Boston Gear®

NEMA 1
AC Motor Controllers

P-3044-BG *Installation , Operation and Maintenance Manual*

Doc. No.

ADX Series
1 - 75 HP

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STORAGE INSTRUCTIONS

If the ADX controller is not to be installed immediately, it should be stored in a clean, dry location at an ambient temperature between -20°C and +55°C (-4°F and +131°F). The surrounding air must be free of corrosive fumes and electrically conductive contaminants. Care must be taken to prevent condensation from forming within the equipment enclosures during storage. A space heater may have to be installed if condensation or excessive moisture is expected.

Motors, transformers and other electrical equipment may also have storage limitations. Refer to the manuals supplied with this equipment for specific recommendations.

If long term storage or conditions other than covered above are expected, contact Boston Gear.

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NOTICE

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

WARNING

The following must be strictly adhered to at all times.

- **YOU AS THE OWNER OR OPERATOR OF THE DRIVE EQUIPMENT HAVE THE RESPONSIBILITY TO HAVE THE USERS OF THIS EQUIPMENT TRAINED IN ITS OPERATIONS AND WARNED OF ANY POTENTIAL HAZARDS OF SERIOUS INJURY.**

- **THE DRIVE EQUIPMENT SHOULD BE INSTALLED, OPERATED, ADJUSTED, AND SERVICED ONLY BY QUALIFIED PERSONNEL FAMILIAR WITH THE CONSTRUCTION AND OPERATION OF THE EQUIPMENT AND THE HAZARDS INVOLVED INCLUDING THOSE DESCRIBED BELOW. FAILURE TO OBSERVE THIS WARNING CAN RESULT IN PERSONAL INJURY, LOSS OF LIFE, AND PROPERTY DAMAGE.**

- **THE NATIONAL ELECTRICAL CODE REQUIRES THAT AN AC LINE DISCONNECT OR CIRCUIT BREAKER BE PROVIDED IN THE AC INPUT POWER LINES TO THE CONTROLLER. THIS DISCONNECT MUST BE LOCATED WITHIN SIGHT OF THE CONTROLLER. DO NOT OPERATE THE CONTROLLER UNTIL THIS CODE REQUIREMENT HAS BEEN MET.**

- **THE DRIVE EQUIPMENT IS AT AC LINE VOLTAGE POTENTIAL WHENEVER AC POWER IS CONNECTED TO THE DRIVE EQUIPMENT. CONTACT WITH AN ELECTRICAL CONDUCTOR INSIDE THE DRIVE EQUIPMENT OR AC LINE DISCONNECT CAN CAUSE ELECTRIC SHOCK RESULTING IN PERSONAL INJURY OR LOSS OF LIFE.**

- **WAIT AT LEAST 5 MINUTES BEFORE OPENING THE CONTROLLER DOOR AFTER THE AC POWER HAS BEEN DISCONNECTED FROM THE CONTROLLER. BE SURE THE POWER INDICATOR IS NOT ILLUMINATED BEFORE TOUCHING ANY COMPONENT, WIRING, TERMINAL, OR ELECTRICAL CONNECTION IN THE DRIVE EQUIPMENT. THE POWER INDICATOR IS LOCATED ON THE CONTROLLER KEYPAD.**

- **ALWAYS WEAR SAFETY GLASSES WHEN WORKING ON THE DRIVE EQUIPMENT.**

- **DO NOT REMOVE OR INSTALL PRINTED WIRING BOARDS, WIRES, OR CABLES WHILE AC POWER IS APPLIED TO THE DRIVE EQUIPMENT. FAILURE TO OBSERVE THIS WARNING CAN CAUSE DRIVE DAMAGE, PERSONAL INJURY, OR LOSS OF LIFE.**

- **ALL DRIVE EQUIPMENT ENCLOSURES, MOTOR FRAMES, AND REMOTE OPERATOR STATIONS MUST BE CONNECTED TO AN UNBROKEN COMMON GROUND CONDUCTOR. AN UNBROKEN GROUNDING CONDUCTOR MUST BE RUN FROM THE COMMON GROUND CONDUCTOR TO A GROUNDING ELECTRODE BURIED IN THE EARTH OR ATTACHED TO A PLANT GROUND. REFER TO THE NATIONAL ELECTRICAL CODE AND LOCAL CODES FOR GROUNDING REQUIREMENTS.**

- **THE ATMOSPHERE SURROUNDING THE DRIVE EQUIPMENT MUST BE FREE OF COMBUSTIBLE VAPORS, CHEMICAL FUMES, OIL VAPOR, AND ELECTRICALLY CONDUCTIVE OR CORROSIVE MATERIALS.**

- **SOLID-STATE DEVICES IN THE CONTROLLER CAN BE DESTROYED OR DAMAGED BY STATIC ELECTRICITY. THEREFORE, PERSONNEL WORKING NEAR THESE STATIC-SENSITIVE DEVICES MUST BE APPROPRIATELY GROUNDED.**

SECTION I

GENERAL INFORMATION

INTRODUCTION

This manual is for use with Boston Gear ADX Series NEMA Type 1 AC Motor Controllers. The manual contains fourteen sections, as follows:

- **Section I, GENERAL INFORMATION,** introduces the user to the ADX controller. This section also provides Express Start-up instructions which allow the user to get the controller running in the least amount of time. Boston Gear encourages the use of the Express Startup because it is applicable for most applications.
- **Section II, INSTALLATION,** provides controller mounting and power wiring instructions, and controller terminal descriptions and locations.
- **Section III, KEYPAD,** describes how to use the controller keypad.
- **Section IV, THE ADX MENU STRUCTURE,** illustrates the controller menus and sub-menus. This section also shows how to navigate the menu structure, and how to save parameter values.
- **Section V, INITIAL POWER UP AND MOTOR ROTATION CHECK**
- **Section VI, EXTERNAL CONTROLS AND DEVICES,** provides wiring diagrams for connecting external operator controls and devices such as meters.
- **Section VII, PID CONTROL,** details the controller internal PID function. This section is not required for all applications.
- **Section VIII, SPECIAL FEATURES,** shows how to apply the special features of the controller.
- **Section IX, OPERATING MODE,** provides instructions for selecting constant torque, variable torque, volts/Hertz, sensorless torque, and closed loop flux vector control operating modes.
- **Section X, SPECIAL FEATURES,** shows how to apply the special features of the controller.
- **Section XI, INITIAL SETUP,** provides instructions for setting initial controller parameters, which need to be done only if the type of motor or the application was unknown when the controller was shipped from the factory, or was changed after the controller was shipped.
- **Section XII, MAINTENANCE AND REPAIR**
- **Section XIII, PARTS LIST**
- **Section XIV, OPTION DESCRIPTIONS**

- **Section XV, PARAMETER LISTS,** shows the minimum, maximum, and factory preset values of all the user accessible parameters in the controller. Space is provided to record parameter values that were changed by the user.

- **Section XVI, RATINGS AND FEATURES**

GENERAL DESCRIPTION

The ADX Series controllers are microprocessor based and software controlled. Included with the controller is a digital control panel (keypad) for set-up, operation, troubleshooting, and diagnostics. Optional capabilities include remote interrogation, digital speed input, and serial communication for direct control by programmable logic controllers and computers.

The ADX Series controllers convert the fixed frequency and voltage of an AC line power source to a sine-coded pulse-width-modulated (PWM) adjustable voltage and frequency output that controls induction or synchronous reluctance motors[1] over a wide speed range. The controller power section uses insulated-gate bi-polar transistors (IGBT's) which provide virtually inaudible motor noise, high starting torque, and cool motor operation.

The ADX Series controllers provide three methods of motor control:

1. Volts/Hertz (Variable Frequency) Control.
2. Sensorless Torque Control for improved torque control over the rated speed range.
3. Closed Loop Flux Vector Control for improved speed range. This method requires Option EP, Encoder Feedback or DC Tachometer Feedback.

The features of the basic controller and available options allow application of ADX controllers to numerous industrial applications requiring constant horsepower and/or constant torque or variable torque.

The ADX Series controllers comply with applicable standards established by the National Electrical Code and NEMA for industrial motor and control equipment.

1. Synchronous reluctance motors should only be used in the V/F Constant Torque mode (see step 5 on page 11-2). The torque limit feature of the ADX controller will not limit torque with synchronous reluctance motors. Acceleration and deceleration control must be used to limit torque with these motors.

Models and Ratings

CONTROLLER IDENTIFICATION

Each ADX controller contains a data label. This label identifies the controller model and provides applicable controller data. Table 1-1 shows the ADX controller model numbers and ratings.

Table 1-1: ADX SERIES MODEL MATRIX

MODEL	VOLTAGE RATING (VAC)	DRIVE RATED AMPS[a]	MOTOR		
			HP[b]	KW	RATED AMPS[b]
ADX40010	460	4.8[c]	1	0.746	2.1
ADX40015		4.8[c]	1-1/2	1.12	3.0
ADX40020		4.8[c]	2	1.49	3.4
ADX40030		4.8[c]	3	2.24	4.8
ADX40050		7.6	5	3.73	7.6
ADX40075		11	7.5	5.60	11
ADX40100		14	10	7.46	14
ADX40150		21	15	11.19	21
ADX40200		27	20	14.92	27
ADX40250		34	25	18.65	34
ADX40300		40	30	22.38	40
ADX40400		52	40	29.84	52
ADX40500		65	50	37.30	65
ADX40600		77	60	44.76	77
ADX40750		96	75	55.95	96
ADX20010	208/230	11[c]	1	0.746	4.6 (208V)/4.2 (230V)
ADX20015		11[c]	1-1/2	1.12	6.6 (208V)/6.0 (230V)
ADX20020		11[c]	2	1.49	7.5 (208V)/6.8 (230V)
ADX20030		11[c]	3	2.24	10.6 (208V)/9.6 (230V)
ADX20050		16.8	5	3.73	16.7 (208V)/15.2 (230V)
ADX20075		24.3	7.5	5.60	24.2 (208V)/22 (230V)
ADX20100		31	10	7.46	30.8 (208V)/28 (230V)
ADX20150		46.2	15	11.19	46.2 (208V)/42 (230V)
ADX20200		59.7	20	14.92	59.4 (208V)/54 (230V)
ADX20250		77	25	18.65	74.8 (208V)/68 (230V)
ADX20300		88.5	30	22.38	88 (208V)/80 (230V)

a. Current ratings listed are the maximum continuous (RMS) rating at 100% rated load. Design overload capacity permits torque limit operation at 150% rated torque for up to 60 seconds.
b. Horsepower ratings are typical. If motor nameplate amps exceed those listed, a higher rated ADX controller must be selected.
c. For 1 - 3HP drives, the Drive Rated Amps Parameter (512) must be set at 4.8 Amps (460V) or 11 Amps (208/230V) for proper drive operation.

MOTOR SELECTION

The ADX Series controllers can control the operation of any conventional or energy efficient three-phase AC induction or synchronous reluctance motor[1]. The most commonly used motors are NEMA Design B.

The controller uses high speed PWM (Pulse Width Modulation) for efficient motor control at all output frequencies. PWM techniques expose the motor to higher spike voltages than it would experience when operated from commercial power at a fixed speed. These higher spike voltages can cause the motor insulation to break down. The motor's ability to tolerate these voltage peaks is a function of the motor design, including the type of magnet wire, method of winding, and other insulation material characteristics. This phenomenon may be a concern on a 460 VAC motor, but is typically less of a concern at 230 VAC or below. The voltage spikes tend to be larger for longer length of cable between the controller and motor.

The following guidelines will help minimize or eliminate motor insulation problems:

- For new installations, specify PWM inverter duty rated motors. These motors have superior insulation systems which will tolerate modest voltage spikes.
- For retrofit applications where motor leads are less than 150 feet (46 meters), use optional motor filters connected between the controller and motor.
- For all applications where motor leads exceed 150 feet (46 meters), consult the factory.

1. Synchronous reluctance motors should only be used in the V/F Constant Torque mode (see step 5 on page 11-2). The torque limit feature of the ADX controller will not limit torque with synchronous reluctance motors. Acceleration and deceleration control must be used to limit torque with these motors.

EXPRESS STARTUP

The ADX Series controllers are normally programmed at the factory for running a general purpose AC motor. Parameters which are usually adjusted for every application (e.g., acceleration rate) are grouped together for easy access by the user. No password is needed to adjust these parameters. All remaining parameters can be password protected to prevent a casual operator from changing them.

To use the ADX controller with its factory setup, perform the following instructions.

If the type of motor and application were unknown when the controller was shipped, if the user changes the motor type or the controller control board, or if the controller is reset to factory settings, refer to Section XI (page 11-1) to set the initial setup parameters.

1. Install the ADX controller. For installation guidelines, refer to page 2-1. For mounting dimensions, refer to pages 2-2 - 2-6, as applicable.

2. Connect the power wiring to the ADX controller. For wiring guidelines, refer to pages 2-6 - 2-9. For wiring diagrams, refer to pages 2-9 - 2-11, as applicable.

3. Become familiar with the controller keypad. If necessary, refer to Section III, page 3-1.

4. Before connecting control wiring (if required) to the controller, refer to “Terminal Descriptions” on pages 2-12 - 2-14.

5. If required, connect external operator controls or devices to the ADX controller as shown in Section VI.

6. If required, check motor rotation as described in Section V.

7. If required, make adjustments to the ADX controller as described in “Changing User Group Parameter Values” on pages 4-2 - 4-7.

Additional information on the installation, operation, menu structure, and controller parameters is included elsewhere in this manual.

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SECTION II

INSTALLATION

Before starting the installation, read this section thoroughly. In addition, a thorough review of the Ratings And Features (Section XVI) is recommended.

MOUNTING THE CONTROLLER

GENERAL INFORMATION

- The ADX controller enclosure is intended for indoor applications in nonhazardous areas. This enclosure should not be used where a watertight, weatherproof, or explosion-proof enclosure is required.
- The atmosphere surrounding the ADX controller must be free of combustible vapors, chemical fumes, oil vapor, and electrically conductive or corrosive materials.
- The air surrounding the ADX controller must not exceed 40 degrees C (104 degrees F). Minimum air temperature is 0 degree C (32 degrees F).

MOUNTING INSTRUCTIONS

1. Check components in the ADX controller for shipping damage. Report shipping damage to the carrier.
2. Verify that the AC line voltage and motor voltage ratings match the ADX controller rating shown on the controller data label.
3. Select a vertical mounting surface that is vibration-free and allows air flow around the controller. Mounting dimensions are shown in Figure 2-1 (page 2-2) through Figure 2-4 (page 2-5). Also see Table 2-1, page 2-2.

   Allow 5 inches (127 mm) minimum clearance at the top and bottom of the ADX controller and 2 inches (51 mm) minimum clearance at each side for adequate cooling.

   Never mount the ADX controller upside down, immediately beside or above heat generating equipment, or directly below water or steam pipes.
4. Bolt the ADX controller to the mounting surface.

Table 2-1: DIMENSIONS AND WEIGHTS

HP RANGE		DIMENSIONS inches (mm)					WEIGHT lbs (Kgs)
		ENCLOSURE			MOUNTING		
(208/230V)	(460V)	H	W	D	H	W	
1 - 5	1 - 5	7.48 (190)	7.25 (184)	7.51 (191)	7.00 (178)	4.63 (118)	6.5 (3.0)
7.5 - 10	7.5 - 10	11.88 (302)	7.25 (184)	8.12 (206)	11.31 (287)	4.63 (118)	14.6 (6.6)
15 - 20	15 - 20	19.13 (486)	7.25 (184)	10.38 (264)	16.63 (422)	4.63 (118)	29.0 (13.2)
25 - 30	NA	28.31 (719)	7.25 (184)	10.38 (264)	24.88 (632)	4.63 (118)	42.5 (19.3)
NA	25 - 30	22.13 (562)	7.25 (184)	10.38 (264)	19.63 (499)	4.63 (118)	34.5 (15.7)
NA	40 - 75	27.00 (686)	14.38 (365)	10.38 (264)	26.25 (667)	11.75 (298)	63.3 (28.7)

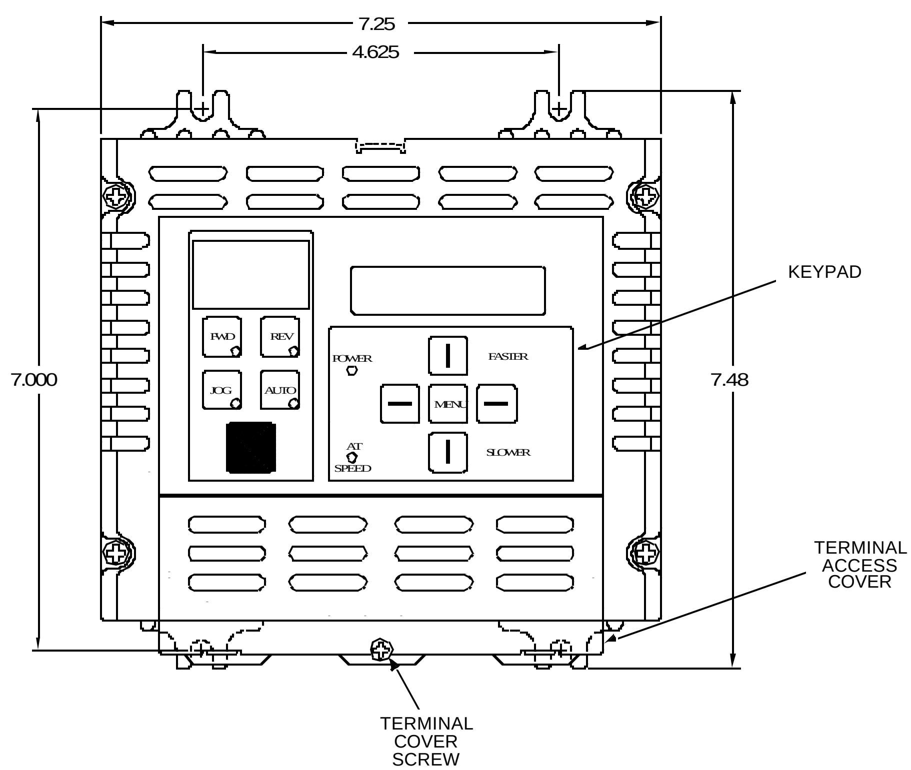


FIGURE 2-1. ADX CONTROLLER MOUNTING DIMENSIONS, 1 - 5HP, 230/460V

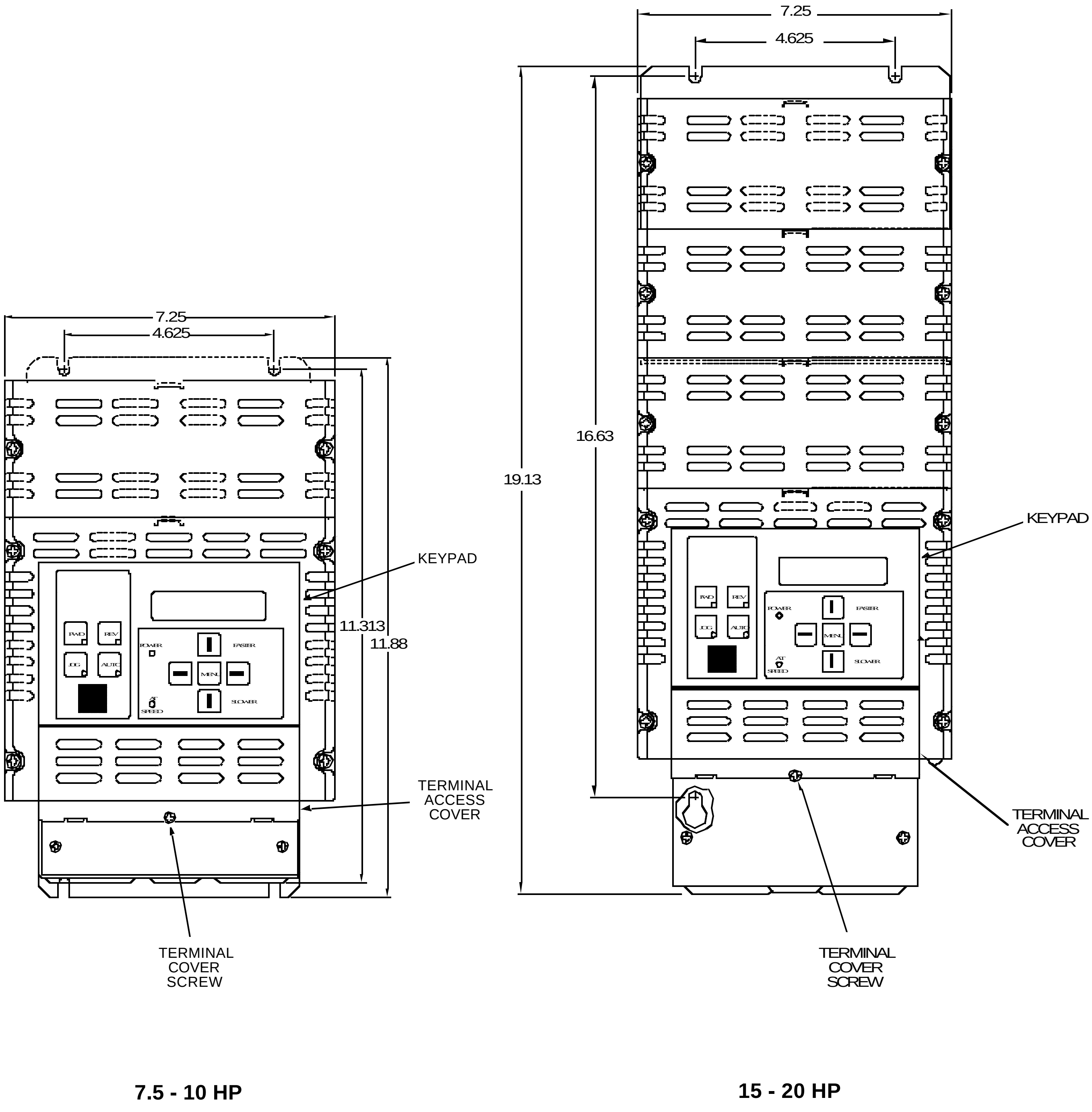
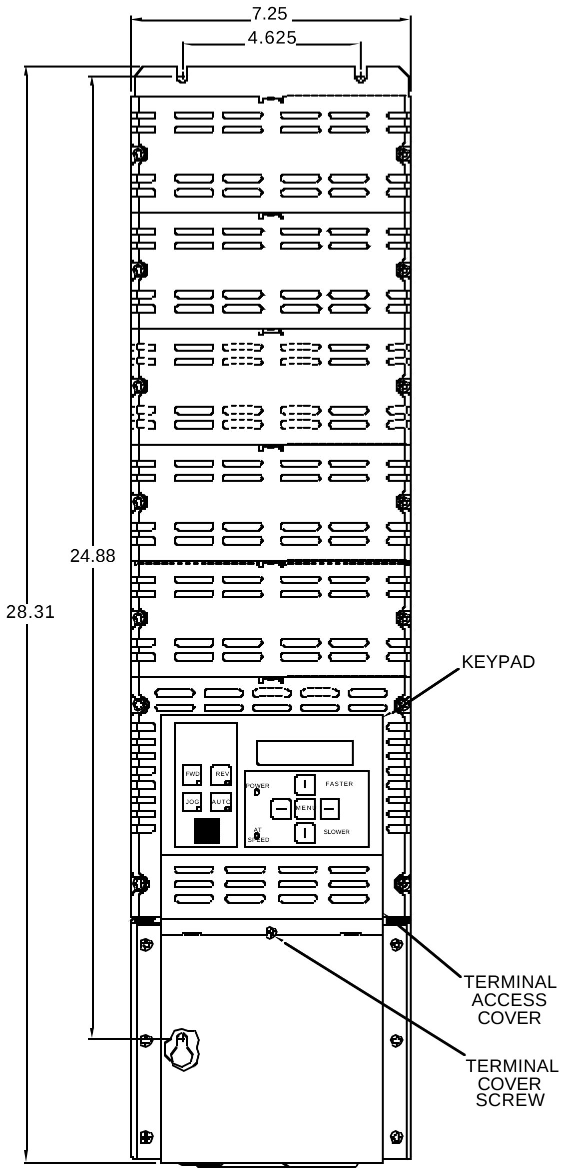
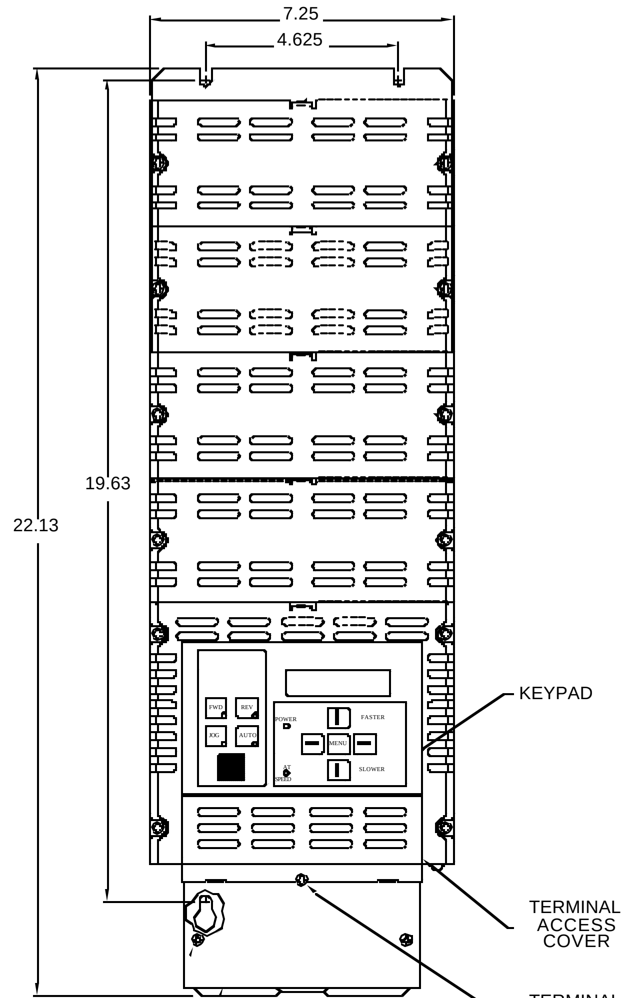


FIGURE 2-2. ADX CONTROLLER MOUNTING DIMENSIONS, 7.5 - 20HP, 230/460V

Mounting Dimensions



25 - 30 HP, 230V



25 - 30 HP, 460V

FIGURE 2-3. ADX CONTROLLER MOUNTING DIMENSIONS, 25 - 30HP, 230/460V

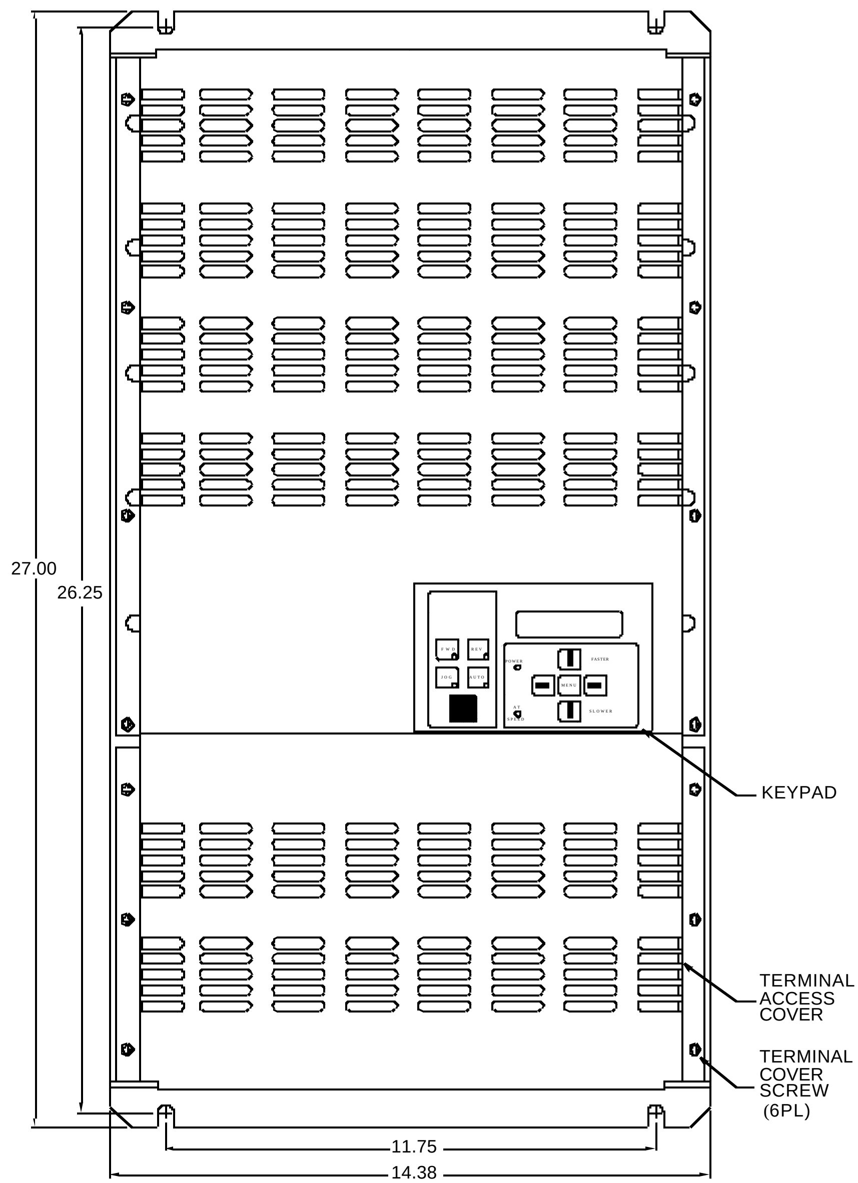


FIGURE 2-4. ADX CONTROLLER MOUNTING DIMENSIONS, 40 - 75HP, 460V

WIRING THE CONTROLLER

BRANCH CIRCUIT PROTECTION

The National Electrical Code requires that a three-pole fused disconnect switch or circuit breaker be installed in the AC line supply to the ADX controller. Although an optional three-pole circuit breaker (Option CBH) is available for the ADX controller, this device should not be considered as branch circuit protection. However, the existing branch circuit breaker **may** already provide the required protection. Refer to the National Electrical Code and local codes.

LINE SUPPLY

The ADX controller should not be connected to a line supply capable of supplying more than 10,000 amperes short-circuit current (rms symmetrical amperes). Short-circuit current can be limited by using an input supply transformer of 330 KVA or less, or by using correctly sized current limiting fuses (Option ILF) in the supply line ahead of the controller. Do not use a transformer with less than the minimum transformer KVA listed in Table 2-2.

Table 2-2: MINIMUM TRANSFORMER KVA

RATED HORSEPOWER	1	1.5	2	3	5	7.5	10	15	20	25	30	40	50	60	75
MINIMUM TRANSFORMER KVA	2	3	3	5	7.5	11	11[a]	20	27	27[a]	34[a]	40[a]	51[a]	63[a]	75[a]

a. Transformer with a K-factor of K-4 or greater. If the K-factor rating is less than K-4, use the next higher rated transformer.

Rated line voltage of the standard controller is either nominal 460 VAC or 208/230 VAC as stated on the controller data label.

If rated line voltage is not available, a line transformer will be required. If the line supply comes directly from a transformer, place a circuit breaker or disconnect switch between the transformer secondary and the ADX controller. If power is switched in the transformer primary, transients may be generated which can damage the controller. See Table 2-2 (above) for minimum transformer KVA.

Do not use power factor correction capacitors on the supply line to the ADX controller.

If high energy transients are present on the line supply, transient suppression will be required to limit transients to 150% of peak line voltage.

WIRING PRACTICES

- The AC line and motor wiring must be sized to comply with the National Electrical Code, and local codes. Refer to the controller data label for line and motor current ratings. Terminals and connection points are designed for stranded wire.

- **Do not use solid wire.**

- Signal and control wiring refer to wiring for potentiometers, transducers, and pushbuttons. Power wiring refers to AC line input and motor stator wiring. Signal and control wiring should not be run in the same conduit with power wiring and should be kept separated from power wiring in an enclosure. The exception to this is 115 VAC control wiring which should be considered low power wiring and kept separate from other control and signal wiring, as well as other power wiring.

- Multi-conductor twisted cable (Alpha 5630B1801 or equal) is recommended for signal and control wiring.

- If shielded wire is used, shielded, twisted wire (Alpha 2422 - two conductor, 2423 - three conductor, 2424 - four conductor or equal) is recommended for signal and control wiring. Connect the shields to chassis ground (ground terminal on the controller base) and tape the opposite ends of the shields. Do not connect the shield at both ends.

- Conduit entry can be made through any of the available openings at the bottom of the standard enclosure.

- The controller uses high speed PWM (Pulse Width Modulation) for efficient motor control at all output frequencies. PWM techniques expose the motor to higher spike voltages than it would experience when operated from commercial power at a fixed speed. These higher spike voltages can cause the motor insulation to break down. The motor's ability to tolerate these voltage peaks is a function of the motor design, including the type of magnet wire, method of winding, and other insulation material characteristics. This phenomenon may be a concern on a 460VAC motor, but is typically less of a concern at 230VAC or below. The voltage spikes tend to be larger for longer length of cable between the controller and motor.

  The following guidelines will help minimize or eliminate motor insulation problems:

  1. For new installations, specify PWM inverter duty rated motors. These motors have superior insulation systems which will tolerate modest voltage spikes.

  2. For retrofit applications where motor leads are less than 150 feet (46 meters), use optional motor filters connected between the controller and motor.

  3. For all applications where motor leads exceed 150 feet (46 meters), consult the factory.

- Insulated-Gate-Bipolar-Transistor (IGBT) based PWM drives have better performance than earlier designed AC drives, but also have more high frequency components in the input and output waveforms. As a result, the following power wiring recommendations should be observed to prevent or help minimize problems caused by electrical noise:

    1. Run the line supply and motor wiring in separate conduits.

    2. For installations with multiple controllers, use individual conduit runs for each controller.

    3. For installations with multiple motors, use individual conduit runs for each motor.

    4. Separate the line supply and motor wiring as much as possible within an enclosure.

    5. If the length of wire between the controller and motor exceeds 150 feet, consult the factory.

WIRING INSTRUCTIONS

1. Be sure the AC line supply is turned OFF.

2. Verify that the AC line voltage and the motor voltage rating matches the ADX controller rating shown on the controller data label.

3. Observe the National Electrical Code and all applicable local codes.

4. The basic ADX controller does not have an input line circuit breaker or line fuses. Therefore, the user must provide AC supply protection. Consult applicable electrical codes for requirements.

5. Motor overload protection must be provided by the user. Consult applicable electrical codes for requirements.

CONNECTING THE LINE SUPPLY

Connect the AC supply lines to the Line Connection Terminals (L1-L2-L3) in the ADX controller. See Figure 2-5 (page 2-9) through Figure 2-7 (page 2-11), as applicable. **The controller is not sensitive to phase rotation.**

CONNECTING THE MOTOR

Refer to “Motor Selection,” page 1-4.

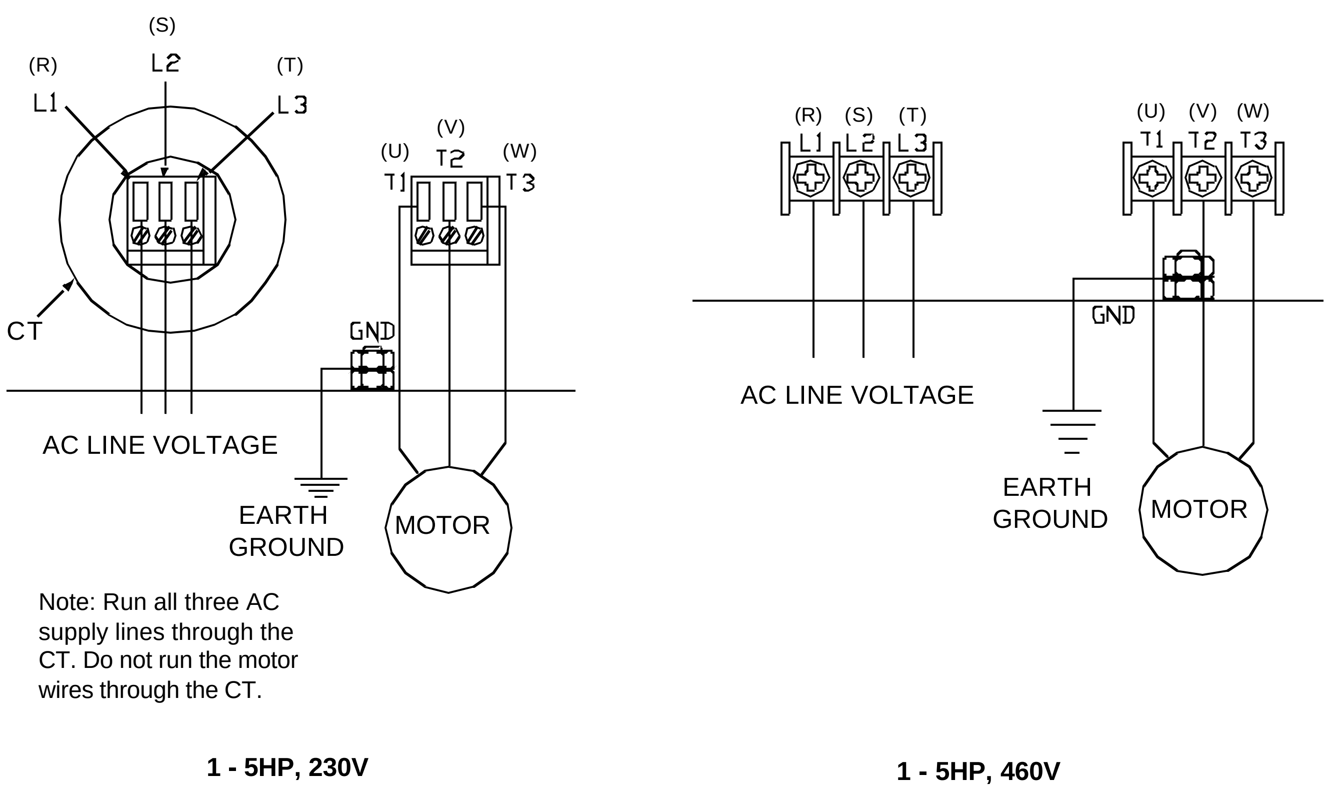
Be sure the motor wiring has been run in a separate conduit. Connect the motor leads to the Motor Connection Terminals (T1-T2-T3) in the ADX controller. See Figure 2-5 (below) through Figure 2-7 (page 2-11), as applicable. **The output phase rotation of the controller is T1-T2-T3 (A-B-C), regardless of the input phase rotation.** Do not ground the motor wiring. Grounded motor wiring will cause an overcurrent fault or a ground fault.

GROUNDING

Connect the green or bare (ground) wire of the line supply to the ground (GND) terminal located in the ADX controller. Connect the motor leads to the Motor Connection Terminals (T1-T2-T3) in the ADX controller. See Figure 2-5 (below) through Figure 2-7 (page 2-11), as applicable. The GND terminal must connect to earth ground.

The motor frame and operator control stations must also connect to earth ground.

Personal injury or loss of life may occur if the ADX controller, motor, and operator stations are not properly grounded.



