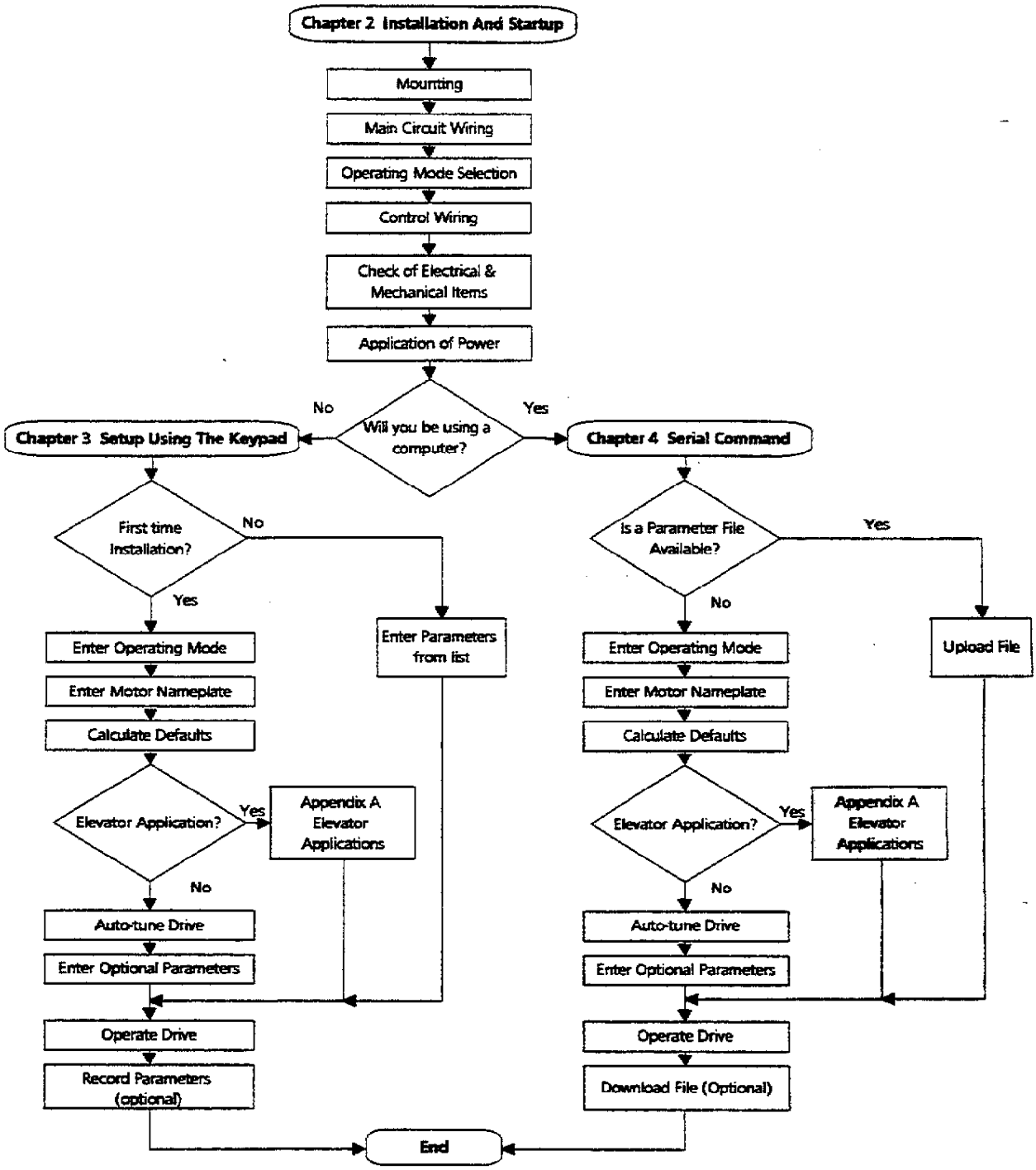
Chapter 2
Installation and Setup

Introduction

The flowchart (figure 2-1) outlines the sections in this manual that should be followed to install and setup the drive. Each block represents the appropriate section of this manual to follow. It is strongly recommended that the flowchart be followed and each section of the manual referenced during the installation, setup, and operation of the drive.

Figure 2-1 Installation and Setup Flow Diagram:



Mounting

(Refer to Chapter 10 for appropriate mounting drawings)

The drive is designed for panel mounting. Mount in a clean dry enclosure with an ambient temperature less than +40° C. Contact factory for derating to be used at higher ambient temperatures. DO NOT mount control above transformer or other heat source. DO provide 2" minimum clear area above and below the control to allow free flow of air over heat sink on the back of the enclosure.

Mounting dimensions are shown on the appropriate drawing given in Chapter 10. Provide access to the front of the enclosure to adjust parameters and to observe the keypad display. Allow room to remove the top cover (if applicable) to gain access to the power components.

Configuring a 460V Drive to Operate on 380 - 400V

A 460V (914X-XXXX-270) drive may be used on a 380-400V AC incoming line by re-configuring the control transformer T1.

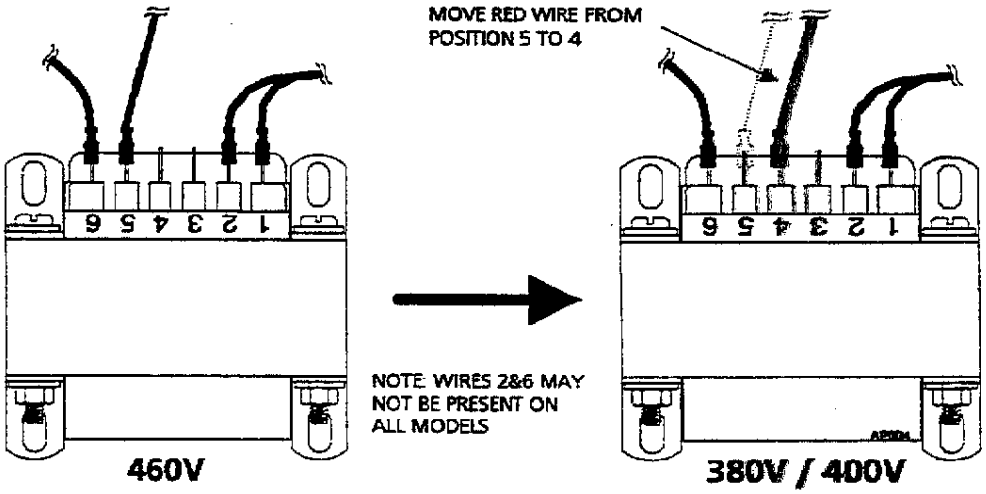
Remove the top cover (if supplied). Locate control transformer T1 (next to the main circuit terminal block TB1). Refer to Figure 1-2 for a picture of a 900 series drive with the cover removed.

Move the RED wire from position 5 to position 4 on the control transformer (refer to Figure 2-2).

WARNING: It is not possible to operate a 230V (912X-XXXX-270) drive on voltages other than is specified on the drive nameplate.

If you are operating on a low line (<380V): You will need to change parameter P96 to 1 (refer to Chapter 3).

Figure 2-2 Configuring The Control Transformer T1 for 380 - 400V



Main Circuit Wiring

CAUTION: Check the motor nameplate and power source voltage to be sure they match the drive nameplate ratings. **DO NOT USE THIS DRIVE ON ANY OTHER VOLTAGES WITHOUT FACTORY APPROVAL.** Refer to the section entitled Configuring a 460V Drive to Operate on 380 - 400V for information on operating a 460V Drive from a 380-400V line.

All wiring shall be in accordance with the National Electric Code and applicable local codes. Install wiring as shown in Figure 2-5 or Figure 2-6. External or remote motor overload protection must be provided in accordance with the National Electrical Code or equivalent. Use the appropriate wire gauge per Chapter 7 and terminal block tightening torques as called out in Appendix F.

The drive requires input power protection in the form of either a circuit breaker or fuses. Required sizes and types of circuit breakers and fuses for this particular drive are given in chapter 7 entitled PROTECTIVE DEVICES. Circuit breakers are recommended.

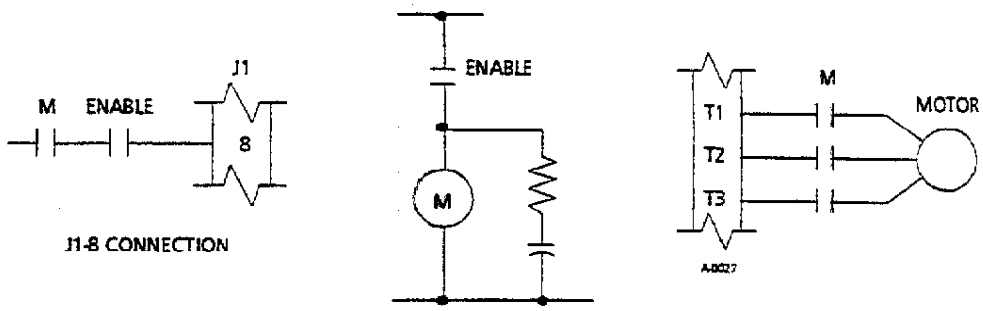
Connect control terminals L1, L2 and L3 to the load side of the customer supplied protective device. The control may be powered with AC three phase power or single phase power. NOTE: Apply only line voltage for which the controller is rated. Phase sequence of incoming power is not important. If single phase power is to be used, connect power to drive terminals L1 and L2. Place a jumper between control input terminals L2 and L3. Size this wire the same as the incoming line to L1. Note that drive capacity is restricted to 60% of normal when operated on single phase power.

