Installation & Operation Manual

SECO® DC Drive

Quadraline 7000 Series Regenerative DC Drives 1/2 through 5 HP 115/230 VAC 1 Phase Input

Seco

AC/DC Drives

TABLE OF CONTENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

For your safety and for proper operation please take time to carefully read all instructions before installing and operating this unit.

1.0 GENERAL INFORMATION

This manual outlines installation and trouble shooting practices for the Quadraline 7000 series of DC controllers (See Figure 1.) It also contains a brief description of the product and includes specifications, replacement parts and optional equipment data.

Before installing or operating the equipment, read and understand this manual. Always observe the following dangers and cautions when operating or working on this equipment.

DANGER

The National Electrical Code (Publication NFPA No. 70) requires that a fused main disconnect switch be installed between the incoming AC line and the drive system or, if used, the power transformer. (Specifically, this includes the Controller.) Serious injury or death may result if a disconnect switch is not provided.

DANGER

The Quadraline Controller is at line voltage when AC power is connected to the unit. The main power feed must be disconnected by a switch before it is safe to touch the internal parts. Serious personal injury or death may result if this procedure is not observed.

DANGER

The Quadraline 7000 unit is combined with user chosen components to form a drive package. The user is responsible for proper selection of parts and subsequent operation. When a Quadraline 7000 Controller is being used, it should be installed, adjusted and serviced only by qualified personnel who are familiar with the operation of all major components in the system. Serious personal injury or death, and / or equipment damage, may result if this procedure is not followed.

1.1 CONTROLLER

The quadraline 7000 is a D.C. motor speed controller with power-conversion components which convert incoming AC line voltage into adjustable DC voltage in order to control a conventional shunt wound or permanent magnet DC motor.

DANGER

The control circuit of the Quadraline 7000 is not isolated from line potential. Neither this circuit nor the speed control signal can be grounded. Where isolation is required, select the external signal models, or add the isolated input option to the basic on-off model.

The Quadraline 7000 controller chassis unit is designed for panel mounting. It consists of a power convertor section with a control card mounted on a hinged bracket above the power convertor.

1.2 FEATURES

The Quadraline 7000 Controller standard features are summarized in Table 1.

In order to be certain of the specific QUADRALINE 7000 you are installing, check the model number with the chart in Figure 1.

- RUN/JOG - FORWARD/REVERSE models instructions are defined in sections 1.0 through 6.
- EXTERNAL SIGNAL models instructions are defined in sections 1.0 through 7.
- OPTIONS either Factory or Field installed are defined in section 7.

Quadraline 7000 Series		Model Numbers							
		Run / Jog -- Forward / Reverse				External Signal		Zero Position Dancer Control	
Input Line Voltage	HP	Chassis	NEMA 4/12	NEMA 4/12 w/Operators	Chassis	NEMA 4/12	NEMA 4/12 w/Operators	Chassis	NEMA 4/12
115 VAC 1 Phase	1/8 - 1/2	Q7006	N/A	N/A	Q7006	N/A	N/A	Q7006-5	N/A
230 VAC 1 Phase	1/4 - 1								
115 VAC 1 Phase	1/4 - 1	Q7002	Q7022	Q7032	Q7002-1	Q7022-1	Q7042-1	Q7002-5	Q7022-5
230 VAC 1 Phase	1/2 - 2								
230 VAC 1 Phase	3 - 5	Q7005	Q7025	Q7035	Q7005-1	Q7025-1	Q7045-1	Q7005-5	Q7025-5

RUN / JOG-FORWARD / REVERSE Includes power unit, control logics and enclosure if specified with or without operator devices. Operator devices include: Start-Stop switch, Run-Jog switch, Forward-Reverse switch, single turn Speed Setting Potentiometer and Power light.

EXTERNAL SIGNAL Includes power unit, control logics, isolated signal follower accepting 4-20 mA, 1-±5 mA, 0-±10 VDC, 1-±14 VDC or 0-±100 VDC reference signal inputs and enclosure if specified with or without operator devices. Operator devices include: Start-Stop switch, Run-Jog switch, Forward-Reverse switch, Auto-Manual switch, single turn Speed Setting Potentiometer and Power Light.

ZERO POSITION DANCER CONTROL For winders with dancer rolls — includes PID fucntion. This feature is used in special appications usually involving web-processing equipment.

Options

Description	Factory Installed M/N Suffix	Field Installed Kits M/N
Isolated Input - Bipolar, input-output with selectable inputs for 0 to ±10VDC, 0 to ±14 VDC, 0 to ±100 VDC, 1 to ±5 mA or 4 to 20 mA	-1	Q7999-1
Fault Module - Contact outputs - trips on overcurrent, overvoltage or field loss	-2	Q7999-2
Independent Accel/Decel Control - Forward accel, forward decel, reverse accel, reverse decel, 4 potentiometers reverse decel, 4 potentiometers	-3	Q7999-3
AC/Pulse Tach Feedback - Converts signals from AC tachometer or pulse generator to direction sensitive DC voltage for improved speed regulation	-4	Q7999-4

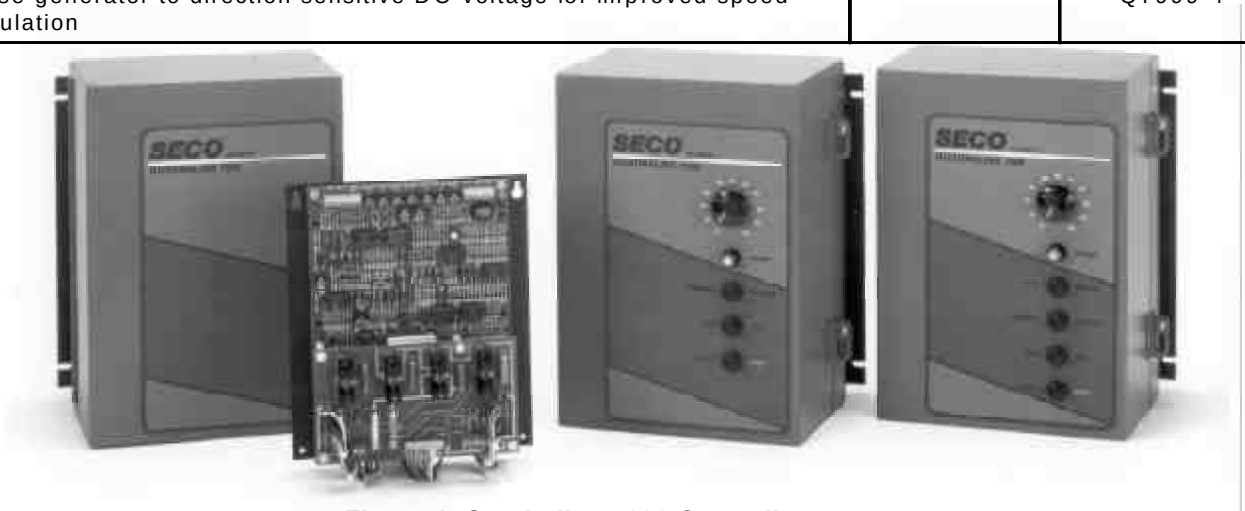


Figure 1. Quadraline 7000 Controller

CAUTION

In cases where the motor speed controller is integrated into a customer-designed drive system, the buyer is responsible for the correct choice of required associated equipment. Incorrectly specified components may cause improper operation and/or damage to the motor speed controller.

Table 1
Quadraline 7000 Standard Features

Model	7006	7002	7005
Specifications			
Horsepower Range			
115 V	1/8 - 1/2	1/4 - 1 HP	Not Used
230 V	1/4 - 1	1/2 - 2 HP	3 - 5 HP
AC Line Input Voltage	115 or 230 V ± 10%	115 or 230 V ± 10%	230 V ± 10%
AC Line Frequency	50/60 Hz ± 2 Hz Single Phase	50/60 Hz ± 2 Hz Single Phase	50/60 Hz ± 2 Hz Single Phase
115 VAC Supply			
Armature Voltage	0 - 90 VDC	0 - 90 VDC	Not Applicable
Field Voltage	50/100 VDC	50/100 VDC	Not Applicable
230 VAC Supply			
Armature Voltage	0 - 180 VDC	0 - 180 VDC	0 - 180 VDC
Field Voltage	100/200 VDC	100/200 VDC	100/200 VDC
Service Factor	1.0	1.0	1.0
Duty	Continuous	Continuous	Continuous
Max. Load Capacity	150% for 1 min.	150% for 1 min.	150% for 1 min.
Line Protection	Fuses	Fuses	Fuses
Operating Conditions			
Ambient Temperature			
Chassis Model	0 - 55°C	0 - 55°C	0 - 55°C
Enclosed Model	0 - 40°C	0 - 40°C	0 - 40°C
Relative Humidity	5 - 95% non-condensing		
Altitude	Sea level to 3300 ft. (1000m)		
Performance Characteristics			
Speed Range	50:1		
Speed Regulation (% of motor base speed) for 95% load change			
Armature Voltage Feedback	±1% to ±2% (depending on motor)		
Tachometer Feedback	±1/2 - 1%	±1/2 - 1%	±1/2-1% (depending on tach generator)
Acceleration (Forward or Reverse)			
Range A	Linear .3 - 3 seconds (To full speed)		
Range B	Linear 3 - 30 seconds (To full speed)		
Adjustments			
Current Range (Nominal-Adjustable) to 150%)	1, 1.5, 2, 3, 5 Amps	2, 3, 4, 6, 10 Amps	15, 25 Amps
Max Speed	70 - 10% of motor base speed		
IR Compensation	Adjustable		

2.0 INSTALLATION

These procedures describe the installation of the Quadraline 7000 Controller.

WARNING

Only qualified maintenance personnel should install the Controller. They should be familiar with drive systems — including operation — and with the possible hazards resulting from improper installation practices. Serious personal injury and/or equipment damage could result if this warning is not observed.

DANGER

The user is responsible for installation of the entire drive system, in accordance with the National Electrical Code, Publication NFPA No. 70; with Electrical Standards for Metalworking Machine Tools, NFPA No. 79; and with all local and national codes which apply. Serious personal injury, death and/or equipment damage could result if this procedure is not followed.

2.1 MOUNTING CONTROLLER

The Quadraline Controller must be mounted in a vertical position with terminals at the top. This orientation permits the required cooling of the heat sinks.

2.1.1 AMBIENT TEMPERATURE

Ambient temperature should not exceed 40°C for enclosed models or 55°C for chassis mounting unit.

2.1.2 ALTITUDE

Altitude should not exceed 1000 meters (3300 feet) unless the Quadraline 7000 has been specially rated for high altitudes. Consult factory for the derating factor for high altitude operation.

2.1.3 AIR CONTAMINANTS

Ambient air should not be contaminated with caustic chemical vapors, excessive dust, dirt, or moisture. If such conditions exist, the proper enclosure and cooling methods recommended for such conditions should be used.

2.1.4 MOUNTING CLEARANCES

Adequate clearance should be allowed for easy access to terminals and adjustments and to facilitate inspection and maintenance.

2.1.5 MOUNTING AREA

Mounting area should be free of vibration and have sufficient clear air circulation available.

2.1.6 GROUND CONDUCTOR

An equipment ground conductor (i.e., ground wire) must be connected to the Controller mounting panel. This conductor must run unbroken to a drive system wire connection point — or ground bus or grounding terminal block, as local usage determines. (See Figure 2-2.) Separate equipment grounding conductors from other major components in the system must also be run unbroken to the star connection. These components include:

- Motor
- Drive
- Isolation transformer case, if used
- Operator control panel, if not on drive enclosure

2.1.7 GROUNDING ELECTRODE

A grounding electrode conductor (i.e., ground wire) or bonding jumper must be run unbroken from the stud connection point (or network ground) to a grounding electrode buried in the earth, or attached to a plant ground. (See NFPA No. 70, Article 250, “Grounding.” Also see Figure 2-2.) Provide a permanent connection that cannot be accidentally broken.

2.1.8 ELECTRICAL CONNECTIONS

When connecting the equipment grounding conductor to the Quadraline 7000 controller’s mounting panel, permanently fix it to the grounding terminal provided.

2.2 ISOLATION TRANSFORMER

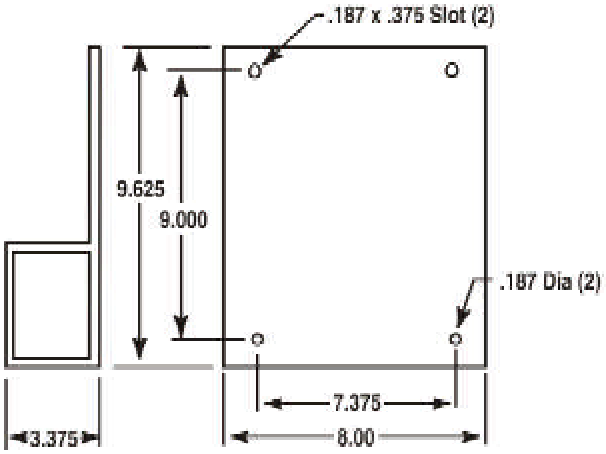
Some applications may require an isolation transformer to compensate for AC line transients or fluctuating input voltages.

2.2.1 TRANSFORMER, CHOICE

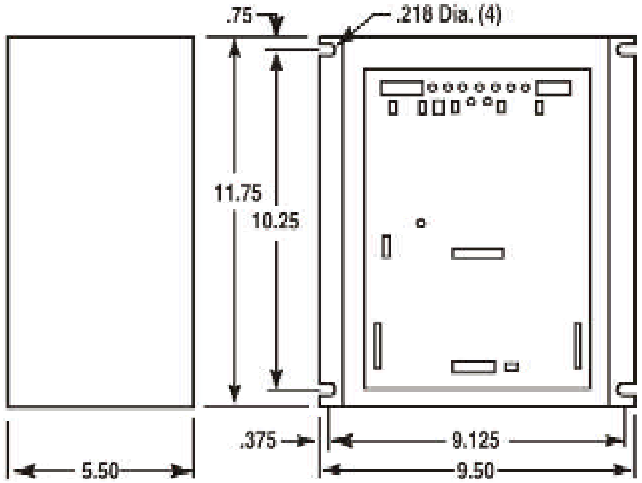
Use an SCR drive type isolation transformer which is designed for phase controlled, DC variable speed drives. See table 2 for continuous duty KVA ratings in relation to horsepower voltages.