1 - 5HP, 230V **1 - 5HP, 460V**

FIGURE 2-5. POWER CONNECTIONS, 1 - 5HP, 230/460V

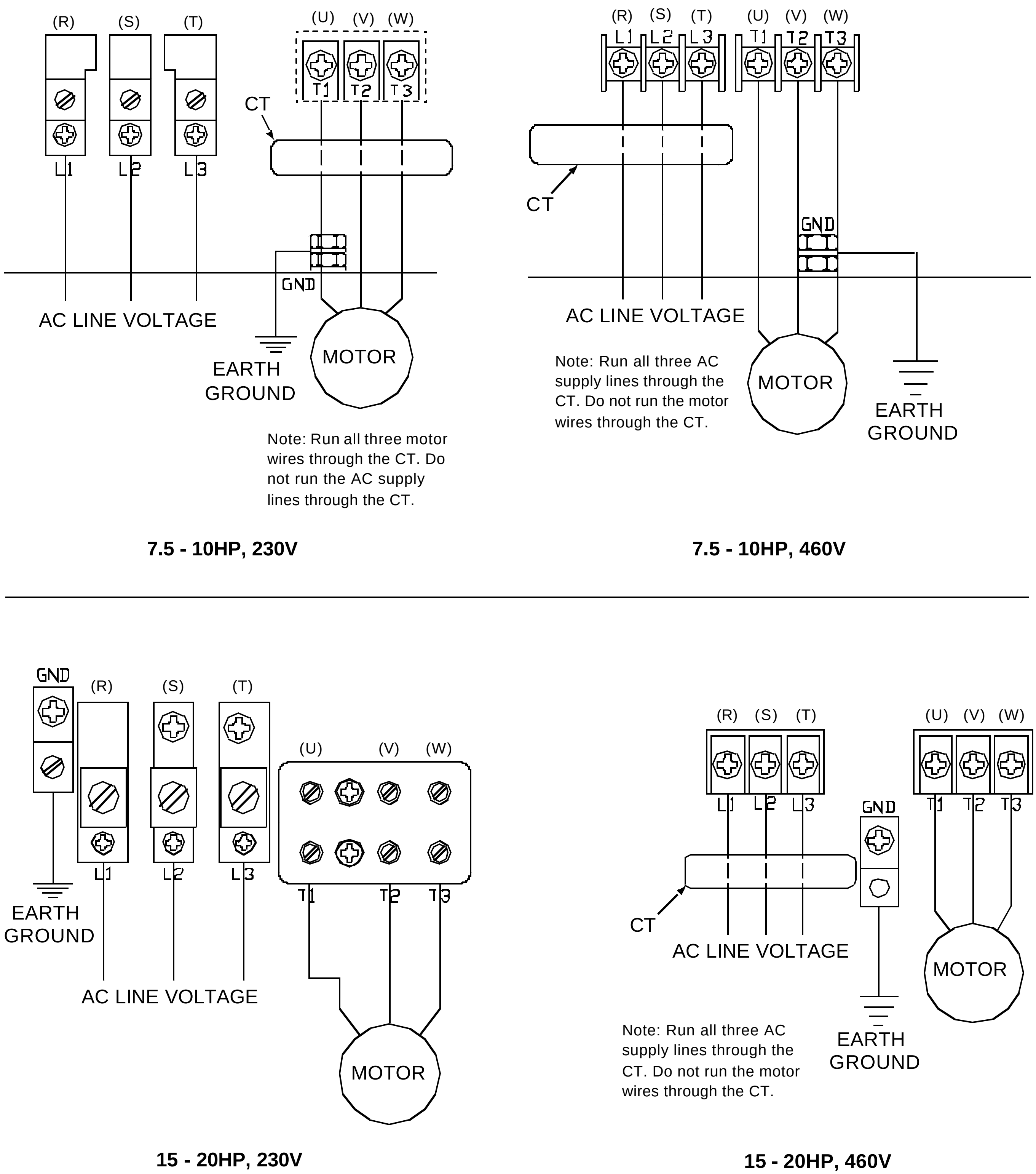
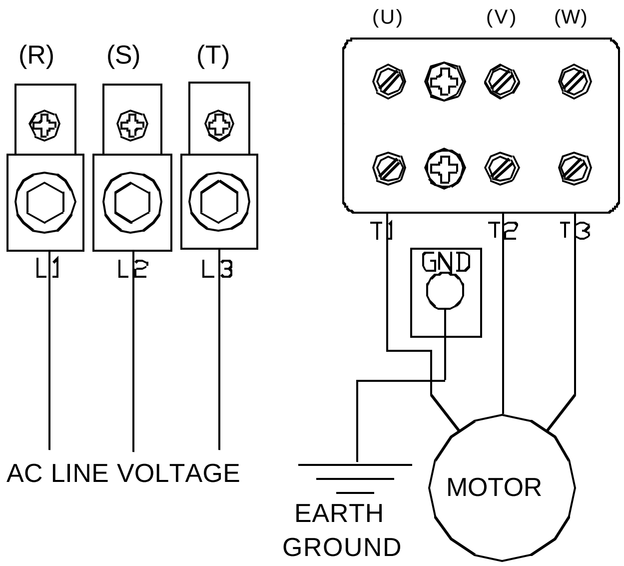
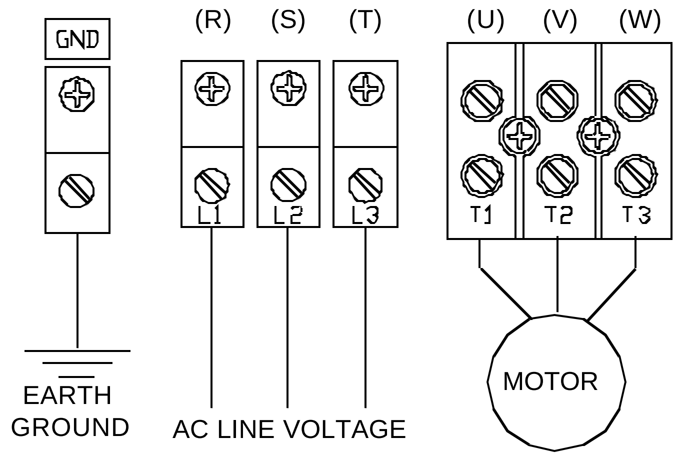


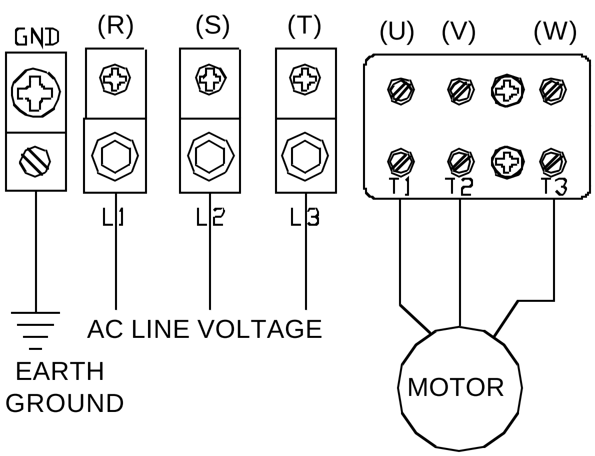
FIGURE 2-6. POWER CONNECTIONS, 7.5 - 20HP, 230/460V



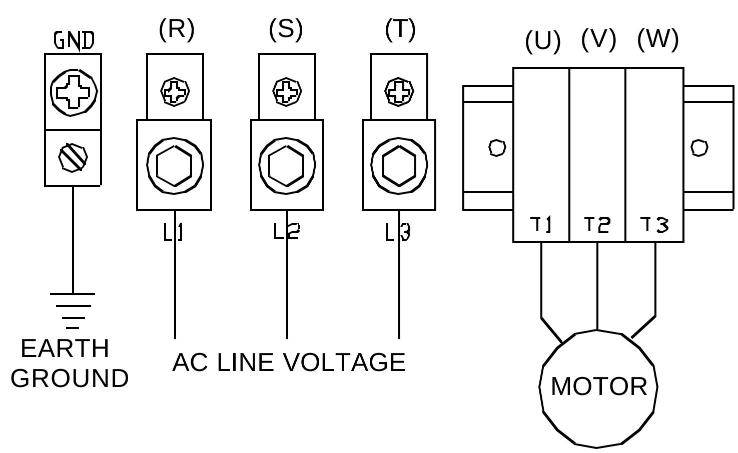
25 - 30HP, 230V



25 - 30HP, 460V



40 - 50HP, 460V

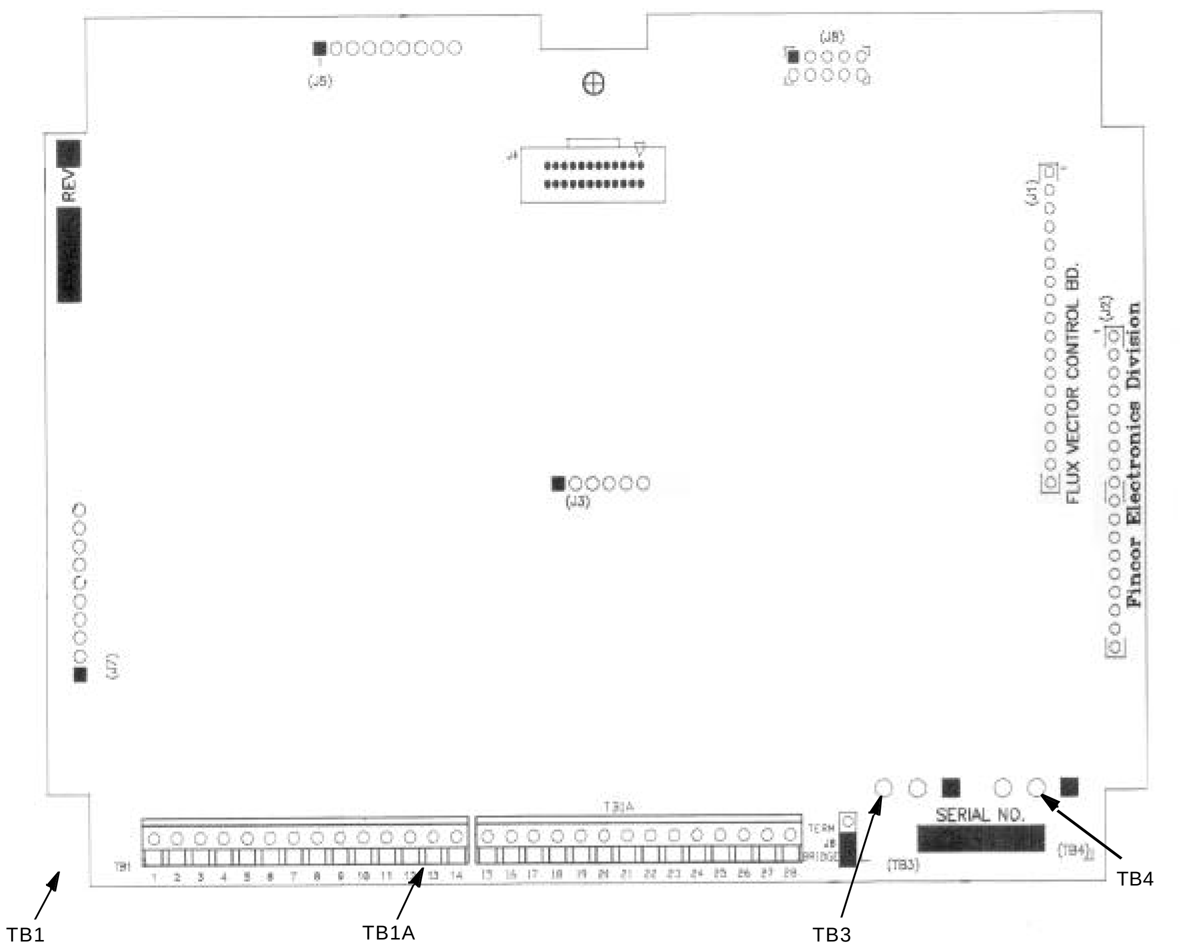


60 - 75HP, 460V

FIGURE 2-7. POWER CONNECTIONS, 25 - 30HP, 230V & 25 - 75HP, 460V

TERMINAL DESCRIPTIONS - CONTROL BOARD

The control board in the ADX controller contains two Terminal Boards (TB1 and TB1A) for connecting external devices to the controller. There are two additional Terminal Boards (TB3 and TB4) on the control board which are used for serial communications.The locations of the terminal boards are shown in Figure 2-8, below.



NOTE: NOT ALL COMPONENTS ARE SHOWN.

FIGURE 2-8. CONTROL BOARD

Terminal Descriptions

Two Terminals (TB1-1 and TB1-2) are provided for a normally-closed Emergency Stop pushbutton or contact as shown in Figure 2-9, below. An Emergency Stop command provides a positive shutdown of the drive. If it is judged that the safety of the system is not compromised by not having an Emergency Stop, a wire jumper may be installed between TB1-1 and TB1-2. The circuit must be closed between TB1-1 and TB1-2. The circuit must also be closed between TB1A-17 and TB1A-18, either by a wire jumper or an external fault contact (e.g., a low/high pressure switch, motor thermal switch).

Figure 2-9 shows the layout of the TB1 and TB1A terminals and Table 2-3 (page 2-14) describes their functions.

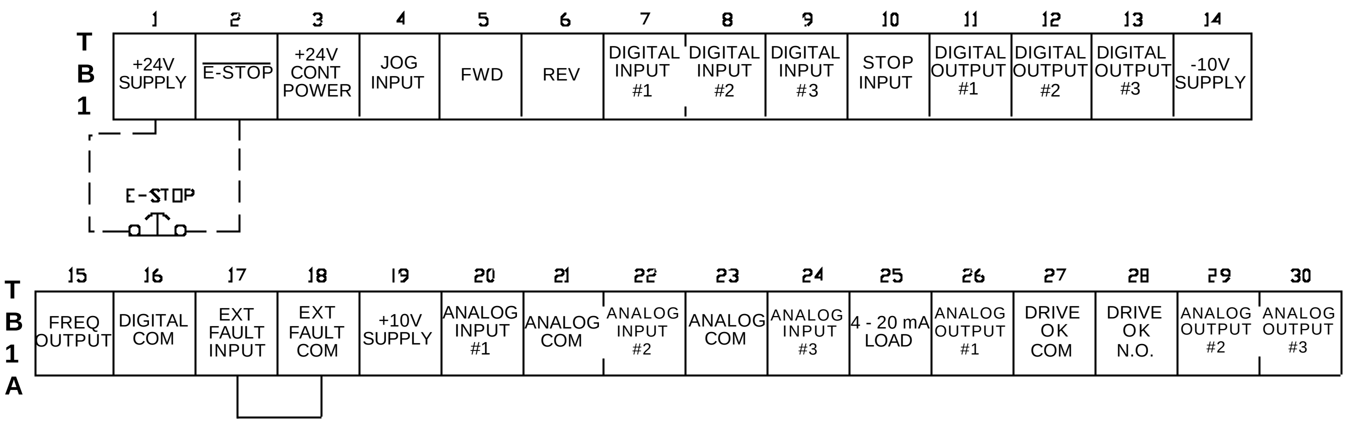


FIGURE 2-9. CONTROL BOARD TB1 AND TB1A TERMINALS

Table 2-3: CONTROL BOARD TERMINAL DESCRIPTIONS

TERMINAL		DESCRIPTION
NUMBER	NAME	
TB1-1	+24V SUPPLY	+24 VDC Power Supply For E-Stop
TB1-2	$\overline{\text{E-STOP}}$	Emergency Stop Input. High (+24V) To Run. Low (0V) To Stop.
TB1-3	+24V CONTROL POWER	+24 VDC Power Supply For Operator Controls And Relay Logic
TB1-4	JOG	Jog Input. High (+24V) To Jog. Low (0V) To Stop.
TB1-5	FORWARD	The Motor Rotates In The Forward Direction When Terminal TB1-5 Is High (+24V)
TB1-6	REVERSE	The Motor Rotates In The Reverse Direction When Terminal TB1-6 Is High (+24V)
TB1-7	DIGITAL INPUT #1	Programmable Digital Input #1
TB1-8	DIGITAL INPUT #2	Programmable Digital Input #2
TB1-9	DIGITAL INPUT #3	Programmable Digital Input #3
TB1-10	STOP INPUT	Stop Input. High (+24V) To Run. Low (0V) To Stop
TB1-11	DIGITAL OUTPUT #1	Programmable Digital Output #1
TB1-12	DIGITAL OUTPUT #2	Programmable Digital Output #2
TB1-13	DIGITAL OUTPUT #3	Programmable Digital Output #3
TB1-14	-10V SUPPLY	-10 VDC Power Supply
TB1A-15	FREQUENCY OUTPUT	Frequency Output Signal (0 To +5V Pulses)
TB1A-16	DIGITAL COM	Digital Common
TB1A-17	EXTERNAL FAULT INPUT	Allows Drive Operation When Connected To Terminal TB1A-18. When Disconnected, The Controller Will Fault. For Use With External Fault Contacts.
TB1A-18	EXTERNAL FAULT COM	External Fault Common
TB1A-19	+10V SUPPLY	+10 VDC Power Supply
TB1A-20	ANALOG INPUT #1	Programmable Analog Input #1. When The AUTO Light is ON, Terminal TB1A-20 Is The Speed Control Input.
TB1A-21	ANALOG COM	Analog Common
TB1A-22	ANALOG INPUT #2	Programmable Analog Input #2
TB1A-23	ANALOG COM	Analog Common
TB1A-24	ANALOG INPUT #3	Programmable Analog Input #3
TB1A-25	4-20 mA LOAD	4-20 mA Input Signal. Input Has A 499 Ohm Burden Resistor.
TB1A-26	ANALOG OUTPUT #1	Programmable Analog Output #1
TB1A-27	DRIVE OK COM	Drive Fault Relay With Form C Contacts. If A Drive Fault Occurs, This Relay De-energizes.
TB1A-28	DRIVE OK N.O.	
TB1A-29	ANALOG OUTPUT #2	Programmable Analog Output #2
TB1A-30	ANALOG OUTPUT #3	Programmable Analog Output #3

SECTION III

KEYPAD

The ADX keypad is used to set-up and monitor all controller operation functions and parameters, used for controller diagnostics, and used as a local operator control station. The user should become thoroughly familiar with the keypad.

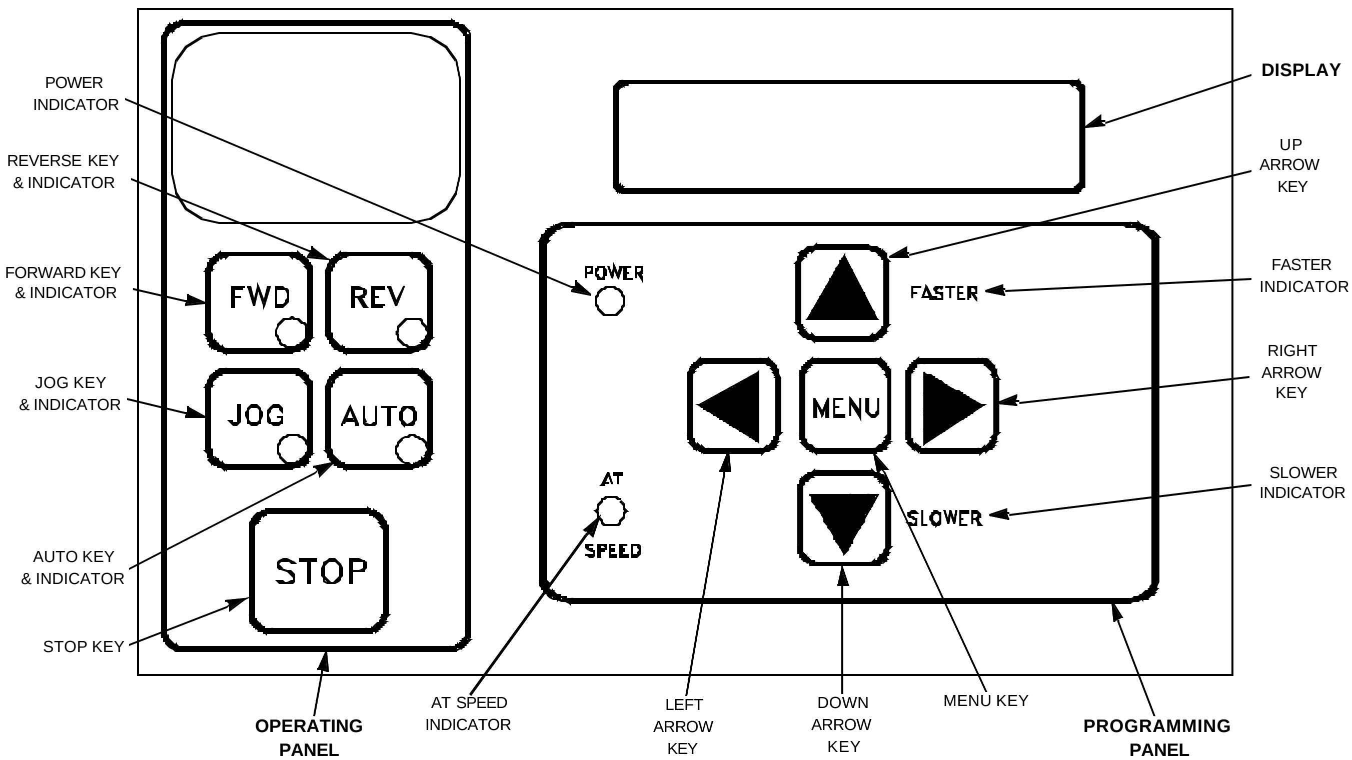


FIGURE 3-1. KEYPAD

The keypad consists of two panels and an LCD display. One panel (Operating Panel) contains the controls for operating the controller, and the remaining panel (Programming Panel) contains five keys for programming the controller. Two of the keys (▲ and ▼) on the programming panel are also used to change motor speed when their respective FASTER and SLOWER indicators are lit. The display is a two-line (16 characters each) readout that shows motor speed, motor load and power, and shows all programmable functions and faults in English language. No cryptic codes are used.

OPERATING PANEL

The following describes the controls on the operating panel.

- POWER Indicator - Lights when AC line voltage is applied to the controller.

- AT SPEED Indicator - Lights when the motor reaches command speed.

- FWD Key - Starts the motor in the forward rotating direction. An LED indicator in the key lights when the Forward mode is activated.

  Two additional indicators will typically light when the Forward mode is activated. They are the FASTER and SLOWER indicators, which indicate that motor speed can be controlled with the ▲ key (increase speed) and the ▼ key (decrease speed) on the Programming Panel.

- REV Key - Performs the same function as the FWD key, except rotates the motor in the reverse direction.

- JOG Key - Alternate pushes activate and deactivate the Jog mode. An LED indicator in the key lights when the Jog mode is activated.

- AUTO Key - Alternate pushes select the Auto and Manual modes. An LED in the AUTO key lights when the Auto mode is selected, and turns-off when the Manual mode is selected. The Manual mode allows manual speed control from the controller keypad or from external operator controls. The Auto mode allows speed and/or torque control commands from an external reference (e.g., process controller). For additional information, see “Auto/Manual Modes,” page 10-11.

- STOP Key - Stops the motor.

  Note: When the controller is programmed for Line Starting, and the STOP key is pushed, the motor will stop, and the controller display will read OPEN RUN COMMAND CLOSE TO RESUME. To restart the motor, either open the Run command (contact) (typically Terminal TB1-5) and then reclose it, or recycle the AC supply to the controller. For all other modes, the STOP key will stop the drive, and restarting will only occur when a Run command is initiated. If an Emergency Stop function is required, use a normally-closed EMERGENCY STOP pushbutton as described on page 2-10 and shown on page 2-11.

PROGRAMMING PANEL

The following describes the controls on the programming panel.

- MENU Key - The MENU key allows the user to toggle between the controller menu structure and the display. The main groups in the controller menu structure are shown in Figure 4-1, page 4-1. The MENU key also causes the controller to respond to changed parameter values. If a User Group (see Figure 4-2, page 4-5) parameter value is changed, the MENU key enters the value into the controller memory. But if the changed parameter value is not in the User Group, the value will return to the factory preset value when power is removed from the controller unless the value is saved as described in “Saving Parameter Values,” page 4-10.

- ARROW Keys - When the controller is operating the motor, the ▲ key increases motor speed and the ▼ key decreases motor speed, and the ◀ and ▶ keys change the display. The ◀ key changes the top line of the display and the ▶ key changes the bottom line. Refer to “Changing The Display,” page 4-8.

  When the controller is not operating the motor, the arrow keys (▲ ▶ ▼ ◀) allow the user to page through the controller menu structure. Figure 4-1 (page 4-1) shows the main groups in the menu structure, and Figures 4-4 through 4-15 (pages 4-13 through 4-24, respectively) show the entire menu structure. The arrow keys allow the user to access any parameter in the menu structure and to change parameter values or selections. For further information on using the arrow keys to access parameters and make changes, see “Accessing Parameters,” page 4-9.

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SECTION IV

THE ADX MENU STRUCTURE

Adjustments can be made to the ADX controller by changing the values of various parameters. These parameters are located in a tree-like arrangement commonly known as a menu structure. Parameters with similar characteristics or functions are located in common groups. The ADX controller contains the parameter groups shown in Figure 4-1.

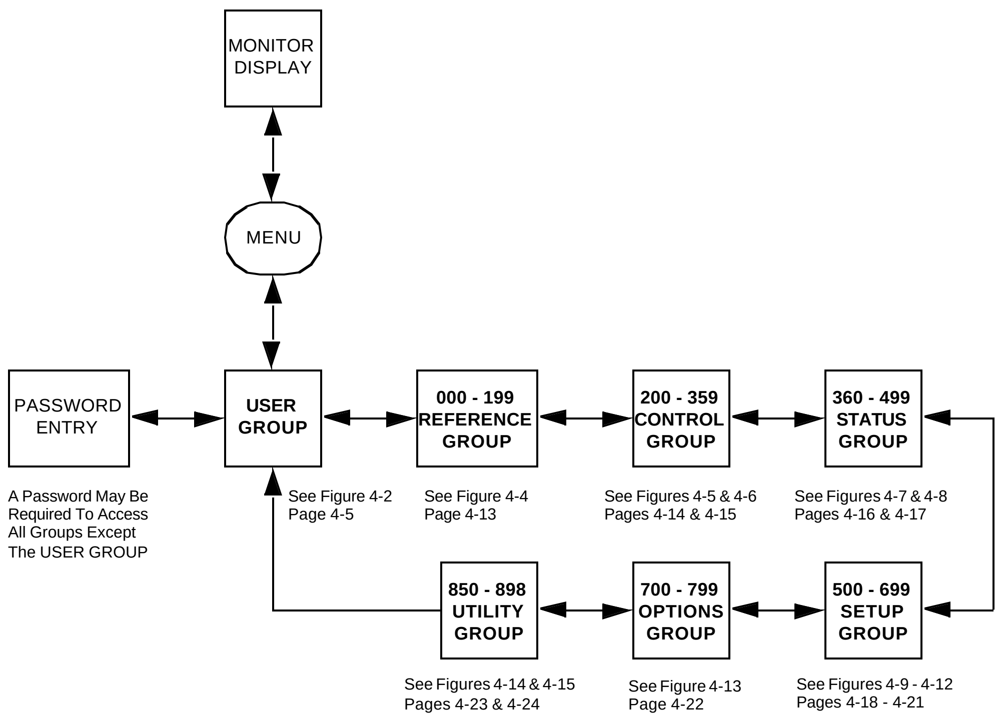


FIGURE 4-1. ADX CONTROLLER PARAMETER GROUPS

The three-digit numbers shown in each group in Figure 4-1 are the parameter numbers in that particular group. For example, the Control Group contains Parameters 200 through 359. These numbers are especially helpful in quickly stepping to a specific parameter.

The menu structure of each group is shown in the referenced figure below the respective group. For example, the menu structure of the parameters in the Reference Group is shown in Figure 4-4.

If the controller parameters are password protected (i.e., a password has been entered into Parameter 860 (Set Password), the password must be entered in the Password Entry parameter to access the parameters in all groups except the User Group. See “Password Entry,” page 4-11. The User Group contains parameters that are most likely to be adjusted by the user. Therefore, a password is never required to access the User Group.

The following instructions describe how to access the User Group and make changes to the parameters in the User Group. For information on using the controller keypad, see Section III, “Keypad.” For instructions on accessing the remaining parameters, see “Controller Menu Structure,” page 4-9.

CHANGING USER GROUP PARAMETER VALUES

1. **Apply AC power to the controller.**

   The controller will perform an internal diagnostic check, after which the POWER indicator should be ON. The AUTO and JOG indicators may be ON or OFF, depending on the factory setup.

2. **The display on the keypad should read as follows:**

```
SPEED        0   RPM
LOAD      0.00 %
```

   If the following display appears, the controller initial setup parameter values will need to be set. To set these parameter values, refer to “Initial SetUp” in Section XI (page 11-1).

```
INITIAL SETUP
PRESS MENU KEY
```

3. **To change a User Group parameter value, refer to Figure 4-2 (page 4-5) and then push the MENU key.** The display should read as follows:

```
USER GROUP
                ↑↓←
```

   The arrows in the display show which arrow keys are operative.

4. **Next push the ▼ key.** The display should now show the first parameter that may be adjusted, as follows:

```
RUN SPEED CMD
000             ↑↓←→
```

   The number in the lower left corner of the display is the parameter number. It does not indicate the value of the parameter.

5. **Next push the ▶ key three times for access to the maximum speed parameter.** The display should read as follows:

```
MAXIMUM SPEED
121             ↑↓←→
```

Assume, for example, that a 75% maximum speed is desired.

First push the ▼ key. The display should read as follows:

```
MAXIMUM SPEED
 100.00  ⇕ %
```

This display shows that maximum speed will be in percent. Its adjustment range, shown on page 4-7, is from 50.00% to 100.00% (equal to maximum frequency).

The line beneath the up/down arrow symbol (⇕) is a cursor which is controlled by the ◀ and ▶ keys.

To enter 75% maximum speed, first push the ◀ key five times so that the cursor is beneath the hundred digit. Then push the ▼ key one time. This will reset the maximum speed display to 50.00% (minimum setting).

Next, push the ▶ key one time to move the cursor to the ten digit. Then, using either the ▲ or ▼ key, increase or decrease the ten digit until it is a 7.

Next, push the ▶ key one time to move the cursor to the unit digit. Then, using either the ▲ or ▼ key, increase or decrease the unit digit until it is a 5. The display should read as follows:

```
MAXIMUM SPEED
  75.00  ⇕ %
```

To enter the 75% maximum speed into the controller memory, push the MENU key. The display should read as follows:

```
SAVE PARAMS NOW?
YES OR NO
```

After a few seconds, the display should read as follows:

```
SAVE PARAMS NOW?
▪YES
```

To change additional parameters in the User Group, use either the ▲ or ▼ key to change the YES to NO on the second line of the display, and then push the MENU key. The display should again read:

```
MAXIMUM SPEED
121          ↑↓←→
```

If there are no additional parameters to change, push the MENU key to save the parameters.

While the parameters are being saved, the display should read as follows:

```
SAVING ALL USER
PARAMETERS NOW
```

When all parameters have been saved, the display should again read:

```
MAXIMUM SPEED
121          ↑↓←→
```

6. **To change additional parameter values, push the ▶ or ◀ key to scroll through the parameters shown in Figure 4-2. The procedure to change or adjust any parameter shown in Figure 4-2 is the same as that described for Maximum Speed. Also see Figure 4-3, page 4-6.**

Notes:
1. If the cursor is allowed to remain beneath the up/down arrow symbol (↕), pushing the ▲ or ▼ key will rapidly increase or decrease the selected parameter value.
2. Many of the parameter values may be changed while the motor is running. If the cursor is beneath the up/down arrow symbol (↕), the motor will respond immediately to the changed value. However, if the cursor is moved beneath any of the digits in the display, a changed value will not be effective until either the cursor is moved back beneath the up/down arrow symbol (↕) or the change is entered into the controller memory by pushing the MENU key.

7. **If there are no more parameter values to change, push the MENU key to go back to the Speed and Load (monitor) display shown below.**

```
SPEED       0  RPM
LOAD     0.00 %
```

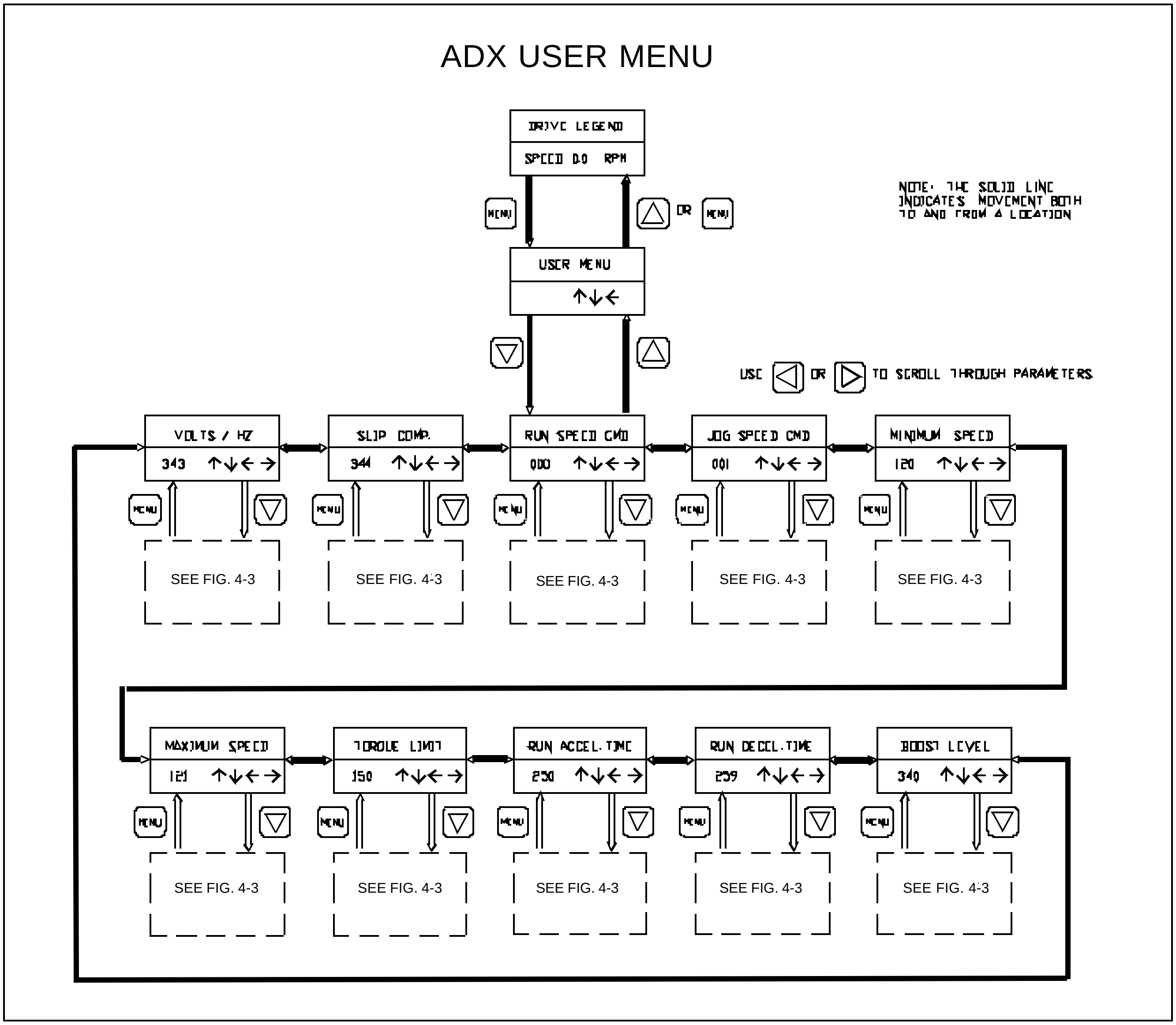


FIGURE 4-2. USER GROUP FLOW CHART

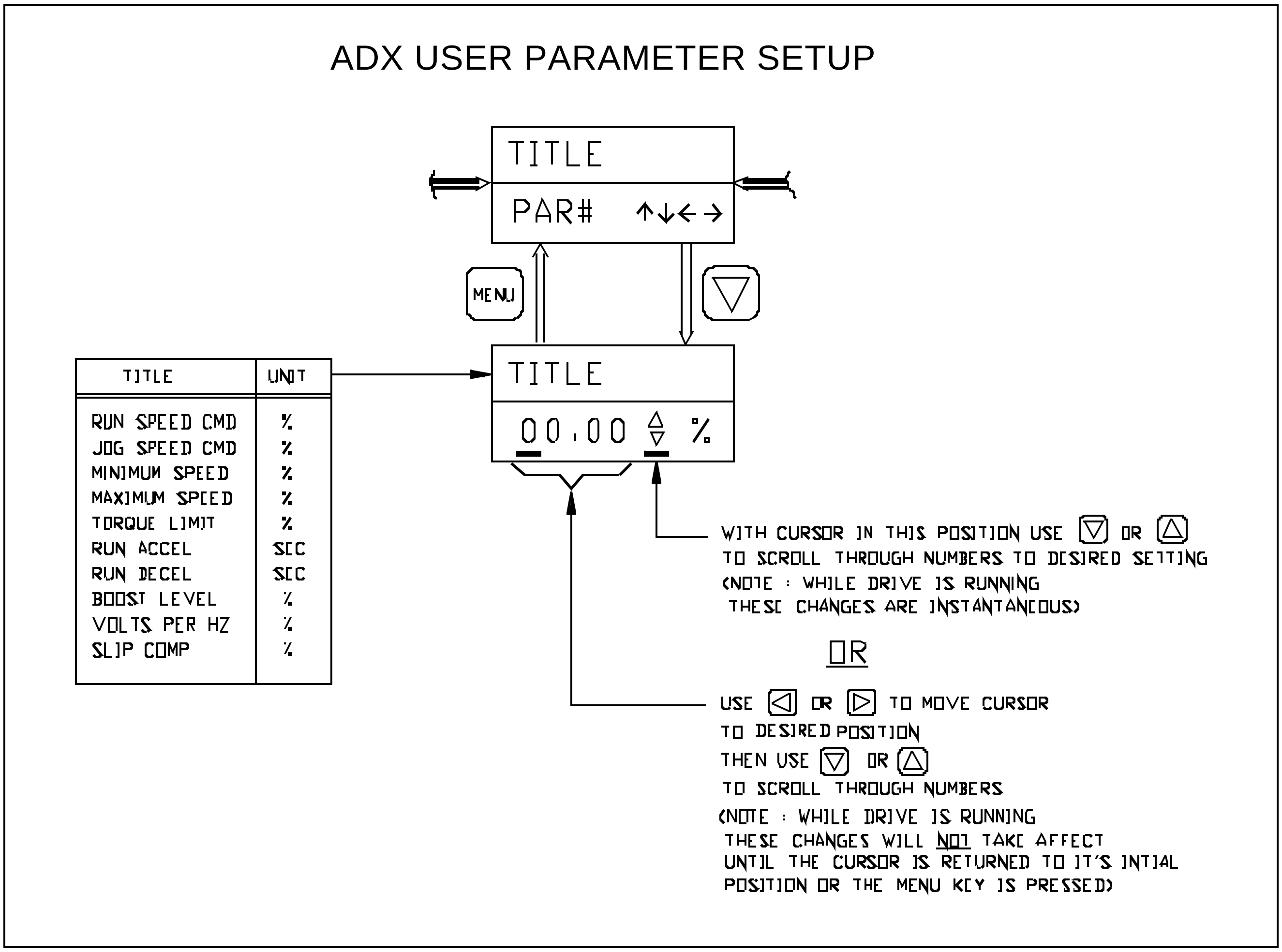


FIGURE 4-3. USER PARAMETER ADJUSTMENT INSTRUCTIONS

Parameters can be added to the User Group and deleted from the User Group. All parameters that must be changed by the user should be placed in the User Group for easy access. Parameters that are not in the User Group can be password protected (i.e., a password must be entered in the Password Entry Parameter to access parameters that are not in the User Group). To add parameters to the User Group or delete parameters from the User Group, refer to “User Group Modifications,” page 10-34.

A description of the parameters shown in Figures 4-2 and 4-3 follows.

- **000 RUN SPEED CMD:** Presets manual run speed. Does not affect auto run speed. Adjustable from 0 to 100% of maximum frequency. Factory set at 0%.
- **001 JOG SPEED CMD:** Presets jog speed. Adjustable from 0 to 100% of maximum frequency. Factory set at 0%.
- **120 MINIMUM SPEED:** Minimum speed. Adjustable from 0 to 75% of maximum frequency. Factory set at 0%[1].
- **121 MAXIMUM SPEED:** Maximum speed. Adjustable from 50% to 100% of maximum frequency. Factory set at 100%[1].
- **150 TORQUE LIMIT:** Limits motor torque. Adjustable from 20% to 200%.[2] Factory set at 150%. If the Operating Mode (Parameter 513) is set to V/F Var Torq, ST Var Torq, or Vect Var Torq (see step 5, page 11-2), Parameter 150 is adjustable from 20% to 125% and is factory set at 115%.

