PRICE $5.00

SERVICE BULLETIN 8804-4
March, 1986

SQUARE D®

omegapak®
Adjustable Frequency Controller

RAMSEY™

BASIC

TYPE PT

CONTROLLER

CONTENTS

NOTE: This service bulletin covers the installation, start-up and servicing of standard controllers and controllers with pre-engineered options. Controllers having variations or special options will be furnished with a set of record drawings which must be consulted to properly and safely install, start-up or service the controller.

1.0 GENERAL

This service bulletin covers basic Class 8804 Type PT adjustable frequency controllers. Class 8804 Type PT 1000, 1500, 2000 and 3000 controllers are covered by Service Bulletin 8804-5. Refer to Section 1.4, the controller nameplate and Figures 1.1 and 1.2 to determine the applicable service bulletin.

1.1 PRECAUTIONS

The following list of "PRECAUTIONS" must be studied and followed during the installation, operation, and servicing of the equipment.

1. Read this service bulletin prior to installing or operating the equipment.
2. Service work should be performed only after becoming familiar with all listed danger and caution statements.
3. If OMEGAPAK controllers are to be stored prior to installation, they must be protected from the weather and be kept free of condensation and dust.
4. Use extreme care when moving or positioning controllers (even if crated) as they contain devices and mechanisms which may be damaged by rough handling.
5. Only authorized personnel should be permitted to operate or service the controller.
6. This equipment generates, uses, and can radiate radio frequency energy and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case the user at his own expense will be required to take whatever measures may be required to correct the interference.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT 5 MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THAT THEY ARE ZERO. DO *NOT* SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

The dc bus capacitors are discharged slowly when input power is removed from the OMEGAPAK controller. To ensure the capacitors are fully discharged, always test with a dc voltmeter (1000vdc scale) before doing any wiring, troubleshooting or work inside the controller enclosure. If no reading is shown on the voltmeter, reduce scale and test again.

If the capacitors are not fully discharged in 5 minutes, contact Square D — *Do not operate the controller.*

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

MANY PARTS, INCLUDING ELECTRONIC PRINTED WIRING BOARDS, IN THIS CONTROLLER OPERATE AT LINE VOLTAGE. DO NOT TOUCH. USE ONLY ELECTRICALLY INSULATED TOOLS WHILE MAKING ADJUSTMENTS.

1.2 PRELIMINARY INSPECTION

Inspect for shipping damage upon receiving the OMEGAPAK controller. If any shipping damage is found, immediately notify the freight carrier and your Square D representative or Ramsey Controls representative. Open the door on the controller and check inside for any visual damage. DO NOT ATTEMPT TO OPERATE THE CONTROLLER IF ANY VISUAL DAMAGE IS NOTED. All printed wiring boards should be in place and secure. Check all connectors to be sure. they are locked and securely in place.

1.3 STORAGE

After the preliminary inspection repack and

store the OMEGAPAK controller in a clean dry location. DO NOT store this equipment in any area where the ambient temperature will rise above 60 °C (140 °F) or go below – 17 °C (0 °F). DO NOT store this equipment in high condensation or corrosive atmospheres. Proper storage is required to prevent equipment damage.

1.4 CONTROLLER IDENTIFICATION

The basic OMEGAPAK Type PT adjustable frequency controller is available as an open panel or in a NEMA Type 1 enclosure. All information necessary to properly install, start-up and troubleshoot the basic controller is contained in this service bulletin.

Basic OMEGAPAK Type PT controllers (both open and NEMA 1 enclosed) have a nameplate affixed to the inside of the heat-sink assembly.

Refer to the appropriate component layout drawing in Section 8, Controller Drawings and Section 4, Controller Photos for the nameplate location. Figure 1.1 shows a typical nameplate for a basic controller.

Included on the nameplate is a controller type number and a listing of MODS (factory installed options.) Figure 1.2 decodes the type number and MODS into a description of the controller. If type numbers or MODS are not covered by Figure 1.2, refer to service bulletin 8804-5, OMEGAPAK Type PT 1000, 1500, 2000, 3000 Controller.

Note: Whenever contacting Square D or Ramsey Controls in reference to this controller or ordering replacement parts, the complete nameplate information **must** be provided.

FIGURE 1.1
TYPICAL NAMEPLATE

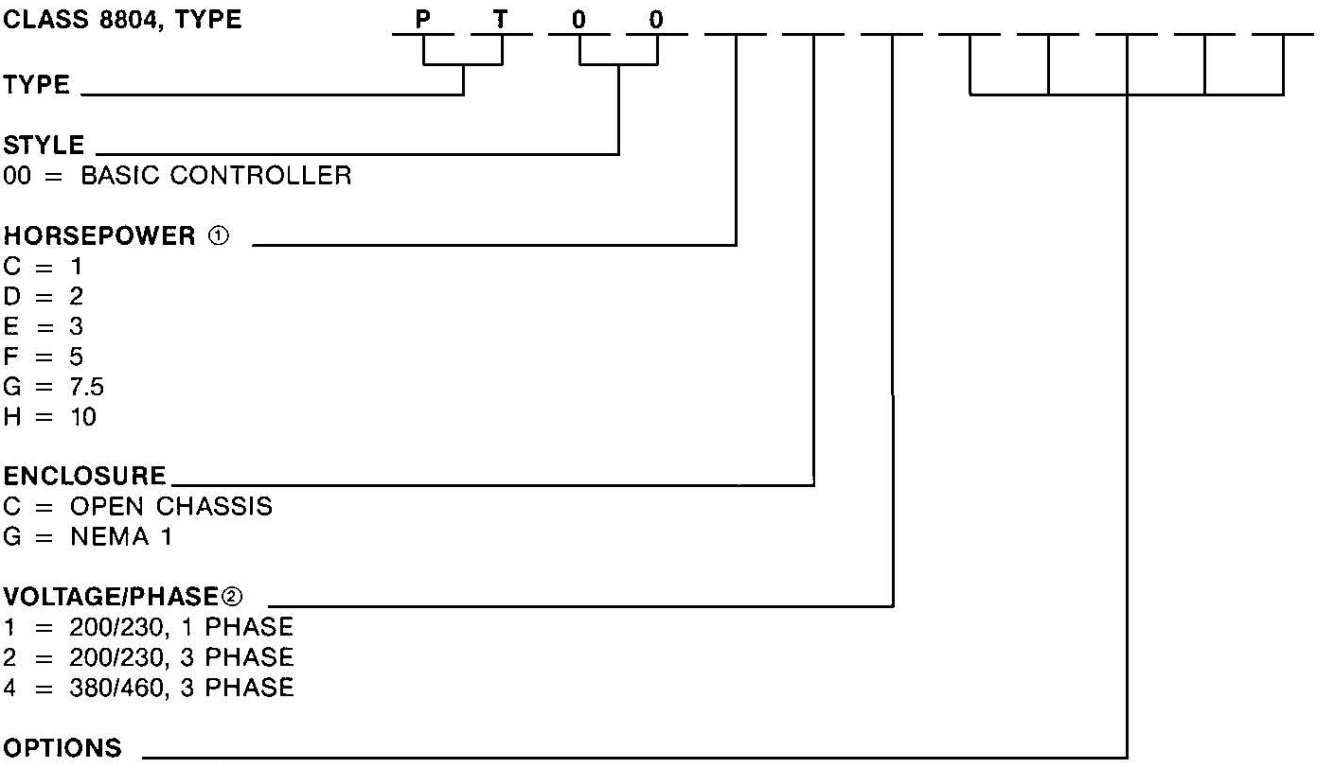
RAMSEY CONTROLS, INC.
SUBSIDIARY OF SQUARE D COMPANY

omegapak®
Adjustable Frequency Controller
Made in U.S.A.

CLASS 8804 TYPE PT 00FG2P10		
SERIES 'A'	INPUT	OUTPUT
VOLTS	230	0-230
PHASE	3	3
MAX. AMPS	17.0	15.2
FREQ. RANGE	50/60	2-60/90/120
OUTPUT H.P.	5	S/N 1023

FIGURE 1.2

CLASS 8804 TYPE PT
TYPE NUMBERS AND OPTIONS FOR BASIC CONTROLLER



NOTES:
① 7.5 AND 10 H.P. NOT AVAILABLE IN 200/230V RATING.
② SINGLE PHASE UNITS AVAILABLE 1-3 H.P. @ 200/230V ONLY.

EXAMPLE:
5 H.P., 230V, 3 PHASE, NEMA 1 ENCLOSED, WITH CONTROLS CLASS 8804 TYPE PT00FG2P10

2.0 INSTALLATION

2.1 MECHANICAL INSTALLATION

The basic OMEGAPAK TYpe PT controller is furnished as an open chassis or in a general purpose NEMA 1 enclosure. It is suitable for use in normal industrial environments:

Temperature range of: Enclosed — 0°C to 40°C (32°-104°F)

Open Chassis — 0°C to 60°C (32°F to 140°F)

Humidity range of 0% to 95% maximum non-condensing

Altitude to 3300 ft. above sea level

Do not mount the controller in direct sunlight or on hot surfaces. The controller must be mounted vertically to allow for proper ventilation. Mounting dimensions, conduit entry areas and controller weights are located in Section 8 of this service bulletin.

Open and enclosed 5 hp 200/230V controllers and open and enclosed 7.5 and 10 hp, 380/460V controllers are equipped with a fan. Care must be exercised to assure that the air flow is not obstructed.

2.2 ELECTRICAL INSTALLATION

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN
MAKE CERTAIN THAT ALL SUPPLIES (MAIN AND REMOTE) ARE DEENERGIZED PRIOR TO INSTALLING THIS EQUIPMENT

2.2.1 INPUT POWER

The OMEGAPAK Type PT controller is designed to operate from 200/230V or 380/460V 50/60 Hz input power as indicated on the controller nameplate. Both single and three phase versions are available from 1 to 3 horsepower at 200/230V only. Five (5) hp 200/230V units and all 380/460V units are available with three phase input only. Note: Controllers in the 1 to 3 hp range must be specifically ordered either for single phase or three phase input. Three phase input controllers cannot be applied to a single phase power system. **All** controllers are designed to operate only with a three phase motor.

Controllers designed for 200/230V operation are factory set for 230V, 60 Hz input power. Controllers designed for 380/460V operation are factory set for 460V, 60 Hz input power. If the controller is to be operated from a different power source, consult Section 5, Start-up Procedure for instructions.

National and local electrical codes require that a disconnect device (circuit breaker or disconnect switch) and branch circuit protection (circuit breaker or fuses) be installed ahead of the controller. It is the responsibility of the user to provide and install a disconnect/branch circuit protective device in accordance with national and local codes based on the maximum input current listed in Section 3, Figure 3.1. The controller is coordinated for fault withstand ratings described in Section 3 **only** if fusing as listed in Figure 3.2 is installed ahead of the controller. Use of a circuit breaker is not recommended unless used in conjunction with current limiting fuses.

2.2.2 INPUT WIRING

The ampacity of power conductors feeding the OMEGAPAK controller should be sized for the maximum input currents listed in Section 3, Figure 3.1, the National Electrical Code and applicable local electrical codes.

The controller must be grounded. A terminal on the power terminal board is provided for this purpose. Refer to Section 4, Controller Photos and Section 8, Controller Drawings to determine the location and configuration of the power terminal board.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN
CONTROLLER PANEL MUST BE PROPERLY GROUNDED BEFORE APPLYING POWER.

OMEGAPAK Type PT controllers operate from input voltage as detailed on the controller nameplate. Section 3.0 specifies other voltage capabilities. For example, 230 volt rated controllers can be used for 200V operation. Input power leads L1, L2 and L3 (if used) are to be connected to terminals provided on the power terminal board. Refer to Section 4, Controller Photos and Section 8, Controller Drawings to determine the location and

configuration of the power terminal board. Refer to Figure 2.1 to determine the range of wire sizes that the terminals will accept and recommended tightening torques. Wires must be sized based on the maximum input current as shown on the nameplate and listed in Section 3, Figure 3.1.

CAUTION

***DO NOT* CONNECT INPUT POWER LEADS TO THE CONTROLLER OUTPUT TERMINALS (T1, T2, T3). DOING SO WILL DAMAGE THE CONTROLLER AND VOID THE WARRANTY.**

2.2.3 OUTPUT WIRING

The ampacity of motor power conductors should be sized according to the motor full load current, National Electrical Code and applicable local electrical codes.

Connect motor conductors to the power terminal board. Refer to Section 4, Controller Photos and Section 8, Controller Drawings for the configuration of the power terminal board.

Refer to Figure 2.1 to determine the acceptable range of wire sizes and the torque requirements.

Electrical Codes require that an overload protection device responsive to motor current be installed in each motor lead or that a thermal sensor be built into or attached to the motor windings to provide motor running overload protection. These two methods of protection are described in more detail.

1. Motor thermal protector or switch —

   The motor thermal switch will protect the motor but may not protect the motor feeder or motor control equipment since motor currents higher than 1.25 times nameplate motor current may be required to cause excessive temperature rise on the motor windings.

2. Overload relay —

   A relay responsive to motor current will protect the motor feeder and motor control apparatus. However, since most motors lose ventilation when operated at speeds lower than base speed, an overload relay will not provide adequate protection against motor overheating on motors utilized in adjustable speed drives.

   Recommended overload protection for single motor drives can be achieved two ways.

1. A thermal switch in the motor will protect the motor, motor feeder, and motor control apparatus provided that the motor thermal switch is sized to operated at less than 1.25 times motor full load current with the motor located in a 40° ambient.

2. A thermal switch in the motor **and** an overload relay must be provided for motor, motor feeder, and motor control apparatus overload protection if the current/temperature characteristics of the motor thermal switch are not known.

Both cases assume that the motor feeder conductors are sized according to National Electric Code and that the motor nameplate current is less than or equal to the controller maximum rated continuous output current. OMEGAPAK Type PT controllers have terminals available to wire an overload relay or motor temperature switch. The controller will shut down and the overtemperature LED will illuminate if the circuit between these terminals is broken. Refer to Section 8, Drawing 8.4.1 to determine which terminals are to be used. The protective device must have a normally closed contact which opens upon the occurence of excessive temperature or load.

The recommended overload relay for protecting Class 8804 OMEGAPAK TYpe PT controllers is the Square D Class 9065, type TR bi-metal overload relay. The relay should be selected per Figure 2.2.

Do not connect the output terminals of the controller (T1, T2, or T3) to the L1, L2, or L3 controller terminals or to any other source of voltage. To do so will cause controller damage. Should it become necessary to bypass a controller not equipped with a controller bypass option, the customer connections to the controller T1, T2, and T3 terminals must be disconnected to prevent backfeeding the controller.

If a customer supplied isolating device is installed between the controller output and the motor (e.g. isolation contactor), the isolating device must not be switched to the open position and then back to the closed position,

unless sufficient time is allowed for the motor open-circuit voltage to decay to less than 10% of the motor nameplate rated voltage. Re-connecting the motor to the operating controller without allowing the motor terminal voltage to decay may cause controller damage. When multiple motors are operated from one controller, several critical requirements must be met to assure proper controller and motor operation.

1. Individual motor overload protection must be provided in accordance with the National Electrical Code or applicable local codes.
2. The total of the connected motor nameplate load currents, as seen by the controller, must not exceed the controller rated output current.
3. If one or more of the motors are to be connected or disconnected from the controller while the controller is operating, the following conditions **must be met.**

   A) The motor isolating device must not allow reconnection of the motor to the controller without first allowing the motor open-circuit voltage to decay to less than 10% of the motor nameplate rated voltage.

   B) The summation of the running currents of the connected motors and the locked rotor current of the motor(s) being reconnected to the controller must be less than 130% of the controller rated output current.

2.2.4 CONTROL WIRING

If the OMEGAPAK Type PT controller does not have pilot devices mounted on the frame, refer to Section 8, controller drawings to determine the proper connection of the remote control station.

NOTE: All remote manual speed potentiometers must be wired with insulated shielded cable. One end of the shield must be grounded at the controller per the wiring diagram. The other end must be insulated from ground and unconnected.

When wiring external control devices to the controller's sequencing circuitry the following guidelines should be considered:

Pilot Devices (push buttons, selector switches, relay contacts, etc.) — The maximum distance from the controller to an external pilot device is limited by the dc resistance of the wiring plus the remote device contact resistance. Wire size must be selected such that the maximum circuit resistance (wire plus remote contact) does not exceed 50 ohms. Higher resistance may result in failure to deliver sufficient voltage to pick up the controller sequencing relay.

Solid State Contacts — Many solid state control devices, such as programmable controllers, use solid state switches (triac or transistors) as output contacts. The control relay circuits in the OMEGAPAK Type PT controller operate from filtered, unregulated dc voltage (approximately 25V dc). Triac devices will not turn off when used in a filtered dc circuit. Transistor switches can be used if proper voltage polarity is observed. Refer to Section 8, Controller Drawings. In addition, the off state resistance of the solid state contact must limit leakage current, with 25V dc applied, to 3 madc or less.

OMEGAPAK Controller Relays — The controller is furnished with a run command relay (RCR) and drive failure relay (DFR). The drive fail relay has one extra form c contact available for customer use. Relay contacts are rated as shown in Section 3.2, Application Data.

NOTE: To avoid electrical noise problems and nuisance tripping of the adjustable frequency controller, all remote controlled inductive loads (relay coils, contactor coils, solenoids, etc.) must be transient suppressed.

2.2.5 WIRING PRACTICE

Good wiring practice requires that control circuit wiring be separated from all power wiring (whether from the same controller, or other controllers). This minimizes the possibility of electrical transients being electrostatically or electromagnetically coupled into the control circuits from the power circuits. The following general wiring practice is recommended in addition to that already prescribed in National Electrical Code and applicable local electrical codes.

Controllers are intended to be wired using conduit. Metallic conduit is preferred. Control and power wiring should never be run in the same conduit. Metallic conduits carrying power wiring and metallic conduits carrying

low level control wiring should be separated by at least three inches. Non-metallic conduits or cable trays carrying power wiring and non-metallic conduits or cable trays carrying low level control wiring should be separated by at least twelve inches. If it is necessary to cross power and control wiring, the above spacing recommendations should be observed and conduits or trays should cross at right angles.

Refer to the controller outline drawings of Section 8.0 for recommended conduit entry areas. All low level control wiring (start-stop circuits, manual speed potentiometer, etc.) may be run in the same conduit or tray. Remote mounted manual speed potentiometers must be wired using shielded cable. The shielded cable must be jacketed and the shield terminated only where shown on the connection diagram. Refer to Section 8, Controller Drawings for connection diagrams of remote pilot devices.

Open Type Controllers are intended for installation into the user's enclosure. When permanently installed, open controllers should be housed in metallic enclosures which are bonded to the controller ground connection.

2.2.6 Transformer Sizing

Controllers described in this service bulletin are designed for operation from a 200/230V or a 380/460V, 50/60 Hz supply. If these voltages are not available, a transformer will be required. Transformers must be sized based on the maximum controller input current listed in Section 3, Figure 3.1. Transformers listed in Section 3, Figure 3.2 have been selected to meet this criteria.

FIGURE 2.1
TERMINAL, WIRE SIZE AND TIGHTENING TORQUE TABLE

TERMINAL LOCATION	WIRE SIZE MIN	WIRE SIZE MAX	TIGHTENING TORQUE
POWER TERMINAL BOARD (INCOMING LINE, MOTOR, GROUND)	22 AWG	8 AWG	22 LB-IN
MAIN CONTROL BOARD (CONTROL CIRCUIT)	N/A	14 AWG	6 LB-IN
POWER INTERFACE BOARD (INTERNAL POWER WIRING)	FACTORY INSTALLED		12 LB-IN

FIGURE 2.2
OVERLOAD RELAY SELECTION

OVERLOAD RELAY CLASS 9065 TYPE*	HORSEPOWER		
	460V	230V	200V
TR 1.4	1 HP	1/2 HP	1/2 HP
TR 2.8	2 HP	1 HP	1 HP
TR 4	3 HP	1-1/2 HP	1-1/2 HP
TR 5.5	5 HP	2 HP	2 HP
TR 8	7-1/2 HP	3 HP	3 HP
TR 11	10 HP	5 HP	5 HP

*Since overload time-current characteristics are not well defined by NEMA, NEC, or UL/CSA, the interchangeability of other manufacturers overload relays is not guaranteed.

3.0 APPLICATION DATA

3.1 INPUT

Power

Voltage	1-3 HP — 200/230V ac +10%, −5% Single or three phase. Note: Three phase units cannot be used with a single phase supply 5 HP — 200/230V ac +10%, −5% three phase only 1-10 HP — 380/460V ac +10%, −5% three phase only
Current	See Figure 3.1
Fault Withstand Rating	1 Phase Input — 10,000 RMS Symmetrical Amps with Class R or Class K fuse per Figure 3.2 3 Phase Input — 65,000 RMS Symmetrical Amps with Class R or Class K fuse per Figure 3.2
Frequency	50/60 Hertz ± 3 Hertz
Displacement Power Factor	.95 Lagging
Control Power	28V ac/25V dc provided by self contained transformer isolated power supply

Control

Manual Speed Potentiometer	5000 ohm, 1/4 watt minimum
Analog Follower Signal	0-5V dc or 0-10V dc, 49.4K ohm minimum input impedance 4-20 ma dc, 635 ohms maximum input impedance
Run Command	Refer to Section 8, Controller Drawings for wiring. Maximum resistance (contact plus wiring) 50 ohms
External Fault Reset	Refer to Section 8, Controller Drawings, for wiring. Maximum resistance (contact plus wiring) 50 ohms.

3.2 OUTPUT

Power

Voltage	0-200V/230V ac or 0-380/460V ac three phase
Maximum Continuous Output Current	Refer to Figure 3.1
Frequency	Selectable 1.75 Hertz to 60, 90 or 120 Hertz
Frequency Stability @ 25°C	Open — ± .1 Hertz Typical, Enclosed — ± .34 Hertz Typical
Frequency Shift With Ambient Temperature	0.014 Hertz/°C
Controller Linearity (Typical) Versus Reference Signal	± .04 Hertz @ F Max = 60 Hertz ± .11 Hertz @ F Max = 90 Hertz ± .11 Hertz @ F Max = 120 Hertz
Waveform	Sine coded PWM (Pulse Width Modulated)
Short Time Overload Capacity	150% of maximum continuous output current for 60 seconds
Continuous Overload Capacity	Refer to Figure 3.1
Instantaneous Overcurrent Trip	155% of maximum continuous output current

Control

Frequency Follower	0-5.0V dc proportional to output frequency (2.5V dc = 60 Hz, 5.0 V dc = 120 Hz) Minimum load impedance 5.0K ohms
Frequency Meter	0-5V dc proportional to output frequency (5V dc = 120 Hz)
Drive Fail Relay	One Form C contact rated 1.0A @ 28V dc or 0.5A @ 120V ac, resistive — signals that an abnormal shutdown has occurred

3.3 ADJUSTMENTS

Acceleration Time	1.5 to 20 seconds
Deceleration Time	1.5 to 20 seconds

Voltage Boost	0-400% of nominal volts per Hertz ratio at 1.75 Hertz, decreasing to 0% at 20 Hertz
Minimum Frequency	1.5 ± .25 Hertz to 50% of adjusted maximum frequency
Maximum Frequency	43 Hertz to 60, 90 or 120 Hertz +10%, −0%

3.4 ENVIRONMENTAL CONDITIONS

Storage Temperature	−17° to 60°C (0°F to 140°F)
Operating (Ambient) Temperature	Enclosed 0° to 40°C (32°F to 104°F) Open 0°C to 60°C (32°F to 144°F)
Altitude	To 1,000 meters (3,300 feet) w/o derating
Relative Humidity	To 95% maximum non-condensing

3.5 PROTECTION/FAULT RESET

Instantaneous Overcurrent Trip	Non-adjustable trip setting of 155% of rated maximum continuous output current
Ground Fault	Non-adjustable trip setting
Over-temperature	Thermostat mounted on heatsink on 5 hp 200/230V (7.5 & 10 hp 380/460V) controllers only. Also accepts N.C. contact from motor mounted temperature sensor
Overvoltage	Protects the controller against excessive dc bus voltage. Trips at 416V ± 21V dc (200/230V controllers) or 832 V ± 21V dc (380/460V controllers)
Undervoltage	Trips at 87.5% of rated input voltage. Automatically resets at 95% of rated input voltage.
Overfrequency	Non-adjustable clamp limits output frequency to not more than 26% above maximum selected operating frequency
Fault Reset	All of the above conditions except undervoltage cause the controller to lockout requiring manual reset. Reset can be accomplished by removing and reapplying power or by closing and opening an external contact between terminals TB1-20 and TB1-21. Refer to Section 8, Drawing 8.4.1.

3.6 DIAGNOSTIC AND STATUS INDICATORS

Light Emitting Diodes (LEDs) are provided for the following: All LEDs except the bus capacitors charged LED are located on the main control board. Refer to Figure 5.3. The bus capacitor charged LED is located on the power interface board. Refer to Section 4, Controller Photos.

Undervoltage (UV)
Overvoltage (OV)
Ground Fault (GF)
Instantaneous Overcurrent (IOC)
Overtemperature (OT)
Power Up Delay (PUD)/Reset
Drive Enabled (DE)
Bus Capacitors Charged

FIGURE 3.1
INPUT/OUTPUT CURRENTS

			Input Current		
Controller Horsepower	Output Current (1) 230V	460V	Single Phase 230V	Three Phase 230V	Three Phase 460V
1	3.6A	1.8A	11.6A	5.0A	3.6A
2	6.8A	3.4A	18.6A	9.2A	5.6A
3	9.6A	4.8A	24.8A	12.0A	7.3A
5	15.2A	7.6A	—	17.0A	12.0A
7.5		11.0A			16.3A
10		14.0A			19.8A

(1) Controller can deliver 115% of this current continuously at rated ambient temperature. When the controller is operated at above listed output current, the input current will increase proportionately.

FIGURE 3.2
TRANSFORMER/INPUT FUSE SELECTION

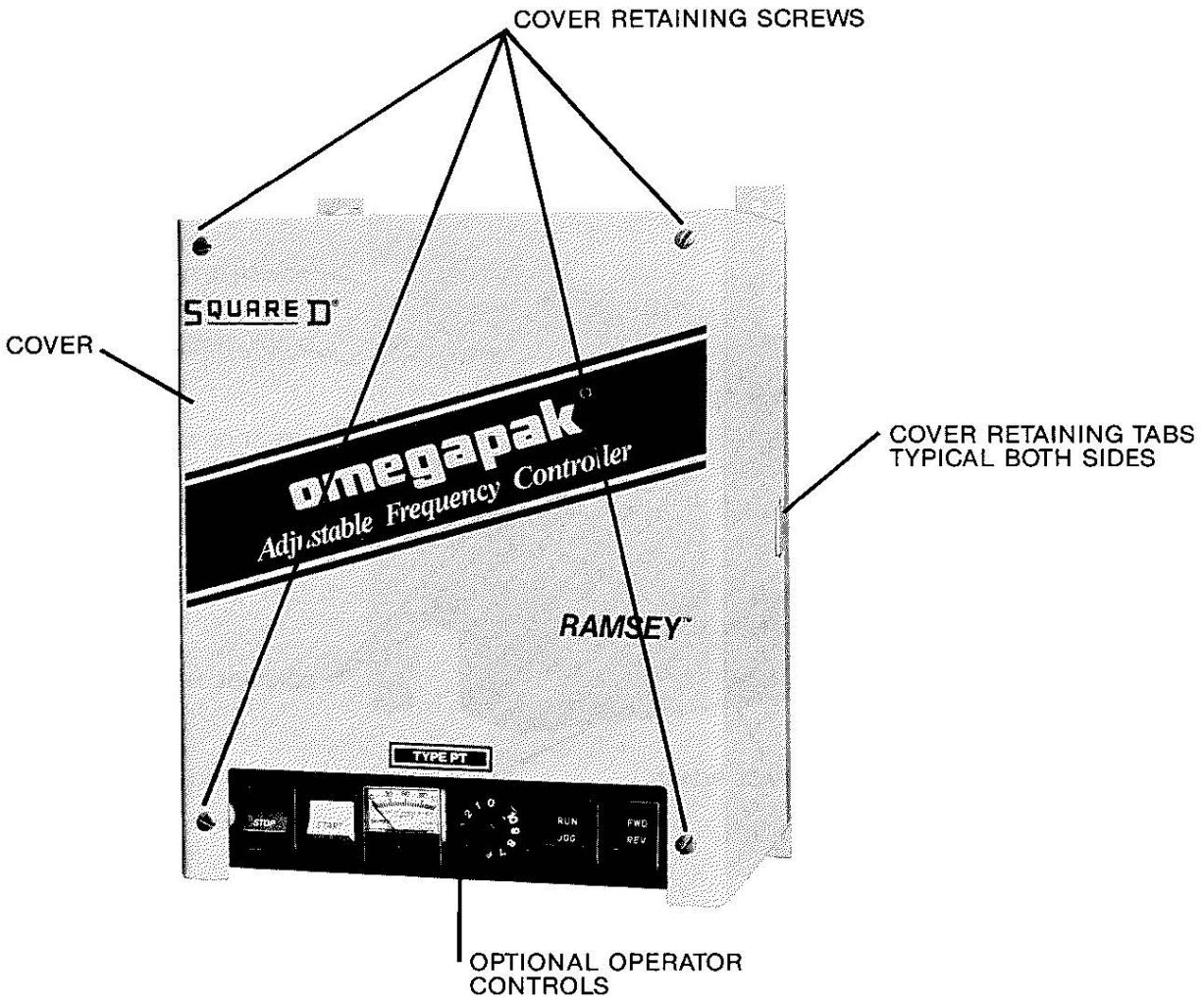
	Input Fuse (1)		Transformer (2)	
Controller Horsepower	Single Phase	Three Phase	Single Phase	Three Phase
1	30A	20A	3KVA	3KVA
2	30A	20A	5KVA	6KVA
3	30A	20A	7.5KVA	6KVA
5		20A		9KVA
7.5		20A		15KVA
10		30A		30KVA

(1) Maximum fuse rating. Must be Class R or Class K current limiting fuse or fault withstand ratings are invalid.