If the drive operates in the wrong direction for your system you must change the phasing of the motor so that the drive matches the desired direction. This is done by swapping the encoder wiring channels (described later in this chapter) and changing the encoder alignment direction (P71) from a one to a zero or vice-versa. it is not necessary to swap any output power wires.

Wire the three phase motor stator to control terminals T1, T2 and T3 using appropriately sized wire per table, Chapter 7. Connect the control to the motor either directly (Figure 2-5, 2-6) or through a contactor as shown in Figure 2-3. Connection of motor temperature sensor / switch is optional (refer to Appendix B). A motor circuit contactor is recommended whenever a positive disconnection must prevent motor motion which could pose a safety hazard to personnel or equipment.

If the direction of the motor does not match the "forward" direction desired, then swap the A+ and A- channels of the encoder wiring (described later in this chapter) and change P71 rom 0 to 1 or vice versa. This will change the direction of rotation of the motor.

Figure 2-3 Typical Connections for Output Contactor



Open the Enable input to J1 at least 20 msec before main M contacts open to prevent arcing at contacts. This greatly increases contactor life and allows use of IEC rated contactors.

Ground **both** the drive chassis ground lug and motor frame to machine or plant ground. Use the same size wire used for the AC connections. Refer to Figure 2-5.

Installation and Wiring of Braking Options

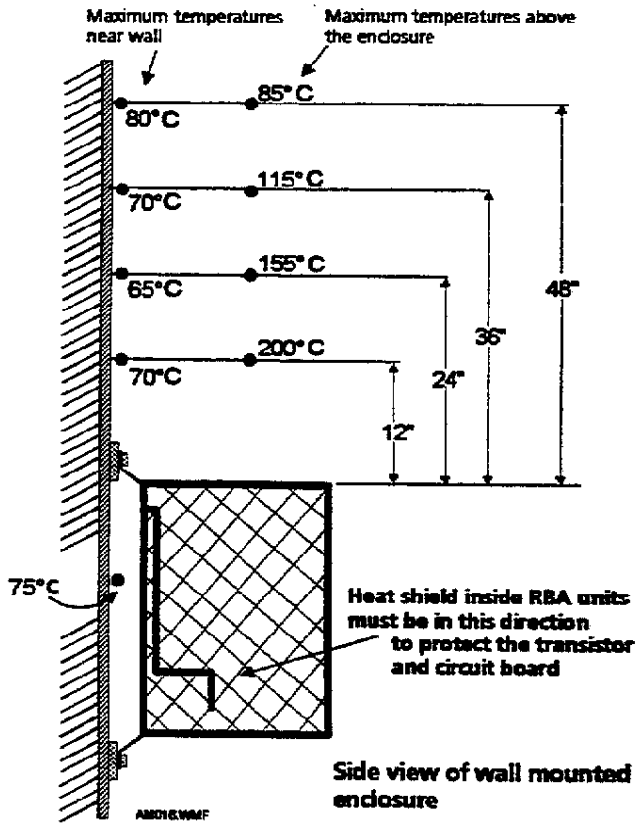
Installation

WARNING: HIGH TEMPERATURES EXIST ABOVE THE BRAKING ASSEMBLY WHEN IT IS USED AT ITS MAXIMUM RATING.

Do not mount the braking assembly onto a combustible surface. The air temperature next to the wall can be as high as 80° C. Th enclosure must be oriented in the position shown in Figure 2-4.

Do not obstruct airflow or mount other equipment above the braking assembly. The air temperature above the braking assembly can be very high (see figure 2-4)

Figure 2-4 Temperatures Maximum Expected, Side View



Dynamic Braking Wiring

If your controller requires dynamic braking capability (optional) an external braking assembly or braking resistor will be required. Refer to section below for appropriate drive model number.

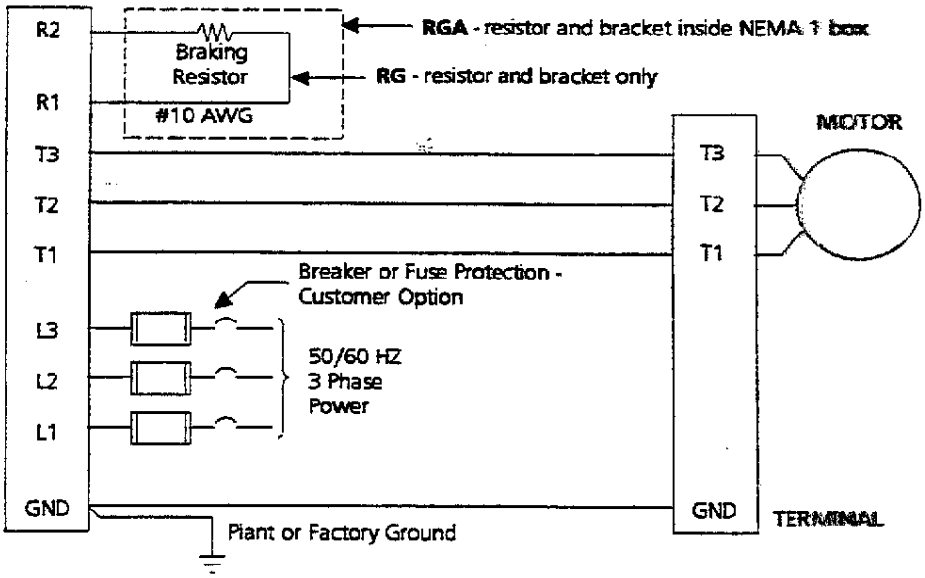
All wiring shall be in accordance with the National Electric Code and applicable local codes. Install wiring as shown in Figure 2-5 through 2-6 .

Models with -1KBO suffix

Minimum resistance of the braking resistor is limited by the regeneration capacity of the drive. Dissipation rating of the resistor must be selected to suit the average regeneration of an overhauling load or dynamic braking deceleration.

Connect regeneration resistor and associated fuse or breaker between control terminals R1 and R2 per Figure 2-5.

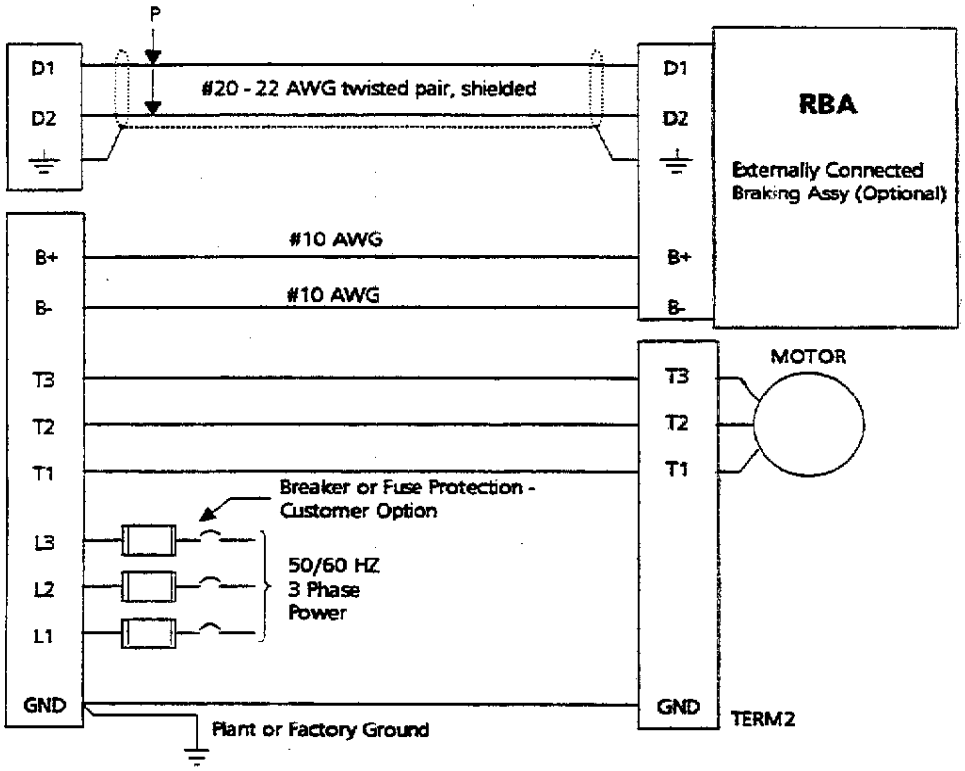
Figure 2-5 Wiring for Models with -1KBO suffix



Drives with -1KOO suffix

Dynamic braking transistor / resistor assemblies must be sized to suit the average regeneration (or dynamic braking deceleration) requirements of the application. The next chapter lists the available braking transistor / resistor assemblies with their appropriate ratings. Connect the assembly to terminals B+, B-, D1, and D2 according to Figure 2-6. Wire the B+ and B- connections using 10 AWG wire. Wire D1 and D2 using 20 - 22 AWG shielded, twisted pair wire with the shields tied to ground at each end.

