



**SSX SERIES
SOFT-START ACCELERATION
AC MOTOR CONTROLLERS
(1/2 - 50HP)
TECHNICAL MANUAL**

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STORAGE INSTRUCTIONS

If the SSX controller is not to be installed immediately, it should be stored in a clean, dry location at an ambient temperature between -25°C (-13°F) and +65°C (149°F). The surrounding air must be free of corrosive fumes and electrically conductive contaminants. Care must be taken to prevent condensation from forming within the controller enclosure during storage.

If long term storage or conditions other than covered above are expected, contact the factory.

NOTICE

Due to periodic engineering design changes to the SSX controller, this manual is provided as a guide only. All drawings contained herein, unless certified, are for reference only. The factory reserves the right to make changes on all products. As a result, this manual is subject to change without notice.



WARNING IS USED IN THIS MANUAL TO INDICATE SITUATIONS THAT COULD LEAD TO PERSONAL INJURY, LOSS OF LIFE, OR PROPERTY DAMAGE.



CAUTION Is Used In This Manual To Indicate Situations That Could Lead To Damage To The SSX Controller.

 **WARNING**

The following must be strictly adhered to at all times.

- **YOU AS THE OWNER OR OPERATOR OF THE SSX CONTROLLER HAVE THE RESPONSIBILITY TO HAVE THE USERS OF THIS CONTROLLER TRAINED IN ITS OPERATIONS AND WARNED OF ANY POTENTIAL HAZARDS OF SERIOUS INJURY.**
- **THE SSX CONTROLLER SHOULD BE INSTALLED, OPERATED, ADJUSTED, AND SERVICED ONLY BY QUALIFIED PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THE CONTROLLER AND THE HAZARDS INVOLVED INCLUDING THOSE DESCRIBED BELOW. FAILURE TO OBSERVE THIS WARNING CAN RESULT IN PERSONAL INJURY, LOSS OF LIFE, OR PROPERTY DAMAGE.**
- **THE NATIONAL ELECTRICAL CODE (NEC) REQUIRES THAT AN AC LINE DISCONNECT OR CIRCUIT BREAKER BE PROVIDED IN THE AC INPUT POWER LINES TO THE SSX CONTROLLER. THIS DISCONNECT MUST BE LOCATED WITHIN SIGHT OF THE CONTROLLER. DO NOT OPERATE THE CONTROLLER UNTIL THIS CODE REQUIREMENT HAS BEEN MET.**
- **THE SSX CONTROLLER IS AT AC LINE VOLTAGE POTENTIAL WHENEVER AC POWER IS CONNECTED TO THE CONTROLLER. CONTACT WITH AN ELECTRICAL CONDUCTOR INSIDE THE CONTROLLER OR AC LINE DISCONNECT CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.**
- **THE SSX CONTROLLER, MOTOR FRAME, AND REMOTE OPERATOR STATION (IF USED) MUST BE CONNECTED TO AN UNBROKEN COMMON GROUND CONDUCTOR. AN UNBROKEN GROUNDING CONDUCTOR MUST BE RUN FROM THE COMMON GROUND CONDUCTOR TO A GROUNDING ELECTRODE BURIED IN THE EARTH OR ATTACHED TO A PLANT GROUND. REFER TO THE NATIONAL ELECTRICAL CODE (NEC) AND LOCAL CODES FOR GROUNDING REQUIREMENTS.**
- **THE ATMOSPHERE SURROUNDING THE SSX CONTROLLER MUST BE FREE OF COMBUSTIBLE VAPORS, CHEMICAL FUMES, OIL VAPOR, AND ELECTRICALLY CONDUCTIVE OR CORROSIVE MATERIALS.**
- **SOLID-STATE DEVICES IN THE SSX CONTROLLER CAN BE DESTROYED OR SEVERELY DAMAGED BY STATIC ELECTRICITY. THEREFORE, PERSONNEL WORKING NEAR THESE STATIC-SENSITIVE DEVICES MUST BE APPROPRIATELY GROUNDED.**

SECTION I

DESCRIPTION AND MODEL TYPES

DESCRIPTION

The SSX Series Soft-Start AC motor controllers provide smooth and step-less acceleration of three-phase AC induction motors. These controllers provide adjustable starting torque, ramp time, and dwell time, allowing the starting characteristics of the motor to be matched to the mechanical characteristics of the drive train for controlled acceleration of the load.

MODEL TYPES

Table 1-1: MODEL TYPES

MODEL	INPUT VOLTAGE (3-PHASE VAC)	RATED OUTPUT AMPS	MOTOR	
			TYPICAL HP	KW
SSX0076	208/230	7.6	2	1.5
SSX0310		31.0	10	7.5
SSX0310DTC ^a		31.0	10	7.5
SSX0520DTC ^a		52.0	20 ^b	15.0 ^b
SSX0076	460	7.6	5	3.7
SSX0310		31.0	20	15.0
SSX0310DTC ^a		31.0	20	15.0
SSX0520DTC ^a		52.0	40	30.0
SSX0076	575	7.6	5	3.7
SSX0310		31.0	25	19.0
SSX0310DTC ^a		31.0	25	19.0
SSX0520DTC ^a		52.0	50	38.0

a. Controller is supplied with a control board that contains options. See Section IV for descriptions of the options.

b. At 230VAC only.

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SECTION II

INSTALLATION

MOUNTING GUIDELINES

- The SSX controller is intended for indoor usage in nonhazardous areas. It should not be used where a watertight, weatherproof, or explosion-proof controller is required.
- The atmosphere surrounding the SSX controller must be free of combustible vapors, chemical fumes, oil vapor, and electrically conductive or corrosive materials.
- The air surrounding the SSX controller must not exceed 40°C (104°F). Minimum air temperature is 0°C (32°F).
- Do not mount the SSX controller on a surface that is combustible. A metal surface is recommended.
- Do not mount the SSX controller immediately beside or above heat generating equipment or directly below water or steam pipes.
- Where severe shock loads and/or vibration are encountered, suitable diaphragm type (or equivalent) flexible isolators are suggested for mounting.
- Review the Warnings on page vi.
- Follow all electrical and safety codes including the National Electrical Code (NEC) and when applicable, the Occupational Safety and Health Act (OSHA). The SSX controller should be installed, adapted and serviced by qualified personnel familiar with the installation and operation of the equipment and the hazards involved.

MOUNTING THE CONTROLLER

1. Comply with the above mounting guidelines.
2. Unpack the SSX controller from the shipping carton and inspect it for shipping damage. Report shipping damage to the carrier immediately.
3. Mount the SSX controller. Mounting dimensions are shown in Figure 2-1 (page 2-2) for Model SSX0076 controllers, and in Figure 2-2 (page 2-3) for Model SSX0310, SSX0310DTC, and SSX0520DTC controllers.