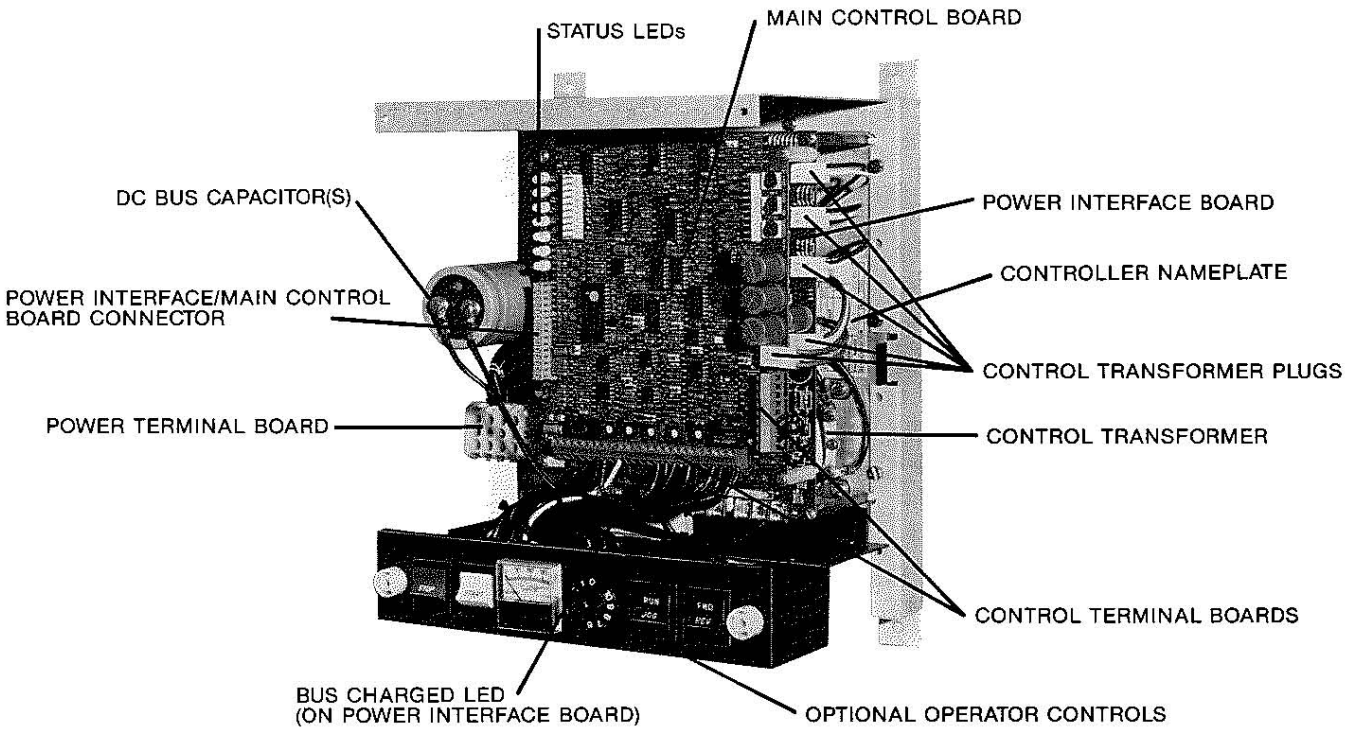
(2) To prevent imbalanced currents, all three phase transformer connections must maintain balanced output impedance. Two winding connections are not suitable for use with these controllers.

4.0 CONTROLLER PHOTOS

4.1 ENCLOSED CONTROLLER WITH CONTROLS



4.2 ENCLOSED CONTROLLER W/CONTROLS — COVER REMOVED



5.0 START-UP AND ADJUSTMENT PROCEDURE

5.1 INITIAL START-UP PROCEDURE

The OMEGAPAK Type PT controller has been tested at the factory and should require only minor adjustments to complete the field installation. This start-up procedure should be followed step by step. In case of difficulty refer to the TROUBLESHOOTING section of this service bulletin.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT FIVE MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THEY ARE ZERO. DO *NOT* SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

WITH ALL INCOMING POWER REMOVED, make the following equipment settings and adjustments:

A. Verify that all equipment disconnect means are open.

B. Verify that the branch circuit feeding the controller is properly fused in accordance with Section 3, Figure 3.2.

C. Verify that the control power transformer primary taps are connected for the proper input voltage per Figure 5.1. Refer to Section 8, Controller Drawings to determine the control power transformer location.

NOTE: 200/230V controllers are factory set for 230V operation, 380/460V controllers are factory set for 460V operation. If 200V or 380V operation is desired, it will be necessary to change the taps.

D. Refer to Figure 5.2, Snip-Out Component Configuration Chart and Figure 5.3, Main Control Board Component Layout. Verify that the volts per Hertz selection resistors are configured properly. Controllers are shipped with all resistors installed which corresponds to 60 Hertz base frequency and constant volts/Hertz.

1. If a base frequency of 50 Hertz is required, resistors as indicated must be removed.
2. If the controller is to be applied to a motor driving a variable torque load, (centrifugal pump or fan) removing the snip-out resistors indicated will result in a reduced volts/Hertz ratio at reduced frequencies. The major effect is reduced motor noise; however, a slight savings of energy may also be realized.

   Removal is optional for variable torque loads; however, the resistors **must not** be removed if the load requires high breakaway torque. Figure 5.4 graphically illustrates the effect of the resistors.

E. Refer to Figure 5.2, Snip-out Component Configuration Chart and Figure 5.3, Main Control Board Component Layout. Verify that the input frequency selection resistor configuration corresponds to the actual input frequency (50 or 60 Hz). The controller is shipped for 60 Hz input. Remove the indicated resistor if the controller is to be operated from a 50 Hz supply.

F. Refer to Figure 5.2, Snip-out Component Configuration Chart and Figure 5.3, Main Control Board Component Layout. Verify that the input voltage selection resistor configuration agrees with the intended controller input voltage. The controller is shipped for either 230V or 460V input. Remove the indicated resistor if the controller is to be operated from a 200V or 380V supply.

G. Refer to Figure 5.2, Snip-out Component Configuration Chart and Figure 5.3, Main Control Board Component Layout. Verify that the output frequency clamp resistor configuration corresponds to the desired maximum operating frequency. The controller is shipped set for 60 Hz maximum output frequency. If 90 Hz or 120 Hz output is required, one or both of the indicated resistors must be removed.

CAUTION
SOME MOTORS AND/OR LOADS MAY NOT BE SUITED FOR OPERATION AT HIGHER THAN NAMEPLATE MOTOR SPEED AND FREQUENCY. TO AVOID DANGER OF OVERSPEED, CONSULT THE MOTOR MANUFACTURER AND EQUIPMENT MANUFACTURER BEFORE OPERATING THE MOTOR ABOVE 60 HERTZ.

H. This step sets the signal level of analog follower inputs. If automatic operation is not desired (speed control via manual speed potentiometer only) skip to step J. Refer to Figure 5.2, Snip-out Component Chart and Figure 5.3, Main Control Board Component Layout. Verify that the follower

FIGURE 5.1
CONTROL POWER TRANSFORMER PRIMARY TAP CONNECTIONS

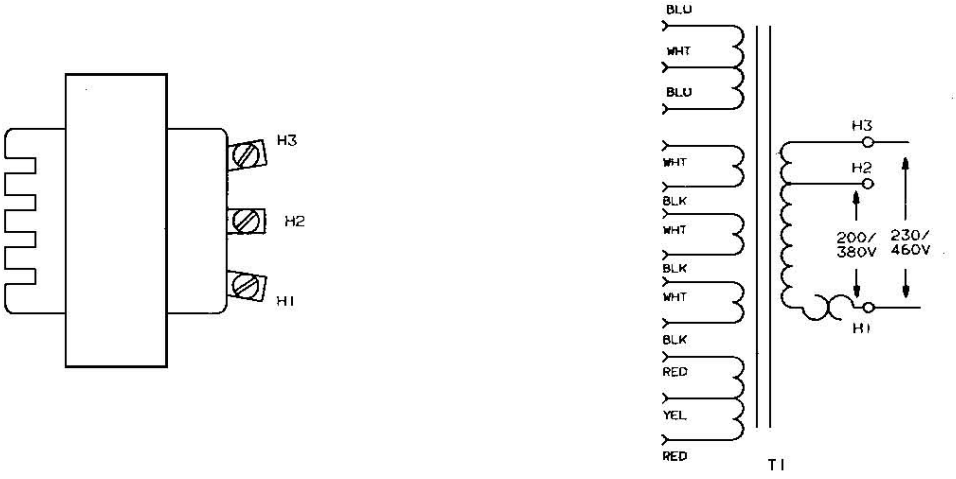


FIGURE 5.2
SNIP-OUT COMPONENT CONFIGURATION CHART①②

Snip-Out Components	Function
R35, R82	50/60 HERTZ OUTPUT FREQUENCY Installed: 60 Hertz base frequency Removed: 50 Hertz base frequency
R38, R135, R138, R141	CONSTANT OR VARIABLE TORQUE (See Figure 5.4) Installed: Constant V/Hz ratio is maintained over a 1.75 Hz to 60 Hz range permitting constant torque at reduced speed. Removed: Reduced V/Hz ratio at reduced output frequency for variable torque loads.
R74	50/60 HERTZ INPUT Installed: Controller accepts 60 Hz input. Removed: Controller accepts 50 Hz input.
R136	200/230 VOLTS INPUT (or 380/460V input) Installed: Controller accepts 230V (or 460V) input. Removed: Controller accepts 200V (or 380V) input.
R86, R87	OUTPUT FREQUENCY CLAMP Installed: Maximum output frequency is clamped to base frequency (50 or 60 Hz) +26%, −0%. Removed: R86 only Maximum output frequency is clamped to base frequency times 1.5, +26%, −0% Removed: R86 **and** R87 Maximum output frequency is clamped to base frequency times 2.0, +26%, −0%
R21	FOLLOWER SIGNAL LEVEL SELECT Installed: Analog follower signals of 0-10 vdc or 4-20 ma dc are permissible. Removed: Analog follower signal of 0-5 vdc is accepted. Note: R21 must be removed on slave controllers of master-slave arrangement.
C37	ACCEL/DECEL RAMP DISABLE Installed: Acceleration and deceleration ramps are adjustable over the normal range. Removed: Acceleration and deceleration ramps are disabled. Output frequency follows input signal directly. Note: This function is used when it is desired to have slave units directly track a master with accel/decel controller by the master.

① Controllers are shipped with all snip-out components installed.
② If a component is to be removed, it is suggested that one lead be snipped and required operation confirmed before completely removing the component.

FIGURE 5.3
MAIN CONTROL BOARD

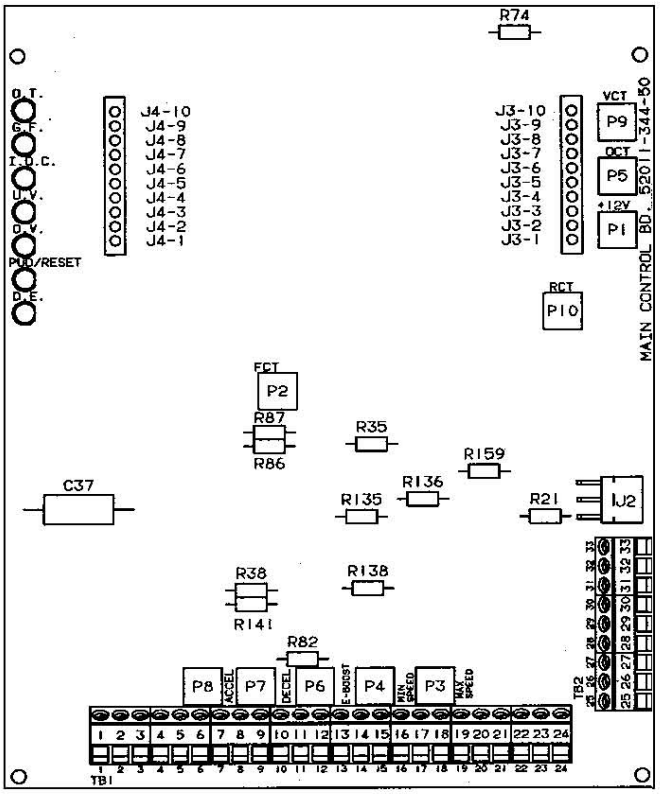
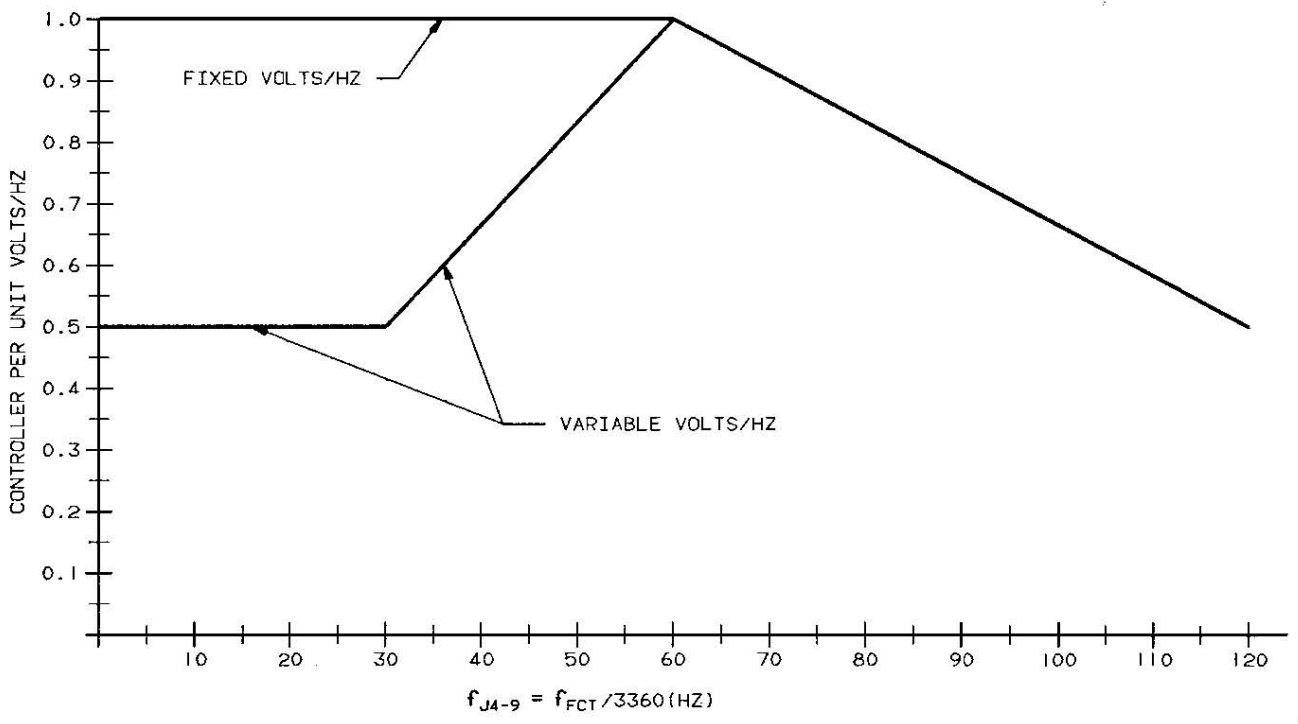


FIGURE 5.4



VOLTS/HZ VS. OUTPUT FREQUENCY (THEORETICAL)

signal level select resistor configuration corresponds to the intended input signal range. The controller as shipped will accept 0-10vdc or 4-20 madc for automatic speed control. If speed control from a 0-5vdc signal is required, the indicated resistor must be removed.

Note: The resistor must be removed on all slave units in a master-slave arrangement.

If operation from a 4-20 ma signal is required, a jumper must be installed from Main Control Board terminal TB1-11 to TB1-12. Refer to Section 8, Drawing 8.4.1.

J. This step allows the controller's acceleration/deceleration ramps to be disabled. If adjustable acceleration/deceleration times are desired, skip to step K. Refer to Figure 5.2, Snip-out Component Configuration Chart and Figure 5.3, Main Control Board Component Layout. Verify that the accel/decel ramp capacitor configuration corresponds to the desired operation of the controller. The controller is shipped with accel/decel ramps adjustable over the range described in Section 3, Application Data. If it is desired to have the controller ramp function disabled, the designated capacitor must be removed.

CAUTION: If the controller ramps are disabled as described above, the accel/decel ramp function must be provided externally, either by the master controller in a master-slave configuration or by the process controller providing the follower signal.

K. Potentiometers located on the main control board were adjusted as shown in Figure 5.5. The function of each potentiometer is described in Figure 5.6. Certain potentiometers indicated as factory adjusted and sealed **must not be adjusted**. Doing so will break the factory seal and **void the warranty**. Other potentiometers are user adjustable to tailor the controller performance to the application. Adjust these, if desired, **only** when directed by the start-up procedure.

FIGURE 5.5
FACTORY SETTINGS OF USER ADJUSTABLE POTENTIOMETERS①

Function①	Potentiometer	Factory Setting
Max Speed	P3	60 Hz Max Frequency
Min Speed	P4	1.75 Hz Min Frequency
E-Boost	P6	Full CCW (Zero Boost)
Decel	P7	Full CW (20 sec)
Accel	P8	Full CW (20 sec)

①Refer to Figure 5.6 for a complete description of potentiometer functions.

FIGURE 5.6
POTENTIOMETER FUNCTIONAL DESCRIPTIONS

POT	Description	Function
P1*	+12V TRIM	Trims positive (+) 12 vdc power supply to compensate for component tolerances.
P2*	FCT TRIM (Frequency Clock Trigger)	Permits trimming of the voltage controlled oscillator that controls output frequency to compensate for component tolerances.
P3	MAX SPEED	Permits adjustment of the maximum output frequency produced by the controller when the speed reference signal (either manual potentiometer or automatic follower) is at maximum.
P4	MIN SPEED	Permits adjustment of the minimum output frequency produced by the controller when the manual speed potentiometer is fully counterclockwise. NOTE: Min speed has no effect on the automatic follower input.
P5*	OCT TRIM (Output Clock Trigger)	Permits trimming of the oscillator which controls the interlock delay of the output transistors to compensate for component tolerances.
P6	E-BOOST (Voltage Boost)	Permits an increase in the volts per Hertz ratio at low frequencies to compensate for voltage drops due to internal winding resistance of the motor and long lead length. E-Boost has maximum effect at 1.75 Hz and tapers to zero at about 20 Hz.
P7	DECEL (Deceleration Time)	Permits adjustment of the time required to ramp the output frequency from a higher to a lower value.
P8	ACCEL (Acceleration Time)	Permits adjustment of the time required to ramp the output frequency from a lower to a higher value.
P9*	VCT TRIM (Voltage Clock Trigger)	Permits the volts per Hertz ratio to be trimmed to compensate for component tolerances.
P10*	RCT TRIM (Reference Clock Trigger)	Permits adjustment of the maximum switching rate of the inverter transistors.

*These potentiometers are factory adjusted and sealed and **must not** be adjusted. Any attempt to adjust these potentiometers will break the factory seal and **void the warranty**.

L. Place the start switch (controller mounted or remote mounted) to the off position.

M. Set the Manual Speed adjustment potentiometer (controller mounted or remote mounted) to minimum (full counterclockwise).

N. Check wiring of input power, ground, motor, manual speed potentiometer (if remote) and start-stop circuit connections (if remote). Refer to Section 8 for controller connection diagrams and wiring diagrams for remote control operators stations.

O. Verify that the incoming line voltage at the line side of the disconnecting means is within +10% to −5% of the controller nameplate input voltage.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

CONTROLLER PANEL MUST BE PROPERLY GROUNDED BEFORE APPLYING POWER. ATTACH AND SECURE CONTROLLER COVER OR CLOSE AND SECURE CONTROLLER DOOR BEFORE APPLYING POWER.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

CERTAIN ADJUSTMENTS AND TEST PROCEDURES REQUIRE THAT POWER BE APPLIED TO THIS CONTROLLER. WHEN WORKING WITH ENERGIZED EQUIPMENT, EXTREME CAUTION MUST BE EXERCISED AS HAZARDOUS VOLTAGES EXIST. THE ENCLOSURE COVER MUST BE ATTACHED AND SECURED OR THE DOOR MUST BE CLOSED AND SECURED WHILE TURNING ON POWER, OR STARTING AND STOPPING THIS CONTROLLER.

P. Insure that a normally closed control circuit contact from an overload relay and/or the motor thermal switch is wired between terminals TB1-4 and TB1-5 as shown on drawing 8.4.1.

Q. Attach and secure the enclosure cover or close and secure enclosure door. Close the equipment disconnect means.
Note: Insure that the plastic cover on a NEMA TYpe 1 enclosed controller properly seats inside the metal tabs on the controller frame. Refer to Section 4, Controller Photos.

R. Initiate the start circuit. Slowly turn the manual speed adjustment potentiometer (controller mounted or remote mounted) clockwise to accelerate the drive motor. Check the direction of motor rotation. If rotation direction is correct proceed to step U. If incorrect, stop the drive. REMOVE ALL POWER!

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT FIVE MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THAT THEY ARE ZERO. DO NOT SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

S. Correct the direction of motor rotation by one of the following methods:

1. If a Forward-Reverse selector switch is not used, place a jumper from TB1-18 to TB1-19 on the main control board.
2. Reverse any two leads connected to output terminals T1, T2, T3.

T. Reset the manual speed adjustment potentiometer setting to minimum speed (full counter clockwise). Secure the enclosure cover or close and secure the enclosure door. Reapply power and restart the controller.

U. Slowly increase the manual speed adjustment potentiometer setting to maximum (full clockwise). The motor speed should follow. If the motor will not accelerate or if the controller trips refer to Section 7 Troubleshooting.

V. The controller was shipped set for a maximum output frequency of 60 Hertz. If 60 Hertz is the desired output frequency, no adjustment is necessary. If a maximum frequency of other than 60 Hertz is required, potentiometer P3, Maximum Speed (MAX SPEED), must be adjusted. Refer to Figure 5.3, Main Control Board Component Layout for the location of P3. Turning P3 counter-clockwise to reduce the maximum output frequency or clockwise to increase maximum output frequency.
NOTE: If the required maximum output frequency exceeds about 66 Hertz, output frequency clamp resistors must be reconfigured as described in Step G of the start-up procedure.

CAUTION
SOME MOTORS AND/OR LOADS MAY NOT BE SUITED FOR OPERATION AT HIGHER THAN NAMEPLATE MOTOR SPEED AND FREQUENCY. TO AVOID DANGER OF OVERSPEED, CONSULT THE MOTOR MANUFACTURER AND EQUIPMENT MANUFACTURER BEFORE OPERATING THE MOTOR ABOVE 60 HERTZ.

W. Return the manual speed adjustment potentiometer to minimum setting (full counterclockwise). The motor speed should follow.
NOTE: If the controller trips during deceleration, refer to Section 7, Troubleshooting.

X. The controller was shipped set for a minimum output frequency of approximately 1.75 Hertz. If this is the desired minimum frequency, no adjustment is necessary. If a higher minimum frequency is desired, potentiometer P4, Minimum Speed (MIN SPEED), must be adjusted. Refer to Figure 5.3, Main Control Board Component Layout for the location of P4. Turn P4 clockwise to increase the minimum output frequency.
NOTE: P4 affects the minimum frequency only when speed control is via a manual speed potentiometer. It has no effect when speed control is via an analog follower signal. Minimum speed in this mode must be set by adjusting the minimum level of the follower signal.

CAUTION
THIS CONTROLLER DOES NOT PROVIDE OVERTEMPERATURE PROTECTION FOR THE MOTOR AT ALL SPEEDS OR LOADING CONDITIONS. A MOTOR THERMAL SENSOR IS RECOMMENDED.

Y. The controller is shipped factory set for an acceleration time of 20 seconds. If this acceleration time is satisfactory, no adjustment is necessary. If a shorter acceleration time is required, potentiometer P8, Acceleration time (ACCEL), must be adjusted. Refer to Figure 5.3, Main Control Board Component Layout for the location of P8. Turn P8 counter-clockwise to decrease the acceleration time.
CAUTION: Setting acceleration time too short may not allow a load sufficient time to accelerate. If this condition exists, the controller will trip due to Instantaneous Over Current (IOC). Refer to Section 7 Troubleshooting for a description of controller fault indicators. Increase the acceleration time until IOC trips during acceleration cease. This will be the shortest permissible acceleration time for this load condition. If IOC trips occur during acceleration with P8 set fully clockwise, refer to Section 7 Troubleshooting.

Z. The controller is shipped factory set for a deceleration time of 20 seconds. If this deceleration time is satisfactory, no adjustment is necessary. If a shorter deceleration time is desired, Potentiometer P7, Deceleration time (DECEL), must be adjusted. Refer to Figure 5.3, Main Control Board Component Layout for the location of P7. Turn P7 counterclockwise to decrease the deceleration time. If Overvoltage (OV) trips occur during deceleration, it will be necessary to increase the deceleration time or install the dynamic braking option.

AA. The controller is shipped factory set for zero (0) voltage boost at 1.75 Hertz. If the load starts and accelerates normally, no adjustment is required. If a load will not break-away, starting torque can be increased by boosting output voltage (increasing the V/Hz ratio). This is accomplished by Potentiometer P6, Voltage Boost (E-BOOST). Refer to Figure 5.3, Main Control Board Component Layout for the location of P6. Turn P6 fully clockwise. If the load starts and accelerates normally, no further adjustment of P6 is necessary. If an instantaneous overcurrent (IOC) trip occurs during starting, rotate P6 counterclockwise slightly and again try to start the controller. Repeat the above procedure, if necessary, until the load breaks away and accelerates normally.

NOTE: Both insufficient and excessive voltage boost can result in an IOC trip. If the above procedure does not result in break-away and acceleration of the load without IOC trips, refer to Section 7, Troubleshooting.

BB. The start-up procedure is now complete.

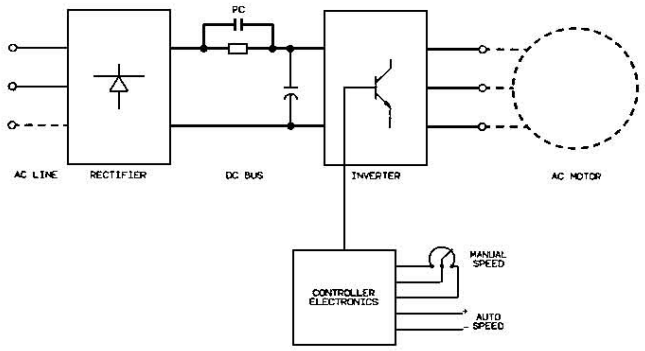
6.0 CONTROLLER OPERATION

6.1 POWER CIRCUIT

The simplified power circuit shown in Figure 6.1 consists of two basic blocks connected by a dc bus. The detailed power circuit is shown in Section 8, Controller Drawings.

1. **Rectifier** — A diode rectifier power block makes up a full wave bridge circuit which changes fixed voltage ac to fixed voltage dc.
2. **DC Bus** — The dc bus couples the rectifier output to the inverter input. One or more capacitors are used to filter the rectifier output. Three phase input controllers use polypropylene bus capacitors and, single phase input controllers use electrolytic bus capacitors. In either case, a precharge circuit consisting of a resistor and relay is used to limit capacitor charging current during power-up of the controller.

Figure 6.1
Simplified Power Circuit



3. **Inverter** — A transistorized inverter stage changes the dc bus voltage back to a three phase ac output voltage. Under control of electronic circuitry, the inverter produces a sine coded, Pulse Width Modulated (PWM) output waveform. Reverse parallel diodes protect the inverter transistors from reverse voltages and provide a path of current flow during periods of regeneration.

6.2 ELECTRONICS

The controller electronic circuitry is contained on two printed wiring boards. A main control board (MCB) holds the logic and control circuits necessary to control the output voltage and frequency in response to an input speed reference. A power interface board (PIB) amplifies and isolates the signals generated on the MCB into base drive signals for the inverter transistors.

Main Control Board (MCB) General Operation (Refer to Section 8, Drawing 8.4.1 for the control block diagram.)

The Main Control (MCB) contains the circuits necessary to provide the transistor base drivers of a 3-phase inverter with PWM signals. By controlling the fundamental frequency and modulation of the PWM signal, the output voltage and frequency of the inverter power stage is controlled. The MCB is also the means for controlling functions such as start-stop, acceleration-deceleration, and output voltage programming. It monitors bus voltage, fault current and overtemperature conditions, and responds to overvalues.

External connections to the MCB are made from switches such as start-stop, run-jog and forward-reverse. Other connections are the manual speed potentiometer, thermal switches, metering, bus voltage and bus current inputs, indicator lamps, fan, and the transistor base drivers.

A. A major circuit on the MCB is the Pulse-Width Modulation Generator IC which requires four clock inputs and two control inputs to control the waveforms to the base drivers. The control inputs are an enable signal obtained from the control logic circuits, and a rotation signal to establish the direction of motor rotation.

   Two of the clock inputs are the constant frequency outputs of stable oscillators. These clocks are labeled the Output Clock Trigger (OCT) and the Reference Clock Trigger (RCT). The RCT determines the maximum inverter switching frequency, and the OCT sets the interlock delay (time between periods of conduction of transistors in the same leg of the inverter).

   A third clock input is the Frequency Clock Trigger (FCT) which is the output of a voltage controlled oscillator whose input voltage is the frequency reference input signal after modification by the acceleration/deceleration ramp circuit.

   The FCT determines the inverter's output frequency and therefore, the motor speed. The frequency reference signal, set by the external Manual Speed Potentiometer is limited by potentiometers P4 (Minimum Speed) and P3 (Maximum Speed).

Acceleration and deceleration ramp times are set by potentiometers P8 (Acceleration) and P7 (Deceleration) and the resulting output is applied to the FCT oscillator.

There is a frequency clamp circuit connected to the input of the FCT oscillator. The clamp frequency is controlled by resistors R86 and R87 which can be removed (snipped out) to change the clamp frequency. With no resistors snipped from the circuit, the nominal output frequency is 60 Hertz. With R86 snipped out it is 90 Hertz, and with R86 and R87 snipped out it is 120 Hertz.

The final clock input to the PWM controller is the voltage clock trigger (VCT). The VCT is a voltage controlled oscillator (VCO) which controls the modulation of the carrier frequency to the motor in order to control the average inverter output voltage for a particular output frequency. This VCO receives its input from the Bus Voltage Detector and a Volts/Hertz Generator circuit that modifies the VCO output in accordance with E-Boost, 50 Hertz, or Pump/Fan service requirements as appropriate.

B. The output of the Accel/Decel circuit, in addition to driving the FCT VCO is provided, through a buffer, as a frequency follower. This allows multiple controllers to be operated in a master/slave arrangement. When used in this mode, R21 on slave units only should be snipped out to allow for proper scaling of the drive controller input when operated from the frequency follower output of the master drive controller. In addition, the Accel/Decel circuit can be bypassed in the slave drive controllers by snipping out C37, thus allowing master ramp operation from the master controller.

C. There are three circuit blocks shown that function in relation to the starting and stopping of the drive. They are the Start/Stop Logic and Minimum Frequency Detector, Power Up Delay and Reset circuits, and the Forward/Reverse Logic and Reference Suicide circuits. During power up there is a 1.5-second signal that is applied to fault latch circuits to ensure reset of the latches when the drive is energized. In addition, this Power Up Delay or Reset signal is OR-ed with fault signals and applied to the Run Command Relay circuit to prevent energizing of that relay until power up is complete. During operation, if an AC Undervoltage condition occurs, there will also be a power up reset signal when voltage recovers. An external Reset button can produce the same effect as the Power Up Delay.