Figure 2-6 Wiring for Model with -1KOO suffix



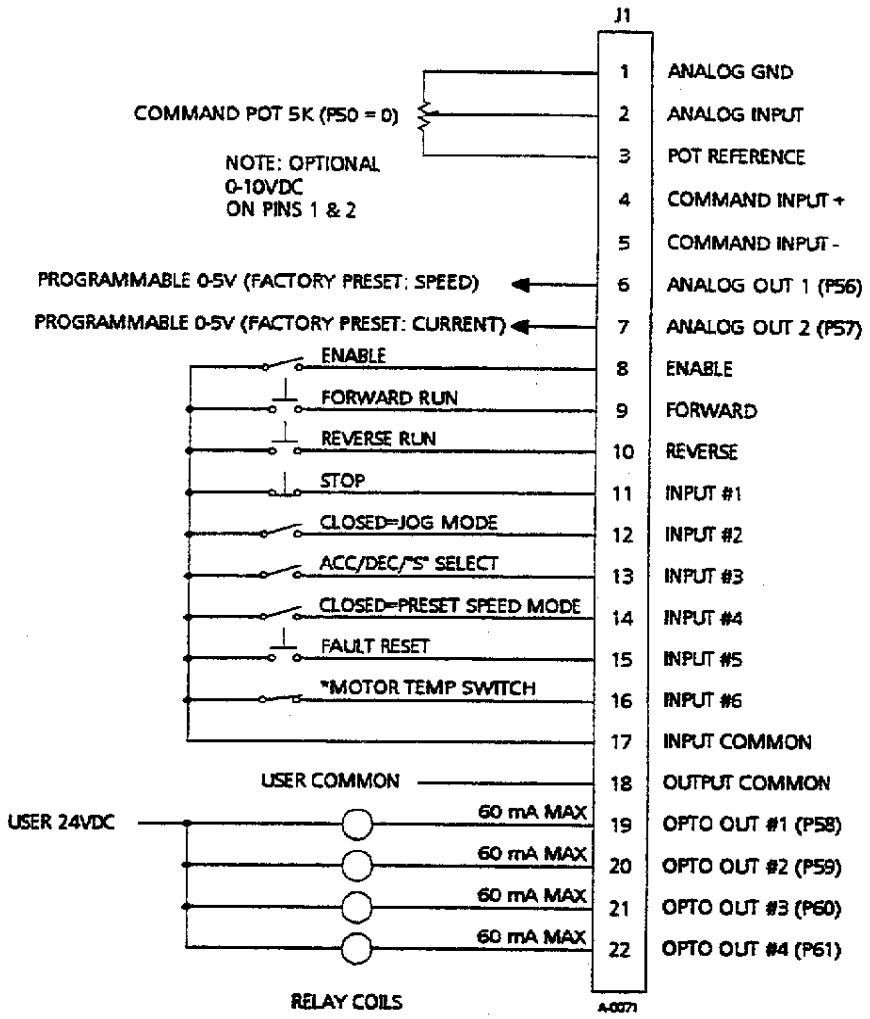
Operating Mode Selection

The controller has four interface modes of operation. Select the operating mode that best suits your application. Refer to Figures 2-7 through 2-10 for typical terminal strip connections for each mode. Refer to Figure 2-3 for use of contactor to provide positive disconnection of power to the motor. During the setup procedure, parameter (P 90) will be set to the value defined below to match the desired mode of operation.

NOTE: The keypad may be used with any of the operating modes below. When the drive is placed in LOCAL keypad control (by pressing the LOCAL key) it bypasses all the terminal strip connections except the external motor temp input J1-16, (if active) to allow front - panel operation.

P90	OPERATING MODE
0	The Drive operates from Speed potentiometer or a 0-10 VDC signal (P50=0). This mode includes logic inputs for Enable, Forward/Reverse selection, Stop, Jog, Fault Reset, and a Motor temp switch. Also included are an input to select between two separate Accel / Decel / "S" curve ramps and an input to command a preset speed (selected with parameter P11, preset speed 1). See Figure 2-7.
1	**PLC INTERFACE** - Drive operates from logic inputs (analog speed input and command input are not used). This mode includes inputs for Enable, Forward / Reverse selection, 15 preset speeds and 2 Accel /Decel / "S" curve ramps. See Figure 2-8.
2	**ANALOG INPUT SPEED INPUT, UNIPOLAR** - The drive follows an analog command from selected input source, some of these options include a differential ±5VDC, ±10VDC, or 4-20mA (see parameter P 50). (See Appendix B for more information on Analog input options). Logic inputs are provided for Enable, Forward and Reverse Limit (provides simple travel limit protection), Home, Fault Reset, Speed or Torque Control, 4 selectable parameter tables, and a motor temp switch. See Figure 2-9 and Appendix B (Selectable parameter tables).
3	**SERIAL CONTROL** - Control is exclusive through the RS232 / 422 / 485 port. Inputs to the ENABLE, FORWARD LIMIT SWITCH, and REVERSE LIMIT SWITCH (1-8,9,10) are still required for safety considerations. Opening the Enable input will cause the motor to coast to a stop. Opening the FORWARD/REVERSE LIMIT SWITCHES will cause the motor to brake to zero speed, and hold zero speed with full torque. All speed and control commands are given digitally via the Serial Command Language (See chapter 4). This mode should be used if serial control is mode of operation. See Figure 2-10.

Figure 2-7 Mode 0 Analog Speed Input, Unipolar (P90=0)



J1-8 OPEN disables the drive & motor coasts to a stop, Closed allows current to flow in the motor and produce torque. Parameter P55 controls Enable polarity.

J1 -9 Momentary CLOSED starts motor operation in the Forward direction. In Jog mode (J1-12 CLOSED), continuous CLOSED jogs motor in the Forward direction.

J1-10 Momentary CLOSED starts motor operation in the reverse direction. In Jog mode (J1-12 CLOSED), continuous CLOSED jogs motor in the Reverse direction.

J1-11 Momentary OPEN drive brakes to a Stop and disables. ****NOTE** This has changed from prior versions.**

J1-12 CLOSED places drive in JOG mode, Forward and Reverse run are used to Jog the motor.

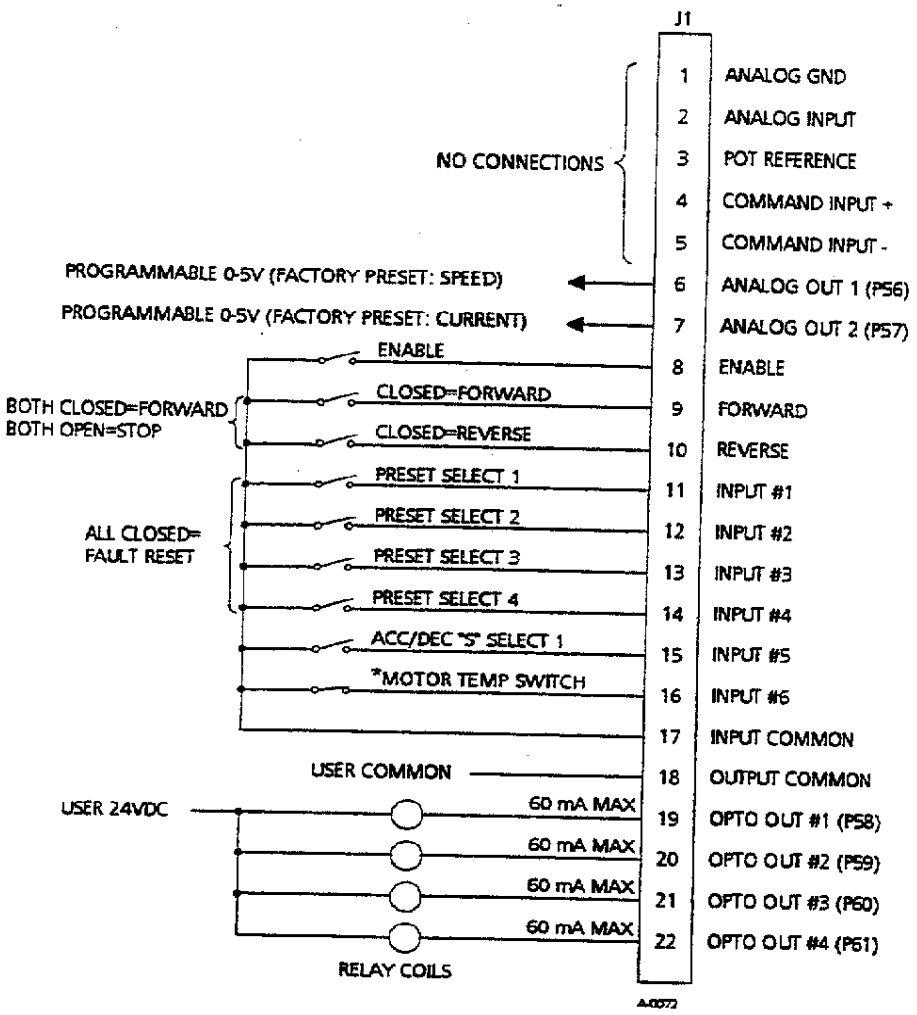
J1-13 OPEN selects ACC / DEC / "S" Curve group #1, CLOSED selects group #2.

J1-14 CLOSED selects preset speed #1 Parameter P11, OPEN allows speed command from Pot input. Jog mode (J1-12) will override this preset speed.

J1-15 OPEN to run, CLOSED to reset fault condition.

J1-16 OPEN causes a motor overtemp to be received by the drive. The drive will disable and display the fault. *This input is optional and is controlled by P80.

Figure 2-8 Mode 1 PLC Interface (P90=1)



J1-14	J1-13	J1-12	J1-11	FUNCTION
Open	Open	Open	Open	Preset 1: P11
Open	Open	Open	Closed	Preset 2: P12
Open	Open	Closed	Open	Preset 3: P13
Open	Open	Closed	Closed	Preset 4: P14
Open	Closed	Open	Open	Preset 5: P15
Open	Closed	Open	Closed	Preset 6: P16
Open	Closed	Closed	Open	Preset 7: P17
Open	Closed	Closed	Closed	Preset 8: P18
Closed	Open	Open	Open	Preset 9: P19
Closed	Open	Open	Closed	Preset 10: P20
Closed	Open	Closed	Open	Preset 11: P21
Closed	Open	Closed	Closed	Preset 12: P22
Closed	Closed	Open	Open	Preset 13: P23
Closed	Closed	Open	Closed	Preset 14: P24
Closed	Closed	Closed	Open	Preset 15: P25
Closed	Closed	Closed	Closed	Fault Reset

J1-8 OPEN disables the drive & motor coasts to a stop, Closed allows current to flow in the motor and produce torque. Parameter P55 controls enable polarity.