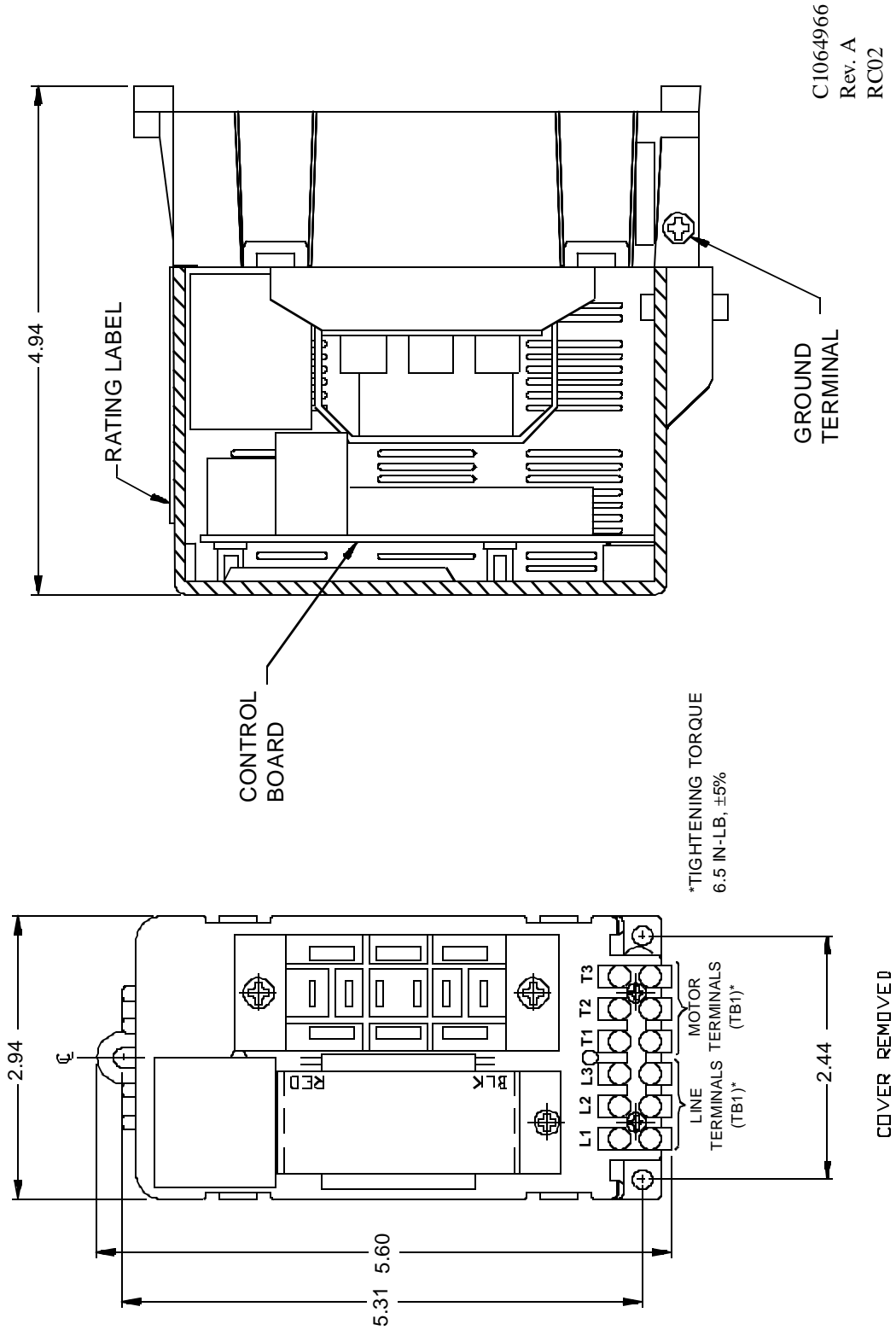
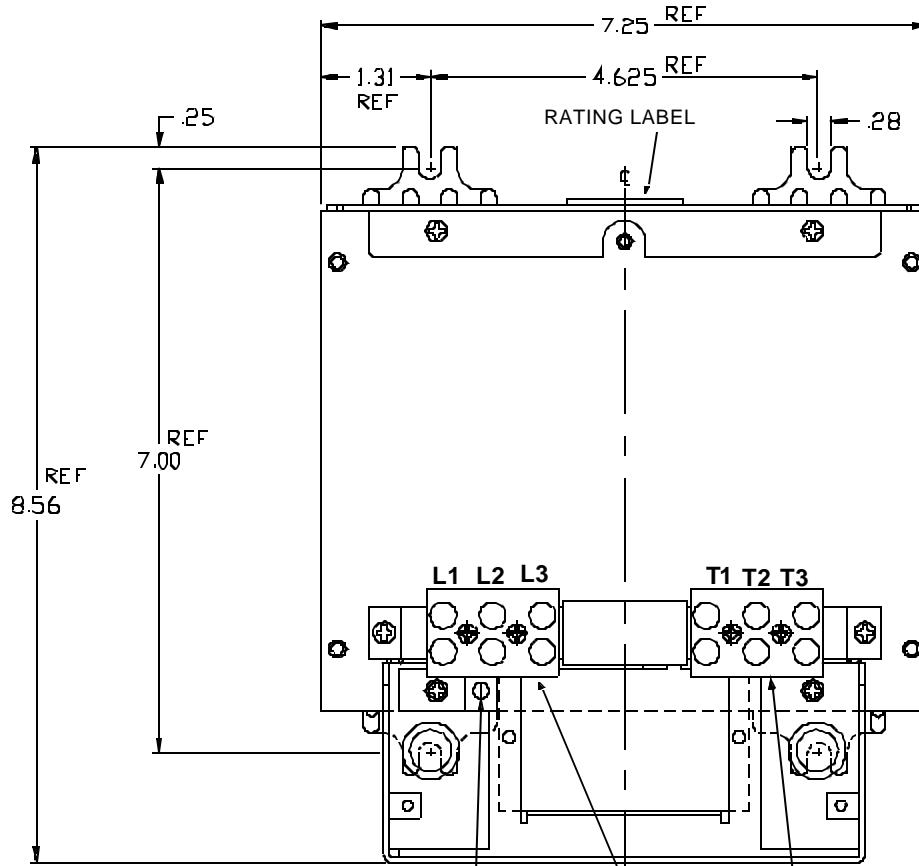
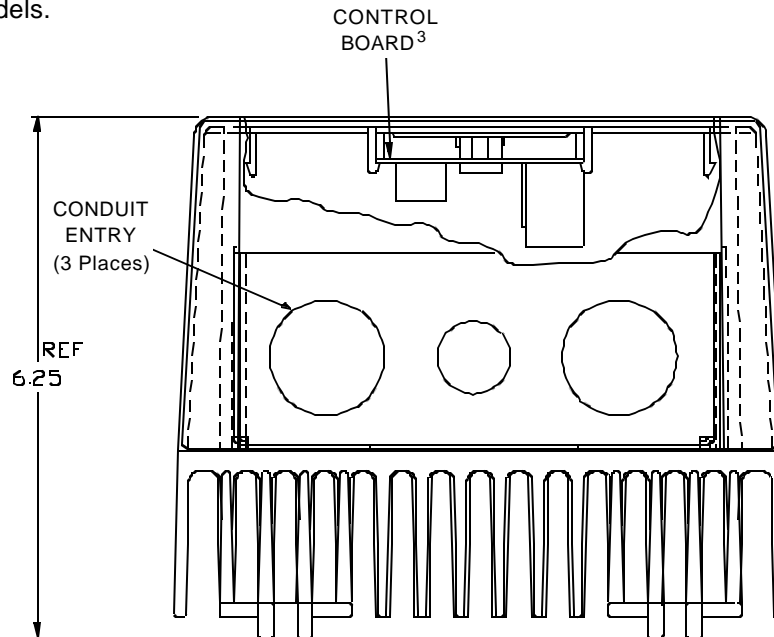


FIGURE 2-1. MOUNTING DIMENSIONS, MODEL SSX0076 CONTROLLERS



- Notes:
1. Cover removed in front view.
 2. Not all components are shown.
 3. The control board will be larger in some models.