The Start/Stop logic circuits provide the Enable signal to the PWM Generator. This Enable signal can be reset by the instantaneous trip signal from the bus overvoltage detector, by the fault or power-up reset signals, or by the Minimum Frequency Signal. The Run command input to the block is an active low signal.

The Ramp Reference output is applied to a Minimum Frequency Detector, which is a comparator whose output switches at frequencies less than 1.75 Hertz. This Minimum Frequency signal is applied to the Start/Stop Logic and to the Forward/Reverse Logic. In the Start/Stop circuit, Minimum Frequency causes the Drive Enable signal to go low, if the Run Command has been removed, once the frequency is ramped to minimum frequency. In the Forward/Reverse circuit, the minimum frequency signal allows the rotation latch to be switched once minimum frequency output is obtained, provided that the Forward/Reverse input has been changed.

The Forward/Reverse function has three inputs: Run Command, Forward/Reverse, and Minimum Frequency. The output of this block is the signal to the PWM Generator that determines direction of motor rotation. Additionally, there is an output from the reference suicide circuit that clamps the Frequency Reference signal low during a change in the Forward/Reverse Command input. A loss of the Run Command input to this block of circuits also causes the Frequency Reference suicide circuit to clamp the frequency reference low.

D. Five circuit blocks are involved directly in the processing of fault signals. The Undervoltage block is divided into two functions. It receives a dc Undervoltage instantaneous trip signal from the Bus Undervoltage and Phase-Loss Detector circuit. This signal causes the drive to stop and latches an undervoltage condition. The Undervoltage block also receives a recti-

fied ac input from the 28V ac input to the MCB. An ac undervoltage occurrence will also cause a trip and an undervoltage latch. However, the ac undervoltage signal is also applied to the Power Up Delay circuit where it initiates a power up reset cycle upon recovery of the ac undervoltage. Once the ac voltage recovers, the Undervoltage latch will be reset by the power up delay and the Drive Enable signal will be restored.

All fault conditions, such as Instantaneous Overcurrent and Ground Fault current will activate fault latches and LEDs. The latched faults provide a signal to the Drive Fault Relay allowing it to drop out. External connections to the relay contacts can provide indication of drive fault.

There is a dc Bus Overvoltage Detector and Ride-through circuit that provides a latched fault trip condition after a 7-millisecond delay allowing transient ride-through, as well as an instantaneous reset of the Start/Stop logic to allow for protection of the power transistors. The power transistors are shut off for 7 milliseconds and then enabled again if a bus overvoltage transient has subsided within that time. Otherwise, an overvoltage trip occurs. The Delayed Trip shown in the block occurs if there are two occurrences of Bus Overvoltage within 28 seconds of each other. The Delayed Trip causes a latched fault signal. This ride-through feature requires that the dynamic braking option be installed to bleed off excess dc bus energy.

E. Another feature depicted on the block diagram is the control circuit for the Pre-Charge (PC) Relay located external from the main control board. From the time that the regulated −12V dc and the −V unregulated voltages are available, there is a 50 millisecond delay before the PC relay is energized. This delay allows the bus capacitors to charge through a limiting resistor that is shunted by a normally open contact of the PC Relay.

F. Controller power supplies are fed from a 200/230-28V (or 380/460-28V) center tapped control transformer. The transformer output is applied to a bridge rectifier which provides positive (+) and negative (−) unregulated voltages for control relays located on the main control board. these voltages are also applied to voltage regulators which provide the regulated +12V dc and −12V dc for the MCB electronics and +10V dc for a manual speed potentiometer.

7.0 TROUBLESHOOTING AND MAINTENANCE GUIDE

7.0.1 MAINTENANCE

During normal use, the drive controller will require minimum maintenance; however, good maintenance practice requires periodic inspection of the controller. The maintenance periods should be scheduled based on the particular operating environment of the controller, but should not exceed one year.

CAUTION

ONLY AUTHORIZED SERVICE PERSONNEL FAMILIAR WITH THIS EQUIPMENT SHOULD BE ALLOWED TO SERVICE THE CONTROLLER.

General maintenance procedures for Square D control gear are covered in Square D publication 30072-200-50. Procedures specific to this controller are as follows.

1) Drive controller operation should be observed. Any deviations from normal operation may be an indication of a controller malfunction. A thorough investigation should be made to determine the cause.

2) REMOVE ALL POWER.

DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT 5 MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THAT THEY ARE ZERO. DO NOT SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

3) Inspect and clean all air passageways in controller using a vacuum cleaner. **Do not** use a compressed air source.

4) Inspect and clean all insulation systems within the controller using a vacuum cleaner. **Do not** use a compressed air source. **Do not "megger" controller!**

5) Check integrity of all mechanical fasteners.

6) Check integrity of all electrical fasteners and joints.

7) Check controller grounding means.

8) Check capacitor bank for damaged, leaky or bulging cans. Replace as required.

7.0.2 TROUBLESHOOTING

A number of diagnostic and status indicating lights have been included on the Main Control Board and Power Interface Board. The intent of these lights is to provide visual indication of a number of controller operating and protective circuit functions to assist in maintenance and troubleshooting.

The following troubleshooting guide can best be utilized by observing the status of the lights and reviewing the symptoms listed to determine which possible problems could cause the observed light pattern. To view the lights, the controller electronics must be exposed with power applied to the controller. If the controller trips while operating, the lights must be viewed before power is removed because removing and re-applying power resets the fault indicators.

CAUTION

ONLY AUTHORIZED SERVICE PERSONNEL FAMILIAR WITH THIS EQUIPMENT SHOULD BE ALLOWED TO SERVICE THE CONTROLLER.

DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

MANY PARTS INCLUDING ELECTRONIC PRINTED WIRING BOARDS IN THIS CONTROLLER OPERATE AT LINE VOLTAGE. DO NOT TOUCH. USE ONLY ELECTRICALLY INSULATED TOOLS WHILE MAKING ADJUSTMENTS.

DANGER

CERTAIN ADJUSTMENTS AND TEST PROCEDURES REQUIRE THAT POWER BE APPLIED TO THIS CONTROLLER. WHEN WORKING WITH ENERGIZED EQUIPMENT, EXTREME CAUTION MUST BE EXERCISED AS HAZARDOUS VOLTAGES EXIST. THE CONTROLLER COVER MUST BE ATTACHED AND SECURED WHILE TURNING ON POWER, OR STARTING AND STOPPING THIS CONTROLLER.

When used in conjunction with the diagnostic and status indicating lights, this guide facilitates troubleshooting to the individual printed wiring board level.

The troubleshooting procedure is organized into three basic sections. The first section, Section 7.1, covers general problems which are identified by symptoms such as "controller/motor will not operate". The second section, Section 7.2, consists of LED annunciated faults such as overvoltage, instantaneous overcurrent, etc. The third section, Section 7.3 is a reference section for the first two sections and contains troubleshooting techniques which require a more detailed description.

If troubleshooting indicates the necessity of component replacement observe all precautions. Refer to Section 7.4 for replacement procedures of major components.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT 5 MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THAT THEY ARE ZERO. DO *NOT* SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

7.0.3 TROUBLESHOOTING ASSISTANCE, SERVICE REQUESTS, RETURNS

When contacting your local Square D/Ramsey representative for troubleshooting assistance or requesting service, it is necessary to have available the information requested on the troubleshooting data sheet in Section 7.5. If the controller is to be returned for repair, a copy of the return material authorization or the return material authorization number (obtained from your local Square D/Ramsey representative) plus a completed copy of the troubleshooting data sheet must accompany the controller.

7.1 TROUBLESHOOTING FLOW CHARTS — GENERAL SYMPTOMS

7.1.1 MOTOR CONTROLLER WILL NOT START

7.1.2 MOTOR WILL NOT ACCELERATE

7.2 TROUBLESHOOTING FLOW CHARTS — LED ANNUNCIATED FAULTS

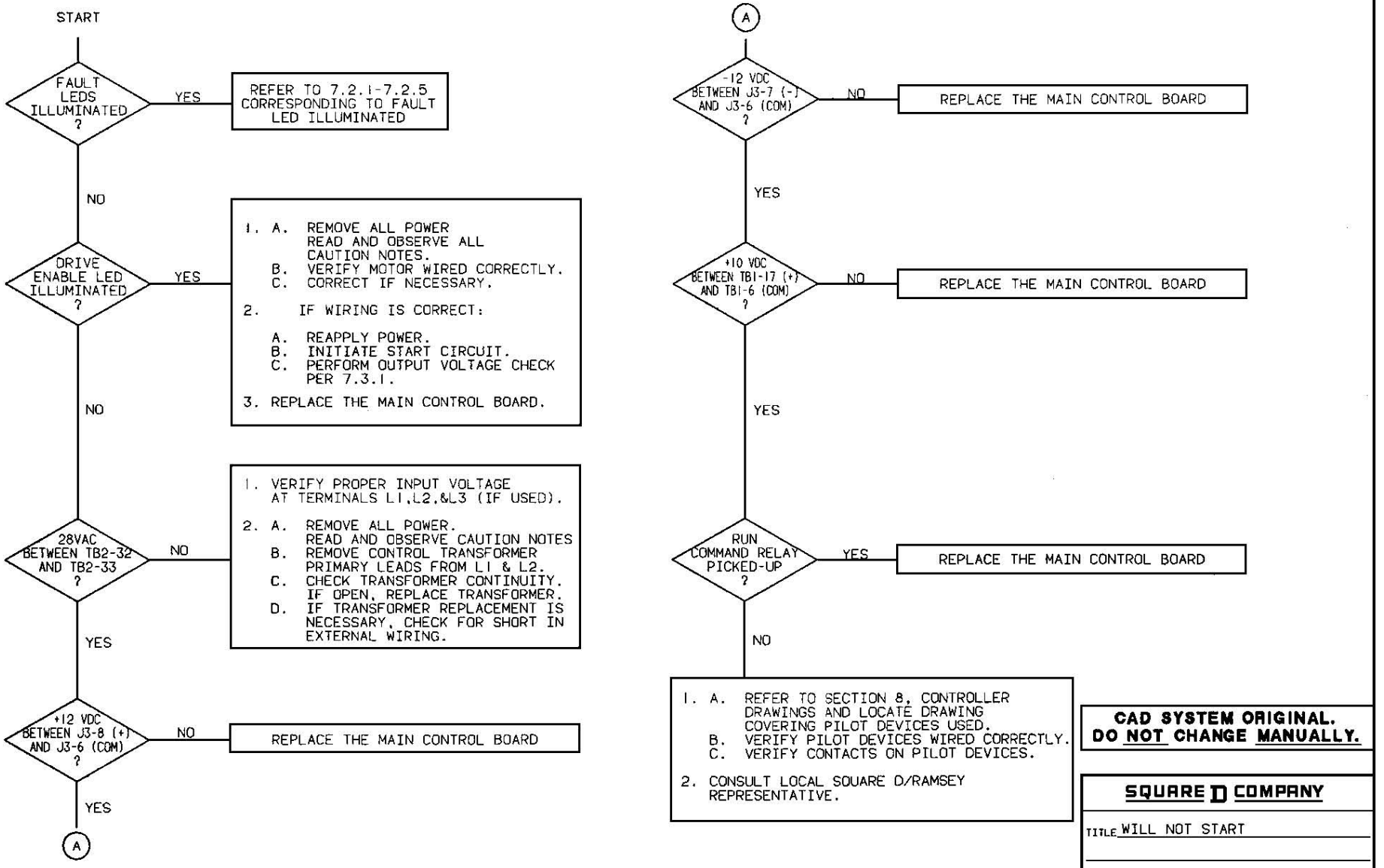
7.2.1 INSTANTANEOUS OVER CURRENT (IOC) LED ILLUMINATED

7.2.2 OVERVOLTAGE (OV) LED ILLUMINATED

7.2.3 GROUND FAULT (GF) LED ILLUMINATED

7.2.4 UNDERVOLTAGE (UV) LED ILLUMINATED

7.2.5 OVERTEMPERATURE (OT) LED ILLUMINATED



CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE WILL NOT START

CLASS____ TYPE ____ FORM____ SER.___

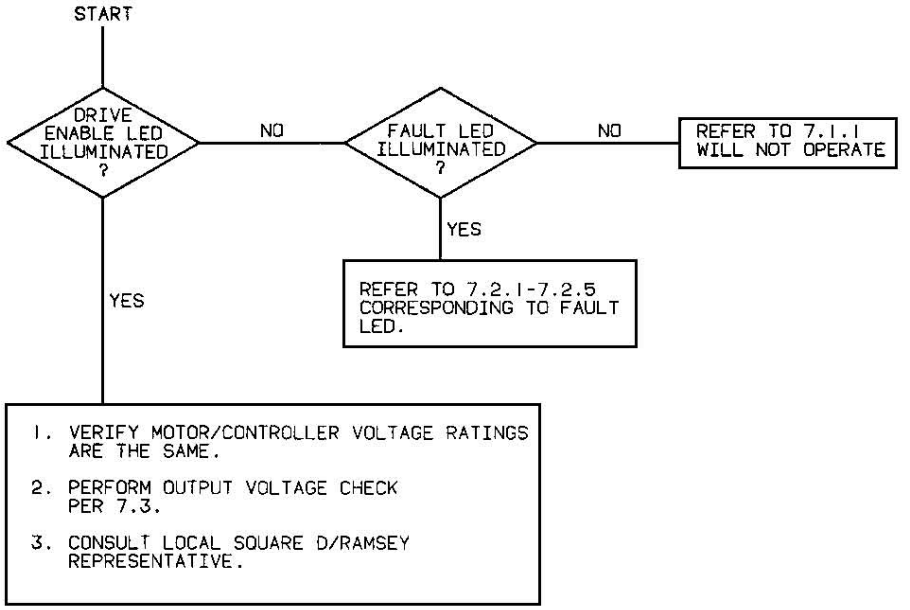
REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. 7.1.1 | SHEET OF

DRN. | CKD. | APP'D

MASTER



CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

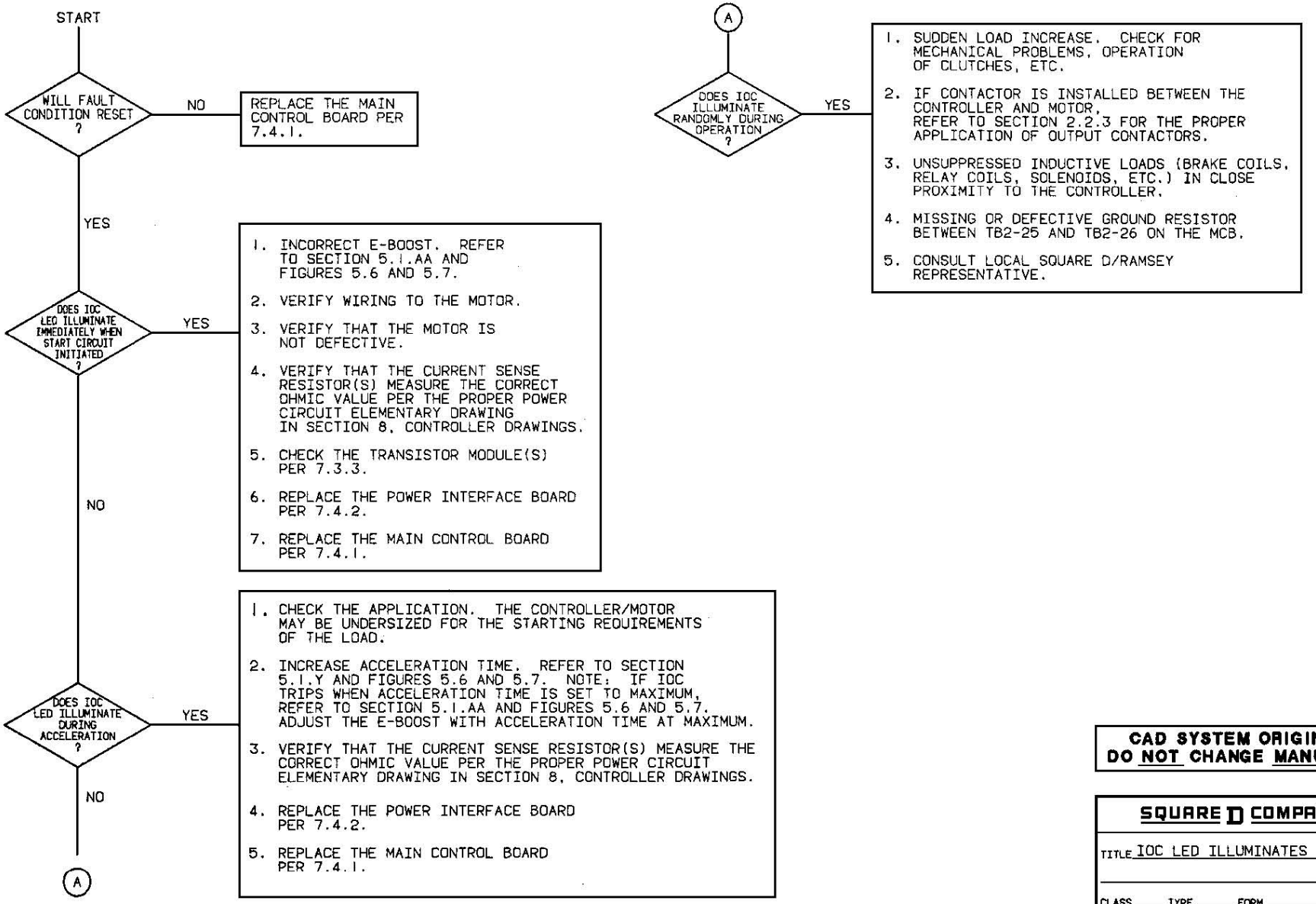
TITLE WILL NOT ACCELERATE

CLASS____ TYPE ____ FORM_____ SER.__

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. MASTER 7.1.2 | SHEET OF
DRN. | CKD. | APP'D



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SQUARE D COMPANY

TITLE IOC LED ILLUMINATES

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

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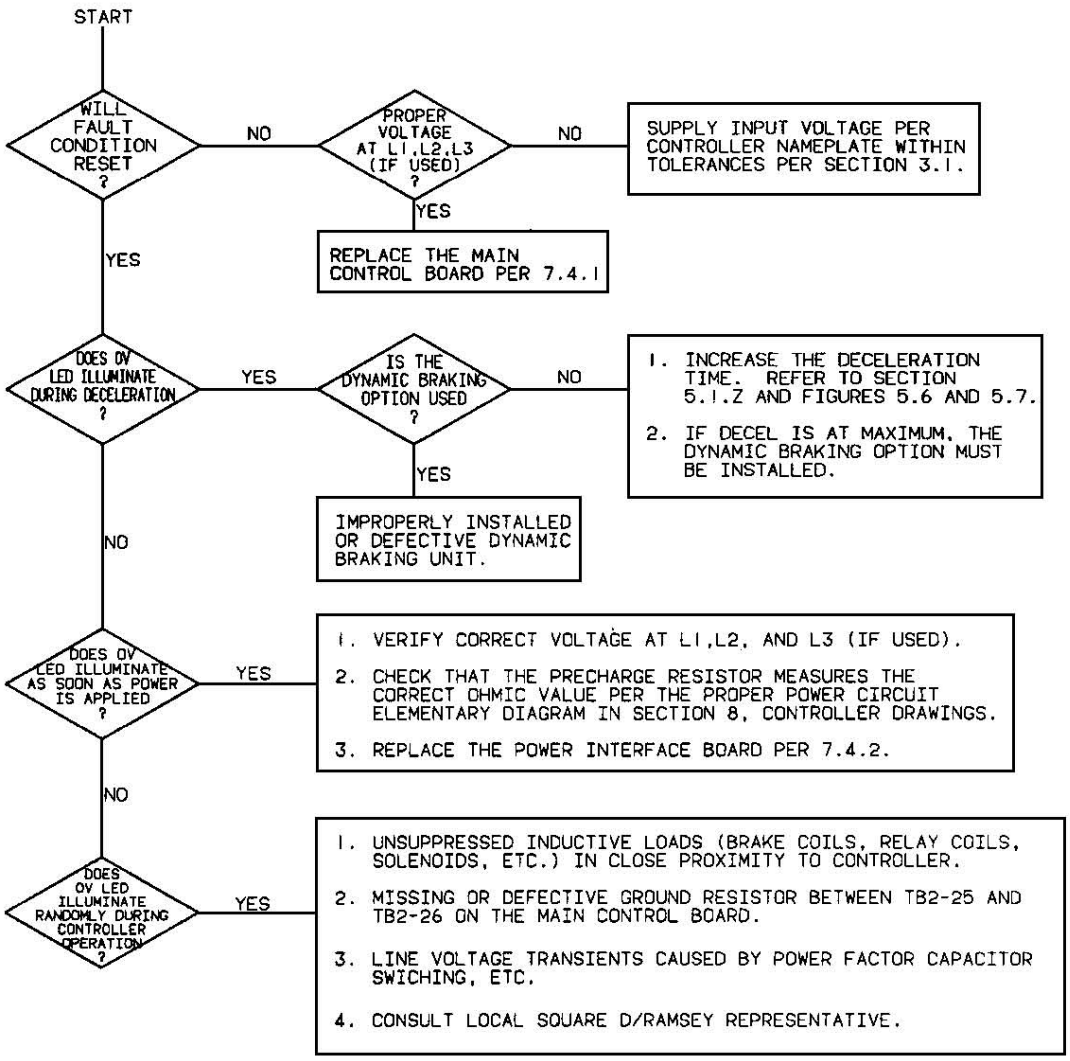
NEXT ASSEN
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRN. | CKD. | APP'D

DRG. NO. 7.2.1 — MASTER

SHEET OF



CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE OV LED ILLUMINATES

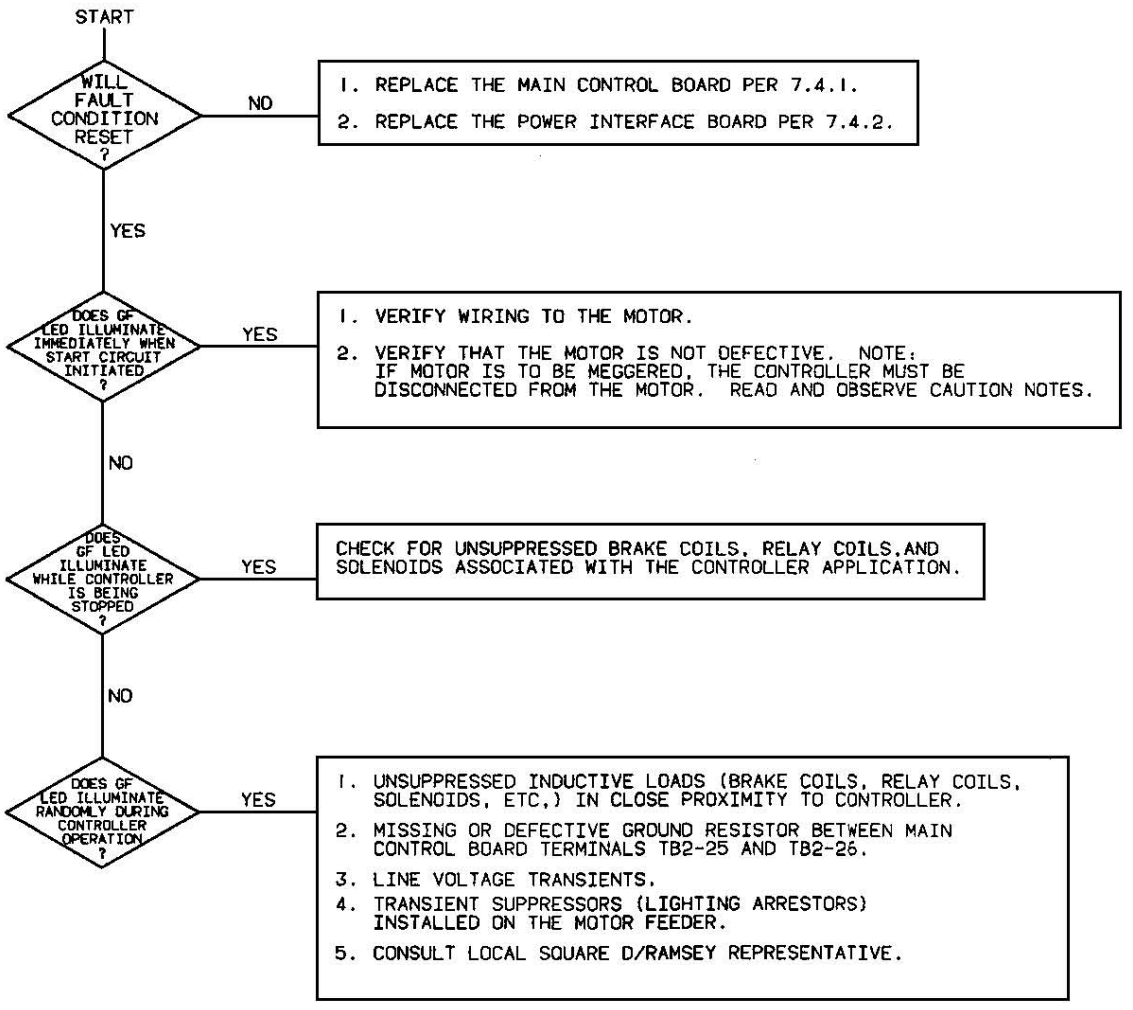
CLASS ____ TYPE ____ FORM ____ SER. ____

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. MASTER 7.2.2 | SHEET OF

DRN. | CKD. | APP'D



CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

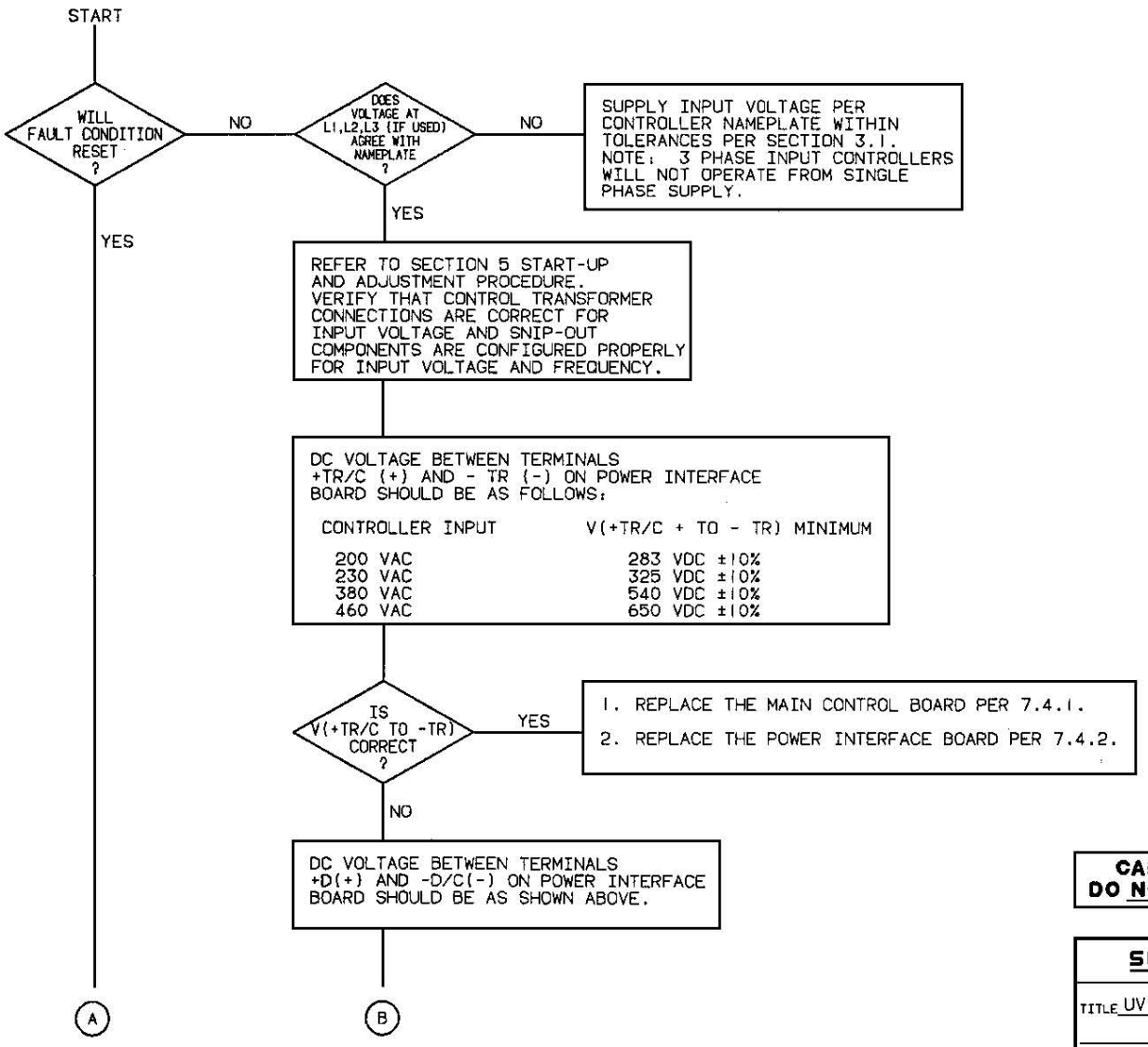
TITLE GF LED ILLUMINATES

CLASS____ TYPE____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 2-86 | DATE REL. | DRG. NO. MASTER 7.2.3 | SHEET OF
DRN. | CKD. | APP'D



CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE UV LED ILLUMINATES

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

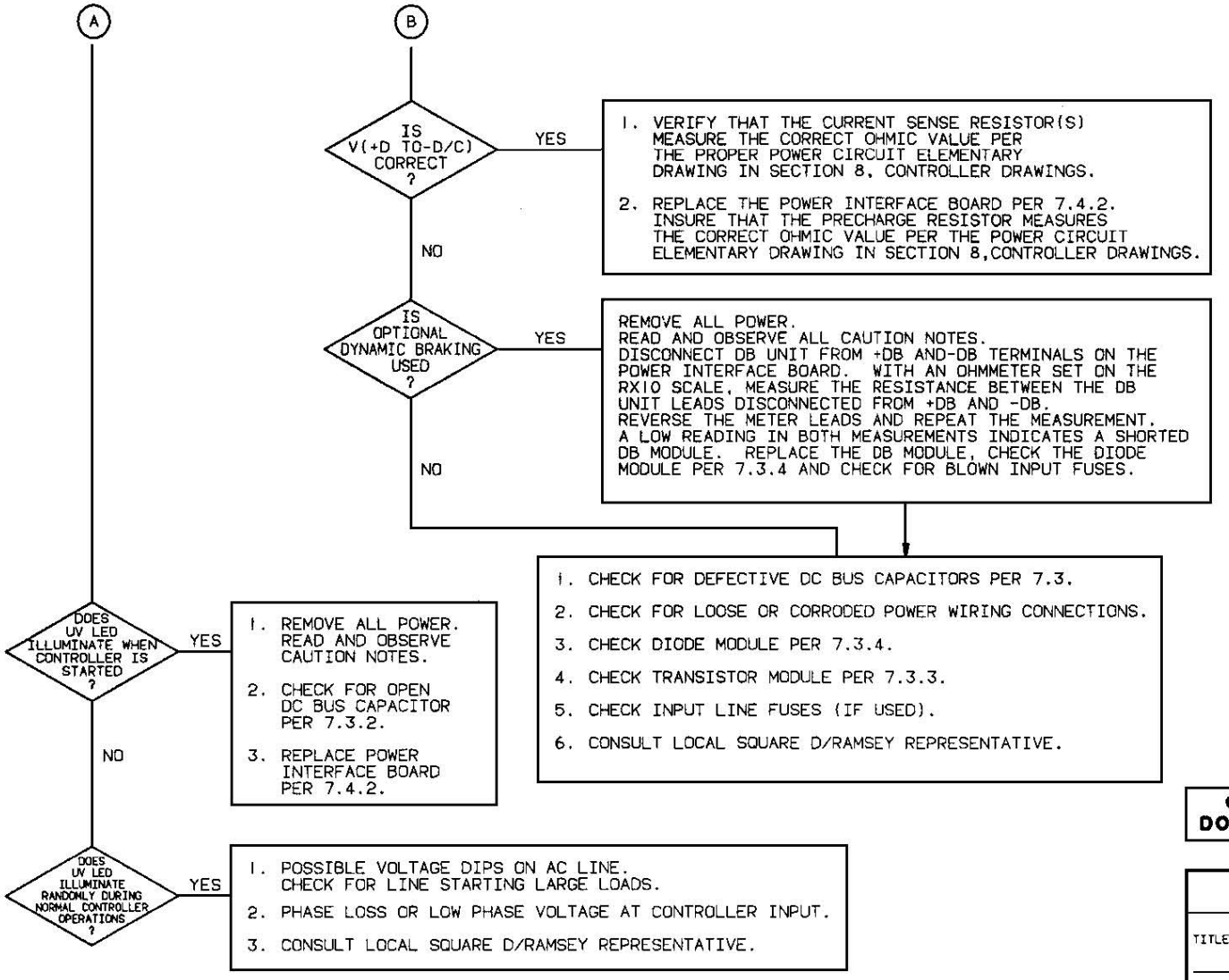
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRN. | CKD. | APP'D

DRG. NO. 7.2.4

MASTER

SHEET 1 OF 2



CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE UV LED ILLUMINATES

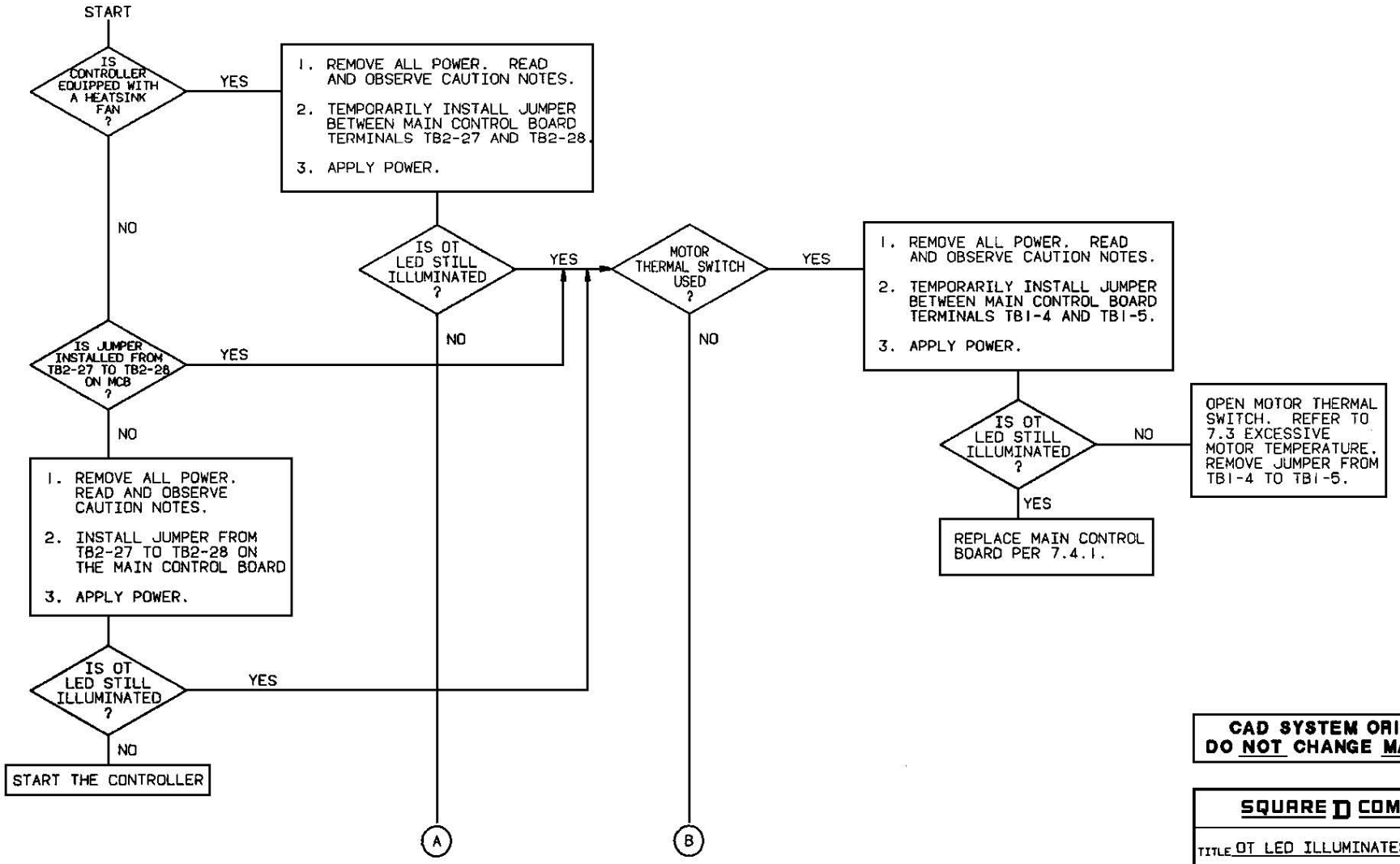
CLASS_____ TYPE _____ FORM_____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. 7.2.4 | MASTER | SHEET 2 OF 2

DRN. | CKD. | APP'D



CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

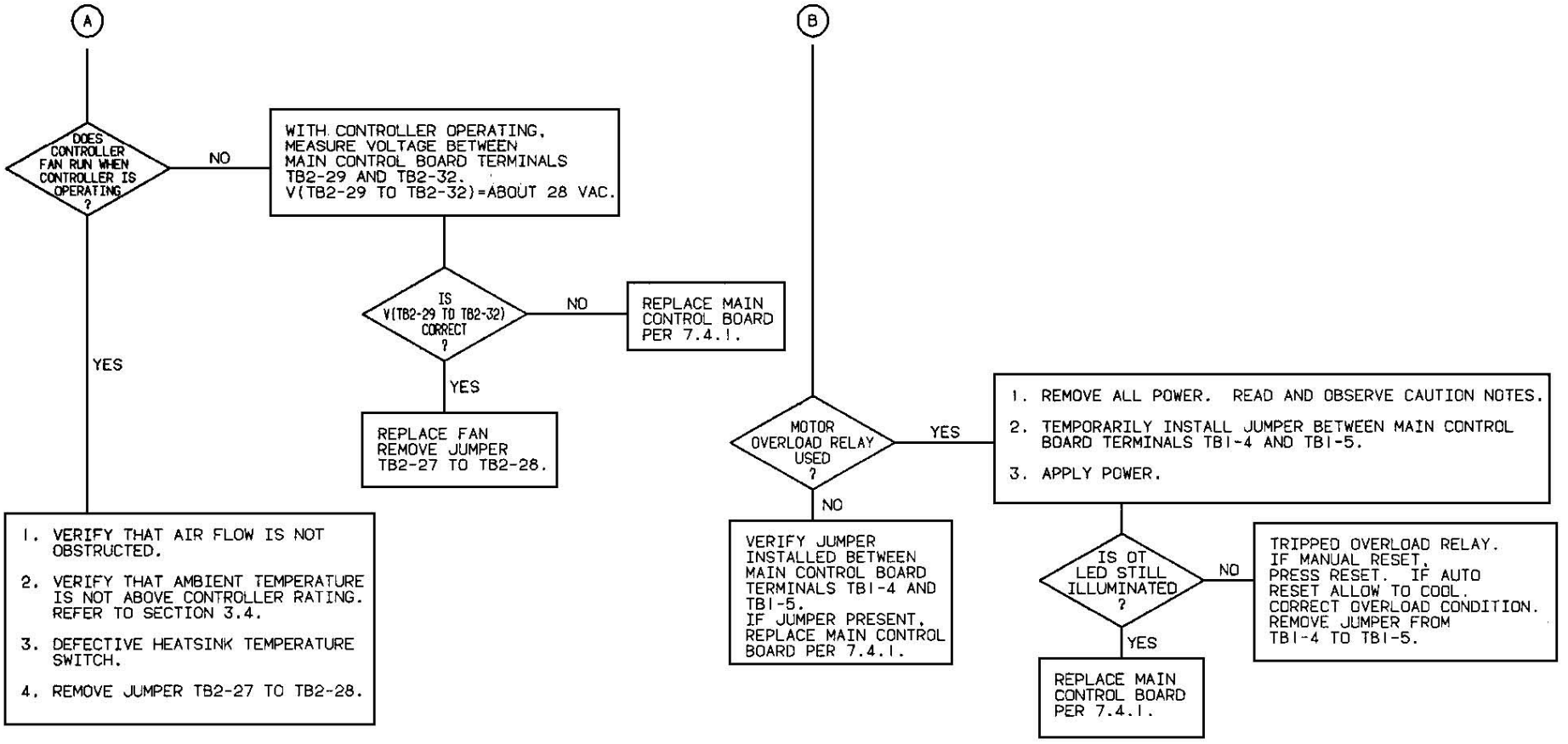
TITLE OT LED ILLUMINATES

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. MASTER 7.2.5 | SHEET 1 OF 2
DRN. | CKD. | APP'D



CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE OT LED ILLUMINATES

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 1-86 | DATE REL. | DRG. NO. 7.2.5 | MASTER | SHEET 2 OF 2

DRN. | CKD. | APP'D

7.3 TROUBLESHOOTING REFERENCE

7.3.1 OUTPUT VOLTAGE CHECK

1. REMOVE ALL POWER.
   Read and observe caution notes concerning controller servicing.
2. Remove the motor leads from terminals T1, T2 and T3.
3. Reapply power and start the controller. Adjust the output frequency to approximately 60 Hertz.
   Note: Manual operation should be used if both manual and automatic operation is possible.
4. Measure the line to line output voltages from T1 to T2 to T3, and T1 to T3. These voltages should be within 5% of each other. The actual voltage reading is not important. Because of the complex output waveform, different voltmeters may read different values. The major concern is that all three readings indicate balanced voltages.
5. If balanced voltages are measured in step 4, skip to step 7.
6. Unbalanced voltages indicate a possible problem with the inverter transistor module(s) base drive signals to the inverter transistor module(s) or poor connections in the wiring from the power interface board to the inverter transistor modules.
   A. REMOVE ALL POWER. Read and observe caution notes concerning controller servicing.
   B. Verify that all fast-on connectors are securely attached to the proper points on the inverter transistor module(s). Refer to the proper connection diagram in Section 8, Controller Drawings.
   C. Check the transistor module(s) per 7.3.3.
   D. If steps 6A and 6B indicate no problems, replace the power interface board per 7.4.2.
   E. If the problem persists after step 6C, replace the main control board per 7.4.1.
7. Stop the controller.
   REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing.
8. Reconnect the motor leads removed in step 2. Tighten screws to torque ratings specified in Section 2, Figure 2.1.

7.3.2 DC BUS CAPACITOR CHECK

The normal failure mode of a dc bus capacitor is a short circuit. This will normally result in a blown input fuse and possibly a blown input rectifier diode. The polypropylene capacitors used on three-phase input controllers have a built-in interrupter which opens the capacitor terminals upon a build-up of pressure inside the can. This condition can be detected by examining the top of the capacitor. The top of the capacitor will be bulged outward creating a dome shape.

All dc bus capacitors, whether electrolytic (used on single phase input controllers) or polypropylene, can be checked by the following procedure.

1. REMOVE ALL POWER.
   Read and observe caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Remove the insulated boot (if used) and disconnect one wire from the capacitor to be checked.
3. With an analog VOM set on the RX1000 resistance scale, connect the meter across the capacitor terminals.
4. The meter should deflect momentarily to a low resistance and quickly return to near infinity.
   A. No deflection — The capacitor may be charged to higher than the VOM battery voltage. Reverse the meter leads and repeat the measurement. If the meter does not deflect, the capacitor is open and must be replaced. See Step 6.
   B. Deflects and remains at low resistance reading-shorted capacitor. Replace per Step 6.
5. Repeat Step 3 for each capacitor in the controller.
6. If readings in Step 3 or 4 indicate a faulty bus capacitor the following procedure must be followed to replace the capacitor:
   A. If electrolytic capacitors are used, mark the wires to insure that they can be reconnected to the capacitor with

the proper polarity. Polypropylene capacitors are not polarity sensitive.

B. Remove the remaining wire from the capacitor, loosen the mounting hardware and remove the capacitor.

C. Install the new capacitor and tighten the mounting hardware.

D. Reconnect wires being careful to observe the polarity if electrolytic capacitors are used.

E. Replace the insulated boots on the capacitor terminals (if used).

7.3.3 INVERTER TRANSISTOR MODULE(S) CHECK

The following procedure checks for a shorted transistor in the inverter output.

NOTE: Failure of an inverter transistor module may result in the application of damaging voltages to the power interface board. If a faulty transistor module is detected the power interface board should be replaced during the replacement of the transistor module(s). Refer to Section 7.4.2 and 7.4.3.

1. REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Disconnect motor leads from terminals T1, T2 and T3.
3. With a VOM set on the RX10 resistance scale, perform the measurements listed in Table 7.1.
   NOTE: Terminals +TR/C and −TR are located on the power interface board.

TABLE 7.1

VOM +LEAD	VOM −LEAD	RESISTANCE READING*
+TR/C	T1	High
+TR/C	T2	High
+TR/C	T3	High
T1	+TR/C	Low
T2	+TR/C	Low
T3	+TR/C	Low
−TR	T1	Low
−TR	T2	Low
−TR	T3	Low
T1	−TR	High
T2	−TR	High
T3	−TR	High

*The actual ohmic value is not important. The high reading should be at least several times higher than the low reading.

4. If a low resistance measurement is encountered where a high resistance measurement is expected, a shorted transistor is indicated.
5. If the controller is rated for 200/230V, all transistors are contained in the same module. Replace the module per 7.4.3.
6. If the controller is rated for 380/460V, three modules, each containing two transistors may be used. Isolate the defective module by studying the power elementary drawing and the connection diagram, refer to Section 8, Controller Drawings, to determine which transistor pair feeds the output terminal where the improper reading occurred. Replace that module per 7.4.3.

7.3.4 DIODE MODULE CHECK

The following procedure checks for a shorted diode in the diode module.

1. REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Disconnect the control transformer primary leads from terminals L1 and L2.
3. With a VOM set on the RX10 resistance scale perform the measurements listed in table 7.2.
   NOTE: Terminals +D and −D/C are located on the power interface board.

TABLE 7.2

VOM +LEAD	VOM −LEAD	RESISTANCE READING*
L1	+D	Low
L2	+D	Low
L3**	+D	Low
+D	L1	High
+D	L2	High
+D	L3**	High
−D/C	L1	Low
−D/C	L2	Low
−D/C	L3**	Low
L1	−D/C	High
L2	−D/C	High
L3**	−D/C	High

*The actual ohmic value is not important. The high reading should be at least several times higher than the low reading.

**Single phase input controllers do not have an L3 terminal, therefore, this measurement cannot be made.

4. If a low resistance is encountered where a high resistance measurement is expected, a shorted diode is indicated.

5. All six diodes are contained in a single module. Replace the diode module per 7.4.4.

6. Be sure to reconnect the control transformer leads removed in step 2.

7.3.5 EXCESSIVE MOTOR TEMPERATURE

Motor overheating can result form the following items:

1. Motor incorrectly sized for the load. Measure motor current and compare to nameplate rating.

2. Insufficient motor ventilation. Since most motors are cooled by shaft-mounted fans, the motor rated current capacity will decrease with speed due to decreased fan speed. If substantial motor torque is required at low speed, motor overtemperature may occur. The motor manufacturer should be consulted to determine the correct motor selection for such applications.

3. Unbalanced output voltage/current. Verify that voltage output is correct per 7.3.1.

   NOTE: With the advent of modern insulation materials, many motors are capable of operating at relatively high winding temperatures. Therefore, motors which seem hot to the touch may be operating well within their temperature limits. The motor nameplate should be consulted as to the class of the motor's insulation system. To properly determine a motor's temperature, the procedures described in NEMA MG-1 may be followed.

7.4 COMPONENT REPLACEMENT GUIDE

When replacing a controller component, procedures detailed in the following sections must be followed to insure personnel safety and prevent damage to the controller. It is suggested that the procedure and any required drawings be studied before starting. The procedures should be followed in a step-by-step manner.

CAUTION

ONLY AUTHORIZED SERVICE PERSONNEL FAMILIAR WITH THIS EQUIPMENT SHOULD BE ALLOWED TO SERVICE THE CONTROLLER.

DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

BEFORE SERVICING, TURN OFF POWER SUPPLY(S) TO THIS EQUIPMENT. WAIT 5 MINUTES. MEASURE CAPACITOR VOLTAGES TO VERIFY THAT THEY ARE ZERO. DO *NOT* SHORT ACROSS CAPACITORS WITH VOLTAGE PRESENT.

7.4.1 MAIN CONTROL BOARD REMOVAL/ REPLACEMENT PROCEDURE

A. MAIN CONTROL BOARD REMOVAL

1. REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing.
2. Mark all wiring to the main control board terminal strips so that the wires can be reconnected properly. It is suggested that the terminal number silk screened on the board be used.
3. Remove all wiring from the main control board terminal strips.
4. Disconnect the control power transformer plug. Refer to Section 4, Controller photos for the plug location.
5. Remove the four screws holding the board to the nylon stand-offs.
   NOTE: It will be necessary to hold the stand-off to prevent its turning.
6. Grasp the main control board at the top and bottom and lift with a rocking motion. This will ease separation of the main control board and power interface board connector.

DANGER

HAZARD OF ELECTRICAL SHOCK OR BURN

DO *NOT* ENERGIZE THE CONTROLLER WITH ANY PRINTED WIRING BOARD REMOVED.

B. MAIN CONTROL BOARD INSTALLATION

1. If the main control board is to be replaced with a different unit, insure that all terminal strip jumpers on the removed board are duplicated on the replacement board and that a ground resistor (1K ohm, 1/4 watt) is installed between terminals TB2-25 and TB2-26. Also configure snip-out components on the replacement board to match the removed board. Refer to Section 5, start-up procedure for additional information.

2. Carefully line-up the long pins on the left side of the power interface board with the connector on the main control board.

   NOTE: The component side of the board must face outward.

3. Gently press the connector until all pins show through the top side about 1//4 inch.
4. Install and tighten the four mounting screws that secure the main control board to the nylon stand-offs.

   NOTE: It will be necessary to hold the stand-off to prevent its turning.

5. Connect the control power transformer plug. Refer to Section 4, Controller Photos for the plug location.
6. Install wiring removed from the main control board terminal strips using care to insure that wires are routed to the proper terminal. Recommended tightening torque is listed in Section 2, Figure 2.1.

7.4.2 POWER INTERFACE BOARD REMOVAL/ REPLACEMENT PROCEDURE

If troubleshooting indicates the necessity of removal or replacement of the power interface board, the following procedure must be followed to insure that the task is accomplished safely and without damage to the controller.

A. POWER INTERFACE BOARD REMOVAL

1. REMOVE ALL POWER
   Read and observe all caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Remove the main control board per 7.4.1.
3. Mark all wiring to the power interface board terminals so that the wires can be reconnected properly. It is suggested that the terminal designation silk screened onto the board be used.
4. Remove all wiring from the power interface board terminals.
5. Disconnect the four control power transformer plugs. Refer to Section 4, Controller Photos for the plug locations.
6. Remove the four screws holding the board to the metal stand-offs.
7. Gently lift the board away from the heatsink assembly until the two wires (+D and −D/C) can be pulled through the board mounted current transformer.
8. Continue to lift the board away from the heatsink assembly until the fast-on connectors attaching the power interface board to the inverter transistor module(s) are accessible.
9. Insure that factory installed wire markers are in place on the wires from the power interface board to the transistor modules. Refer to the proper connection diagram in Section 8, Controller Drawings.
10. Remove the wires for the power interface board to the transistor module(s) by pulling on the connector at the transistor module(s).

    NOTE: Rocking the connector back and forth will ease removal. **Do not** pull on the wire.

DANGER
HAZARD OF ELECTRICAL SHOCK OR BURN
DO *NOT* ENERGIZE THE CONTROLLER WITH ANY PRINTED WIRING BOARD REMOVED.

B. POWER INTERFACE BOARD INSTALLATION

1. If the power interface board is to be replaced with a different unit, a precharge resistor must be installed between terminals RA and RB on the lower left hand portion of the board. Refer to the proper connection diagram in Section 8.
2. If the power interface board is to be replaced with a different unit, the four nylon stand-offs must be installed to support the main control board.

   NOTE: The stand-offs from the removed board may be used.

3. Hold the power interface board near enough to the heat sink assembly so that the black and white wires can be connected to the transistor module(s).

4. Insert the fast-on connectors onto the pins provided using the proper controller connection diagram (Refer to Section 8, Controller Drawings) and the designations marked on the wires. Use care to avoid bending the pins.

   NOTE: The proper connection drawing based on the controller horsepower and voltage **must** be used. Each connection diagram shows different transistor module terminal details based on the module manufacturer. Be absolutely sure that the correct terminal detail is used.

CAUTION

IMPROPER OPERATION AND POSSIBLE CONTROLLER DAMAGE MAY RESULT FROM INCORRECT CONNECTION OF WIRING FROM THE POWER INTERFACE BOARD TO THE INVERTER TRANSISTOR MODULE(S).

5. Hold the power interface board component side facing outward. Carefully route the black and white wires over the upper left edge of the board between the top left nylon stand-off and the main control board connector pins.
6. Insert the +D and −D/C leads through the power interface board current transformer and pull until slack is removed. Be sure that both leads enter the current transformer from the solder side of the power interface board.
7. Rest the power interface board on the metal stand-offs. Verify that wiring to the transistor module(s) is not pinched. Insert all four mounting screws and tighten securely. Be certain that the lower left screw is installed. This is the power interface board grounding point.
8. Insert the control power transformer plugs in the jacks on the power interface board.

   NOTE: Plugs with black and white wires are connected to J100, J200 and J300 in any order. the plug with blue and white wires must go to J400. Refer to the proper connection diagram in Section 8, Controller Drawings and Section 4, Controller Photos.
9. Reconnect other wiring to the power interface board terminals using care to insure that wires are routed to the proper terminals. Tighten the terminal screws to the torque specifications in Section 2, Figure 2.1.
10. Replace the main control board per 7.4.1.

7.4.3 INVERTER TRANSISTOR MODULE REPLACEMENT PROCEDURE

If troubleshooting indicates the necessity of replacing an inverter transistor module, the procedure below must be followed to insure that the task is accomplished safely and without damage to the controller.

1. REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Remove the main control board per 7.4.1.
3. Remove the power interface board per 7.4.2.
4. Refer to the proper controller component layout and connection diagram in Section 8, Controller Drawings based on the controller horsepower and voltage. Locate the transistor module. Determine the manufacturer of the transistor module(s) installed in the controller and select the proper detail from the connection diagram.
5. Mark the wires remaining on the transistor module(s) to agree with the connection drawing detail.
6. Remove the wires from the transistor module(s) to be replaced.
7. Remove the mounting screws from the transistor module to be replaced and remove the module.
8. Thoroughly clean the heatsink surface. All dust, dirt and thermal joint compound must be removed. Verify that no nicks, scratches or other irregularities are present.
9. With a solid applicator, apply a light film of thermal joint compound, Square D Corporate number 1619-100011 (Thermacote) or equivalent. Spread evenly over the heatsink contact area of the transistor module. Do not allow the

compound to be contaminated by dust or grit. When properly applied, the film should evenly cover the entire contact area but be thin enough so that the contact surface is visible.

10. Carefully place the transistor module on the heatsink surface so that the mounting holes line up with those in the heatsink.
11. Install mounting screws and tighten until just snug. Torque the screws to 25 lb-in.
12. Reconnect power wiring removed in Step 6, using care to insure that the wires are routed to the proper terminals. Refer to the proper connection diagram in Section 8 and the detail corresponding to the transistor module manufacturer to determine the terminal locations. Torque the connections to 17 lb-in.
13. Install the power interface board per 7.4.2.
14. Install the main control board per 7.4.1.

7.4.4 DIODE MODULE REPLACEMENT PROCEDURE

If troubleshooting indicates the necessity of replacing the diode module, the procedure below must be followed to insure that the task is accomplished safely and without damage to the controller.

1. REMOVE ALL POWER
   Read and observe caution notes concerning controller servicing. Be absolutely sure that the bus capacitors are completely discharged before proceeding.
2. Remove the main control board per 7.4.1.
3. Remove the power interface board per 7.4.2.
4. Refer to the proper controller component layout and connection diagram in Section 8, Controller Drawings based on controller horsepower and voltage. Locate the diode module.
5. Mark the wires on the module to agree with the connection diagram.
6. Remove the wires from the module.
7. Remove the mounting screws and remove the module.
8. Thoroughly clean the heatsink surface. All dust, dirt and thermal joint compound must be removed. Verify that no nicks, scratches or other irregularities are present. Clean and inspect the contact surface of the replacement diode module.
9. With a solid applicator, apply a light film of thermal joint compound, Square D Corporate number 1619-10011 (Thermacote) or equivalent. Spread evenly over the heatsink contact area of the replacement diode module. Do not allow the compound to be contaminated by dust or grit. When properly applied the film should evenly cover the entire contact area but be thin enough so that the contact surface is visible.
10. Carefully place the diode module on the heatsink surface so that the mounting holes line up with those in the heatsink. Be sure that the terminals are oriented per the connection drawing.
11. Install the mounting screws and tighten until just snug. Torque the screws to 25 lb-in.
12. Reconnect wiring removed in Step 6 using care to insure that wires are routed to the proper terminals. Refer to the proper connection diagram in Section 8, Controller Drawings.
13. Install the power interface board per 7.4.2.
14. Install the main control board per 7.4.1.

7.5 TROUBLESHOOTING DATA SHEET

PLACE THE TROUBLE SHEET WITH THE AUTHORIZED RETURN PAPER RECEIVED FROM LOCAL SQUARE D/RAMSEY REPRESENTATIVE

The purpose of the "Trouble Sheet" is to obtain as much pertinent information about the controller as possible. By fully filling out the form the time to repair the controller, and the cost of troubleshooting the controller are reduced. The following is an explanation of the type of information we need on this form.

USER NAME AND ADDRESS: Where the controller is installed

PERSON TO CONTACT: Someone at the user who is familiar with the problem and application. Contact for additional information may be required.

CONTROLLER DATA: Completely fill in the sample nameplate given on the form.

MOTOR DATA: Fill in the requested information. If you have multiple motors give the information for all the motors controlled by the AFC.

APPLICATION DATA:
- Ambient temperature
- Basic power flow from supply to motor. Indicate if any contactors or circuit breakers are installed before the motor, or between the controller and motor. Is there any line bypass or across-the-line start capabilities?
- Is this a multiple motor scheme? Are the motors started all at the same time or sequenced?
- Type of speed control
  Hand pot, analog input signal (4-20 ma, 0-10V dc, etc.)
- Braking options installed
- If remote control wiring is installed detail the functions (start-stop, run-jog, etc.) and the terminals to which your wiring is connected.

PROBLEM INFORMATION:

Description of Symptoms:
- Does fault occur
  - When only power is on the controller
  - When start button is pushed
  - When changing speeds
  - When running at constant speed
  - When stopping
  - When motor load changes
- Does problem have a pattern (I.E. does problem occur at same time during day?) or is the problem random?
- Visible signs of damage (bulging capacitor cans, blown fuses, discoloration on boards)

CONTROLLER TROUBLE SHEET

DETAIL TROUBLESHOOTING STEPS TAKEN

In the service bulletins there are a number of troubleshooting steps to be taken. List the steps taken and the results of those steps. If you have done any troubleshooting on associated equipment detail, those steps and results also.

USER NAME_____

ADDRESS_____

CITY, STATE, ZIP_____

PERSON TO CONTACT_____

PHONE_____

PURCHASER (DISTRIBUTOR)_____ P.O. # IF AVAILABLE_____

CONTROLLER DATA:

(FILL IN NAMEPLATE INFORMATION)

RAMSEY CONTROLS, INC. SUBSIDIARY OF SQUARE D COMPANY

omegapak®
Adjustable Frequency Controller
Made in U.S.A.

