diode D4 (or Test Point TP10, if available) and adjust the VOLT LIMIT Potentiometer (R34) until the oscilloscope records -6.64 VDC, ±60 millivolts.
4. Adjust the V/HZ Potentiometer (R43) until the -6.64 VDC potential just starts to decrease.
5. Initiate a Stop function and disconnect the oscilloscope.

MINIMUM SPEED

See step 11 of the "Startup Procedure" on page 21.

MAXIMUM SPEED

If the preliminary instructions were followed correctly, the controller should supply 230 VAC at 60 Hz to the motor when the motor speed potentiometer is turned fully clockwise. For a lower maximum speed, turn the MAX SPD

Potentiometer (R9) counterclockwise. If desired, maximum speed can be decreased to 60% of motor base speed.

ACCELERATION/DECELERATION

See step 13 of the "Startup Procedure" on page 21.

STARTING TORQUE

The VOLT BOOST Potentiometer (R37) and the MIN FREQ Potentiometer (R46) adjust starting torque, and are normally factory set at full counterclockwise rotation. These potentiometers should not be readjusted unless starting torque is insufficient to start the motor and its connected load.

To increase starting torque, turn Potentiometers R37 and R46 clockwise together, so that both potentiometers maintain about the same setting, until starting torque is sufficient to start the motor and its connected load. After this initial setting is established, Potentiometers R37 and/or R46 can be "fine tuned" for the most desirable starting characteristics.

If the motor cannot accelerate its connected load and Potentiometers R37 and R46 are turned fully clockwise, check for a mechanical overload. Excessive load will cause an instantaneous overload fault and shut down the controller.

Note: If Potentiometer R37 is turned too high, the motor will "growl" at low speed and light load. This may cause a fault and shut down the controller.

After readjusting starting torque, the volts/Hertz adjustment must also be readjusted, as follows:

VOLTS/HERTZ

1. The volts/Hertz needs to be adjusted only if the starting torque Potentiometers (R37 and R46) were readjusted.

2. Connect a DC voltmeter (0-300 VDC) to the terminals on Capacitor C5 in 1/4 to 2 HP controllers (see figure 29), and to the capacitor bus bars in 3 and 5 HP controllers (see figure 30).

3. Initiate a Run function and turn the motor speed potentiometer fully clockwise to attain maximum speed.

4. Turn the V/HZ Potentiometer (R43) counterclockwise until the voltmeter reading starts to decrease. Then turn Potentiometer R43 clockwise until the voltmeter reads 300 VDC.

5. After readjusting volts/Hertz, the VOLT LIMIT Potentiometer (R34) must also be readjusted. Follow steps 1, 2, and 3 under "Preliminary" on page 28.

INSTANTANEOUS OVERLOAD

The instantaneous overload fault trip point is set with the ISO ADJ Potentiometer (R126). See Standard Feature No. 2 on page 4. To raise the trip point, turn Potentiometer R126 clockwise, and to lower the trip point, turn R126 counterclockwise.

TIMED OVERLOAD

The timed overload fault trip point is set with the TO ADJ Potentiometer (R125). See Standard Feature No. 3 on page 4. To raise the trip point, turn Potentiometer R125 clockwise, and to lower the trip point, turn R125 counterclockwise.

Note: Some controllers have a nonadjustable timed overload and, therefore, do not have Potentiometer R125.

OSCILLATOR

If the oscillator requires readjustment, connect a frequency meter or ungrounded (or isolated) oscilloscope to Terminal 11 on Terminal Board TB1 and Test Point TP5, and readjust the OSC CAL Potentiometer (R66) for 360 Hz, ±1 Hz.

TROUBLESHOOTING

Most electrical failures are caused by incorrect connections, overload, or the accumulation of dirt, dust, or moisture. Dirt and dust deposits limit the transfer of heat from the solid-state components. Moisture, usually caused by either "wash-down" or condensation, can cause insulation failures and short circuits. Be sure the controller remains clean and dry.

****
WARNING
****

1. BE SURE ALL AC POWER IS REMOVED (TURNED-OFF) FROM THE CONTROLLER BEFORE CLEANING OR REPAIRING THE CONTROLLER.
2. WAIT 2 MINUTES AFTER TURNING-OFF THE AC POWER FOR THE FILTER CAPACITORS TO DISCHARGE. IF THE FILTER CAPACITOR CIRCUIT FAILS, HIGH VOLTAGE CAN REMAIN IN THE CONTROLLER FOR A LONG TIME AFTER THE AC POWER IS TURNED-OFF. BE SURE THE VOLTAGE ACROSS THE FILTER CAPACITOR TERMINALS IS LESS THAN 10 VOLTS BEFORE TOUCHING ANY COMPONENT, WIRING, TERMINAL OR ELECTRICAL CONNECTION. FAILURE TO OBSERVE THIS WARNING CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.