*TIGHTENING TORQUE
 21.0 IN-LB, ±5%



D1064998

FIGURE 2-2. MOUNTING DIMENSIONS, MODEL SSX0310, SSX0310DTC, AND SSX0520DTC CONTROLLERS

WIRING GUIDELINES

- Be sure the AC power source conforms to the requirements of the SSX controller and motor. The line supply may range from 208 to 575 VAC ($\pm 10\%$) at a line frequency from 48 to 62 Hertz.
- All wiring should be rated for at least 600 volts. Use copper conductors only for all wiring. Size all wiring based on 75°C wire only.
- Do not use solid wire.
- All wiring must conform to the National Electrical Code (NEC) and all applicable local codes.
- The National Electrical Code (NEC) requires that a three-pole fused disconnect switch or circuit breaker be installed in the AC line supply to the SSX controller.
- Model SSX0310DTC and SSX0520DTC controllers are supplied with overload protection at 115% of setting. Model SSX0076 and SSX0310 controllers must be provided with overload protection by the user.
- AC power wiring, motor wiring, and control wiring (if used) should be run separately from each other.
- The SSX controller and motor must be securely and adequately grounded. Connect the green or bare (ground) wire of the AC line supply to the green-colored ground terminal. For the location of the ground terminal, refer to Figure 2-1 (page 2-2) for Model SSX0076 controllers, and Figure 2-2 (page 2-3) for Model SSX0310, SSX0310DTC, and SSX0520DTC controllers.
- If high-energy transients are present on the line supply, transient suppression will be required to limit transients to 150% of peak line voltage.
- Do not wire the AC power leads to the motor connection terminals. This will damage the SSX controller.
- Do not use power factor correction capacitors on the line supply or on the wiring to the motor.

WIRING THE CONTROLLER

1. Review the Warnings on page vi.
2. Review the Wiring Guidelines on page 2-4.
3. Connect the SSX controller as shown in Figure 2-3 (below). An AC line starter should be used to provide electrical isolation of the controller and motor when the motor is shut down. Refer to applicable electrical codes.

For Model SSX0076 controllers, the power wiring (AC line and motor) connection terminals are located under a flip-up door (see Figure 2-4 on page 2-6 and Figure 2-1 on page 2-2). Terminal legends are located on the flip-up door.

For Model SSX0310, SSX0310DTC, and SSX0520DTC controllers, the power wiring (AC line and motor) connection terminals are located beneath a terminal access cover (see Figure 2-5 on page 2-6 and Figure 2-2 on page 2-3). Terminal legends are located on the control board in the controller.

The connection scheme shown in Figure 2-3 allows the motor to start automatically when AC power is applied to the controller. If remote starting is required, remove the wire jumper from TB1 Terminals 1 and 2 on the SSX control board, and connect a normally-open contact to Terminals 1 and 2 as shown in Figure 2-3. The contact should be a low power bifurcated type capable of switching 11 milliamperes DC @ 5 VDC. When the contact closes, the motor will start, and when the contact opens, the motor will stop.

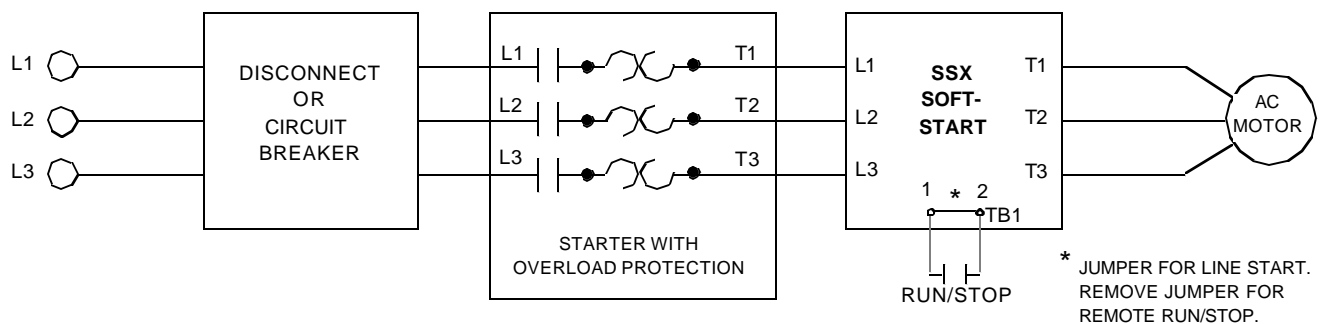
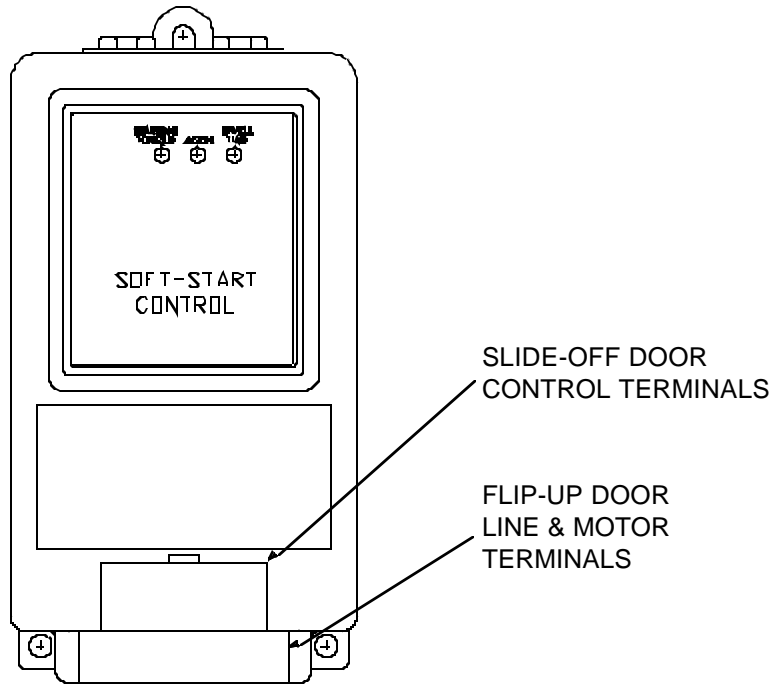
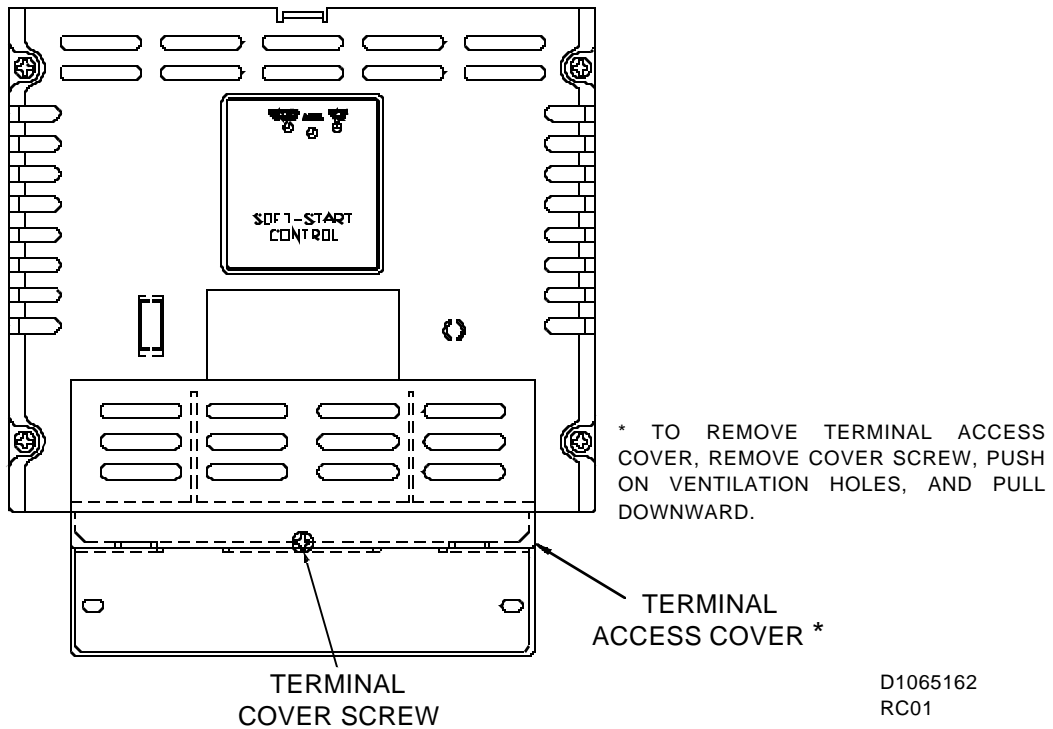