CLASS 8804 TYPE PT		
SERIES 'A'	INPUT	OUTPUT
VOLTS		
PHASE		
MAX. AMPS		
FREQ. RANGE		
OUTPUT H.P.		S/N

DO NOT DETACH THIS SHEET

CONTROLLER TROUBLE SHEET (CONTINUED)

MOTOR DATA:

HP_____ VOLTAGE_____ FULL LOAD CURRENT_____
SERVICE FACTOR_____ NEMA DESIGN TYPE_____ SPEED_____

APPLICATION DATA:

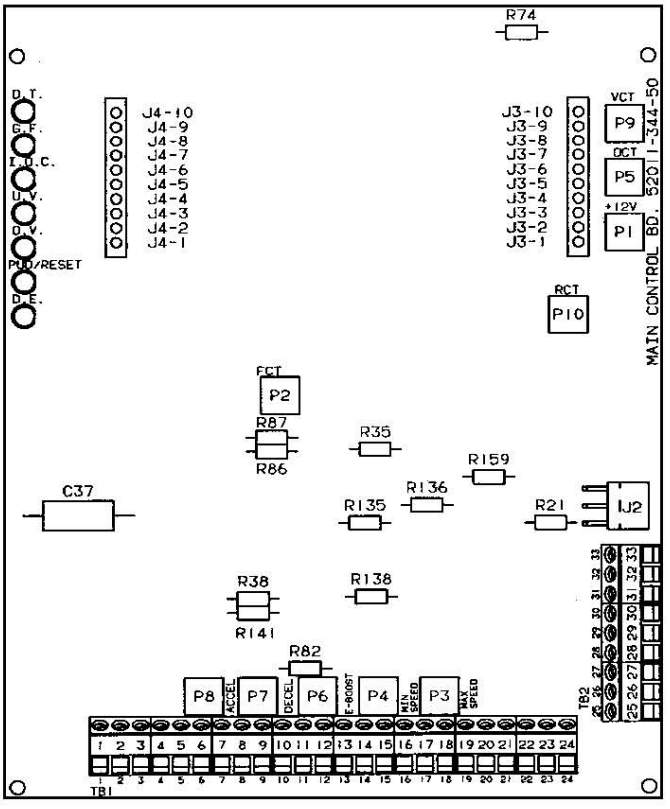
APPLICATION (DESCRIBE)_____

_____

_____

SPEED RANGE: MAX. SPEED_____ MIN. SPEED_____ DUTY CYCLE_____

PROBLEM INFORMATION:
LED'S THAT ARE ILLUMINATED (MARK DRAWING)



MAIN CONTROL BOARD

LENGTH OF TIME CONTROLLER HAS OPERATED PROPERLY:

_____ MONTHS, OR PROBLEM OCCURRED AT START-UP _____
DESCRIPTION OF SYMPTOMS_____

_____

DETAIL TROUBLESHOOTING STEPS TAKEN_____

_____

_____

_____

_____

7.5 TROUBLESHOOTING DATA SHEET

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MOTOR DATA: Fill in the requested information. If you have multiple motors give the information for all the motors controlled by the AFC.

APPLICATION DATA:
- Ambient temperature
- Basic power flow from supply to motor. Indicate if any contactors or circuit breakers are installed before the motor, or between the controller and motor. Is there any line bypass or across-the-line start capabilities?
- Is this a multiple motor scheme? Are the motors started all at the same time or sequenced?
- Type of speed control
  Hand pot, analog input signal (4-20 ma, 0-10V dc, etc.)
- Braking options installed
- If remote control wiring is installed detail the functions (start-stop, run-jog, etc.) and the terminals to which your wiring is connected.

PROBLEM INFORMATION:

Description of Symptoms:
- Does fault occur
  - When only power is on the controller
  - When start button is pushed
  - When changing speeds
  - When running at constant speed
  - When stopping
  - When motor load changes
- Does problem have a pattern (I.E. does problem occur at same time during day?) or is the problem random?
- Visible signs of damage (bulging capacitor cans, blown fuses, discoloration on boards)

CONTROLLER TROUBLE SHEET

DETAIL TROUBLESHOOTING STEPS TAKEN

In the service bulletins there are a number of troubleshooting steps to be taken. List the steps taken and the results of those steps. If you have done any troubleshooting on associated equipment detail, those steps and results also.

USER NAME_____

ADDRESS_____

CITY, STATE, ZIP_____

PERSON TO CONTACT_____

PHONE_____

PURCHASER (DISTRIBUTOR)_____ P.O. # IF AVAILABLE_____

CONTROLLER DATA:

(FILL IN NAMEPLATE INFORMATION)

RAMSEY CONTROLS, INC. SUBSIDIARY OF SQUARE D COMPANY

omegapak®

Adjustable Frequency Controller

Made in U.S.A.

CLASS 8804 TYPE PT		
SERIES 'A'	INPUT	OUTPUT
VOLTS		
PHASE		
MAX. AMPS		
FREQ. RANGE		
OUTPUT H.P.		S/N

CUT ALONG LINE TO DETACH

CONTROLLER TROUBLE SHEET (CONTINUED)

MOTOR DATA:

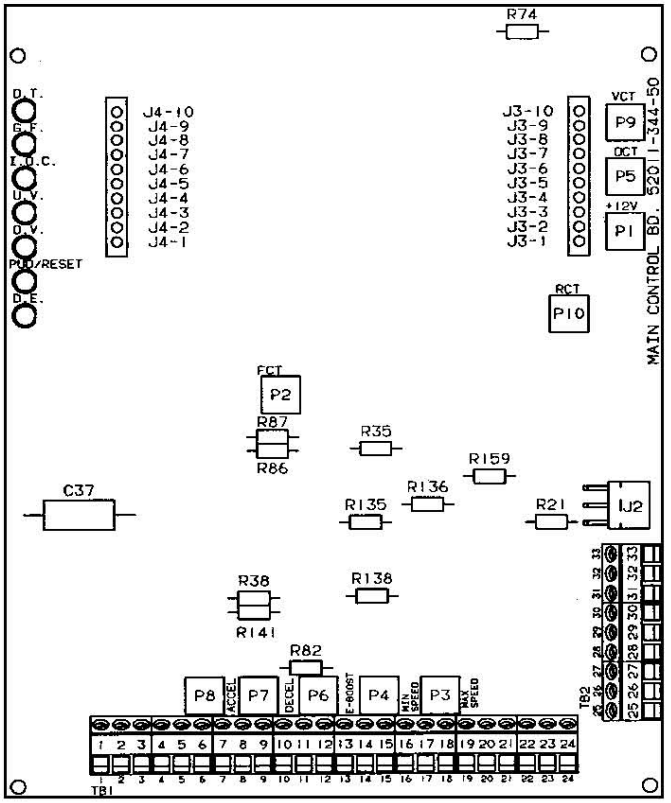
HP_____ VOLTAGE_____ FULL LOAD CURRENT_____
SERVICE FACTOR_____ NEMA DESIGN TYPE_____ SPEED_____

APPLICATION DATA:

APPLICATION (DESCRIBE)_____

SPEED RANGE: MAX. SPEED_____ MIN. SPEED_____ DUTY CYCLE_____

PROBLEM INFORMATION:
LED'S THAT ARE ILLUMINATED (MARK DRAWING)



MAIN CONTROL BOARD

LENGTH OF TIME CONTROLLER HAS OPERATED PROPERLY:

_____ MONTHS, OR PROBLEM OCCURRED AT START-UP _____
DESCRIPTION OF SYMPTOMS_____

DETAIL TROUBLESHOOTING STEPS TAKEN_____

7.5 TROUBLESHOOTING DATA SHEET

PLACE THE TROUBLE SHEET WITH THE AUTHORIZED RETURN PAPER RECEIVED FROM LOCAL SQUARE D/RAMSEY REPRESENTATIVE

The purpose of the "Trouble Sheet" is to obtain as much pertinent information about the controller as possible. By fully filling out the form the time to repair the controller, and the cost of troubleshooting the controller are reduced. The following is an explanation of the type of information we need on this form.

USER NAME AND ADDRESS: Where the controller is installed

PERSON TO CONTACT: Someone at the user who is familiar with the problem and application. Contact for additional information may be required.

CONTROLLER DATA: Completely fill in the sample nameplate given on the form.

MOTOR DATA: Fill in the requested information. If you have multiple motors give the information for all the motors controlled by the AFC.

APPLICATION DATA:
- Ambient temperature
- Basic power flow from supply to motor. Indicate if any contactors or circuit breakers are installed before the motor, or between the controller and motor. Is there any line bypass or across-the-line start capabilities?
- Is this a multiple motor scheme? Are the motors started all at the same time or sequenced?
- Type of speed control
  Hand pot, analog input signal (4-20 ma, 0-10V dc, etc.)
- Braking options installed
- If remote control wiring is installed detail the functions (start-stop, run-jog, etc.) and the terminals to which your wiring is connected.

PROBLEM INFORMATION:

Description of Symptoms:
- Does fault occur
  - When only power is on the controller
  - When start button is pushed
  - When changing speeds
  - When running at constant speed
  - When stopping
  - When motor load changes
- Does problem have a pattern (I.E. does problem occur at same time during day?) or is the problem random?
- Visible signs of damage (bulging capacitor cans, blown fuses, discoloration on boards)

CONTROLLER TROUBLE SHEET

DETAIL TROUBLESHOOTING STEPS TAKEN

In the service bulletins there are a number of troubleshooting steps to be taken. List the steps taken and the results of those steps. If you have done any troubleshooting on associated equipment detail, those steps and results also.

USER NAME_____

ADDRESS_____

CITY, STATE, ZIP_____

PERSON TO CONTACT_____

PHONE_____

PURCHASER (DISTRIBUTOR)_____ P.O. # IF AVAILABLE_____

CONTROLLER DATA:

(FILL IN NAMEPLATE INFORMATION)

RAMSEY CONTROLS, INC. SUBSIDIARY OF SQUARE D COMPANY

omegapak®

Adjustable Frequency Controller

Made in U.S.A.

CLASS 8804 TYPE PT		
SERIES 'A'	INPUT	OUTPUT
VOLTS		
PHASE		
MAX. AMPS		
FREQ. RANGE		
OUTPUT H.P.		S/N

CUT ALONG LINE TO DETACH

CONTROLLER TROUBLE SHEET (CONTINUED)

MOTOR DATA:

HP_____ VOLTAGE_____ FULL LOAD CURRENT_____
SERVICE FACTOR_____ NEMA DESIGN TYPE_____ SPEED_____

APPLICATION DATA:

APPLICATION (DESCRIBE)_____

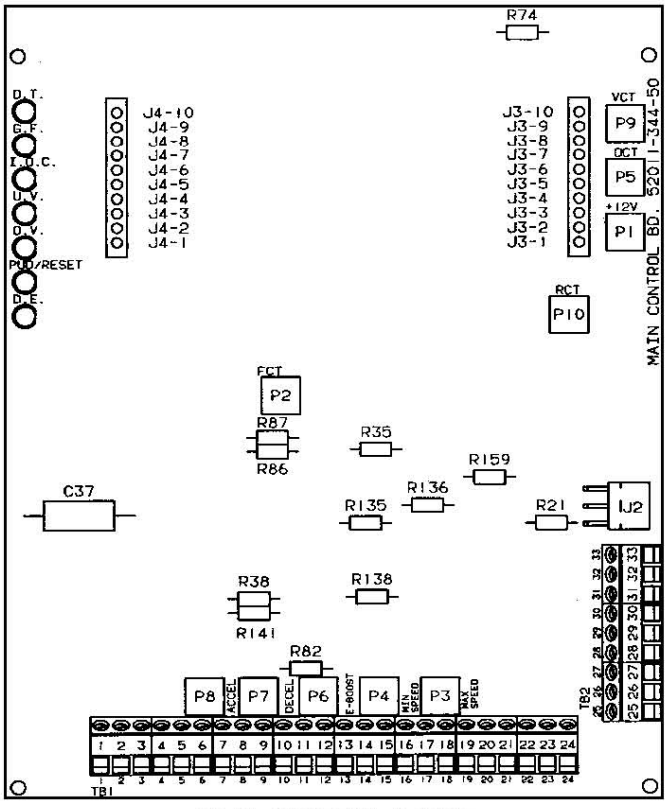
_____

_____

SPEED RANGE: MAX. SPEED_____ MIN. SPEED_____ DUTY CYCLE_____

PROBLEM INFORMATION:

LED'S THAT ARE ILLUMINATED (MARK DRAWING)



MAIN CONTROL BOARD

LENGTH OF TIME CONTROLLER HAS OPERATED PROPERLY:

_____ MONTHS, OR PROBLEM OCCURRED AT START-UP _____
DESCRIPTION OF SYMPTOMS_____

_____

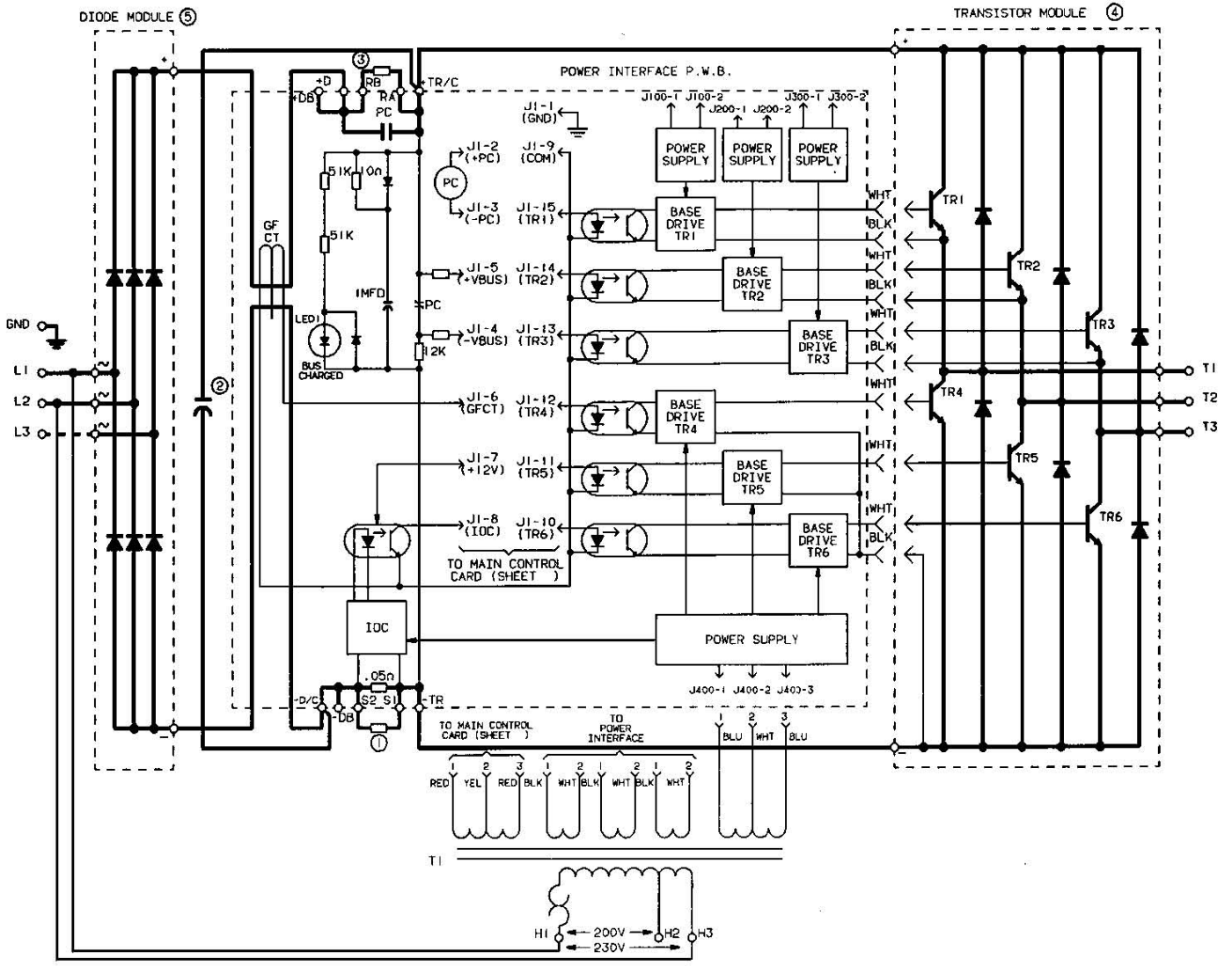
DETAIL TROUBLESHOOTING STEPS TAKEN_____

_____

_____

_____

_____



HP	TRANSISTOR MODULE ④	CURRENT SENSE ①	POWER INTERFACE 52011-390	SINGLE PHASE INPUT			THREE PHASE INPUT		
				DIODE MODULE ⑤	BUS CAPACITORS ⑫	PRECHARGE RESISTORS ③	DIODE MODULE ⑤	BUS CAPACITORS ⑫	PRECHARGE RESISTORS ③
1	15A,600V	NOT USED	-50	30A,600V	1-860MFD 450VDC	2Ω,30W	20A,600V	1-80MFD 240VAC	10Ω,30W
2	20A,600V	.12Ω,5%	-50	30A,600V	2-860MFD 450VDC	2Ω,30W	20A,600V	2-80MFD 240VAC	10Ω,30W
3	30A,600V	.05Ω,5%	-51	50A,600V	2-1400MFD 450VDC	2Ω,30W	30A,600V	2-80MFD 240VAC	10Ω,30W
5	50A,600V	.022Ω,5%	-52	———	———	———	50A,600V	2-80MFD 240VAC	10Ω,30W

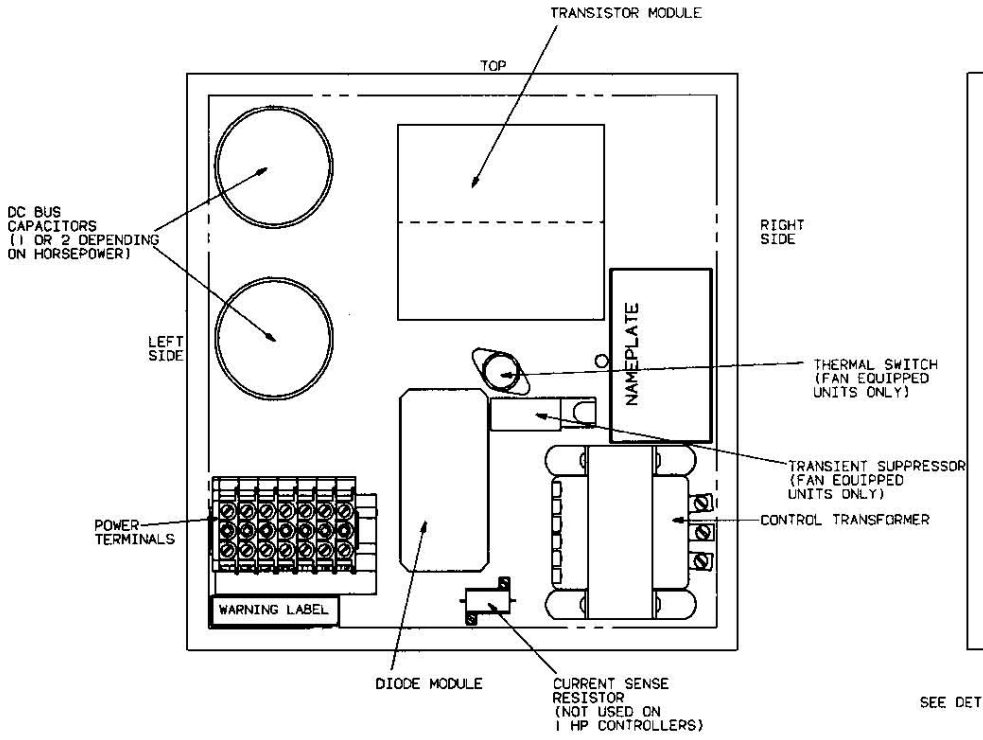
CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

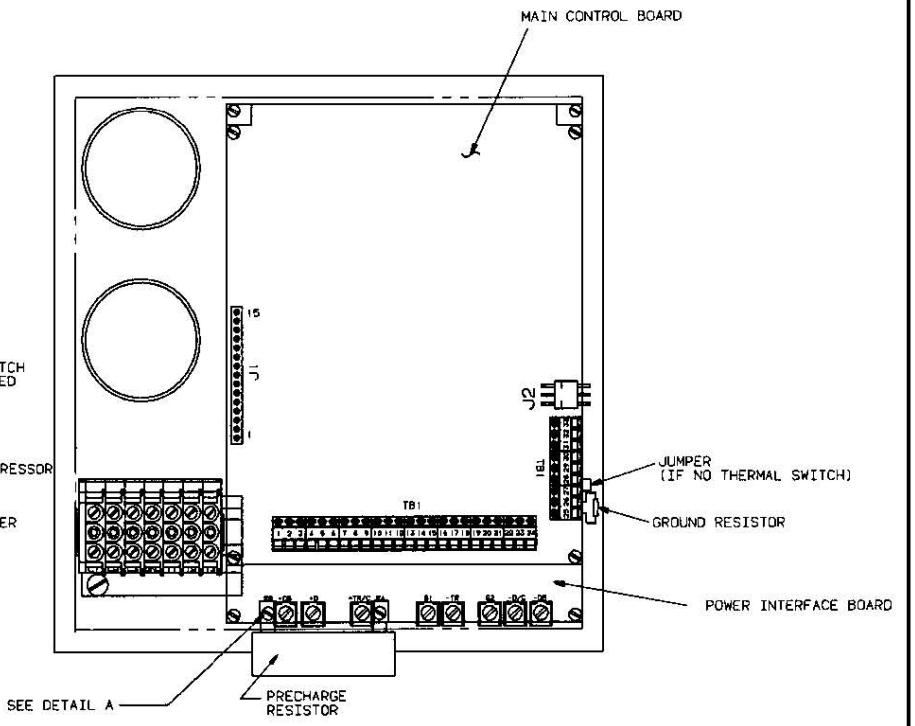
TITLE OMEGAPAK ADJ. FREQ. CONTROLLER
POWER ELEM DIAGRAM (1-5HP 200/230V)
CLASS____ TYPE____ FORM____ SER.____

REV	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.
DATE DRN. 12-85
DATE REL.
DRN. CHD. APPD.
DRG. NO. 8.1.1
MASTER
SHEET OF

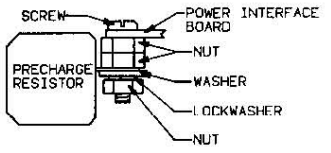


POWER COMPONENTS, CONTROLLER SKELETON



FRONT VIEW, CONTROLLER SKELETON

DETAIL A
TYP. 2 PLACES



CONTROLLER COMPONENT LOCATION

CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER COMPONENT LAYOUT
(1-5 HP, 200/230V)

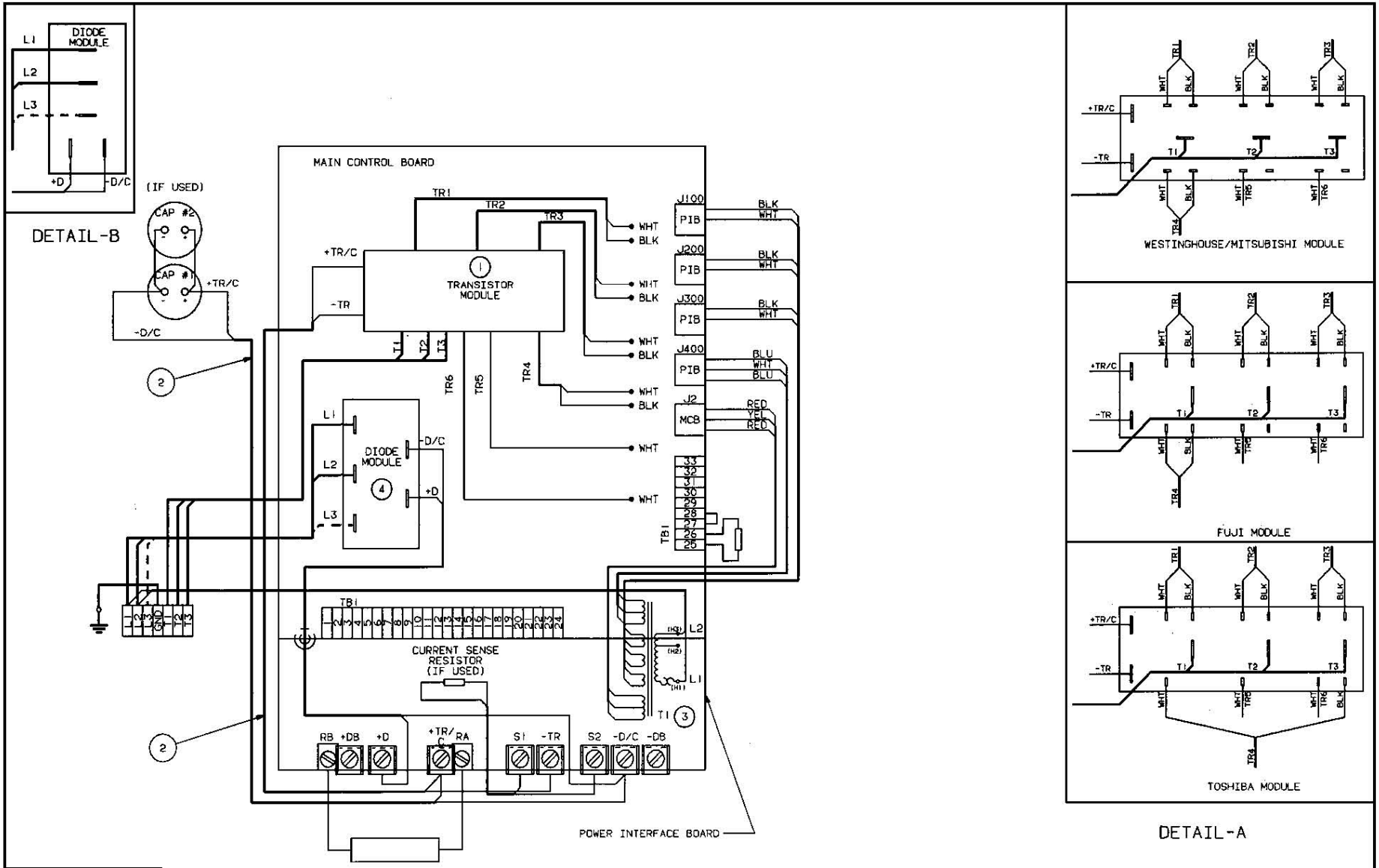
CLASS____ TYPE____ FORM____ SER. ___

REV	DATE	REVISION DESCRIPTION	BY

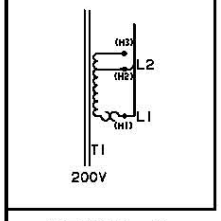
REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRN. | CHD. | APPD.

DWG. NO. MASTER 8.1.2 | SHEET OF



DETAIL-B



DETAIL-C

DETAIL-A

1. FOR CONNECTIONS TO TRANSISTOR MODULE SEE DETAIL-A.
2. CRITICAL DC WIRING; WIRING PAIRS MUST BE BUNDLED TIGHTLY TOGETHER AND RUN VIA THE MOST DIRECT ROUTE.
3. CONNECTIONS FOR 230V SHOWN. SEE DETAIL-C FOR 200V CONNECTIONS.
4. FOR ALTERNATE DIODE BLOCK CONNECTIONS SEE DETAIL B.

CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER CONNECTION DIAGRAM
1 AND 2 HP 200/230V

CLASS____ TYPE ____ FORM ____ SER. ____

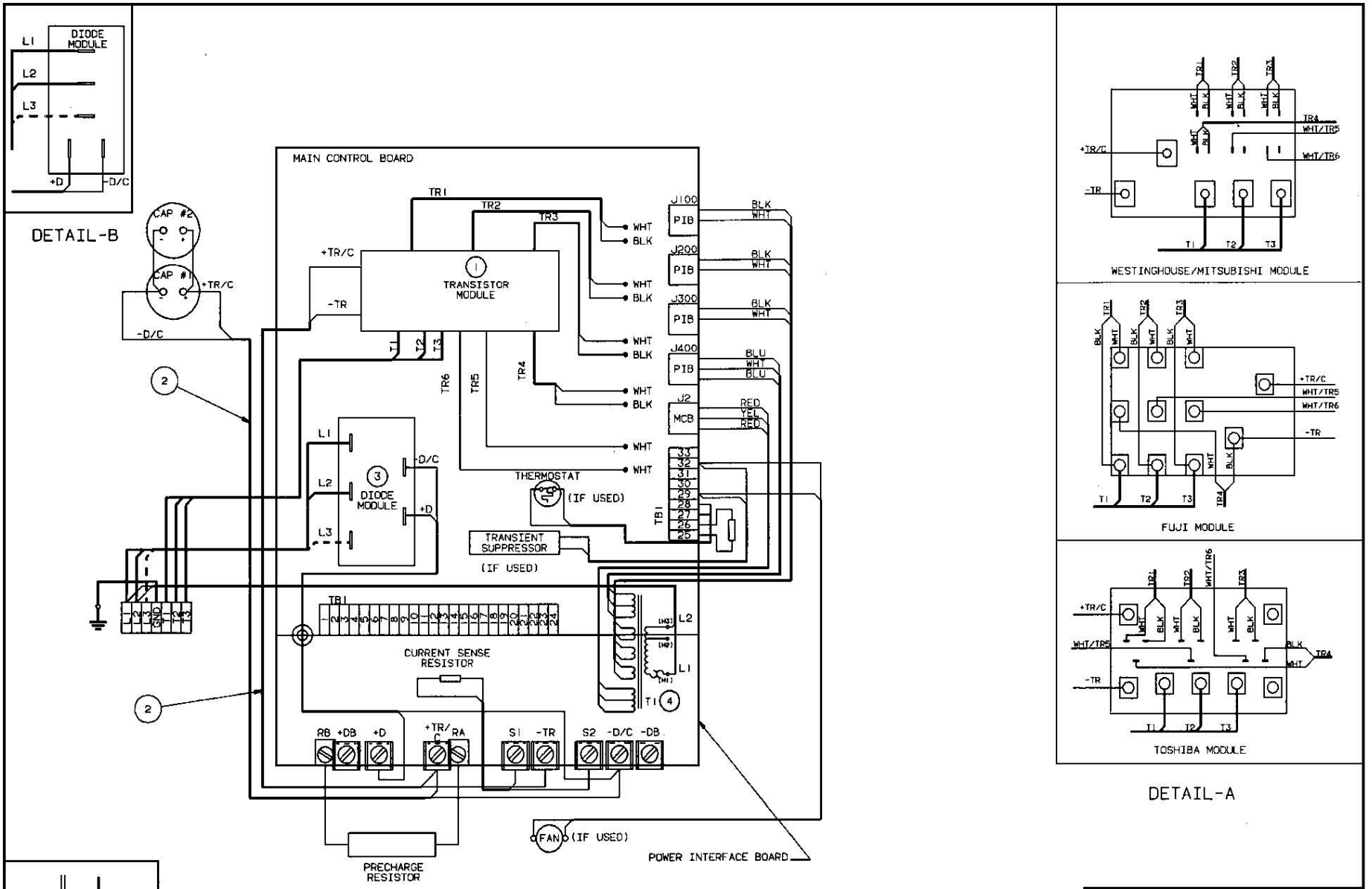
REV	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85
DATE REL.
DRN.
CHD.
APPD.

DWG. NO. MASTER 8.1.3

SHEET OF



1. FOR CONNECTIONS TO TRANSISTOR MODULE SEE DETAIL-A.
2. CRITICAL DC WIRING; WIRING PAIRS MUST BE BUNDLED TIGHTLY TOGETHER AND RUN VIA THE MOST DIRECT ROUTE.
3. FOR ALTERNATE DIODE BLOCK CONNECTION SEE DETAIL-B.
4. CONNECTIONS FOR 230V SHOWN. SEE DETAIL-C FOR 200V CONNECTIONS.

CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER CONNECTION DIAGRAM

3 & 5HP, 200/230V

CLASS____ TYPE ____ FORM ____ SER. ___

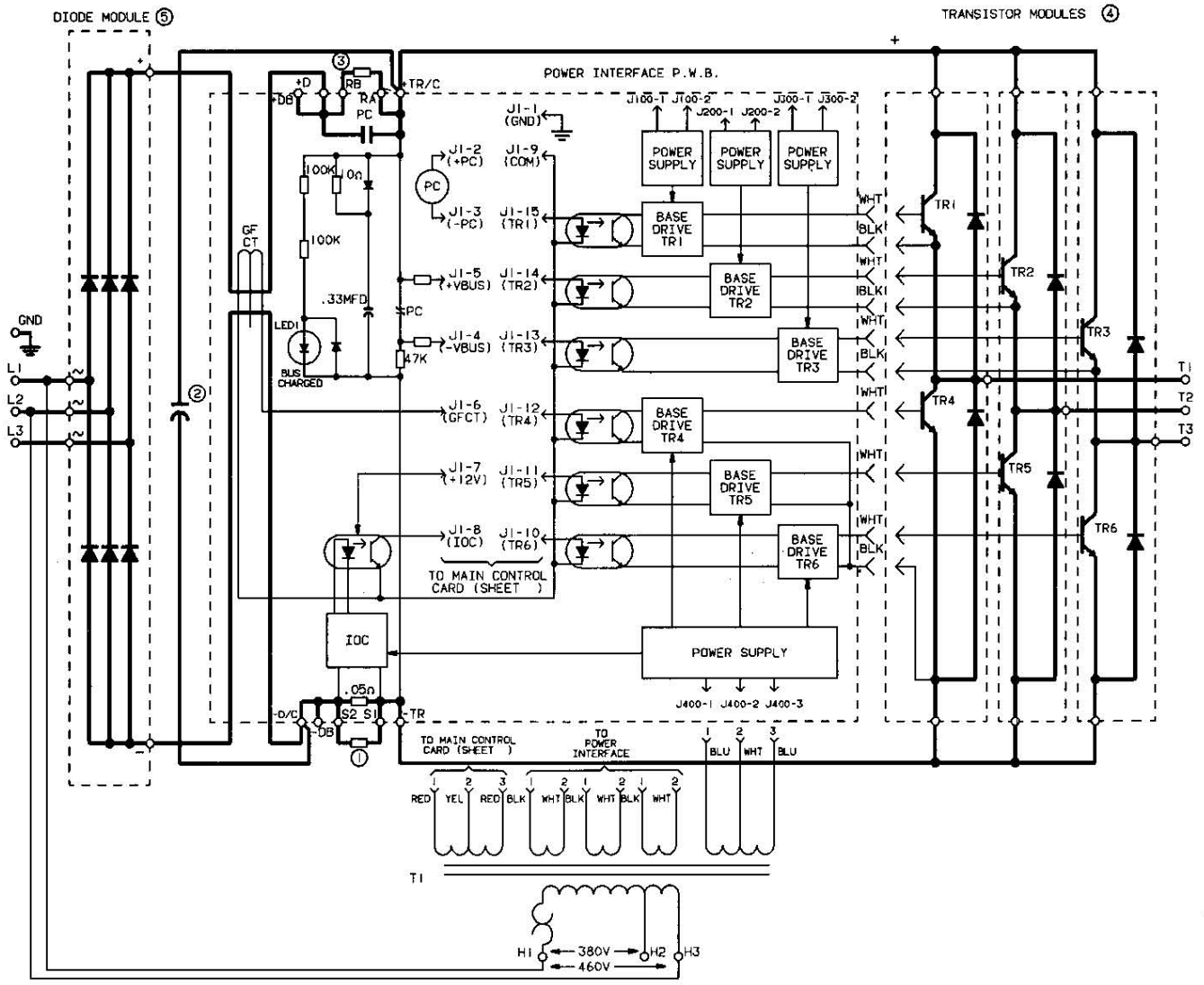
REV	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85
DATE REL.
DRN. CHD. APPD.

DWG. NO. MASTER
8.1.4

SHEET OF



HP@ 460V	TRANSISTOR MODULE ④	CURRENT SENSE ① RESISTOR	POWER INTERFACE 52011-390	THREE PHASE INPUT		
				DIODE MODULE ⑤	BUS CAPACITORS ②	PRECHARGE RESISTORS ③
1-3	30A, 1200V	1.0Ω, 5%	-53	30A, 1200V	1-90MFD 480VAC	10Ω, 30W
5	30A, 1200V	.05Ω, 5%	-53	30A, 1200V	2-90MFD 480VAC	10Ω, 30W
7.5	50A, 1200V	.022Ω, 5%	-54	50A, 1200V	2-90MFD 480VAC	10Ω, 30W
10	50A, 1200V	.022Ω, 5%	-54	50A, 1200V	2-90MFD 480VAC	10Ω, 30W

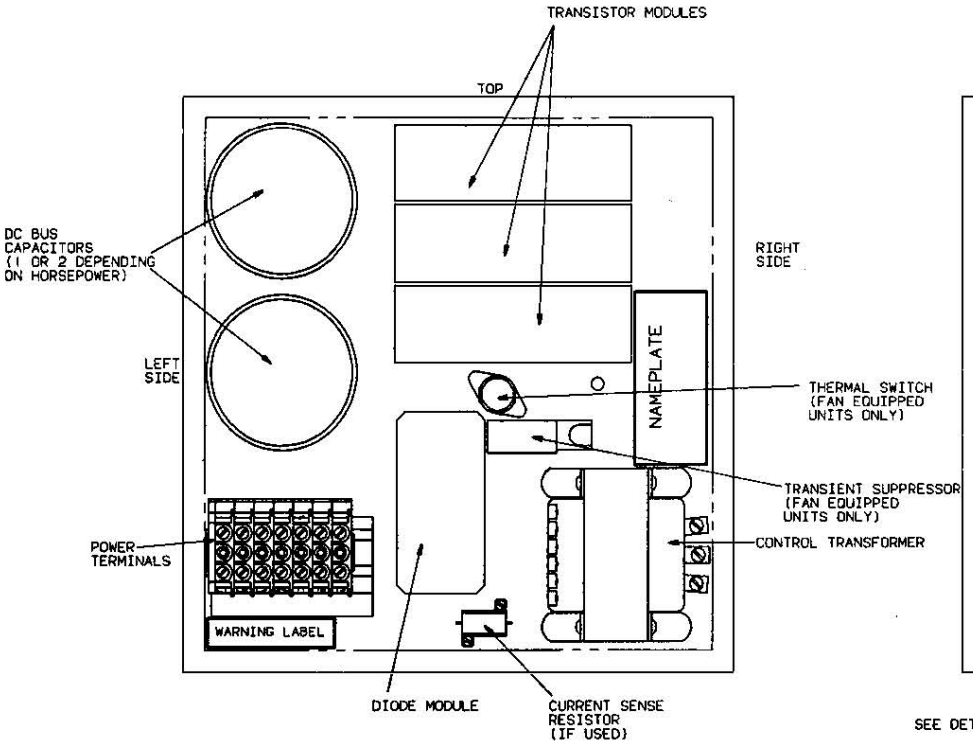
CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

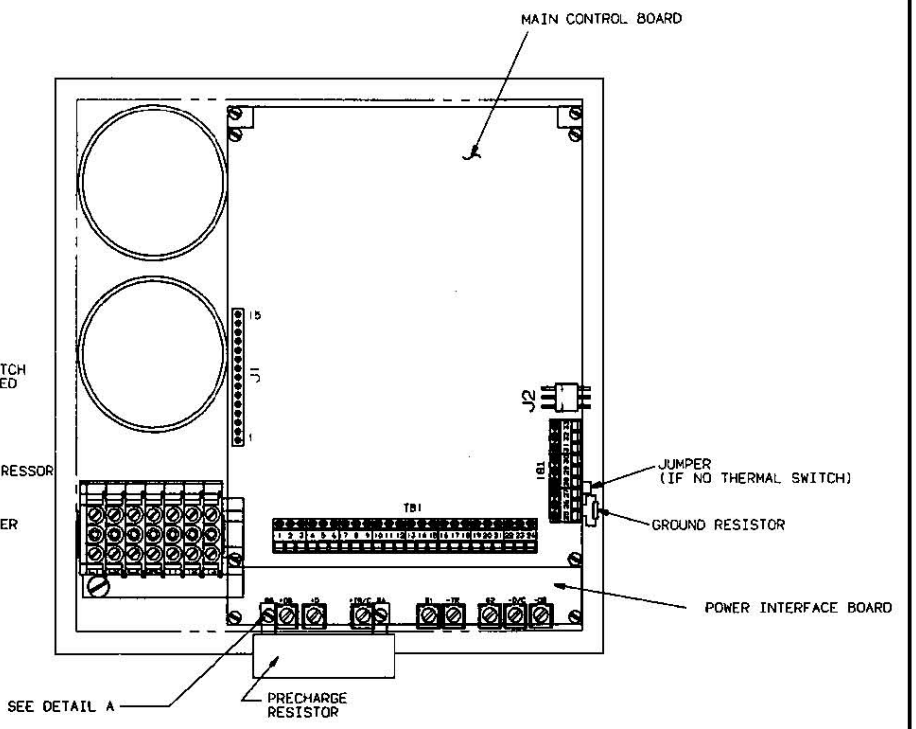
TITLE OMEGAPAK ADJ. FREQ. CONTROLLER
POWER ELEM DIAGRAM (1-10 HP@ 460V)
CLASS____ TYPE____ FORM____ SER. ___

REV	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.
DATE DRN. | DATE REL.
DRN. | CHD. | APPD.
DWG. NO. MASTER 8.2.1
SHEET OF

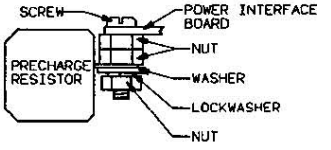


POWER COMPONENTS, CONTROLLER SKELETON



FRONT VIEW, CONTROLLER SKELETON

DETAIL A
TYP. 2 PLACES



460V CONTROLLER COMPONENT LOCATION

CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER COMPONENT LAYOUT
1-10HP @ 460V

CLASS____ TYPE____ FORM____ SER.____

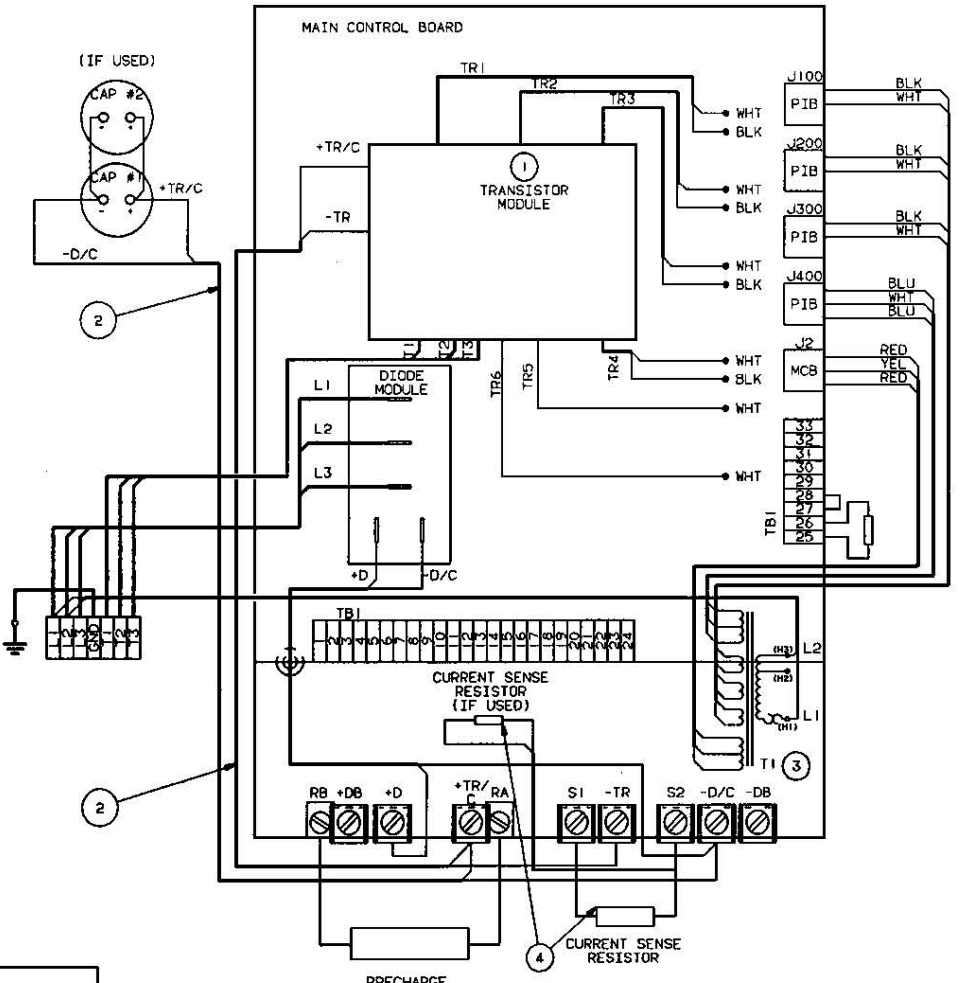
REV	DATE	REVISION DESCRIPTION	BY

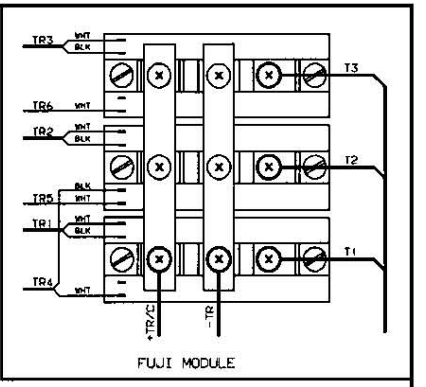
REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85
DATE REL.
DRN.
CHD.
APPD.

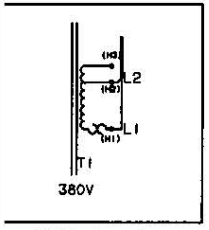
DRG. NO. MASTER
8.2.2

SHEET
OF





DETAIL-A



DETAIL-B

1. FOR CONNECTIONS TO TRANSISTOR MODULE SEE DETAIL-A.
2. CRITICAL DC WIRING; WIRING PAIRS MUST BE BUNDLED TIGHTLY TOGETHER AND RUN VIA THE MOST DIRECT ROUTE.
3. CONNECTIONS FOR 460V SHOWN. SEE DETAIL-B FOR 380V CONNECTIONS.
4. HEAT SINK MOUNTED RESISTOR USED ON 5 HP CONTROLLER ONLY. AXIAL LEAD RESISTOR USED ON 1-3 HP CONTROLLER.

CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER CONNECTION DIAGRAM
1-5HP @ 460V

CLASS ____ TYPE ____ FORM ____ SER. ____

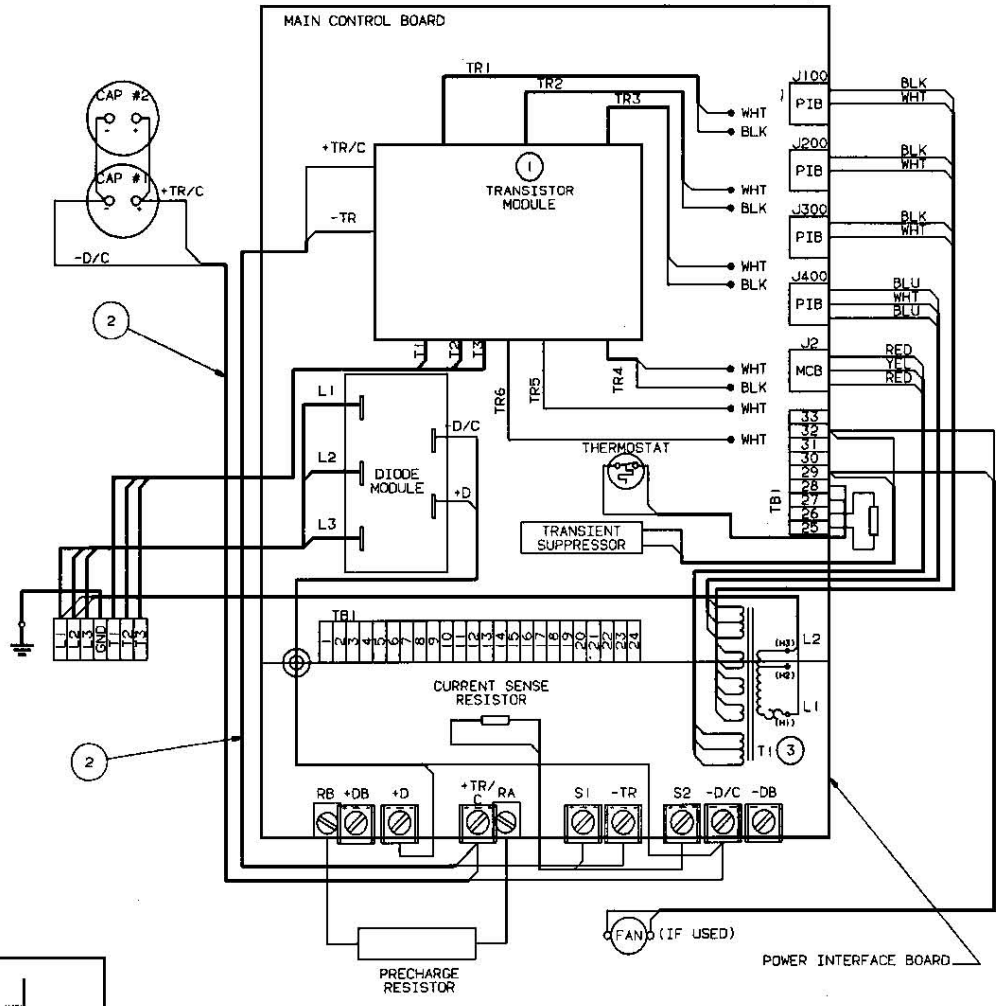
REV	DATE	REVISION DESCRIPTION	BY

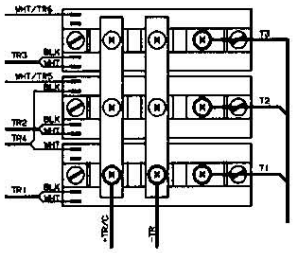
REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRN. | CHD. | APPD.

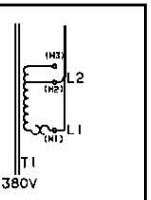
DWG. NO. MASTER 8.2.3

SHEET OF





DETAIL-A



DETAIL-B

1. FOR CONNECTIONS TO TRANSISTOR MODULE SEE DETAIL-A.
2. CRITICAL DC WIRING; WIRING PAIRS MUST BE BUNDLED TIGHTLY TOGETHER AND RUN VIA THE MOST DIRECT ROUTE.
3. CONNECTIONS FOR 460V SHOWN. SEE DETAIL-B FOR 380V CONNECTIONS.

CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONTROLLER CONNECTION DIAGRAM

7.5-10HP @ 460V

CLASS____ TYPE____ FORM____ SER.___

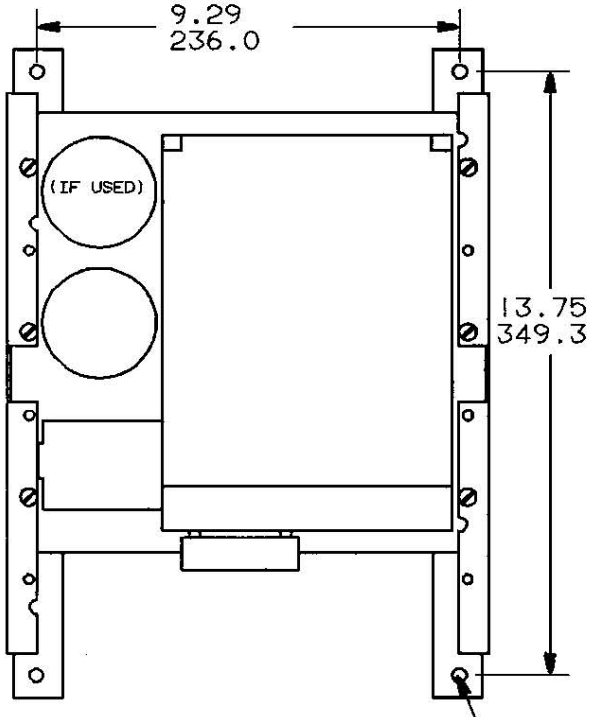
REV	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.

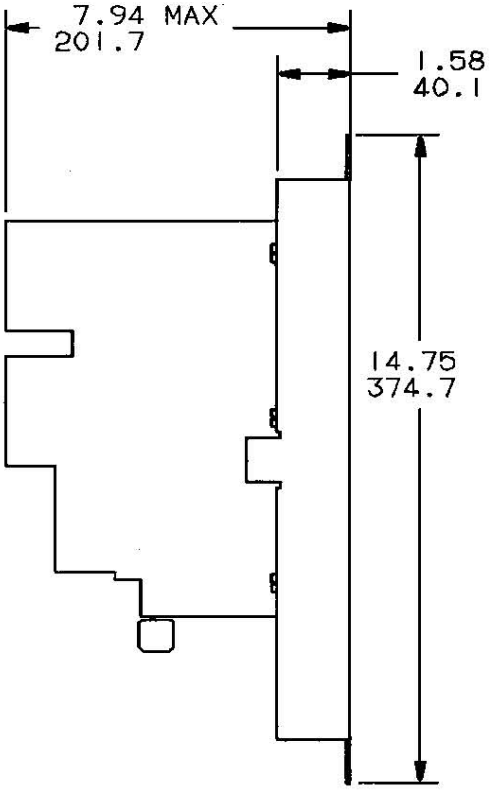
DATE DRN. 12-85 | DATE REL. | DRN. | CHD. | APPD.

DWG. NO. MASTER 8.2.4

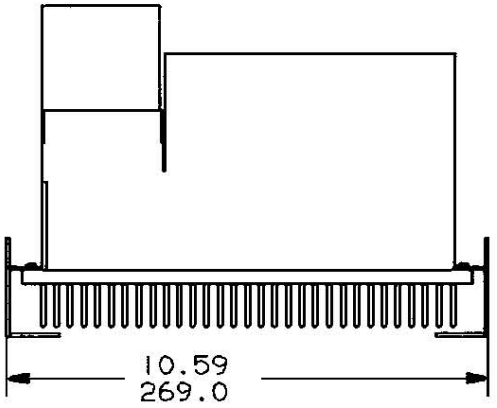
SHEET OF



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

DUAL DIM. INCHES / MILLIMETERS

APPROXIMATE WEIGHT= 23 LBS (10.5 KG)

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY.

REV.	DATE	REVISION DESCRIPTION	BY

SHEET 8 OF

DRG. NO. 8.3.1

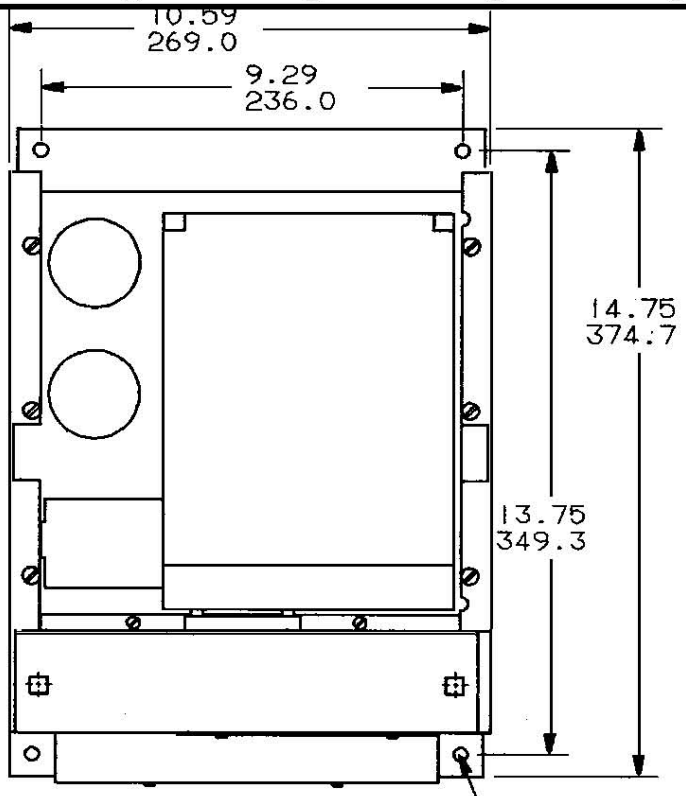
CRITICAL DIMENSION CODE	TOLERANCE-INCHES				TOLERANCE-MILLIMETERS			
F-FUNCTION	LINEAR		HOLES		LINEAR		HOLES	
M-MATING	1 PLACE	±.060	2 PLACE	+.004 -.002	0 PLACE	±1.5	1 PLACE	+.10 -.05
A-AUDIT	2 PLACE	±.020	3 PLACE	±.002	1 PLACE	±0.5	2 PLACE	±.05
ANGLES	3 PLACE	±.006	REAM	+.002 -.000 OR AS SPECIFIED	2 PLACE	±0.15	REAM	+.05 -.0 OR AS SPECIFIED
DIM ±1° / UNDIM 90° ±2°	4 PLACE				3 PLACE			

SQUARE D COMPANY

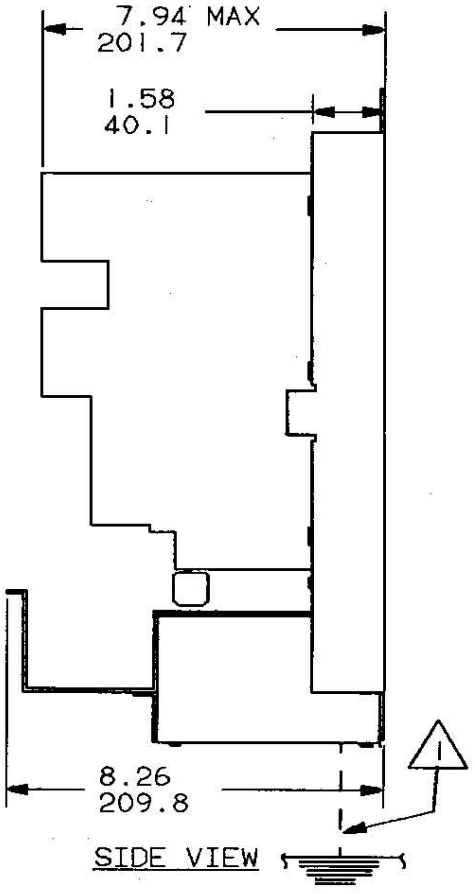
TITLE OUTLINE DRAWING 1-3HP 200/230V
(1-5HP 380/460V) OPEN CHASSIS

CLASS____ TYPE____ FORM____ SER.___

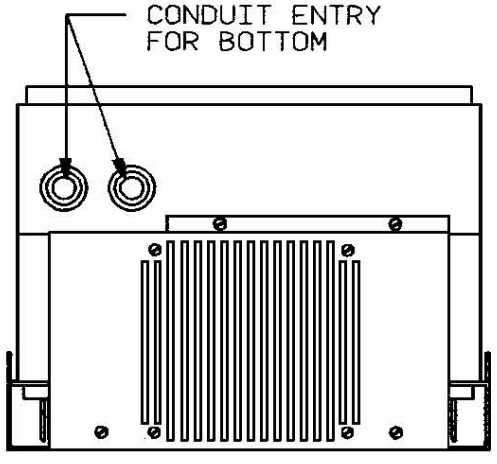
REF.		DATE DRN. 12-85	DATE REL.	DRG. NO. 8.3.1	MASTER	SHEET OF
NEXT ASSEM		DRN.	CKD.	APP'D		
PROJ. NO.						



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

1 LEAVE MINIMUM OF 1" FROM SURFACE.

DUAL DIM. INCHES / MILLIMETERS

APPROXIMATE WEIGHT= 28 LBS. (12.7 KG)

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY.