J1 -9 CLOSED operates motor in the Forward direction (with J1-10 OPEN).

J1-10 CLOSED operates motor in the Reverse direction (with J1-9 OPEN).

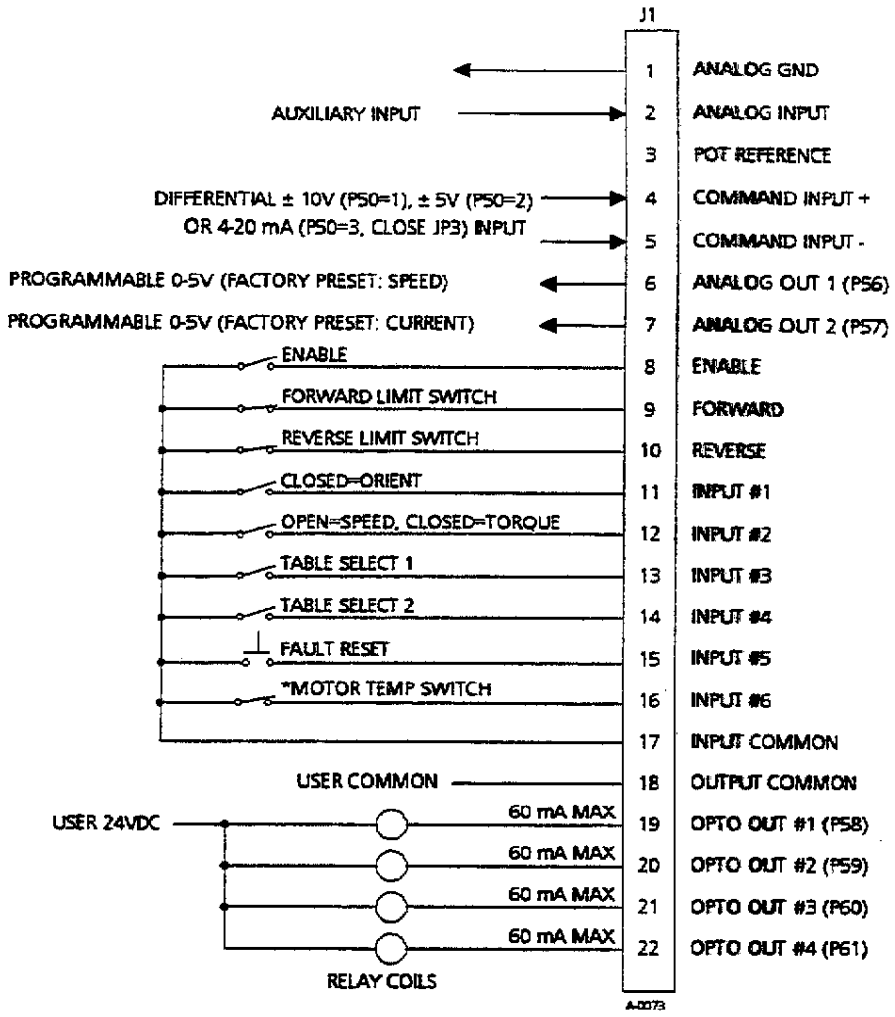
J1-11-14 Selects preset speeds, (see table left).

J1-15 Selects ACC / DEC. group. (see table below).

J1-15	FUNCTION
OPEN	ACC/DEC GROUP 1
CLOSED	ACC/DEC GROUP 2

J1-16 OPEN causes a motor overtemp to be received by the drive. The drive will disable and display the fault. *This input is optional and is controlled by P80.

Figure 2-9 Mode 2 Analog Input Speed or Torque Controller, Bipolar (P90=2)



J1-8 OPEN disables the drive & motor coasts to a stop, CLOSED allows current to flow in the motor and produce torque. Parameter P55 controls enable polarity.

J1-9 CLOSED to enable operation in the Forward direction. OPEN to disable Forward operation (drive will brake to a stop if a Forward command is still present).

J1-10 CLOSED to enable operation in the Reverse direction. OPEN to disable Reverse operation (drive will brake to a stop if a Reverse command is still present).

NOTE: OPENING both J1-9 and J1-10 causes the drive to brake to a stop.

J1-11 CLOSED commands the drive to stop the motor at a predefined home / orient position. OPEN for normal control.

J1-12 OPEN for Speed control, CLOSED for Torque Control.

J1-13&14 Select from four Parameter tables (see table below). For more information refer to Appendix B.

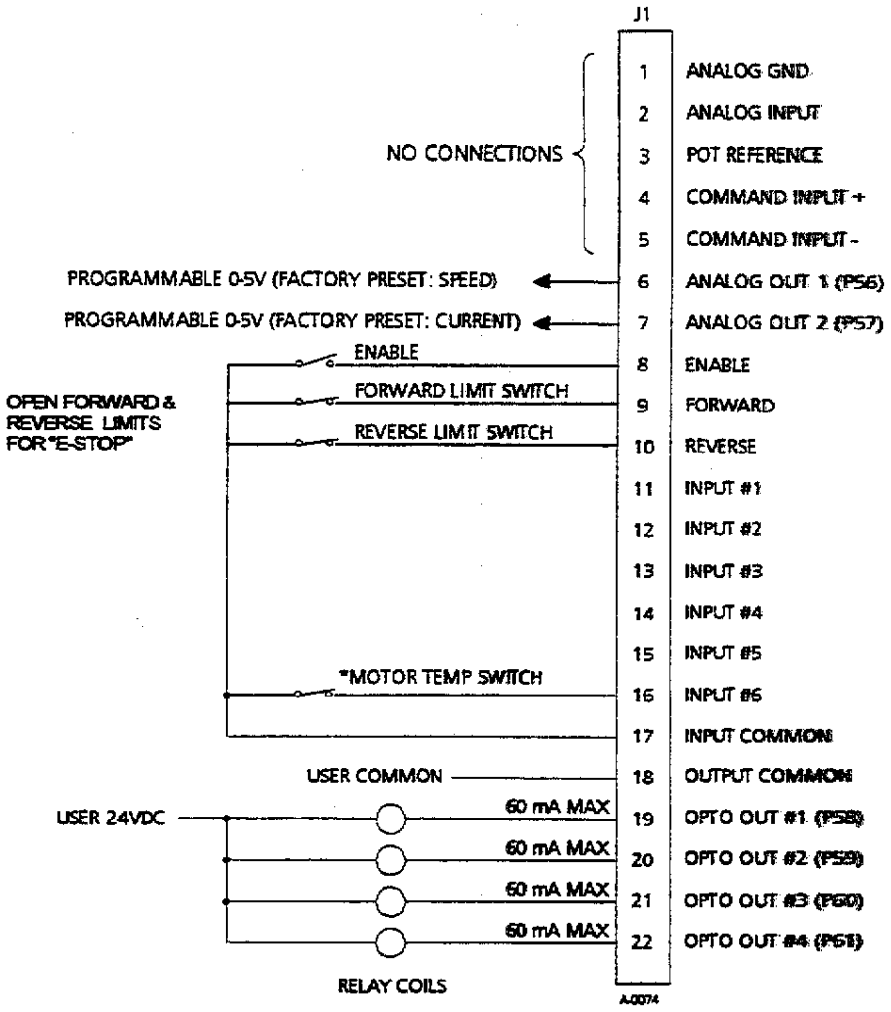
J1-15 OPEN to run, CLOSED to reset fault condition.

J1-16 OPEN causes a motor overtemp to be received by the drive. The drive will disable and display the fault.

J1-14	J1-13	FUNCTION
OPEN	OPEN	Parameter table #0
OPEN	CLOSED	Parameter table #1
CLOSED	OPEN	Parameter table #2
CLOSED	CLOSED	Parameter table #3

*This input is optional and is controlled by P80.

Figure 2-10 Mode 3 Serial Control (P90=3)



J1-8 CLOSED allows serial control of the motor current. (Drive is not enabled until a serial enable command is given). OPEN prevents the drive from operation, (if the motor is in operation it will coast to a stop). Parameter P55 controls enable polarity.

J1-9 CLOSED to enable operation in the Forward direction. OPEN to disable Forward operation (drive will brake to a stop if a Forward command is still present).

J1-10 CLOSED to enable operation in the Reverse direction. OPEN to disable Reverse operation (drive will brake to a stop if a Reverse command is still present). NOTE: OPENING both J1-9 and J1-10 causes the drive to regen to a stop.

J1-16 OPEN causes a motor overtemp to be received by the drive. The drive will disable and display the fault. *This input is optional and is controlled by P80.