Chassis

Q7006 Series



Q70002/7005 Series



Enclosed

Q7002/7005 Series

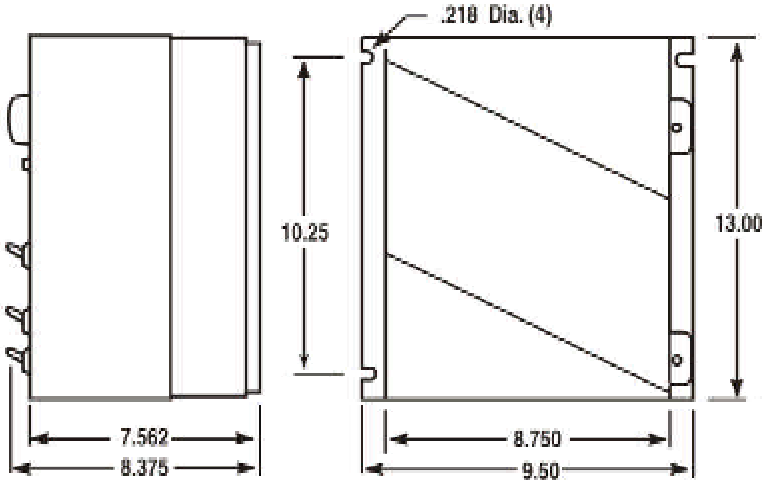
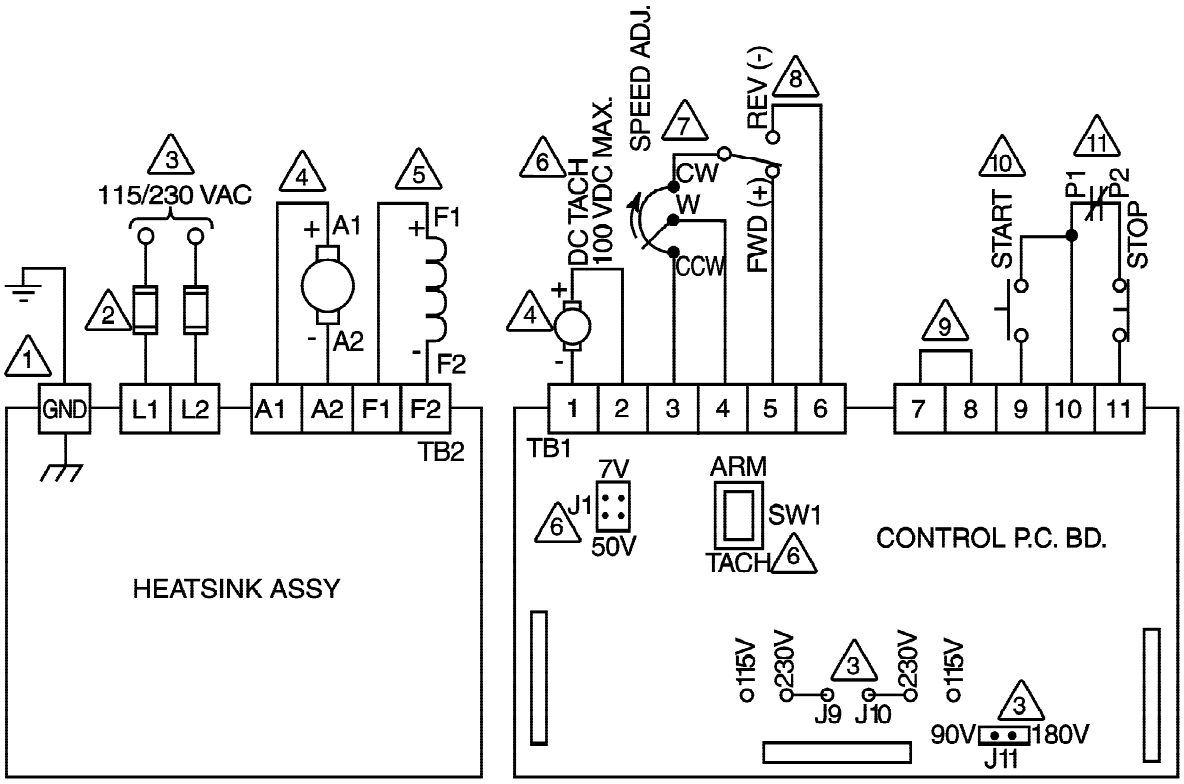


Figure 2-1. Mounting Dimensions



△ NOTES:

1. GROUND CONTROL PER LOCAL AND NATIONAL CODES.
2. CUSTOMER SUPPLIED LINE FUSES; SIZE FOR PROTECTION OF AC LINE WIRING AND TRANSFORMER PER LOCAL AND NATIONAL CODES.
3. PROGRAMMING JUMPERS J9, J10, AND J11 ON CONTROL BOARD MUST BE POSITIONED FOR 115 or 230 VAC LINE.
4. POLARITY SHOWN IS FOR POSITIVE SPEED REFERENCE VOLTAGE AT TB1-4 (FWD DIRECTION).
5. FOR PM MOTORS, NO CONNECTION IS NECESSARY TO F1 AND F2.
6. DC TACHOMETER (7 VDC OR 50 VDC/1000 RPM) IS OPTIONAL; WHEN USED, SELECT TACH FEEDBACK MODE (SW1) AND TACH VOLTAGE LEVEL (J1).
7. SPEED ADJUST POTENTIOMETER: 2KΩ TO 10KΩ.
8. SELECTOR SWITCH DETERMINES DIRECTION OF MOTOR ROTATION. FOR BI-DIRECTIONAL OPERATION WITHOUT SWITCH, CONNECT CW POTENTIOMETER LEAD TO TB1-5 AND CCW LEAD TO TB1-6.
9. TB1-7 AND 8 MUST BE CONNECTED TOGETHER TO ENABLE CONTROL; JUMPER IS FACTORY INSTALLED. OPEN THIS CIRCUIT TO DISABLE CONTROL.
10. START (N.O.) AND STOP (N.C.) MOMENTARY PUSHBUTTONS ARE USED FOR CONVENTIONAL 3-WIRE CONTROL. IF 2-WIRE CONTROL IS REQUIRED, CONNECT MAINTAINED SWITCH OR CONTACT BETWEEN TB1-9 AND TB1-11.
11. IF MOTOR THERMOSTAT (P1, P2) IS AVAILABLE, CONNECT IN SERIES WITH STOP PUSHBUTTON AS SHOWN.

Figure 2-2. Connection Diagram

Table 2 Transformer KVA Ratings

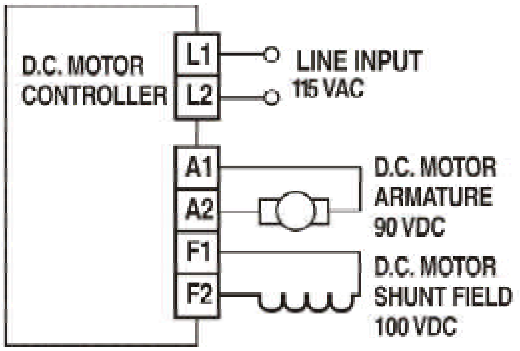
Drive HP	Transformer Rating (KVA)
1/4	1/2
1/2	1
1	2
1-1/2	3
2	5
3	7.5
5	10

2.2.2 DISCONNECT WIRING

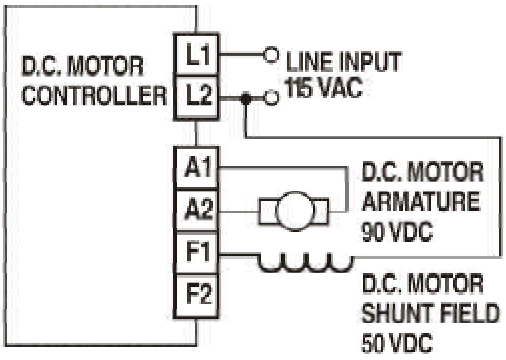
If and isolation transformer is used, the main disconnect switch should be installed in the primary side.

2.2.3 MOUNTING ENVIRONMENT

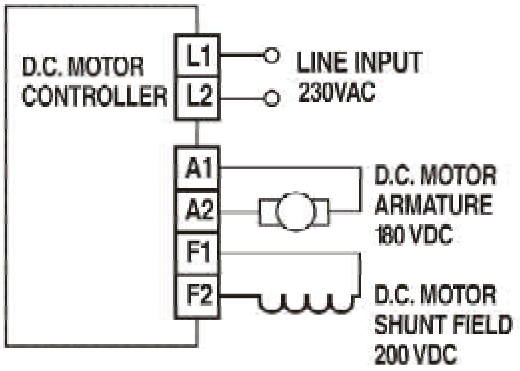
The transformer(s), if used, should be mounted in a way that permits proper ventilation. Be certain that the installation area provides the following environmental conditions.



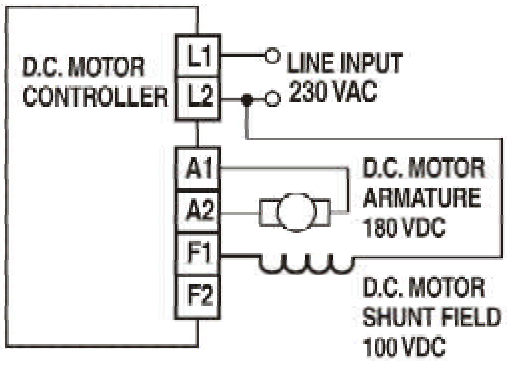
Connections for a D.C. motor with a 90 VDC armature and 100 VDC shunt field.



Connections for a D.C. motor with a 90 VDC armature and 50 VDC shunt field.



Connections for a D.C. motor with a 180 VDC armature and 200 VDC shunt field.



Connections for a D.C. motor with a 180 VDC armature and 100 VDC shunt field.

Figure 2-3. Shunt Field Connections for D.C. Motors

- Ambient temperature should not exceed 40°C (104°F) for enclosed models or 55°C (130°F) for chassis models.
- Altitude should not exceed 1000 meters (3300 feet) unless specified.
- Ambient air should not be contaminated with caustic chemical vapors, excessive dust, dirt or moisture.
- Adequate clearance to allow easy access for inspection and maintenance should be allowed.
- Sufficient air circulation for cooling must be provided.

2.3 INSTALLATION WIRING

Be sure that the AC power supplied is the voltage and frequency called for on the Controller's name plate. Also be sure that the power line is capable of supplying at least the number of AC amperes indicated on the chart provided without voltage reduction. Improper voltage may damage the equipment, and insufficient current will cause erratic operation of the drive. A typical connection diagram is shown in Figure 2-2.

It is recommended that separate conduits be for
- Controller AC power
- Motor armature and field
- Control circuits and tachometer generator, if used
- Reference signals

2.3.1 WIRING CODES

All interconnection wiring should be installed in conformance with the National Electrical Code published by the National Fire Protection Association as well as any other applicable local codes.

2.3.2 SHIELDED CABLE

Shielded cable is recommended for the tachometer generator, speed potentiometer, indicating meters, and all low-level signal circuits, to eliminate the possibility of electrical interference. If shielded cable is not available, the wires to such items should be twisted together with about 6 turns per foot. Connect the shield to chassis ground at the controller end of the cable.

CAUTION

Follow the installation wiring diagram provided in figure 2-2. When connecting the motor, pay particular attention to the marking on the motor leads. It is possible to damage the Controller and motor if incorrect connections are made.

2.3.3 MOTOR SHUNT FIELD

Quadraline 7000 Controllers have a standard field voltage supply as follows:

- 115 VAC Controllers 50/100 VDC shunt field supply
- 230 VAC Controllers 100/200 VDC shunt field supply

Some motors are furnished with dual voltage fields. If so, they will have 4 field leads marked F1, F2, F3 (or F11), and F4 (or F22). In such instances, check the motor nameplate for the field voltages and connect the motor nameplate for the field voltages and connect the motor leads for the field voltage provided by the drive.

2.3.4 PERMANENT MAGNET MOTORS

If the Quadraline 7000 is to be used with a permanent magnet motor, no connection is required to the field terminals.

2.3.5 MOTOR SERIES FIELD

If the motor has other leads marked S1 and S2 (series stabilizing field), carefully insulate these leads so that they do not touch each other or any other lead or part of the motor. The series field is not required for regenerative operation.

2.3.6 MOTOR THERMOSTAT

If the motor has additional leads labeled P1 and P2 (motor thermal switch) connect these wires in series with the STOP push-button as shown in Figure 2-2.

2.3.7 MOTOR WIRING

In all instances, the following must be done in connecting the motor to the Quadraline 7000 Controller

- If the motor is equipped with dual shunt field coils, both must be connected.
- Where a series field (S1 and S2) is provided, it must **not** be connected.

Connecting the series field may cause current overflowing through the series field to weaken or collapse the magnetic flux of the shunt field resulting in extremely unstable operation, high armature current and erratic speed control.

2.3.8 SUPPRESSION

All relay, starter and/or solenoid coils used in equipment associated with the drive system must be suppressed. For 115 or 230 VAC circuits, use SECO part #PCA-1028-00 or equivalent. For circuits having voltage ratings above 230 VAC, contact Danaher Motion Engineered Systems Center for a recommended suppressor network.

3.0 START UP CHECKS

The procedures listed in this section, when performed in the order presented, ensure a safe, orderly initial examination and start up of a drive system with a Quadraline 7000 Controllers.

- Only qualified electrical personnel should perform theses procedures.
- Personnel must be familiar with and follow electrical safety procedures.
- The drive system must have been installed and wired according to the procedures listed in Section 2.0 of this manual
- The recommended test equipment or equivalent must be used and used in the specified manner.

DANGER

The start up, calibration and servicing of this equipment should be performed only by personnel familiar with electronic equipment, the equipment in the drive system, related machinery, and the potential hazards involved. Failure to observe this warning can result in serious personal or even fatal injury and/or equipment failure.

The start up procedures should be carried out in the following sequence:

- Visual inspection
- Ground checks
- Initial pot and jumper settings
- Motor inspection
- Ground checks
- Incoming AC line voltage verification
- Start up

3.1 TEST EQUIPMENT

Recommended test equipment is listed in Table 3. Because of the high voltages present in the drive system, exercise great caution when using the equipment.

DANGER

Use only the recommended test instruments, or equivalents, when performing service on a Quadraline 7000 drive system. Failure to observe this warning can cause serious personal injury, death and/or damage to the equipment.

TABLE 3. RECOMMENDED TEST EQUIPMENT

Equipment	Manufacturer	Type
Multimeter	Simpson	260 VOM
(VOM)	Triplett	630 VOM
Oscilloscope[1]	Tektronix	T9-12
DC ammeter[2]	Various	Shunt
(or equivalent)		

[1] Oscilloscope is not essential to the installation, start up or maintenance of a Quadraline 7000 system, although it will be useful.

[2] Must be capable of 150% of rated armature current. (See Table 2.)

Isolated equipment which does not electrically common the case with the test leads is highly recommended. If a non-isolated oscilloscope or multimeter is used, it must be treated as potentially live and dangerous equipment. Keep in mind that other plant personnel may not be aware of the danger. Always clearly label the oscilloscope as dangerous and, whenever possible, restrict unnecessary personnel from the area.

3.2 VISUAL INSPECTION

This paragraph discusses the visual inspections which must be carried out while AC power is off. It may be considered as an inspection of proper installation practices and possible transit damage.

DANGER

Before proceeding further, make sure that the main machine disconnect switch is turned off and locked out. With a VOM, measure the High-Voltage Area and Control Assembly's terminals to make sure no voltages are present in the equipment.

DANGER

High voltages may, in some drives, exist in the enclosure even after the main machine disconnect is opened. Wiring codes specify the use of yellow insulation on wires not controlled by the switch. Find the source for those wires, and remove power. Serious personal injury can result in this caution is not followed.

a) Inspect AC power connections to fuse terminals L1 and L2 to ensure that they are secure and tight.
b) Inspect the controller for possible physical damage and to ensure connections are secure
c) Inspect controller for foreign matter (e.g., packing material, pieces or wire, etc.) and remove.
d) Inspect printed circuit board for possible physical damage. Be sure that all wired connections, including edge connectors are secure and tight.
e) Refer to the system drawing in order to determine the exact model of the controller. Then, refer to the wiring diagram that applies and use it to make sure the wiring is correctly installed.

3.3 INITIAL SETTINGS

The following procedure must be followed to check if jumper connections have been made correctly and that potentiometers are adjusted correctly. See Figure 3-1.