REV.	DATE	REVISION DESCRIPTION	BY

SHEET 8 OF

DRG. NO. 8.3.2

CRITICAL DIMENSION CODE
F-FUNCTION
M-MATING
A-AUDIT

ANGLES: DIM ±1° / UNDIM 90° ±2°

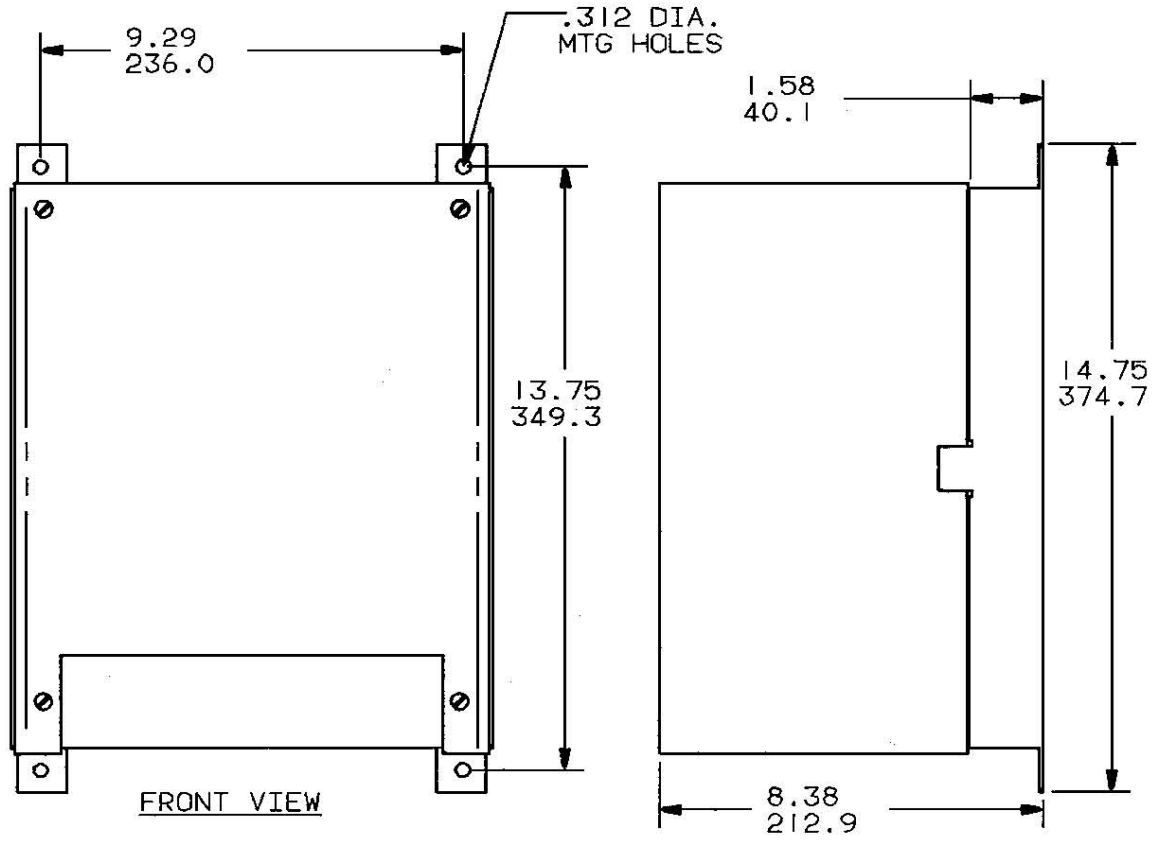
TOLERANCE-INCHES				TOLERANCE-MILLIMETERS			
LINEAR		HOLES		LINEAR		HOLES	
1 PLACE	±.060	2 PLACE	+.004 −.002	0 PLACE	±1.5	1 PLACE	+.10 −.05
2 PLACE	±.020	3 PLACE	±.002	1 PLACE	±0.5	2 PLACE	±.05
3 PLACE	±.006	REAM	+.002 −.000 OR AS SPECIFIED	2 PLACE	±0.15	REAM	+.05 − 0 OR AS SPECIFIED
4 PLACE				3 PLACE			

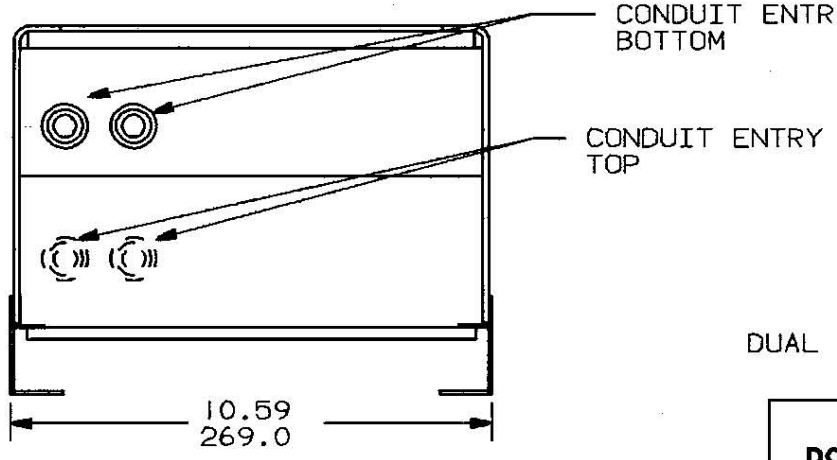
SQUARE D COMPANY

TITLE OUTLINE DRAWING 5HP 200/230V (7.5-10HP 380/460V) OPEN CHASSIS

CLASS____ TYPE____ FORM____ SER.____

REF.		DATE DRN. 12-85	DATE REL.	DRG. NO.	SHEET
NEXT ASSEM		DRN.	CKD.	APP'D	MASTER 8.3.2	OF
PROJ. NO.					





APPROXIMATE WEIGHT=
23 LBS.(10.5 KG)

DUAL DIM. INCHES / MILLIMETERS

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY.

REVISION DESCRIPTION | BY | DATE | REV.

SHEET 8.3.3 OF DOC. NO.

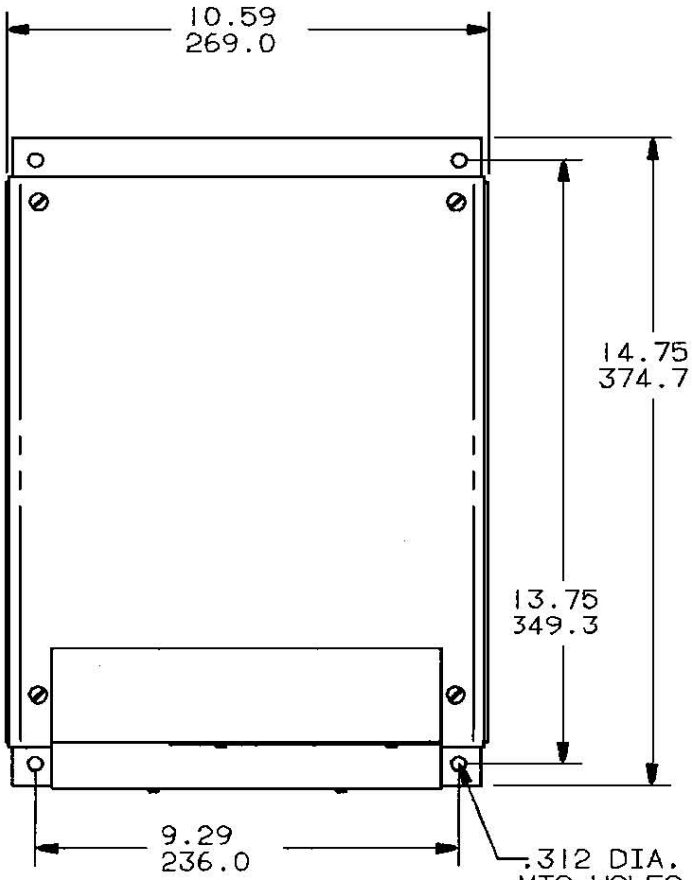
CRITICAL DIMENSION CODE	TOLERANCE-INCHES				TOLERANCE-MILLIMETERS			
F-FUNCTION	LINEAR		HOLES		LINEAR		HOLES	
M-MATING	1 PLACE	±.060	2 PLACE	+.004 -.002	0 PLACE	±1.5	1 PLACE	+.10 -.05
A-AUDIT	2 PLACE	±.020	3 PLACE	±.002	1 PLACE	±0.5	2 PLACE	±.05
ANGLES	3 PLACE	±.006	REAM	+.002 -.000 OR AS SPECIFIED	2 PLACE	±0.15	REAM	+.05 -.0 OR AS SPECIFIED
DIM ±1° / UNDIM 90° ±2°	4 PLACE				3 PLACE			

SQUARE D COMPANY

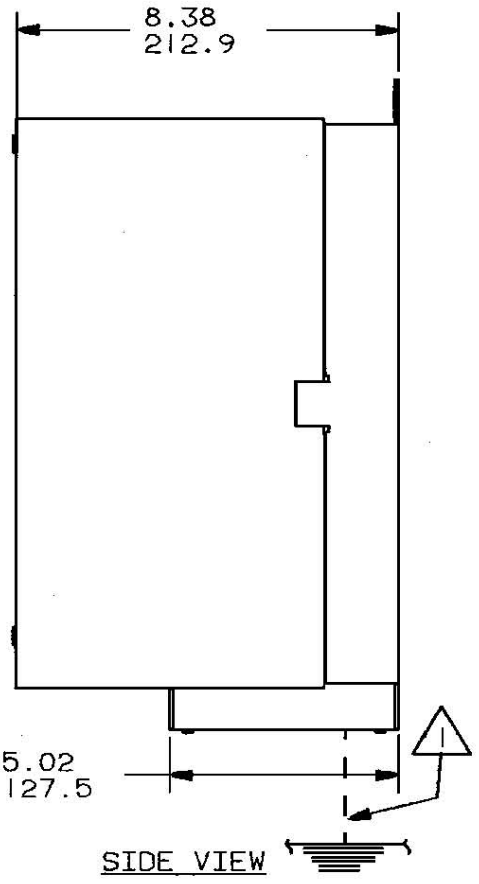
TITLE OUTLINE DRAWING 1-3HP 200/230V (1-5HP 380/460V) NEMA 1 ENCLOSED.

CLASS____ TYPE____ FORM____ SER.___

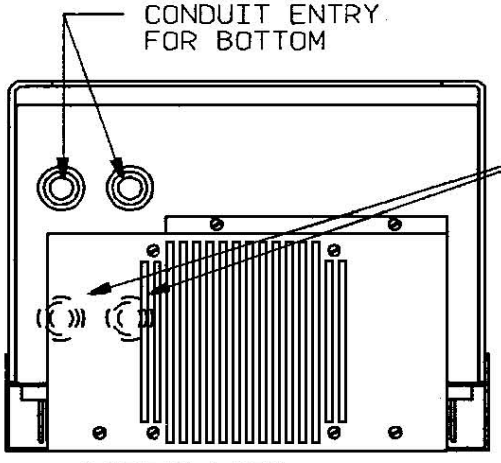
REF.	DATE DRN. 12-85	DATE REL.	DRG. NO. 8.3.3	MASTER	SHEET OF
NEXT ASSEM	DRN.	CKD.	APP'D		
PROJ. NO.					



FRONT VIEW



SIDE VIEW



BOTTOM VIEW

APPROXIMATE WEIGHT=
28 LBS (12.7 KG)

1 LEAVE MINIMUN OF 1" FROM SURFACE.

DUAL DIM. INCHES / MILLIMETERS

CAD SYSTEM ORIGINAL
DO NOT CHANGE MANUALLY.

REVISION DESCRIPTION | BY | DATE | REV.

SHEET OF | DRG. NO. 8.3.4

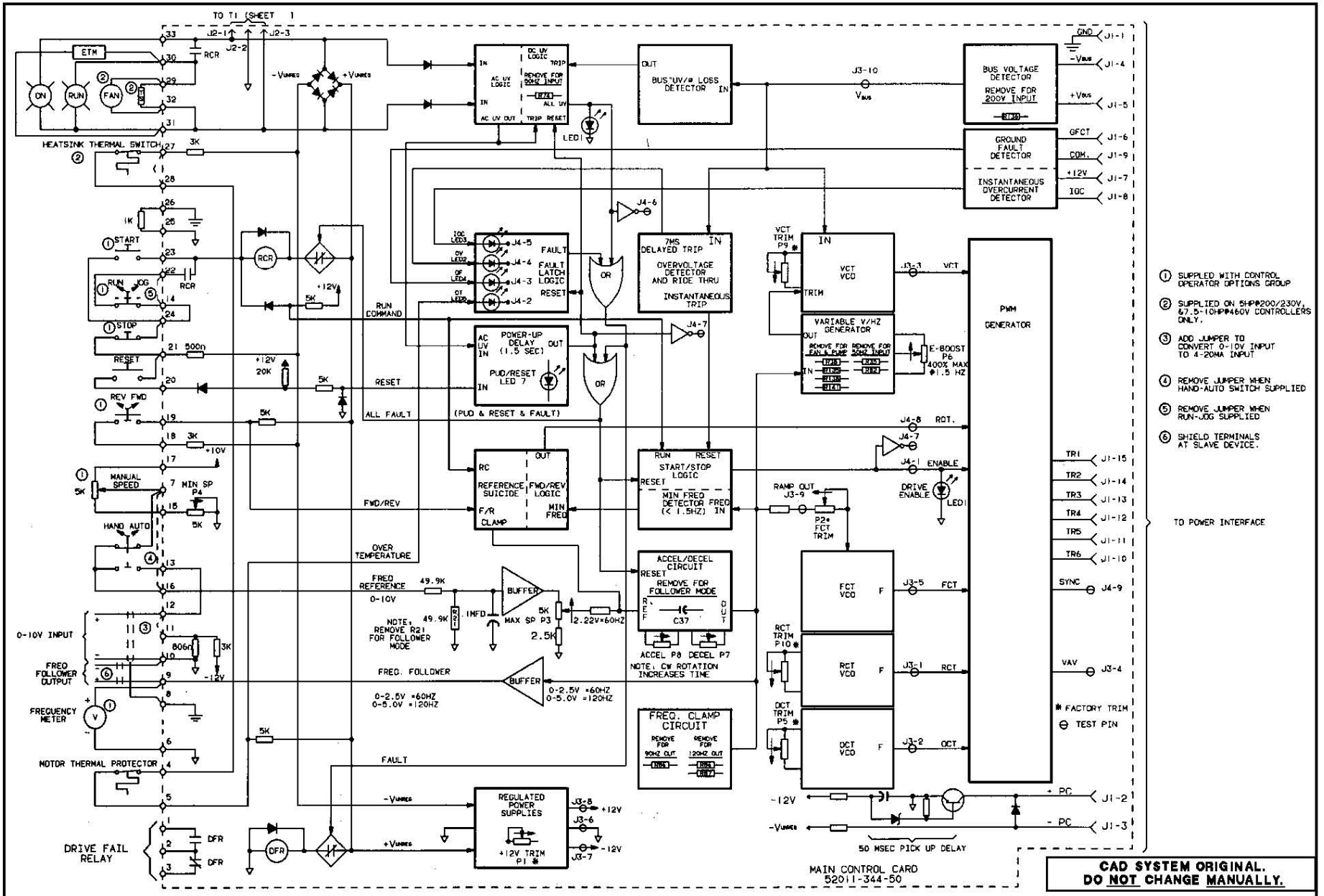
CRITICAL DIMENSION CODE	TOLERANCE-INCHES				TOLERANCE-MILLIMETERS			
F-FUNCTION M-MATING A-AUDIT	LINEAR		HOLES		LINEAR		HOLES	
	1 PLACE	±.060	2 PLACE	+.004 −.002	0 PLACE	±1.5	1 PLACE	+.10 −.05
ANGLES	2 PLACE	±.020	3 PLACE	±.002	1 PLACE	±0.5	2 PLACE	±.05
DIM ±1° / UNDIM 90° ±2°	3 PLACE	±.006	REAM	+.002 −.000 OR AS SPECIFIED	2 PLACE	±0.15	REAM	+.05 − 0 OR AS SPECIFIED
	4 PLACE				3 PLACE			

SQUARE D COMPANY

TITLE OUTLINE DRAWING 5HP 200/230V
(7.5-10HP 380/460V) NEMA 1 ENCLOSED

CLASS____ TYPE____ FORM____ SER.___

REF.		DATE DRN. 12-85	DATE REL.	DRG. NO.	MASTER	SHEET
NEXT ASSEM		DRN.	CKD. APP'D	8.3.4		OF
PROJ. NO.						



1. SUPPLIED WITH CONTROL OPERATOR OPTIONS GROUP
2. SUPPLIED ON 5HP@200/230V, &7.5-10HP@460V CONTROLLERS ONLY.
3. ADD JUMPER TO CONVERT 0-10V INPUT TO 4-20MA INPUT
4. REMOVE JUMPER WHEN HAND-AUTO SWITCH SUPPLIED
5. REMOVE JUMPER WHEN RUN-JOG SUPPLIED
6. SHIELD TERMINALS AT SLAVE DEVICE.

CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

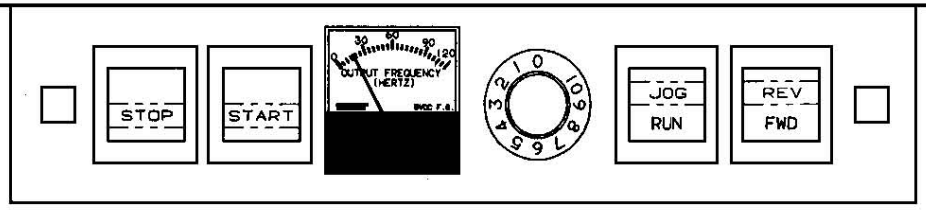
TITLE OMEGAPAK ADJ. FREQ. CONTROLLER (1-10HP 460V)
CONTROL BLOCK DIAGRAM (1-5HP 200/230V)

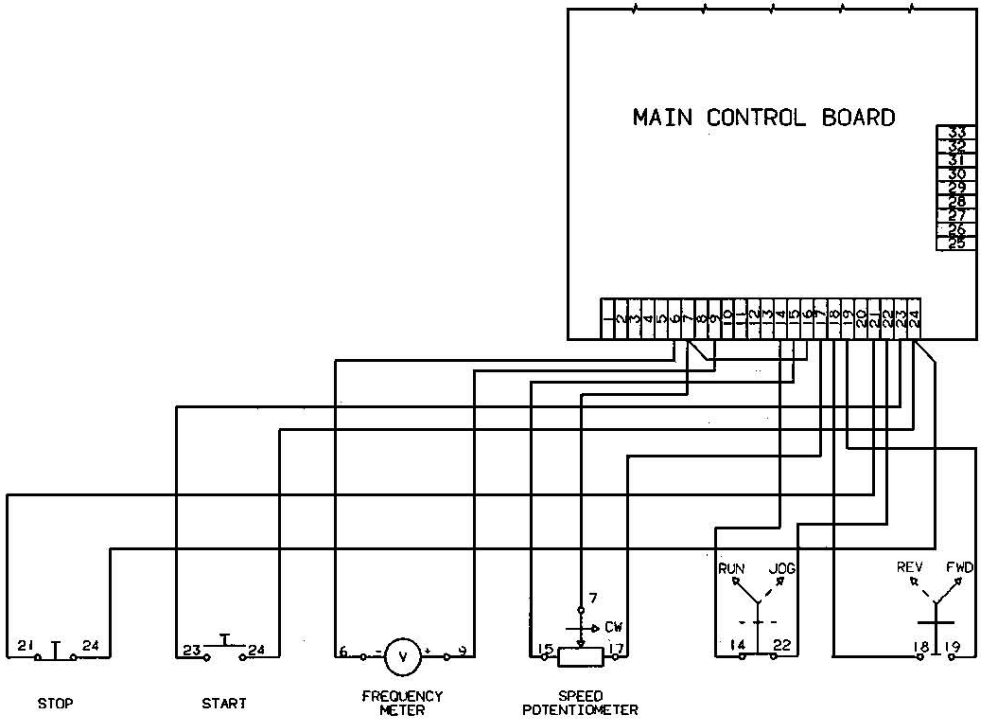
CLASS____ TYPE____ FORM____ SER.____

REV.	DATE	REVISION DESCRIPTION	BY

REFERENCE
NEXT ASSEM.
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.4.1 | SHEET OF
DRN. | CHD. | APPD.





MOD P10
KIT TYPE PK-1

CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM
PILOT DEVICE/METER GROUP
CLASS____ TYPE____ FORM____ SER.____

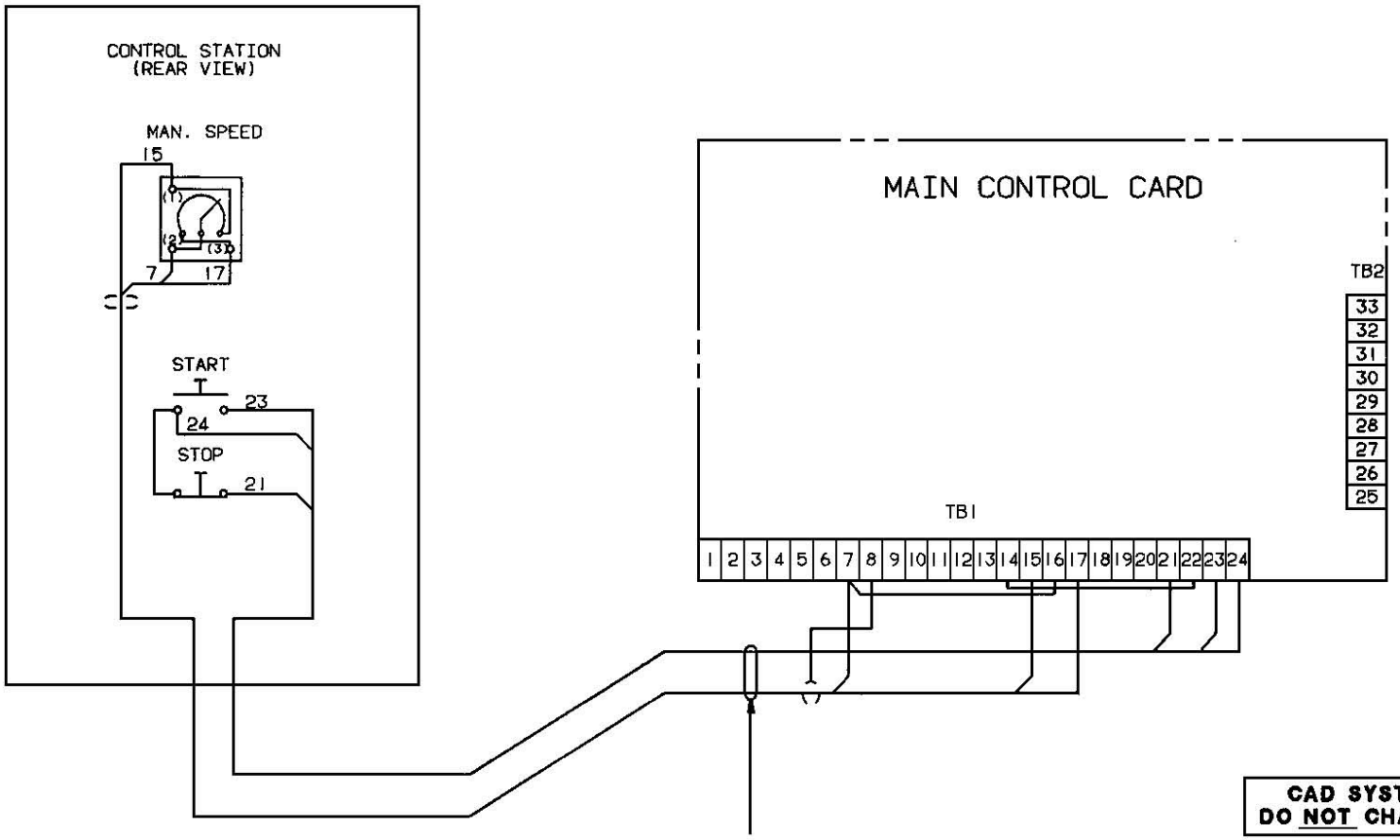
REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.5.1 | SHEET OF
DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP



LOW LEVEL CONTROL WIRING. THESE CONDUCTORS MAY BE ROUTED IN THE SAME RACEWAY. MAINTAIN 3" SEPARATION (CONDUIT) OR 12" SEPARATION (TRAY) FROM OTHER TYPES OF POWER OR CONTROL WIRING. ALL CONDUCTORS TO BE #18 AWG MINIMUM. SHIELDED CABLE TO BE JACKETED. GROUND SHIELD ONLY WHERE SHOWN. INSULATE OTHER END OF SHIELDED CABLE.

CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

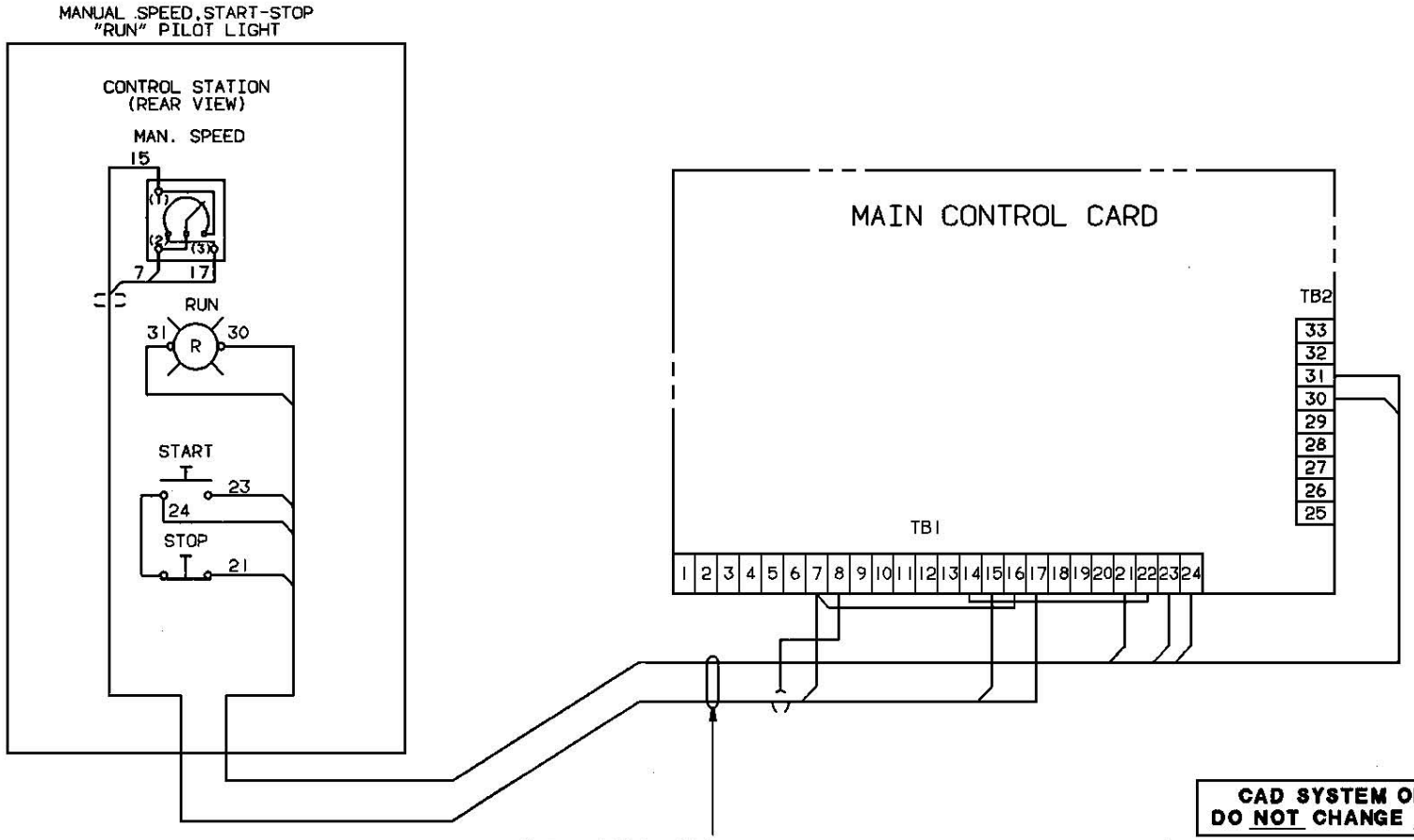
TITLE CONNECTION DIAGRAM TYPE CA-31
REMOTE OPERATOR STATION

CLASS____ TYPE____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.1 | SHEET OF
DRN. | CKD. | APP'D



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-41
REMOTE OPERATOR STATION

CLASS ____ TYPE ____ FORM ____ SER. ____

REV.	DATE	REVISION DESCRIPTION	BY

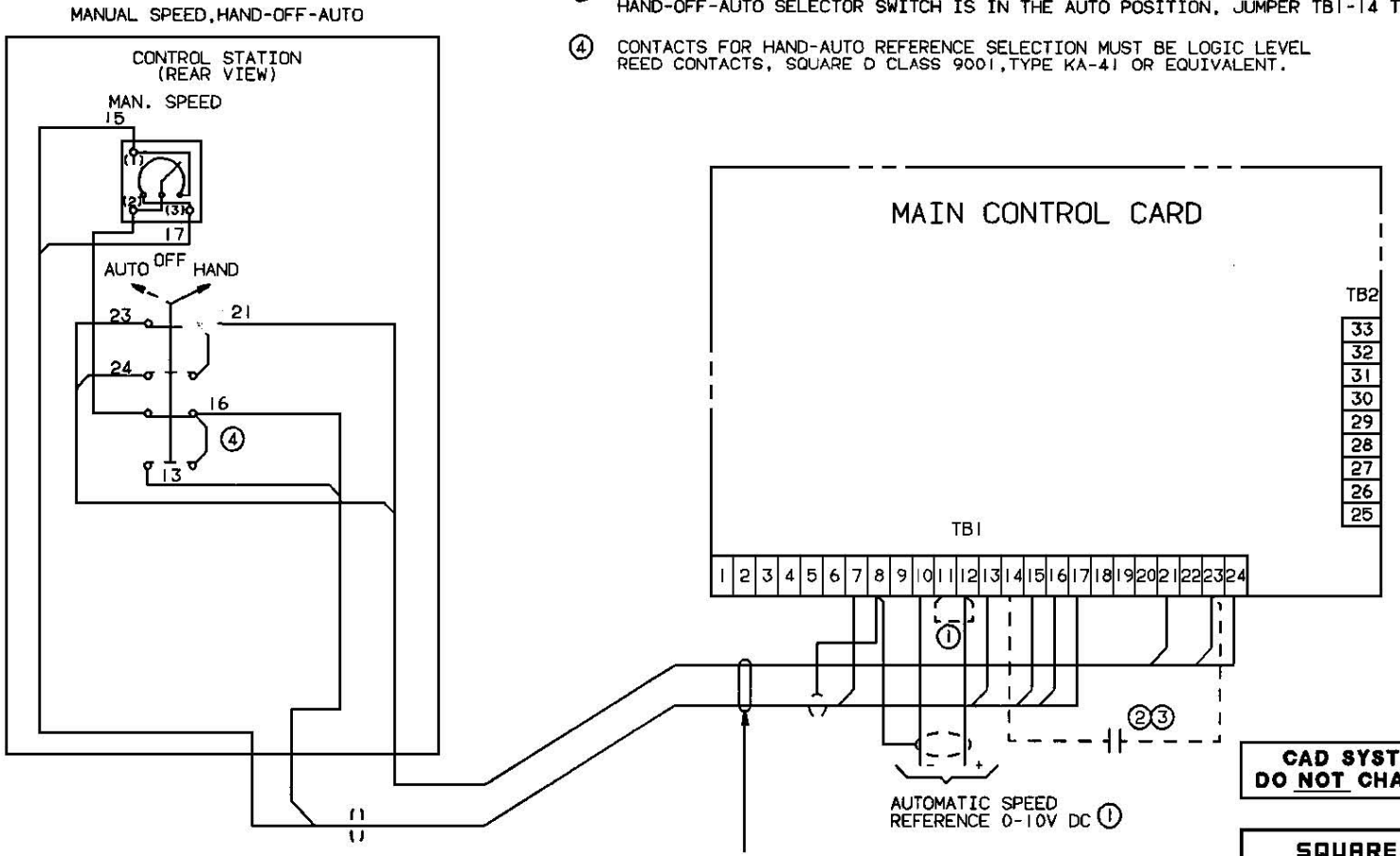
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.2 | SHEET OF
DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

NOTES:

1. ADD JUMPER TB1-11 TO TB1-12 IF AUTOMATIC SPEED REFERENCE IS 4-20 MA DC.
2. AUTOMATIC START CONTACT (USER FURNISHED).
3. IF IT IS DESIRED TO HAVE THE CONTROLLER OPERATE CONTINUOUSLY WHEN THE HAND-OFF-AUTO SELECTOR SWITCH IS IN THE AUTO POSITION, JUMPER TB1-14 TO TB1-23.
4. CONTACTS FOR HAND-AUTO REFERENCE SELECTION MUST BE LOGIC LEVEL REED CONTACTS, SQUARE D CLASS 9001, TYPE KA-41 OR EQUIVALENT.