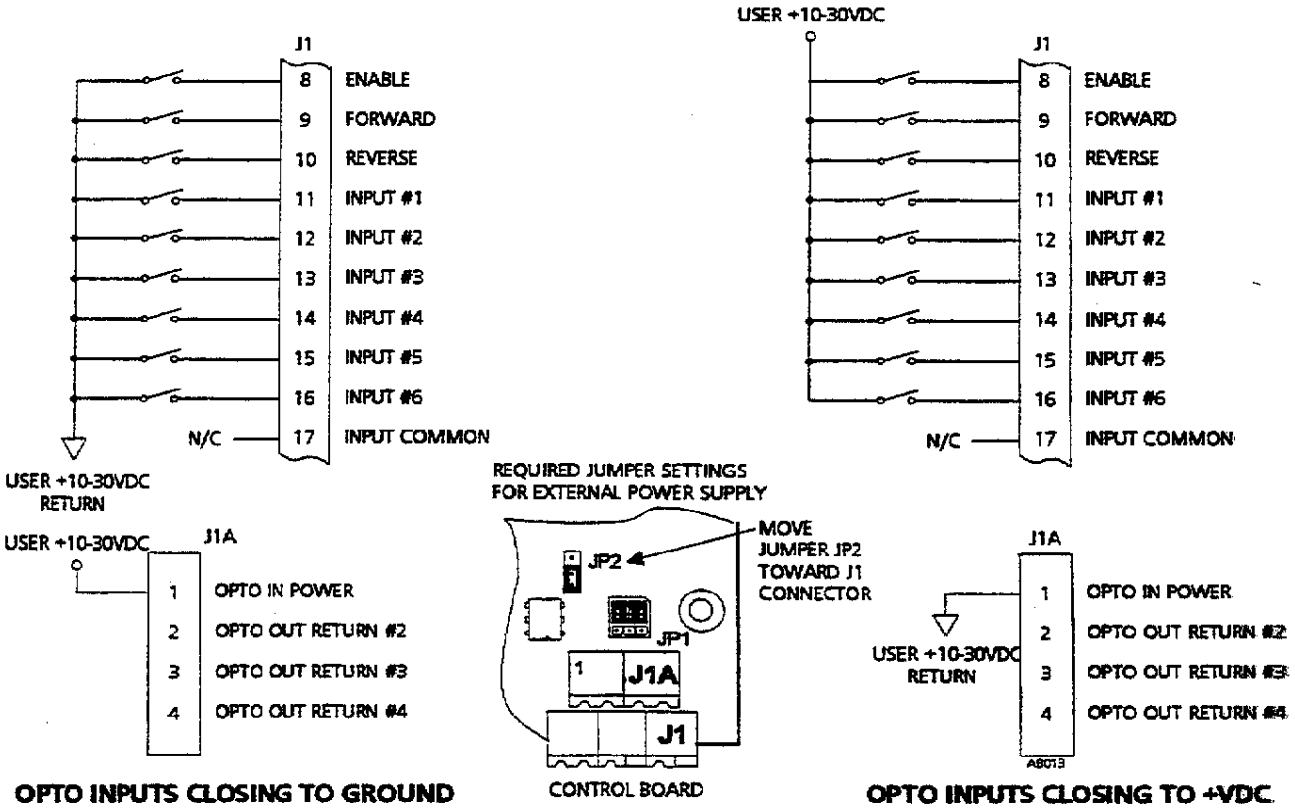
Control Wiring (J1)

All control connections are made to terminal strip J1 located on the edge of the control board, above the power connections. This terminal strip contains chassis ground referenced analog I/O circuits, and opto isolated discrete I/O circuits. The front panel cover (if supplied) will need to be removed to access these connections. Make control connections per the appropriate Figure 2-7 thru 2-10 for your selected operating mode.

Opto-Isolated Inputs

The opto-isolated inputs (J1-8 to J1-16) are normally operated by closing contacts or switches between them and the Input Common J1-17. All switches shown in Figures 2-7 through 2-10 may be replaced by static logic outputs from a PLC, CNC or computer if the outputs of such devices are open collector and the ground is connected to Input Common (J1-17). Jumper JP2 is factory preset on 1 and 2 for use with the internal supply. When using an external supply (10-30 VDC) with the opto-isolated inputs the JP2 jumper must be moved to pins 2 & 3 (refer to Figure 2-11). The inputs can be configured to close to common or to positive DC voltage.

Figure 2-11 Using an external power supply with the opto inputs



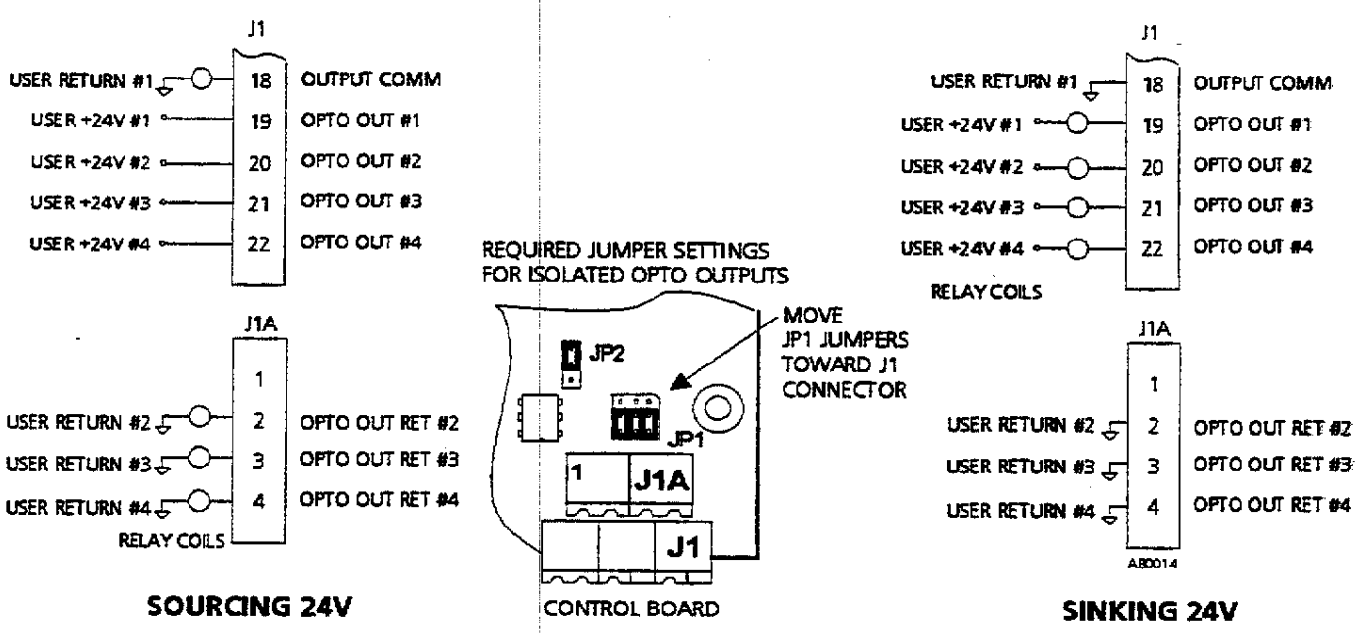
Opto-Isolated Outputs

Four programmable opto-isolated outputs are provided on J1 (J1-19 to J1-22). These outputs can be used to provide indications of various drive conditions. The source of these outputs is programmed with parameters P58 - P61. The opto-isolated outputs will sink up to 60 mA of current. The minimum voltage from opto output to common, when active, is 2.5 VDC (this is not TTL compatible). Their factory preset connection with common emitters (Jumpers on JP1 set towards J1) is shown in the appropriate connection diagram (Figures 2-7 through 2-10). See appendix B for complete schematic diagram.

NOTE: An internal +24V supply is available on J1A pin 1 when the jumper JP2 is connected across pins 1 & 2. This supply is normally connected to the opto inputs.

The four opto-isolated outputs can be disconnected from each other by moving the jumpers on JP1 toward the J1 connector. Each output can then be used to switch an external 10 - 30 VDC supply in either a sourcing or sinking mode. Connections are shown in Figure 2-12. The complete schematic diagram of the output circuits is shown in Appendix B.

Figure 2-12 Using isolated supplies with the opto outputs



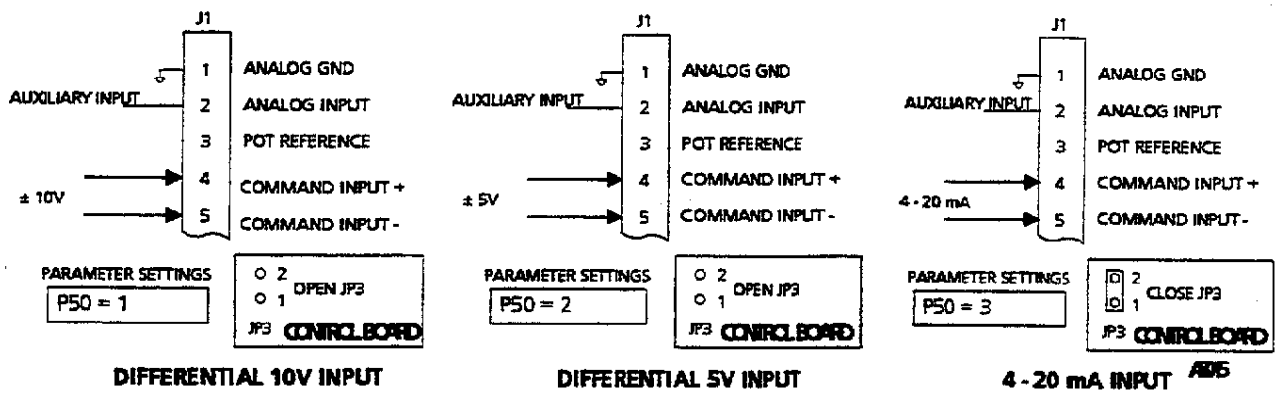
Analog Inputs

Two analog speed inputs are available on J1, the auxiliary or pot input (J1-1 to J1-3), and the command input (J1-4 and J1-5).

The auxiliary input is used when Parameter P50 is set to 0 (speed pot). The reference comes from a 5K pot connected as shown in Figure 2-7, or a 0-10V signal on J1-1 and J1-2.

The command input (J1-4 to J1-5) accepts a differential ±5V, ±10V or 4-20mA as selected in Parameter P50 (refer to Figure 2-13). This input is buffered to provide 40 db common mode isolation with up to ±15 Volts common mode relative to common. Either analog input may be grounded provided the common mode range is not exceeded.