All controllers will have been tested at the factory under actual motor load. Factory settings for potentiometers are indicated in the procedure.

a) **Line Voltage Selection (Model 7002 or 7006 only)** These controllers are suitable for operation on either 115 or 230V single phase, 50/60 Hz supply.

AC Supply

Jumper J9 and J10- should be in the 230V position for 230V operation or in the 115V posi-

tion for 115V operation.

Feedback
Jumper J11 should be in the 180V position for 230V operation or in the 90V position for 115V operation

Model 7005 controller is factory set for a 230 volt AC single phase, 50/60 Hz supply; and for 180 VDC armature output.

b) **Current Scaling**
The factory setting for the Controller has been made for the maximum horsepower rating shown on the nameplate. Connections may be made for lower maximum current ratings by connecting Jumper J6 as follows:

- The Quadraline Model 7005 is intended for operation from 230 VAC to control 3 or 5 HP DC motors. The Model 7005 can, if necessary, be operated from 115 VAC. However, it is necessary to correctly position Jumpers 9, 10 and 11 for 115 VAC input and 90 VDC output as listed in 3.3a.

c) **Speed Feedback Selection**
1) Tachometer generator voltage selection:
Jumper J1 selects the tachometer generator voltage either 7V DC/1000 RPM (12.25 V max. for 1750 RPM motor) or 50V DC/1000 RPM (87.5V max. for 1750 RPM motor).

d) **Linear Acceleration/Deceleration Time**
There are two ranges of acceleration rate; the factory setting is the 3-30 second range. Other ranges may be selected by moving Jumper J3 and J4 as follows:

J4 Position	J3 Position	Accel/Decel Time
A	A	Linear Adjustable 0.3 - 3 Sec.
B	A	Linear Adjustable 3 - 30 Sec.
A or B	$\overline{A}$	Current Limit

NOTE: The acceleration time for a forward direction is the same as for the reverse deceleration. The acceleration time for a reverse direction is the same as for the forward deceleration. If independent adjustments for forward acceleration, forward deceleration, reverse acceleration and reverse deceleration are required, a four potentiometer adjustment option is available that plugs into the Quadraline controller.

e) **Torque or Speed Control**
The factory setting is for speed control. If the torque control mode is required, move jumper J2 from SPEED to TORQUE. If an analog tachometer generator has been used for the SPEED mode it most be disconnected from Terminals TB1-1 and 2 for the TORQUE mode operation. Move switch SW1 to TACH position. In the TORQUE mode, the Q7000 operates as a current controller; the current or torque level is determined by the setting of the external Speed Adjust Potentiometer. The maximum current limit levels are still determined by pots R5 and R6 (see Figure 3-1). If the load is removed from the motor in the TORQUE mode, motor speed is limited to approximately base speed.

f) **AC Supply Frequency**
The factory setting is for 60 Hz operation. If this unit is to be used on a 50 Hz supply, move Jumper J5 from 60 Hz to 50 Hz.

g) **Potentiometer Setting**
The following potentiometer settings should be checked before AC power is applied. The factory settings indicated are set when the controller is tested with a motor load. During start-up, it may be necessary to modify them for a specific drive application. Generally, clockwise (CW) rotation of a potentiometer increases a setting and counterclockwise (CCW) rotation decreases a setting.

1) **Maximum Speed**
The factory setting is at 100% of rated speed. It can be adjusted to run between 70 and 105% of rated motor speed by adjusting pot MAX SPEED.

2) **Acceleration Rate Forward**
The factory setting full CW represents 3 seconds nominal. Adjusting ACCEL FORWARD also controls the deceleration rate in the reverse direction.

3) **Acceleration Rate Reverse**
This control is similar to Accel Rate Forward, but controls acceleration rate in reverse direction and deceleration rate in the forward direction.

4) **IR Compensation**
This control provides a means of improving motor speed regulation in the armature feedback mode. The factory setting of full CCW provides no compensation. To compensate for IR motor losses, run the motor at the required speed at no load, then increase the load to maximum and adjust R2, IR COMP to obtain the same

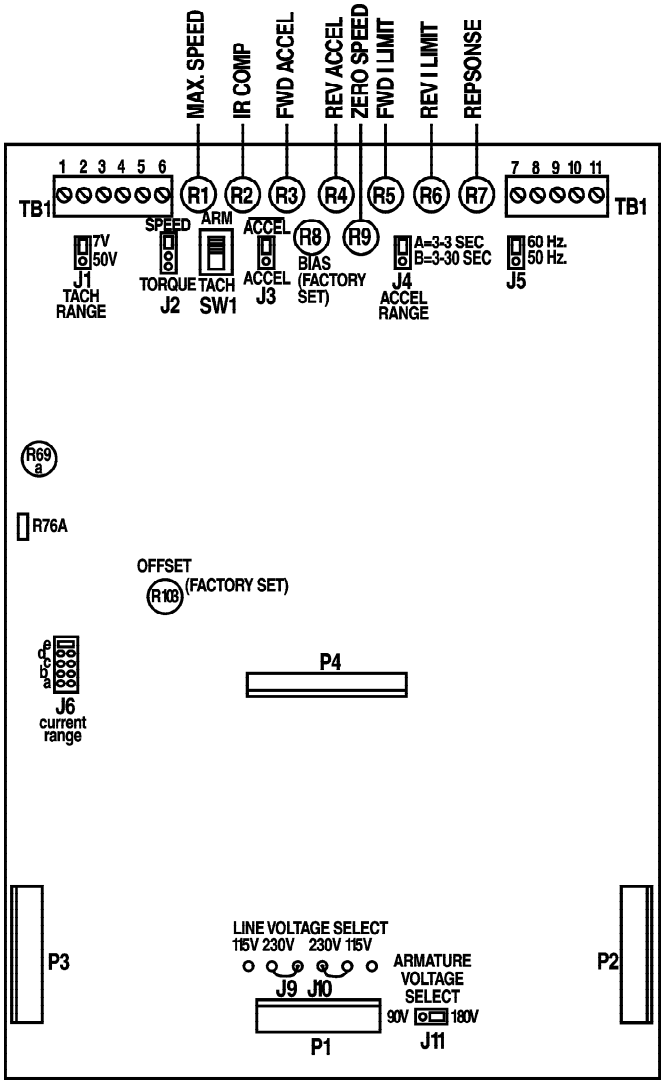


Figure 3-1. Adjustment Locations

motor speed as with no load. CAUTION: Excessive IR Compensation can cause instability.

5) **Response**
The factory setting is adequate for most applications. In some circumstances such as those involving high inertia loads or loads requiring rapid acceleration and deceleration this control may require adjustment. Faster response may be obtained by adjusting R7-Response in a CCW rotation. Care must be taken to avoid system instability.

6) **Current Limit Forward**
The factory setting of the 3/4 full CW represents a current limit of 100% of maximum for the unit. It is possible to adjust the forward current limit of the drive from 0 to 150% by turning pot R5 FORWARD I LIMIT.

Individual application conditions, such as load or speed changes or acceleration of high inertial loads, may require a change in current limit setting.

Note that an adjustment too low for the actual load may prevent the motor from reaching the correct speed or accelerating at the programmed rate.

7) **Current Limit Reverse**
The factory setting at 3/4 full CW represents a current limit of 100% of maximum. It is possible to adjust the reverse current limit from 0 to 150% of nominal by turning pot R6 REVERSE I LIMIT.

Note that, depending on the direction of motor rotation and whether the motor is regenerating power or not, each current limit setting will affect the motor in a particular way. Thus, for forward rotation, motoring, or reverse rotation regenerating Current Limit Forward will be effective. For reverse rotation, motoring or forward rotation regenerating Current Limit Reverse will be effective.

8) **Zero Speed**
This is a factory-set adjustment and should not be changed.

9) **R69A**
This is a factory adjustment and should not be changed.

10) **Bias**
This is a factory adjustment and should not be

changed.

11) **Offset**
This is a factory adjustment and should not be changed.

Note: If, at any time, it becomes necessary to replace the Control Board Assembly, it is essential that all of the jumpers on the replacement board are in the same positions as on the board being replaced, as well as the adjustment pot settings.

3.4 MOTOR INSPECTION

Inspect the motor to ensure it is free to rotate, and that the tachometer generator, if fitted, is coupled and aligned correctly.

Check connections to motor armature motor field (if required), tach generator (if required), and motor thermal switch (if supplied), to make sure all are correct and secure.

3.5 ISOLATION TRANSFORMER

When an isolation transformer is used, ensure that the primary and secondary voltage connections are correct and secure.

4.0 START UP PROCEDURE

The following procedures verify that the motor field excitation. A.C. control voltage, reference voltage, and motor current are within tolerance and that direction of motor rotation is correct.

4.1 FIELD EXCITATION (Shunt wound motors only)

a) Before applying AC power, disconnect armature lead A1 and insulate safely.
b) Apply AC power and verify that one of the following voltages exists across the F1, F2 terminals of the motor:
   50 V or 100 V, on a 115 VAC drive
   100 V or 200 V, on a 230 VAC drive

4.1 CONTROL VOLTAGE

a) With a VOM, verify that a voltage of +10 VDC exists between terminals 5-3 on the control board, and that -10 VDC exists between terminals 6-3
b) Verify proper operation of all pilot lights, relays, limit switches, etc., as required in the particular installation.

On completion of this phase of the start-up procedure, turn off the AC power, reconnect the motor armature lead to terminal A1. Set the drive for armature voltage feedback by moving switch S1 to the armature voltage position (ARM). This will permit verification of direction of motor rotation and correct tachometer polarity. All drives should be started up in this mode, regardless of the final mode of feedback control.

4.3 MOTOR ROTATION

Follow this procedure only after the operation of all relays, push-button switches, etc., has been verified. (See paragraph 3.8.2). **Note:** Disconnect motor from driven machine for these tests, especially if the machinery can be damaged by reverse rotation.

a) Set the speed command to zero speed and apply AC power.
b) Depress the START push-button or activate the start command circuit.
c) Slowly rotate the speed adjusting potentiometer, or gradually increase the speed command signal and note rotation of the motor. If the motor direction of rotation is incorrect, turn off AC power, interchange motor armature leads A1 and A2 at the controller terminals.

Tachometer Feedback Only:

If tachometer feedback is to be used, restart the drive and measure the voltage polarities at the tachometer and speed potentiometer terminals on the Quadraline controller. See Figure 4-1.

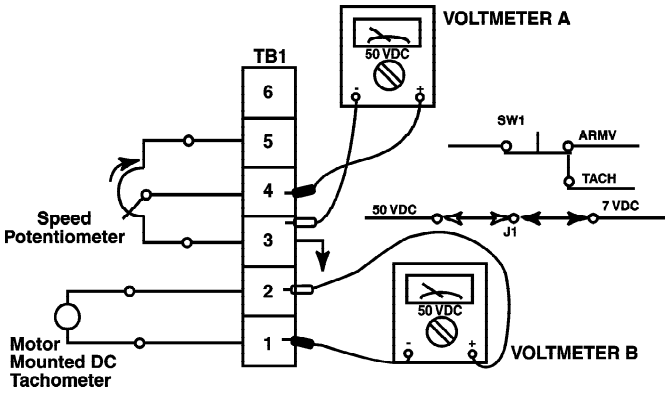


Figure 4-1. Tachometer Feedback Connections

1. With the motor running at approximately 20% of rated speed the polarities must be the same. If they are not, stop the drive, disconnect the AC power to the control, and reverse the tachometer connections at terminals TB1-1 and TB1-2.
2. Move Jumper J1 to the correct position
   - For 7 VDC/1000 RPM Tach: J1 in 7V position
   - For 50 VDC/1000 RPM Tach: J1 in 50V position
3. Place switch SW1 in the TACH position.
4. Reapply AC power to the controller.
5. Restart the drive/motor.

4.4 SPEED SETTING ADJUSTMENT

Turn on AC power, enable drive, operate start circuit, slowly turn Set Speed potentiometer fully clockwise. Check to verify that motor speed is 100% of nameplate rating. Adjust Max. Speed control as required.

4.5 LOADING

This is to verify that the horsepower requirements of the drive load are within the power rating of the Drive Package. Since the armature current is directly proportional to motor torque, excessive armature current indicates a motor load which is too high.

a) With AC power removed, insert a zero center DC ammeter in series with either motor armature lead. The capacity of the meter should be of a high enough rating for the possible currents. See Table 4.

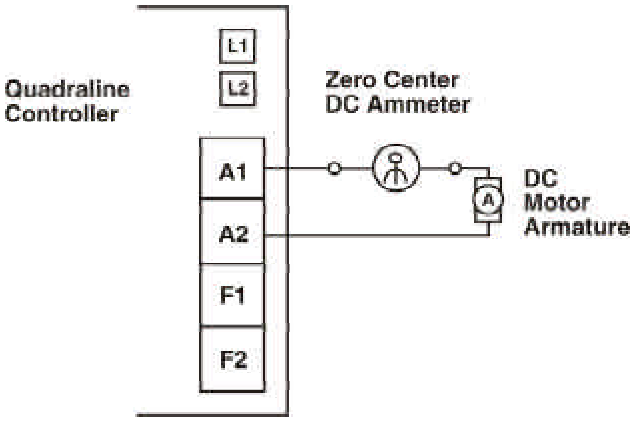


Table 4. D.C. Motor Armature Amps (Nominal Full Load)

HP	90 DC Armature Amps	180 DC Armature Amps
1/4	2.5	1.2
1/2	5	2.5
3/4	7.5	3.7
1	10	5
1-1/2	—	7.5
2	—	10
3	—	15
5	—	25

b) Reapply AC power and start the system.
c) Measure armature current under all conditions of operation. Verify that full load current never exceeds the motor nameplate rating or controller rating, on a continuous basis.

5.0 THEORY OF OPERATION

This chapter describes the operating theory of the regenerative DC motor controller.

5.1 DRIVE SYSTEM

A Quadraline drive system is designed to produce an accurately controlled DC motor speed in response to a reference voltage input. The accuracy of commanded speed and speed regulation are determined by feedback loops contained within the drive system.

5.2 CONTROL ELECTRONICS

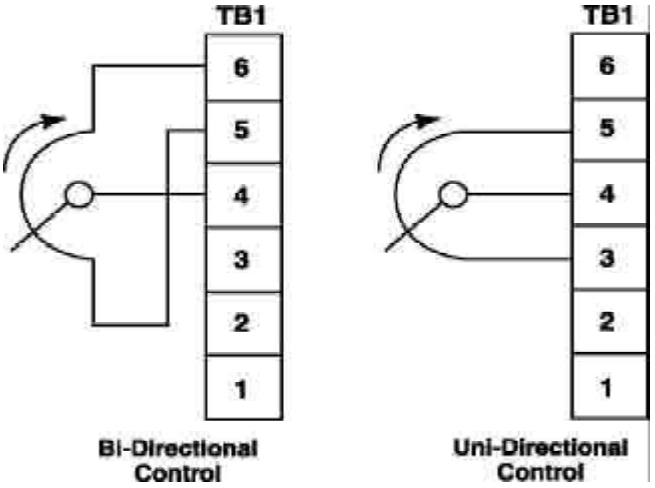
The control electronics printed circuit card contains the low voltage power circuit, current loop amplifier, speed amplifier, and gate drive circuits.

5.3 BASIC BLOCK

The basic block diagram for the Quadraline 7000 controller (Figure 4-1.) shows the relationships between the power convertor, control electronics, operators controls, and motor and tachometer generator. A brief description of each circuit function follows.