   Note: To discharge the filter capacitors rapidly, refer to the note on page 27.

To measure line current, use a meter that reads "true RMS." If another type of meter is used, actual line current may be 1½ to 3 times measured values.

When measuring motor current, the controller output frequency must be greater than the low frequency limit of the meter at the time of the measurement.

If repeated line fuse blowing and/or power bridge failures oocur, check the AC input supply for transients (high level spikes) or rapid power fluctuations.

If a circuit board fails, check all input to the board for proper values before replacing the board.

Use standard troubleshooting procedures, e.g., continuity checks, to detect faults in relay and switching logic and operator controls.

TABLE 7. TROUBLESHOOTING

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
1. AC Line Fuse(s) (F1, F2) blows when power is applied to the controller	Wiring faulty or incorrect	Check all external wiring connected to the controller. Correct accordingly.
	Circuit, component, or wiring grounded	Remove unwanted ground.
	Power Bridge BR1 shorted	Replace BR1.
	Power board failure	Replace power board.
	Control board failure	Replace control board.
2. AC Line Fuse(s) (F1, F2) blows when motor starts	Power Bridge BR1 shorted	Replace BR1.
	Control board failure causing SCR(s) to turn-on fully	Replace control board.
3. Base drive indicators do not light when a Run function is initiated and the motor speed potentiometer is turned fully counter-clockwise. Motor won't run when motor speed potentiometer is turned clockwise	Ribbon cable not connected, faulty, or installed incorrectly	Replace or repair ribbon cable.
	AC Line Fuse(s) (F1, F2) blown	See Indication 1.
	Driver board(s) not seated in its socket	Reseat driver board(s) in socket(s).
	Driver board(s) faulty	Replace driver board(s).
	Operator controls or relay and switching logic faulty or connected incorrectly.	Repair accordingly.

(Cont'd on next page)

TABLE 7. TROUBLESHOOTING (Cont'd)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
4. FAULT indicator illuminates when motor starts to turn	Acceleration rate set too high	Turn ACCEL Potentiometer R10 counterclockwise. See step 13 on page 21.
	Excessive electrical noise in the input supply or control wiring	Ground the controller common by connecting Terminal 11 on Terminal Board TB1 to the controller chassis. See step 2 under "Wiring Instructions" on page 8. See step 4 under "Wiring Instructions" on page 9.
	Voltage boost misadjusted	See "Adjustment Instructions."
	Output transistor(s) shorted	Replaced shorted transistor(s).
	Motor shorted or grounded	Repair or replace motor.
	Motor overloaded	Check for mechanical overload. If unloaded motor shaft does not rotate freely, replace motor bearings. Be sure controller and motor ratings are adequate.
	Wrong resistor wire(s) removed from the power board	See step 5 of the "Startup Procedure," page 20.
	Power board failure	Replace power board.
	Control board failure	Replace control board.
	Driver board(s) failure	Replace driver board(s).
5. Motor runs rough (erratic) at low speeds	Output transistor(s) open (identified by a dimly illuminated base drive indicator)	Replace open transistor(s).
	Voltage boost set too high	See "Adjustment Instructions."
	Control board failure	Replace control board.
	Power board failure	Replace power board.
	Driver board(s) failure	Replace driver board(s).
	Motor faulty	Repair or replace motor.

(Cont'd on next page)

TABLE 7. TROUBLESHOOTING (Cont'd)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
6. Motor stops while running	Motor overloaded (FAULT indicator illuminated)	Check for mechanical overload. If unloaded motor shaft does not rotate freely, replace motor bearings. Be sure controller and motor ratings are adequate.
	Output transistor(s) open	Replace open transistor(s) and repair or replace driver board(s). Resistor(s) on driver board(s) overheats if transistor(s) opens while motor is running.
	Output transistor(s) shorted	Replace shorted transistor(s).
	Volts/Hertz and/or volt limit misadjusted	See "Adjustment Instructions."
	Control board failure	Replace control board.
	Driver board(s) failure	Replace driver board(s).
	Operator controls faulty	Repair accordingly.
7. Motor does not attain top speed	Motor overloaded	Check for mechanical overload. If unloaded motor shaft does not rotate freely, replace motor bearings. Be sure controller and motor ratings are adequate.
	Motor speed potentiometer failure	Replace potentiometer.
	MAX SPD Potentiometer R9 misadjusted	See "Adjustment Instructions."
	Control board failure	Replace control board.
8. Motor runs at high speed only	Control board failure	Replace control board.
	Motor speed potentiometer failure	Replace potentiometer.
	Wiring faulty or incorrect	Check wiring and connections between controller and operator controls.