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-21
REMOTE OPERATOR STATION

CLASS____ TYPE____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

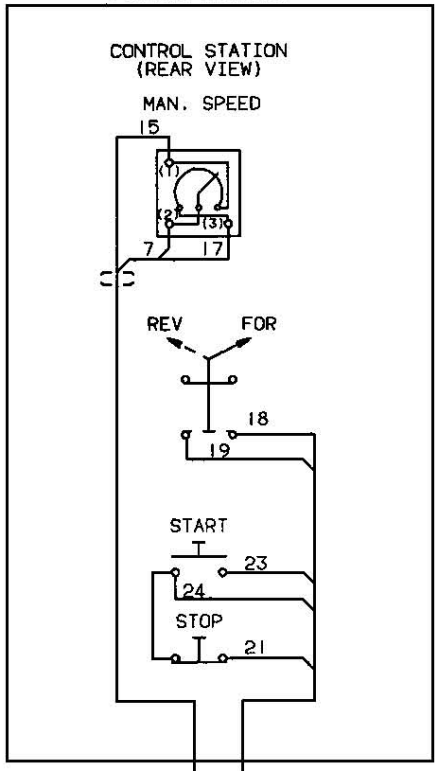
REF.
NEXT ASSEM
PROJ. NO.

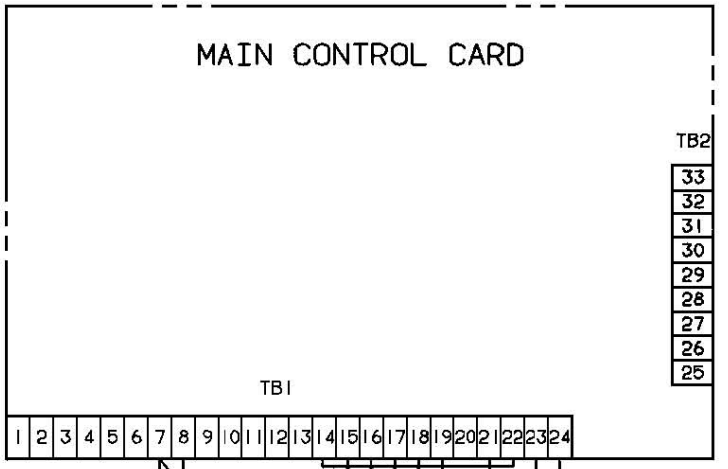
DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.3 | SHEET OF

DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP
FORWARD-REVERSE





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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-43
REMOTE OPERATOR STATION

CLASS ____ TYPE ____ FORM ____ SER. ____

REV.	DATE	REVISION DESCRIPTION	BY

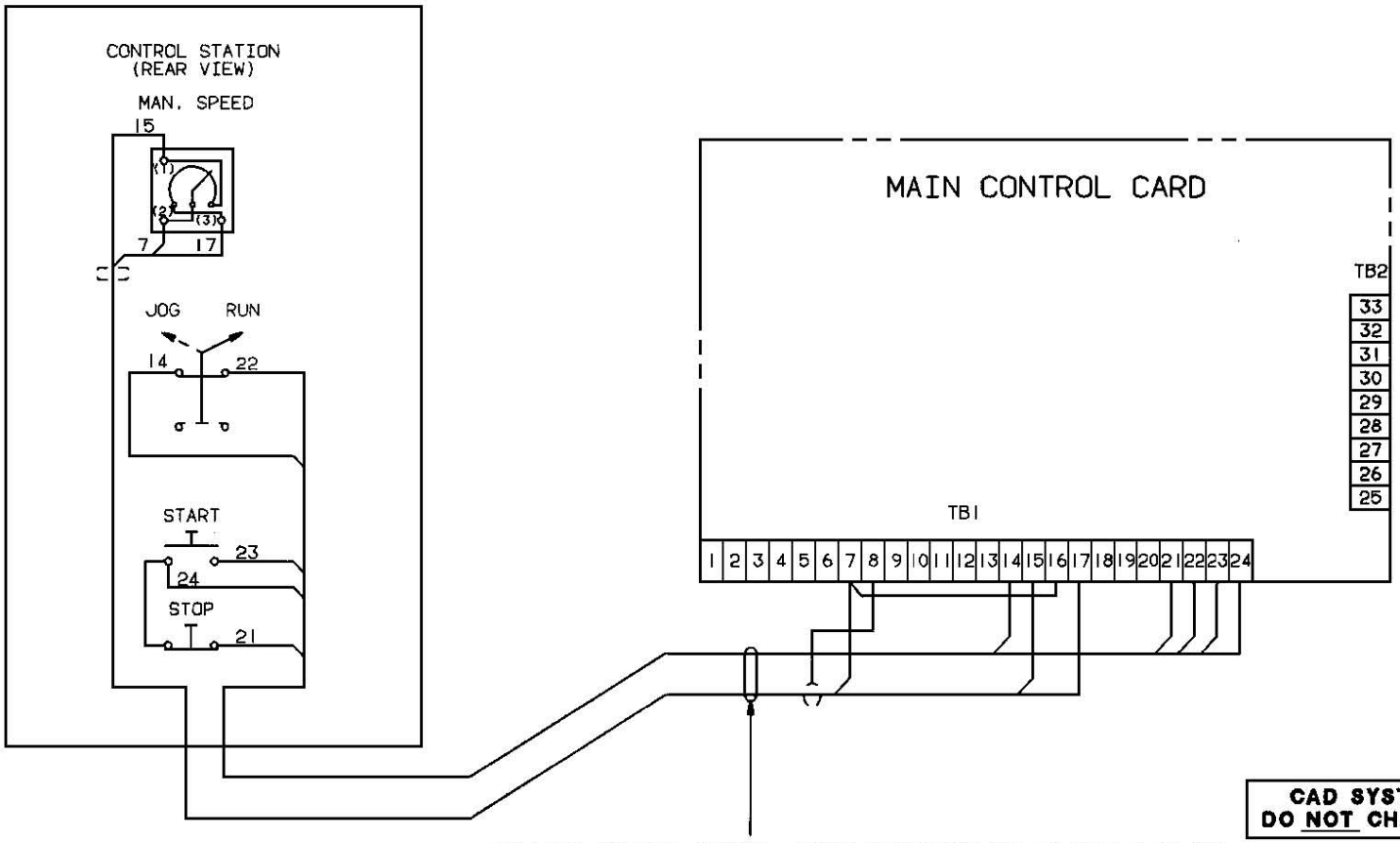
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.4 | SHEET OF

DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP
RUN-JOG



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-44
REMOTE OPERATOR STATION

CLASS____ TYPE____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

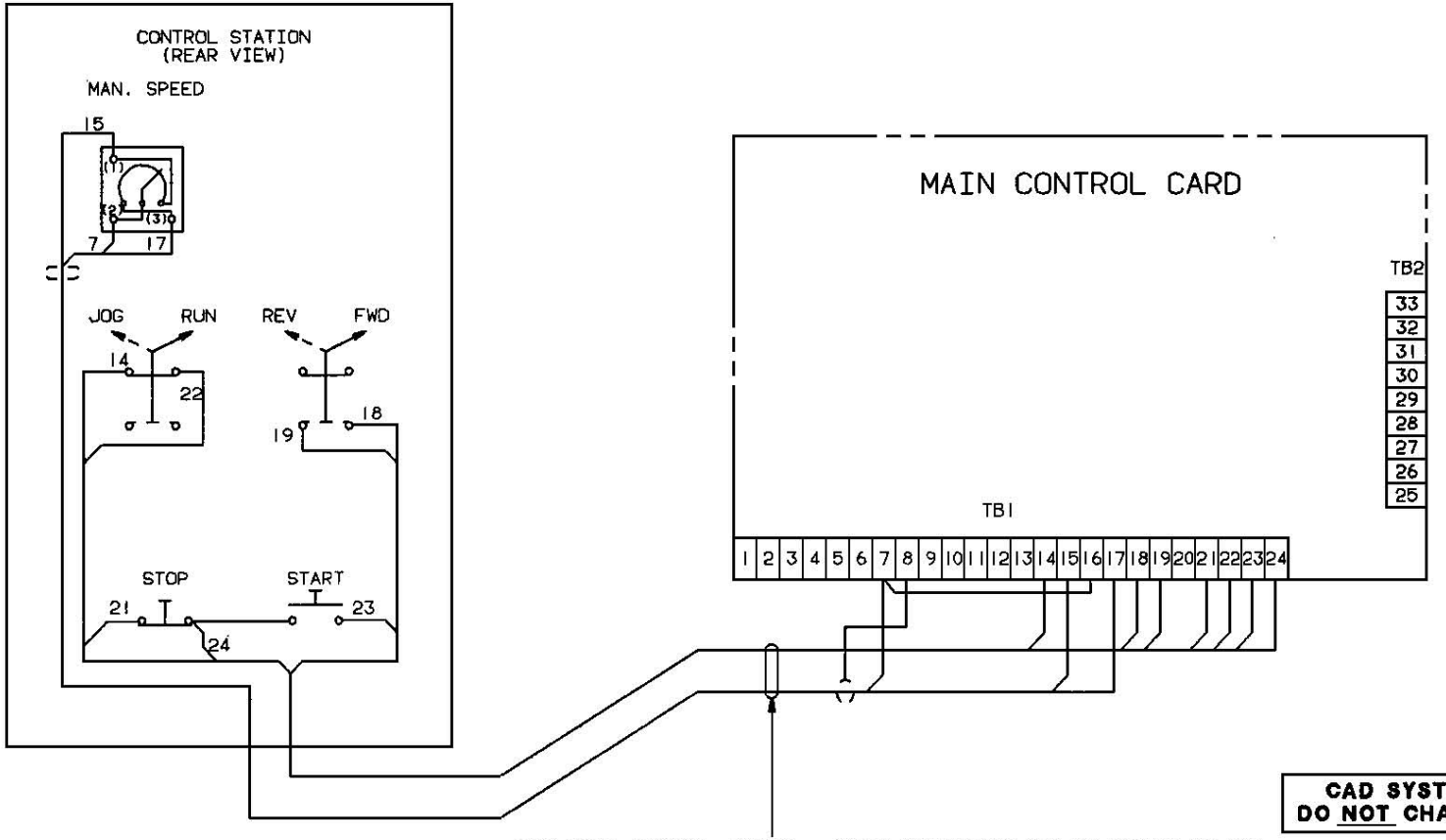
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.5 | SHEET OF

DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP, RUN-JOG
FORWARD-REVERSE



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-61
REMOTE OPERATOR STATION

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

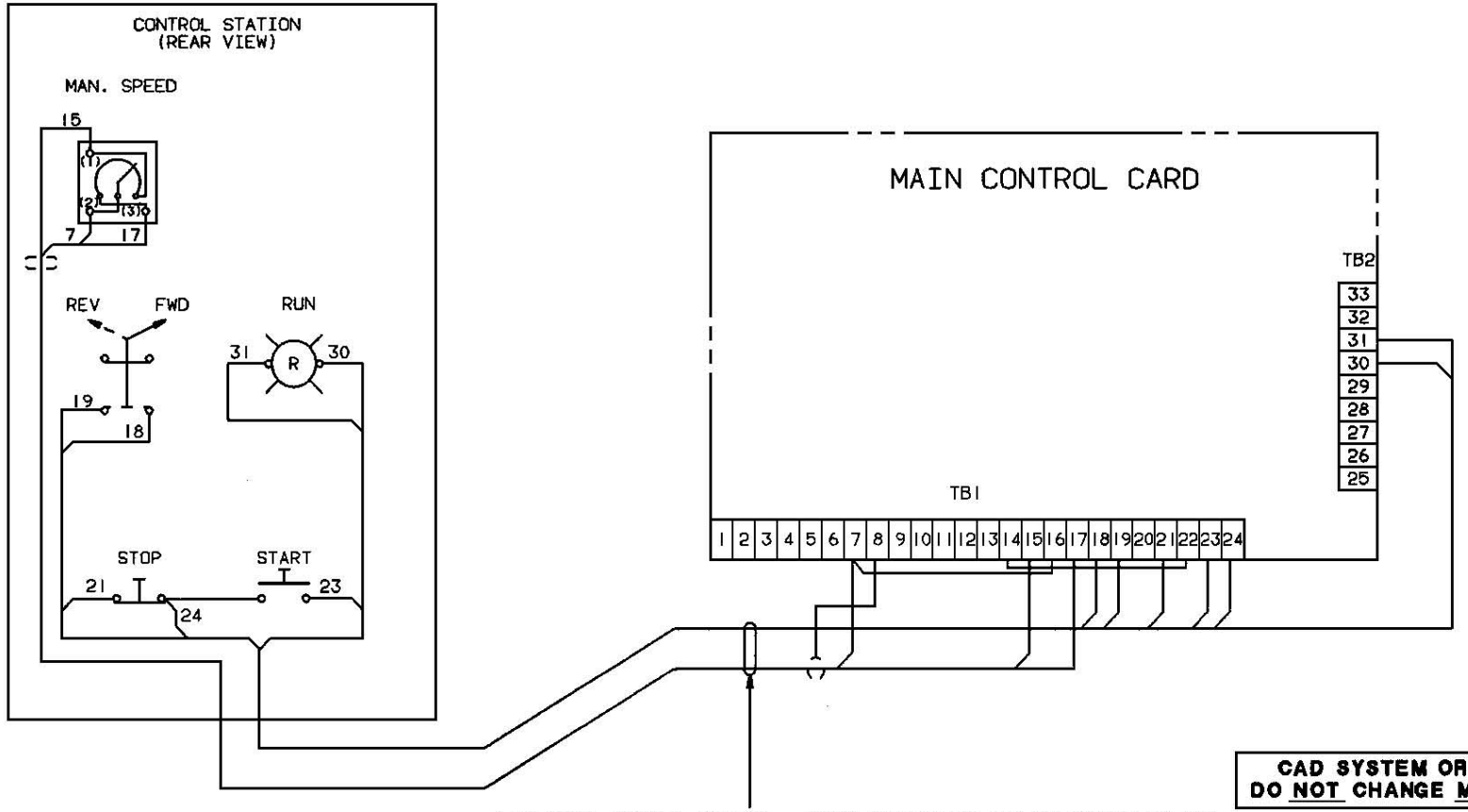
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.6 | SHEET OF

DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP, FORWARD-REVERSE
"RUN" PILOT LIGHT



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

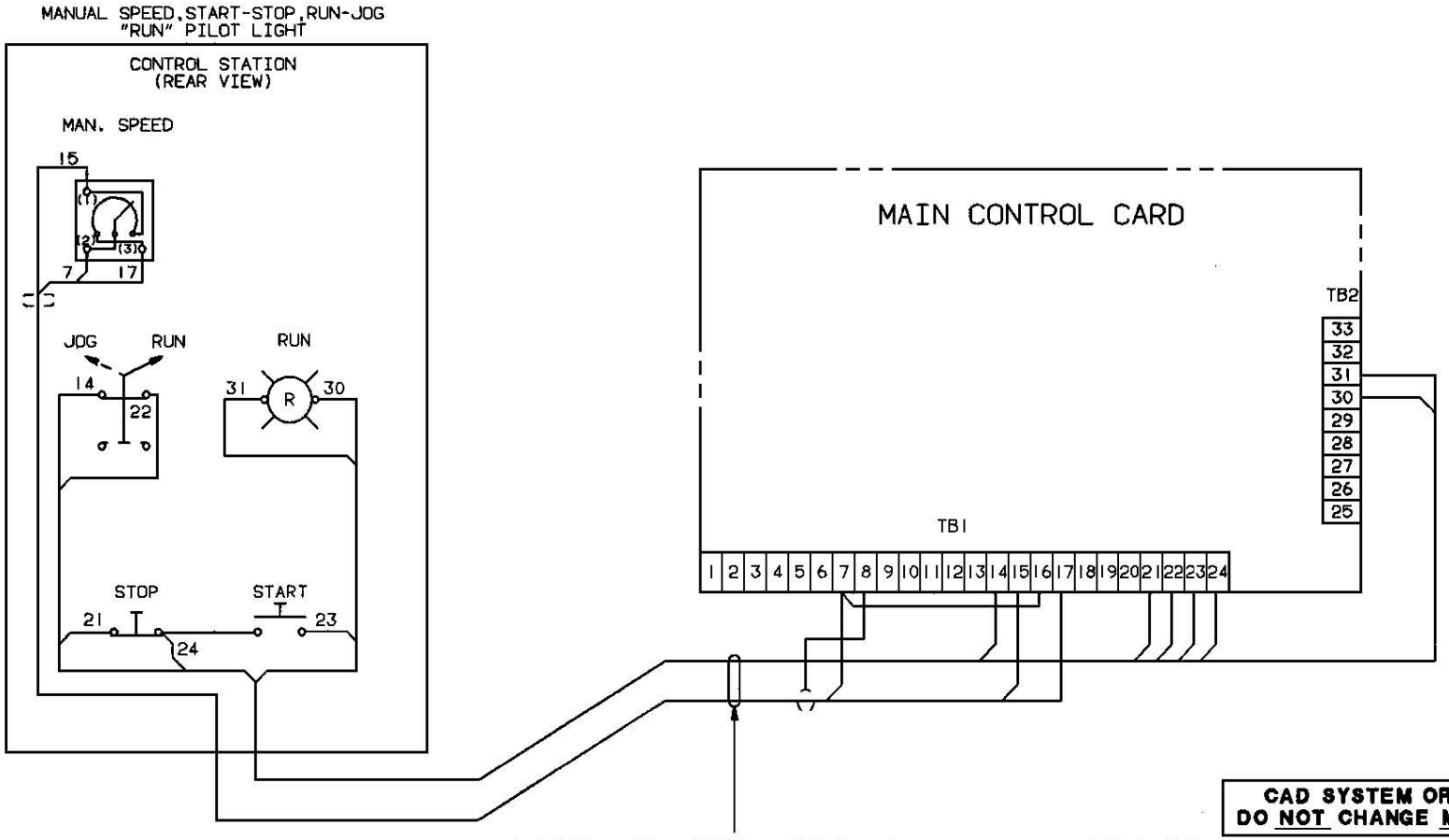
TITLE CONNECTION DIAGRAM TYPE CA-62
REMOTE OPERATOR STATION

CLASS____ TYPE ____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.7 | SHEET OF
DRN. | CKD. | APP'D



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-63
REMOTE OPERATOR STATION

CLASS ____ TYPE ____ FORM ____ SER. ____

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRN. | CKD. | APP'D

DRG. NO. 8.6.8

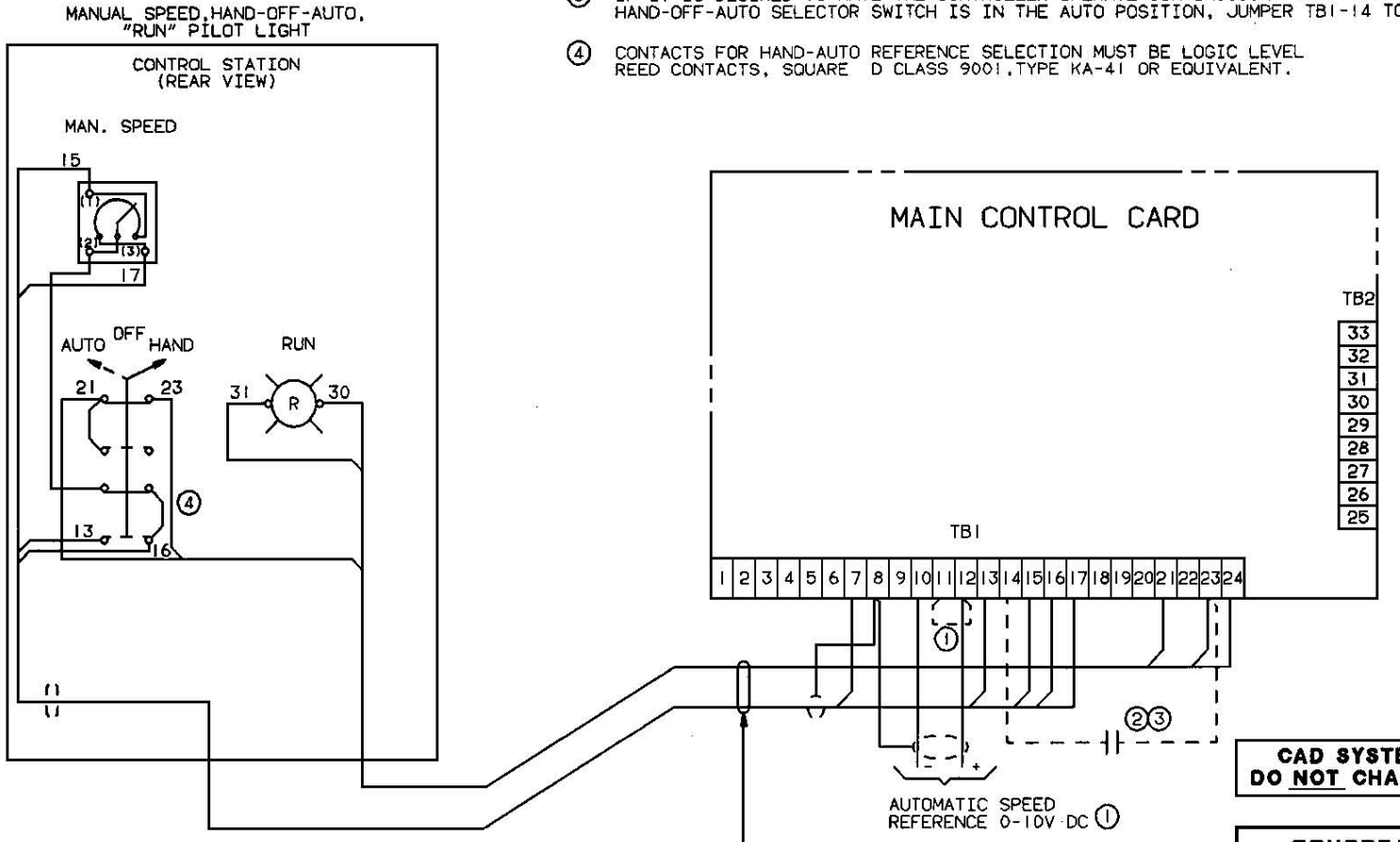
MASTER

SHEET OF

A B C D E F G H I J K L M N O P

NOTES:

1. ADD JUMPER TB1-11 TO TB1-12 IF AUTOMATIC SPEED REFERENCE IS 4-20 MA DC.
2. AUTOMATIC START CONTACT (USER FURNISHED).
3. IF IT IS DESIRED TO HAVE THE CONTROLLER OPERATE CONTINUOUSLY WHEN THE HAND-OFF-AUTO SELECTOR SWITCH IS IN THE AUTO POSITION, JUMPER TB1-14 TO TB1-23.
4. CONTACTS FOR HAND-AUTO REFERENCE SELECTION MUST BE LOGIC LEVEL REED CONTACTS, SQUARE D CLASS 9001,TYPE KA-41 OR EQUIVALENT.



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CAD SYSTEM ORIGINAL. DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-32
REMOTE OPERATOR STATION

CLASS____ TYPE ____ FORM____ SER.____

REV.	DATE	REVISION DESCRIPTION	BY

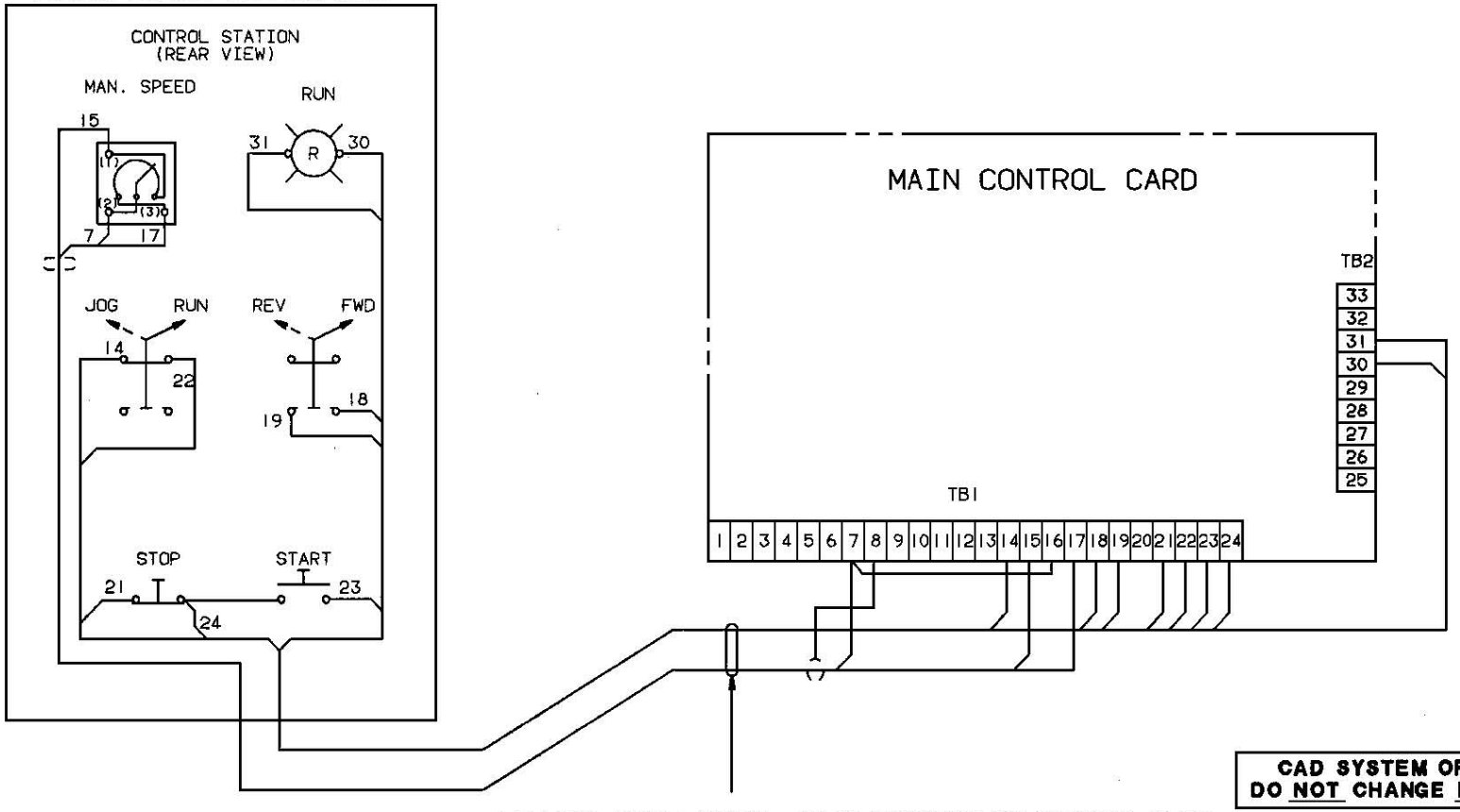
REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.10 | SHEET OF

DRN. | CKD. | APP'D

A B C D E F G H I J K L M N O P

MANUAL SPEED, START-STOP, RUN-JOG
FORWARD-REVERSE, "RUN" PILOT LIGHT



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CAD SYSTEM ORIGINAL.
DO NOT CHANGE MANUALLY.

SQUARE D COMPANY

TITLE CONNECTION DIAGRAM TYPE CA-64
REMOTE OPERATOR STATION

CLASS____ TYPE____ FORM____ SER.___

REV.	DATE	REVISION DESCRIPTION	BY

REF.
NEXT ASSEM
PROJ. NO.

DATE DRN. 12-85 | DATE REL. | DRG. NO. MASTER 8.6.9 | SHEET OF
DRN. | CKD. | APP'D

9.0 RENEWAL PARTS

9.1 NON VOLTAGE DEPENDENT ITEMS (ALL CONTROLLERS)

9.1.1 ELECTRONIC BOARDS

DESCRIPTION	PART NUMBER
MAIN CONTROL BOARD	BN457

9.1.2 CONTROL/MISCELLANEOUS ITEMS

DESCRIPTION	PART NUMBER
GROUND RESISTOR	RM190
MANUAL SPEED POTENTIOMETER (1)	RP064
STOP SWITCH (1)	DS127
START SWITCH (1)	DS128
FORWARD-REVERSE SWITCH (1)	DS129
RUN-JOG SWITCH (1)	DS130
FREQUENCY METER (1)	DM057
HEATSINK FAN (2)	DT011
HEATSINK THERMOSTAT (2)	FK014
TRANSIENT SUPPRESSOR (2)	SV023

(1) USE ONLY FOR REPLACEMENT DEVICES ON CONTROLLERS FURNISHED WITH P10, OPERATOR CONTROLS.

(2) USED ON 5 HP, 200/230V AND 7.5-10 HP, 380/460V CONTROLLERS ONLY.

9.2 VOLTAGE DEPENDENT ITEMS

9.2.1 ELECTRONIC BOARDS

DESCRIPTION	PART NUMBER
POWER INTERFACE BOARD	
1-2 HP, 200/230	BN463
3HP, 200/230V	BN464
5HP, 200/230V	BN465
1-5HP, 380/460V	BN466
7.5-10HP, 380/460V	BN467

9.2.2 POWER DEVICES

DESCRIPTION	PART NUMBER
DIODE MODULE	
1-2 HP, 200/230V, 1 PHASE INPUT	SD105
3 HP, 200/230V, 1 PHASE INPUT	SD106
1-2 HP, 200/230V, 3 PHASE INPUT	SD077
3 HP, 200/230V, 3 PHASE INPUT	SD105
5 HP, 200/230V, 3 PHASE INPUT	SD106
1-5 HP, 380/460V, 3 PHASE INPUT	SD109
7.5-10 HP, 380/460V, 3 PHASE INPUT	SD110
TRANSISTOR MODULE	
1 HP, 200/230V	ST078
2 HP, 200/230V	ST079
3 HP, 200/230V	ST080
5 HP, 200/230V	ST081
1-5 HP, 380/460V	ST082
7.5-10 HP, 380/460V	ST083
DC BUS CAPACITOR	
1-2 HP, 200/230, 1 PHASE INPUT	CF027
3 HP, 200/230V, 1 PHASE INPUT	CF028
1-5 HP, 200/230V, 3 PHASE INPUT	CK024
1-10 HP, 380/460V, 3 PHASE INPUT	CK025
PRECHARGE RESISTOR	
1-3 HP, 200/230V, 1 PHASE INPUT	RW066
1-5 HP, 200/230V, 3 PHASE INPUT	RW067
1-10 HP, 380/460V, 3 PHASE INPUT	RW067
CURRENT SENSE RESISTOR	
1 HP, 200/230V	NONE USED
2 HP, 200/230V	RZ017
3 HP, 200/230V	RZ018
5 HP, 200/230V	RZ019
1-3 HP, 380/460V	RZ020
5 HP, 380/460V	RZ018
7.5-10 HP, 380/460V	RZ019

9.2.3 CONTROL/MISCELLANEOUS

DESCRIPTION	PART NUMBER
CONTROL POWER TRANSFORMER	
200/230V	TT200
380/460V	TT202

Bulletin 8804-4 CS 3/86 10M

Printed in U.S.A.