Figure 2-13 Analog Input Options for Mode 2



Analog Outputs

Two programmable analog outputs are provided on J1, (J1-6 & J1-7). These outputs are scaled 0-5VDC and can be used to provide real-time status of various drive conditions. The type of output is selected by parameters P56 and P57 (see Appendix D). Additional information on the Analog Outputs is available in Appendix B.

Encoder Wiring (J2)

The controller requires the use of an encoder mounted on the shaft of the motor. The encoder power and input connections are made to terminal strip J2. A 5VDC supply is provided, on J2-7, to power the encoder (350 mA max).

NOTE: When installing the encoder take note of the number of counts per revolution, this number will be used later in Chapter 3 to set parameter P95.

Encoder wiring must be in twisted shielded pairs per Figure 2-14, #22 AWG minimum size, 150' maximum, with an insulated overall shield. Connect all shields to J2-8. DO NOT CONNECT ANY SHIELDS TO THE ENCODER CASE OR MOTOR FRAME. Maximum wire-wire or wire-shield capacity shall not exceed 7500 picofarads per pair (50 pf/foot at 150'). Baldor=Sweodrive stocks encoder cable as an optional accessory. Electrical isolation of the encoder case and shaft from the motor is highly recommended to prevent capacitively coupled motor noise from influencing the encoder signal.

The encoder +5 VDC power supply output provided by the drive at J2-7 is referenced to circuit board common. DO NOT CONNECT THIS OUTPUT TO GROUND OR ANOTHER POWER SUPPLY or damage to the drive may result.

WARNING: Make sure that unexpected operation of the motor shaft during start-up will not cause injury to personnel or damage to equipment.

Check of Motors / Couplings

Verify freedom of motion for all motor shafts and that all motor couplings are tight without backlash.

Check that the encoder shaft coupling and encoder body mounting have no backlash or looseness.

Verify the holding brakes, if any, are properly adjusted to fully release and set to the desired torque value.

Momentary Application of Power

Double check electrical and mechanical connections before applying power to the control.

Verify that Enable input to J1-8 is off.

Temporarily apply power and observe that the display indicates a 0 (zero). If this indication doesn't occur, double check all connections and verify input voltage and refer to Chapter 6 "Troubleshooting". If fault indication occurs, refer to Chapter 6.

Chapter 3
Setup Using the Keypad

This Chapter describes the setup and tuning of the controller from the keypad. If you are not yet familiar with the operation of the keypad please refer to the section entitled USING THE KEYPAD in Chapter 1.

The flow diagram at the beginning of Chapter 2 outlines the setup procedure.

NOTE: If you have a completed Parameter list available for your application, enter all the parameters from that list (refer to USING THE KEYPAD in Chapter 1) and skip ahead to the section entitled: OPERATE THE DRIVE.

The following procedure assumes that you have successfully completed the installation of the control and have momentarily applied power as outlined in Chapter 2.

Drive Setup From Motor Nameplate Data

Verify that the Enable input to J1 is off. Apply power to the controller and verify that the keypad display does not indicate a fault condition.

To enter the parameters that follow, the keypad must be in program mode. This is accomplished by pressing the PROG key on the keypad to light the PROG indicator. If this is not a first-time setup you may be prompted for a security code. To exit the program mode at any time press the PROG or DISP keys.

Setup Parameters

The first step of the setup procedure is to enter the desired operating mode, the motor nameplate data, and the encoder counts per revolution in the parameters that follow.

PARAMETER	DESCRIPTION AND PROCEDURE
P90	**OPERATING MODE** Enter the mode number chosen in Chapter 2 (Figures 2-7 thru 2-10).
P91	**MOTOR RATED VOLTAGE** Enter the rated voltage of the motor in RMS volts from the motor nameplate.
P92	**MOTOR RATED CURRENT** Enter the rated full load current of the motor in RMS amps from the motor nameplate.
P93	**MOTOR RATED SPEED** Enter the rated or base speed of the motor in RPM exactly as shown on the motor nameplate. **NOTE: DO NOT ENTER DESIRED OR RATED MAXIMUM SPEED OR ROUND OFF THE RATED NAMEPLATE SPEED**

P94 **MOTOR "RATED" OR "BASE" FREQUENCY**
Enter the rated or base frequency in Hertz from the motor nameplate.

P95 **ENCODER LINES PER MOTOR REVOLUTION**
Enter directly from encoder nameplate or data sheet for direct coupled encoder. Geared or belt coupled encoders are not recommended, if used they must have positive ratio with no slippage and encoder lines per motor revolution must be entered here.

Calculate Control Parameters

This procedure uses the nameplate data to compute initial values for various remaining parameters.

NOTE: Parameters with their factory preset marked as CALC or referenced to another parameter in the parameter list (Appendix D) will be overwritten by this procedure.

P99 **CALCULATE AND LOAD FACTORY PRESET DATA.** Set P99 to 1 to automatically calculate flux vector control parameter and load other parameters with factory preset data. This procedure also clears all recorded fault conditions in the fault log. When the procedure is finished, it will reset P99 to zero. MANUALLY CALCULATED PARAMETERS THAT YOU WISH TO RETAIN MUST BE RE-ENTERED AFTER THIS STEP.

Auto-Tuning the Drive

CAUTION: The auto-tuning tests are not recommended for elevator applications, with the exception of test AU1 & AU2. Please refer to appendix A for elevator setup procedures.

Automatic tuning of the controller to the motor is accomplished by running a six step tuning procedure activated through Parameter P100. The resulting parameters P71 through P78 selected by the microprocessor may be manually changed if required to suit the application.

WARNING: THESE PROCEDURES MAY ROTATE THE MOTOR UP TO MAXIMUM SPEED. DO NOT PERFORM AUTO TUNING UNLESS IT IS SAFE TO ROTATE THE MOTOR UNDER AUTOMATIC CONTROL OF THE DRIVE.

These procedures require the motor and encoder to be properly wired, shielded, and grounded per Figures 2-2 through 2-12. They also require that the motor rotor be free to rotate with no external load or source of significant windage or friction. The tests must be run in sequence from Au01 to Au06.

To run each auto-tuning procedure, first disable the drive and select Parameter P100 (Press Enter) to gain access to the tests (ALL, AU01,..., Au06). Use the arrow keys to select the desired test, enable the drive (except for AU01), and press Enter again to start. **NOTE:** Selecting "ALL" will automatically advance through all tests (AU01 through AU06, and provided they all pass will display "DonE" when completed. If running each test individually, the display will indicate either "PASS" or "Err" to announce the individual test result. Press Enter, and the next test number will be displayed. Repeat the procedure until all tests have been run successfully.

Enabling the Drive

All of the tuning tests except AU01 require the drive to be enabled. The drive may be enabled by closing J1-8 on the J1 terminal strip (some operation modes require J1-9 & 10 to be closed also), or from the keypad by entering LOCAL mode (press LOCAL, the led will be lit) then pressing FWD. Once enabled, current will flow in the motor.

Running the Tests

NOTE: Prior to running any auto-tuning test, you must set P99 to one to calculate flux vector control parameter for auto-tuning to be successful.

During the operation of the tests, tuning variables will be displayed on the keypad. If you are having trouble getting a test to pass, take note of the final value on the display before consulting the factory for assistance.

ALL **RUN ALL TESTS**
Running this test will sequence through all tests (AU01 - AU06) automatically. If a test fails the procedure will stop. Select "ALL", enable the drive, and press Enter to run the procedure.

AU01 **COMMAND OFFSET TRIM**
Trims out any voltage offsets on the differential command input (J1-4 & J1-5). It does not trim the Analog (POT) input (J1-1, 2, 3). This test is required only if the controller is to be used in mode 2; you can skip this procedure for other modes. Apply input command to J1-4 and J1-5 corresponding to zero speed, disable the drive (open the Enable input J1-8 or press STOP on the keypad), select AU01, and press Enter to run the procedure. IF THE PROCEDURE FAILS, J1-4 to J1-5 input is too high to trim out. Measure voltage J1-4 to J1-5 and command voltage near zero before re-running.

AU02 **CURRENT LOOP COMPENSATION**
Enable the drive, select AU02 and press Enter to run the procedure. This procedure measures current response to commanded pulses of 1/2 rated motor current. The test sets the values for Parameters P73 - Current Controller Proportional Gain, and P74 - Current Controller Integral Gain. If this procedure fails, retry once before consulting factory for assistance.

AU03 **FLUX (EXCITATION) CURRENT SETTING**
Enable the drive, select AU03 and press Enter to run procedure. This procedure runs the motor near rated speed for up to several minutes and sets flux current (P72) based on line voltage and motor nameplate data. IF PROCEDURE FAILS, remove the Enable (OPEN J1-8) and check P90 through P95 entries, motor grounding, and proper voltage at L1, L2, L3.

AU04 **ENCODER TESTS**
Enable the drive, select AU04 and press Enter to run the procedure. This procedure checks the values entered in Parameters P95 - Encoder lines per revolution, and P71 Encoder alignment direction. This is accomplished by accelerating the motor "open loop", detecting the phasing of encoder feedback and counting the number of encoder pulses per revolution of the motor. The test will automatically switch the

value of P71 to match motor rotational direction. IF THE PROCEDURE FAILS OR THE CONTROLLER APPEARS UNSTABLE, check motor and drive grounding, encoder coupling, P95 encoder lines selection, wiring and shielding, and then repeat the test. If the test still fails, Open the Enable input (J1-8) to disable the controller, put the keypad in Display RPM mode (Press the DISP key until the RPM indicator is lit) and observe RPM on the display while rotating motor rotor by hand. Zero RPM or erratic display indicates malfunctioning encoder, power supply, encoder wiring error or damaged encoder line receiver on the control board. If display seems OK, manually change P71 from 1 to zero or vice-versa and retry.