5.3.1 SPEED REFERENCE

The speed reference circuit provides a voltage source for the operator speed potentiometer. The polarity of the speed reference voltage can be selected by its connection to the operator speed potentiometer. For bidirectional control from the speed pot, connect the outer potentiometer leads across the ± 10V supply TB1-5 and TB1-6. For unidirectional speed control, connect the outer speed pot leads to TB1-5 or TB1-6 and common terminal, TB1-3. In either bidirectional or unidirectional operating modes, the center or wiper lead from the speed setting potentiometer is connected to the Quadraline controller signal input at terminal TB1-4.



5.3.2 ACCELERATION/DECELERATION CIRCUIT

The acceleration/deceleration circuit provides a controlled and independently adjustable linear rate of acceleration and deceleration to, or from, operating speed. Adjustment of the time to reach full speed can be made in the range of 0.3 seconds to 3 seconds, or 3 to 30 seconds. The effective range of adjustment is selected by connecting Jumpers J3 and J4 as described in paragraph 3.3.d. Due to the bidirectional speed capability of the Quadraline 7000 regenerative drive, the acceleration and deceleration rates are interrelated. Forward Accel Control adjusts the acceleration in the positive motoring direction and deceleration in the negative motoring direction. Reverse Accel Control adjusts the acceleration in the negative motoring direction and deceleration in the positive motoring direction.

5.3.3 TACH SCALING CIRCUIT

The tach generator scaling circuit takes the voltage from a D.C. tach generator and conditions it to the correct value for the speed control amplifier. The correct selection is made as follows:

Tach Voltage At 1750 RPM	J1 Jumper Terminals
12.25 VDC (7 VDC/1000 RPM)	7 V
87.5 VDC (50 VDC/1000 RPM)	50 V

The correct top speed for a particular combination of tach generator and motor is set using the Max. Speed pot. Note: The tachometer circuit must be physically selected by placing Switch SW1 in the TACH position.

5.3.4 ARMATURE VOLTAGE SCALING

The armature voltage scaling and buffer circuit provide a scaled voltage proportional to the motor's armature voltage for those drive systems which do not use tachometer generator feedback. Note that to select armature voltage feedback, Switch SW1 must be in the ARM position.

5.3.5 SPEED LOOP REGULATOR AND IR COMP

The speed loop amplifier sums the speed command signal (from the acceleration control circuit) and the speed feedback signal (either tachometer or armature voltage). The resulting voltage is amplified and modified and provides the input to the current regulator.

When armature voltage feedback is used, speed errors caused by armature circuit resistance are compensated by the IR Compensation circuit. A voltage proportional to armature current is summed with the speed reference voltage input to the speed reference voltage input to the speed regulator. This compensation voltage causes the voltage applied to the motor armature to be increased up to 5% of rated armature voltage and will compensate for the IR drop in the armature caused by load current.

The speed regulator output voltage is limited by the FORWARD AND REVERSE I LIMIT current pots. These set the maximum value of the current allowed to flow in the motor armature during motoring and regenerating. The operation of the pots is interrelated such tat FORWARD I LIMIT sets the current for motoring in the positive direction of rotation and for regenerating in the negative direction of rotation. REVERSE I LIMIT set the current for motoring in the reverse direction of rotation and for regenerating in the negative direction of rotation.

5.3.6 CURRENT REGULATOR

The current regulator sums the current command signal from the Speed Loop controller with the current feedback signal from the Current Feedback Amplifier. The output signal is amplified and stabilized and sent to the A Forward and B Reverse Firing Circuits.

5.3.7 FIRING CIRCUITS

The Firing Circuits. A Forward and B Reverse, provide the firing pulses which are fed to the gates of the SCRs to turn on the SCRs and produce output power. They produce correctly phased firing pulses controlled by the current regulator signal. The firing circuits also have an input from the current feedback regulator which prevents firing pulses from being sent to an SCR bridge when current is still flowing in the motor armature from the other bridge. This signal is called the Lockout Signal.

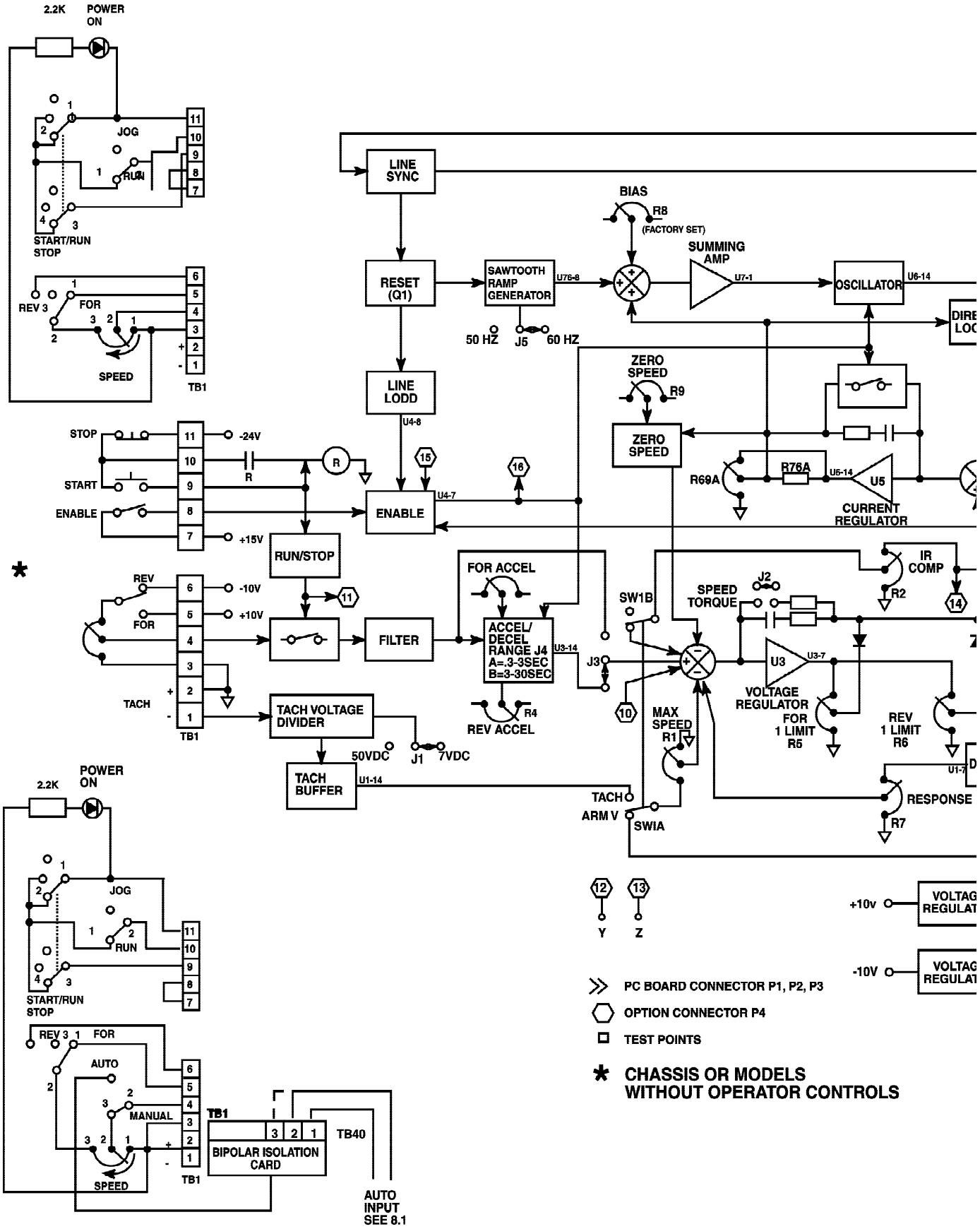
5.3.8 ENABLE CIRCUIT

The Enable Circuit electronically prevents the speed and current loop amplifiers from operating unless the Enable Circuit is energized. The Quadraline controller is enabled by connecting ±5 volts to the input of the Enable Circuit.

5.3.9 OVERSPEED CIRCUIT

The Overspeed Circuit electronically locks out the regenerative circuits if the motor armature voltage exceeds a safe value, or if the A.C. line input voltage falls below a safe level. This prevents a malfunction known as an "Inversion Fault" which could cause fuses to blow.

RUN/JOG - FORWARD/REVERSE / Models with Operator Controls



EXTERNAL SIGNAL / Models with Operator Controls

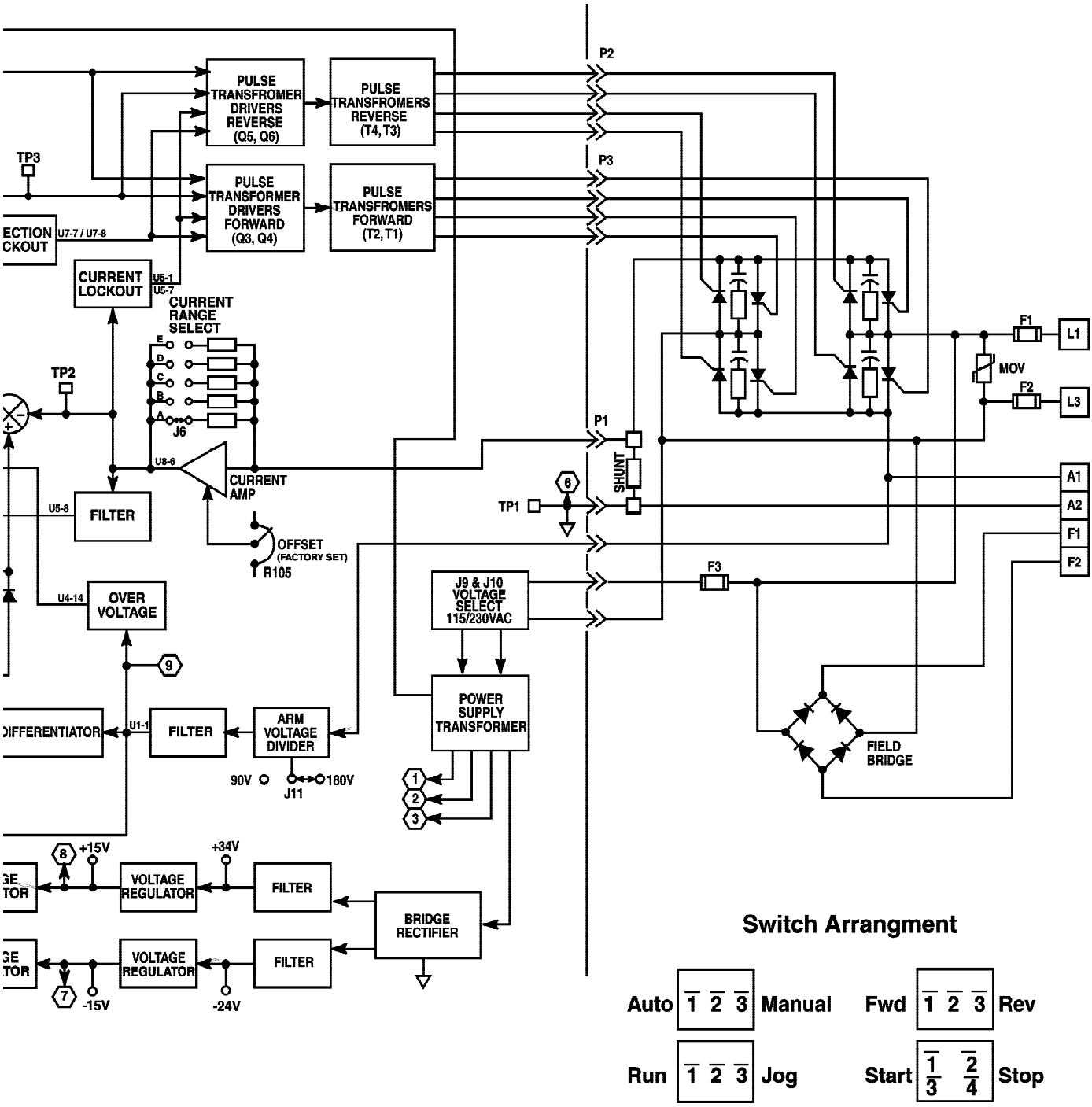


Figure 5-1. Block Diagram

6.0 TROUBLESHOOTING

This chapter contains troubleshooting information for the Quadraline 7000 packaged controller. The organization of the chapter is as follows:

- Safety procedures (Paragraph 6.1)
- Recommended instruments (Paragraph 6.2)
- General troubleshooting area (Paragraph 6.3)
- Test meter (Paragraph 6.4)
- Checking with external meter (Paragraph 6.5)
- Symptoms, probable cause (Paragraph 6.6)

DANGER

The Quadraline 7000 Controller should be installed, adjusted and serviced by qualified electrical maintenance personnel familiar with the construction and operation of the equipment and potential hazards. Failure to follow this procedure may cause serious personal injury, death and/or equipment damage.

DANGER

Dangerous high voltages are present in the Quadraline 7000 Controller when incoming AC line power is connected. Make all changes to the equipment with the main machine disconnect locked in the OFF position. Failure to follow this procedure may cause serious personal injury, death and/or equipment damage.

6.1 SAFETY PROCEDURES

Certain basic safety procedures must always be practiced when troubleshooting this equipment.

DANGER

Observe the safety procedures listed here, NEC recommendations, local practices and plant rules when working on the Quadraline 7000 equipment. Failure to follow these procedures may cause serious personal injury, death, and/or equipment failure.

Do not assume the procedure listed here forms a complete safety list. They are only a basic starting point.

- Always use appropriate high-voltage safety techniques when working on the equipment.
- Visually check for possible short circuits before applying power. Accidental shorts may result in extremely high current. They may also cause serious personal injury and even death.
- Use padlocks to ensure that power remains off at the main machine disconnect switch.
- Use personal safety equipment. Wear safety clothing, eye protection, rubber soled shoes (without nails).
- Keep one hand in a pocket when servicing live equipment and avoid bracing yourself on the unit.

6.2 RECOMMENDED INSTRUMENTS

The following instruments are recommended for troubleshooting:

- VOM; choose a Simpson VOM 260, Triplett 630, or an equivalent meter with a minimum sensitivity of 20,000 ohms/volt.
- DC ammeter; choose a unit capable of measuring at least 150% of motor armature current, as indicated on the motor nameplate.
- Oscilloscope; choose an isolated type scope, if possible.

Refer to Table 3 for details.

DANGER

Always exercise great care when using a non-insulated type of oscilloscope. In such designs, one of the leads may be connected to the metal case. This lead should not be connected to an underground part of the Quadraline 7000 Controller or drive system unless the scope is isolated from ground. Also, in this circumstance, consider the metal case as a live high-voltage conductor. Serious personal injury, death and/or equipment damage can result if this procedure is not followed.

6.3 TROUBLESHOOTING AREAS

General troubleshooting areas that can be categorized into the following groups:

- Loose connections
- Wiring errors
- Incoming AC line problems
- Motor problems
- Controller malfunctions

6.3.1 LOOSE CONNECTIONS

Some industrial applications generate vibrations which eventually cause connections to become loose. With power removed at the main machine disconnect switch, check and tighten all electrical connections, such as mounting screws or terminal board screws. Also, be sure that all relays and fuses are properly seated in their respective sockets and brackets.

6.3.2 WIRING ERRORS

The most common problem in a DC drive's operation is incorrect wiring within a system. Before doing tests or replacements, spend some time examining the wiring. (Keep in mind that a loose or grounded wire can occur in a drive that had previously been operating correctly.)