  Note: Torque limit varies with motor characteristics and operating speed.
- **250 RUN ACCEL:** Sets linear acceleration time. Adjustable from 0.1 second to 1900 seconds. Factory set at 10 seconds.[3]
- **259 RUN DECEL:** Sets linear deceleration time. Adjustable from 0.1 second to 1900 seconds. Factory set at 10 seconds.[3]
- **340 BOOST LEVEL:** Boost level determines the starting torque of the motor. If motor torque is insufficient at low speed or if a motor current fault occurs when the motor is started, increase this parameter value slightly. Adjustable from 0 to 200.00. Factory setting varies depending on the application and the type of motor used. Typical factory setting is 10.0. A setting of 100.0 will result in 100% starting torque with most commonly used motors.[4]
- **343 VOLTS PER HERTZ:** Volts per Hertz adjusts the ratio between the voltage and the frequency that is applied to the motor. Adjustable from 80% to 120%. Factory set at 100%.[4]

  If the motor load is light, reducing the volts per Hertz ratio may save energy. Readjustment requires an ammeter to measure motor current. Run the motor and its connected load at normal operating speed, and then change the volts per Hertz ratio for minimum motor current. If motor speed slows, increase the volts per Hertz ratio until the motor returns to the commanded speed.
- **344 SLIP COMP:** Slip compensation is used to improve speed regulation. Adjustable from 0 to 100%. Factory set at 0%. If slip compensation is set too high, motor speed may become unstable.[4]

---

1. If maximum speed (Parameter 121) is set lower than minimum speed (Parameter 120), maximum speed will override minimum speed.
2. At carrier frequencies above 3 KHz, torque limit is limited to less than 200%..
3. If Ramp Type (Parameter 270) is set to 1 (S Curve) the range of acceleration and deceleration is adjustable from 3.0 seconds to 120 seconds.
4. Parameter is active only when the Operating Mode (Parameter 513) is set to V/F Const Torq or V/F Var Torq (see step 5, page 11-2).

CHANGING THE DISPLAY

The top line of the display normally shows motor speed in RPM, and the bottom line shows the percent of load connected to the motor. These are the factory preset selections.

Both the top and bottom lines of the display can be changed to monitor any of the following:

- **CUSTOM PARAMETER -** User programmable. See "Custom Displays," page 10-14.
- **EXTEND MONITOR -** Allows all parameters to be monitored by selecting their respective parameter number.
- **LEGEND -** A user programmable name, number, or description of the drive, function, or application. See "Drive Legend," page 10-20.
- **MOTOR CURRENT -** Motor current in amperes.
- **MOTOR LOAD -** Percent of load applied to the motor (e.g., 100% = rated load).
- **MOTOR SPEED -** Motor speed in RPM.
- **NONE -** Nothing displayed.
- **OPERATING HOURS -** Actual hours that the AC line supply is applied to the controller.
- **OUTPUT FREQUENCY -** Controller output frequency in Hertz.
- **OUTPUT POWER -** Controller output power in kilowatts.
- **OUTPUT VOLTAGE -** Controller output voltage applied to the motor.
- **SPEED RATIO -** Percent speed ratio between a lead or master drive and a follower or slave drive.
- **SPEED REFERENCE -** Percent of speed reference.
- **STATUS -** Displays TORQUE LIMIT, MOTOR OVERLOAD, REGEN LIMIT, FAULTED, SPEED MATCH, ACCELERATION, DECELERATION, SPEED AVOIDANCE, DC BRAKING, SPEED SEARCH, RIDE THROUGH, ZERO SPEED, BUS VOLTAGE LIMIT, TORQUE LIMIT & MOTOR OVERLOAD, DWELLING, STOPPED, or AT SPEED.
- **TORQUE LIMIT -** Torque limit in percent.
- **TIME AND DATE -** A real time clock.

Before attempting to change the display, be sure the display is showing one or two of the above selections. This ensures that the controller is in the display mode

To change the top line of the display, push the ◀ key for the desired selection, and to change the bottom line, push the ▶ key for the desired selection.

Unless the changes made to the display are saved into the controller memory, the factory preset selections will reappear when power is removed from the controller and then reapplied. To save display changes, follow the instructions under “Saving Parameter Values,” page 4-10.

CONTROLLER MENU STRUCTURE

The ADX Series controllers contain hundreds of parameters as shown in Figures 4-4 through 4-15, pages 4-13 through 4-24, respectively. For instructions on accessing these parameters refer to the following.

ACCESSING PARAMETERS

To access User Group parameters, see “Changing User Group Parameter Values,” page 4-2.

To access parameters that are not in the User Group, refer to the flow charts (Figures 4-4 through 4-15), while performing the following instructions.

To access a menu to the right of the menu being displayed, push the ▶ key. Conversely, to access a menu to the left of the menu being displayed, push the ◀ key. If either the ◀ or ▶ key is pushed repeatedly, the group, menu, or parameter selection will eventually repeat.

To access a menu below the menu being displayed or to enter a menu, push the ▼ or key. Conversely, to access a menu above the menu or parameter being display, push the ▲ key.

To access a particular parameter without using a flow chart, push either the ◀ or ▶ key repeatedly to step through the main groups. Each group will display the range of parameters that are located in its respective group (or menus). This is shown in Figure 4-1, page 4-1. When a range of parameters that contains the desired parameter is displayed, push the ▼ key to access a menu, which will display the range of parameters in that particular menu. If the desired parameter is in that particular menu, push the ▼ key to access the range of parameters, and then push either the ◀ or ▶ key to go to the desired parameter. If the desired parameter is not in a particular menu, push either the ◀ or ▶ key until the menu is displayed that contains the desired parameter. Then push the ▼ key to access the range of parameters, and then push either the ◀ or ▶ key to go to the desired parameter.

A parameter value may be changed as was described in “Changing User Group Parameter Values,” page 4-2.

SAVING PARAMETER VALUES

To enter all changed parameter values and selections into the controller memory, perform the following five steps.

1. Go to the Utility Group Menu. The display should read as follows:

```
UTILITY GROUP
850-898      ↓←→
```

2. Go to the Program Manager Menu by pushing the ▼ key one time. The display should read as follows:

```
PROGRAM MANAGER
850         ↑↓←→
```

3. Push the ▼ key until the following display appears.

```
PROGRAM MANAGER
 SAVE USER DATA
```

4. Push the MENU key one time to enter the data into the controller memory. The display should read as follows:

```
SAVING ALL USER
PARAMETERS NOW
```

   When the parameters have been saved, the display should again read as follows:

```
PROGRAM MANAGER
850         ↑↓←→
```

5. Go to the Display (Monitor) mode by pushing the MENU key one time. The display should return to the original selections that were displayed before the controller menu structure was entered. If the factory preset selections have not been changed, the display should read as follows:

```
SPEED        0  RPM
LOAD      0.00  %
```

ADDING A PASSWORD

Except for the parameters in the User Group, all remaining parameters can be password protected (i.e., a password must be entered in the Password Entry parameter to access the password protected parameters). Any three-digit number can be added as a password, as follows:

1. Go to the Utility Group (see Figure 4-1, page 4-1).

2. Enter the Utility Group and go to Set Password Parameter 860 (see Figure 4-14, page 4-23).

3. Enter Set Password Parameter 860 and add any three-digit number as the password, as follows:

   a. Push the ◀ key three times so that the cursor is beneath the hundred digit. Then increase the hundred digit by pushing the ▲ key.

   b. Push the ▶ key one time so that the cursor is beneath the ten digit. Then increase the ten digit by pushing the ▲ key.

   c. Push the ▶ key one time so that the cursor is beneath the unit digit. Then increase the unit digit by pushing the ▲ key.

4. Push the MENU key to enter the password into Set Password Parameter 860.

5. Save the password by following the instructions in "Saving Parameter Values," page 4-10.

PASSWORD ENTRY

If the controller parameters are password protected, a password must be entered in the Password Entry parameter to access the protected parameters. The Password Entry Parameter is accessible from the Password Entry Menu. To enter the Password Entry Menu from the Speed and Load (Monitor) display, proceed with the following.

1. Go to the User Group Menu by pushing the MENU key one time. The display should read as follows:

```
USER GROUP
             ↑↓←
```

2. Go to the Password Entry by pushing the ◀ key one time. The display should read as follows:

```
PASSWORD ENTRY
870          ↕ →
```

3. Enter the Password Entry Menu by pushing the ▼ key one time. The display should read as follows:

```
PASSWORD ENTRY
      0   ↕
```

4. Enter the password, as follows:.

   a. Push the ◀ key three times so that the cursor is beneath the hundred digit. Then increase the hundred digit by pushing the ▲ key.

   b. Push the ▶ key one time so that the cursor is beneath the ten digit. Then increase the ten digit by pushing the ▲ key.

   c. Push the ▶ key one time so that the cursor is beneath the unit digit. Then increase the unit digit by pushing the ▲ key.

5. Push the MENU key.

6. Go back to the User Group Menu by pushing the ▶ key one time. If the correct password has been entered, the following display will appear.

```
USER GROUP
             ↑↓←→
```

   Notice the right arrow symbol that was not present previously. The arrow symbols in the display always indicate which arrow keys are operative.

7. Push the ▶ key to go to the Reference Group Menu, and then use the appropriate keys to navigate through the **ADX** menu to the desired menus and parameters as described in “Accessing Parameters,” page 4-9.