(Cont'd on next page)

TABLE 7. TROUBLESHOOTING (Cont'd)

INDICATION	POSSIBLE CAUSE	CORRECTIVE ACTION
9. Unstable speed	Oscillating load connected to the motor	Correct condition accordingly.
	SCR's misfiring or false firing	Replace Power Bridge BR1.
	Control board faulty	Replace control board.
10. FAULT indicator illuminates during deceleration	Overhauling load causing overvoltage on the DC bus	Increase deceleration time by turning DECEL Potentiometer R12 counterclockwise or install electronic braking (Option 1045A).
	Volts/Hertz set too high	See "Adjustment Instructions."
11. Motor thermoguard open (if used) NOTE: If thermoguard opens frequently when running at low speeds, a motor blower or a motor with a larger frame size may be required.	Ventilation insufficient	Free the motor intake and exhaust screens from dirt, dust, and debris.
	Motor drawing excessive current	Check for mechanical overload and shorted motor windings. If unloaded motor shaft does not rotate freely, replace motor bearings. Be sure controller and motor ratings are adequate.
	Volts/Hertz misadjusted	See "Adjustment Instructions."
	Motor faulty	Repair or replace motor.

SECTION VI

PARTS LIST

TABLE 8. PARTS LIST, SERIES 5100 CONTROLLERS

PART DESCRIPTION	FINCOR PART NUMBER ¼ - 2 HP	FINCOR PART NUMBER 3 & 5 HP	QUANTITY USED
Capacitor, 1900 mfd, 350 VDC	3402320	3402320	1 (¼ - 1½ HP) 2 (2 HP) 3 (3 HP) 4 (5 HP)
Choke L1	1043913 02	1043913 04	1
Control Board	1044359 01	1044359 01	1
Driver Board	1044360 01	1044360 01	2
Feedback Board	1043910	1043910	1
Fuse F1, F2 (20A, 250V)	3002001	———	2
Fuse F1, F2 (45A, 250V)	———	3002299	2
Input Board	2660211	2660211	1
Insulator, Transistor	3700043	1043931	6
Personality Module, 14-Pin*	1044632 01	1044632 01	1
Personality Module, 16-Pin*	1046790 01	1046790 01	1
Power Board	1044361 01	1044362 01	1
Power Board Cable Assembly	1044032 01	1044032 02	1
Power Bridge	2660228 01	1043228 01	1
Ribbon Cable	1043935 01	1043935 01	1
Run Relay K1	3022163	3022163	1
Transistor Replacement Kit (Type 6062 Power Transistors)	3304072	3304072	6 (¼ - 2 HP) 12 (3 HP) 18 (5 HP)
Transistor 2N6079	———	3304145	6

*Notes: 1. The controller has either a 14-pin or a 16-pin personality module, which are not interchangeable.

2. The part numbers listed for the personality modules in table 8 are for the standard modules. Optional modules have different part numbers. Always refer to the actual part number on the personality module in the controller when ordering a replacement.

TABLE 9. SPARE PARTS LIST, SERIES 5100 CONTROLLERS

KIT	KIT COMPONENTS (2)	CONTROLLER MODEL	STOCK NUMBER (1)
A	Fuses 6	5101/5102	104435801
		5103/5105	104435804
B	Fuses 6, Power Cube, Power Transistors 2 (1 and 2 HP), Power Transistors 6 (3 and 5 HP)	5101/5102	104435802
		5103/5105	104435805
C	Fuses 6, Power Board Power Cube, Control Board, Driver Board, Power Transistors 2 (1 and 2 HP) 6 (3 and 5 HP) Driver Transistors 2 (3 and 5 HP only)	5101/5102	104435803
		5103/5105	104435806

NOTES: (1) Order by Stock Number.
(2) Underlined numbers denote quantity.

SECTION VII

OPTIONS

Options are available for Series 5100 Controllers in combinations shown in table 10. Options can be added to the controller at any time. Each option includes all required components, mounting hardware, wiring harness (if used), and an instruction sheet.