FIGURE 2-3. WIRING DIAGRAM, SSX CONTROLLER



C1064966
Rev. A
RC01

FIGURE 2-4. TERMINAL ACCESS, MODEL SSX0076 CONTROLLERS



D1065162
RC01

FIGURE 2-5. TERMINAL ACCESS, MODEL SSX0310, SSX0310DTC, AND SSX0520DTC CONTROLLERS

SECTION III

START-UP PROCEDURE

The following start-up procedure should be performed for all model SSX controllers. If the controller has a control board with options (Model SSX0310DTC and SSX0520DTC controllers), refer to Section IV, “Options,” after performing this Start-Up Procedure.

1. Be sure all wiring is correct and all connections are tightened securely. **INCORRECT CONNECTIONS MAY DAMAGE THE SSX CONTROLLER.**
2. Set the potentiometers, accessible from the front of the SSX controller, as follows:
 - **STARTING TORQUE:** Fully counterclockwise (minimum)
 - **ACCEL:** Fully clockwise (30 seconds)
 - **DWELL TIME:** Fully clockwise (6 seconds)
3. Turn-on the AC supply voltage to the SSX controller. If a remote Run/Stop contact is used, close the contact.



WARNING

THE CONTROLLER CONTAINS HIGH VOLTAGE WHICH CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.

4. **STARTING TORQUE**

Turn the **STARTING TORQUE** potentiometer clockwise slowly until the motor starts to rotate. After the six-second dwell time (set by the **DWELL TIME** potentiometer), the motor will begin to accelerate. Remove the AC supply and allow the motor to come to a complete stop. Reapply the AC supply and repeat this step until the starting torque is set correctly for the application. Starting torque is adjustable from 0 to 100% of rated voltage, and is increased by turning the **STARTING TORQUE** potentiometer clockwise. See Figure 4-2 on page 4-5.

5. DWELL TIME

Dwell time is adjustable from 0 to 6 seconds (see Figure 4-2 on page 4-5). During this time period the motor will remain at the initial starting torque level. Dwell time is decreased by turning the DWELL TIME potentiometer counterclockwise. Remove the AC supply from the SSX controller and allow the motor to come to a complete stop. Reapply the AC supply and observe the load. Decrease the dwell time to the minimum time necessary for the application. Dwell time allows the system to take up slack at low torque levels to eliminate mechanical shock. Dwell time can also help extend the start time on lightly loaded motors.

6. ACCEL (Acceleration)

The ACCEL potentiometer changes the amount of time for the controller to apply full voltage to the motor (see Figure 4-2 on page 4-5). Time is adjustable from 1 to 30 seconds, and has been factory set for 30 seconds. If this time is too long, turn the ACCEL potentiometer counterclockwise. Remove the AC supply from the SSX controller and allow the motor to come to a complete stop. Reapply the AC supply and observe the load.

Note: Since the interaction of all three of the previous adjustments determines the actual time it takes for the motor to reach full speed, readjustment of all three potentiometers may be necessary to attain the ideal start for the application.

SECTION IV

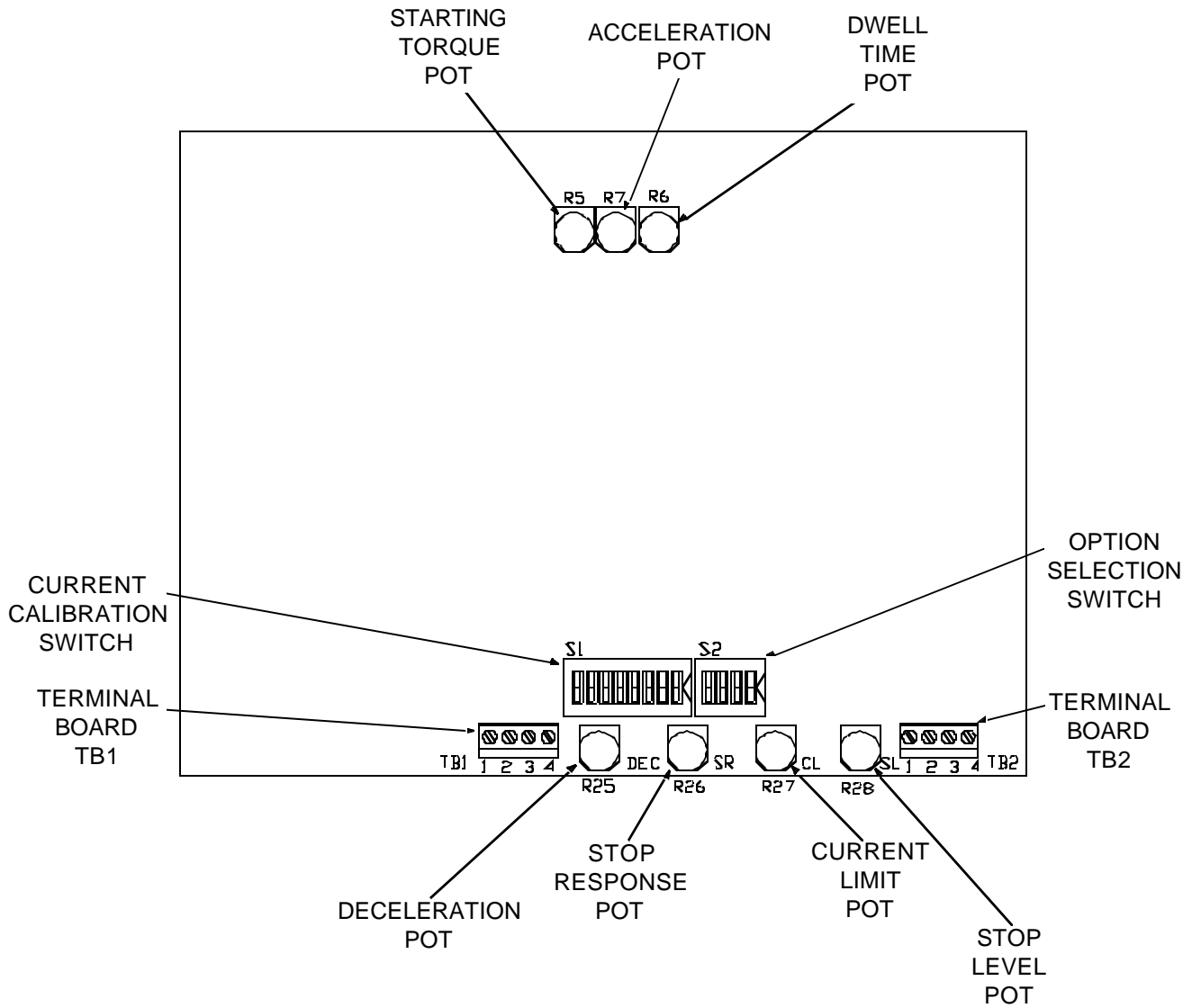
OPTIONS

Model SSX0310DTC and SSX0520DTC controllers are supplied with a control board that provides the options listed in Table 4-1. These options are selectable with a four-segment DIP Switch (S2), located on the control board. See Figure 4-1 (page 4-2) for the location of Option Selection Switch S2, and see Table 4-1 for a listing of Switch S2 selections.