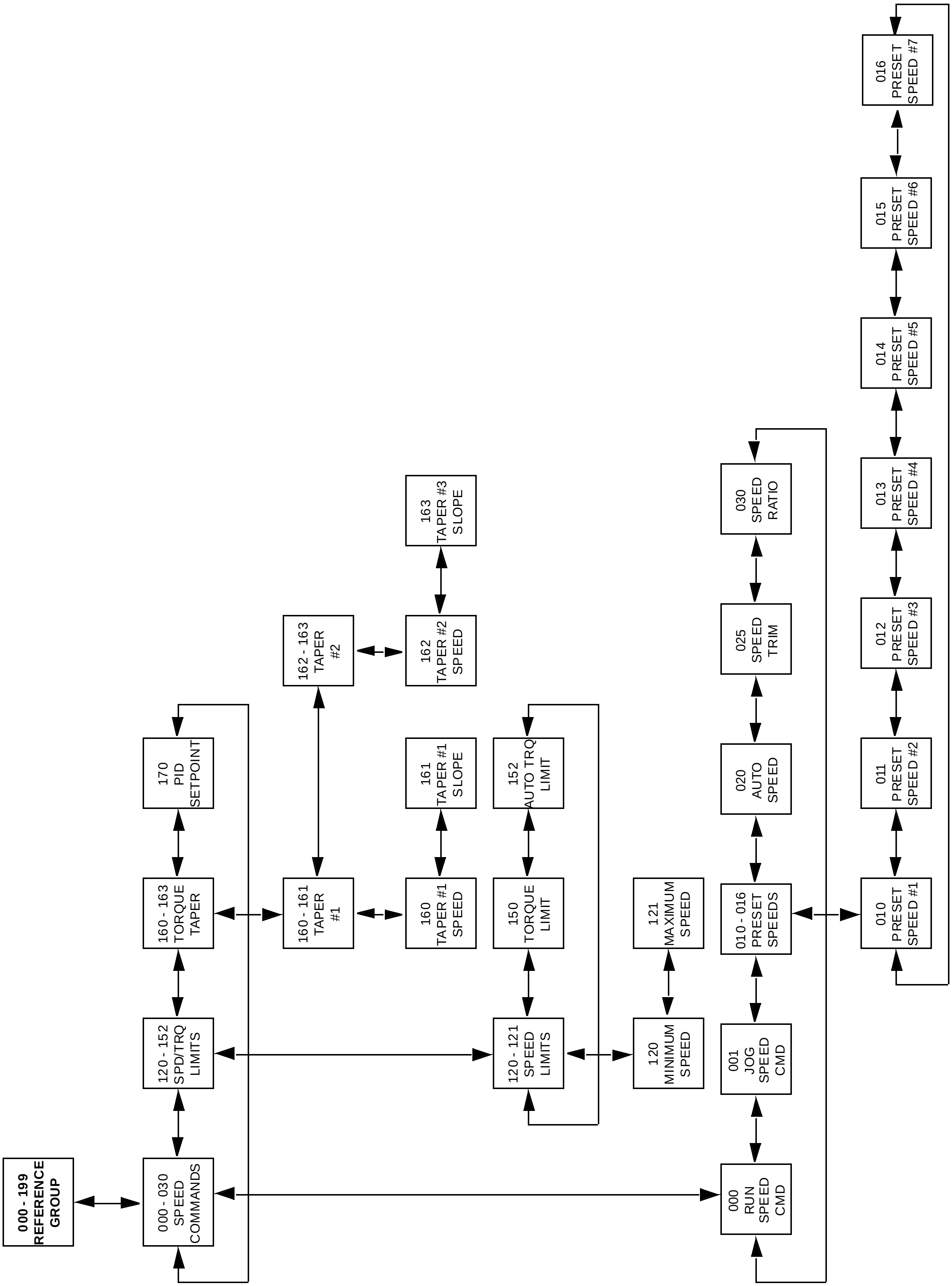


FIGURE 4-4. ADX MENU FLOW CHART, REFERENCE GROUP

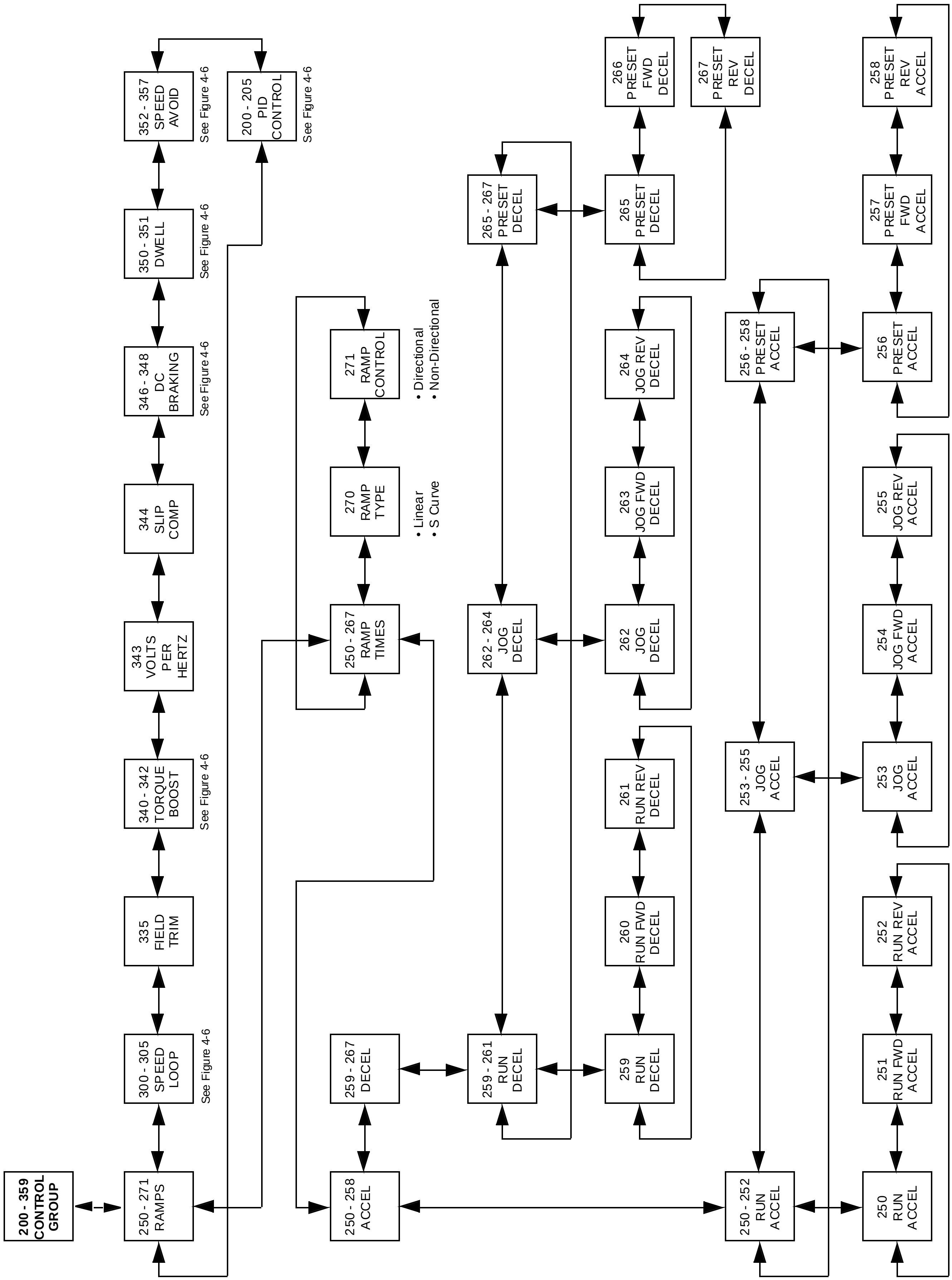


FIGURE 4-5. ADX MENU FLOW CHART, CONTROL GROUP, PART A

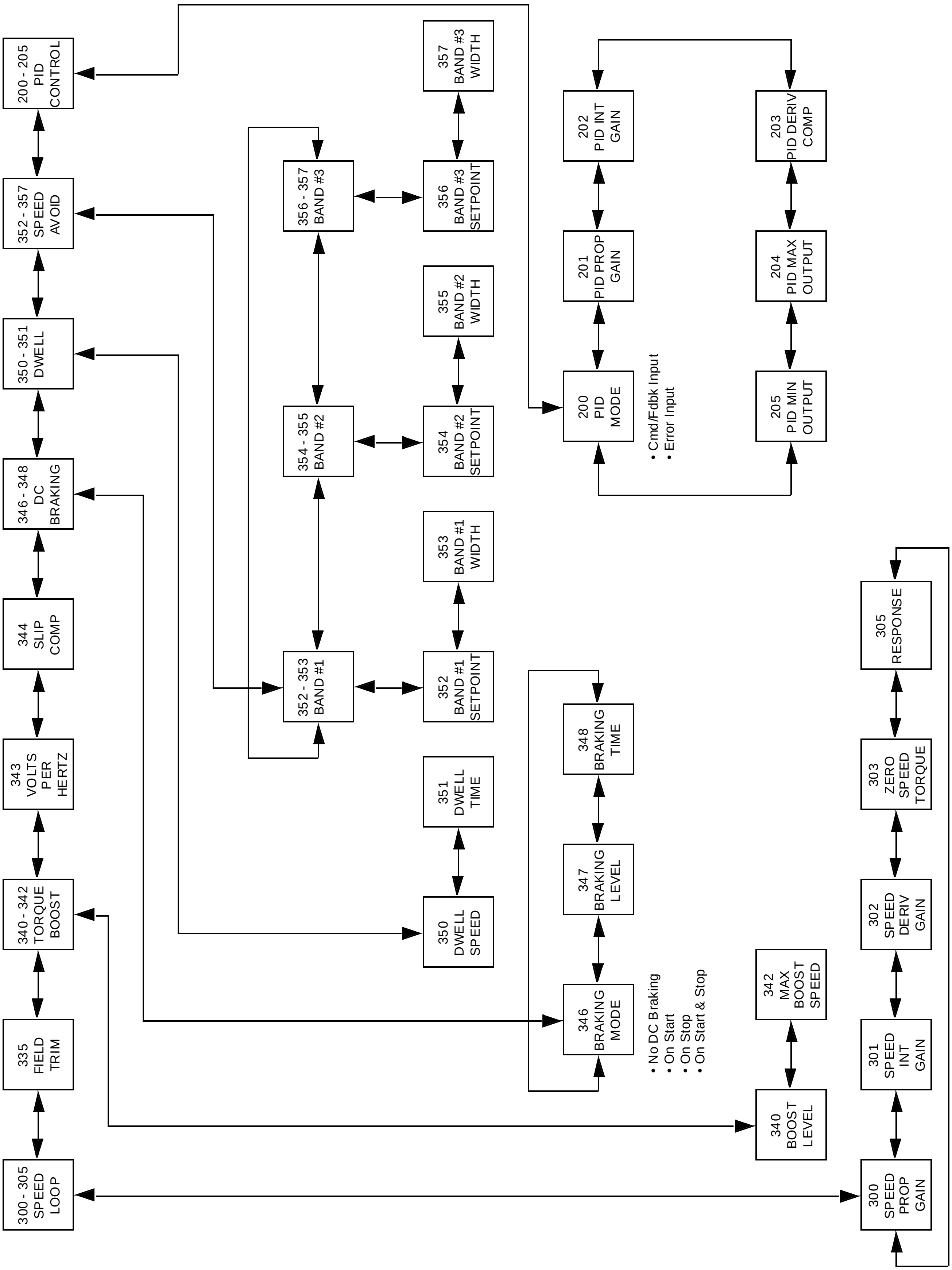


FIGURE 4-6. ADX MENU FLOW CHART, CONTROL GROUP, PART B

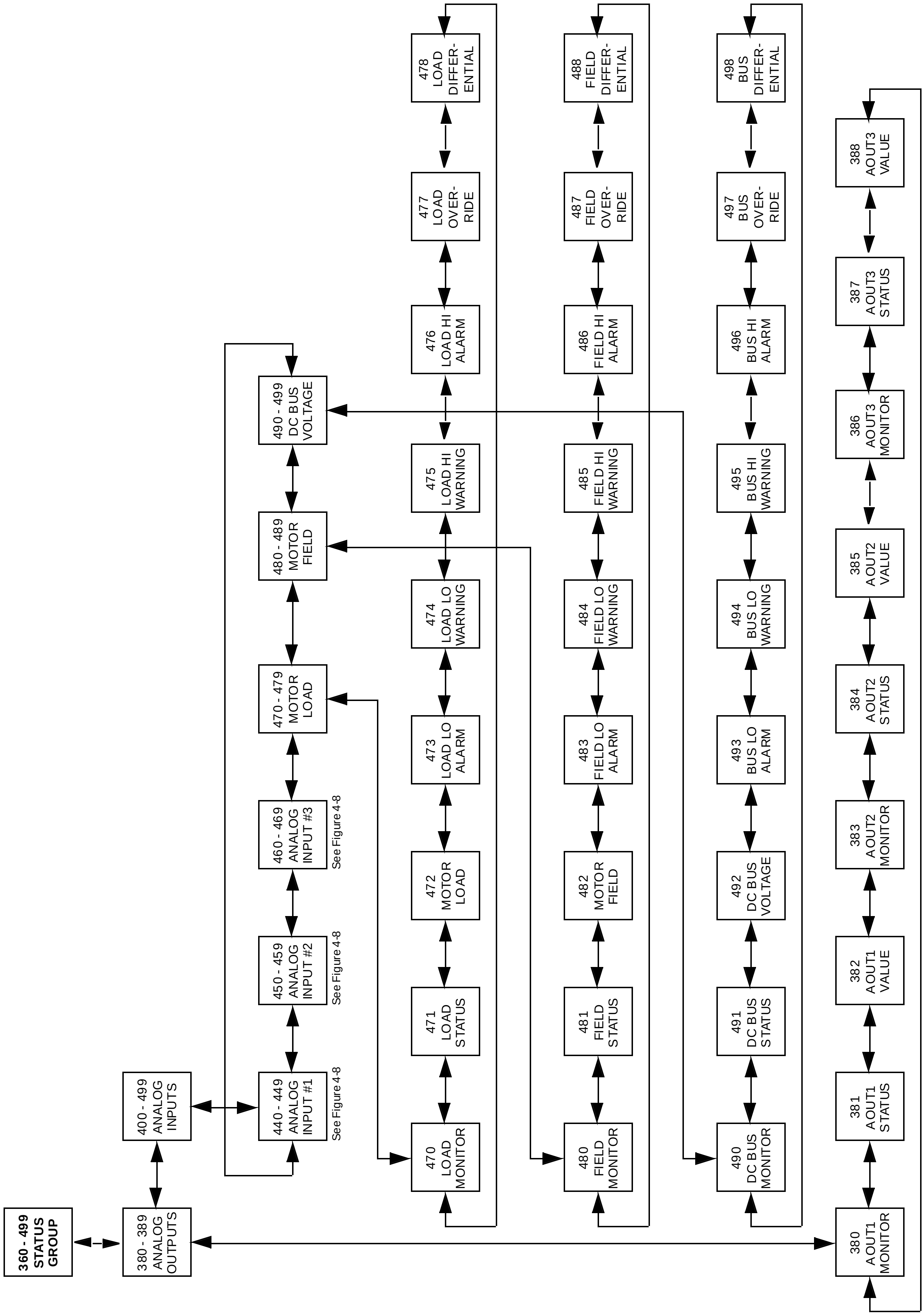


FIGURE 4-7. ADX MENU FLOW CHART, STATUS GROUP, PART A

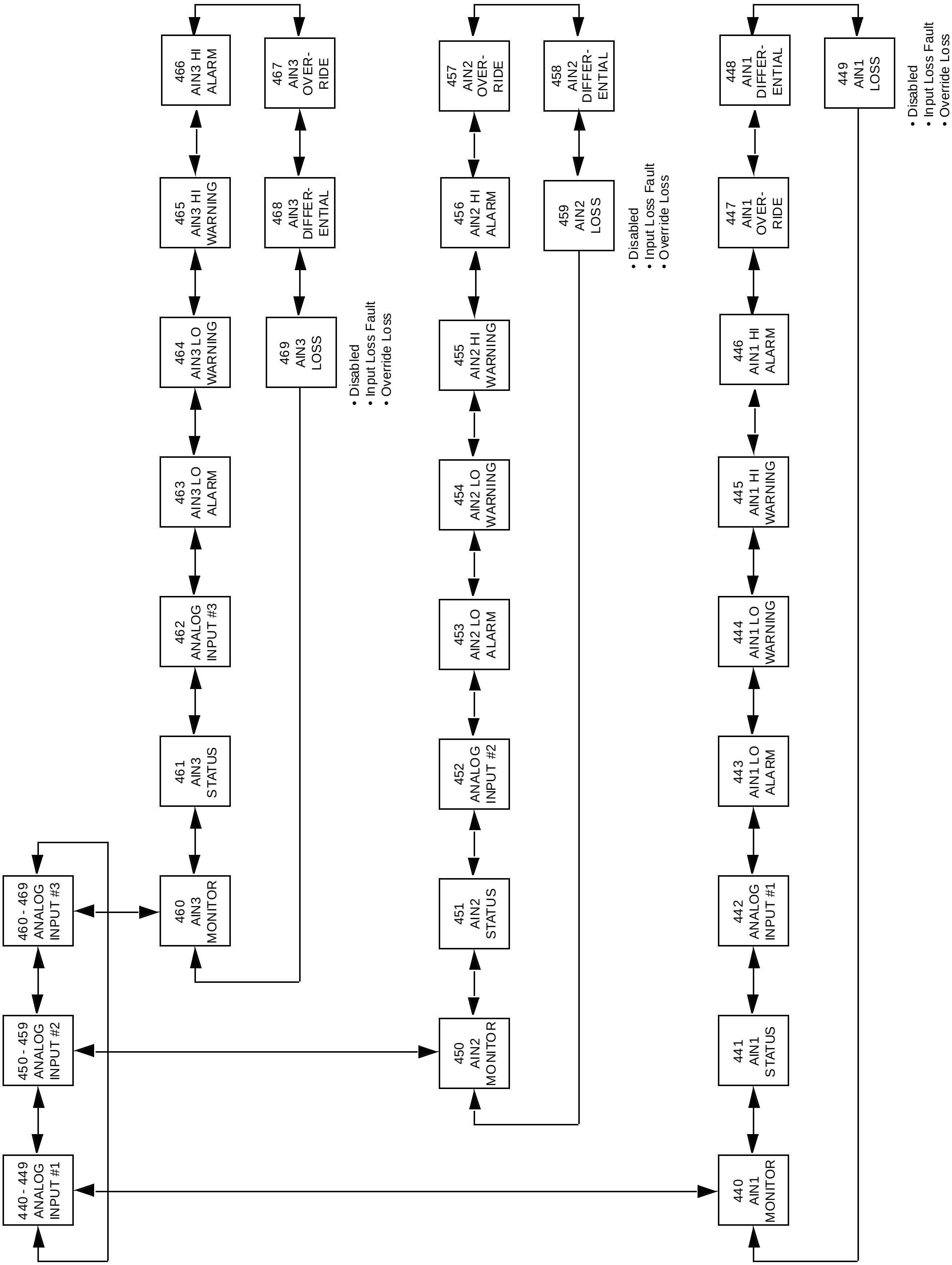


FIGURE 4-8. ADX MENU FLOW CHART, STATUS GROUP, PART B

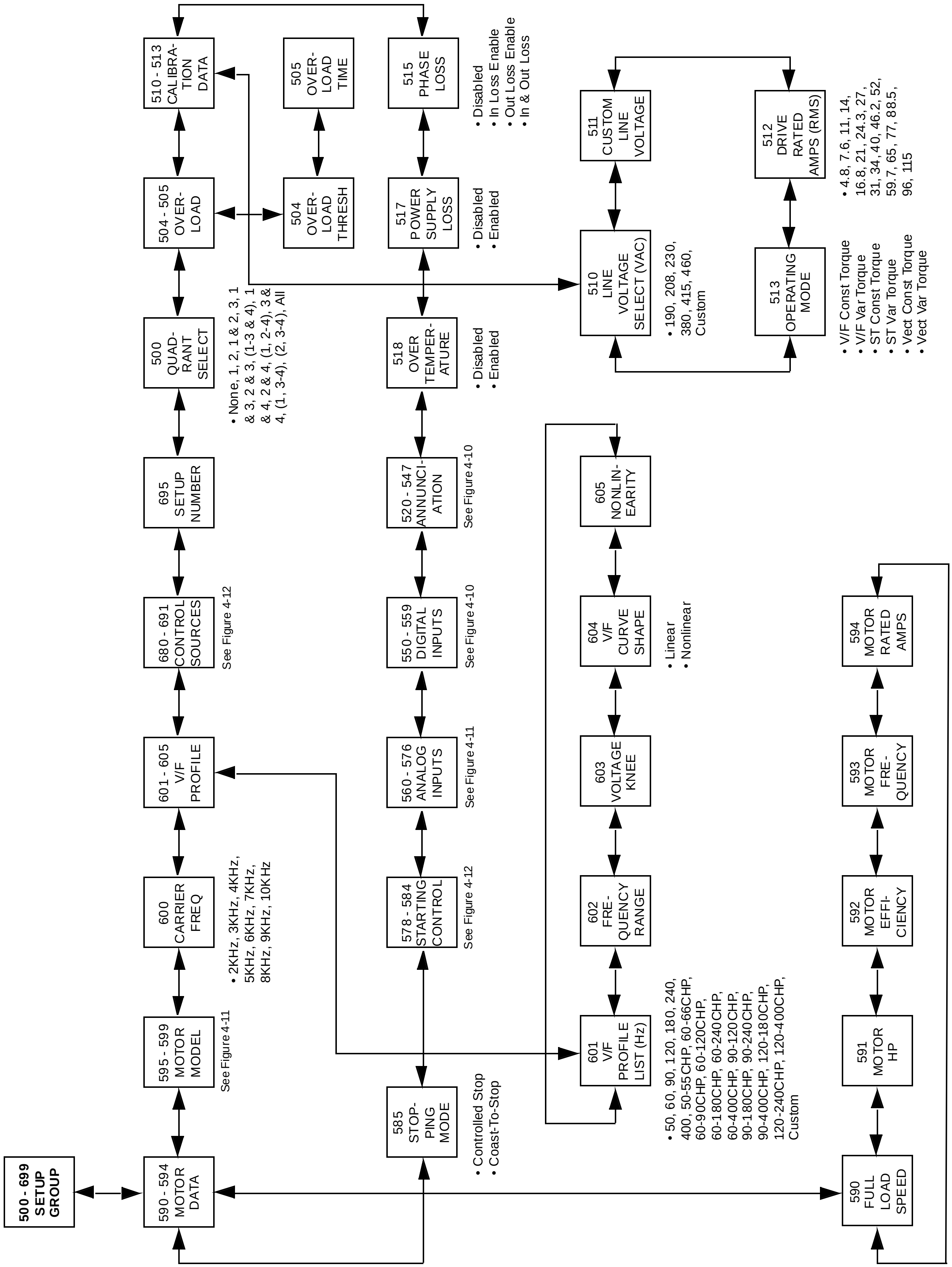


FIGURE 4-9. ADX MENU FLOW CHART, SETUP GROUP, PART A

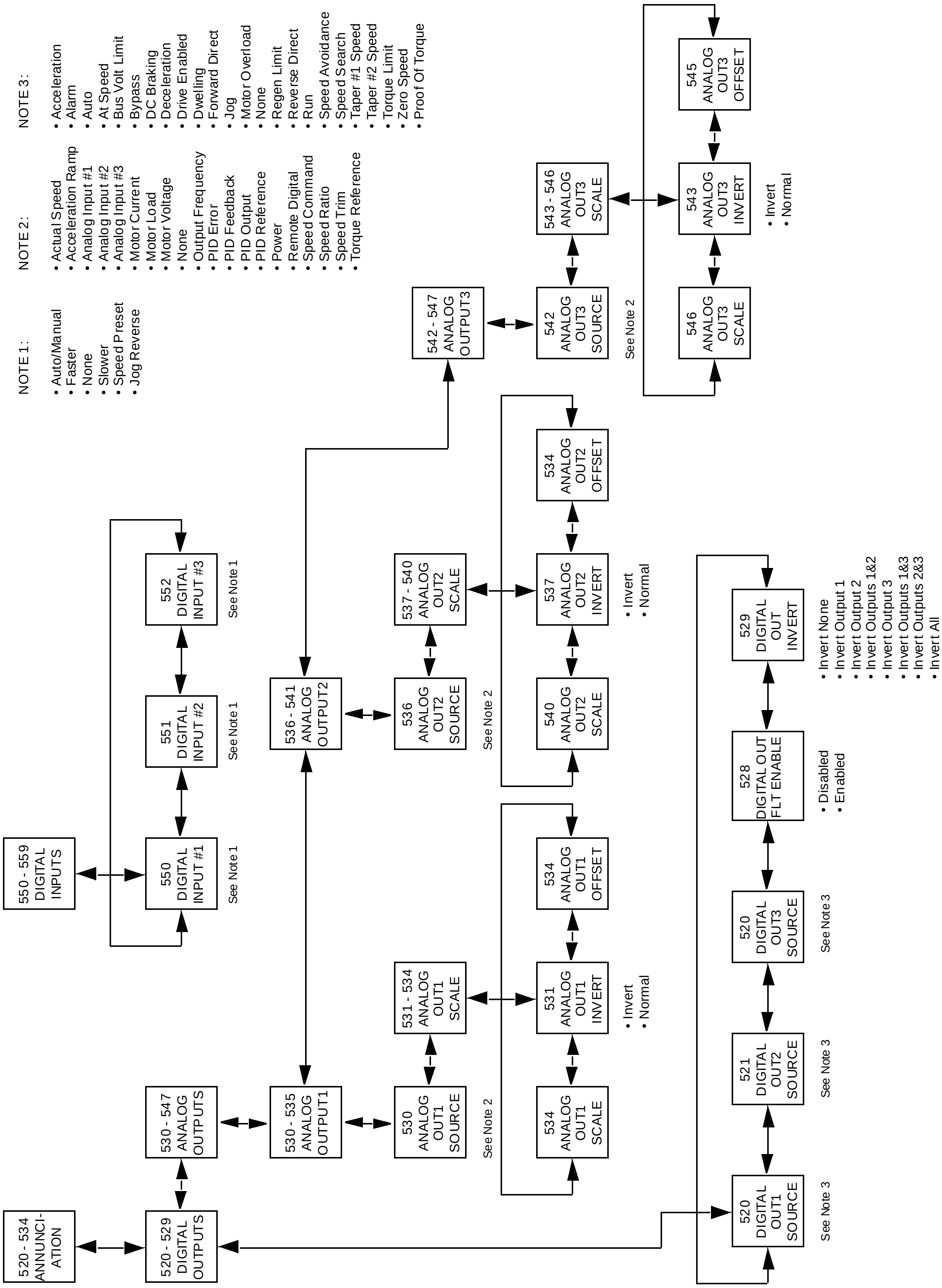


FIGURE 4-10. ADX MENU FLOW CHART, SETUP GROUP, PART B

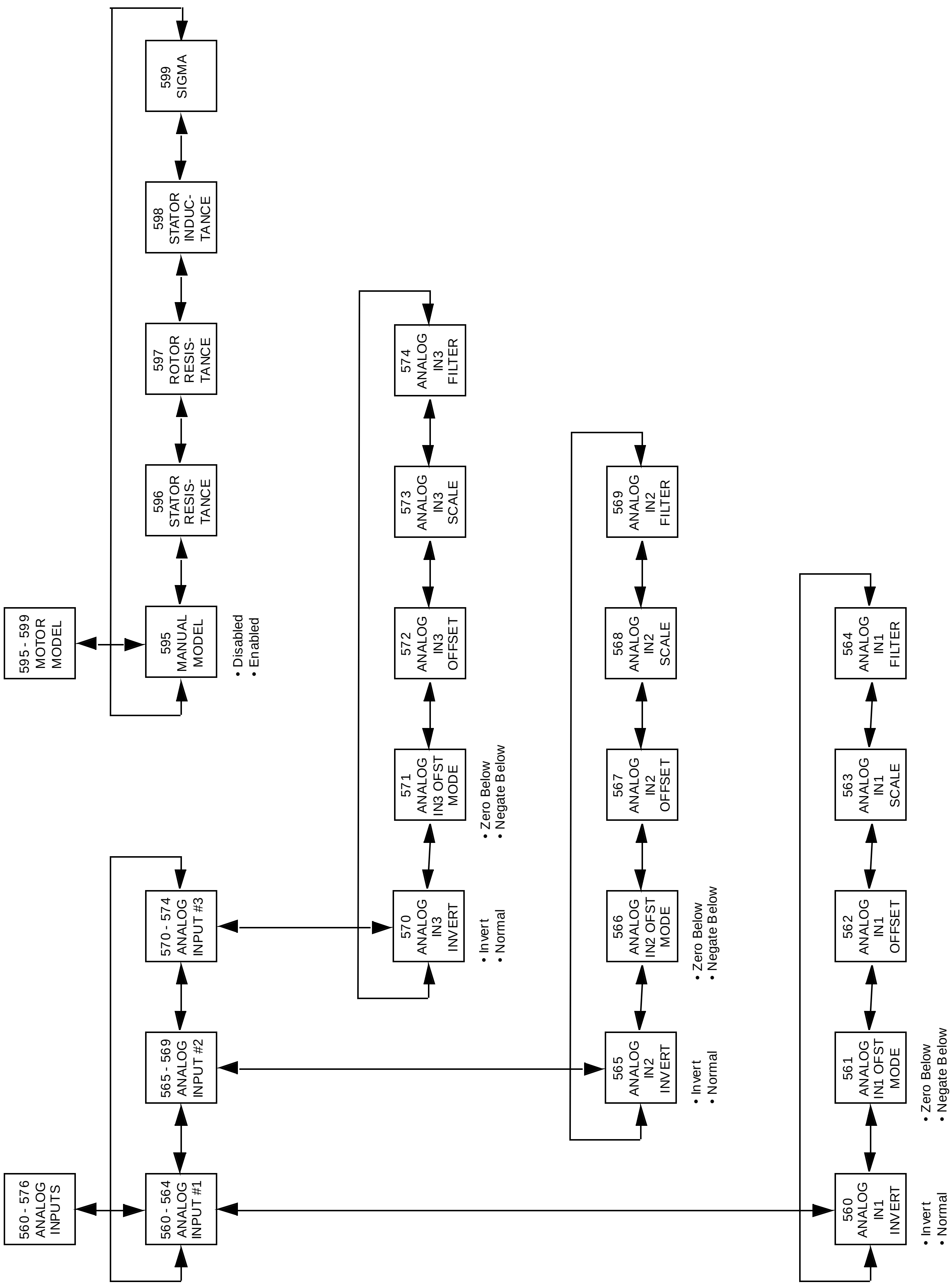


FIGURE 4-11.ADX MENU FLOW CHART, SETUP GROUP, PART C

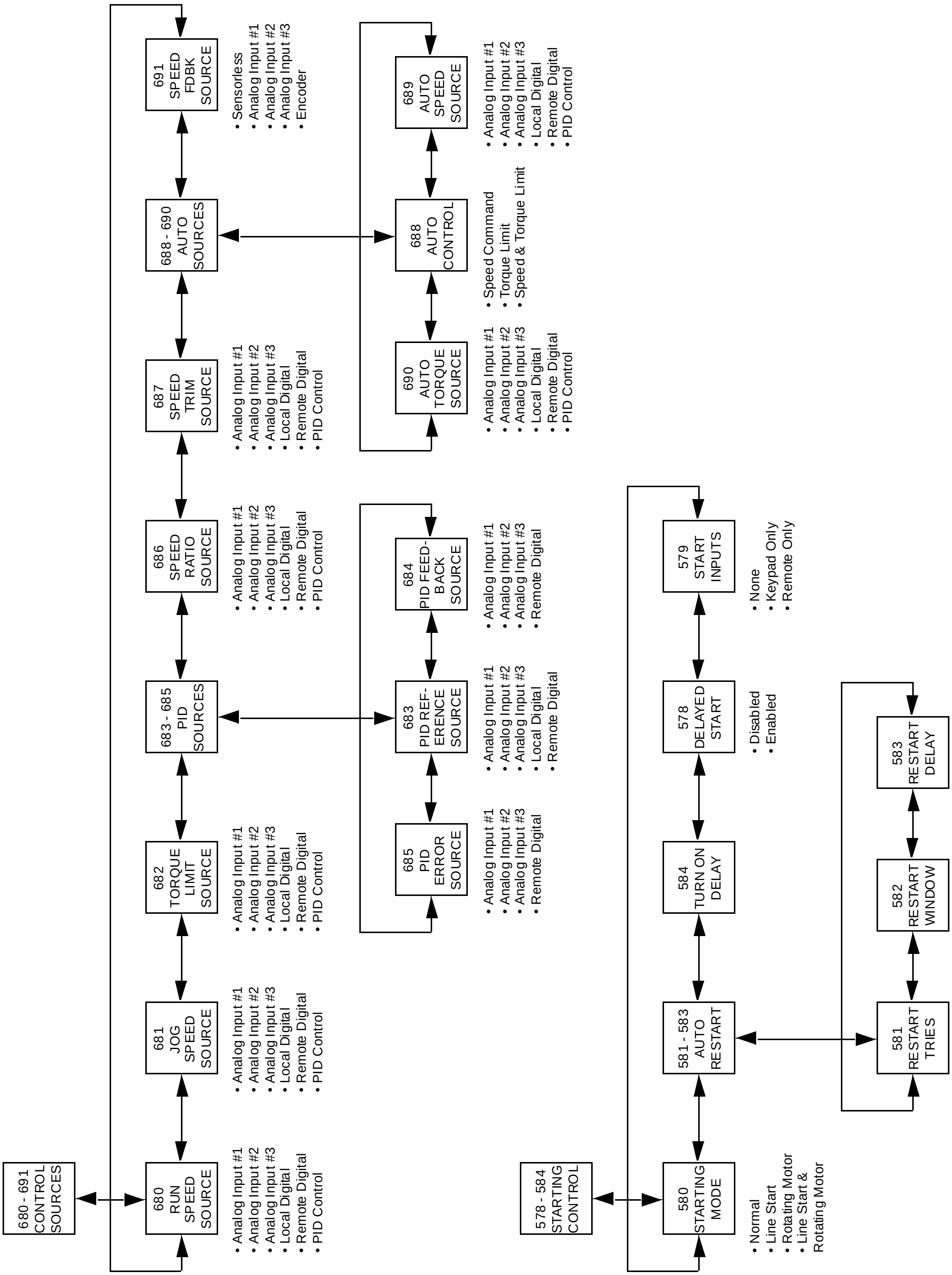


FIGURE 4-12. ADX MENU FLOW CHART, SETUP GROUP, PART D

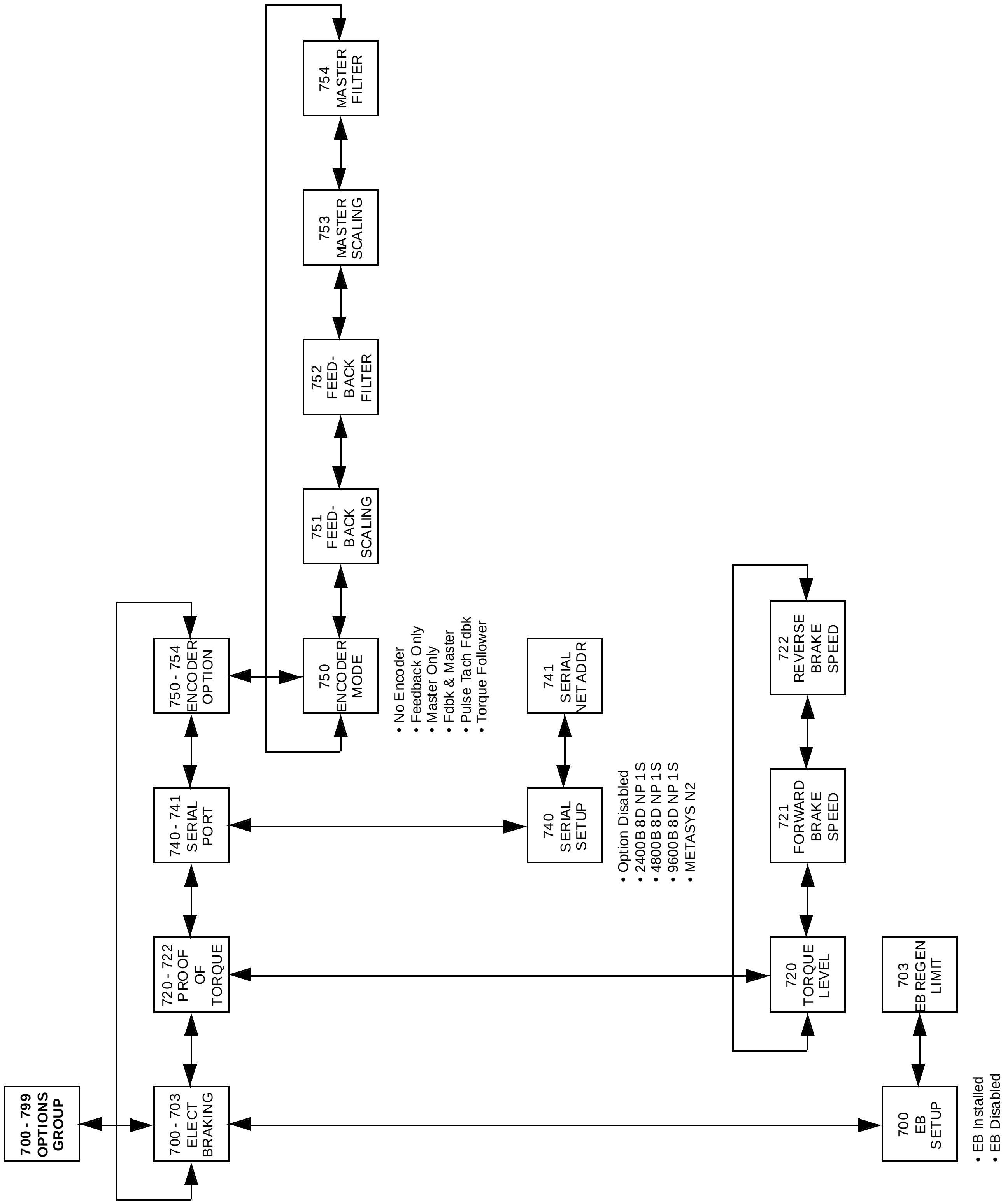


FIGURE 4-13. ADX MENU FLOW CHART, OPTIONS GROUP

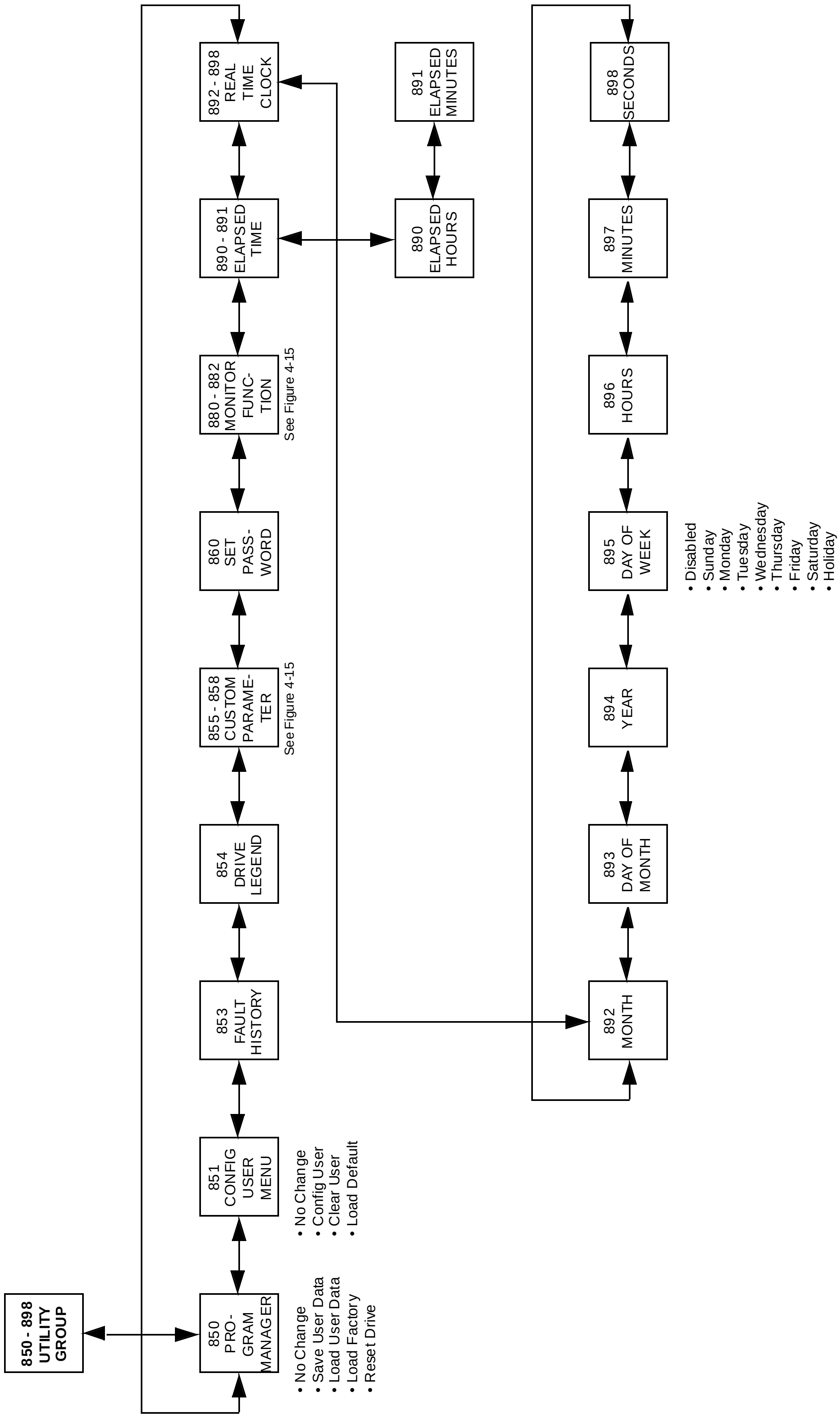


FIGURE 4-14. ADX MENU FLOW CHART, UTILITY GROUP, PART A

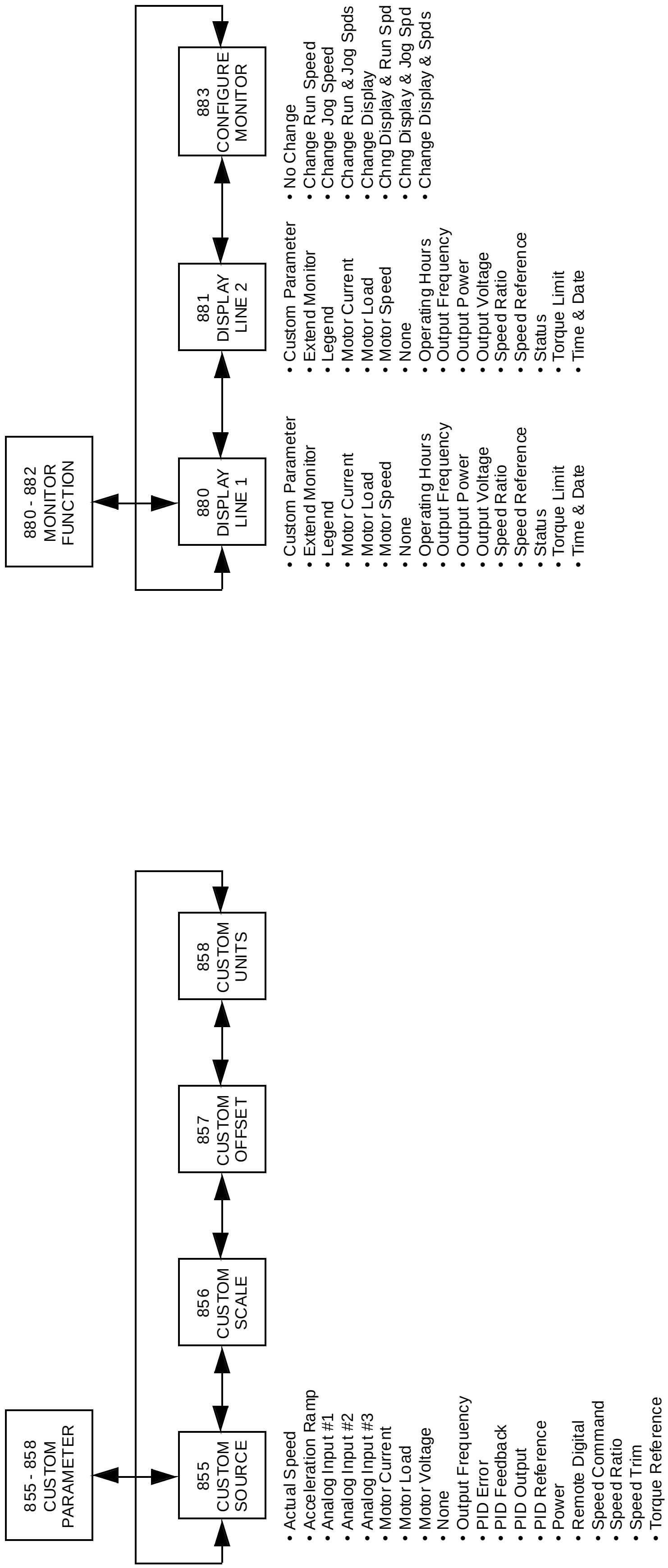


FIGURE 4-15. ADX MENU FLOW CHART, UTILITY GROUP, PART B

SECTION V

INITIAL POWER UP: MOTOR ROTATION CHECK

The first time the drive is powered up, motor rotation should be checked. In some applications, motor rotation must be checked before the system can be operational. The following is a SUGGESTED way to verify the correct motor rotation.

Standard ADX controllers are set up for manual operation from the keypad. Some ADX controllers, however, are set up at the factory for specific applications, and their respective keypads may be disabled. If the controller contains a special factory setup, it will be noted on the schematic diagram supplied with the controller.

- **For ADX controllers that are set up for manual operation, perform the following two steps.**

1. **Start the drive in manual and increase speed (via the keypad) until the motor begins to rotate. Check the rotation of the motor shaft. If motor rotation is opposite to what is required, TURN THE POWER OFF AND CHANGE THE MOTOR CONNECTIONS AT THE CONTROLLER MOTOR TERMINALS. When motor rotation is correct, stop the drive.**

2. **If supplied, activate the Bypass mode and again check motor rotation. If the rotation is opposite to what is required, TURN THE POWER OFF AND CHANGE THE POWER CONNECTIONS AT THE LINE TERMINALS OF THE BYPASS OPTION. Check motor rotation again, and when it is correct, turn-off the bypass mode.**

- **For ADX controllers with disabled keypads that are set up for a specific application, perform the following four steps.**

1. **Program the controller for Manual operation from the keypad, as follows:**

   a. If required, enter the controller password to gain access to the parameters. Password entry instructions are given on page 4-11.

   b. Set the Starting Mode (Setup Group - Starting Control - Starting Mode Parameter 580) to NORMAL. Push the MENU key to accept this change.

   c. Set the Start Inputs (Setup Group - Starting Control - Start Inputs Parameter 579) to KEYPAD ONLY. Push the MENU key to accept this change.

   d. Set the Digital Input #1 (Setup Group - Digital Inputs - Digital Input #1 Parameter 550) to NONE. Push the MENU key to accept this change.

   e. Set the Program Manager (Utility Group - Program Manager Parameter 850) to SAVE USER DATA. Push the MENU key to accept this change.

2. **Start the drive in manual and increase speed (via the keypad) until the motor begins to rotate. Check the rotation of the motor shaft. If motor rotation is opposite to what is required, <u>TURN THE POWER OFF AND CHANGE THE MOTOR CONNECTIONS AT THE CONTROLLER MOTOR TERMINALS.</u> When motor rotation is correct, stop the drive.**

3. **Program the controller back to normal operation, as follows:**

   Note: Refer to the ADX schematic for specific settings.

   a. If required, enter the controller password to gain access to the parameters.

   b. Set the Starting Mode (Setup Group - Starting Control - Starting Mode Parameter 580) to the setting shown on the ADX schematic. Push the MENU key to accept this change.

   c. Set the Start Inputs (Setup Group - Starting Control - Start Inputs Parameter 579) to the setting shown on the ADX schematic. Push the MENU key to accept this change.

   d. Set the Digital Input #1 (Setup Group - Digital Inputs - Digital Input #1 Parameter 550) to AUTO/ MANUAL. Push the MENU key to accept this change.

   e. Set the Program Manager (Utility Group - Program Manager Parameter 850) to SAVE USER DATA. Push the MENU key to accept this change.

4. **Activate the Bypass mode (if supplied) and again check motor rotation. If the rotation is opposite to what is required, <u>TURN THE POWER OFF AND CHANGE THE POWER CONNECTIONS AT THE LINE TERMINALS OF THE BYPASS OPTION.</u> Check motor rotation again, and when it is correct, turn-off the bypass mode.**

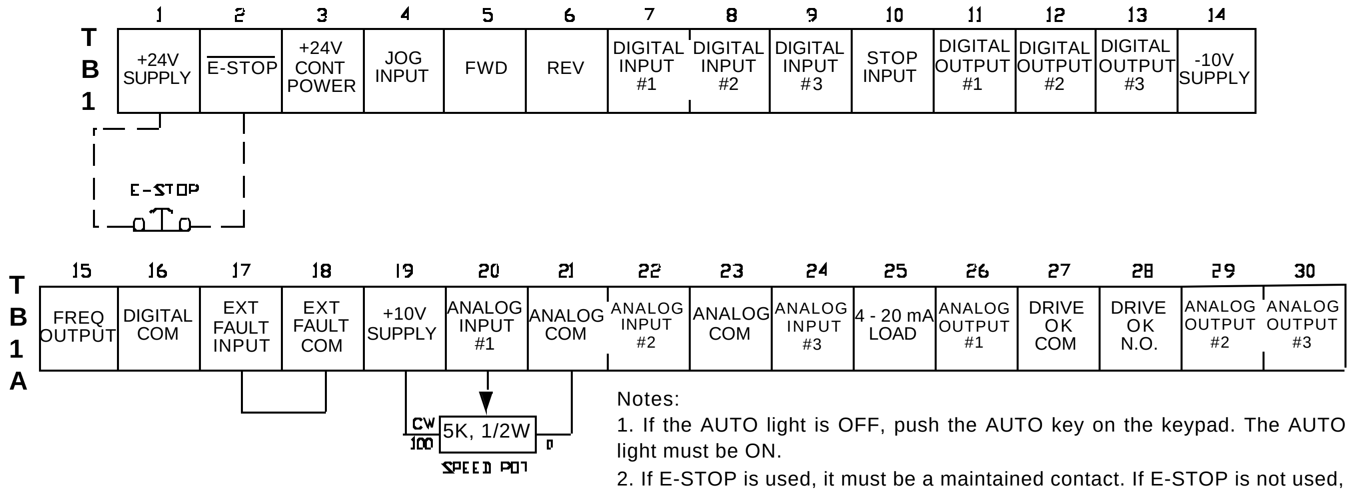
SECTION VI

EXTERNAL CONTROLS AND DEVICES

This section is for users who wish to connect external operator controls or devices to the ADX controller.

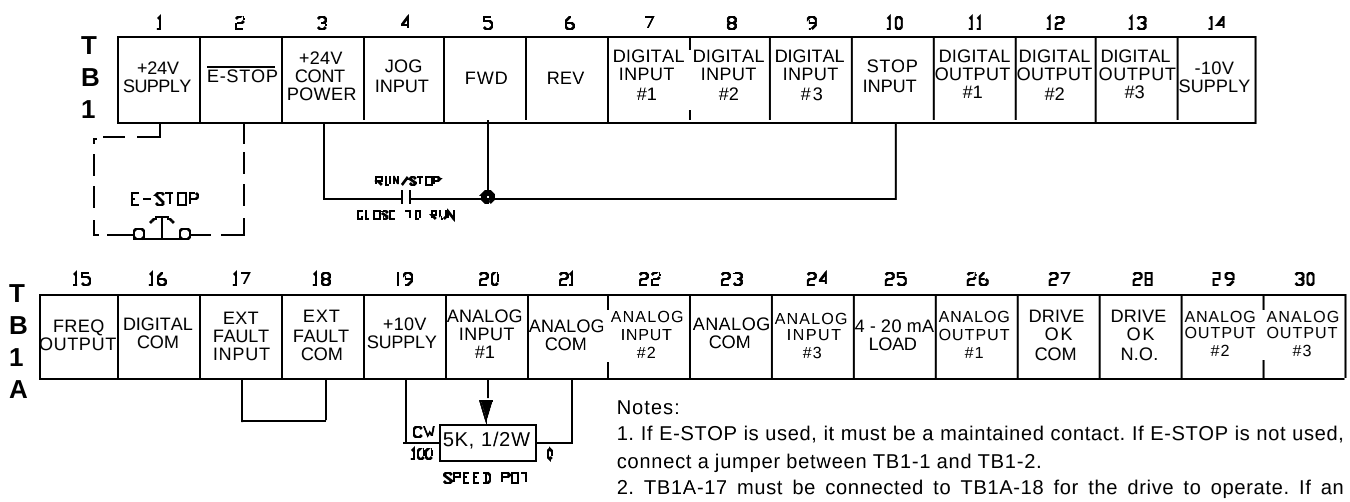
Included are wiring diagrams showing the following connections:

- Figure 6-1, Page 6-2: Speed Control Potentiometer - Keypad Operation.
- Figure 6-2, Page 6-2: Two Wire Start/Stop and Speed Control Potentiometer - Remote Operation.
- Figure 6-3, Page 6-3: Start and Stop Buttons, Run/Jog Switch, and Speed Control Potentiometer - Remote Operation.
- Figure 6-4, Page 6-3: Forward, Reverse and Stop Buttons, Run/Jog Switch, and Speed Control Potentiometer - Remote Operation.
- Figure 6-5, Page 6-4: Forward, Reverse and Stop Buttons, Run/Jog Switch, and 0 - 10 VDC Speed Reference Signal - Remote Operation.
- Figure 6-6, Page 6-4: Start and Stop Buttons, Forward/Reverse and Run/Jog Switches, and Speed Control Potentiometer - Remote Operation.
- Figure 6-7, Page 6-5: Boston Gear RCS1 Remote Station (Run and Stop Buttons, and Speed Control Potentiometer) - Remote Operation.
- Figure 6-8, Page 6-5: Boston Gear RCS2A Remote Station (Run and Stop Buttons, Forward/Reverse Switch, and Speed Control Potentiometer) - Remote Operation.
- Figure 6-9, Page 6-6: Boston Gear RCS5 Remote Station (Run, Stop and Jog Buttons, and Speed Control Potentiometer) - Remote Operation.
- Figure 6-10, Page 6-6: Boston Gear RCS6 Remote Station (Forward, Reverse and Stop Buttons, and Speed Control Potentiometer) - Remote Operation.
- Figure 6-11, Page 6-7: Run Forward, Run Reverse, Jog Forward, Jog Reverse and Stop Buttons, and Speed Control Potentiometer - Remote Operation.
- Figure 6-12, Page 6-7: Frequency Meter and Speed Meter - Keypad or Remote Operation.



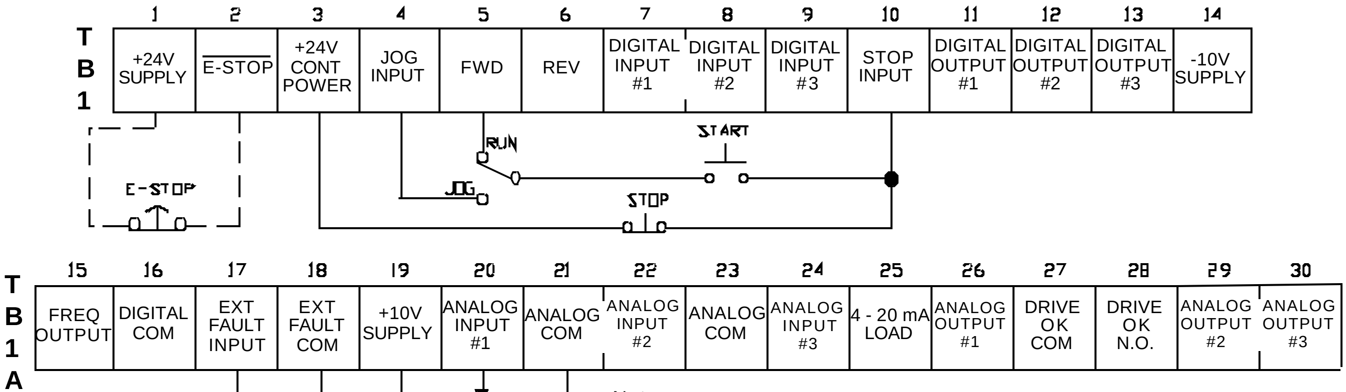
Notes:
1. If the AUTO light is OFF, push the AUTO key on the keypad. The AUTO light must be ON.
2. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
3. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

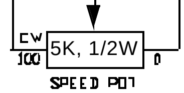
FIGURE 6 - 1. WIRING DIAGRAM, SPEED CONTROL POT - KEYPAD OPERATION



Notes:
1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
4. Set the Starting Mode (Parameter 580) to LINE START or to LN STRT/ROT MTR.
5. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

FIGURE 6 - 2. WIRING DIAGRAM, TWO-WIRE START/STOP & SPEED CONTROL POT - REMOTE OPERATION

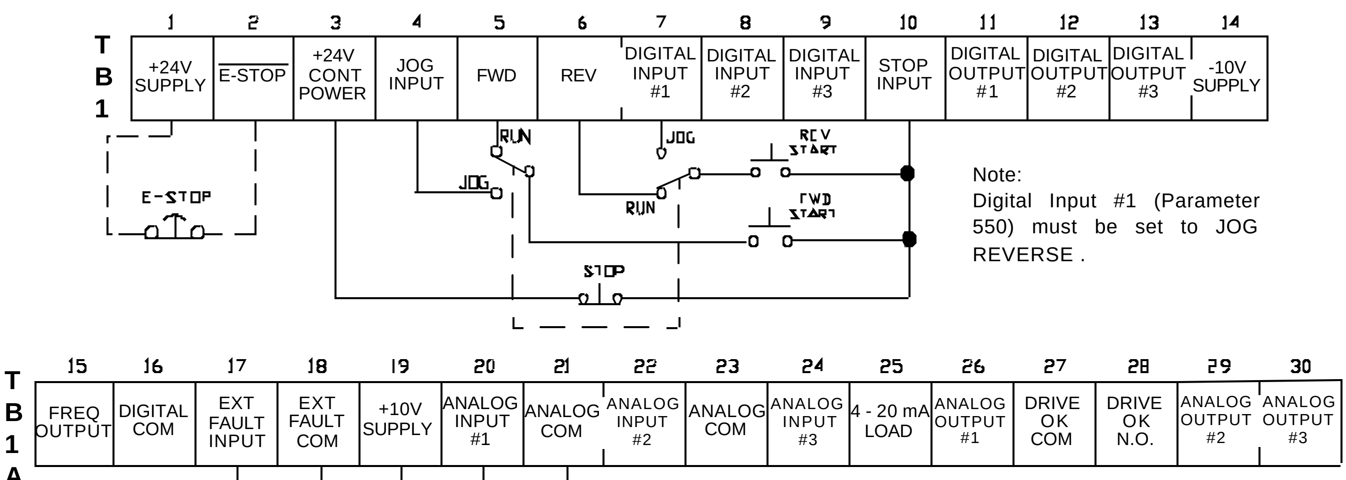




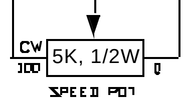
Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
4. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

FIGURE 6 - 3. WIRING DIAGRAM, START & STOP BUTTONS, RUN/JOG SWITCH, & SPEED CONTROL POT - REMOTE OPERATION



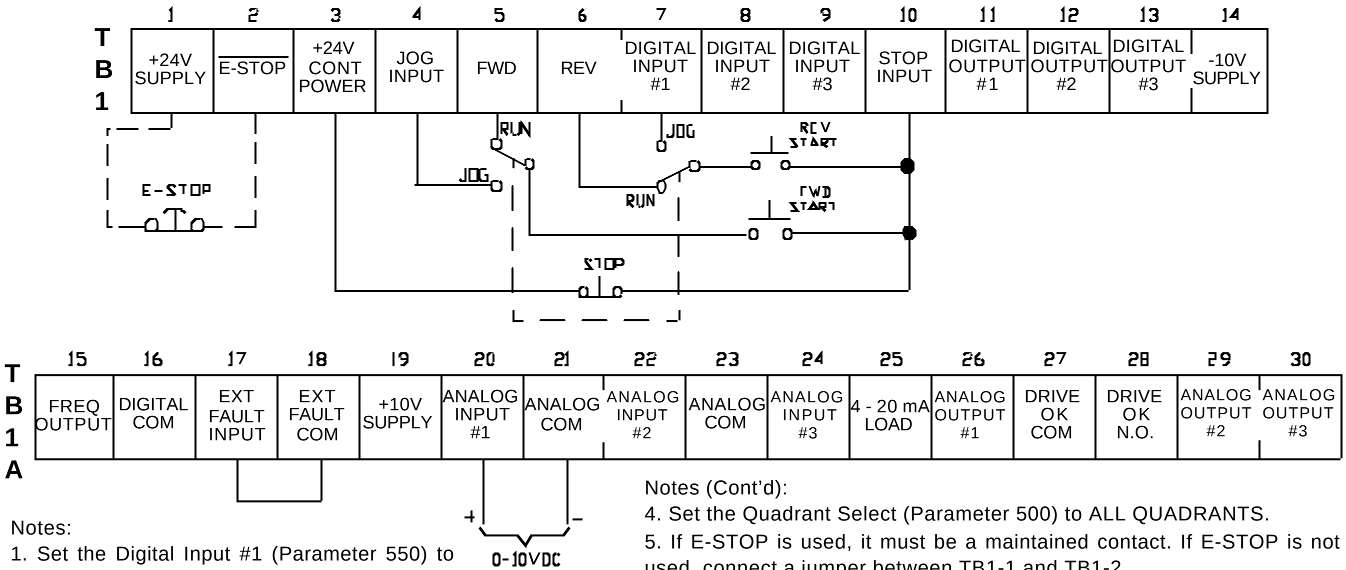
Note:
Digital Input #1 (Parameter 550) must be set to JOG REVERSE .



Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
4. Set the Start Inputs (Parameter 579) to REMOTE ONLY.
5. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.

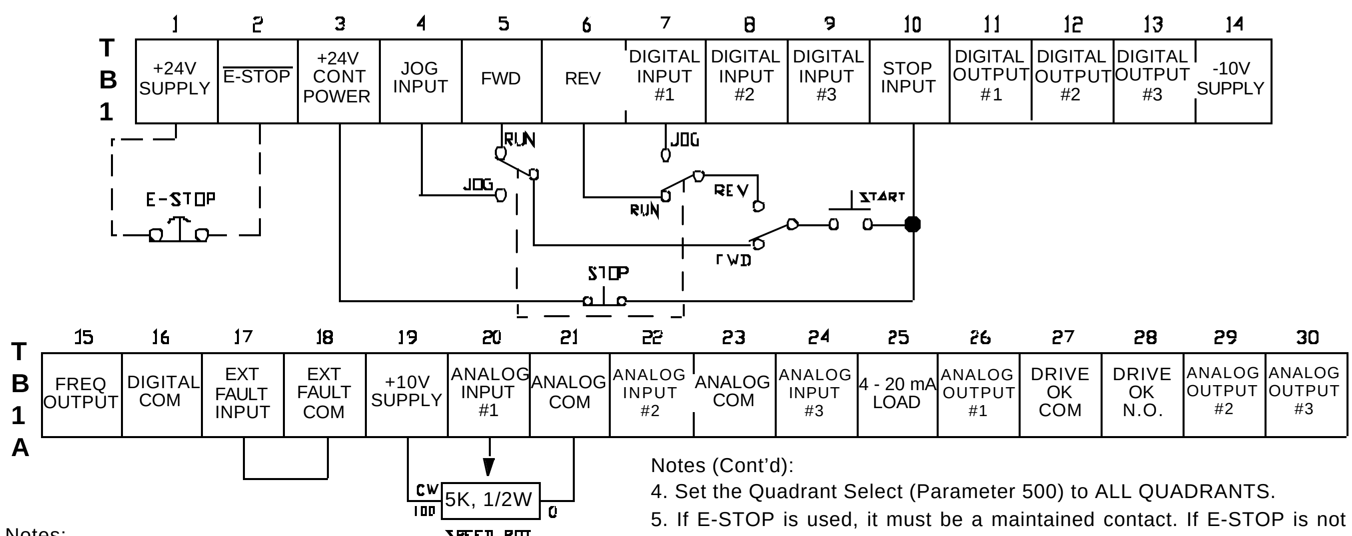
FIGURE 6 - 4. WIRING DIAGRAM, FORWARD, REVERSE & STOP BUTTONS, RUN/JOG SWITCH, & SPEED CONTROL POT - REMOTE OPERATION



Notes:
1. Set the Digital Input #1 (Parameter 550) to JOG REVERSE.
2. Set the Start Inputs (Parameter 579) to REMOTE ONLY.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.

Notes (Cont'd):
4. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.
5. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
6. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

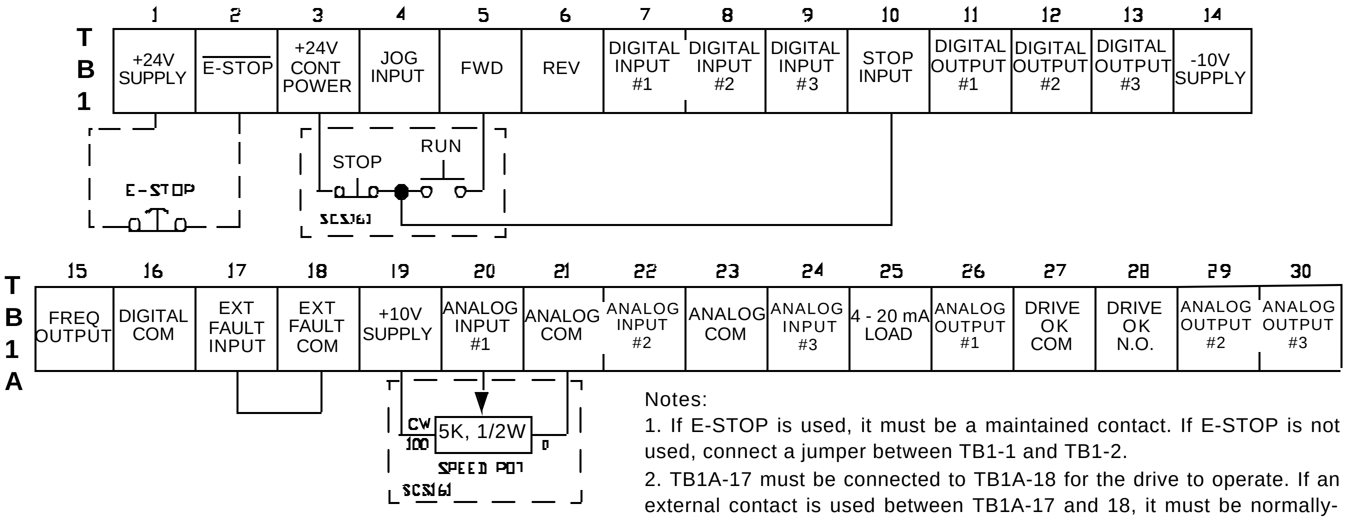
FIGURE 6 - 5. WIRING DIAGRAM, FORWARD, REVERSE & STOP BUTTONS, RUN/JOG SWITCH, & 0 - 10 VDC SPEED REFERENCE SIGNAL - REMOTE OPERATION



Notes:
1. Set the Digital Input #1 (Parameter 550) to JOG REVERSE.
2. Set the Start Inputs (Parameter 579) to REMOTE ONLY.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.