TABLE 10. ALLOWABLE OPTION COMBINATIONS

OPTION GROUP	OPTION NUMBER	DESCRIPTION	REMARKS
A(1)	1037	Input/Feedback Adapter, Interface Board	Feedback Options: Choice of one within this group unless Option 1037 is selected. Can be combined with options selected from all groups.
	1060A	Slip Compensation (Torque Limit)	
	1061C	Feedback, Tachometer AC or DC	
	1251	Energy Saver	
B(1)	1006B	Reversing, Speed Potentiometer	Input Options: Choice of one within this group unless Option 1037 is selected. Can be combined with options selected from all groups.
	1037	Input/Feedback Adapter, Interface Board	
	1049	Follower, External DC Signal	
	1050	Follower, External AC Signal	
	1050A	Follower, AC Current Transducer	
	1051	Follower, MIRC	
	1055	Follower, AC or DC Tachometer Generator	
	1057A	Follower, Digital Pulse Generator	
	1059	Reference, Precision	
	1065	Isolator, Speed Potentiometer	
	1258	Reference, Precision/Dwell Timer	
C(1)		Personality Modules	Personality Modules: Choice of one within this group. Can be combined with options selected from all groups.
	1250A	60 Hz/1.0/2-20 sec	
	1250B	90 Hz/1.5/2-20 sec	
	1250C	120 Hz/2.0/2-20 sec	
	1250D	180 Hz/3.0/2-20 sec	
	1250E	50 Hz/1.0/2-20 sec	
	1250F	60 Hz/1.0/6-60 sec	
	1250G	90 Hz/1.5/6-60 sec	
	1250H	120 Hz/2.0/6-60 sec	
	1250J	180 Hz/3.0/6-60 sec	
	1250K	50 Hz/1.0/6-60 sec	
	1250L	120 Hz/1.0/2-20 sec	
C(1) (cont.)	1250N	60 Hz/1.0/0.5-5 sec	Personality Modules: Choice of one within this group. Can be combined with options selected from all groups.
	1250P	60 Hz/1.0/0.7-7 sec	
	1250S	120 Hz/2.0/0.5-5 sec	
	1250U	120 Hz/1.0/6-60 sec	
D(2)	1006A(a)	Reversing, Static	Miscellaneous Options: Choice of any or all within this group. Can be combined with options selected from all groups. Notes: (a) This option is a standard feature of all 5100 controllers and only requires the selection of the proper operator control station. (b) Input/Feedback Adapter must be mounted externally and the option does not include the switching, mounting hardware or wiring.
	1022(a)	Jog, Toggle Switch Selection	
	1037A(b)	Input/Feedback Adapter, 1-Position	
	1037B(b)	Input/Feedback Adapter, 2-Position	
	1045A	Braking, Electronic	
	1058A(a)	Follower/Manual Mode Select (Toggle Switch)	
	1120	Control Station	
	1120A	Potentiometer, Ten-Turn Motor Speed	
	1120B	Potentiometer, Single-Turn Motor Speed Assembly	
	1120C	Potentiometer, Ten-Turn Motor Speed (Digital)	
	1166	Manual Instruction	
	1255	Motor Contactor Interface	

NOTES: (1) Options in Groups A, B and C can be furnished as factory installed or as field kits. Groups A, B and C options are simple plug-in additions.
(2) Options in Group D can also be furnished as factory installed or as field kits. All of the options except Option 1045A (Braking, Electronic) are external to the 5100 controller.