6.3.3 INCOMING AC LINE

The following are typical problems located in the incoming AC line:

- AC line voltage is not within ±10% range of the nameplate rating of the drive.
- AC line voltage is incorrectly matched for the specific drive.

6.3.4 MOTOR CHECKS

CAUTION
Do not use a Megger to check for grounds unless the motor wiring to the Controller is completely disconnected. Damage to the circuitry will result if this procedure is not followed.

- Field. Check the field windings for open or short circuits
- Armature. Check continuity through the armature and brushes. Use the A1/A2 conductors at the Controller terminals.
- Brushes. When replacing worn brushes, use parts **identical** to the original equipment. Excessively worn brushes cause a loss of spring tension and subsequent malfunction.
- Commutator. Inspect the condition of the commutator. A shiny and light brown surface generally indicated good condition. If oil, grease or other foreign matter is noted, clean thoroughly. Brush carbon is to be removed with a commutator stone. **Do not** use any other type of abrasive.
- Bearings. Gear box. Inspect these two areas for proper lubricant levels. (Refer to the manufacturer's recommendations for type and frequency).
- Tachometer. Inspect this unit's mounting bolts for firmness. Inspect the coupling for cracks or excessive wear due to improper alignment and/or excessive motor shaft end play.
- Mounting. Coupling. Inspect mounting hardware for tightness. The coupling between the motor and the load should be checked for alignment and physical condition.
- Cooling. Inspect the motor housing ventilation openings. They should be clean and without dust or dirt.
- Fan-cooled types. Inspect the fan and shroud condition. Make sure that the openings are clean and cleared to allow maximum air circulation across the motor case. The motor housing must be kept free of dust, dirt, oil, grease and other matter which causes poor transfer of heat.
- Filters. Verify that filters, if used, are clean and able to allow the passage of air. Replace or clean them on a frequent schedule. (The location of the motor and general environment will dictate the need.)

6.4.1 CONTROLLER PROBLEMS

The most common problem experienced with four quadrant drives is fuse blowing. When fuses blow, there is not always a problem with the drive. Fuse blowing in a good drive can be caused by one of the following problems:

1. Fuse blowing can be caused by the AC line voltage dropping below the rated input voltage, while the drive is regenerating at or near maximum speed.
   A. This voltage drop can be caused by general low-line conditions, a brownout, or by the momentary inrush loading caused by some other piece of equipment being started or operated.
   B. The sizing and length of the power wiring can also cause line voltage drop. Note: The overspeed circuit is designed to prevent this from occurring.
2. Fuse blowing can be caused by a momentary power loss while the drive is regenerating. A power loss as short as 1/2 one cycle can cause the failure. In some areas, the power companies use fast-acting switch gear which sometimes interrupts the power for a period of between 1/2 to several cycles.
3. Fuse blowing can be caused by the maximum motor speed being set too high. This causes the same problem as a drive at rated speed being supplied from a low voltage line. Note: The overspeed circuit is designed to prevent this from occurring.

4. Fuse blowing can also be caused by an overload of the drive.
5. It is difficult to determine if fuse blowing is being caused by a drive malfunction or by improper operating conditions. Since improper operating conditions are the cause of most fuse blowing incidents, it is important to check the following before assuming the drive is defective.

6.4.2 CHECKING WITH AN EXTERNAL METER

The Quadraline 7000 circuits may be checked with a VOM. Use a meter of the specified type as listed in Table 3.

1. Check the AC power line voltage with an accurate voltmeter to make sure it is not more than 10% below the nominal AC line voltage or more than 10% above nominal AC line voltage.

Nominal Line Voltage	10% Low Line	10% High Line
115 VAC	103 VAC	126 VAC
230 VAC	206 VAC	253 VAC

2. Check that the motor maximum speed never exceeds the motor nameplate rating.

If the controller is still thought to be defective after the above checks, the controller may be tested by following the procedures outlined below.

WARNING

During the following tests, frequent application and removal of the AC input voltage is required. It is essential that the troubleshooter has sufficient knowledge to do so at appropriate times.

6.5 VOLTAGE CHECK

Using a VOM, check the voltages listed in Table 5. Take great care when connecting a meter to the points described to avoid short circuiting adjacent terminals.

Table 5. Voltage Check

Location	Function	Voltage	
		115 VAC	230 VAC
Power			
L1 - L2	AC Line Input	103 to 126 VAC	206 to 253 VAC
A1 - A2	Armature Output	0 to ±90 VDC	0 to ±180 VDC
F1 - F2	Field Output	85 to 110 VDC	190 to 220 VDC
Control			
TB1: 7 - 3	+15 VDC Supply	+14 to +16 VDC Enabled	
TB1: 5 - 3	+10 VDC Supply	+9 to + 10 VDC	
TB1: 6 - 3	-10 VDC Supply	-9 to -10 VDC	
TB1: 8 - 3	ENABLE Input	+14 to +16 Enabled -14 to -16 Disabled	
TB1: 4 - 3	Reference Input	0 to +10 VDC	
TB1: 11 - 3	-24 VDC Supply	-21 to -28 VDC	
TB1: 9 - 3	START Signal	-21 to -28 VDC, START 0 VDC, STOP	
TP2 - TP1	Current Amp Output	±1.3 VDC Nominal at 100% Armature Current (each range) signal is proportional to current (±2 VDC at 150%).	

6.6 TROUBLESHOOTING GUIDE

Symptom	Possible Cause	Solution
1. Motor will not run. (No Armature Voltage)	-Control not ENABLED -Control not STARTED -No Reference Signal -Control fuse F3 blown -Line Fuse F1 or F2 blown	-Check for +15V at TB1-8 -Check for -24VDC at TB1-9 -Check for Ref. Voltage TB1-4 -Check fuse & replace if blown -Check for correct line voltage set up (J9, J10) -Check fuses and replace if blown -Check for motor defect, wiring problem, defective SCR module or control circuit.
2. Motor will not run (Armature Voltage Present)	-Motor overloaded -Torque too low	-Check for overload -Check for proper Armature current range selection
3. Motor “runs away” (No speed control)	-Tach feedback mode, or tach reversed -Control in TORQUE mode, not SPEED mode.	-Use Arm voltage feedback if no tach (SW1). If tach used, check polarity and range. (J1) -Check set up (J2)
4. Motor will not reach desired operating speed	-Motor overload -Torque too low -Incorrect Armature Voltage -MAX SPEED setting incorrect -Incorrect Tach Range	-Check Armature current -Check Current Range (J6) -Check Voltage Range (J11) -Check adjustment (R1) -Check Set up (J1)
5. Motor speed unstable	-Load unstable -IR COMP set too high (in Arm. V. Feedback mode)	-Check load -Readjust IR COMP (R2)
6. Motor “creeps” with zero reference.	-ZERO SPEED pot incorrectly adjusted	-Adjust ZERO SPEED pot (R9) clockwise until motor stops

6.7 SERVICE

It is intended that the Quadraline 7000 should be serviced by replacing major subassemblies. The replacement Parts List lists all of the subassemblies required to service Quadraline 7000 drives. It is recommended that users keep these parts readily available to support the drive’s critical applications.

For additional assistance or the name of our closest authorized service center, please call Danaher Motion Engineered Systems Center at 704-588-5693.

Quadraline 7000
Table 6. Replacement Parts List

	Part Number		
Description	**Q7002**	**Q7005**	**Q7006**
Control Board Assembly	SPC35933-00	SPC35933-00	SPC35933-00
Line Fuse (F1, F2)	226636-001 (BussJJN-30A)	226636-000 (BussJJN-60A)	PFU1010-00 (MDA-15A)
SCR Module	226836-000	226628-000	—
Field Bridge	226122-000	226122-000	—
Power Board Assembly	—	—	SPC36019-00
FOR/REV SWITCH	226644-000	226644-000	—
RUN/JOG SWITCH	224551-000	224551-000	—
START/STOP SWITCH	224554-000	224554-000	—
SPEED POTENTIOMETER	224552-000	224552-000	—
POT NUT, Waterproof	224638-000	224638-000	—
SWITCH BOOT	224639-000	224639-000	—
BULB, Pilot Light	226723-000	226723-000	—
ZERO POSITION DANCER Control Board Assembly	Q7999-05	Q7999-05	N.A.
EXTERNAL SIGNAL Control Board Assembly	Q7999-01	Q7999-01	Q7999-01
FAULT MODULE OPTION Control Board Assembly	Q7999-02	Q7999-02	Q7999-02
INDEPENDENT ACCEL/ DECEL Option Control Board Assembly	Q7999-03	Q7999-03	Q7999-03
AC/PULSE TACH FEED-BACK Option Control Board Assembly	Q7999-04	Q7999-04	Q7999-04

N.A.: Not Available

*When repalcing the Control Board Assembly, it is essential that all of the set-up jumpers and adjustment potentiometers on the new board are identical to those on the board being replaced. It may be necessary to readjust the potentiometers on the new board for correct operation. See Section 3.0 of this Manual.

7.0 OPTIONS — FACTORY OR FIELD INSTALLED

Installation

Each version of the Q7000 control except the Q7006 has provision for mounting up to two option boards. Q7006 units have room for one option board.

If one option board is fitted it will be in position A in Figure A. The second option board will be fitted in position B. Reference Figure A.

a. For Field Installation of one option, the correct mounting hardware will be supplied with the option kit.

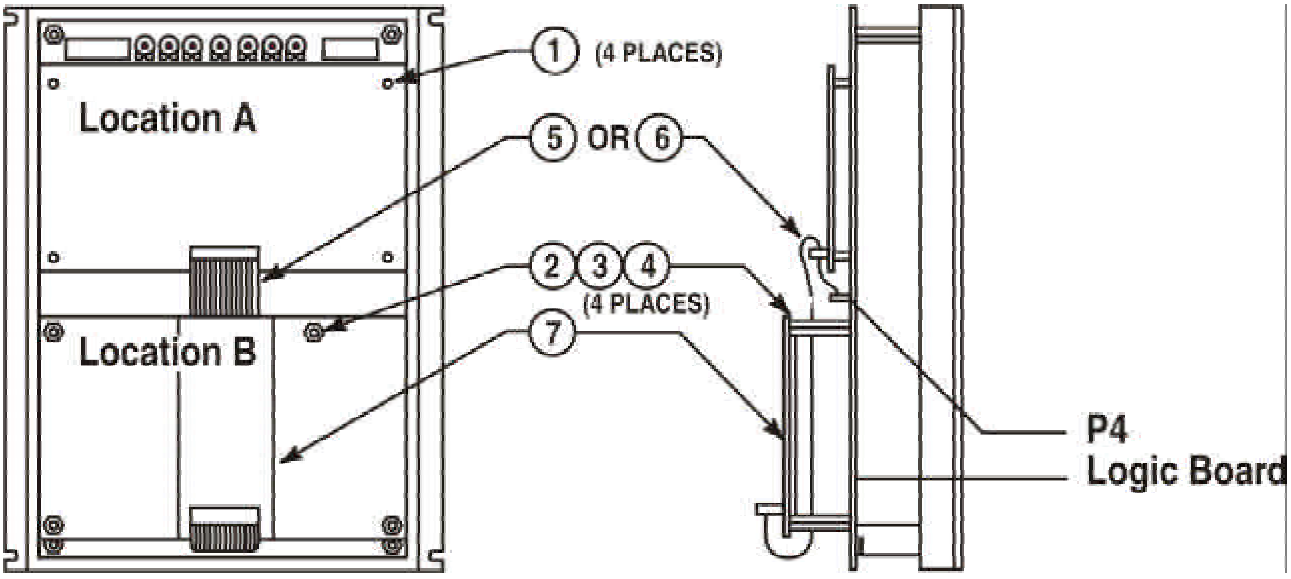
   Mounting hardware for Location A consists of:

   Qty.
   4 - HFA 4026-03 PCB standoffs
   1 - HFA 1049-01 Ribbon Cable Assembly

b. For Field Installation of two options, an additional mounting kit Q7098-00 for Location B is required.

   This kit consists of:

   Qty.
   4 - HFA 4045-00 Nylon Standoffs 1-1/2" length
   4 - HNB 1005-02 Nylon Screws 6 - 32
   4 - HNB 3031-00 Washer #6 Flay Nylon
   1 - HPA 1049-00 Ribbon Cable Assembly
   1 - HMI 1107-00 Foam Tape



QTY PER ASSY		ITEM	PART NUMBER	DESCRIPTION
B	A			
LOCATION				
1		7	HMI1107-00	URETHANE FOAM TAPE, 3-3/4"L X 1"W
	1	6	HPA1049-01	RIBBON CABLE ASSY.
1		5	HPA1049-00	RIBBON CABLE ASSY.
4		4	HNB3031-00	WASHER #6 FLAT NYLON
4		3	HNB1005-02	SCREW, 6-32 X 3/8 PAN SLOT
4		2	HFA4045-00	NYLON STANDOFF, 1-1/2"
	4	1	HFA4028-03	PCB STANDOFF, 3/4"

Figure A. Installation Location

7.1 BIPOLAR ISOLATION OPTION

Factory Installed

NOTE: Use this setup procedure for all external signal models.

1. **General Description**
   The Bipolar Isolation Option Board provides an isolated interface between the Q7000 control and a wide range of voltage or current signals. The Option Board mounts easily to the Q7000 Control Board via standoffs and a ribbon cable.

2. **Specifications**
   a. Input

Signals:	**Current**	**Voltage**
	1 - 5 mA DC	0 to ±10 VDC
	4 - 20 mA DC	0 to ±14 VDC
		0 to ±100 VDC

   b. Output
   Voltage: 0 to ±10 VDC

3. **Operation and Adjustment**
   a. Jumper Selection
      1. Select input range (see Figure B).

         For voltage input, connect input wires to the VIN and COM (common) positions on TB40. Jumper J40 as follows:

Jumper Position	**Voltage Input Range**
0 - 10 VDC	0 to ±10 VDC
0 - 14 VDC	0 to ±14 VDC
0 - 100 VDC	0 to ±100 VDC

         For current input, connect input wires to the I IN and COM (common) position on TB40. Jumper J40 as follows:

Jumper Position
1 - 5 mA DC
4 - 20 mA DC

      2. Ensure Jumper J41 is in position A.

   b. Adjustments
      1. With minimum input into the option card, adjust minimum speed (R41) control on the Isolation Option Card for zero volts at TB41-1 with respect to TB41-2.
      2. Increase input to maximum and adjust maximum speed (R42) control on the Isolation Option Card for 10 volts at TB41-1 with respect to TB41-2.