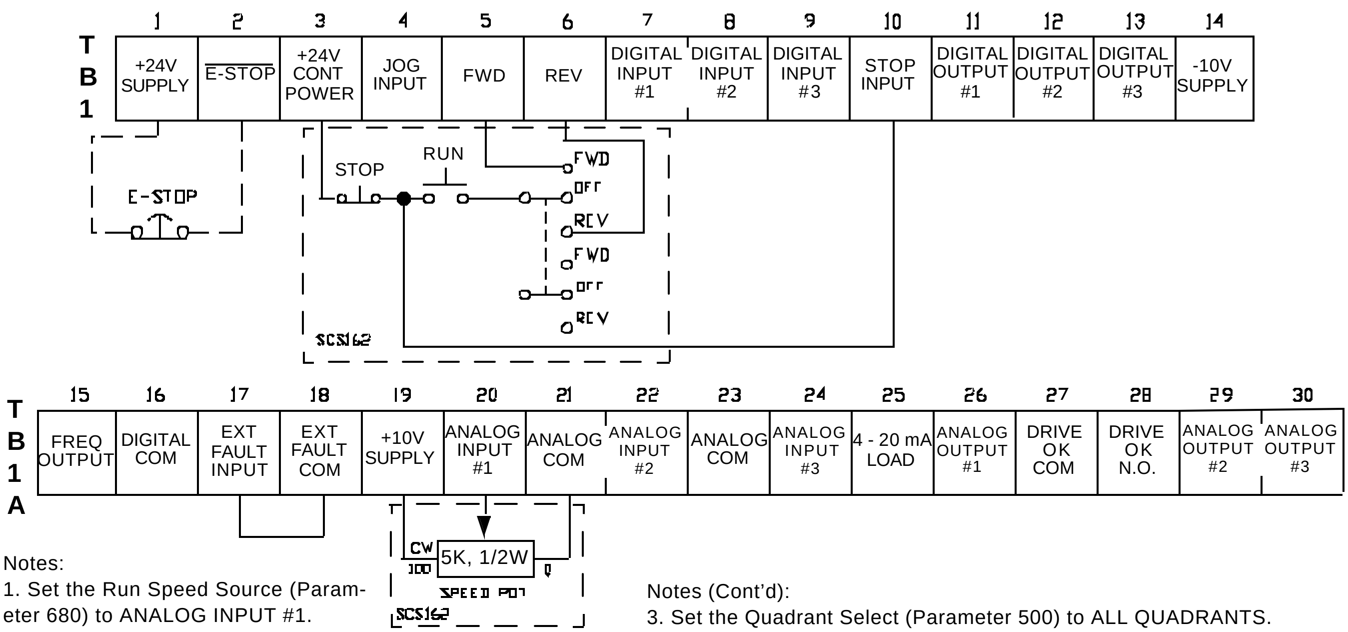
Notes (Cont'd):
4. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.
5. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
6. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

FIGURE 6 - 6. WIRING DIAGRAM, START & STOP BUTTONS, FORWARD/REVERSE & RUN/JOG SWITCHES, & SPEED CONTROL POT - REMOTE OPERATION



Notes:
1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
4. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

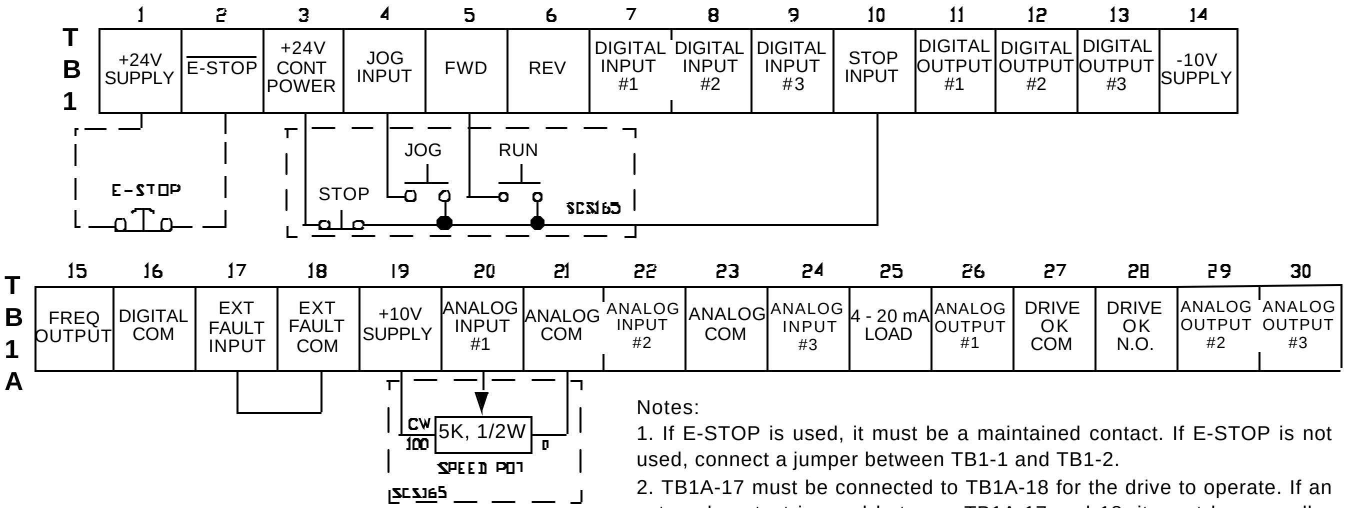
FIGURE 6 - 7. WIRING DIAGRAM, BOSTON GEAR RCS1 REMOTE STATION (RUN & STOP BUTTONS, & SPEED CONTROL POT) - REMOTE OPERATION



Notes:
1. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
2. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

Notes (Cont'd):
3. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.
4. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
5. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

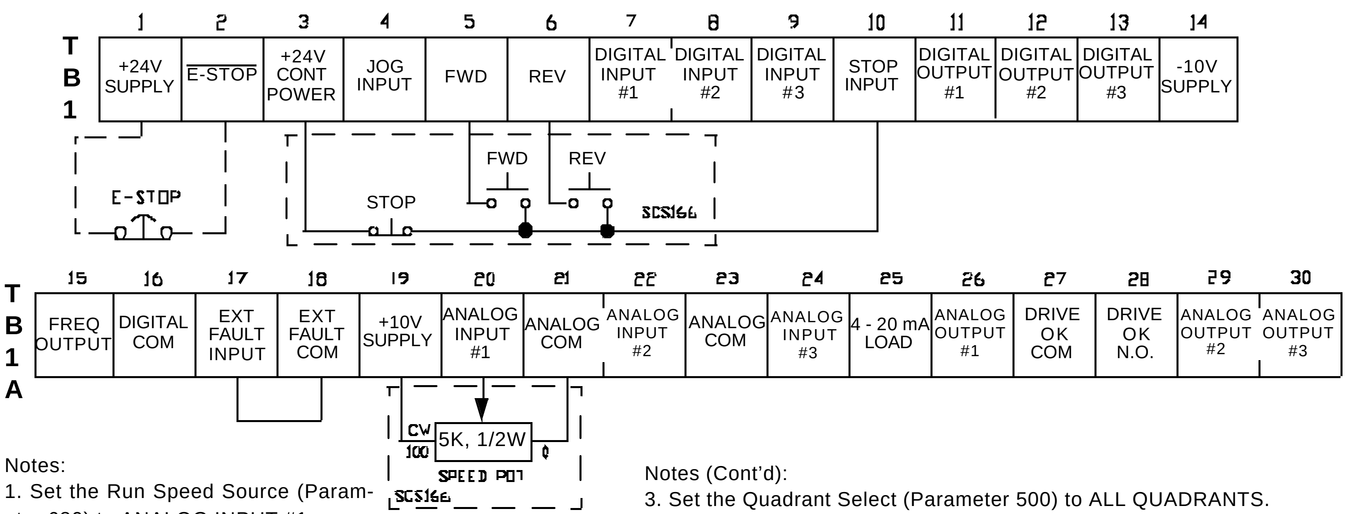
FIGURE 6 - 8. WIRING DIAGRAM, BOSTON GEAR RCS2A REMOTE STATION (RUN & STOP BUTTONS, FORWARD/REVERSE SWITCH, & SPEED CONTROL POT) - REMOTE OPERATION



Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
4. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

FIGURE 6 - 9. WIRING DIAGRAM, BOSTON GEAR RCS5 REMOTE STATION (RUN, STOP & JOG BUTTONS, & SPEED CONTROL POT) - REMOTE OPERATION



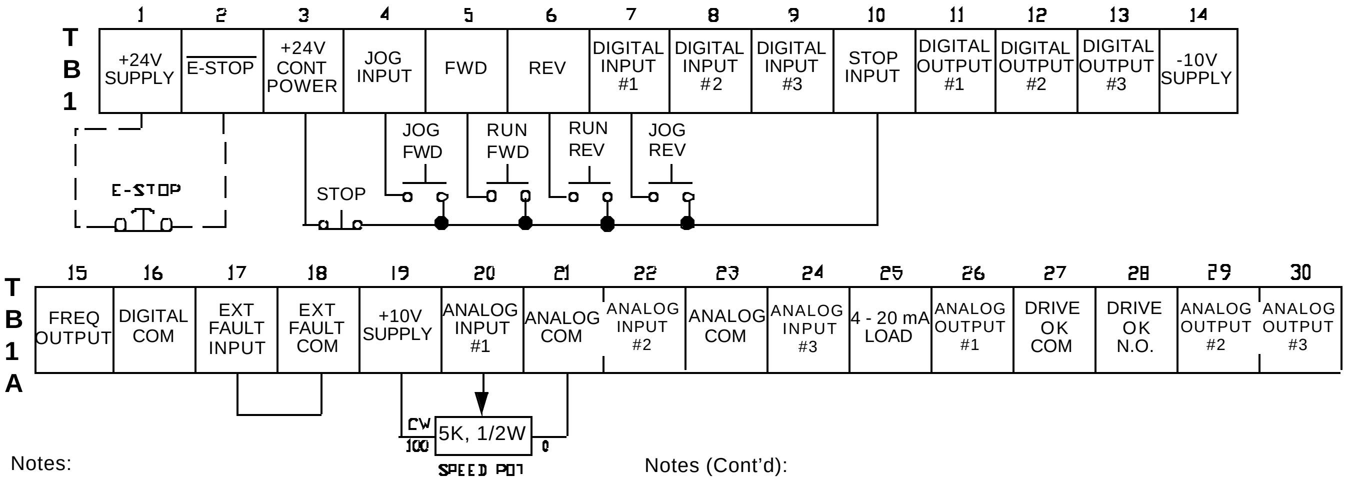
Notes:

1. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
2. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

Notes (Cont'd):

3. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.
4. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
5. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

FIGURE 6 - 10. WIRING DIAGRAM, BOSTON GEAR RCS6 REMOTE STATION (FORWARD, REVERSE & STOP BUTTONS, & SPEED CONTROL POT) - REMOTE OPERATION



Notes:

1. Set the Run Speed Source (Parameter 680) to ANALOG INPUT #1.
2. Set the Start Inputs (Parameter 579) to REMOTE ONLY.

Notes (Cont'd):

3. Set the Quadrant Select (Parameter 500) to ALL QUADRANTS.
4. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
5. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

FIGURE 6 - 11. WIRING DIAGRAM, RUN FORWARD, RUN REVERSE, JOG FORWARD, JOG REVERSE & STOP BUTTONS, & SPEED CONTROL POT - REMOTE OPERATION

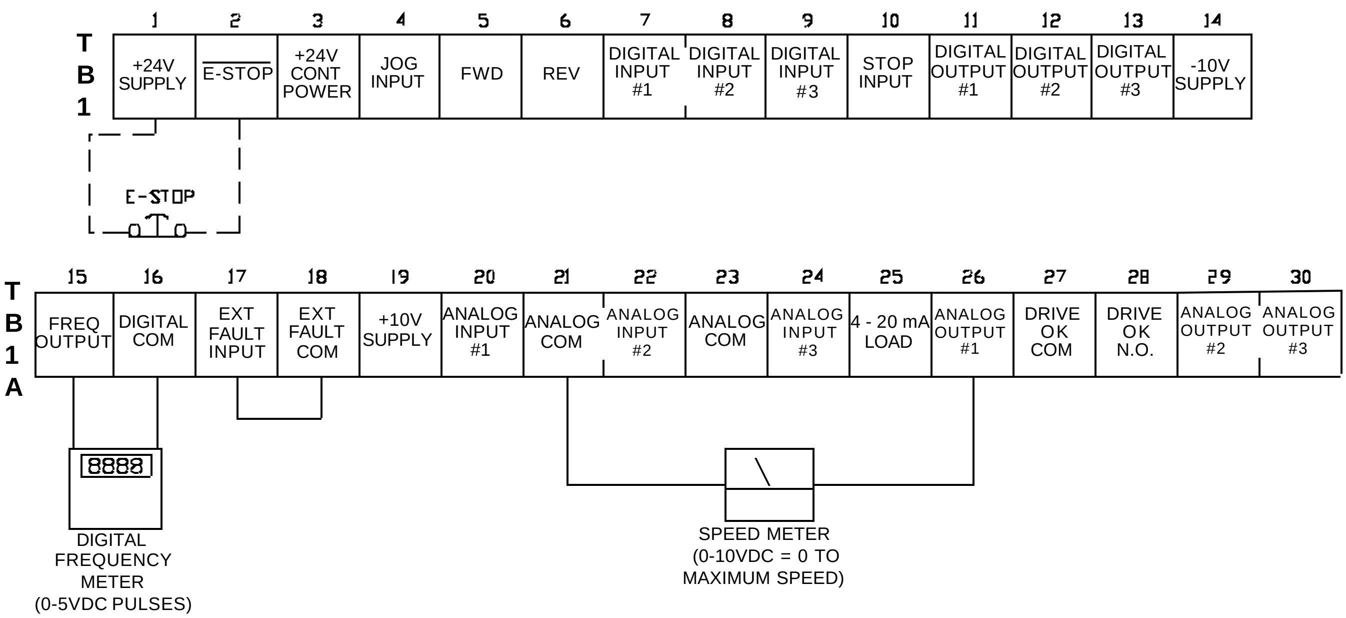


FIGURE 6 - 12. WIRING DIAGRAM, FREQUENCY & SPEED METERS - KEYPAD OR REMOTE OPERATION

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SECTION VII

PREPROGRAMMED SETUP MODES

Preprogrammed setup modes are provided for users who need a specific application program. These programs are activated by selecting an appropriate number in the Setup Number Menu (Parameter 695). Each number (1 - 11) in Parameter 695 represents a specific application program. If no specific application is required, set Parameter 695 to 0.

Setup Numbers 6 through 11 are generally used for RAC (Refrigeration and Air Conditioning) applications. These setups simplify setting up the ADX controller to control a process variable, such as pressure, flow, or temperature by using a 4 - 20 mA or 0 - 10 VDC transducer feedback or speed reference signal. RAC setups may be preset at the factory. If the ADX controller is factory preset with a preprogrammed setup mode, the setup will be noted on the controller data label.

Following is a list of the Preprogrammed Setups in Parameter 695 and their associated Setup Numbers.

- 0 = No preprogrammed setup mode selected.
- 1 = Faster/Slower push-button control.
- 2 = Line starting.
- 3 = Line starting with auto restart.
- 4 = Hand/Auto selection with 0 - 10 VDC reference.
- 5 = Hand/Auto selection with 4 - 20mA reference.
- 6 = Auto/Manual selection with 0 - 10 VDC reference and 5 VDC analog speed output.
- 7 = Auto/Manual selection with an inverse 0 - 10 VDC reference and 5 VDC analog speed output.
- 8 = PID setpoint control with 4 - 20mA feedback and 5 VDC analog speed output.
- 9 = PID setpoint control with an inverse 4 - 20mA feedback and 5 VDC analog speed output.
- 10 = PID setpoint control with 4 - 20mA feedback, acceleration/deceleration control, and 5 VDC analog speed output.
- 11 = PID setpoint control with an inverse 4 - 20mA feedback, acceleration/deceleration control, and 5 VDC analog speed output.
- 12 = RAC factory preset setup.
- 13 = Restore factory preset setup.

WIRING INSTRUCTIONS

1. Turn-off the AC supply voltage to the ADX controller.

2. Wait at least 5 minutes for the DC bus capacitors to discharge, and then remove the terminal access cover.

3. Make the necessary connections to the controller control board as shown in Figure 7-1 - 7-3, 7-10, or 7-11, as applicable. Figures 7-1 - 7-3 are for general applications. Figures 7-10 and 7-11 are for RAC applications.

PREPROGRAMMED SETUPS FOR GENERAL APPLICATIONS

Following are descriptions of the preprogrammed setups that are typically used for general industrial applications. For RAC applications, refer to "Preprogrammed Setups For RAC Applications," page 7-5.

- 1 = Faster and slower control using external push buttons or contacts. See Figure 7-1, page 7-3.

- 2 = Line starting **without** automatic restart. If a fault occurs, the controller will shut down, and will not restart until the fault is cleared and the user resets the controller either by pressing the STOP key on the controller keypad, or by removing and reapplying the AC line voltage. See Figure 7-2, page 7-3.

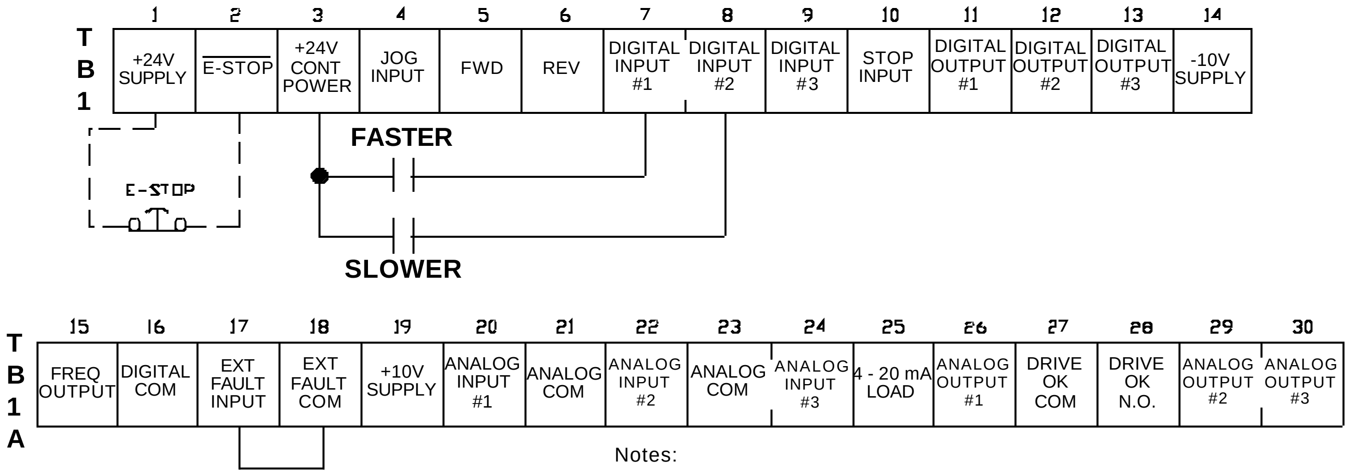
- 3 = Line starting **with** automatic restart. **If a fault occurs, the controller will shut down, but will try to restart automatically after 5 seconds.** If the fault is not cleared, the controller will try to restart 5 times. After the fifth restart try, the controller will remain shut down until the fault is cleared and the user resets the controller either by pressing the STOP key on the controller keypad, or by removing and reapplying the AC line voltage. See Figure 7-2, page 7-3.

- 4 = Using an external 0 - 10 VDC speed reference signal and a HAND/OFF/AUTO switch. See Figure 7-3, page 7-4.

- 5 = Using an external 4 - 20 mA speed reference signal and a HAND/OFF/AUTO switch. See Figure 7-3, page 7-4.

Note: When one of the above Setup Numbers (1 - 5) has been selected in Setup Number Parameter 695, the following parameters **cannot** be changed from the keypad.

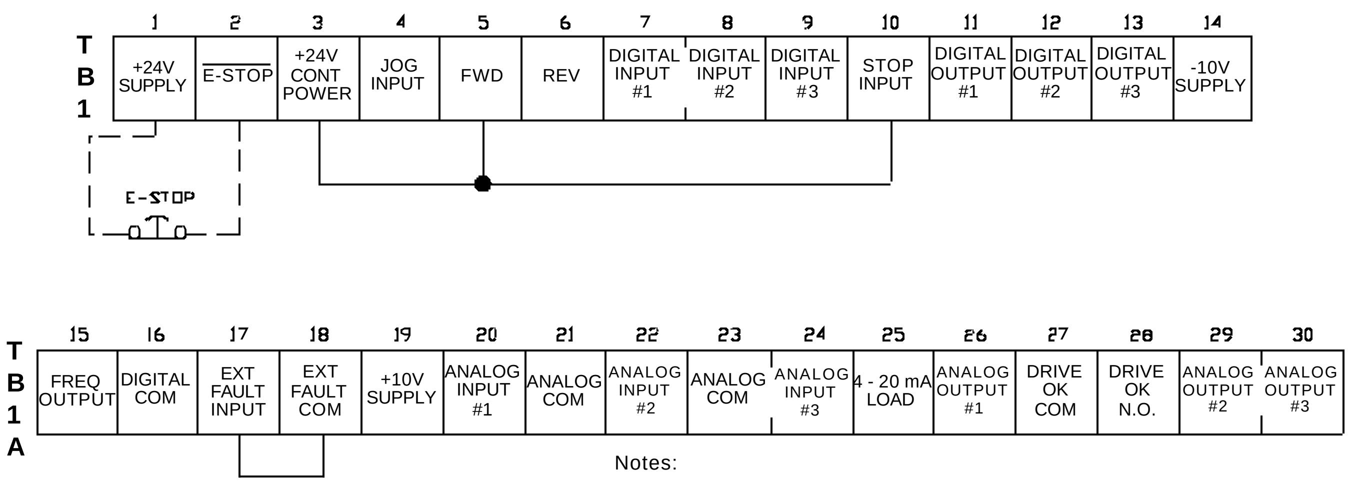
- 530 (Analog Output #1 Source)
- 534 (Analog Output #1 Scale)
- 550 (Digital Input #1)
- 551 (Digital Input #2)
- 565 (Analog Input #2 Invert)
- 566 (Analog Input #2 Offset Mode)
- 567 (Analog Input #2 Offset)
- 568 (Analog Input #2 Scale)
- 569 (Analog Input #2 Filter)
- 579 (Start Inputs)
- 580 (Starting Mode)
- 581 (Restart Tries)
- 680 (Run Speed Source)
- 684 (PID Feedback Source)
- 689 (Auto Speed Source)



Notes:

1. If the AUTO light is OFF, push the AUTO key on the keypad. The AUTO light must be ON.
2. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
3. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
4. The preset setting for Start Inputs Parameter 579 is KEYPAD ONLY. If remote contacts are used to start the drive, change Parameter 579 to REMOTE ONLY.

FIGURE 7 - 1. WIRING DIAGRAM FOR SETUP MODE #1, FASTER/SLOWER - KEYPAD OR REMOTE OPERATION

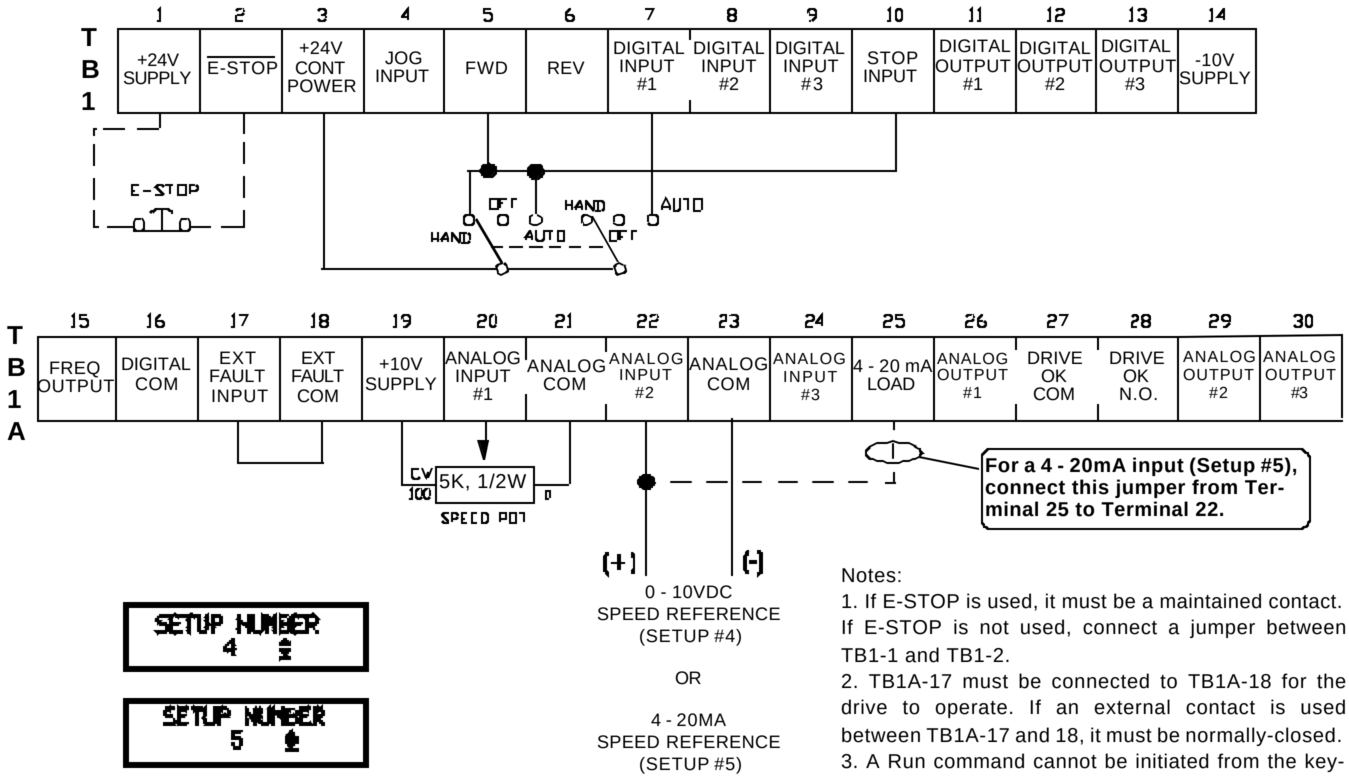


Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. Use Setup #2 for Line Starting Without Auto Restart, or use Setup #3 for Line Starting With Auto Restart. See page 7-1 for more information.

FIGURE 7 - 2. WIRING DIAGRAM FOR SETUP MODE #2 OR #3, LINE STARTING WITH OR WITHOUT AUTO RESTART

Preprogrammed Setup Wiring Diagram



Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. A Run command cannot be initiated from the keypad.
4. When the switch is in HAND position, the speed reference must be set with the Faster/Slower keys.

FIGURE 7 - 3. WIRING DIAGRAM FOR SETUP MODE #4 OR #5, HAND/OFF/AUTO SWITCH WITH 0-10 VDC OR 4-20MA SPEED REFERENCE - REMOTE OPERATION

Preprogrammed Setups

PREPROGRAMMED SETUPS FOR RAC APPLICATIONS

Following are descriptions of the preprogrammed setups that are typically used for RAC (Refrigeration and Air Conditioning) applications.

Note: If the RAC preprogrammed setup (Setup Number 6 - 11) has been altered, deleted, or is inappropriate for the application, use Figure 7-4 (page 7-8) as a guide to determine which RAC setup number to select.

SETUP #6 - DIRECT FOLLOWER CONTROL

Direct follower control is used when motor speed is to simply change in direct proportion to the control signal. This type of control is typically used in applications with an energy management or process controller. The feedback signal, which represents pressure, flow, or temperature, is already processed (i.e., a device outside of the ADX controller compares a setpoint to feedback and sends the ADX controller a speed reference signal). A 0 - 10 VDC[1] speed reference signal produces directly proportional motor speed from 0 to 100%. When the control signal increases, motor speed increases.

For a typical air handling application, see Figure 7-5 (page 7-9). Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

SETUP #7 - INVERSE FOLLOWER CONTROL

Inverse follower control is similar to direct follower control except a 0 - 10 VDC[1] control signal produces inversely proportional motor speed from 100% to 0. When the control signal increases, motor speed decreases.

For a typical air handling application, see Figure 7-6 (page 7-10).

Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

1. The ADX controller can be reconfigured to use a 4 - 20 mA speed reference signal. See page 7-18.

SETUP #8 - DIRECT PID CONTROL

Direct PID (Proportional/Integral/Derivative) control is used when the feedback control signal is **not** processed (e.g., applications where a 4 - 20 mA[1] transducer senses actual pressure or flow, and is connected directly to the ADX controller). The ADX controller compares this signal to an internal preset PID setpoint, and maintains the desired pressure or flow. This control type allows the ADX controller to provide the additional function of a process controller. An increase in the 4 - 20 mA feedback control signal above the setpoint causes the motor to slow down to maintain pressure or flow.

The basic purpose of PID control is to adjust motor speed until the transducer feedback signal equals the setpoint. See Section VIII, "PID Control" for additional information.

For a typical example of an air handling application, see Figure 7-7 (page 7-11).

Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

SETUP #9 - INVERSE PID CONTROL

Inverse PID control is similar to direct feedback PID control (Setup #8) except the system requires an inverted function for one of the following reasons:

1. The transducer output is inverted (i.e., the transducer output is minimum when the process variable (pressure, flow, or temperature) is maximum, and vice versa). Refer to Figure 7-8 (page 7-12) for a typical example of an air handling application.

2. Motor operation is inverted (i.e., an increase in the process variable above the setpoint causes an increase in motor speed). For a typical example of temperature control of a cooling tower, see Figure 7-9, page 7-13. If the temperature increases above the setpoint, motor speed will increase to reduce temperature.

Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

Note: In some instances, overcurrent faults may occur when the drive is started. If this occurs, first reduce the setpoint to zero (this may require setting Minimum Speed Parameter 120 and PID Min Output Parameter 205 to zero). Start the drive and slowly increase the setpoint to the desired value. If tripping still occurs, the ADX drive may be undersized or incorrectly calibrated to the motor. If tripping does **not** occur, select Setup #10 or #11, as applicable.

1. The ADX controller can be reconfigured to use a 0 - 10 VDC speed reference signal. See page 7-18.

SETUP #10 - DIRECT PID CONTROL WITH ACCEL/DECEL [1]

Direct PID control with acceleration/deceleration is similar to direct PID control (Setup #8) except acceleration/deceleration control is available which may eliminate overcurrent faults in applications where these faults occur.

This setup inserts acceleration and deceleration ramps into the PID function to soften starts. Adjust acceleration time with Parameter 250 and deceleration time with Parameter 259. These two values should be equal and set to the minimum value that prevents overcurrent trips. Also, proportional gain (PID Prop Gain Parameter 201) and integral gain (PID Int Gain Parameter 202) will need to be lower. Suggested settings: Parameter 201 = 50 and Parameter 202 = 10.

For a typical example of an air handling application, see Figure 7-7 (page 7-11)

Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

SETUP #11 - INVERSE PID CONTROL WITH ACCEL/DECEL [1]

Inverse PID control with acceleration/deceleration is similar to direct PID control with acceleration/deceleration (Setup #10) except the system requires an inverted function for one of the following reasons:

1. The transducer output is inverted (i.e., the transducer output is minimum when the process variable (pressure, flow, or temperature) is maximum, and vice versa). Refer to Figure 7-8 (page 7-12) for a typical example of an air handling application.

2. Motor operation is inverted (i.e., an increase in the process variable above the setpoint causes an increase in motor speed). For a typical example of temperature control of a cooling tower, see Figure 7-9, page 7-13. If the process variable (temperature) increases above the setpoint, motor speed increases to reduce temperature.

Refer to Figure 7-10 (page 7-14) for a typical wiring diagram.

SETUP #12 -RAC FACTORY PRESET

This selection resets the factory preset values used for RAC applications. Setup #12 will load factory preset values for RAC applications. When one of the RAC Setups (6 - 11) is to be used, Setup Number 12 must first be selected to enable Line Starting. Then, RAC Setup Number (6 - 11) may be selected.

1. Acceleration and deceleration are enabled only in the Manual mode. When Terminal 3 is connected to Terminal 7 on TB1 (Auto mode), acceleration and deceleration are disabled.

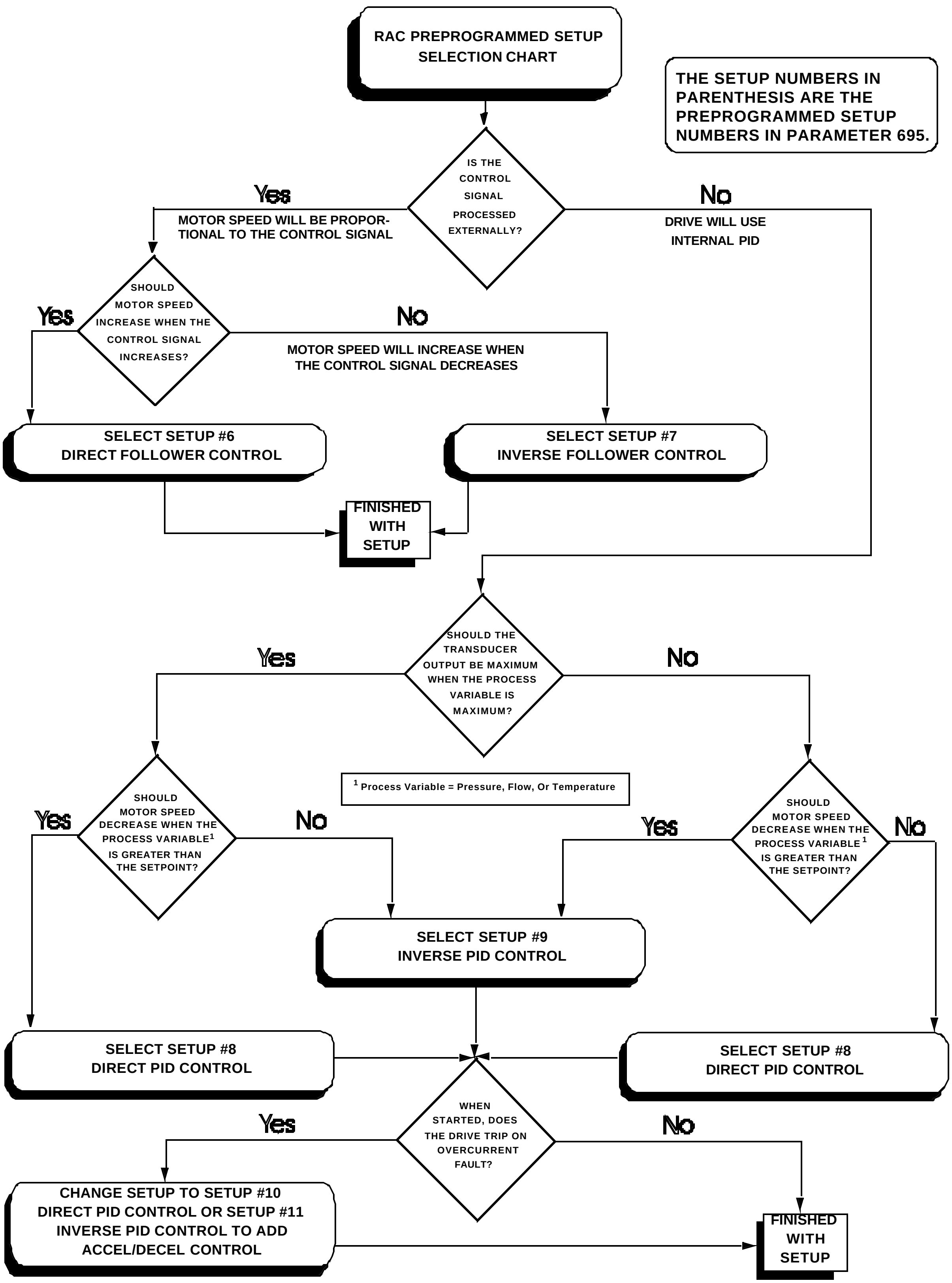


FIGURE 7-4. RAC PREPROGRAMMED SETUP SELECTION GUIDE

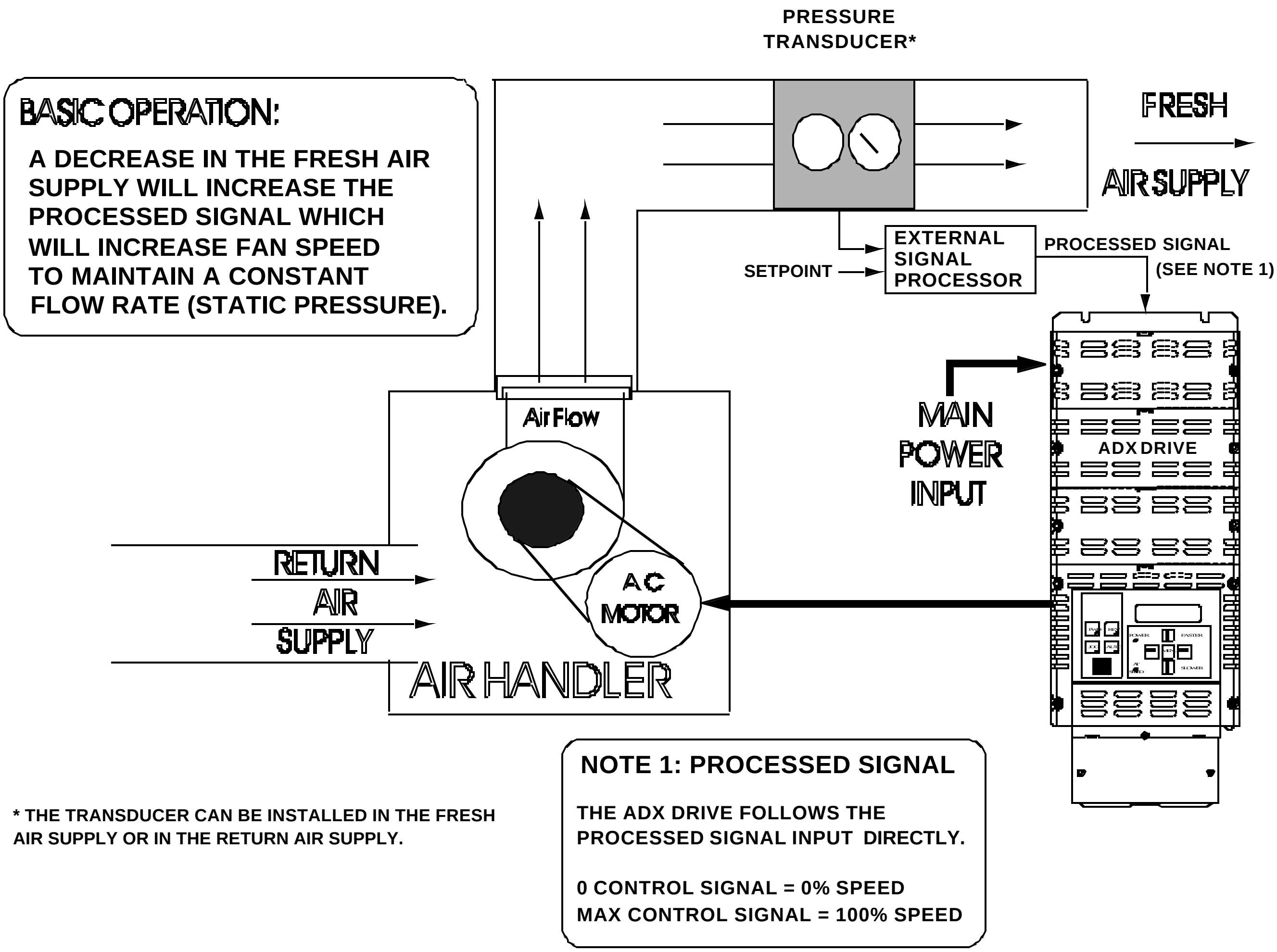


FIGURE 7-5. TYPICAL EXAMPLE OF AN AIR HANDLING APPLICATION USING DIRECT FOLLOWER CONTROL (SETUP #6)

Application Example For Setup #7

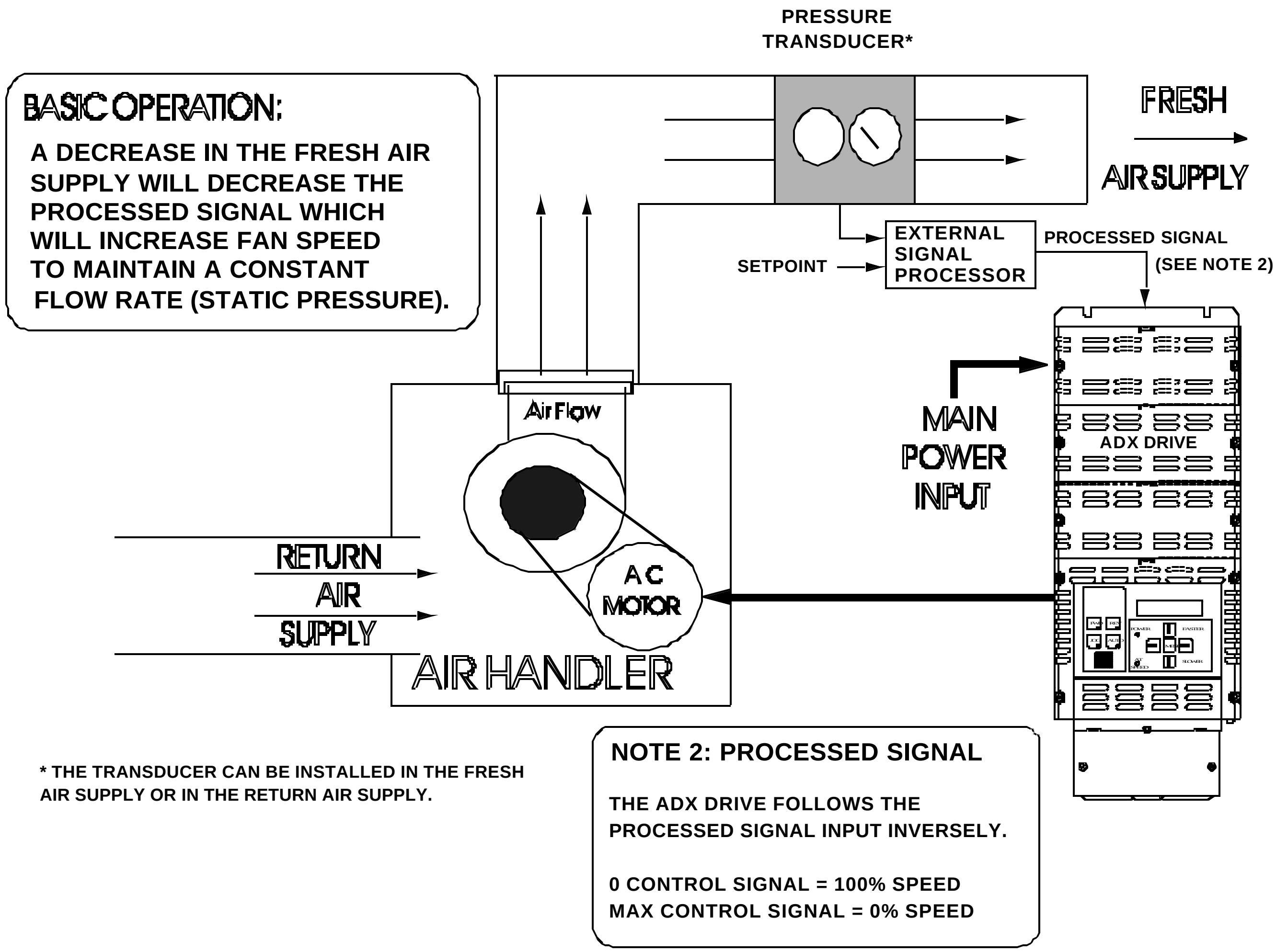


FIGURE 7-6. TYPICAL EXAMPLE OF AN AIR HANDLING APPLICATION USING INVERSE FOLLOWER CONTROL (SETUP #7)