Table 4-1: OPTION SELECTIONS

SWITCH		OPTION
S2-2 ^a	S2-3 ^a	
OFF	OFF	Motor Overload
ON	OFF	Current Limit (Torque Control) and Motor Overload
OFF	ON	Deceleration and Motor Overload
ON	ON	Current Limit (Torque Control), Deceleration, and Motor Overload

a. S2-1 and S2-4 may be in either position.



Note: Not all components are shown.

FIGURE 4-1. CONTROL BOARD FOR MODEL SSSX0310DTC AND SSSX0520DTC CONTROLLERS

The motor overload and current limit (torque control) options require calibrating the SSX controller to the full-load current rating of the motor. Current calibration is performed by the setting of the Current Calibration Switch (S1). See Figure 4-1 for the location of Switch S1. Each segment or section of Switch S1 represents a particular current rating shown in the following table.

Table 4-2: SWITCH S1 SELECTIONS

SWITCH	S1-1	S1-2	S1-3	S1-4	S1-5	S1-6	S1-7	S1-8
FULL-LOAD CURRENT (AMPS)	0.25	0.5	1.0	2.0	4.0	8.0	16.0	32.0

The total full-load current setting is the sum of the S1 switch sections that are in ON position. For example, if a motor is rated at 14.0 full-load amps, S1-6, S1-5, and S1-4 (8.0A + 4.0A + 2.0A = 14A) would be placed in ON position to calibrate the SSX controller to a 14.0 amp motor.

Calibrate the SSX controller to the full-load motor current rating by placing various sections of Switch S1 in ON position as shown in the following table.

Table 4-3: FULL-LOAD CURRENT CALIBRATION

NEMA FULL-LOAD MOTOR CURRENT RATING (AMPS)	SWITCH S1 SETTINGS (ON POSITION)
9.0	S1-3 & S1-6 (9.0A)
9.6	S1-1, S1-2, S1-3 & S1-6 (9.75A)
10.6	S1-1, S1-2, S1-4 & S1-6 (10.75A)
11.0	S1-3, S1-4 & S1-6 (11A)
14.0	S1-4, S1-5 & S1-6 (14A)
15.2	S1-1, S1-3, S1-4, S1-5 & S1-6 (15.25A)
16.8	S1-3 & S1-7 (17A)
17.0	S1-3 & S1-7 (17A)
21.0	S1-3, S1-5 & S1-7 (21A)
22.0	S1-4, S1-5 & S1-7 (22A)
24.3	S1-2, S1-6 & S1-7 (24.5A)
27.0	S1-3, S1-4, S1-6 & S1-7 (27A)
28.0	S1-5, S1-6 & S1-7 (28A)
31.0	S1-3, S1-4, S1-5, S1-6 & S1-7 (31A)
32.0	S1-8 (32A)
34.0	S1-4 & S1-8 (34A)
40.0	S1-6 & S1-8 (40A)
41.0	S1-3, S1-6 & S1-8 (41A)
42.0	S1-4, S1-6 & S1-8 (42A)
46.4	S1-2, S1-4, S1-6 & S1-8 (46.5A)
52.0	S1-5, S1-7 & S1-8 (52A)

MOTOR OVERLOAD

The motor overload circuit will shut down the SSX controller if the motor draws from 115% to 250% full-load current for 60 seconds (30 seconds with full-load current greater than 250%). If this occurs, the Fault Relay (K2) will drop out, and open a contact between Terminals TB2-1 and TB2-2 on the SSX control board. See Figure 4-1 for the location of Terminal Board TB2. The K2 contact is rated 10.0A at 120VAC or 28VDC resistive, or 120VA at 120VAC pilot duty. This contact can be used for an external fault indication.

CURRENT LIMIT (TORQUE CONTROL)

The main purpose of current limit is to cap the peak current. It may also be used to extend the acceleration time. The range of adjustment is from 0% to 500% with the CURRENT LIMIT potentiometer (see Figure 4-1 for location). However, current limit must be set high enough to allow the motor to reach full speed. Caution should be taken not to set the current limit too low on variable starting loads as this will cause the motor to stall and eventually cause the motor overload to trip.

DECELERATION

Deceleration provides step-less deceleration control. If deceleration is selected with Option Selection Switch S2, remove the wire jumper from Terminals TB1-3 and TB1-4 on the SSX control board, and connect a contact to these terminals. See Figure 4-1 for the location of Terminal Board TB1. Also see Figure 8-2 on page 8-3. When this Deceleration contact is closed and the Run/Stop contact closes, the motor will accelerate to full speed. When the Deceleration contact is opened while the motor is running, the motor will decelerate to a stop. If the Run/Stop contact is opened while the motor is running, the motor will coast to a stop.

Three adjustments are provided (see Figure 4-2, page 4-5): Stop Response, Deceleration and Stop Level (drop out). See Figure 4-1 for the location of these potentiometers.

- **STOP RESPONSE** - The STOP RESPONSE potentiometer determines the voltage at which the deceleration ramp starts when a Deceleration command is initiated. This adjustment eliminates the dead band in the deceleration mode that is experienced while the voltage drops to a level where the motor deceleration rate is responsive to decreased voltage. This feature allows an instantaneous drop in voltage when a Deceleration command is initiated.

Note: The Stop Response adjustment also affects motor voltage during acceleration, as shown in Figure 4-2.

- **DECELERATION** - The DECELERATION potentiometer adjusts the deceleration ramp time from 1 to 30 seconds, and sets the time it takes to reach the stop voltage level set point. However, AC motor design (NEMA Type A, B, C, D) and the load characteristics (inertia and work load) can vary the adjustment range.
- **STOP LEVEL** - The STOP LEVEL potentiometer sets the point where the deceleration voltage drops to zero.