SECTION VIII

ILLUSTRATIONS

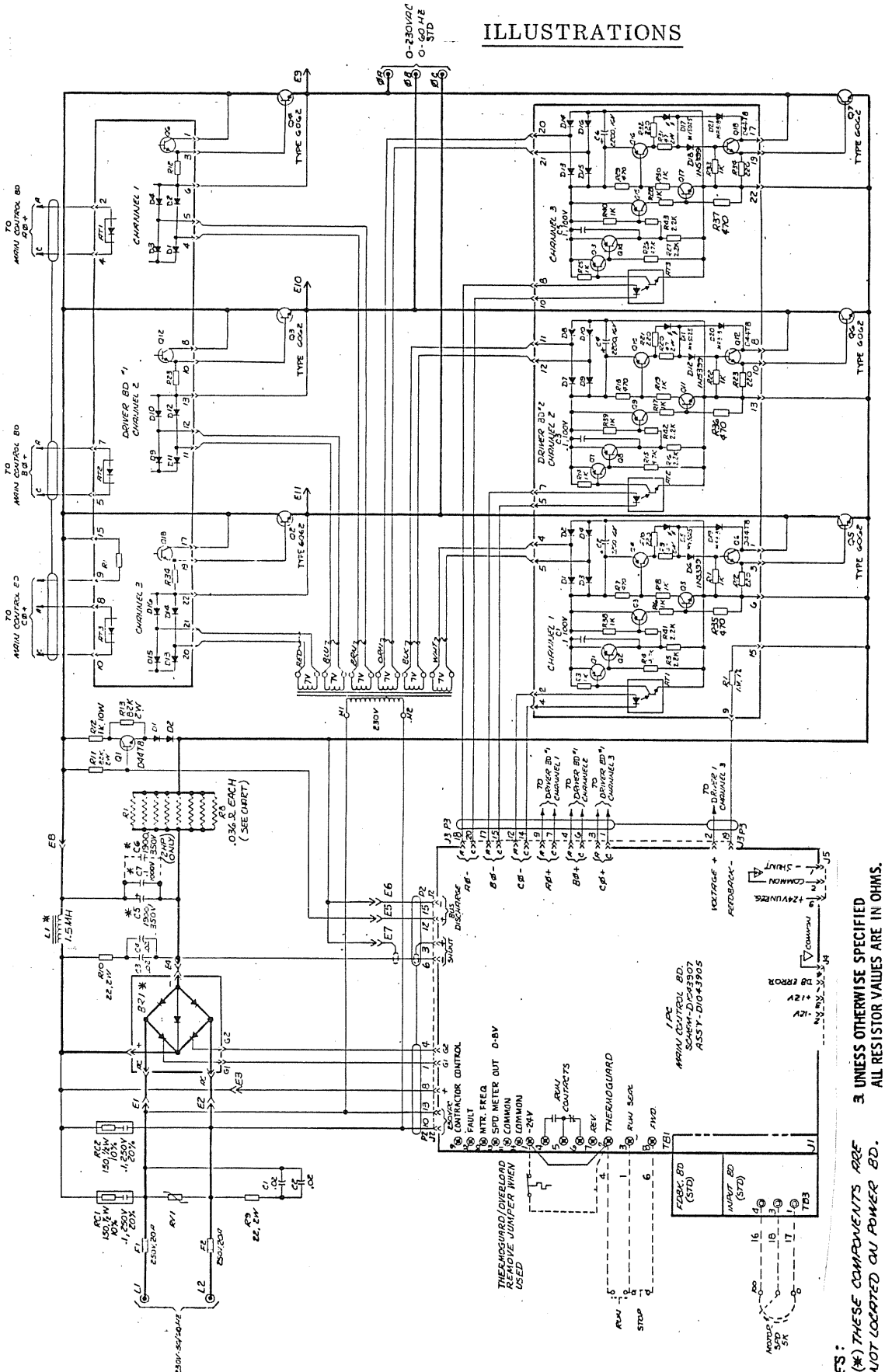
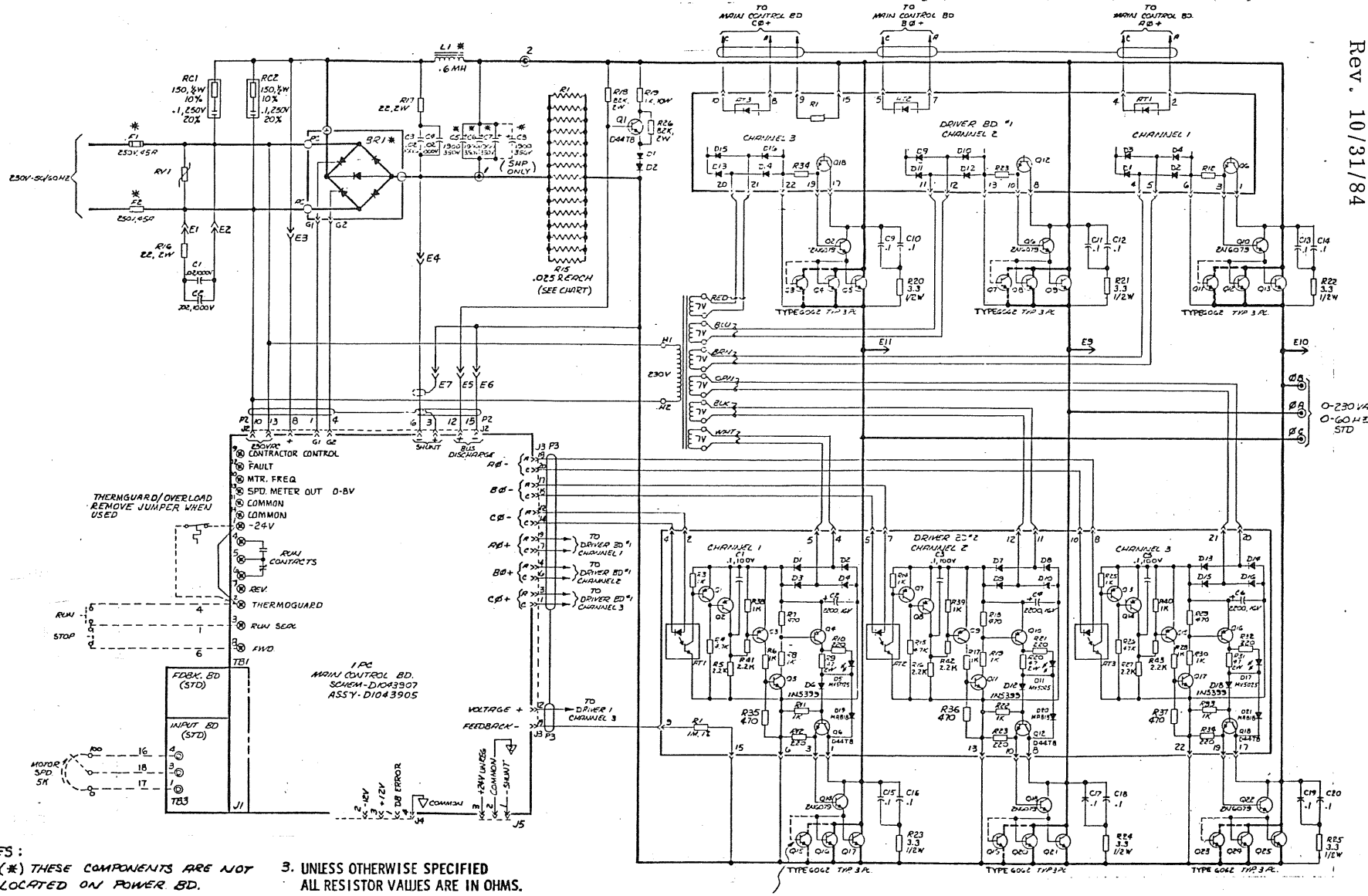