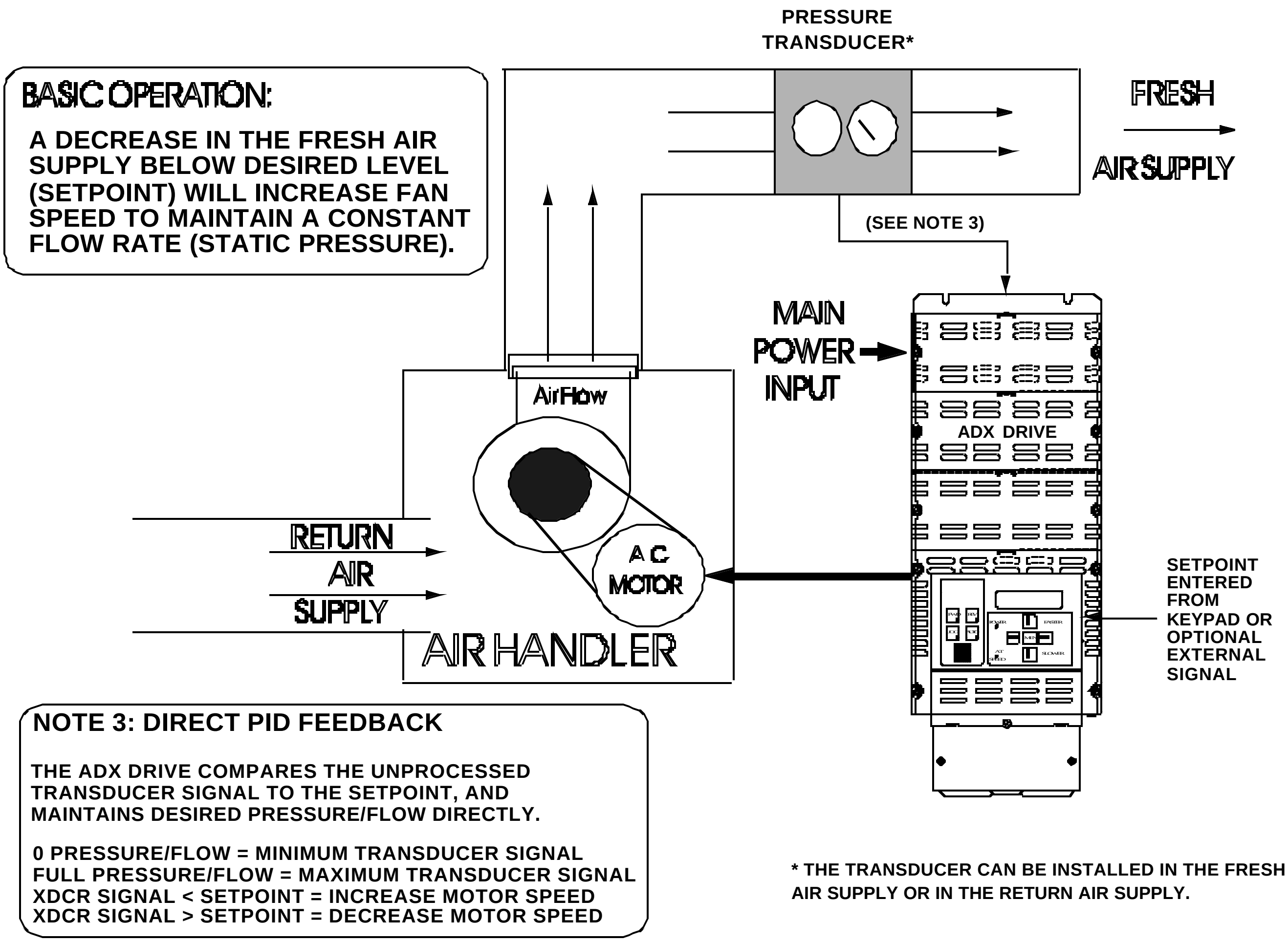


FIGURE 7-7. TYPICAL EXAMPLE OF AN AIR HANDLING APPLICATION USING DIRECT PID CONTROL (SETUP #8 OR SETUP #10)

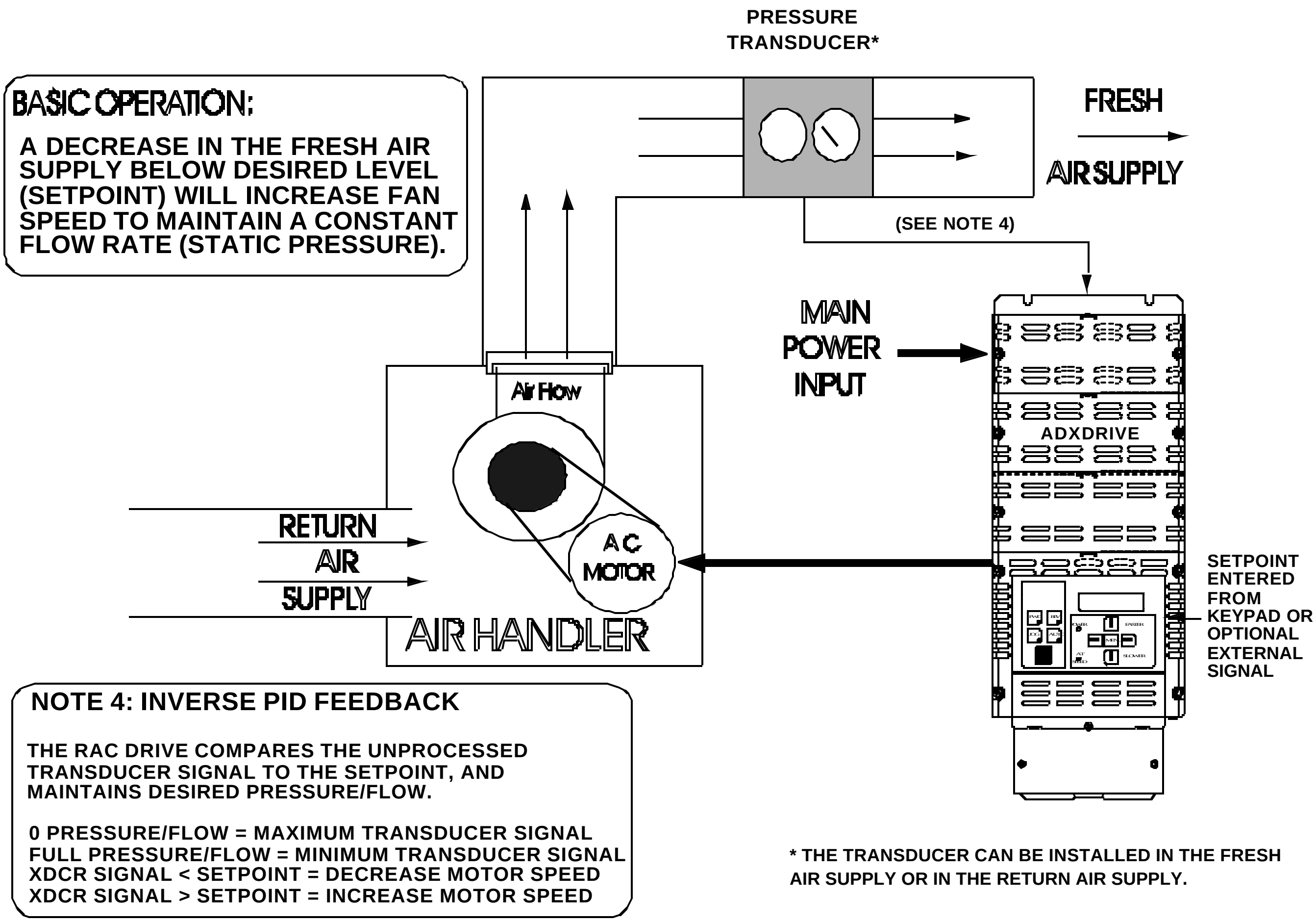
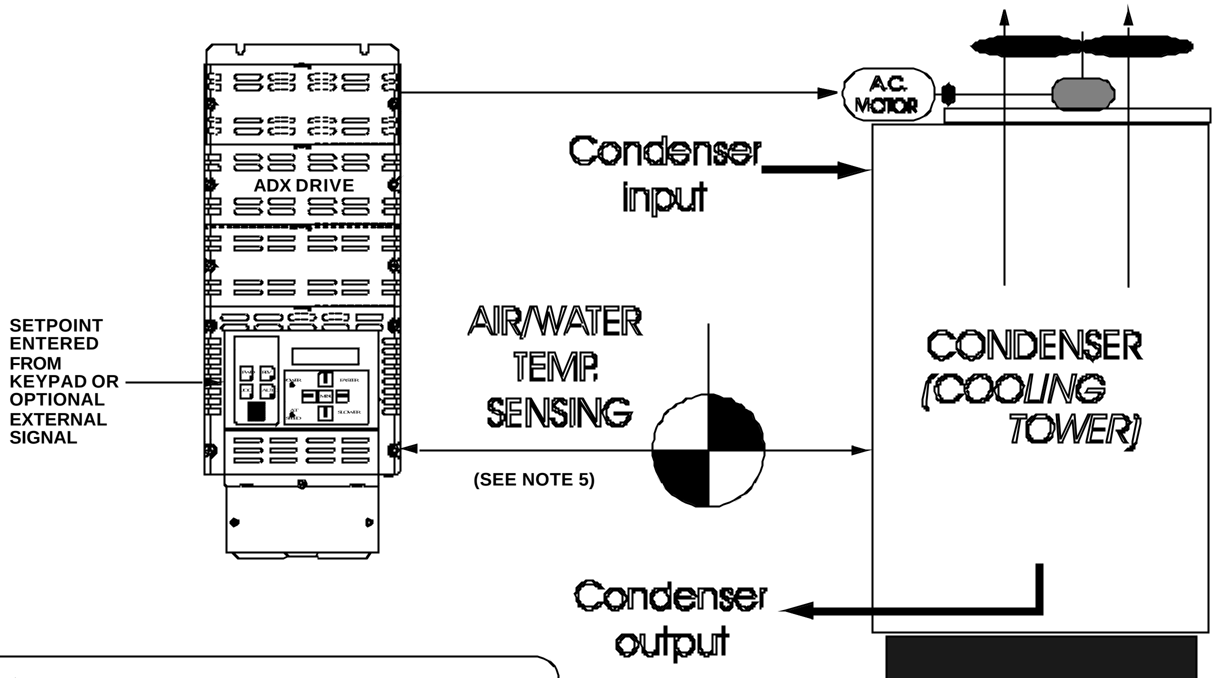


FIGURE 7-8. TYPICAL EXAMPLE OF AN AIR HANDLING APPLICATION USING INVERSE PID CONTROL (SETUP #9 OR SETUP #11)

Application Example For Setups #9 & #11



BASIC OPERATION:

AS THE TEMPERATURE INCREASES ABOVE THE DESIRED SETTING (SETPOINT), THE FAN SPEED WILL INCREASE TO MAINTAIN A CONSTANT TEMPERATURE IN THE COOLING TOWER.

NOTE 5: INVERSE PID CONTROL

THE ADX DRIVE COMPARES THE UNPROCESSED TRANSDUCER SIGNAL TO THE SETPOINT, AND MAINTAINS DESIRED PRESSURE/TEMPERATURE.

0 PRESSURE/LOW TEMP= MINIMUM TRANSDUCER SIGNAL
FULL PRESSURE/TEMP = MAXIMUM TRANSDUCER SIGNAL
XDCR SIGNAL < SETPOINT = DECREASE MOTOR SPEED
XDCR SIGNAL > SETPOINT = INCREASE MOTOR SPEED

FIGURE 7-9. TYPICAL EXAMPLE OF A COOLING APPLICATION USING INVERSE PID CONTROL (SETUP #9 OR SETUP #11)

Preprogrammed Setup Wiring Diagram

Notes:

1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. The logic shown is for external control of Run/Stop and Auto/Manual. For local (keypad) control, first change Setup Number Parameter 695 to zero, and then change Starting Mode Parameter 580 to NORMAL, change Digital Input #1 Parameter 550 to NONE, and change Start Inputs Parameter 579 to KEY-PAD ONLY.
4. For Direct or Inverse PID Control (Setups 8 - 11), change Restart Tries Parameter 581 to zero.
5. Acceleration and deceleration are enabled only in the Manual mode. When Terminal 3 is connected to Terminal 7 on TB1 (Auto mode), acceleration and deceleration are disabled.

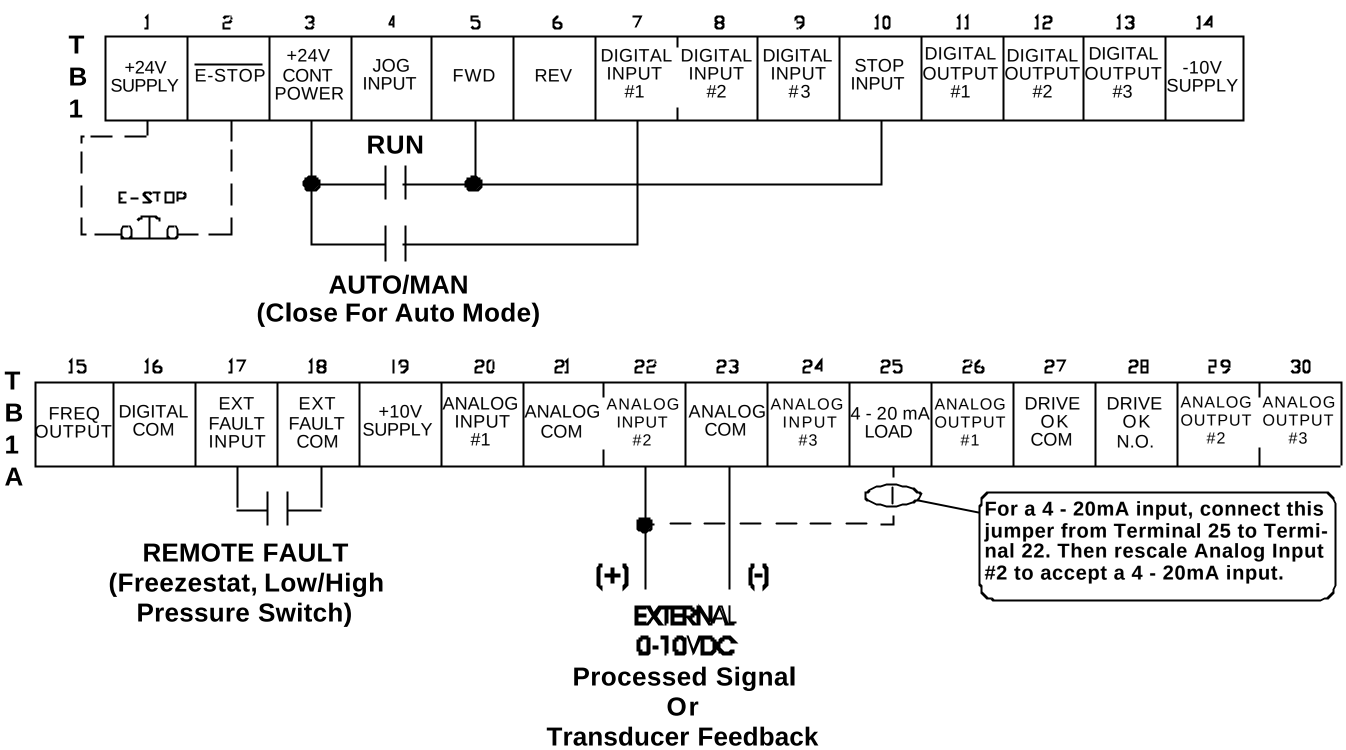


FIGURE 7-10. TYPICAL WIRING DIAGRAM FOR APPLICATIONS WITH DIRECT FOLLOWER CONTROL (SETUP #6), INVERSE FOLLOWER CONTROL (SETUP #7), DIRECT PID CONTROL (SETUP #8 OR #10), OR INVERSE PID CONTROL (SETUP #9 OR #11)

Notes:
1. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
2. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.
3. The logic shown is for external control of Run/Stop and Auto/Manual. For local (keypad) control, first change Setup Number Parameter 695 to zero, and then change Starting Mode Parameter 580 to NORMAL, change Digital Input #1 Parameter 550 to NONE, and change Start Inputs Parameter 579 to KEY-PAD ONLY.

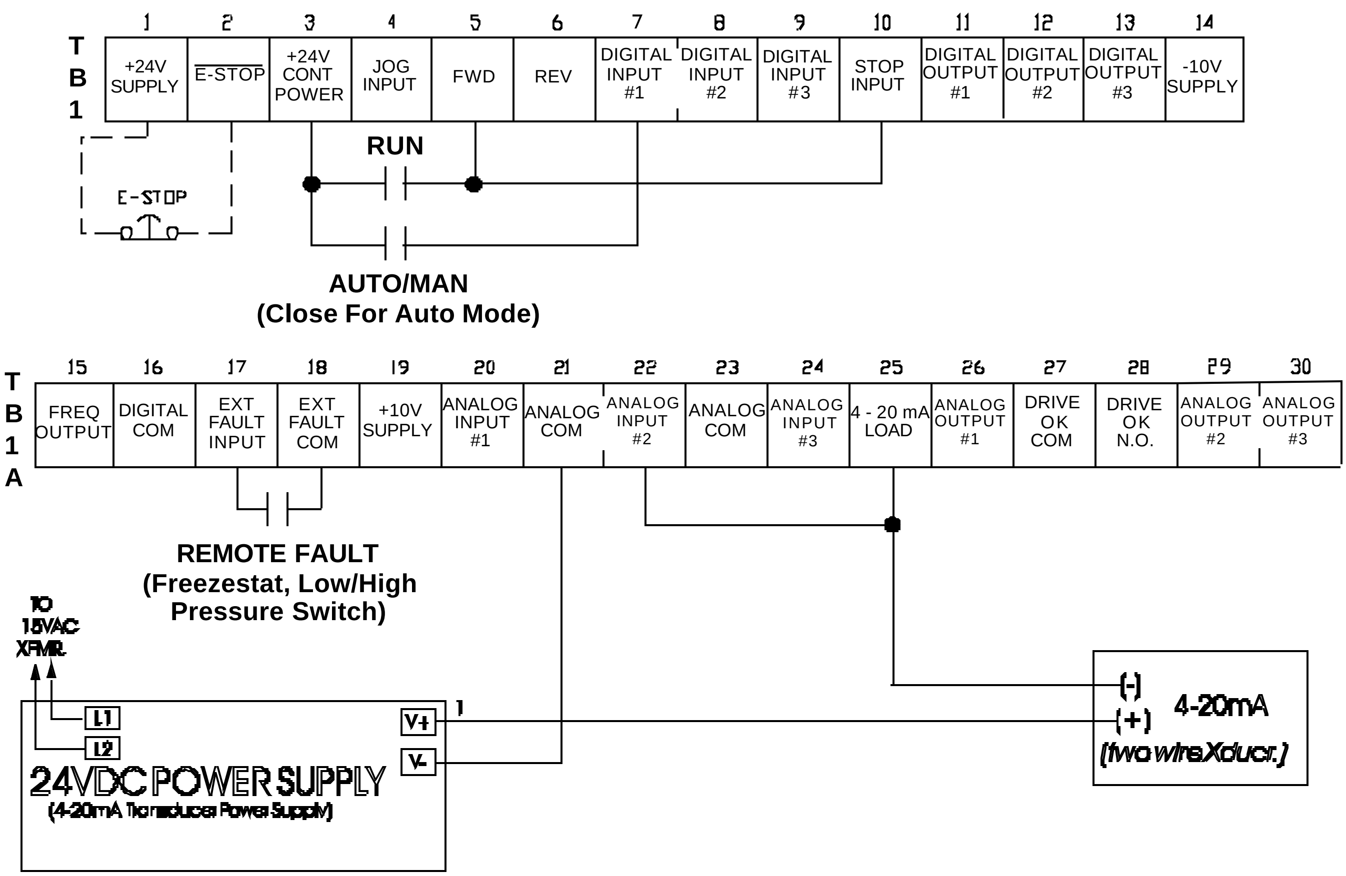


FIGURE 7-11. TYPICAL WIRING DIAGRAM FOR A TWO-WIRE TRANSDUCER WITH AN EXTERNAL POWER SUPPLY

SELECTING A PREPROGRAMMED SETUP

To use one of the preprogrammed setups, select the appropriate setup number in Setup Number Parameter 695, as follows:

Note: If Setup Number 6, 7, 8, 9, 10, or 11 is to be selected, Setup #12 must first be selected to enable Line Starting. Setup Number 6 - 11 may then be selected.

1. Set the Setup Number (Parameter 695), located in the Setup Group Menu, to the desired setup number (see "Accessing Parameters," page 4-9).

2. Push the MENU key to accept the setup. The display should read:

```
RESET DRIVE NOW?
RESET REQUIRED
```

3. When the bottom line of the display reads YES, push the MENU key to enter the selected setup into the controller memory.

The parameters affected by the preprogrammed setups are listed in Tables 7-1 and 7-2, page 7-17.

CHANGING PARAMETER VALUES FROM PREPROGRAMMED SETUP MODE

When a preprogrammed setup has been entered into the controller memory, the controller prevents certain parameter values from being changed from the keypad. To change any of these locked parameter values, proceed as follows:

1. Set the Setup Number (Parameter 695), located in the Setup Group Menu, to zero. This will maintain all parameter values that were changed when a preprogrammed setup was selected, but will allow changes to be made to any parameter value in the ADX menu structure.

2. Push the MENU key to accept the zero value.

3. Change the desired parameter values.

4. Save all changed parameter values (see "Saving Parameter Values," page 4-10).

   Note: If a preprogrammed setup number is re-entered into Setup Number Parameter 695, all parameter values will change to the preprogrammed setup number parameter values.

Table 7-1: PREPROGRAMMED SETUP NUMBER MATRIX

Setup Number	0	1	2	3	4	5	13
Analog Out1 Src 530	No Change	No Change	No Change	No Change	No Change	No Change	Output Freq
Analog Out1 Scale 534	No Change	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%
DIN1 Function 550	No Change	Faster	None	None	Auto/Mnl	Auto/Mnl	None
DIN1 Function 551	No Change	Slower	None	None	None	None	None
AIN2 Invert 565	No Change	Normal	Normal	Normal	Normal	Normal	Normal
AIN2 Offset Mode 566	No Change	Zero Below	Zero Below	Zero Below	Zero Below	Zero Below	Zero Below
AIN2 Offset 567	No Change	20.00%	20.00%	20.00%	2.00%	20.00%	20.00%
AIN2 Scale 568	No Change	123.58%	123.58%	123.58%	100.00%	123.58%	123.58%
AIN2 Filter 569	No Change	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%
Start Inputs 579	No Change	No Change	Remote	Remote	Remote	Remote	Keypad
Starting Mode 580	No Change	Normal	Line Start	Ln Strt/Rot Mtr	Normal	Normal	Normal
Restart Tries 581	No Change	0	0	5	0	0	0
Run Speed Source 680	No Change	Lcl Digital	Lcl Digital	Lcl Digital	Anlg In #1	Anlg In #1	Lcl Digital
PID Fdbk Source 684	No Change	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2
PID Error Source 685	No Change	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2
Auto Spd Source 689	No Change	Anlg In #1	Anlg In #1	Anlg In #1	Anlg In #2	Anlg In #2	Anlg In #1

Table 7-2: RAC PREPROGRAMMED SETUP NUMBER MATRIX

Setup Number	6	7	8	9	10	11	12
Analog Out1 Src 530	No Change	No Change	No Change	No Change	No Change	No Change	Actual Spd
Analog Out1 Scale 534	50.00%	50.00%	50.00%	50.00%	50.00%	50.00%	100.00%
DIN1 Function 550	Auto/Mnl	Auto/Mnl	Auto/Mnl	Auto/Mnl	Auto/Mnl[a]	Auto/Mnl[a]	None
DIN1 Function 551	None	None	None	None	None	None	None
AIN2 Invert 565	Normal	Invert	Normal	Invert	Normal	Invert	Normal
AIN2 Offset Mode 566	Zero Below	Negate Blw	Zero Below	Negate Blw	Zero Below	Negate Blw	Zero Below
AIN2 Offset 567	2.00%	100.00%	20.00%	100.00%	20.00%	100.00%	20.00%
AIN2 Scale 568	100.00%	100.00%	123.58%	123.58%	123.58%	123.58%	123.58%
AIN2 Filter 569	5.00%	5.00%	100.00%	100.00%	100.00%	100.00%	5.00%
Start Inputs 579	Remote	Remote	Remote	Remote	Remote	Remote	Remote
Starting Mode 580	No Change	No Change	No Change	No Change	No Change	No Change	Line Start
Restart Tries 581	5	5	5	5	5	5	0
Run Speed Source 680	Lcl Digital	Lcl Digital	Lcl Digital	Lcl Digital	PID Cont	PID Cont	Lcl Digital
PID Fdbk Source 684	Rmt Digital	Rmt Digital	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Rmt Digital
PID Error Source 685	Rmt Digital	Rmt Digital	Anlg In #2	Anlg In #2	Anlg In #2	Anlg In #2	Rmt Digital
Auto Spd Source 689	Anlg In #2	Anlg In #2	PID Cont	PID Cont	PID Cont	PID Cont	Anlg In #1

a. Acceleration/deceleration are enabled only in the Manual mode with Setups 10 and 11. See the footnote on page 7-7.

CHANGING THE SPEED REFERENCE SIGNAL

If the ADX controller has been programmed with Setup Number 6 or 7, it will be set up for operation with a 0 - 10 VDC speed reference signal. However, the controller can be reconfigured for operation with a 4 - 20 mA speed reference signal by following the instructions below.

If the controller has been programmed with Setup Number 8, 9, 10 or 11, it will be set up for operation with a 4 - 20 mA speed reference signal. However, the controller can be reconfigured for operation with a 0 - 10 VDC speed reference by following the instructions below.

CHANGING FROM 0 - 10 VDC TO 4 - 20 mA SPEED REFERENCE SIGNAL

1. Turn-off power to the ADX controller.

2. Connect the controller for a 4 - 20 mA speed reference signal as shown in Figure 7-10 (page 7-14) or Figure 7-11 (page 7-15), as applicable.

3. Turn-on power to the controller.

4. Set the Setup Number (Parameter 695), located in the Setup Group Menu, to 0.

5. Push the MENU key. The display should read as follows:

```
RESET DRIVE NOW?
RESET REQUIRED
```

6. Select YES, and then push the MENU key again to save the change.

7. Set the Anlg In2 Offset (Parameter 567), located in the Setup Group Menu - Analog Inputs Menu, to 20.00% for Setup #6 or to 100.00% for Setup #7.

8. Push the MENU key to accept the change.

9. Set the Anlg In2 Scale (Parameter 568), located in the Setup Group Menu - Analog Inputs Menu, to 123.58%.

10. Push the MENU key to accept the change.

11. Save the changes as described in “Saving Parameter Values,” page 4-10.

CHANGING FROM 4 - 20 mA TO 0 - 10 VDC SPEED REFERENCE SIGNAL

1. Turn-off power to the ADX controller.

2. Connect the controller for a 0 - 10 VDC speed reference signal as shown in Figure 7-10 (page 7-14) or Figure 7-11 (page 7-15), as applicable.

3. Turn-on power to the controller.

4. Set the Setup Number (Parameter 695), located in the Setup Group Menu, to 0.

5. Push the MENU key. This display should read as follows:

```
RESET DRIVE NOW?
RESET REQUIRED
```

6. Select YES, and then push the MENU key again to save the change.

7. Set the Anlg In2 Offset (Parameter 567), located in the Setup Group Menu - Analog Inputs Menu, to 2.00% for Setup #8 or #10, or to 100.00% for Setup #9 or #11.

8. Push the MENU key to accept the change.

9. Set the Anlg In2 Scale (Parameter 568), located in the Setup Group Menu - Analog Inputs Menu, to 100.00%.

10. Push the MENU key to accept the change.

11. Save the changes as described in "Saving Parameter Values," page 4-10.

SPEED CONTROL POTENTIOMETER

If a manual speed control potentiometer is desired follow the instructions below.

1. Turn-off power to the ADX controller.

2. Connect the potentiometer to the controller as shown in Figure 7-3, page 7-4.

3. Turn-on power to the controller.

4. Set the Setup Number (Parameter 695), located in the Setup Group Menu, to 0.

5. Push the MENU key. This display should read as follows:

```
RESET DRIVE NOW?
RESET REQUIRED
```

6. Select YES, and then push the MENU key again to save the change.

7. Set the Run Speed Source (Parameter 680), located in the Setup Group Menu - Control Sources Menu, to ANALOG INPUT #1.

8. Push the MENU key to accept the selection.

9. Save the change as described in “Saving Parameter Values,” page 4-10.

ADJUSTMENTS

By changing the values of the parameters listed in Table 7-3 (below), the preprogrammed setups can be ‘fine tuned’ for a specific application. **However, for most applications, changing parameter values should not be needed.**

Adjustments made to parameters in the User Group are saved in the controller memory when the MENU key is pushed. Adjustments made to parameters that are not in the User Group can only be saved by following the instructions under, “Saving Parameter Values,” page 4-10.

For instructions on accessing parameters in the menu structure, see “Accessing Parameters,” page 4-9.

The suggested starting values shown in Table 7-3 will provide acceptable system operation for most applications.

Table 7-3: ADJUSTMENT PARAMETERS FOR PREPROGRAMMED SETUPS

PARAMETER		MENU LOCATION	SUGGESTED STARTING VALUE
NUMBER	NAME		
250	RUN ACCEL[a]	USER GROUP	10.0 Seconds
259	RUN DECEL[a]	USER GROUP	10.0 Seconds
580	STARTING MODE[b]	SETUP GROUP STARTING CONTROL	LN STRT/ROT MTR

a. For Setups 6 and 7, Run Accel/Decel will affect both Auto and Manual modes. For Setups 8, 9, 10, and 11, Run Accel/Decel will affect only the Manual mode.

b. For Setups 1 through 5, the Starting Mode cannot be changed without first changing Setup Number Parameter 695 to zero.

Save all changed parameter values.

PID ADJUSTMENTS (SETUPS 8, 9, 10, & 11 ONLY)

If Preprogrammed Setup 8, 9, 10, or 11 was selected, PID adjustments will usually be required. Final PID adjustments should be made 'on line' (i.e., while the drive is operating). If additional PID adjustments are required that are not covered in this section, see Section VIII, "PID Control."

Adjustments made to parameters in the User Group are saved in the controller memory when the MENU key is pushed. Adjustments made to parameters that are not in the User Group can only be saved by following the instructions under, "Saving Parameter Values," page 4-10.

For instructions on accessing parameters in the menu structure, see "Accessing Parameters," page 4-9.

Preliminar PID Adjustments

Suggested starting values for PID adjustments are shown in Table 7-4.

Table 7-4: PID PRELIMINARY PARAMETER VALUES

PARAMETER		MENU LOCATION	SUGGESTED STARTING VALUE	
NUMBER	**NAME**		**SETUPS 8 & 9**	**SETUPS 10 & 11**
201	PID PROP GAIN	Control Group PID Control	150.00%	50.00%
202	PID INT GAIN	Control Group PID Control	50.00%	10.00%
203	PID DERIV GAIN	Control Group PID Control	0.00%[a]	
204	PID MAX OUTPUT	Control Group PID Control	100.00%	
205	PID MIN OUTPUT	Control Group PID Control	0.00%	
684	PID FDBK SOURCE	Setup Group Control Sources	ANALOG INPUT #2	
170	PID SETPOINT	Reference Group PID Setpoint	Value of desired operating point (level)[b]	
120	MINIMUM SPEED	User Group	Value of Parameter 205[c]	
250	ACCELERATION TIME	User Group	NA	[d]
259	DECELERATION TIME	User Group	NA	[d]

a. The value of Parameter 203 must remain at 0.00%.
b. A value of 0.00% in Parameter 170 will result in near zero speed and a value of 100.00% will result in 100% speed. **Never set Parameter 170 = 0.00%.**
c. The value of Parameter 120 must always = Parameter 205 value.
d. Parameters 250 and 259 should be equal, and set to the minimum value that prevents over-current fault trips.

Save all changed parameter values.

Final PID Adjustments

The final PID adjustments should be made while the drive is in actual operation, as follows:

Note: PID Proportional Gain Parameter 201 and PID Integral Gain Parameter 202 should be increased slowly to avoid system oscillations which may stress the transducer.

1. Display the PID parameter value that is to be changed.

2. Change the parameter value in either of the following two ways:

   a. By using the or key, place the cursor beneath the up/down arrow symbol (). Then increase or decrease the value rapidly by pushing the or key, respectively. When the parameter value is changed while the motor is running, the motor will respond immediately to the changed value.

   b. By using the or key, place the cursor beneath any digit in the display. Then increase or decrease the digit by using the or key, respectively. The changed value will not affect motor speed until the cursor is moved back beneath the up/down arrow symbol () or the change is entered into the controller memory by pushing the MENU key.

If the PID Setpoint (Parameter 170) value was changed, the change must be saved into memory. **IF THE CHANGED VALUE IS NOT SAVED, THE PREVIOUS VALUE WILL RETURN WHEN POWER IS REMOVED FROM THE CONTROLLER.** See “Saving Parameter Values,” page 4-10.

SECTION VIII

PID CONTROL

PID DESCRIPTION

The ADX controller has a software proportional, integral, derivative (PID) function which can be used with external transducer signals to expand the use of the drive. The PID control is an outer control loop algorithm which provides user adjustable parameters to optimize the controller's response to an external signal. Signals which represent pressure, flow, temperature, or tension can be used with the controller to regulate these process variables through motor speed adjustments.

The basic purpose of PID control is to allow the drive to regulate a process variable such as pressure, flow, temperature, or tension by adjusting motor speed. The PID algorithm requires a setpoint which represents the desired value of the process variable. A feedback signal senses the actual value of the process variable. By comparing the setpoint to the feedback, the PID algorithm adjusts motor speed to make these values equal. The P, I, and D parameters are "tuning" constants which help the drive respond closely and quickly to changes in the process variable.

The "proportional" parameter causes a speed change in direct proportion to the "error" (error = setpoint - feedback). The "integral" parameter adjusts speed as a function of the time the feedback does not match the setpoint. "Derivative" adjustments provide a change in speed in response to the rate of change of the error. The PID automatically resets to zero when the drive is stopped.

PID MODES

There are two modes of PID control (selected by PID Mode Parameter 200), as follows:

- **Command/Feedback Input**

  This is the most commonly used mode in ADX drive applications. It compares a command source (setpoint) to a feedback source. Both sources are programmable.

- **Error Input**

  This mode is used with transducers that sum the setpoint and feedback into one error signal that is applied to the ADX controller. This type of transducer would have both a means of sensing the actual process variable (e.g., pressure), as well as a means for user adjustment of the setpoint pressure. A typical wiring diagram (Figure 8-1) and a block diagram (Figure 8-2) of the Error Input mode are shown on page 8-2.

Notes:
1. If the AUTO light is OFF, push the AUTO key on the keypad. The AUTO light must be ON.
2. If E-STOP is used, it must be a maintained contact. If E-STOP is not used, connect a jumper between TB1-1 and TB1-2.
3. TB1A-17 must be connected to TB1A-18 for the drive to operate. If an external contact is used between TB1A-17 and 18, it must be normally-closed.

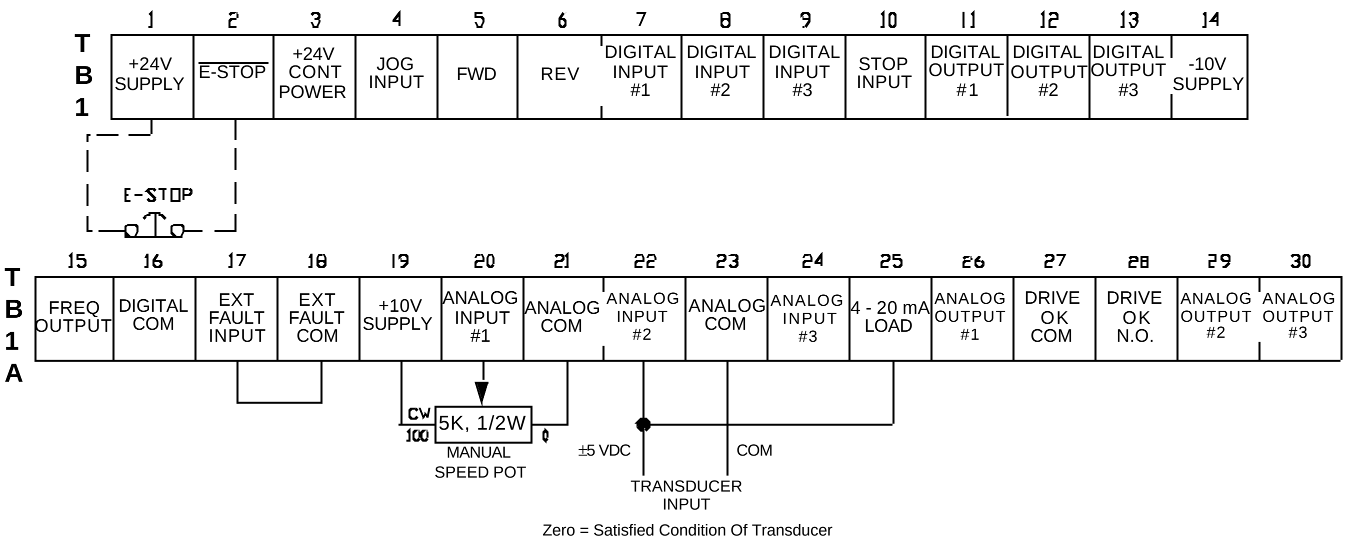


FIGURE 8 - 1. WIRING DIAGRAM, PID ERROR INPUT MODE CONNECTIONS

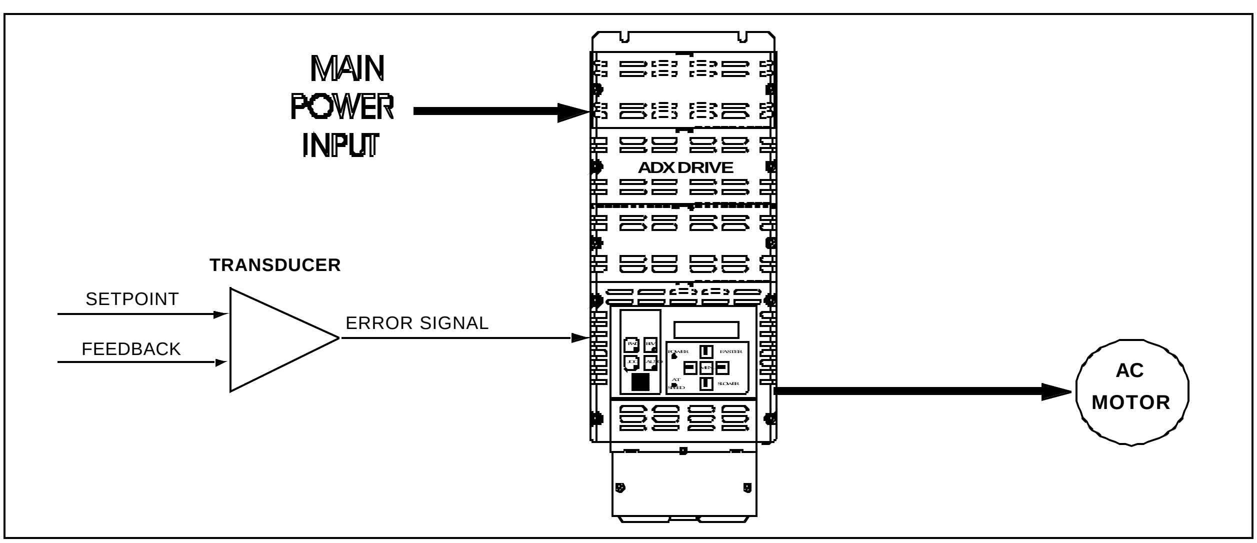


FIGURE 8 - 2. BLOCK DIAGRAM, PID ERROR INPUT MODE

PID APPLICATIONS

The most common type of PID applications for ADX controllers is process control where a transducer senses a process variable such as pressure, flow, temperature, or tension. The ADX controller, in turn, changes motor speed to regulate the process variable. The CMD/FDBK INPUT and ERROR INPUT selections in PID Mode Parameter 200 are used for process control. See "PID Process Control Setup," page 8-4.