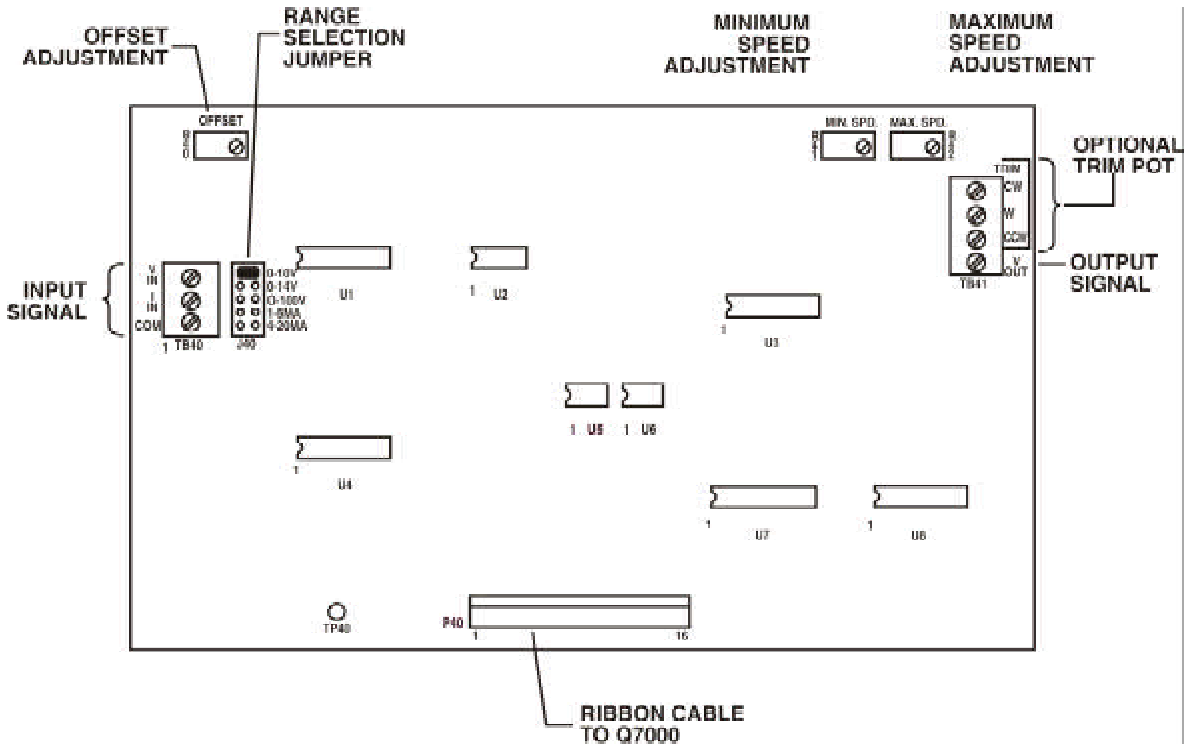
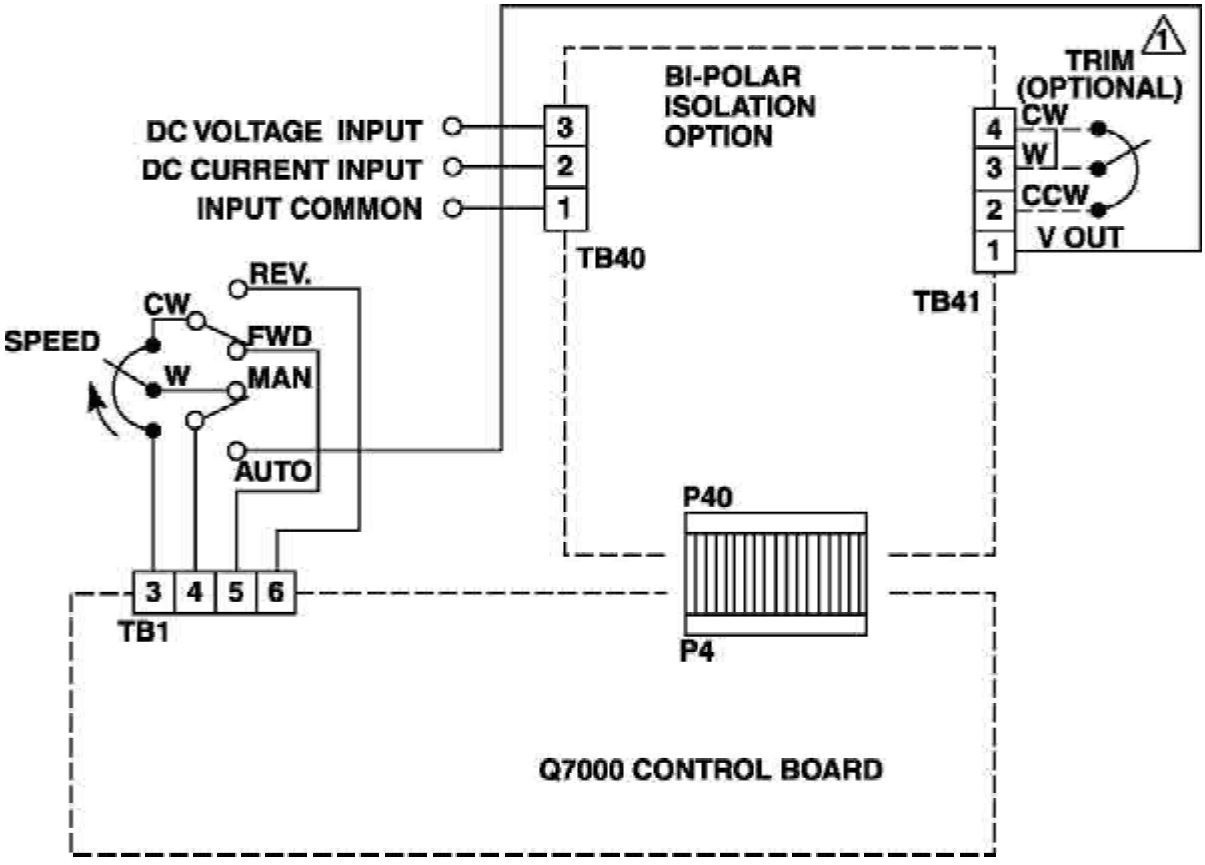


Figure B. Component Location (Bipolar Isolation)



1. If optional trim pot is used, remove jumper from TB41-3 and 4.
2. Mounted on the enclosure door of External Signal Models equipped with this provision.

Figure C. Connection Diagram (Bipolar Isolation)

7.2 FAULT MODULE OPTION
Factory Installed

1. **General Description**

   The Fault Module Option Board provides adjustable overvoltage and overcurrent as well as field loss protection for the Q7000 series of DC motor controllers. The overcurrent protection can be jumper-ed for either instantaneous overcurrent trip or timed overcurrent trip. (An overload will eventually cause an overcurrent trip with the time to trip decreasing as the current level increases when the timed mode is selected.) An open collector transistor output is provided to indicate when an overload is present. Four Red LEDs are on the board, to indicate overcurrent trip, overvoltage trip, field loss trip, and overload.

   Two from C contacts are provided from the fault relay that change state in the event of a fault trip. An on board reset push-button or quick disconnect connections are provided for resetting the drive after a fault occurs. When a fault occurs, the drive is disabled, turning off the SCR power bridge, the motor will coast to a stop. If the fault relay contacts are wired into the stop circuitry, the Start/Stop relay in the Quadraline 7000 controller will drop out.

2. **Specifications**

   A. Adjustable Instantaneous or Timed Overcurrent Trip. Current trip setting 30 to 150% rated current.

   B. Adjustable Overvoltage Trip. Voltage trip setting 10 to 10% rated voltage.

   C. Fault relay, with 2 form C contacts, that is energized when power is applied and no faults are present.

   E. Open collector output signifying an overcurrent condition is present. Timed overcurrent trip will occur if the overload remains (Overcurrent LED D30 indicates output in on.) This circuit can handle 250 mA (24VDC max.) when the output is pulled down to zero during an overload.

   F. Four Red LEDs
      1. Overcurrent trip
      2. Overcurrent Trip
      3. Field loss trip
      4. Overcurrent present

3. **Operation and Adjustment**

   A. The Fault Module attaches to the Q7000 via standoffs and a 16 conductor ribbon cable; refer to Figure A for installation information, to Figure D for component location, and to Figure E for connection information.

   B. There are two modes of operation for the adjustable overcurrent detection. With Jumper J31 in the factory set “A” position, a timed overcurrent type protective feature, similar to a thermal overload relay, is active. The higher the overcurrent, the quicker the trip will occur. The circuit is factory adjusted to allow continuous operation at 100% of the nominal current range. An overcurrent trip will occur in approximately 6 minutes at 150% load. If the control operates at 100% load increases to 150%, an overcurrent trip will occur in approximately 1 minute. By placing J31 in the “B” position, an instantaneous trip will occur whenever the current level exceeds the overcurrent adjustment level. (See paragraph H for adjustment.)

   C. If a Permanent Magnet motor is used, place Jumper J30 to the PM position. This will prevent the field loss detection circuit from causing a field loss trip to occur. For a shunt wound motor, place J30 in the SH position it insure Field Loss Protection.

   D. If the Fault Module is to be part of the Start/Stop circuitry, refer to Figure E for a suggested wiring schematic. A normally open contact (closed when power is applied) from the fault relay is wired in series with the normally closed Stop Push-button.

E. A remote Reset connection is provided through “quick-connect” terminals P31 and P32. A normally open push-button is connected across the terminals to allow reset after a fault. Turning on and off AC power to the Q7000 will also reset a fault trip.

F. Terminal Strip TB30 is a nine position terminal strip that provides easy customer connection to the two form C contacts for the fault relay and also to the open collector output signifying an overload is present. Terminal Strip TB31 is a two position terminal strip to be wired in series with the field connections for field loss detection on a shunt wound motor.

G. The four Red LEDs provide help in trouble shooting the drive when a fault trip has occurred. The overcurrent, overvoltage and Field Loss Trip LEDs will stay on after a trip until either AC power is turned off or the drive is reset via the on board push-button or the external reset connections.

H. The following table shows the test points and voltage settings for adjusting the overcurrent and overvoltage potentiometers.

Function	Potentiometer	Test Points	% Range	Setting
Overcurrent Adjust	R31	TP31 - TP30 (common or negative meter lead)	30 50 75 100 110 125 150	-1.7 VDC -2.7 VDC -4.0 VDC -5.3 VDC -5.8 VDC -6.6 VDC -7.8 VDC
Overvoltage Adjust	R30	TP32 - TP30 (common or negative meter lead)	10 25 50 75 105	0.68 VDC 1.5 VDC 3.0 VDC 4.5 VDC 6.3 VDC
For further information, refer to Figure D.				

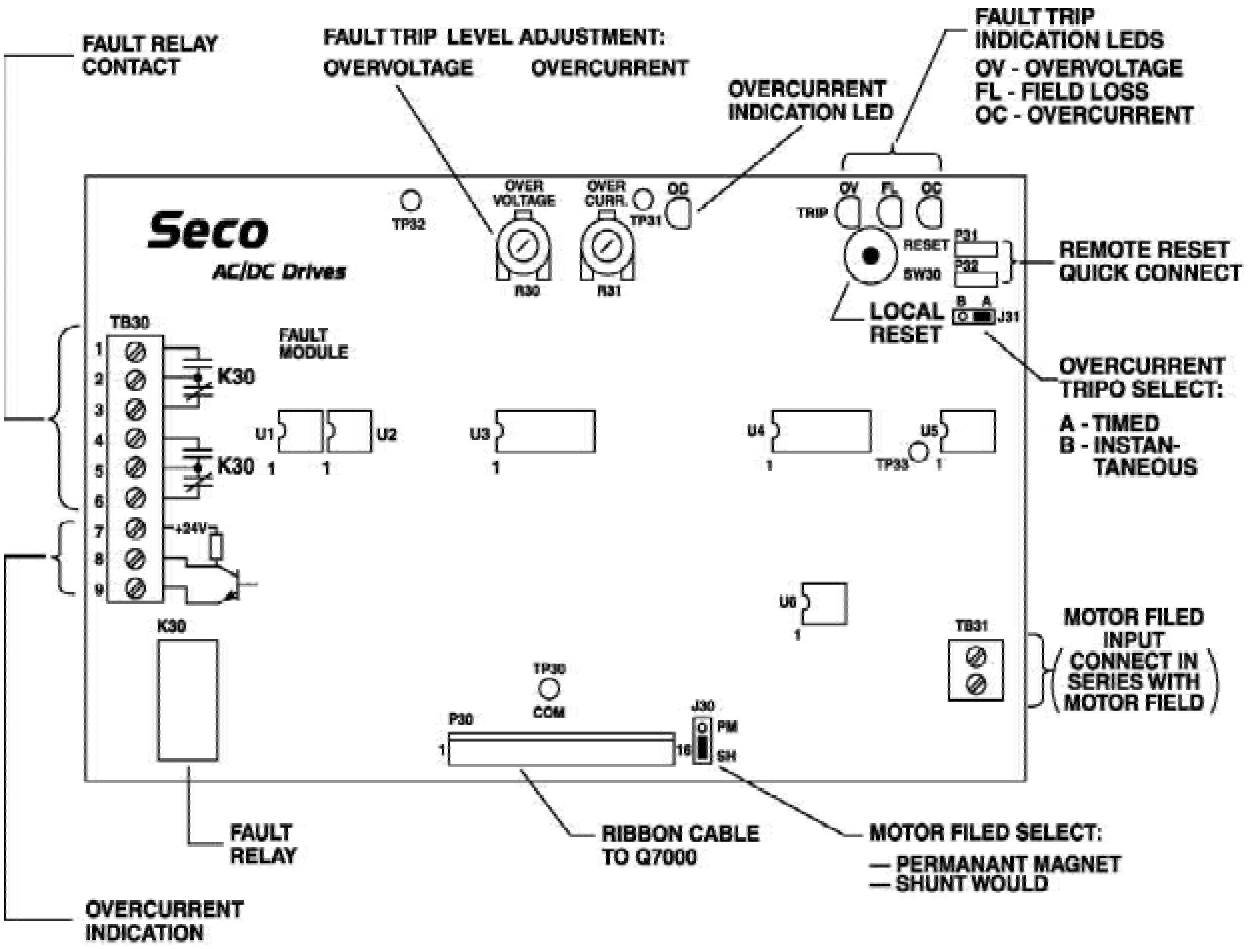
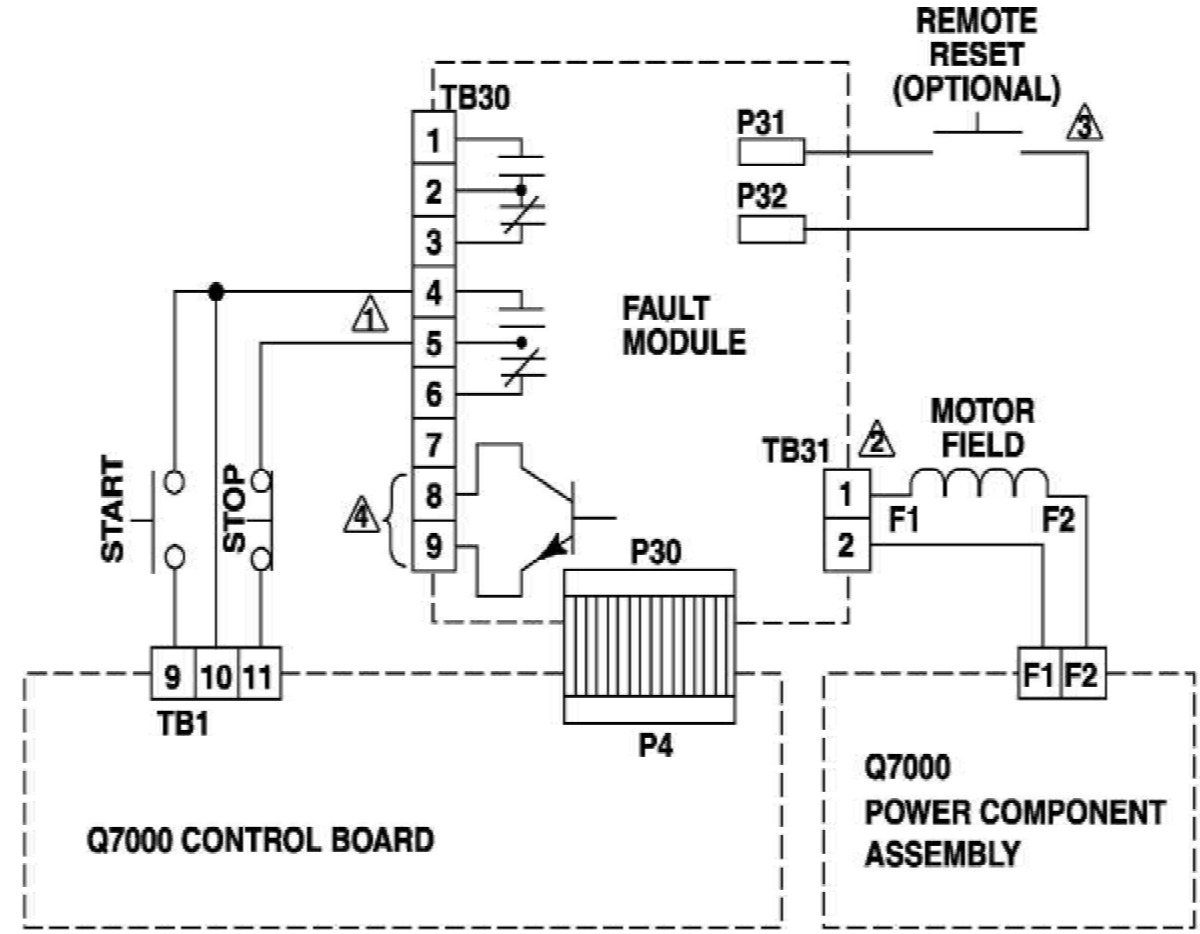