AU05 **SLIP FREQUENCY TEST**
Enable the drive, select AU05 and press Enter to run the procedure. This procedure repeatedly accelerates motor to test Parameter P78 and will yield errant results if there are significant windage or friction loads on the motor. IF THE PROCEDURE FAILS, manually reset P78 to the value calculated from the CALCULATE DEFAULT PARAMETERS section above.

AU06 **SPEED CONTROLLER COMPENSATION**
Enable the drive, select AU06 and press Enter to run the procedure. This procedure accelerates the motor to measure the current to acceleration ratio (P75). It also adjusts Parameters P76 - Speed Controller Integral Gain and P77 Speed Controller Differential Gain. Because the auto-tune is usually done at no load, it will generally set P76 too high for high inertia motors and loads if current limit P33 is set too low. If the controller is too responsive when the drive is loaded, set current limit to the proper value and rerun this procedure. NOTE: This auto-tune procedure can be run with the drive loaded. IF THIS PROCEDURE FAILS or drive is still too responsive, adjust P75 manually as discussed in Appendix C.

After the tuning tests are complete, disable the drive and exit the auto tuning mode by pressing RESET on the keypad.

NOTE: The following section is optional. If your application does not require any of the parameters described below you can skip ahead to the section entitled OPERATE THE DRIVE.

Selection of Optional Parameters (P0 - P65)

These parameters are not required to set up the control to match the motor; they are used to specify analog and digital inputs, outputs, and other functions to suit the application.

System Control Parameters

PARAMETER	DESCRIPTION AND PROCEDURE
P0	**JOG SPEED** (RPM) This is the speed that the drive uses when a Jog command is given from J1-12 in mode 0, the keypad, or the serial port.

NOTE: Although the Accel / Decel ramps are defined as having a maximum value of 999.9, this is dependent on the max speed of the motor. The slowest profile the drive can apply to a command is 3.25 RPM per second. For example, if 1000 RPM is max speed, then maximum Acc / Dec would be: 307 sec; 2000 RPM = 615 sec; and 3000 RPM = 923 sec.

P1 **JOG ACCEL** (0 TO MAX SPEED) (SEC) Sets the time in seconds for the Jog command to rise linearly from zero to the maximum speed (set with P30) Adjustable from zero to 999.9 seconds with resolution of 0.1 seconds.

P2 **JOG DECEL** (MAX SPEED TO 0) (SEC) Sets the time in seconds for the jog command to fall linearly from the maximum speed (set with P30) to zero. Adjustable from zero to 999.9 seconds with resolution of 0.1 seconds. The drive will follow this rate if a braking option is used, otherwise the drive will take longer to decelerate.

P3 **JOG "S" CURVE** (TIME TO MAX ACCEL) (SEC) Sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum speed set with P30 or fall from the maximum speed to zero. Adjustable from zero to 99.99 seconds with a resolution of 0.01 seconds. Increasing the S-Curve time softens the acceleration transient the drive will apply to the driven equipment and lengthens the time required to change speed. Refer to Figure 3-1.

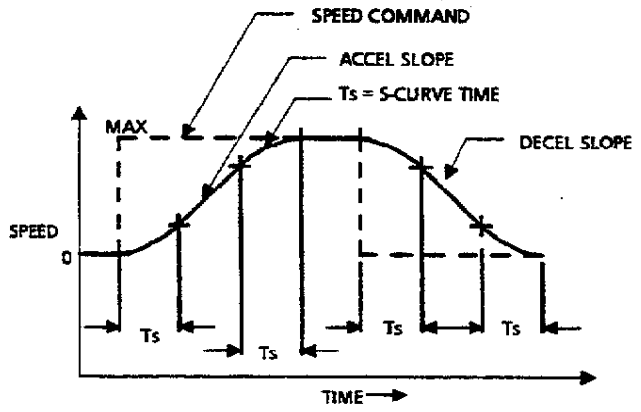
P4 & P7 **ACCEL #1 and #2** (0 TO MAX SPEED) SEC Sets the time in seconds for the speed command to rise linearly from zero to the maximum speed (P30) Adjustable from zero to 999.9 seconds with resolution of 0.1 seconds. Two independent Acc / Dec / S-curve groups are available.

P5 & P8 **DECEL #1 and #2** (MAX SPEED TO 0) (SEC) Sets the time in seconds for the speed command to fall linearly from the maximum speed (P30) to zero. Adjustable from zero to 999.9 seconds with resolution of 0.1 seconds. Two independent Acc / Dec / S-curve groups are available. The drive will follow this decel rate if a braking option is used, otherwise the drive will take longer to decelerate.

P6 & P9 **"S" CURVE #1 and #2** (TIME TO MAX ACCEL) (SEC) Sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum value set with P30 or fall from the maximum to zero. Adjustable from zero to 99.99 seconds with a resolution of 0.01 seconds. Increasing the S-Curve time softens the acceleration transient the drive will apply to the driven equipment and lengthens the time required to change speed. Two independent Acc / Dec / S-curve groups are available. Refer to Figure 3-1.

P11 - P25 **PRESET SPEEDS #1 - #15** (RPM) These parameters select the preset speeds to be used in Mode 1 (Mode 0 uses preset #1). These speeds are selected from logic inputs J1-11 - J1-14 (in mode 1). All preset speeds are factory preset to 0.

Figure 3-1 Typical S-Curve Limited Velocity Profile



P26 **HOMING / ORIENT SPEED** (RPM) Sets the command speed in RPM for the motor when Home / Orient logic input is applied. Upon a Home / Orient input the drive will accelerate or decelerate to this speed in the forward direction. The drive will rotate at this speed until the Home (or Orient) marker input is received, then it will position as described below.

NOTE: Homing is always done in the FORWARD direction. If the drive orients in the wrong direction for your system you must change the phasing of the motor so that "drive" forward matches the desired homing direction. This is done by swapping the encoder wiring channels (described later in this chapter) and changing the encoder alignment direction (P71) from a one to a zero or vice-versa. it is not necessary to swap any output power wires.

P27 **HOME OFFSET (IN ENCODER COUNTS AFTER X4 MULTIPLICATION)** Sets the distance past the Home marker input at which the motor will decelerate and hold position. Resolution is four times the number of encoder lines per revolution. Home position will be the rising edge of the marker input plus this offset. It is recommended that this distance be set at least 100 counts to provide deceleration distance and avoid an abrupt stop.

Misc Operating Parameters

P30 **DESIRED MAXIMUM MOTOR SPEED** (RPM) Enter desired maximum motor speed in RPM. **THIS MUST NOT EXCEED MOTOR NAMEPLATE MAXIMUM SPEED.**

P31 **MINIMUM SPEED (RPM)** This parameter sets the offset applied to analog speed commands in Mode 0 only. This sets the minimum speed command in RPM which will occur with zero volts input. P51, - Analog Input Deadband, should be set to zero whenever P31 is non-zero.

P32 **CONSTANT POWER SPEED (RPM)** This parameter defines the speed in RPM below which the flux current is constant (the constant torque region). Above this speed the flux current is reduced inversely with increasing speed for constant HP operation. This setting is made automatically during the setup procedure. Lowering the setting operates the motor at lower voltage in the constant HP region to provide better dynamic response. Raising the setting results in maximum voltage supplied to the motor and provides maximum output torque in the constant HP region speeds.

P33 **CURRENT LIMIT (AMPS)** Sets maximum current in amps the control will supply to the motor. This parameter is automatically set to 2 times the motor rated current (P92) when the motor parameters are entered. This parameter may be set to any current within the peak rating of the control. Settings below the peak control current rating will allow higher continuous current for variable torque applications with maximum continuous capability equal to the variable torque current rating when the current limit is set to this value.

P34 **REGEN RESISTANCE (OHMS)** This parameter sets the value of the external regen resistor (if one is used) in ohms. From this parameter and P35 the controller calculates the maximum obtainable value of regenerative energy. NOTE: if no regen resistor is used, set this value to 0. Set this value to 1 for a Multi-Axis System.

P35 **REGEN RESISTOR POWER (WATTS)** This parameter sets the wattage rating of the external regen resistor (if one is used).

P36 **TORQUE RATE LIMIT (mSEC)** This parameter is used to limit the rate of change of a torque command. The parameter sets the time in milliseconds for the torque command to rise linearly from 0 to the maximum value.

P37 **KEYPAD CONTROL** (0-9) This parameter sets the control functions which are active from the keypad. Appendix D gives a matrix of possible choices for this parameter. The default setting is 0, which allows forward and reverse jog, forward and reverse run, and stop to be controlled from the keypad.

P38 **KEYPAD SPEED** (0-5) This parameter controls the method of running (speed control) and stopping the motor from the keypad. Appendix D gives a matrix of possible choices for this parameter. There are 3 ways to control speed: Increment (@ACC / DEC rate), Entered speed, and Preset speed. Each of these can be set for Coast to stop or brake to Stop in conjunction with decel time (P5).

Increment Control: (P38 = 0 or 1)

Described in Chapter 1, Using the Keypad.

Entered Speed Control: (P38 = 2 or 3)

Allows entry of an exact digital speed command. To use this mode the drive must be in LOCAL keypad control, viewing an output condition (not in PROGram mode). Press ENTER, UP or DOWN, the display will change to RPM with the RPM indicator flashing. Use the arrow and shift keys to select the desired speed. Press ENTER, the drive will now command the speed and return to viewing the selected output condition.