PID INPUT SIGNAL CHARACTERISTICS

The input signals for PID control may be either digital or analog. The analog reference may be 0 - 10 VDC or 4 - 20 mA. Refer to "Analog Inputs" (page 10-2) for setup parameters. The input impedance of the analog inputs is 100K ohms. There is a +10 VDC supply available on TB1A Terminal 19 and a 4 - 20 mA (burden resistor) load available on TB1A Terminal 25. If two 4 - 20 mA sources are to be used, an external 500 ohm load resistor must be connected to analog common (TB1A Terminal 21 or 23) for the additional source. Refer to the wiring diagram on page 10-3.

PID PROCESS CONTROL SETUP

Reference: Figure 8-3, PID Set-Up Flow Chart For Process Control, Pages 8-5 & 8-6

Figure 8-3 shows the following steps. The specific parameter values are system dependent and will likely need to be adjusted.

To set-up the ADX controller PID function to control pressure, flow, temperature, or tension, do the following:

1. Connect a wire jumper between TB1 Terminals 3 and 7.
2. Configure the drive into PID control by setting Auto Speed Source Parameter 689 to PID CONTROL.
3. Set Start Inputs Parameter 579 to REMOTE ONLY.
4. Set Digital Input #1 Parameter 550 to AUTO/MANUAL.
5. Set PID Mode Parameter 200.
6. Select PID Reference (Setpoint) Source Parameter 683 and PID Feedback Source Parameter 684 or select PID Error Source Parameter 685.
7. Set PID Minimum Output Parameter 205.
8. Set PID Maximum Output Parameter 204.
9. Set PID Proportional Gain Parameter 201.
10. Set PID Integral Gain Parameter 202.
11. Set PID Derivative Gain Parameter 203 = 0.

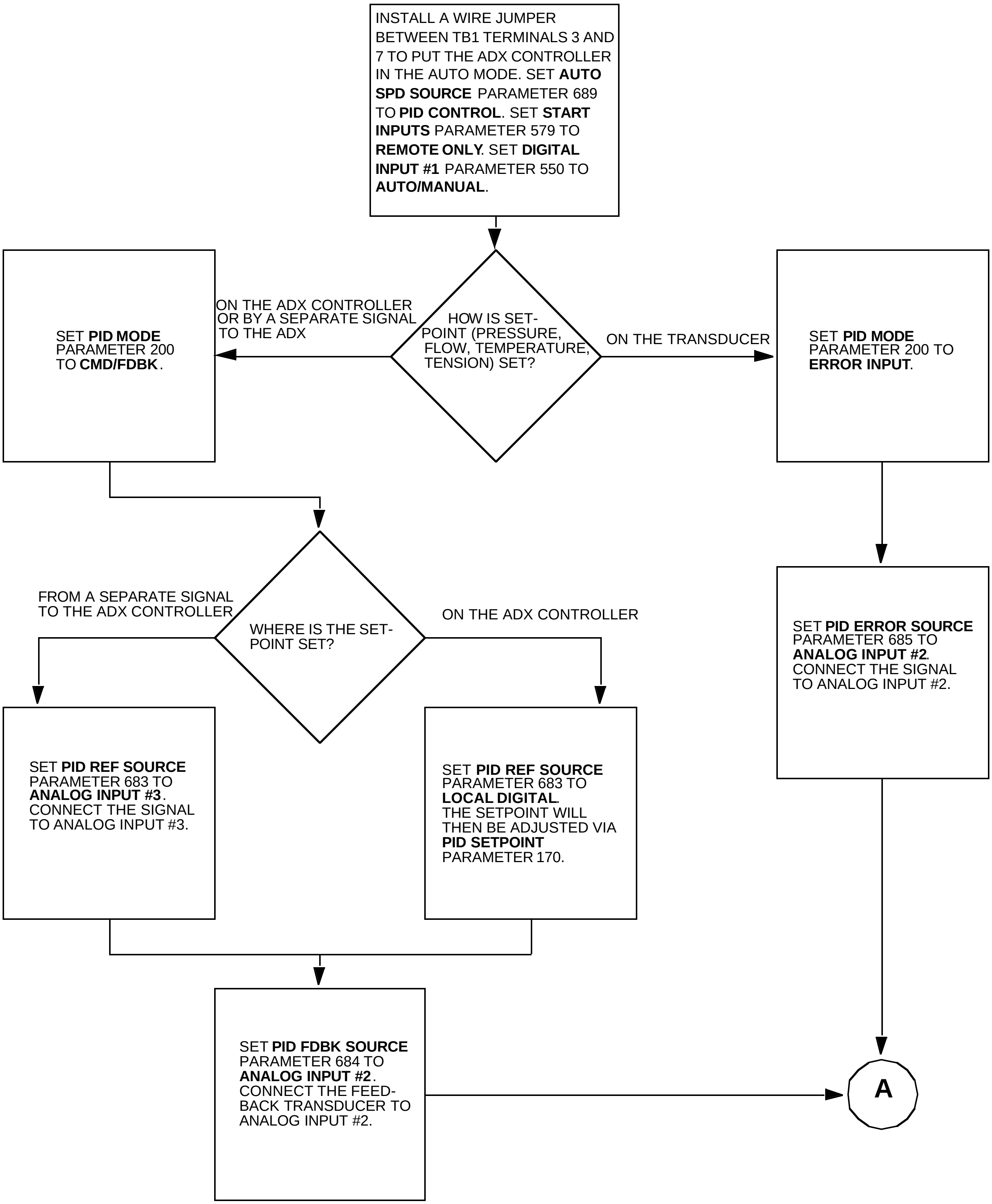


FIGURE 8 - 3. PID SET-UP FLOW CHART FOR PROCESS CONTROL (Cont'd On Next Page)

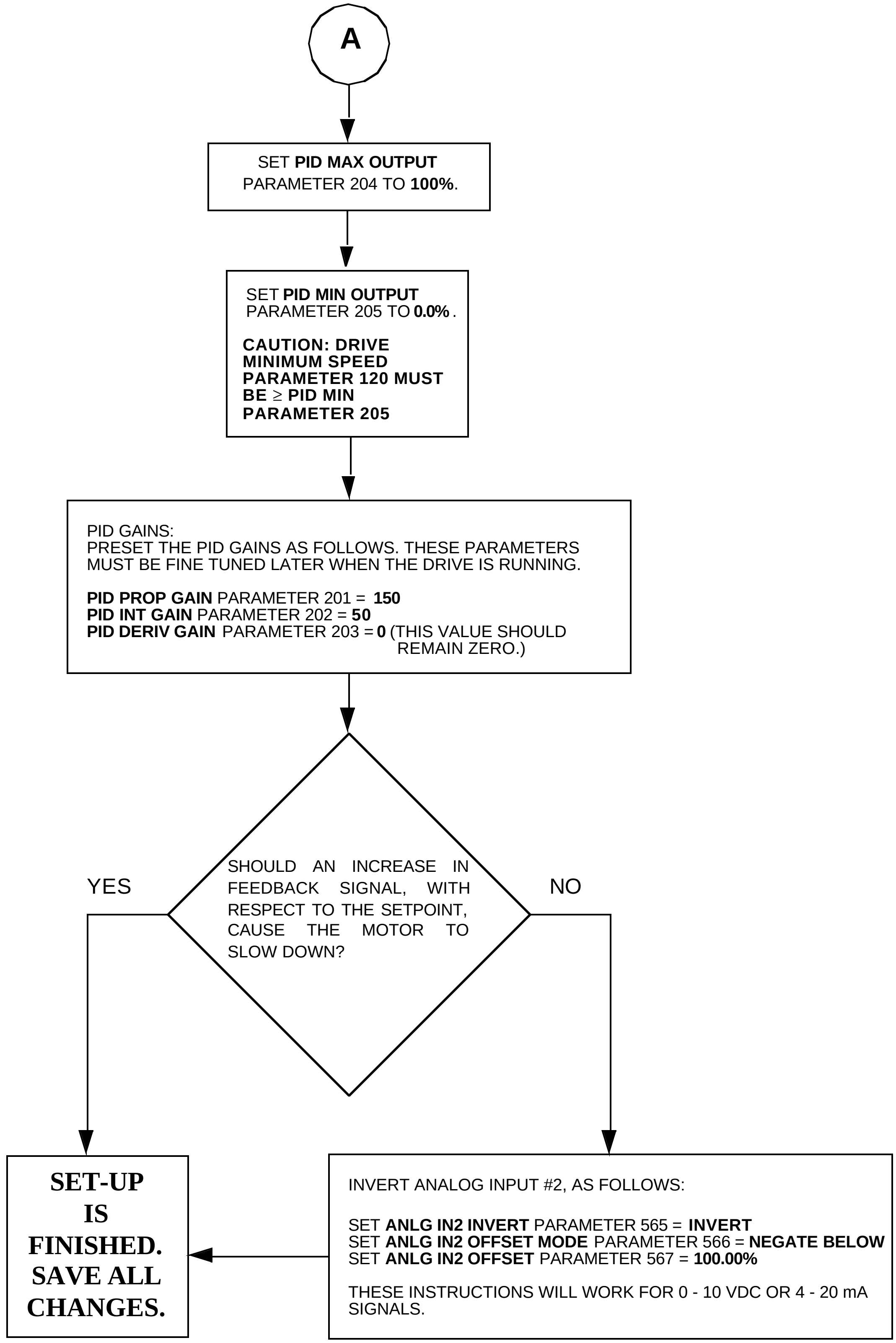


FIGURE 8 - 3. PID SET-UP FLOW CHART FOR PROCESS CONTROL (Cont'd)

PID PARAMETERS

The following is a list of parameters and menus used to program the PID control.

689 AUTO SPEED SOURCE

Selections:

- ANALOG INPUT #1 - Speed is set by an analog input.
- ANALOG INPUT #2 - Speed is set by an analog input.
- ANALOG INPUT #3 - Speed is set by an analog input.
- LOCAL DIGITAL - Speed is set by Parameter 20 through the keypad.
- REMOTE DIGITAL - Speed is set by serial port command to Parameter 21.
- PID CONTROL - Speed is controlled by PID function.

Factory Preset: ANALOG INPUT #1

Setting for PID Control: PID CONTROL

PID control will control the speed of the drive in the Auto mode. Acceleration and deceleration will be disabled.

200 PID MODE

Description of the selections can be found on page 8-1 under PID Modes.

Selections:

- CMD/FDBK INPUT - Requires setup of Parameters 683 and 684.
- ERROR INPUT - Requires setup of Parameter 685.

Factory Preset: CMD/FDBK INPUT

683 PID REF SOURCE

Selections:

- LOCAL DIGITAL - PID reference (setpoint) is set by Parameter 170 through the keypad.

Set the PID setpoint to a value between 0 and 100.00%. The value should be greater than the PID minimum output.

(Cont'd on next page.)

- ANALOG INPUT #1 - PID setpoint is set by an analog input.
- ANALOG INPUT #2 - PID setpoint is set by an analog input.
- ANALOG INPUT #3 - PID setpoint is set by an analog input.
- REMOTE DIGITAL - PID reference (setpoint) is set by serial port command to Parameter 171.

Set the PID setpoint to a value between 0 and 100.00%. The value should be greater than the PID minimum output.

Factory Preset: LOCAL DIGITAL

684 PID FDBK SOURCE (Feedback Source)

Selections:

- ANALOG INPUT #1 - PID feedback is set by an analog input.
- ANALOG INPUT #2 - PID feedback is set by an analog input.
- ANALOG INPUT #3 - PID feedback is set by an analog input.
- REMOTE DIGITAL - PID feedback is set by serial port command to Parameter 172.

Factory Preset and Setting for PID Control: ANALOG INPUT #2

685 PID ERROR SOURCE

Selections:

- ANALOG INPUT #1 - PID error is set by an analog input.
- ANALOG INPUT #2 - PID error is set by an analog input.
- ANALOG INPUT #3 - PID error is set by an analog input.
- REMOTE DIGITAL - PID error is set by serial port command to Parameter 173.

Factory Preset and Setting for PID Control: ANALOG INPUT #2

201 PID PROP GAIN (Proportional Gain)

- Minimum Value: 0
- Factory Preset Value: 0
- Maximum Value: 300.00%

Recommended starting value: 150% for process control.

Sets the proportional gain of the PID control loop.

202 PID INT GAIN (Integral Gain)

- Minimum Value: 0
- Factory Preset Value: 0
- Maximum Value: 300.00%

Recommended starting value: 50% for process control.

Sets the integral gain of the PID control loop.

The maximum and minimum values of the integrator are determined by PID Max Output Parameter 204 and PID Min Output Parameter 205, respectively. A setting of 0.01% will be the slowest response while 100.00% will be the fastest response.

203 PID DERIV GAIN (Derivative Gain)

- Minimum Value: 0
- Factory Preset Value: 0
- Maximum Value: 300.00%

Recommended starting value: 0% for process control.

Sets the derivative gain of the PID Control Loop.

204 PID MAX OUTPUT (Maximum Output)

- Minimum Value: -200.00%
- Factory Preset Value: 100.00%
- Maximum Value: 200.00%

Determines the maximum value the output of the PID loop can reach. It also sets the limit for the PID integral gain.

205 PID MIN OUTPUT (Minimum Output)

Parameter 205 must be set equal to or less than the minimum speed setting (Parameter 120).

PID applications do not normally reverse. Therefore, Parameter 205 should not be set lower than 0%.

- Minimum Value: -200.00%
- Factory Preset Value: 0.00%
- Maximum Value: 200.00%

Determines the minimum value the output of the PID loop can reach. It also sets the limit for the PID integral gain.

PID "READ ONLY" PARAMETERS

The ADX controller has several "Read Only" parameters which aid troubleshooting by showing actual values of PID control. These parameters can be accessed by the following steps.

1. Go to the Utility Group.
2. Select MONITOR FUNCTION.
2. Go to Display Line #1 Parameter 880 and set it to EXTEND MONITOR.
3. Go to Display Line #2 Parameter 881 and set it to EXTEND MONITOR.
4. Left and right arrow keys select the "Read Only" parameter to be displayed.

The PID "Read Only" parameters are listed below.

Table 8 - 1: PID READ ONLY PARAMETERS

PARAMETER			VALUE	
NO.	NAME	DESCRIPTION	MIN.	MAX.
910	PID OUTPUT	PID Regulator Output	-300.00%	300.00%
925	PID REFERENCE	PID Setpoint	-300.00%	300.00%
926	PID FEEDBACK	PID Feedback Value	-300.00%	300.00%
927	PID ERROR	PID Setpoint - Feedback	-300.00%	300.00%
928	PID INTEG	PID Integral Gain	-300.00%	300.00%
929	PID DERIV	PID Derivative Gain	-300.00%	300.00%

APPLICATION CAUTION: OVERCURRENT FAULTS

In some process control applications, overcurrent faults may occur when the drive is started. If this occurs, first reduce the setpoint to zero (this may require setting Minimum Speed Parameter 120 and PID Min Output Parameter 205 to zero). Start the drive and slowly increase the setpoint to the desired value. If tripping still occurs, the ADX controller may be undersized or incorrectly calibrated to the motor. If tripping does **not** occur then follow these steps:

1. Remove the jumper between TB1 Terminals 3 and 7 (this selects the Manual mode).
2. Set Run Speed Source Parameter 680 to PID CONTROL.
3. This change inserts acceleration and deceleration ramps into the PID function to soften starts. Adjust acceleration time through Parameter 250 and deceleration time through Parameter 259. These two values should be equal and set to the minimum value that prevents overcurrent trips. Also, proportional gain (PID Prop Gain Parameter 201) and integral gain (PID Int Gain Parameter 202) will need to be lower. Suggested settings: Parameter 201 = 50 and Parameter 202 = 10.

SECTION IX

OPERATING MODES

DESCRIPTION

The ADX drive can operate in any of the following modes, as determined by the setting of Parameter 513 (Operating Mode).

0. V/F CONST TORQ[1] (Volts/Hertz Control, Constant Torque)
1. V/F VAR TORQ (Volts/Hertz Control, Variable Torque)
2. ST CONST TORQ (Sensorless Torque Control, Constant Torque)
3. ST VAR TORQ (Sensorless Torque Control, Variable Torque)
4. VECT CONST TORQ (Closed Loop Flux Vector Control, Constant Torque)
5. VECT VAR TORQ (Closed Loop Flux Vector Control, Variable Torque)

The setting of Parameter 513 determines the values of the parameters listed in the following table:

PARAMETER	CONSTANT TORQUE MODE	VARIABLE TORQUE MODE
150 Torque Limit	150.00%	115.00%
151 Remote Torque Limit		
152 Auto Torque Limit		
153 Remote Auto Torque Limit		
504 Overload Threshold	115.00%	105.00%
505 Overload Time	60.00 Seconds	60.00 Seconds

Speed regulation, based on the setting of Parameter 513, is shown in Table 16-2, page 16-4. The speed regulation for the Closed Loop Flux Vector control mode is listed in Table 16-2 as Encoder Feedback.

The Volts/Hertz control mode provides the least accurate torque regulation at low speeds. The maximum frequency is determined by Parameters 601 through 605.

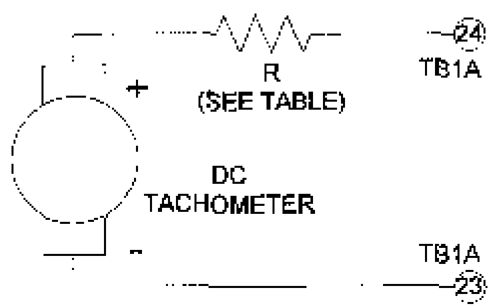
The Sensorless Torque control mode provides improved torque regulation over a broad speed range (typically 50:1) through the use of a software based motor model. This model uses values set by the user for Full Load Speed (Parameter 590), Motor Horsepower (Parameter 591), Motor Efficiency (Parameter 592), Motor Frequency (593), and Motor Rated Amps (Parameter 594) to calculate the values for the Motor Model Parameters (596 - 599). Therefore, the values entered into Parameters 590 - 594 are critical for sensorless torque operation. For most applications, the motor model parameters do not need further adjustment. However, for high performance applications, the motor model parameters can be manually adjusted for optimum performance. For more information, contact the factory.
The maximum speed for sensorless torque control is determined by Parameter 590 (Motor Full Load Speed).

1. Factory preset selection.

The Closed Loop Flux Vector control mode provides the best torque regulation over a broad speed range (typically 100:1) by using the sensorless torque motor model parameters with the addition of speed feedback (see below). The maximum speed is determined by Parameter 590 (Motor Full Load Speed).

Closed Loop Flux Vector control requires a speed feedback device, usually an encoder or DC tachometer generator. When Parameter 513 (Operating Mode) is set for VECT CONST TORQ or VECT VAR TORQ, the ADX controller will be configured automatically to use encoder feedback. If this selection is made, Option EP (Encoder Feedback) or a DC tachometer generator (see the following paragraph) must be used with the ADX controller, and Parameter 750 (Encoder Mode) must be set to FEEDBACK ONLY or to FDBK & MASTER. Refer to the Instruction Sheet (ISP0795) supplied with Option EP for additional information on encoder feedback.

If a DC tachometer generator is used for speed feedback, connect it as shown below. Select an external scaling resistor from the following table, and adjust Parameter 573 (Anlg In3 Scale) as shown in the table. To enable DC Tachometer Feedback, set Parameter 591 (Speed Feedback Source) to ANALOG INPUT #3.



MOTOR MAXIMUM SPEED	DC TACHOMETER VOLTAGE	RESISTOR (R) VALUE	PARAMETER 573 ANLG IN3 SCALE
1800 RPM	50V/1000 RPM	1 Meg Ohm	114.00%
3600 RPM	50V/1000 RPM	2 Meg Ohms	108.00%
1800 RPM	100V/1000 RPM	2 Meg Ohms	108.00%
3600 RPM	100V/1000 RPM[a]	[a]	[a]

a. Not recommended. Use a 50V/1000 RPM tachometer.

SECTION X

SPECIAL FEATURES

This section describes ADX drive features that can be used to adapt the drive to special applications.

Before attempting to change parameter values in the ADX Menu, be sure the instructions in Section IV, “The ADX Menu Structure,” are fully understood.

ANALOG INPUTS

DESCRIPTION

Three analog signal inputs are provided. The three input signals may be grounded or ungrounded, but must be referenced to common. These inputs can be programmed to accept one each of any of the following:

- Run Speed Command
- Jog Speed Command
- Torque Limit
- PID Reference
- PID Feedback
- PID Error
- Speed Ratio
- Speed Trim
- Auto Speed Command
- Auto Torque Limit
- Speed Feedback
- None (input is unused)

Each analog input may be programmed for offset, scaling, and inverse operation. These operations are applied to the input signal in the sequence of offset, scaling, and inversion. Analog Inputs #1 and #3 are factory preset for a 0 - ±10 VDC input, producing 0 to 100% speed. Analog Input #2 is factory preset for a 4 - 20 mA input, producing 0 to 100% speed.

WIRING

The analog inputs are available at the control board Terminal Board (TB1) on the following terminals:

TB1A TERMINAL	
NAME	**NUMBER**
Analog Input #1	20
Common	21
Analog Input #2	22
Common	23
Analog Input #3	24

4 - 20 mA Input

The analog inputs can be converted to accept 4 - 20 mA signals instead of 0 - ±10 VDC, as follows:

1. Analog Input #2 (For a single input, this is the preferred method)

   a. Jumper TB1A Terminals 22 and 25. Refer to the wiring diagram on page 9-3.

   b. Connect 4 - 20 mA signal to TB1A Terminals 22(+) and 23(-).

   c. Set Parameter 567 (Analog Input #2 Offset) to 20.00.

   d. Set Parameter 568 (Analog Input #2 Scale) to 123.58.

2. Analog Input #1

   a. Connect a 500 ohm, 1/4 watt resistor to TB1A Terminals 20 and 23. See the following wiring diagram.

   b. Connect 4 - 20 mA signal to TB1A Terminals 20(+) and 21(-).

   c. Set Parameter 562 (Analog Input #1 Offset) to 20.00.

   d. Set Parameter 563 (Analog Input #1 Scale) to 123.58.

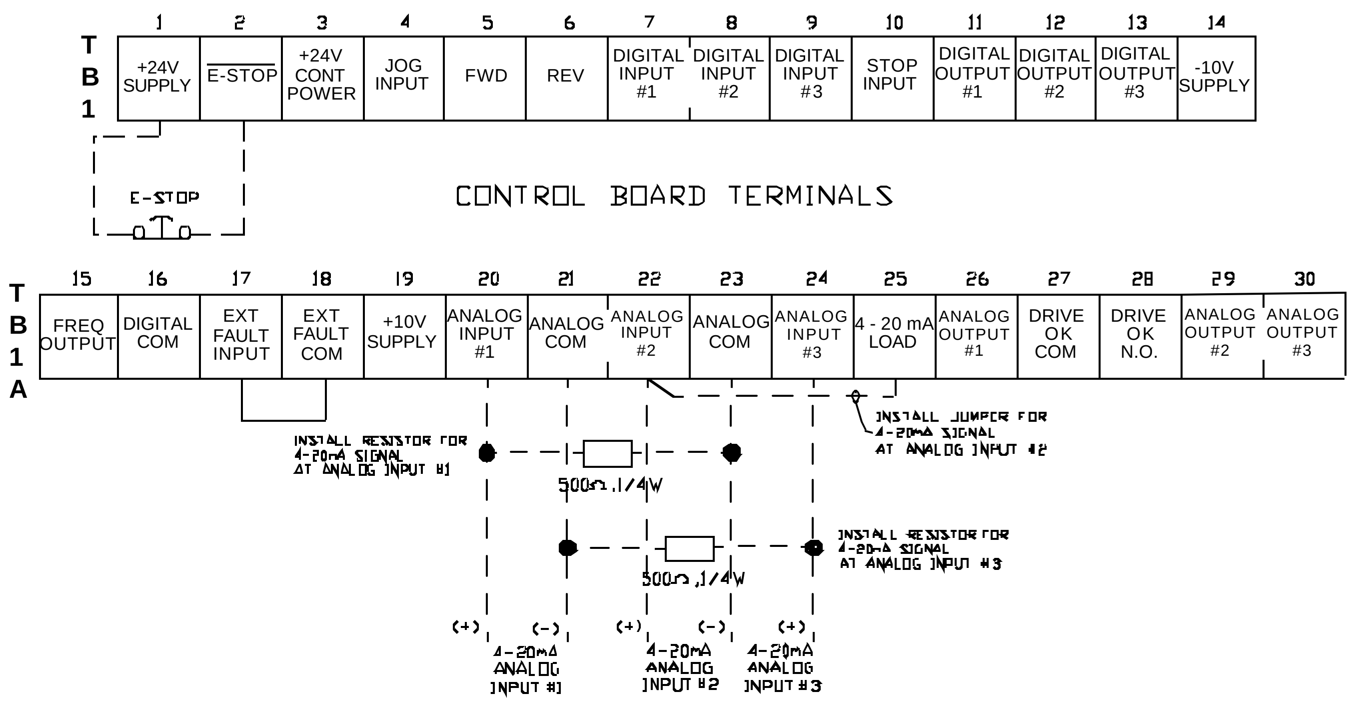
3. Analog Input #3

   a. Connect a 500 ohm, 1/4 watt resistor to TB1A Terminals 21 and 24. See the following wiring diagram.

   b. Connect 4 - 20 mA signal to TB1A Terminals 21 (-) and 24 (+).

   c. Set Parameter 572 (Analog Input #3 Offset) to 20.00.

   d. Set Parameter 573 (Analog Input #3 Scale) to 123.58.



WIRING DIAGRAM, ANALOG INPUTS

SETUP

The following fifteen Parameters (560 - 574) are used to program the analog inputs. These parameters are part of the Setup Group and are located in the Analog Inputs Menu.

560 - 564 ANALOG INPUT #1

Analog Input #1 is factory scaled for a 0 - $\pm$10 VDC input producing a 0 to 100.00 percent value in Parameter 442 (Analog Input #1).

560 ANLG IN1 INVERT (Analog Input #1 Invert)

Selections:

- INVERT (Scaled input is inverted, i.e., multiplied by -1)
- NORMAL (Scaled input is not inverted)

Factory Preset: NORMAL

561 ANLG IN1 OFST MD (Analog Input #1 Offset Mode)

Selections:

- ZERO BELOW (Offset cannot produce negative values)
- NEGATE BELOW (Offset can produce negative values)

Factory Preset: ZERO BELOW

562 ANLG IN1 OFFSET (Analog Input #1 Offset)

- Minimum Value: -300.00%
- Factory Preset Value: 2.00%
- Maximum Value: 300.00%

Percentage of full scale input subtracted from the input voltage before scaling. Preset setting for 0 - 10 VDC input.

For a bi-directional (zero center) potentiometer:

1. Set Anlg In1 Offset (Parameter 562) to 50%

2. Set Anlg In1 Ofst Md (Parameter 561) to NEGATE BELOW

3. Set Anlg In1 Scale (Parameter 563) to 200%

563 ANLG IN1 SCALE (Analog Input #1 Scale)

- Minimum Value: 0.00
- Factory Preset Value: 100.00%
- Maximum Value: 327.67%

Allows scaling of the analog input to compensate for input voltages less than 10 VDC, full scale input other than 100%, or input offset setting. Normal setting is 100%.

564 ANLG IN1 FILTER (Analog Input #1 Filter)

- Minimum Value: 0.10%
- Factory Preset Value: 5.00%
- Maximum Value: 100.00%

Controls the amount of Low Pass Filtering of Analog Input #1. Lower values provide greater filtering of the analog input. A value of 100.00% will provide no filtering of Analog Input #1. The factory preset value of 5.00% provides adequate filtering for potentiometer setpoint inputs. If the analog input will be used as feedback for the PID control loop, a higher setting (perhaps even 100.00%) will be required.

565 - 569 ANALOG INPUT #2

Analog Input #2 is factory scaled for a 4 - 20 mA input producing a 0 to 100.00 percent value in Parameter 452 (Analog Input #2).

565 ANLG IN2 INVERT (Analog Input #2 Invert) - Same as Parameter 560.

566 ANLG IN2 OFST MD (Analog Input #2 Offset Mode) - Same as Parameter 561.

567 ANLG IN2 OFFSET (Analog Input #2 Offset)

- Minimum Value: -300.00%
- Factory Preset Value: 20.00%
- Maximum Value: 300.00%

Percentage of full scale input subtracted from the input voltage before scaling. Preset setting for 4 - 20 mA input.

568 ANLG IN2 SCALE (Analog Input #2 Scale)

- Minimum Value: 0
- Factory Preset Value: 123.58%
- Maximum Value: 327.67%

Allows scaling of the analog input to compensate for input voltages less than 10 VDC, full scale input other than 100%, or input offset setting. Normal setting is 123.58% for a 4 - 20 mA input.

569 ANLG IN2 FILTER (Analog Input #2 Filter) - Same as Parameter 564.

570 - 574 ANALOG INPUT #3

Analog Input #3 is factory scaled for a 0 - ±10 VDC input producing a 0 to 100.00 percent value in Parameter 462 (Analog Input #3).

570 ANLG IN3 INVERT (Analog Input #3 Invert) - Same as Parameter 560.

571 ANLG IN3 OFST MD (Analog Input #3 Offset Mode) - Same as Parameter 561.

572 ANLG IN3 OFFSET (Analog Input #3 Offset)

- Minimum Value: -300.00%
- Factory Preset Value: 2.00%
- Maximum Value: 300.00%

Percentage of full scale input subtracted from the input voltage before scaling. Preset setting for 0-10 VDC input.

For a bi-directional (zero center) potentiometer:

1. Set Anlg In3 Offset (Parameter 572) to 50%

2. Set Anlg In3 Ofst Md (Parameter 571) to NEGATE BELOW

3. Set Anlg In3 Scale (Parameter 573) to 200%

573 ANLG IN3 SCALE (Analog Input #3 Scale) - Same as Parameter 563.

574 ANLG IN3 FILTER (Analog Input #3 Filter) - Same as Parameter 564.

Analog Inputs

The analog inputs can be programmed to control any three signals from the list under “Description” on page 9-2. To do this, access the appropriate parameter from the list below, and select Analog Input #1, Analog Input #2 or Analog Input #3 from that parameter’s selections. These parameters are part of the Setup Group and are located in the Control Sources Menu.

- 680 RUN SPEED SOURCE
- 681 JOG SPEED SOURCE
- 682 TORQUE LIMIT SOURCE
- 683 PID REFERENCE SOURCE
- 684 PID FEEDBACK SOURCE
- 685 PID ERROR SOURCE
- 686 SPEED RATIO SOURCE
- 687 SPEED TRIM SOURCE
- 689 AUTO SPEED SOURCE
- 690 AUTO TORQUE SOURCE
- 691 SPEED FEEDBACK SOURCE

ANALOG OUTPUTS

DESCRIPTION

Three analog outputs,[1] each rated 0 to 10 VDC at 2 mA, are provided. Each output can be programmed to follow any one of the following parameters:

- Output Frequency
- None
- Motor Voltage
- Motor Load
- Motor Current
- Analog Input #3
- Analog Input #2
- Analog Input #1
- Acceleration Ramp
- Actual Speed (RPM)
- Torque Reference
- Speed Trim
- Speed Ratio
- Speed Command
- Remote Digital (a parameter set through the serial port)
- Power
- PID Reference
- PID Output
- PID Feedback
- PID Error

The analog output may be programmed for offset, scaling, and inverse. The output may be used with external meters or as a speed reference for other drives in a system.

WIRING

The analog outputs are available at Terminals 26, 29, and 30 on Terminal Board TB1A.

SETUP

The following twelve parameters are used to configure the analog outputs. These parameters are part of the Setup Group and are located in the Annunciation Menu.

1. Some controllers may have only one analog output, which may be increased to three analog outputs with the use of the optional Analog Output Expansion Board.

530, 531, 533, and 534 ANALOG OUTPUT #1

530 ANLG OUT1 SOURCE (Analog Output #1 Source)

Selections:

- ACTUAL SPEED (Parameter 958)
- ACCEL RAMP (Parameter 904)
- ANALOG INPUT #1 (Parameter 442)
- ANALOG INPUT #2 (Parameter 452)
- ANALOG INPUT #3 (Parameter 462)
- MOTOR CURRENT (Parameter 936)
- MOTOR LOAD (Parameter 932)
- MOTOR VOLTAGE (Parameter 962)
- NONE
- OUTPUT FREQ (Parameter 944)
- PID ERROR (Parameter 927)
- PID FEEDBACK (Parameter 926)
- PID OUTPUT (Parameter 910)
- PID REFERENCE (Parameter 925)
- POWER (Parameter 963)
- REMOTE DIGITAL (Parameter 535)
- SPEED COMMAND (Parameter 903)
- SPEED RATIO (Parameter 916)
- SPEED TRIM (Parameter 955)
- TORQUE REF (Parameter 931)

Factory Preset: OUTPUT FREQ

531 ANLG OUT1 INVERT (Analog Output #1 Invert)

Selections:

- INVERT (Negative parameter values will produce positive analog output)
- NORMAL (Positive parameter values will produce positive analog output)

Factory Preset Selection: NORMAL

533 ANLG OUT1 OFFSET (Analog Output #1 Offset)

- Minimum Value: -300.00%
- Factory Preset Value: 0.00
- Maximum Value: 300.00%

Analog offset voltage in percent of maximum output voltage. Adjust the Analog Out1 Scale (Parameter 534) for the desired voltage swing, and then adjust the Analog Out1 Offset (Parameter 533) for the desired output level (typically zero volts).

534 ANLG OUT1 SCALE (Analog Output #1 Scale)

- Minimum Value: 0.00
- Factory Preset Value: 100.00%
- Maximum Value: 327.67%

Allows scaling of the analog output to meet output voltage requirements. The factory preset value produces a 0 to $\pm$10 VDC output.

536, 537, 539, and 540 ANALOG OUTPUT #2

536 ANLG OUT2 SOURCE (Analog Output #2 Source) **-** Same as Parameter 530.

537 ANLG OUT2 INVERT (Analog Output #2 Invert) **-** Same as Parameter 531.

539 ANLG OUT2 OFFSET (Analog Output #2 Offset) **-** Similar to Parameter 533, except as follows:

Adjust the Analog Out2 Scale (Parameter 540) for the desired voltage swing, and then adjust the Analog Out2 Offset (Parameter 539) for the desired output level (typically zero volts).

540 ANLG OUT2 SCALE (Analog Output #2 Scale) **-** Same as Parameter 534.

542, 543, 545, and 546 ANALOG OUTPUT #3

542 ANLG OUT3 SOURCE (Analog Output #3 Source) **-** Same as Parameter 530.

543 ANLG OUT3 INVERT (Analog Output #3 Invert) **-** Same as Parameter 531.

545 ANLG OUT3 OFFSET (Analog Output #3 Offset) **-** Similar to Parameter 533, except as follows:

Adjust the Analog Out3 Scale (Parameter 546) for the desired voltage swing, and then adjust the Analog Out3 Offset (Parameter 545) for the desired output level (typically zero volts).

546 ANLG OUT3 SCALE (Analog Output #3 Scale) **-** Same as Parameter 534.

AUTO/MANUAL MODES

The ADX controller can be switched between two reference sources by using the Auto/Manual function. The AUTO key on the keypad toggles between the Auto mode and the Manual mode, provided Start Inputs Parameter 579 is set for KEYPAD ONLY. An LED in the AUTO key lights when the Auto mode is selected, and turns-off when the Manual mode is selected.

The auto speed source is determined by the selection made in Auto Speed Source Parameter 689. The manual speed source is determined by the selection made in Run Speed Source Parameter 680.

Switching between Auto and Manual modes can be done with an external contact connected between Terminals 3 and 7 (Digital Input #1) on Terminal Board TB1.

SETUP

1. Connect the external normally-open contact between TB1 Terminals 3 and 7.

2. Set Digital Input #1 Parameter 550 = AUTO/MANUAL.

Note: When an external contact is used for selection, the AUTO key will be disabled. However, the LED in the AUTO key will light indicating when the Auto mode is selected.

AUTO RESTART

In some applications, drive trips may occur due to temporary overloads in the process, brief power outages, etc. It may be desirable to program the controller to automatically restart after the fault. This feature is particularly beneficial in critical applications where the drive is unattended, such as water or sewage pumping applications.

SETUP

Four Parameters (580 - 583) are used to program Auto Restart. These parameters are part of the Setup Group and are located in the Starting Control Menu.

580 STARTING MODE

Selections:

- NORMAL
- LINE START
- ROTATING MOTOR
- LN STRT/ROT MTR (Line Start & Rotating Motor)

Factory Preset: NORMAL

1. Select LINE START.
2. Push the MENU key one time. The display should read:

```
RESET DRIVE NOW?
RESET REQUIRED
```

3. When the bottom line of the display reads YES, push the MENU key one time.

581 RESTART TRIES

- Minimum Value: 0
- Factory Preset Value: 0
- Maximum Value: 5

Number of times the drive will try to restart automatically after a fault. To disable this feature, set the value to zero.

582 RESTART WINDOW

- Minimum Value: 300 Seconds
- Factory Preset Value: 300 Seconds
- Maximum Value: 65,535 Seconds

Maximum time in seconds from the first restart until the maximum number of restarts (see Parameter 581) occurs. If the maximum number of restarts occurs within this time window, no more restarts will be allowed, and the drive will be faulted and will require a manual reset. A manual reset can be made with the STOP key on the controller keypad. A manual reset cannot be made, however, with an EMERGENCY STOP button connected to Terminals 1 and 2. If the time difference between the present time and the time of the first restart exceeds the time entered in this parameter, and the maximum number of restarts has not occurred, the restart count will be set to zero and the window timer will also be set to zero.

583 RESTART DELAY

- Minimum Value: 3 Seconds
- Factory Preset Value: 5 Seconds
- Maximum Value: 60 Seconds

Time delay in seconds from the time a fault occurs until a restart of the drive is attempted.

CUSTOM DISPLAYS

The controller can be programmed to monitor a custom parameter on the keypad display as a USER display. Display Line #1 or Display Line #2 can be selected to display the custom USER parameter.

To set-up the controller to monitor a custom parameter, perform the following instructions.