Figure D. Component Location (Fault Option)



NOTES:

1. FAULT RELAY CONTACTS ARE SHOWN IN TRIP OR POWER OFF CONDITION. CONNECT CONTACT IN SERIES WITH STOP CIRCUIT AS SHOWN TO ACTIVATE STOP FUNCTION WHEN TRIP OCCURS, IF THIS CONNECTION IS NOT MADE, CONTROL IS DISABLED WHEN TRIP OCCURS AND WILL START WHEN TRIP CIRCUIT IS RESET.
2. NO CONNECTION IS REQUIRED FOR PM MOTOR.
3. CLOSE CONTACTS TO RESET TRIP CIRCUIT.
4. OVERCURRENT INDICATION: OPEN COLLECTOR OUTPUT SINKS UP TO 250 MA IF CURRENT EXCEEDS OVERCURRENT LEVEL. (24VDC MAX.)

Figure E. Connection Diagram (Fault Option)

7.3 INDEPENDENT ACCELERATION/ DECELERATION CONTROL OPTION

General Description

The standard Q7000 Series DC motor control has a single forward acceleration adjustment pot and single reverse acceleration adjustment pot. The FORWARD ACCELERATION pot sets the acceleration rate in the forward direction and the deceleration rate in the reverse direction, i.e. both of these rates will be the same. Conversely, the REVERSE ACCELERATION pot sets the acceleration rate in the Reverse direction and the deceleration rate in the Forward direction, again, both rates are the same.

Two modes of Accel/Decel control can be programmed with this option.

The first, or Mode A, provides two acceleration adjustment pots and two deceleration adjustment pots. This allows for independent adjustment of the forward acceleration rate, forward deceleration rate, reverse acceleration rate, and reverse deceleration rate.

The second, Mode B, allows two different Accel/ Decel rates to be selected by an outside sourced contact closure. Like the Basic Quadraline 7000 the Forward Acceleration and Reverse deceleration rates are identical as are the Reverse Acceleration and Forward Deceleration rates. The Mode B difference allows the ability to switch through contact change from either of two sets of adjustments, thereby giving two entirely different rates rather than the single rate allowed with the basic Quadraline 7000 controller.

The adjustment setting for acceleration determines the amount of time the motor controller will take to drive the motor from standstill or zero speed up to maximum speed. The adjustment setting for deceleration determines the time the motor controller will take to brake the motor from maximum speed to zero. If a drive is adjusted for a 10 second acceleration time for 0 to 1750 RPM, a change in speed from 875 RPM to 1750 RPM would take 5 seconds. If the torque required to accelerate takes 5 seconds. If the torque required to accelerate or decelerate the motor exceeds the current limit adjustments, the time to accelerate or decelerate will increase. The time to accelerate or decelerate will then be dependent on load requirements and the current limit settings.

2. **Specifications**
   a. Accel/Decel Time Range:
      Jumper Selectable for each pot
      (J21 - J24)
      - F Range .3-3 seconds (zero to full speed)
      - S Range 3-30 seconds (zero to full speed)
   b. Operating Modes:
      Jumper Selectable (J20)

- A Mode	Acceleration Forward	R21
	Deceleration Forward	R20
	Acceleration Reverse	R22
	Deceleration Reverse	R23
- B Mode	Pot operation in the B mode is controlled by a contact closure or jumper on TB20.	

Forward acceleration and reverse deceleration rates are identical and set by the adjustment pot.

Forward deceleration and reverse acceleration rates are identical and set by the adjustment pot.

Terminals 1 & 1 TB20 Contact Open	**Terminals 1 & 2 TB20 Contact Closed**
R23 Active R21 Not Used	R21 Active R23 Not Used
R22 Active R20 Not Used	R20 Active R22 Not Used

If the jumper is opened or closed while the motor is running, the acceleration and deceleration rates will immediately change to the adjustment pot as specified above. The state of the contact or jumper on TB20, either open or closed, has no effect in Mode A.

NOTE: Forward direction is defined as a positive voltage reference at TB1 terminal 4 with respect to common on TB1 terminal 3 located on the Quadraline 7000 controller board. Reverse direction is a negative voltage reference input from TB1-4 to TB1-3.

3. **Operation and Adjustment**

   a. Install board per Figure A.

   b. Component location Figure G.

   c. Connect board per Figure F.

   d. Select desired time ranges by positioning jumpers J21 through J24 as shown here. The F (fast) position allows an adjustable range of 0.3 to 3 seconds and the S (slow) position range is 3 to 30 seconds. Turning the adjustment post in the clockwise (CW) direction will decrease the time it takes the motor to accel or decel. For example, an accel pot, with the appropriate jumper in the F (fast) position, turned full CW will take 0.3 seconds to go from zero to full speed. Turning the pot full counterclockwise (CCW) will change the acceleration rate to 3.0 seconds.

Jumper Number	Adjustment Pot
J21	R20
J22	R21
J23	R22
J24	R23

   e. Select operating Mode A or B by placement of jumper J20. Operation is defined in the specifications section 2b.

   f. Select Time Range for each pot; J21 selects the range of adjustment for R20, J22 for R21, J23 for R22, and J24 for R23. The F (fast) position gives a time range of .3 to 3 seconds (zero to full speed). The S (slow) position gives a time range of 3 to 30 seconds.

The following chart summarizes the operation of the board in the two operating modes.

Operating Mode (J20) Selection	TB20 Terminal 1-2	Motor Direction of Rotation	Reference Polarity TB1-4 to TB1-3	Motor Action	Adjustment Pot Selected
A	X	FWD	+	Accel	R21
A	X	FWD	+	Decel	R20
A	X	REV	-	Accel	R22
A	X	REV	-	Decel	R23
B	Open	FWD	+	Accel	R23
B	Open	FWD	+	Decel	R22
B	Open	REV	-	Accel	R22
B	Open	REV	-	Decel	R23
B	Closed	FWD	+	Accel	R21
B	Closed	FWD	+	Decel	R20
B	Closed	REV	-	Accel	R20
B	Closed	REV	-	Decel	R21

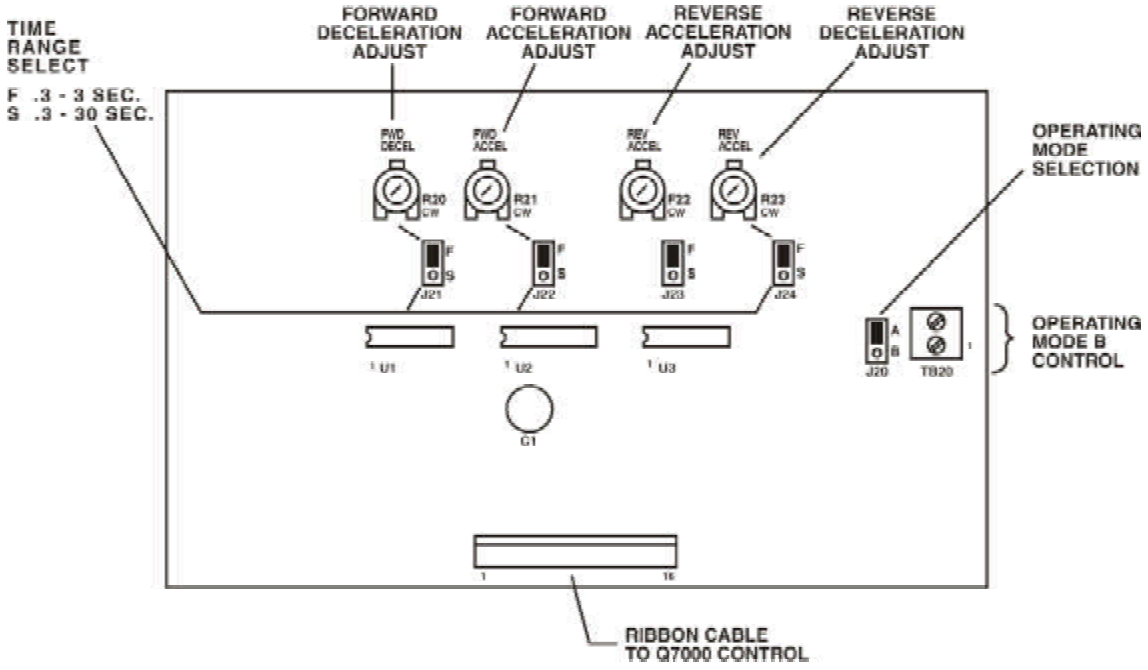
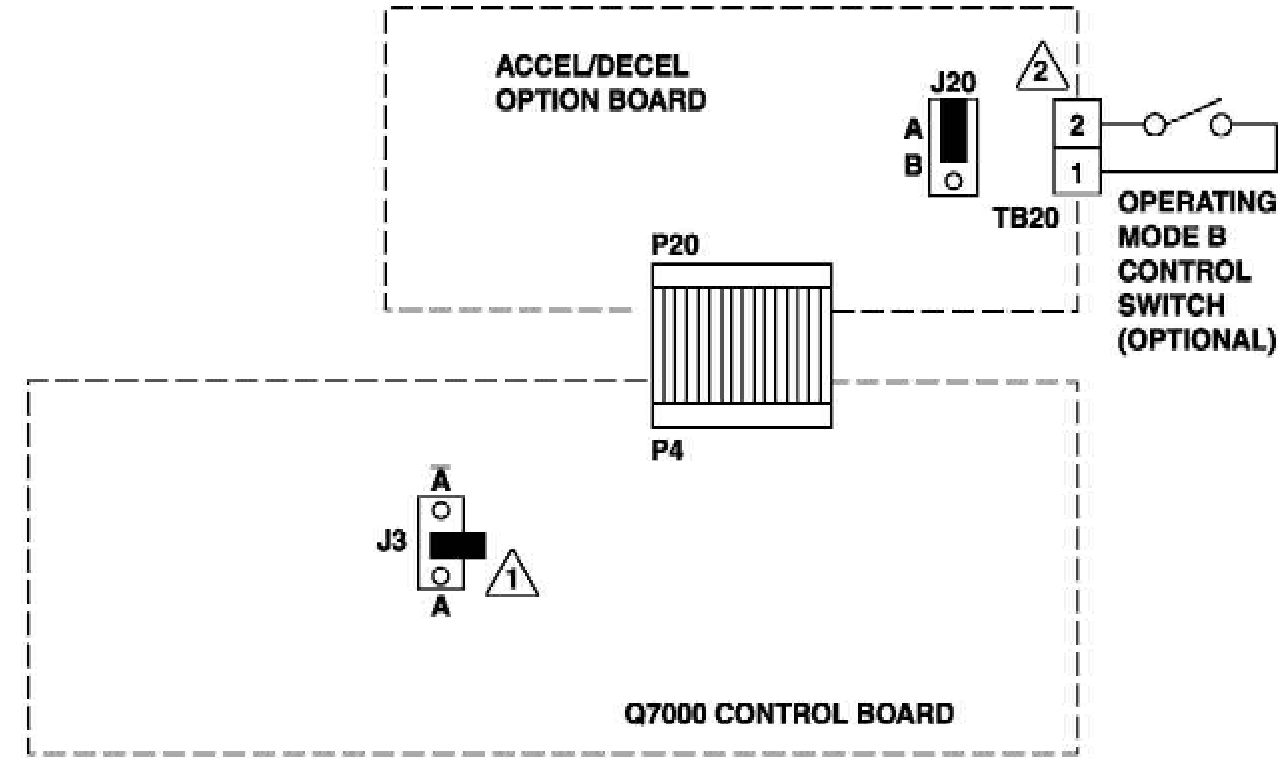


Figure F. Component Location (Accel/Decel Option)



NOTES:

1. **JUMPER J3 ON Q7000 CONTROL BOARD MUST BE PLACED IN THE "CENTER" POSITION AS SHOWN FOR PROPER OPERATION OF ACCEL/DECEL OPTION BOARD.**

2. **REFERENCE SECTION 2.b FOR DESCRIPTION OF OPERATION MODES.**

Figure G. Connection Diagram (Accel/Decel Option)

7.4 AC/PULSE TACH FEEDBACK OPTION

Factory Installed

1. **General Description**
   The AC/Pulse Tach Option Board allows the use of either an AC tachometer or a magnetic pulse tach for speed feedback to the Q7000. A ring tach, such as the MTK series used with the Digital 9000 series DC motor controllers, can be used. The standard drive requires a DC analog tachometer V/1000 RPM, or 50V/1000 RPM, if a tachometer is to be used. If an encoder is to be used, please consult Danaher Motion Engineered Systems Center for adjustment procedures.

2. **Specifications**
   Input signal - Primarily designed for 60 pulse per revolution pulse tachometers. Maximum frequency input is 3600 Hz. Minimum frequency for full output voltage is 1200 Hz.
   - Maximum voltage 100V.

   Output signal - 0 to 10 VDC.

3. **Operation and Adjustment**
   a. Install the AC/Pulse Tach Option Board as shown in Figure A. Refer to Figure H for component location, and to Figure 1 for wiring connections.
   b. Locate the SW1 switch on the main printed circuit board of the Q7000 control and place it in the Tach Feedback position. Jumper J1 for a 7V/1000 RPM tachometer, and adjust R1, Max. Speed, fully CCW. Refer to Figure I.
   c. Offset Potentiometer R40 is preset at the factory fully CCW.
   d. Start the drive and bring the motor up to the maximum speed with the speed potentiometer turned fully clockwise. Adjust the Max. Speed Pot R42, on the AC/Pulse Tach Feedback Option Board to desired maximum motor speed. Turning the R42 Pot CCW will increase the motor speed, while CW rotation will decrease the motor speed.