FIGURE 26. SCHEMATIC, 5100 CONTROLLER, 1/4 - 2 HP



NOTES:

1. (*) THESE COMPONENTS ARE NOT LOCATED ON POWER BD.

2.

H.P. RATING	RESISTANCE WIRE TO REMOVE
3	R10 THRU R15
5	NONE

3. UNLESS OTHERWISE SPECIFIED
ALL RESISTOR VALUES ARE IN OHMS.
ALL CAPACITOR VALUES ARE IN MICROFARADS
ALL RESISTORS ARE 1/4 W, 5%
ALL CAPACITORS ARE 500 V, 10%
ALL DIODES ARE IN5393
ALL NPN TRANSISTORS ARE 2N4401
ALL PNP TRANSISTORS ARE 2N4403

D1043926
Rev. K

FIGURE 27. SCHEMATIC, 5100 CONTROLLER, 3 & 5 HP

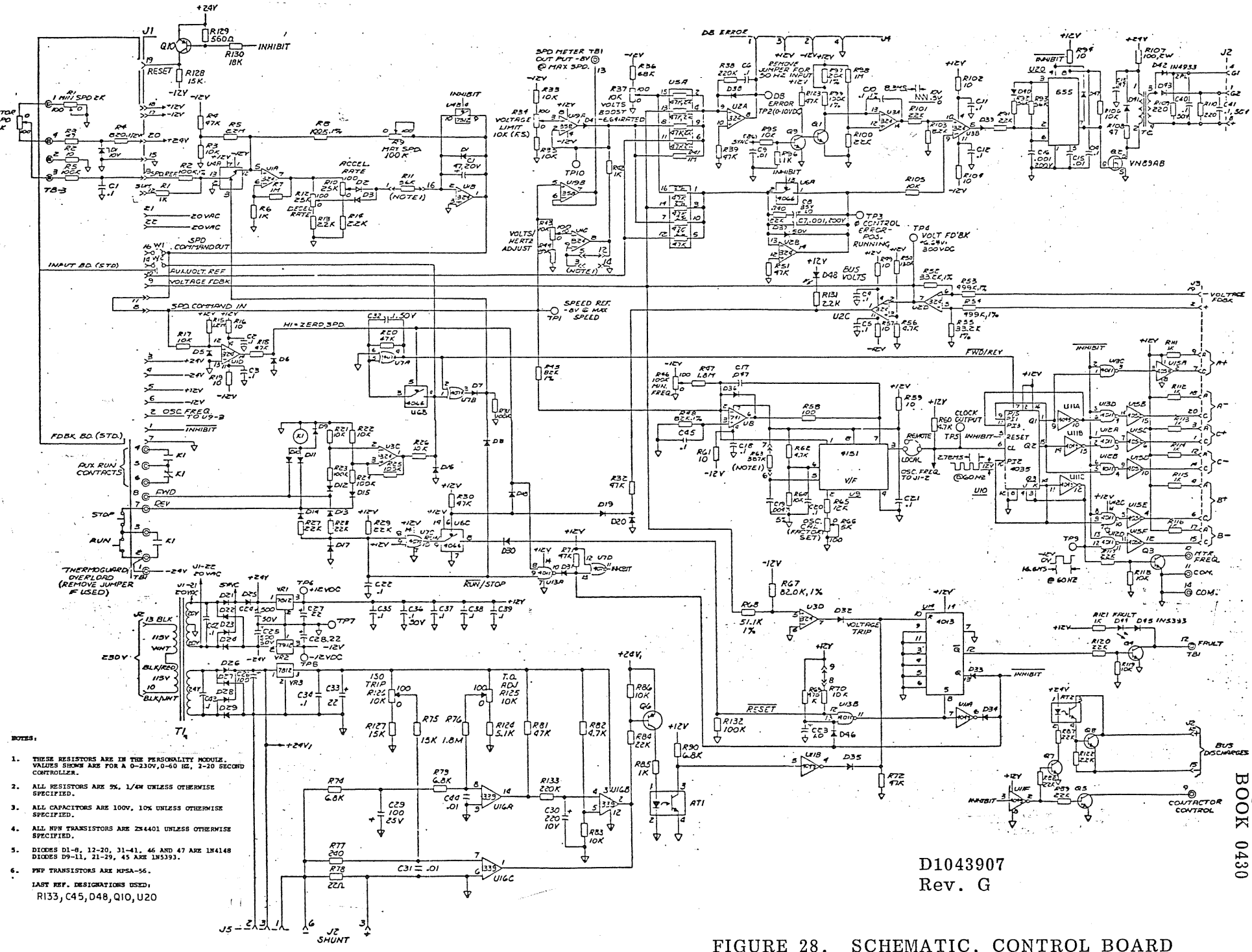


FIGURE 28. SCHEMATIC, CONTROL BOARD

D1043907
Rev. G

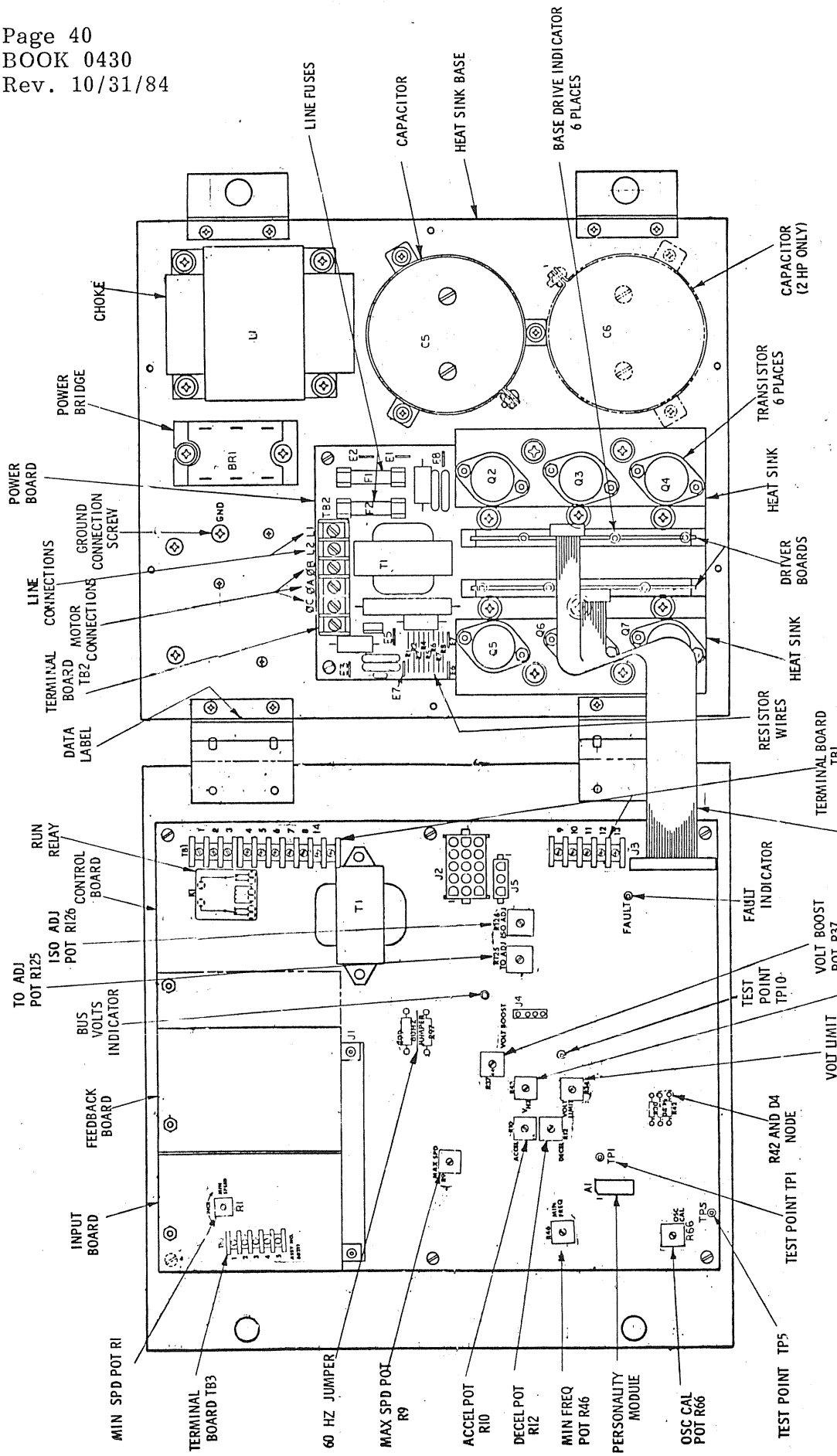


FIGURE 29. 5100 CONTROLLER, 1/4 - 2 HP

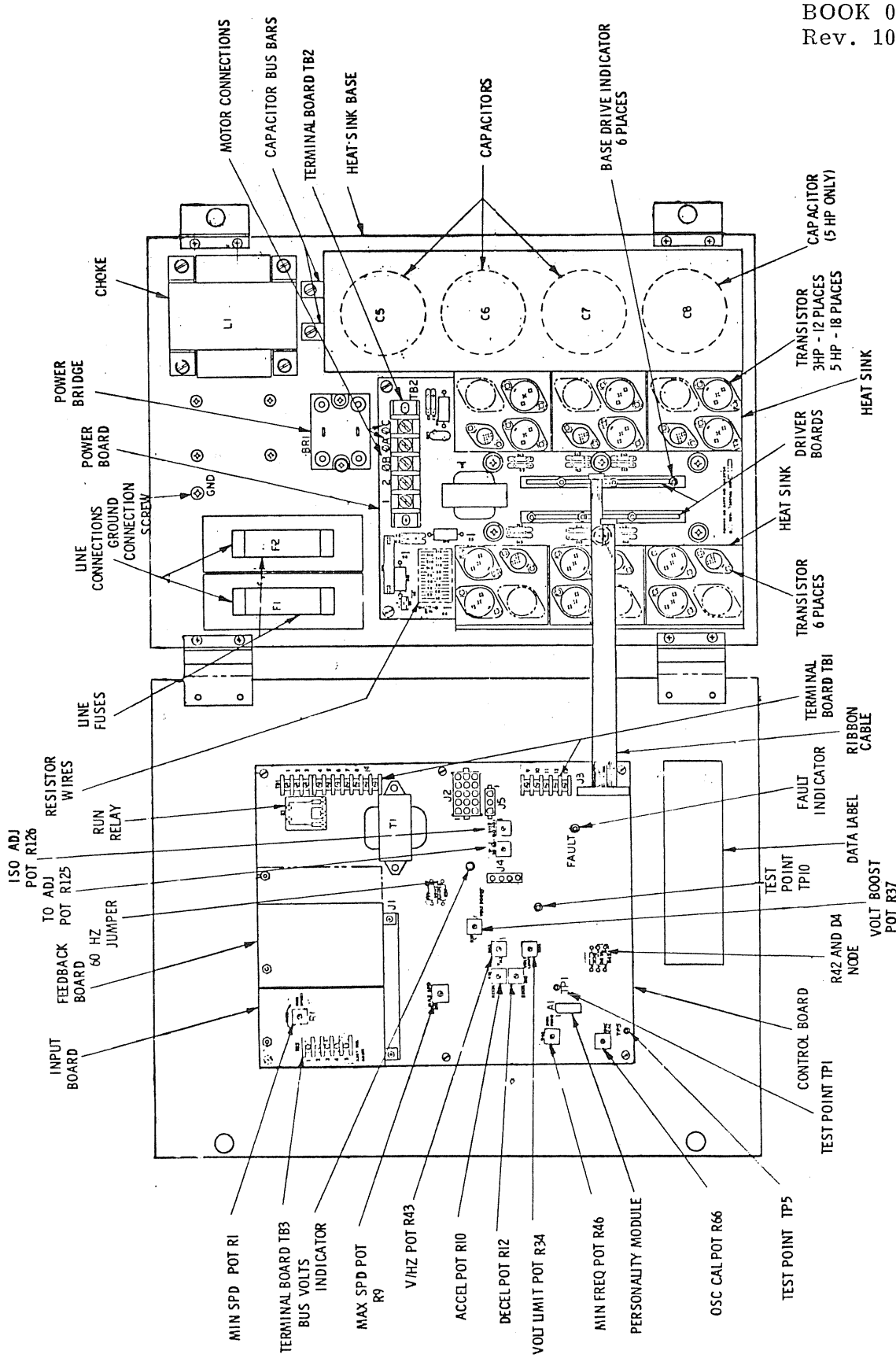


FIGURE 30. 5100 CONTROLLER, 3 & 5 HP