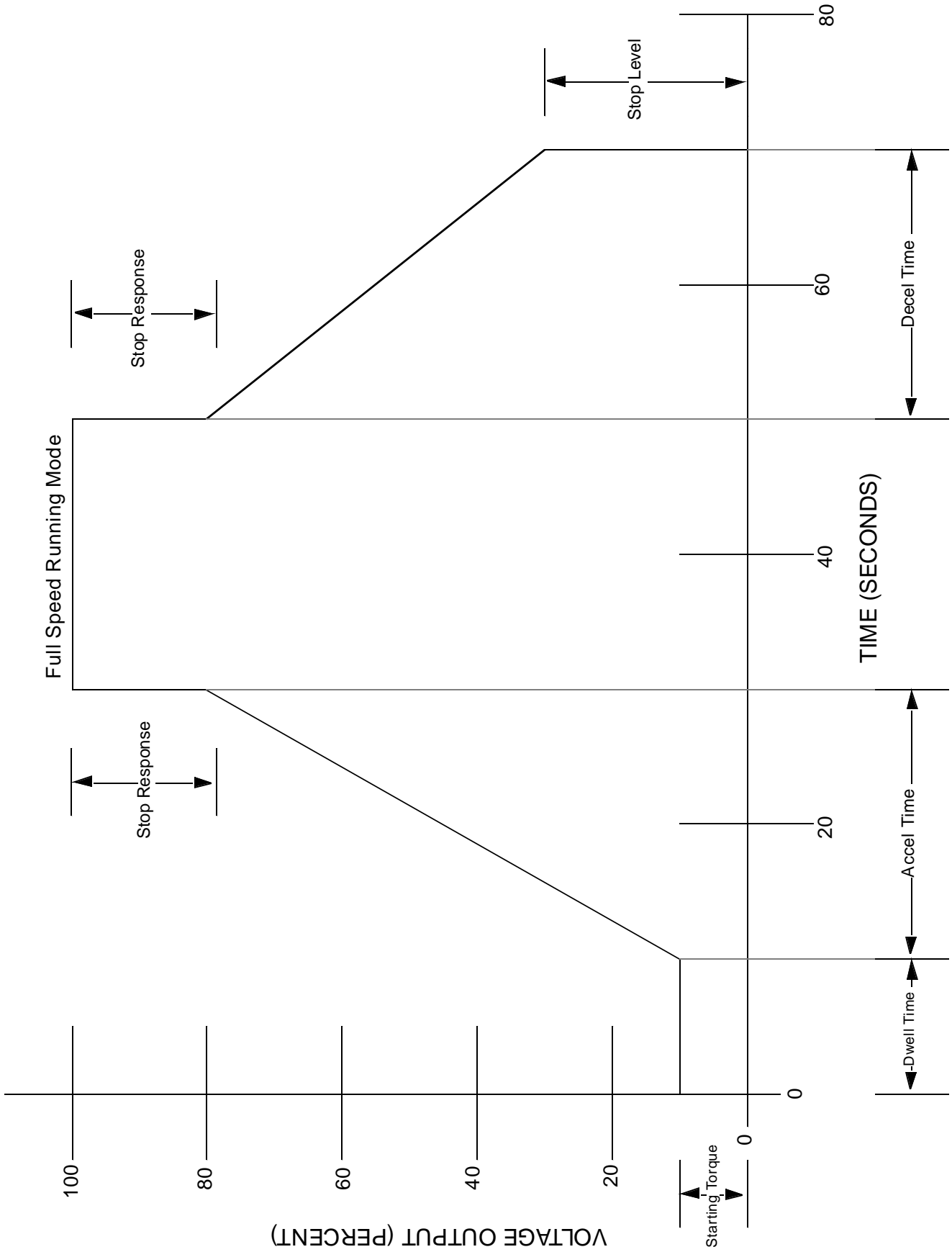


FIGURE 4-2. Ssx CONTROLLER OPERATION AND ADJUSTMENTS

BYPASS

The Bypass Relay (K1) energizes when the controller reaches full output voltage. When Relay K1 picks up, it closes a contact between Terminals TB2-3 and TB2-4. This contact may be used to energize a motor contactor or starter which could be used to switch the motor directly across the AC supply line. The K1 contact is rated 10.0A at 120VAC or 28VDC resistive, or 120VA at 120VAC pilot duty.

FAULT

See Motor Overload on page 4-4.

SECTION V

MAINTENANCE AND TROUBLESHOOTING

MAINTENANCE



WARNING

BE SURE THE AC SUPPLY IS TURNED-OFF BEFORE WORKING ON THE SSX CONTROLLER. THE SSX CONTROLLER CONTAINS HIGH VOLTAGE WHICH CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.

Maintenance consists of keeping the controller clean and dry. No parts require periodic replacement.



CAUTION

NEVER USE COMPRESSED AIR ON THE SSX CONTROLLER. Dirt blown beneath and into components can cause shorts and ground which can damage the controller.

TROUBLESHOOTING



CAUTION

NEVER CONNECT HIGH POTENTIAL TEST EQUIPMENT (E.G., A MEGGER) TO THE SSX CONTROLLER. High potentials can damage the controller.

Most controller failures are caused by incorrect connections, overload, or the accumulation of dirt, dust or moisture.

If motor operation becomes faulty, proceed as follows:

1. Check for:
 - a. Tripped circuit breaker and overload relays, or blown line fuses, as applicable.
 - b. Loose or missing terminal screws.
 - c. Unattached wires.

- d. Charred, darkened, or punctured components and wires.
2. Measure the three-phase AC supply voltage to the SSX controller on Terminals L1, L2, and L3. Voltage must be balanced within $\pm 10\%$ of rated at each phase.
3. Measure the three-phase output voltage to the motor on Terminals T1, T2, and T3. No voltage or unbalanced voltage indicates a faulty SSX controller.
4. If the SSX controller is faulty, replace it and return the faulty controller to the factory for repair.
5. To operate the motor without the SSX controller, turn-off the AC supply voltage to the controller, and reconnect the six wires that were connected to the SSX controller, as follows:

Connect L1 to T1, L2 to T2, and L3 to T3. Insulate the connections properly.

SECTION VI

PARTS LIST

Table 6-1: PARTS LIST

PART	PART NUMBER			
	MODEL SSX0076	MODEL SSX0310	MODEL SSX0310DTC	MODEL SSX0520DTC
Control Board	(1) 106493501	(1) 106493501	(1) 106509201	(1) 106509201
SCR Module	(1) 3301196	(3) 3301199	(3) 3301199	(3) 3301201
R/C Networks	(1) 106497001	(3) 106497001	(3) 106497001	(3) 106497001
Power Transformer	(1) 1064973	(1) 1064973	(1) 1065141	(1) 1065141
Current Transformer	NA	NA	(2) 3411265	(2) 3411265
Fan	NA	NA	(1) 5101164	(1) 5101164

Note: The numbers in parenthesis indicate quantities used.

SECTION VII

RATINGS, OPERATING CONDITIONS, & FEATURES

RATINGS

- Power Source: 230V, 460V, or 575V, 3-Phase, 50/60Hz
- Output Voltage: 0 to 100% of line voltage
- Service Factor: 1.15
- Duty: Continuous
- Overload Capacity: 115% Continuous
- Efficiency (At Rated Speed And Rated Load)

SSX Controller only: 99%

SSX Controller With Motor: 92%

OPERATING CONDITIONS

- Line Voltage Variation: $\pm 10\%$ of rated
- Line Frequency Variation: 48 to 62Hz
- Ambient Temperature Range: 32°F - 104°F (0°C - 40°C)
- Altitude (Standard): 3300 Feet (1000 Meters) Maximum
- Load: Three-Phase Ungrounded AC Induction Motor

FEATURES

- **Phase Insensitive:** The SSX controller will operate with any phase rotation.
- **Line Protection:** Fuses or circuit breaker provided by the user.
- **Restart:** A 250 millisecond delay is required between starts. Restarting the motor in less time can damage the SSX controller.