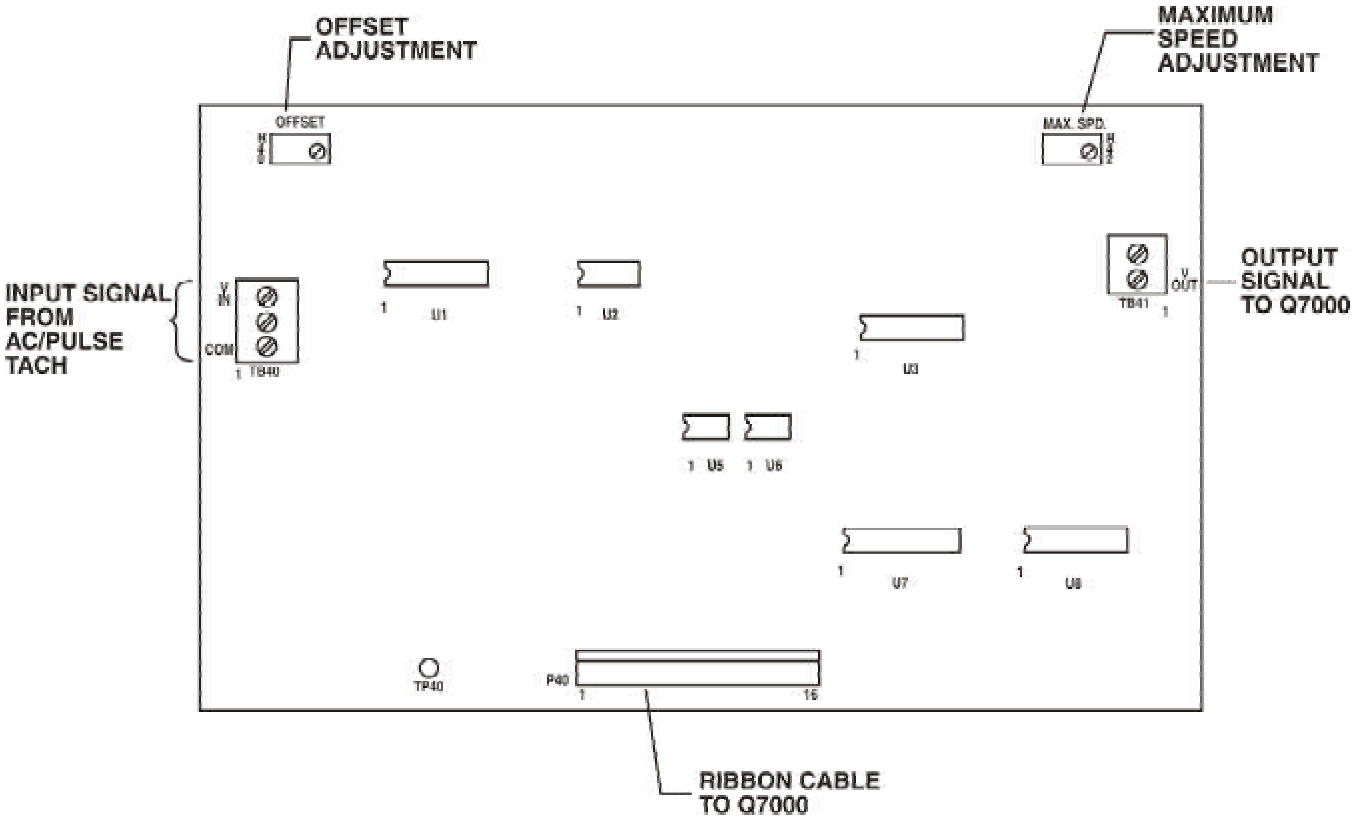
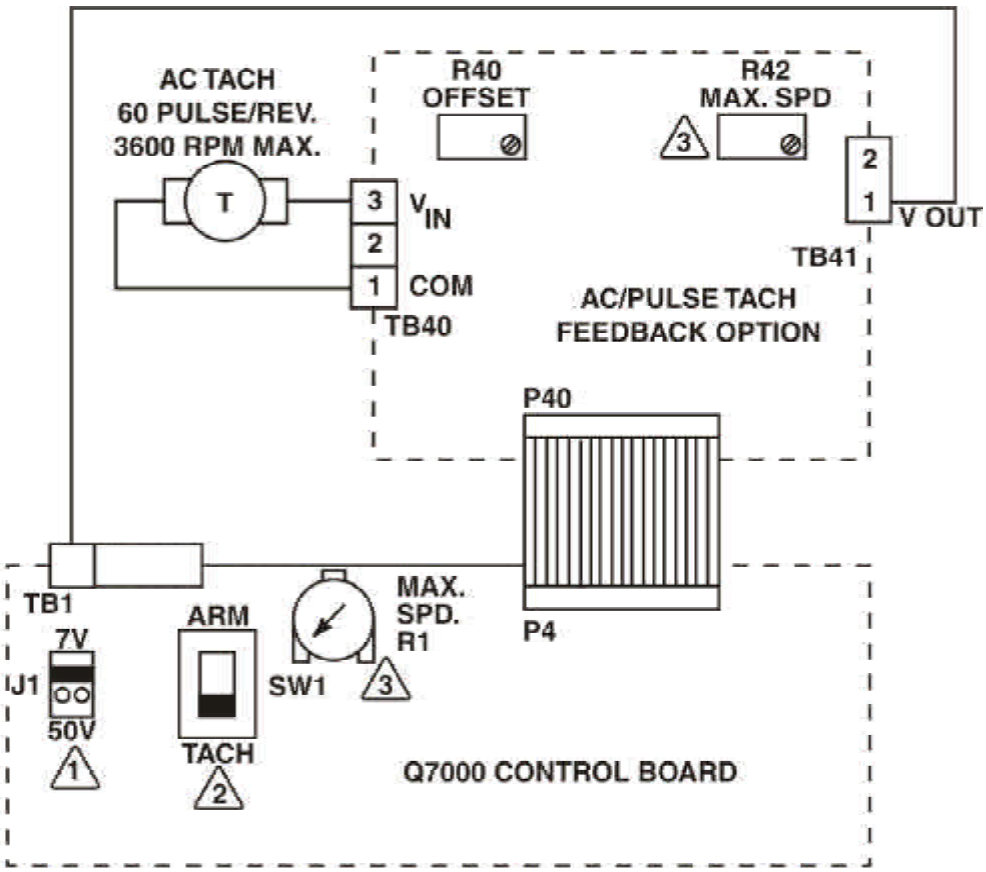


Figure H. Component Location (Pulse Tach Feedback Option)

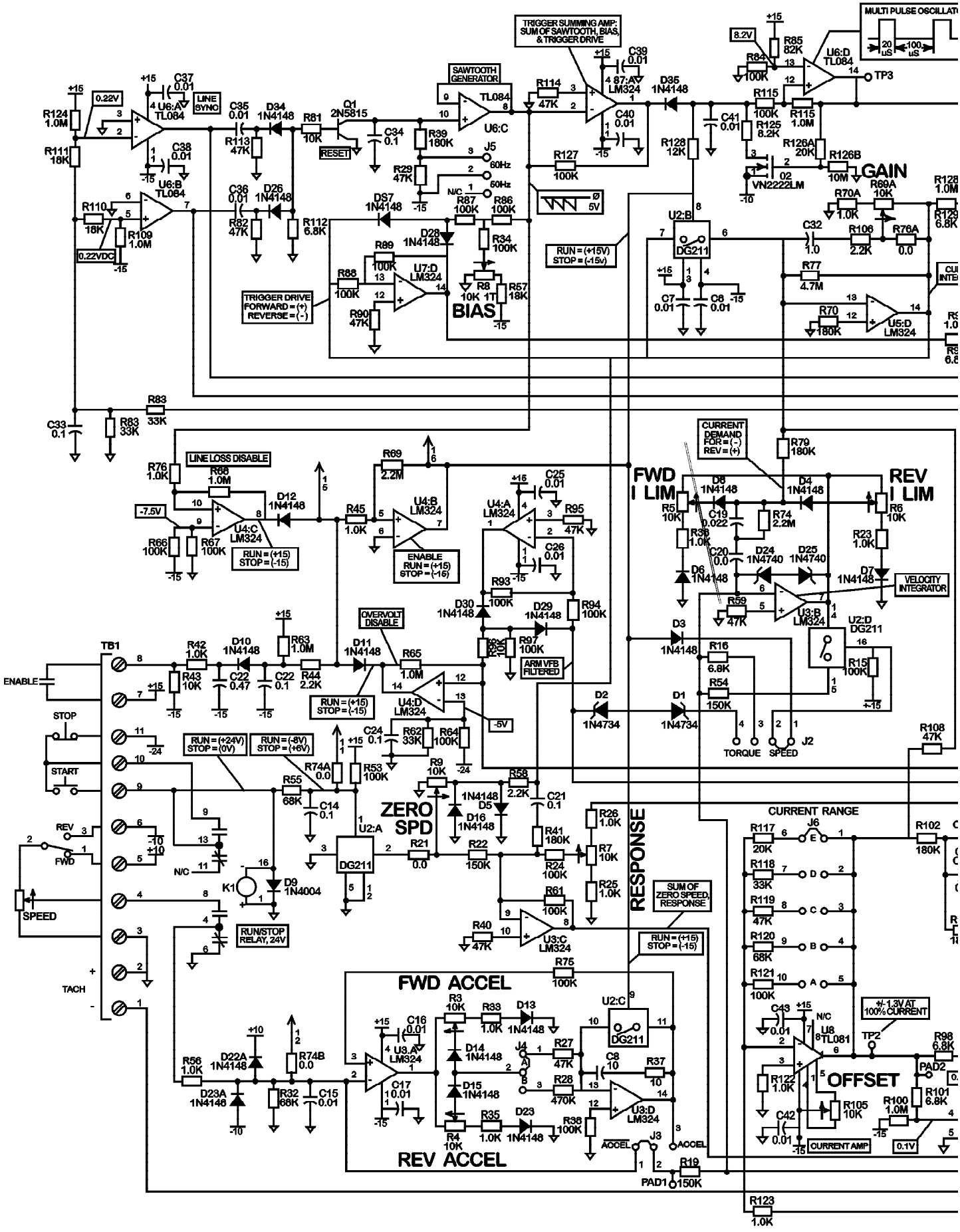


NOTES:

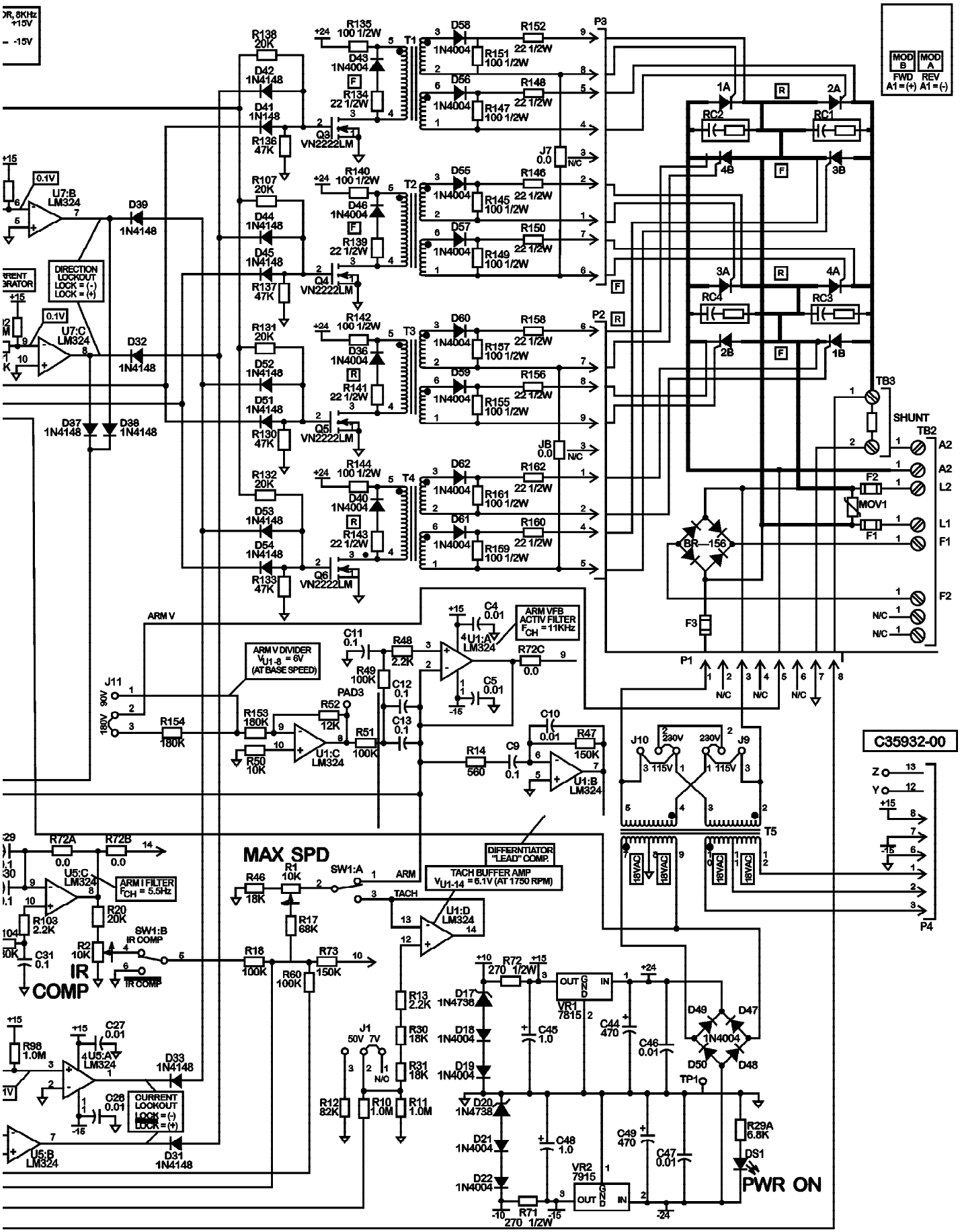
1. PLACE JUMPER J1 IN 7V POSITION.
2. SELECT TACH FEEDBACK MODE. (SW1)
3. ADJUST R42, MAX. SPD. TO SET MAXIMUM MOTOR SPEED (R1, MAX. SPD. ON Q7000 CONTROL BOARD SHOULD BE SET FULLY CCW).

Figuire I. Connection Diagram (Pulse Tach Feedback Option)

NOTES:


TRIGGER SUMMING AMP: SUM OF SAWTOOTH, BIAS, & TRIGGER DRIVE
SAWTOOTH GENERATOR
MULTI PULSE OSCILLATOR
LINE SYNC
RESET
TRIGGER DRIVE FORWARD = (+) REVERSE = (-)
BIAS
GAIN
RUN = (+15V) STOP = (-15v)
LINE LOSS DISABLE
RUN = (+15) STOP = (-15)
ENABLE RUN = (+15) STOP = (-15)
CURRENT DEMAND FOR = (-) REV = (+)
FWD I LIM
REV I LIM
VELOCITY INTEGRATOR
OVERVOLT DISABLE
ARM VFB FILTERED
RUN = (+15) STOP = (-15)
RUN = (+24V) STOP = (0V)
RUN = (-8V) STOP = (+6V)
RUN/STOP RELAY, 24V
ZERO SPD
RESPONSE
SUM OF ZERO SPEED, RESPONSE
CURRENT RANGE
FWD ACCEL
REV ACCEL
OFFSET
+/- 1.3V AT 100% CURRENT
CURRENT AMP
TORQUE
SPEED
ENABLE
STOP
START
REV
FWD
TACH
TB1
PAD1
PAD2

Board Schematics



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