Preset Speed Control: (P38 = 4 or 5)

Allows speed selection from the 15 preset speeds, Parameters P11 -P25. To do this, the drive must be in LOCAL keypad control, viewing an output condition, and not in PROGram mode. Press ENTER, UP or DOWN key and the display will change to RPM with the RPM indicator flashing. Use the arrow and shift keys to select the preset speed number (1 thru 15). Press ENTER, the drive will now command the preset speed and return to viewing the selected output condition.

P39 **SECURITY CONTROL** (0-3) Sets the level of security applied to the changing of parameters. Valid choices are 0 - 3.

P39 = 0

No security code is required from the keypad or the serial port.

P39 = 1

A security code must be entered to change parameters from BOTH the keypad and the serial port.

P39 = 2

A security code is required from keypad only.

P39 = 3

A security code is required from serial port only.

P40 **BAUD RATE** (0-4) Sets the baud rate of the serial port for serial commands. Possible values range from 0 for 1200, 2 for 4800, 3 for 9600 (factory preset) and 4 for 19,200 baud. NOTE: parity = None, Data Bits = 8, and Stop Bits = 1 for all selections.

P41 **DRIVE ADDRESS** (0, 1-31) The serial command language supports from 1 to 32 drives on a common serial line. This parameter sets the address of this controller.

The default value is 0 for single system and the drive acts upon all valid serial commands. With a setting of 1 or higher the drive will wait to be addressed before accepting a command. See Chapter 4 and Appendix E for more information on Serial Command.

NOTE: Setting this to a nonzero value will automatically turn echo off for serial commands.

P42 **AUTO FAULT RESET** (FAULTS/HOUR) This parameter allows the user to select automatic reset of up to 5 faults per hour. The factor preset value of 0 selects no auto reset, a value of 1 selects 1 auto reset/hour, etc. All faults are stored in the fault log (up to 15 total) for retrieval during troubleshooting.

P43 **AUTO RESET DELAY TIME** (SEC) This parameter sets the time delay in seconds before the controller will auto reset a fault. The adjustable range is 0 to 120 seconds. The factory preset value is 0.

P44 **POWER LOSS RESET** (0,1) A value of 1 turns on the power loss reset, the factory preset of 0 turns it off. When power loss reset is on, the controller will automatically reset from a momentary loss of input power using the values set in P42 and P43. When power loss reset is off a momentary loss of input power will cause a power loss fault.

I/O Parameters

P50 **ANALOG INPUT** (0-4) This parameter controls the type of analog input used for speed commands in mode 2 (in mode 0 the input is 0-10VDC, or a speed pot on J1-1 to J1-2). 0 selects a 0-10 VDC signal on J1-1 and J1-2 (see Figure 2-4). 1 = a ±10 V signal on J1-4 and J1-5, 2 = a ±5 V signal on J1-4 and J1-5, 3 = a 4-20 ma signal on J1-4 and J1-5, 4 = ±10 V signal on J1-4 and J1-5 with a 0-5 V torque limit on J1-1 and J1-2 (5 V = FULL TORQUE). Appendix B has schematic.

P51 **ANALOG DEADBAND FOR ZERO SPEED COMMAND (RPM)** This parameter sets the input threshold below which the analog input signal will result in zero speed command to the drive in mode 2. This "dead zone" allows the drive to hold zero speed for small offsets or drifts in the speed command input. (Example - P51 = 30 RPM will cause the drive to hold zero speed for analog inputs commanding less than 30 RPM.) Set P31 = 0 whenever P51 is non-zero.

P55 **ENABLE POLARITY** (0,1) Controls the polarity of the enable input (J1-8). The factory preset is 0 and requires an open on J1-8 to disable the motor. A setting of 1 requires a closed connection. This defeats the open wire protection!

P56 & P57 **SELECTION FOR ANALOG OUTPUTS #1,2** (0-20) This parameter selects the output at J1-6 & J1-7. Valid choices are given in Appendix D and an explanation of each is given in Appendix B.

P58 - P61 **SELECTION FOR OPTO OUTPUT #1 - #4** (J1-19 - J1-22) Valid choices are given in Appendix D and an explanation of each of is given in Appendix B.

I/O Threshold Parameters (For Opto Outputs)

P62 **ZERO SPEED TOLERANCE (RPM)** This threshold sets the dead zone for the zero speed logic output in RPM. Speeds equal to or less than this setting will cause the zero speed output to be closed, speeds greater than this setting will cause the zero speed output to be open. See Opto-Isolated Outputs in Appendix B.

P63 **AT SPEED TOLERANCE (%)** This parameter sets the width of the band about the commanded speed which will cause the At-Speed logic output to be closed. The setting defines the tolerance band in percent of base speed for speeds below base speed and percent of commanded speed above base speed. See Opto-Isolated Outputs in Appendix B.

P64 **POSITION TOLERANCE** (ENCODER COUNTS) This parameter sets the number of encoder counts a serial positioning command is allow to be off before it tries to correct.

P65 **SET SPEED (RPM)** This parameter defines the speed in RPM below which the Set Speed logic output is open. At or above this speed, the Set Speed logic output is closed. See Opto-Isolated Outputs in Appendix B.

Flux Control Parameters

P70 **ENCODER FILTER** (0 - 7) This is the number of servo cycles the encoder counts are accumulated over to provide the RPM feedback. It is automatically set to suit the encoder resolution. The preset filter frequency may be reduced to obtain smoother low speed operation. The higher the number, the more filtered the signal but less bandwidth is available. Valid frequencies are 0 - 7.

P71 **ENCODER ALIGNMENT DIRECTION** (0 OR 1) This parameter sets the encoder's electrical direction of rotation to match that of the motor. This parameter is normally set during the auto-tuning procedure.

NOTE Parameters P72 through P78 are set during the tuning procedure. Appendix C covers these parameters in greater detail.

P79 **POSITION GAIN** This value sets the gain for serial positioning commands, it is automatically calculated by the controller.

P80 **PROTECTIVE FEATURE** Refer to Appendix B for descriptions and method of selection.

P81 **NUMBER OF PARALLEL CONTROLS**
No entry normally required. If multiple controls are connected, this number needs to be entered before Auto-Tuning the Drive. Normally P81 = 1, unless multiple control modules are connected in parallel to drive motors requiring more current than is available from a single control module. Enter number of parallel controls for those systems which include the necessary equipment to parallel control modules.

P82 **PWM RIPPLE FREQUENCY** (KHz) Sets the ripple frequency of the controller in .1 KHz increments. Valid selections are from 2 KHz - 20 KHz for the IGBT high frequency version, 2 KHz - 5 KHz for the IGBT low frequency version, and 2 KHz - 10 KHz for the Bipolar version. NOTE: Operation of the drive above its factory preset ripple frequency will reduce its output capability.

P96 **LOW LINE OPERATION** For use only with Model ZD184XX drives. This parameter lowers the overvoltage and undervoltage, and regen thresholds when operating a 460V drive on lessthan 380V line. **Do not** change this parameter if the line voltage is above 380VAC.

Operate the Drive

Now that the controller is setup it should be run to verify correct operation. The controller should be enabled, and given speed commands to verify that the motor response is adequate for the application. (The motor can be run from the terminal strip as defined in the appropriate Figure 2-4 through 2-7, or from the keypad as outlined in Chapter 1).

If the drive operates in the wrong direction for your system you must change the phasing of the motor so that the drive matches the desired direction. This is done by swapping the encoder wiring channels (described later in this chapter) and changing the encoder alignment direction (P71) from a one to a zero or vice-versa. it is not necessary to swap any output power wires.

If the drive trips (indicates a fault condition on the display) refer to Chapter 6 for troubleshooting information.

Adjust Control Parameters to Suit the Application

The factory preset parameters or auto-tuned parameters set up the controller to operate properly with only the motor rotor as a load. When the actual load to be driven is connected, it may be necessary to adjust some of the parameters to optimize performance. Other parameters should not be changed as they are difficult to adjust to obtain increased performance.

1. After initial setup, DO NOT ADJUST P72, P73, P74 or P78. These are normally automatically set near-ideal. See Appendix C for methods of calculating flux vector parameters if auto-tuning cannot be used.

2. The speed loop parameters P75, P76 and P77 can often be manually adjusted to better suit the application. See Appendix C for PI (proportional plus integral) controller background and setup procedures. The P70 encoder filter may also be used to smooth the speed loop response.

3. The constant power speed P32 may need adjustment for ideal high speed performance.

4. If homing is used, the homing speed and offset may require adjustment to suit the application.

5. Preset speeds and accel, decel and S-curves should be adjusted to suit the application.

6. Current limit P33 can be adjusted to limit maximum torque the motor will apply to the load.

Select Security Code

The security code (P101) is an optional entry. It works with parameter P39 to prevent keypad or serial users from entering the Program mode where parameter

variables may be altered but does allow users to view any variable. The factory preset value is 9999.

The security code value may be set by changing parameter P101 to the desired value (see Chapter 1 for information on how to use the keypad). Once the number is selected, record it in a safe place. Next P39 will need to be changed to select the desired security mode (see P39 earlier in this chapter or Appendix D for more information).

After a security code is entered and P39 is set for keypad security code, when pressing PROG to enter the program mode for the first time you will be prompted to enter the security code. Press Enter and use the shift and arrow keys to select the code, Press Enter again and the program mode will be active (PROG LED lit). Once the security code has been entered you can toggle in and out of program mode without re-entering the code, (the program led will flash when out of program mode to indicate that the security code is still entered). To clear (and re-activate) the entered security code press Reset while in Program mode or when the PROG led is flashing. The next time the PROG key is pressed you will be prompted for the security code again.

Record Parameters

Record the parameters values from the display for future reference. The vector drive parameter sheet in Appendix D provides a convenient form for the data. Parameter data may also be stored in a computer file by the procedure given in Chapter 4.