SECTION VIII

SCHEMATIC DIAGRAMS

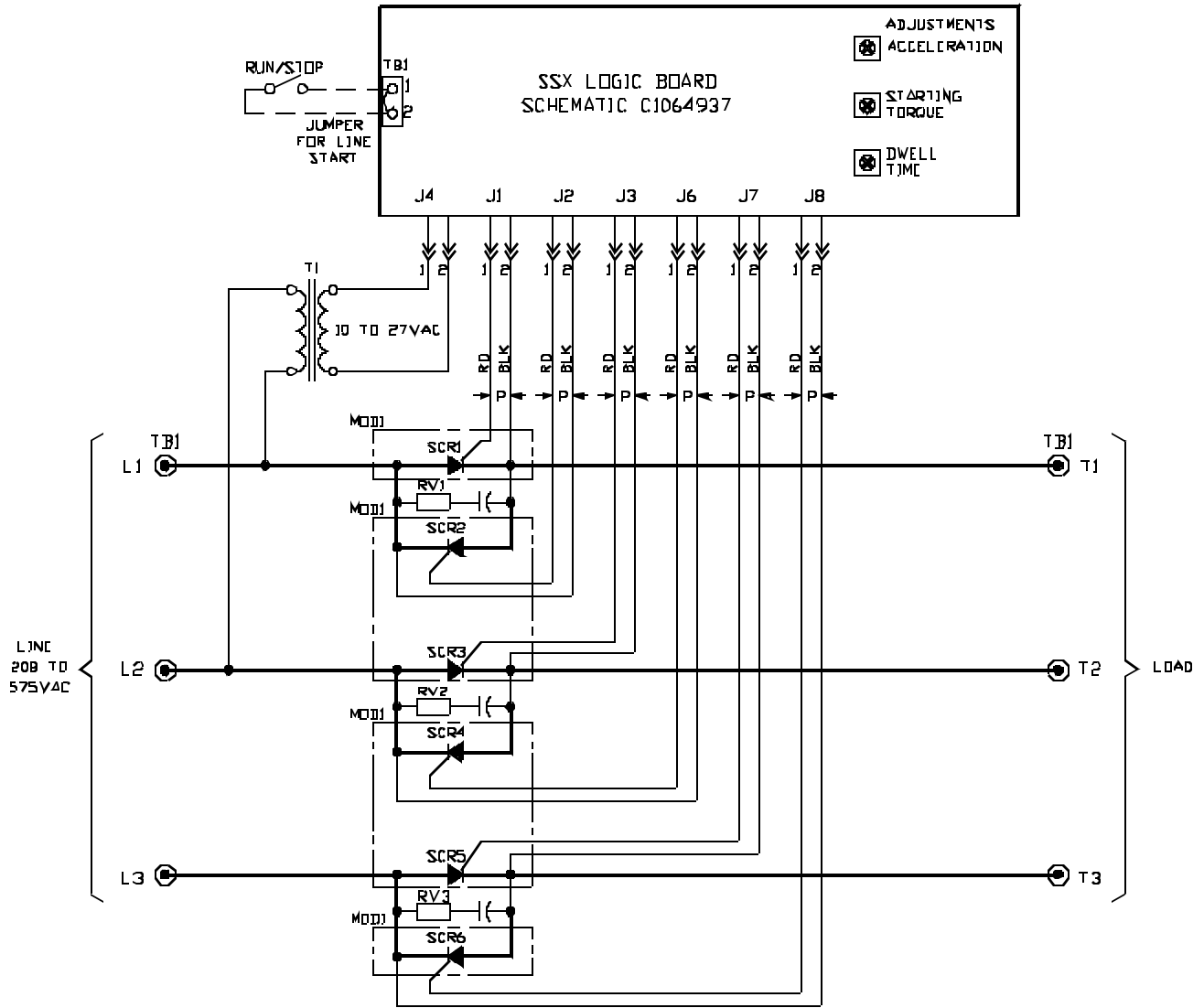
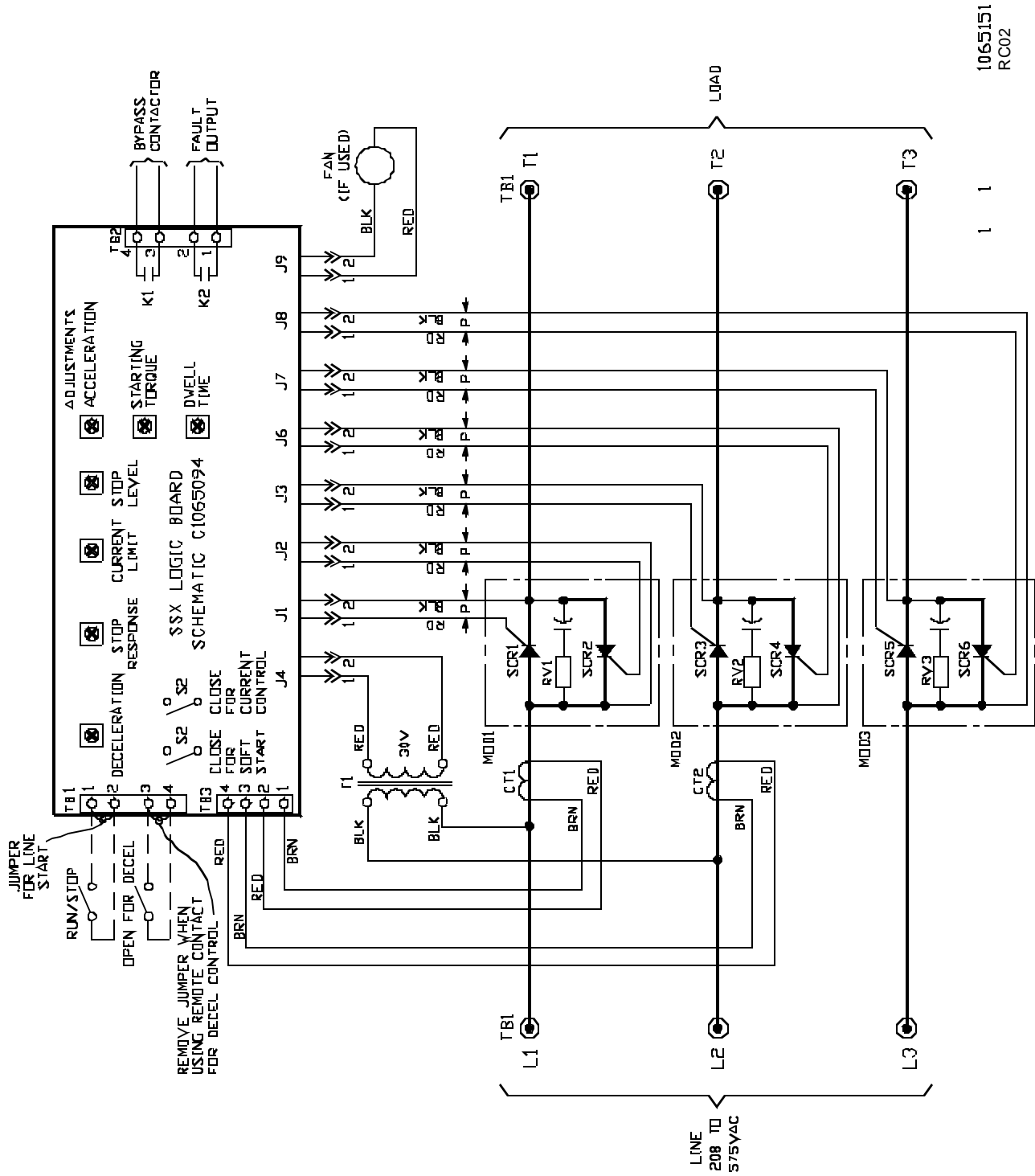


FIGURE 8-1. SCHEMATIC, MODEL SSX0076 AND SSX0310 CONTROLLERS



1065151
RC02

FIGURE 8-2. SCHEMATIC, MODEL SSX0310DTC AND SSX0520DTC CONTROLLERS

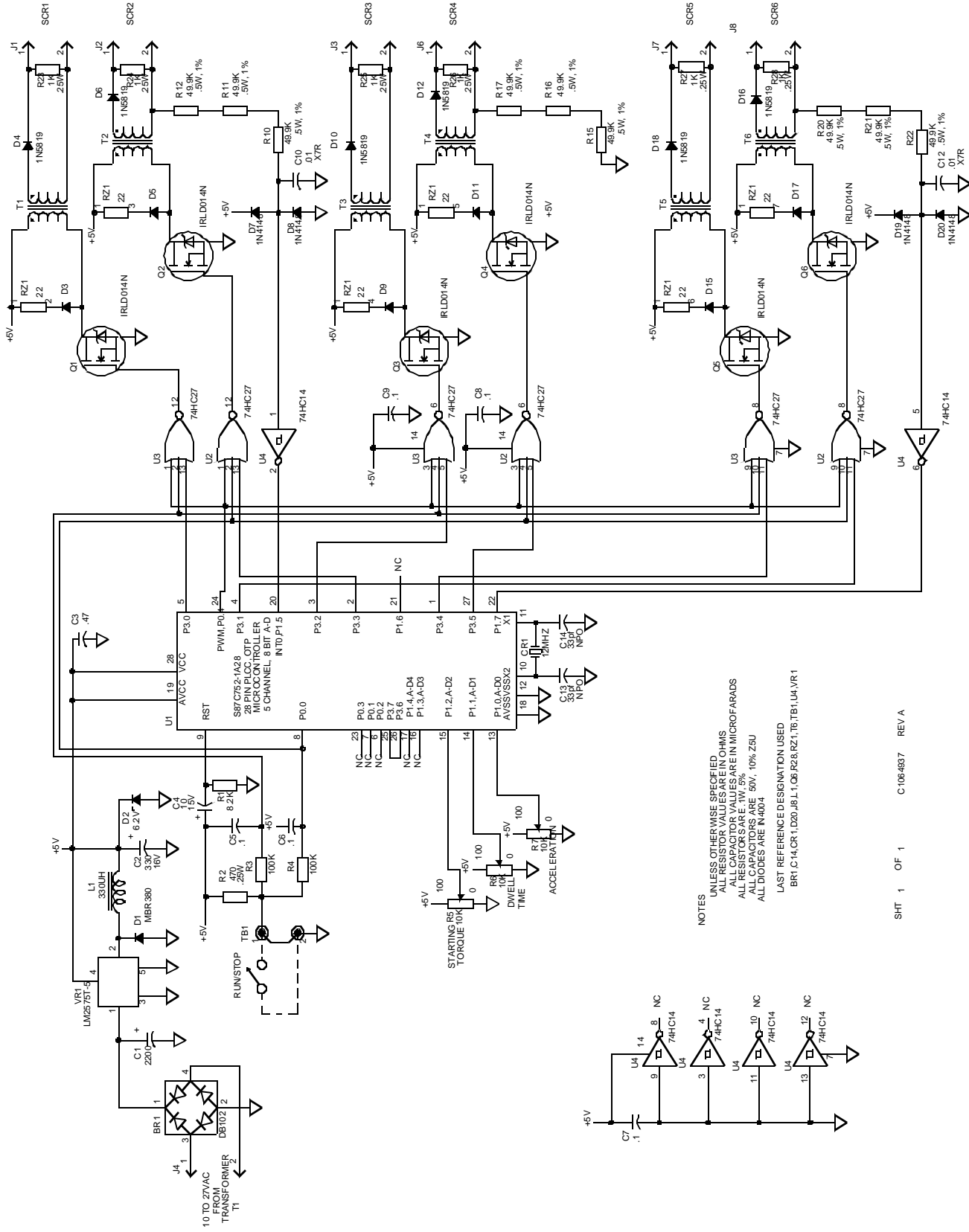
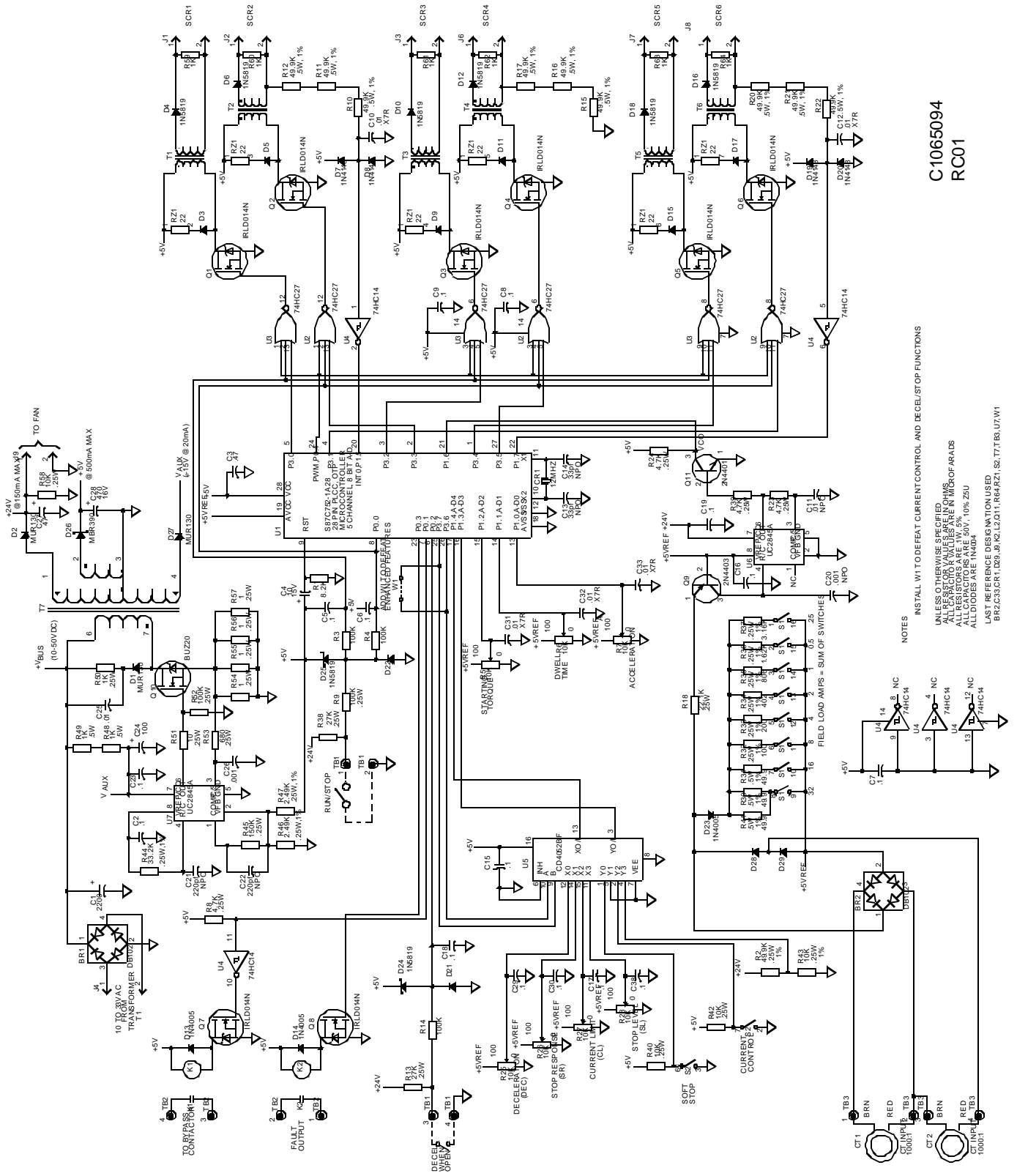


FIGURE 8-3. SCHEMATIC, CONTROL BOARD FOR MODEL SSS0076 AND SSS0310 CONTROLLERS



C1065094
RC01

NOTES
 INSTALL W1 TO DEFEAT CURRENT CONTROL AND DECELSTOP FUNCTIONS
 UNLESS OTHERWISE SPECIFIED
 ALL RESISTOR VALUES ARE IN OHMS UNLESS OTHERWISE NOTED
 ALL RESISTORS ARE 1% 5% 10% 25% 50% 100% 250% 500% 1000%
 ALL DIODES ARE 1N4007
 LAST REFERENCE DESIGNATION USED
 BR2,C3,CR1,D29,J8,K2,L2,Q11,R66,RZ1,S2,T7,TB3,U7,W1

FIGURE 8-4. SCHEMATIC, CONTROL BOARD FOR MODEL SXX0310DTC AND SXX0520DTC CONTROLLERS



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