1. Go to the Utility Group and select Custom Parameter Menu #855-858.

2. Go to Custom Source Parameter 855, and select one of the following parameters to be monitored.

   - ACTUAL SPEED (Parameter 958)
   - ACCEL RAMP (Parameter 904)
   - ANALOG INPUT #1 (Parameter 442)
   - ANALOG INPUT #2 (Parameter 452)
   - ANALOG INPUT #3 (Parameter 462)
   - MOTOR CURRENT (Parameter 936)
   - MOTOR LOAD (Parameter 932)
   - MOTOR VOLTAGE (Parameter 962)
   - NONE
   - OUTPUT FREQ (Parameter 944)
   - PID ERROR (Parameter 927)
   - PID FEEDBACK (Parameter 926)
   - PID OUTPUT (Parameter 910)
   - PID REFERENCE (Parameter 925)
   - POWER (Parameter 963)
   - REMOTE DIGITAL (Parameter 535)
   - SPEED COMMAND (Parameter 903)
   - SPEED RATIO (Parameter 916)
   - SPEED TRIM (Parameter 955)
   - TORQUE REF (Parameter 931)

   Factory Preset: ACTUAL SPEED

   The selected parameter (source) will be the value that will be used for the custom display.

3. Go to Custom Scale Parameter 856, and enter a value to scale the selected source value (Parameter 855). The custom scale value is in percent, as follows:

   - Minimum Value: 0.00%
   - Factory Preset Value: 100.00%
   - Maximum Value: 327.67%

4. Go to Custom Offset Parameter 857, and enter a value to be subtracted from Parameter 855 before scaling. The custom offset value is in percent, as follows:

   - Minimum Value: -327.67%
   - Factory Preset Value: 0.00%
   - Maximum Value: 327.67%

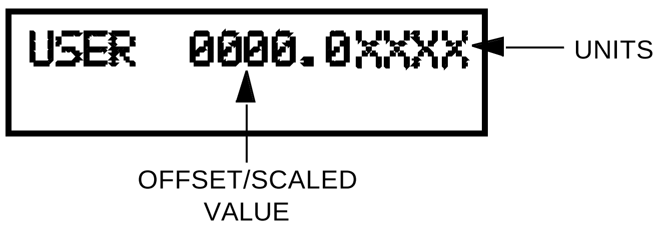
5. Go to Custom Units Parameter 858, and enter four characters. These may be letters, numbers, or symbols, and will appear to the right of the custom parameter value in the keypad display.

6. Go the Monitor Function Menu #880-882.

7. Go to either Display Line #1 Parameter 880 or Display Line #2 Parameter 881, and select CUSTOM PARAM.

8. Save the setup as described in “Saving Parameter Values,” page 4-10.

The display should read as follows:



DC INJECTION BRAKING

The ADX controller can be programmed to supply DC to the motor windings, thereby producing braking torque to stop the motor. DC injection braking provides minimal braking torque at high motor speeds, but can provide significant braking torque at low motor speeds. Electronic Braking (Option EB) provides braking torque at high motor speeds. Therefore, if both DC injection braking and optional Electronic Braking are enabled, Electronic Braking will supply braking torque at high speeds, and DC injection braking will supply braking torque at low speeds.

SETUP

Three Parameters (346 - 348) are used to program DC injection braking. These parameters are part of the Control Group and are located in the DC Braking Menu.

346 BRAKING MODE

Selections:

- NO DC BRAKING
- ON START (DC braking activates for a preset time when drive is started. After this time period, the motor accelerates to commanded speed).
- ON STOP (DC braking activates when a Stop command is initiated).
- ON START & STOP (DC braking activates on both conditions above).

Factory Preset: NO DC BRAKING (Disabled)

347 BRAKING LEVEL

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 100.00%

Establishes the DC braking current as a percent of Motor Rated Amps (Parameter 594).

348 BRAKING TIME

- Minimum Value: 0.0
- Factory Preset Value: 0.0
- Maximum Value: 25.5 Seconds

Establishes the time in seconds that DC braking is applied each time it is activated.

DIGITAL OUTPUTS

Four buffered open collector outputs, each rated 24 VDC at 50 mA, are available for external monitoring. One of these outputs is dedicated, as a square wave at controller output frequency. The three remaining are user programmable to be any of the following parameters:

- Acceleration
- Alarm
- Auto
- At Speed
- Bypass
- Coasting
- DC Braking
- Deceleration
- Drive Enabled
- Dwelling
- Forward Direct
- Jog
- Motor Overload
- None
- Regenerative Limit
- Reverse Direct
- Run
- Speed Avoidance
- Speed Search
- Taper #1 Speed
- Taper #2 Speed
- Torque Limit
- Zero Speed
- Proof Of Torque

Programmable signal inversion is available on the three programmable outputs.

Option RO is available which provides relay outputs for these parameters.

WIRING

The digital outputs are available at Terminal Board (TB1) on the following terminals:

TB1 TERMINAL	
NAME	NUMBER
Digital Output #1	11
Digital Output #2	12
Digital Output #3	13

SETUP

Five Parameters (520, 521, 522, 528, 529) are used to program the digital outputs. These parameters are part of the Setup Group and are located in the Annunciation Menu.

520 DIG OUT1 SOURCE (Digital Output #1 Source)

Selections:

- ACCELERATION
- ALARM
- AUTO
- AT SPEED
- BYPASS
- COASTING
- DC BRAKING
- DECELERATION
- DRIVE ENABLED
- DWELLING
- FORWARD DIRECT
- JOG
- MOTOR OVERLOAD
- NONE
- REGEN LIMIT
- REVERSE DIRECT
- RUN
- SPEED AVOID
- SPEED SEARCH
- TAPER #1 SPEED
- TAPER #2 SPEED
- TORQUE LIMIT
- ZERO SPEED
- PROOF OF TORQUE

Factory Preset: AT SPEED

521 DIG OUT2 SOURCE (Digital Output #2 Source)

Selections: Same as Parameter 520, except the factory preset selection is ZERO SPEED.

522 DIG OUT3 SOURCE (Digital Output #3 Source)

Selections: Same as Parameter 520, except the factory preset selection is MOTOR OVERLOAD.

528 DOUT FLT ENABLE (Digital Output Fault Enable)

Selections:
- DISABLED (Factory Preset)
- ENABLED

If enabled, all digital outputs will turn off (high) if the controller is faulted. If disabled, the digital outputs will remain in the state they were in when the fault occurred.

529 DIG OUT INVERT (Digital Output Invert)

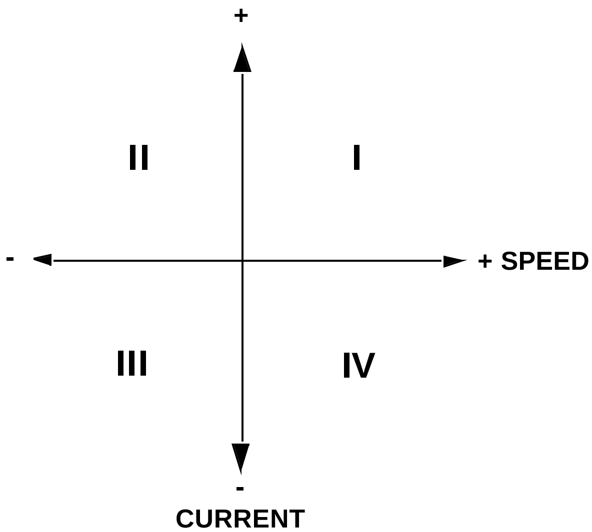
Selections:

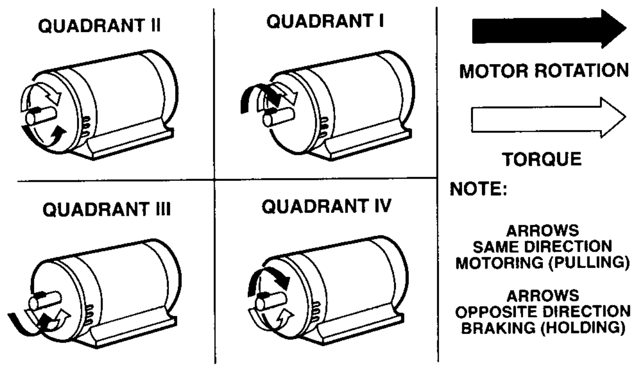
- INVERT NONE
- INVERT OUT 1
- INVERT OUT 2
- INVERT OUT 1&2
- INVERT OUT 3
- INVERT OUT 1&3
- INVERT OUT 2&3
- INVERT ALL

Factory Preset: INVERT ALL

DISABLING MOTOR REVERSAL

This feature can be used to prevent the motor from rotating in the reverse direction, or to disable optional electronic braking (if installed). **Standard regenerative braking of 15% - 20% is available in all quadrants.**





The quadrants shown above are described in the following table.

QUADRANT	DESCRIPTION
I	Forward Motoring - Normal running mode - Electronic braking is disabled.
II	Reverse Braking - Motor is braking to a stop in the reverse rotating direction - Electronic braking is enabled.
III	Reverse Motoring - Electronic braking is disabled.
IV	Forward Braking - Motor is braking to a stop in the forward rotating direction - Electronic braking is enabled.

SETUP

Parameter 500 (Quadrant Select) is used to select the quadrants in which the motor will operate. This parameter is part of the Setup Group and is located in the Quadrant Select Menu. Factory preset is QUADRANTS 1&4.

If operation requires the motor to run in the forward direction and brake to zero speed, select QUADRANTS 1&4. When these quadrants are selected, the motor will have the capability to ramp to full speed and brake to zero speed in one direction only.

DRIVE LEGEND

The controller can be programmed to display a one to sixteen character legend, typically used to describe the equipment being controlled by the ADX controller (e.g., COOLING FAN).

To set-up the controller to display a custom legend, perform the following instructions.

1. Go to the Utility Group and select Drive Legend #854.

2. Enter a legend, up to sixteen characters, to be displayed using the Up, Down, Left, and Right arrow keys. Letters can be found by pushing the Up arrow key, while symbols and numbers can be found by pushing the Down arrow key. The factory preset legend is ????????????????.

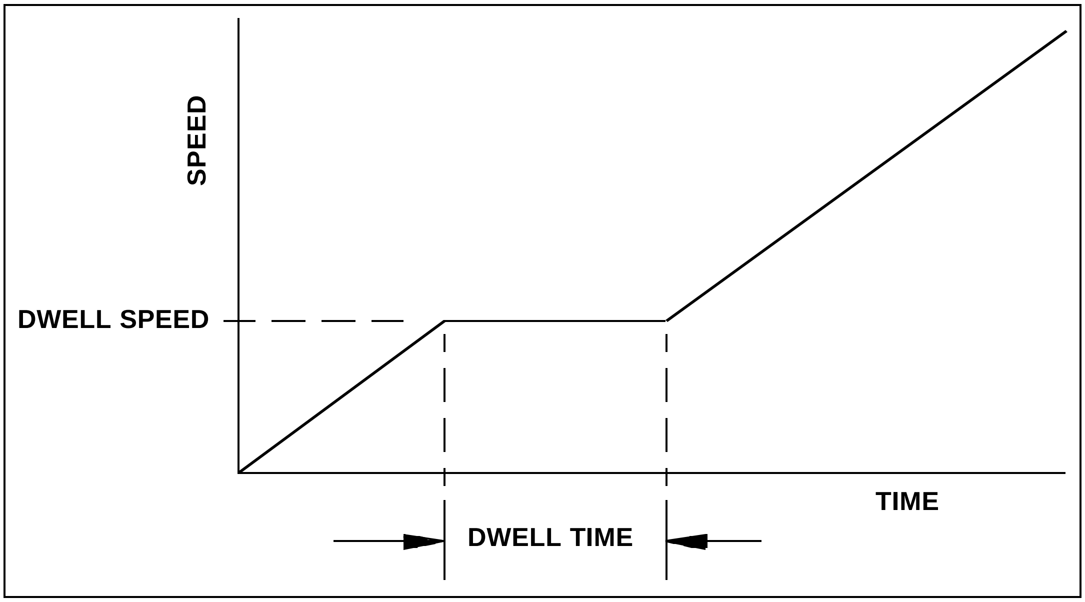
3. Go to the Monitor Function Menu #880-882.

4. Go to either Display Line #1 Parameter 880 or to Display Line #2 Parameter 881 and select LEGEND.

5. Save the legend as described in “Saving Parameter Values,” page 4-10.

DWELL

The dwell feature allows the user to program a speed at which the motor will pause (or dwell) as it accelerates to commanded speed. The dwell time is also programmable.



SETUP

Two Parameters (350 & 351) are used to program this feature. These parameters are part of the Control Group and are located in the Dwell Menu.

350 DWELL SPEED

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 100.00%

Defines the speed the motor will run for an adjustable time period (Dwell Time Parameter 351) each time the drive is started or direction is reversed. This feature is only active if LINEAR ACCELERATION is selected by the Ramp Type (Parameter 270). Parameter 270 is part of the Control Group and is located in the Ramps Menu.

351 DWELL TIME

- Minimum Value: 0.0
- Factory Preset Value: 0.0
- Maximum Value: 25.5 Seconds

Selects the time period in seconds that the motor pauses at the dwell speed (Parameter 350) before accelerating to commanded speed.

INVERSE TIME OVERLOAD

The current and duration parameters, which cause an overload trip, can be adjusted. The term “inverse time” implies an overload calculation which is a function of I^2T (i.e., proportional to the time an overload current is present and proportional to the square of magnitude of current above the overload level).

SETUP

Two Parameters (504 & 505) are used to adjust this feature. These parameters are part of the Setup Group and are located in the Overload Menu.

504 OVERLOAD THRESH

- Minimum Value: 20.00%
- Factory Preset Value: 105.00% or 115.00%[1]
- Maximum Value: 115.00%

Sets the motor current, in percent of Motor Rated Amps (Parameter 594), above which an overload trip will occur if the overload is present for the required time set by Overload Time Parameter 505.

505 OVERLOAD TIME

- Minimum Value: 1.0 Second
- Factory Preset Value: 60.00 Seconds
- Maximum Value: 60.00 Seconds

Determines the amount of time, in seconds, that current limit is active before an overload trip occurs. If the motor current exceeds the setting of Overload Thresh (Parameter 504), but is less than the current limit setting, the controller may still trip, but the time required for the overload trip will be greater than the time entered in Parameter 505.

1. Factory Preset Value will be 105.00% when the Operating Mode (Parameter 513) is set to V/F VAR TORQ, ST VAR TORQUE, or VECT VAR TORQ. Factory Preset Value will be 115% when Parameter 513 is set to V/F CONST TORQ, ST CONST TORQUE, or VECT CONST TORQ.

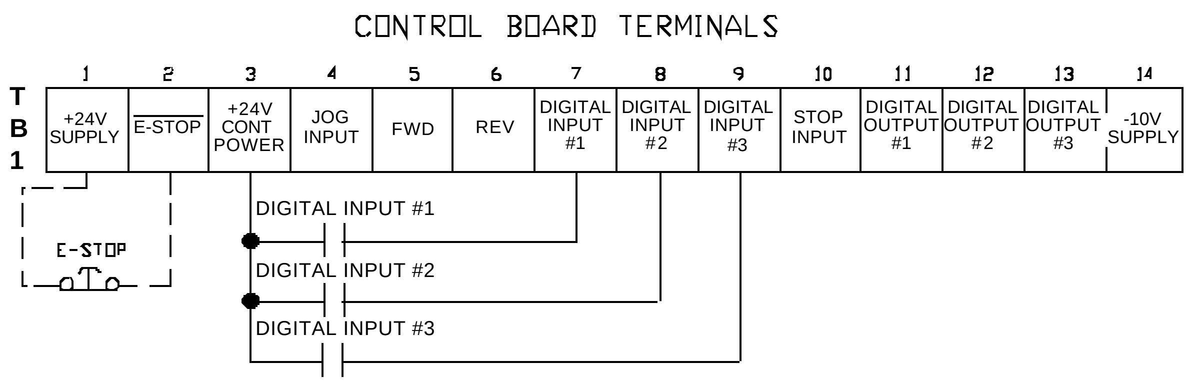
DIGITAL INPUTS/PRESET SPEED

The ADX controller has three digital inputs which can be used to select up to seven preset speeds. These digital inputs are designed to be used with the +24 CONT POWER (Terminal TB1-3). The preset speed feature allows a digital input to select one preset speed. Because the controller interprets the three inputs as a binary coded value, two inputs can select up to three preset speeds and three inputs can select up to seven preset speeds.

WIRING

The digital inputs are available at the control board Terminal Board (TB1) on the following terminals:

TB1 TERMINAL	
NAME	**NUMBER**
Digital Input #1	7
Digital Input #2	8
Digital Input #3	9



WIRING DIAGRAM, PRESET SPEEDS

The preset speeds are selected by connecting Terminal 3 to the desired input as shown in the following table.

DIGITAL INPUT #1	DIGITAL INPUT #2	DIGITAL INPUT #3	PRESET SPEED
OFF	OFF	OFF	NONE
ON	OFF	OFF	#1
OFF	ON	OFF	#2
ON	ON	OFF	#3
OFF	OFF	ON	#4
ON	OFF	ON	#5
OFF	ON	ON	#6
ON	ON	ON	#7

SETUP

Three Parameters (550 - 552) are used to program the digital inputs. These parameters are part of the Setup Group and are located in the Digital Inputs Menu.

550 DIGITAL INPUT #1

Selections:

- AUTO/MANUAL (Controls Auto/Manual mode switching)
- FASTER (Remote Faster/Slower pushbutton speed control)
- NONE
- SLOWER (Remote Faster/Slower pushbutton speed control)
- SPEED PRESET (Selects one of up to seven preset speeds)
- JOG REVERSE (Allows input to function as a Jog Reverse input)

Factory Preset: NONE

551 DIGITAL INPUT #2

Selections: Same as Parameter 550.

552 DIGITAL INPUT #3

Selections: Same as Parameter 550.

1. Determine the number of preset speeds required.

2. Go to the Setup Group and select the Digital Inputs Menu #550-552.

Digital Inputs/Preset Speed

3. Set only the digital input parameters required, as follows:

   • Digital Input #1 Parameter 550 = SPEED PRESET
   • Digital Input #2 Parameter 551 = SPEED PRESET
   • Digital Input #3 Parameter 552 = SPEED PRESET

4. Go back to the Reference Group and select the Speed Commands Menu #000-030.

5. Set only the preset speed parameters required, as follows:

   • Preset #1 Parameter 010 = Desired preset speed (-100% to 100%)
   • Preset #2 Parameter 011 = Desired preset speed (-100% to 100%)
   • Preset #3 Parameter 012 = Desired preset speed (-100% to 100%)
   • Preset #4 Parameter 013 = Desired preset speed (-100% to 100%)
   • Preset #5 Parameter 014 = Desired preset speed (-100% to 100%)
   • Preset #6 Parameter 015 = Desired preset speed (-100% to 100%)
   • Preset #7 Parameter 016 = Desired preset speed (-100% to 100%)

6. Set the rates of acceleration/deceleration by going to the Control Group and selecting the Ramps Menu #250-271.

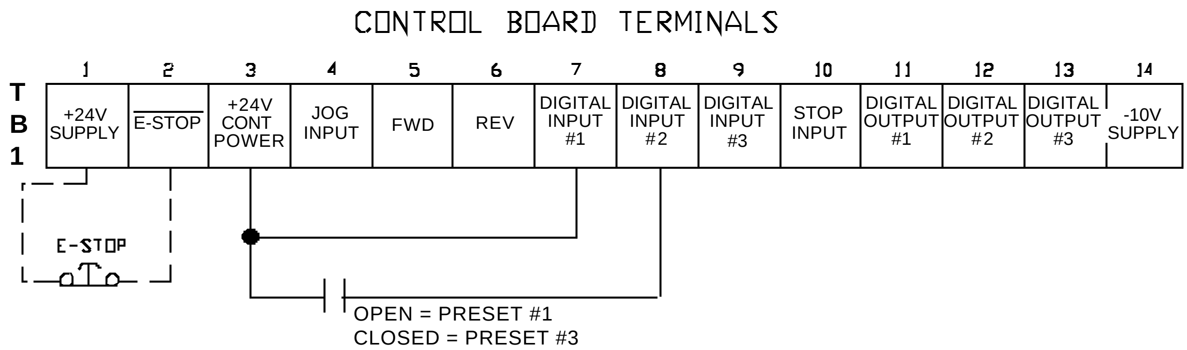
   • Set Preset Accel Parameter 256 = Desired acceleration rate (must be greater than zero)
   • Set Preset Decel Parameter 259 = Desired deceleration rate (must be greater than zero)

7. Save the setup as described in “Saving Parameter Values,” page 4-10.

For Remote Faster/Slower Pushbutton Control operation, set Run Speed Source Parameter 680 to LOCAL DIGITAL, set one Digital Input for FASTER, and set another Digital Input for SLOWER.

SPECIAL APPLICATION OF PRESET SPEED

The following configuration allows two preset speeds to be selected with only one external contact. Preset Speeds #1 and #3 are used.



WIRING DIAGRAM, TWO PRESET SPEEDS WITH ONE CONTACT

SETUP

1. Set Digital Input #1 Parameter 550 = SPEED PRESET.
2. Set Digital Input #2 Parameter 551 = SPEED PRESET.
3. Set Preset #1 Parameter 010 = Desired preset speed (-100% to 100%).
4. Set Preset #3 Parameter 012 = Desired preset speed (-100% to 100%).
5. Set the rates of acceleration/deceleration as described in step 6, page 10-24.
6. Save the setup as described in “Saving Parameter Values,” page 4-10.

RESONANT FREQUENCY AVOIDANCE

In some applications, certain motor speeds can cause undesirable resonance or vibration in the system in which the AC motor is running. An example is a fan used for building ventilation. At certain fan speeds, the air flow may cause an audible noise due to the resonance of the air moving in the duct work.

The ADX controller has a frequency avoidance feature which can be user programmed to avoid these motor speeds (and frequencies) and therefore eliminate noise or other undesirable conditions.

Three different speeds can be set in the ADX controller to be avoided. Each speed also has a bandwidth parameter to define the range of speed to be avoided.

SETUP

Six Parameters (352 - 357) are used to program this feature. These parameters are part of the Control Group and are located in the Speed Avoidance Menu. Each parameter is expressed as a percent of maximum speed.

352 BAND #1 SETPOINT

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 100.00%

This parameter sets the center, in percent of maximum speed, of a band of speeds to be avoided.

353 BAND #1 WIDTH

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 20.00%

This parameter sets the width, in percent of maximum speed, of a band of speeds to be avoided. Setting this value to zero disables speed avoidance for Band #1.

Note: Do not allow the bandwidths to overlap.

354 BAND #2 SETPOINT - Similar to 352 BAND #1 SETPOINT.

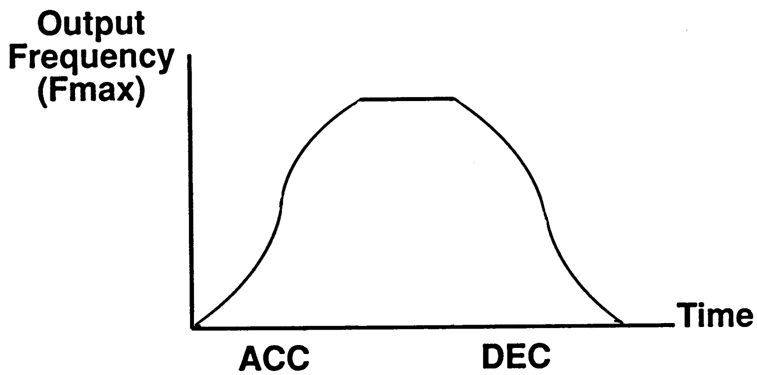
355 BAND #2 WIDTH - Similar to 353 BAND #1 WIDTH.

356 BAND #3 SETPOINT - Similar to 352 BAND #1 SETPOINT.

357 BAND #3 WIDTH - Similar to 353 BAND #1 WIDTH.

S CURVE RAMP ACCELERATION/DECELERATION

This feature softens or diminishes both the beginning and ending of selectable control ramps. It provides a smooth initial takeoff when a speed change is commanded, and a soft final approach. The acceleration/deceleration profile approximates that of an ‘S’ curve, as shown below.



This feature may be used for soft starting and to prevent acceleration overshoot.

SETUP

One Parameter (270 Ramp Type) is used to select this feature. This parameter is part of the Control Group and is located in the Ramps Menu.

Selections:

- LINEAR (0.1 to 1900.0 seconds linear acceleration/deceleration)
- S CURVE (3.0 to 120.0 seconds S curve acceleration/deceleration)

Factory Preset: LINEAR

When S Curve is selected, it affects all selected ramps and ramp times.

SERIAL COMMUNICATIONS

The Serial Communications Package (COM485) is a software utility that runs on a personal computer (286 or higher), and allows communication with the RS485 serial port on the controller control board.

Serial Communications Package COM485 provides the following features:

- Read and write controller parameters.
- Load and save parameter values to a disk.
- Setup of the serial port and options.
- Monitor parameters.
- Read parameters in all controllers in a system.
- A help screen

START INTO ROTATING MOTOR

This is a special starting mode which allows the controller to synchronize its frequency to the speed of a rotating motor. Ventilation fans are typical applications. When the fan is not powered, air movement through the fan may cause it to rotate. This feature allows the controller to catch the motor as it rotates and accelerate it to commanded speed.

SETUP

One Parameter (580 Starting Mode) is used to select this feature. This parameter is part of the Setup Group and is located in the Starting Control Menu.

Selections:

- NORMAL (Forward or Reverse button must be pushed after power up to start the drive.)
- LINE START (The drive will start when power is applied if the start input is hard wired into the start condition.)
- ROTATING MOTOR (The drive will synchronize its frequency to the speed of the motor when started.)
- LN STRT/ROT MTR (Combination of the Line Start and Rotating Motor modes.)

Factory Preset: NORMAL

1. Select ROTATING MOTOR.

2. Push the MENU key one time. The display should read:

```
RESET DRIVE NOW?
RESET REQUIRED
```

3. When the bottom line of the display reads YES, push the MENU key one time.

If ROTATING MOTOR or LN STRT/ROT MTR is selected, the controller will start the motor at a reduced Field Current setting and a reduced Torque Limit setting. If the speed command is greater than 30%, the controller will try to match the speed of the motor and accelerate the motor to the commanded speed (Speed Search Mode #1). Once a speed match is found (torque limit no longer active), the Field Current and Torque Limit will be ramped to the user setting. If a speed match is not found after a programmed time (typically 10 seconds), the Field Current will then be ramped to the user setting. If the speed command is less than 30%, the controller will attempt to stop or slow the motor before accelerating the motor to speed (Speed Search Mode #2). If the motor stops or slows while attempting to match motor speed, it may accelerate to a speed higher than the speed command. Once a speed match is found, the Field Current and Torque Limit will ramp to the user setting. If a speed match is not found after a programmed time (typically 10 seconds), the Field Current will then be ramped to the user setting.

If Bus Overvoltage Faults occur repeatedly during motor starts, the AC line voltage may be higher than nominal. Installing optional Electronic Braking is an effective way to prevent Bus Overvoltage Faults during Rotating Motor starts.

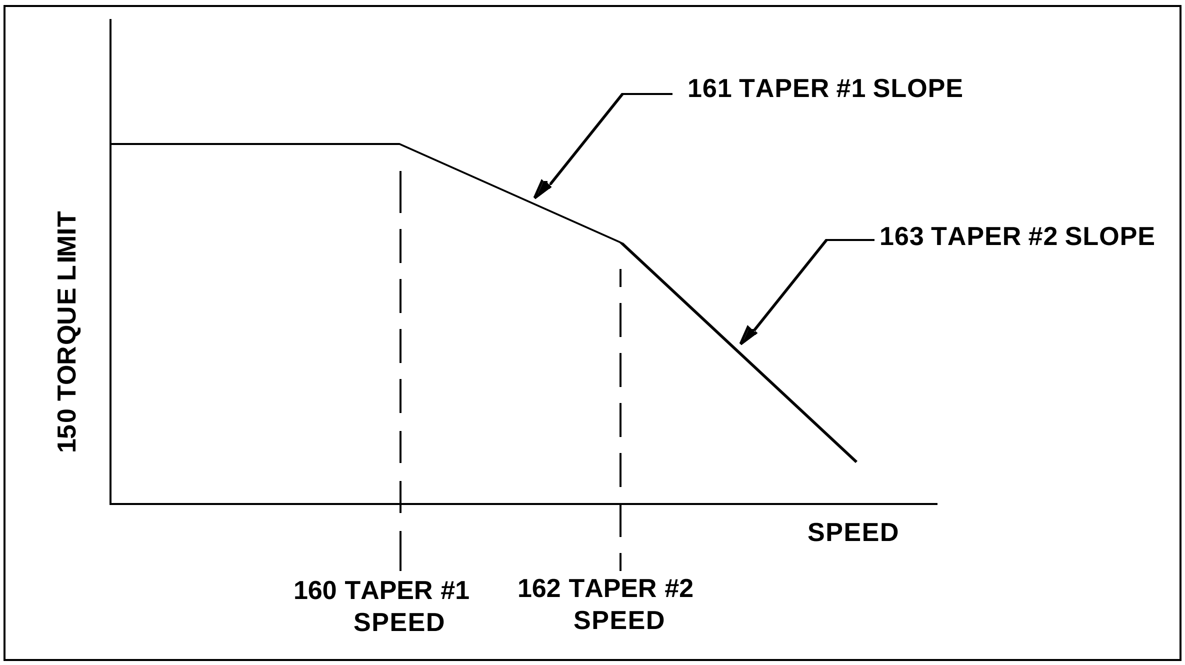
Rotating Motor starting only works if a single motor is connected to the controller output terminals. If multiple motors are connected to the controller and rotating motor starting is desirable, configure the controller for DC BRAKING ON START (Parameters 346, 347, and 348 in the Control Group).

TORQUE TAPER

The ADX controller can be programmed to automatically reduce its torque limit as speed increases. This feature can be useful in applications such as center driven winders. Constant material tension can be approximated by starting at a reduced torque level with a small diameter roll, and progressively increasing torque up to the controller torque limit setting as the roll diameter builds. Motor speed will decrease as the diameter builds, thereby providing constant line (web) speed.

DESCRIPTION

Two speed set points and two slopes of torque-versus-speed can be programmed.



SETUP

Four Parameters (160 - 163) are used to program this feature. These parameters are part of the Reference Group and are located in the Torque Taper Menu.

160 TAPER #1 SPEED

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 100.00%

Determines the speed, in percent of maximum speed, at which Taper #1 Slope takes effect. Below this speed, the torque command will be the Torque Limit (Parameter 150 in the User Group Menu) setting. For proper operation of torque taper, Taper #1 Speed should always be less than or equal to Taper #2 Speed (Parameter 162).

161 TAPER #1 SLOPE

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 300.00%

Determines the rate, in percent, that the torque command is reduced for each 1% difference between the commanded motor speed and Taper #1 Speed. This slope is effective only when the commanded motor speed is between Taper #1 Speed and Taper #2 Speed.

162 TAPER #2 SPEED

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 100.00%

Determines the speed, in percent of maximum speed, at which Taper #2 Slope takes effect. Below this speed, the torque command will be controlled by the Taper #1 Slope or the Torque Limit (Parameter 150 in the User Group Menu) setting. For proper operation of torque taper, Taper #2 Speed should always be greater than or equal to Taper #1 Speed (Parameter 160).

163 TAPER #2 SLOPE

- Minimum Value: 0.00
- Factory Preset Value: 0.00
- Maximum Value: 300.00%

Determines the rate, in percent, that the torque command is reduced for each 1% difference between the commanded motor speed and Taper #2 Speed. This slope is effective only when the commanded motor speed is higher than Taper #2 Speed.

ADDING AND DELETING USER GROUP PARAMETERS

The User Group allows easy access to frequently used parameters. Parameter values in the User Group can be changed without entering a controller password. The factory selected parameters in the User Group are shown in Figure 4-2, page 4-5. Any ADX controller parameter can be added to the User Group or removed from the User Group. Regardless of whether a parameter is in the User Group, it can still be accessed in its normal location in the ADX menu structure.

ADDING A PARAMETER TO THE USER GROUP

1. Go to the Utility Group and then to Config User Menu Parameter 851.

2. Select CONFIG USER.

3. Push the MENU key.

4. Go to the parameter that is to be added to the User Group.

5. Push the key.

   Instead of the normal numeric values or list of selections for that parameter, the bottom display line should read X USER MENU X. This indicates that the selected parameter has been added to the User Group.

   To add another parameter to the User Group, go to the parameter and push the key.

DELETING A PARAMETER FROM THE USER GROUP

1. Follow steps 1 - 3, above.

2. Go to the parameter in the User Group that is to be deleted.

3. Push the key.

   The bottom line of the display should read X USER MENU X. This indicates that the selected parameter has been deleted from the User Group.

   To delete another parameter from the User Group, go to the parameter and push the key.

When all parameters have been added/deleted, press the MENU key again to exit the Add/Delete mode.

To save the changes made to the User Group, refer to "Saving Parameter Values" on page 4-10.

SECTION XI

INITIAL SETUP

The ADX controller is normally set up at the factory to operate a particular motor for a specific application. This setup is performed by presetting initial setup parameter values. However, if the type of motor and application were unknown when the controller was shipped, or if the user changes the motor type or the controller control board, or if the parameters are reset to the factory settings, the initial setup parameter values may not be correct.

If the initial setup parameter values are not correct, the following display should appear on the controller keypad.

```
INITIAL SETUP
PRESS MENU KEY
```

If the above display appears, the user must set the initial setup parameter values by performing the following instructions.

Refer to Figure 11-1 (page 11-5) while performing the following instructions.

1. Record the following information from the motor nameplate:

   a. Full Load Speed ___________________________RPM

   b. Horsepower ___________________________HP

   c. Efficiency ___________________________%
   If unknown, record 89%.

   d. Frequency ___________________________Hz

   e. Rated Current ___________________________AMPS

2. Record the line voltage rating of the ADX controller _____________VAC

3. Press the MENU key on the keypad for the first selection. The display should read **LINE VOLTAGE SEL**, as shown in Figure 11-1. Six standard voltage selections and a custom voltage selection are provided, selectable with the ▲ and ▼ keys. Line voltage selection, the controller voltage rating, and the AC line voltage must be identical. Press the MENU key to enter the selection into the controller memory.

   If an incorrect value is entered into the controller memory, it can be changed as described in step 15 or step 13 on page 11-3.

4. The next parameter to set is **DRIVE RATED AMPS**. Drive Rated Amps is selectable as shown in Figures 11-1. Select the value with the ▲ or ▼ key based on the motor horsepower rating and line voltage rating shown in Table 11-1, page 11-6. Press the MENU key to enter the selection into the controller memory.

5. The next parameter to set is **OPERATING MODE**. This parameter determines whether the drive will operate in the Constant Torque (CONST TORQ) or the Variable Torque (VAR TORQ) mode, and whether the drive will operate as a Variable Frequency (V/F), Sensorless Torque (ST), or Closed Loop Flux Vector (VECT) Control unit. Six selections of Operating Modes are provided, selectable with the ▲ and ▼ keys. The factory preset selection is V/F CONST TORQ (Variable Frequency Control Constant Torque). Setting the Operating Mode sets the parameters listed in the following table at the values shown.

PARAMETER	OPERATING MODE	
	CONSTANT TORQUE	VARIABLE TORQUE
150 Torque Limit	150.00%	115.00%
151 Remote Torque Limit	150.00%	115.00%
152 Auto Torque Limit	150.00%	115.00%
153 Remote Auto Torque Limit	150.00%	115.00%
504 Overload Threshold	115.00%	105.00%
505 Overload Time	60.00 Seconds	60.00 Seconds

Press the MENU key to enter the selection into the controller memory.

6. The next parameter to set is **FULL LOAD SPEED.** To change Full Load Speed to that recorded in step 1, press the ◀ key until the cursor is beneath the digit to be changed. Then use the ▲ (increase) or ▼ (decrease) key to change the digit. Full load speed is adjustable from 350 RPM to 24,000 RPM.

Any of the digits may be changed by moving the cursor beneath the digit using the ◀ or ▶ key, and then using the ▲ or ▼ key to change the digit value. If the cursor is allowed to remain beneath the up/down arrow symbol (⇕), pushing the ▲ or ▼ key will rapidly increase or decrease the whole parameter value.

Press the MENU key to enter the value into the controller memory.

7. The next parameter to set is **MOTOR HORSEPOWER**. Motor Horsepower is adjustable from 1.0 - 75.0. The factory preset value is 3.0 horsepower. Use the same procedure to change Motor Horsepower as was given in step 6 (above).

8. The next parameter to set is **MOTOR EFFICIENCY**. Motor Efficiency is adjustable from 60% to 99%. The factory preset value is 89%. Use the same procedure to change Motor Efficiency as was given in step 6.

9. The next parameter to set is **MOTOR FREQUENCY**. Motor Frequency is adjustable from 25 to 600 Hz. The factory preset value is 60 Hz. Use the same procedure to change Motor Frequency as was given in step 6.

10. The next parameter to set is **MOTOR RATED AMPS**. Motor Rated Amps is adjustable from 1.00 to 115.00. The factory preset value is 4.80. Use the same procedure to change Motor Rated Amps as was given in step 6. If the current rating of the motor is not known, set the Motor Rated Amps based on the motor horsepower rating shown in Table 11-1, page 11-6.

11. The next parameter to set is **CARRIER FREQ**. The factory preset selection is 5 KHz. Use the ▲ or ▼ key to make the desired selection. Higher carrier frequencies provide quieter motor operation but increase drive power consumption, whereas lower carrier frequencies decrease drive power consumption but increase motor noise. Press the MENU key to enter the selection into the controller memory.

CAUTION: DO NOT SELECT A CARRIER FREQUENCY HIGHER THAN THE ALLOWABLE SELECTIONS LISTED IN THE FOLLOWING TABLE.

CONTROLLER RATING	CARRIER FREQUENCY (KHZ)[a]								
	2	3	4	5	6	7	8	9	10
3 - 15 HP, 208/230V 3 - 30 HP, 460V	X	X	X	X	0	0	0	0	0
20 - 30 HP, 208/230V 40 - 75 HP, 460V	X	X	0	0	0	0	0	0	0

a. X indicates selection is allowed.
0 indicates selection is **not** allowed.

If the carrier frequency is set higher than the allowable selections in the above table, a Carrier Frequency fault or controller damage may occur.

12. The next parameter to set is **V/F PROFILE LIST**. Twenty-one preset selections and one custom selection are provided, selectable with the ▲ and ▼ keys. The factory preset selection is 60 Hz. The V/F profile determines the operating characteristics of the ADX drive. Each selection is shown graphically in Figure 11-2, page 11-7. If necessary, change the V/F profile to that desired. For most applications, the 60 Hz CT selection will provide the optimum performance. Press the MENU key to enter the selection into the controller memory.

13. The last display in the menu asks if the initial setup parameter values should be saved. If there are no more changes to be made, push the MENU key when YES is displayed. After the controller performs an internal diagnostic check, the following display should appear.

```
SPEED      0  RPM
LOAD    0.00  %
```

If the display reads EMERGENCY STOP, re-close the Emergency Stop circuit between Terminals TB1-1 and TB1-2.

If there are changes to be made to the initial setup parameter values, push the ▼ key to select NO. Then push the MENU key. The display will return to the first selection (LINE VOLTAGE SEL) in the Initial Setup Menu. The user may then scroll through the menu and make the desired parameter value changes.

14. Be sure the parameter values in the User Group are set correctly.

15. If the user desires to return to the Initial Setup Menu at a later time, perform the following instructions:

    CAUTION: PERFORMING THE FOLLOWING INSTRUCTIONS WILL CAUSE ALL PARAMETER VALUES IN THE INITIAL SETUP MENU TO GO BACK TO THE FACTORY PRESET VALUES[1]. ALL PREVIOUSLY CHANGED VALUES IN THIS MENU WILL BE LOST.

    a. Turn-off the AC line voltage to the ADX controller.

    b. Wait for the controller display to go blank and the cooling fans to stop running.

    c. Push and hold the ◀ and ▶ keys while turning-on the AC line voltage to the ADX controller.

    d. Release the ◀ and ▶ keys when the displays reads LOADING FACTORY PARAMETERS NOW.

    e. After an initialization sequence, the following display should now appear, allowing access to the initial setup parameters.

```
INITIAL SETUP
PRESS MENU KEY
```

    f. Check the Carrier Frequency (Parameter 600) and be sure the selection is one of the allowable selections listed in the table on page 11-3.

1. An E-STOP contact or wire jumper must be connected to Terminals TB1-1 and TB1-2. If this circuit is open, the initial setup parameters will not reset to the factory preset values.

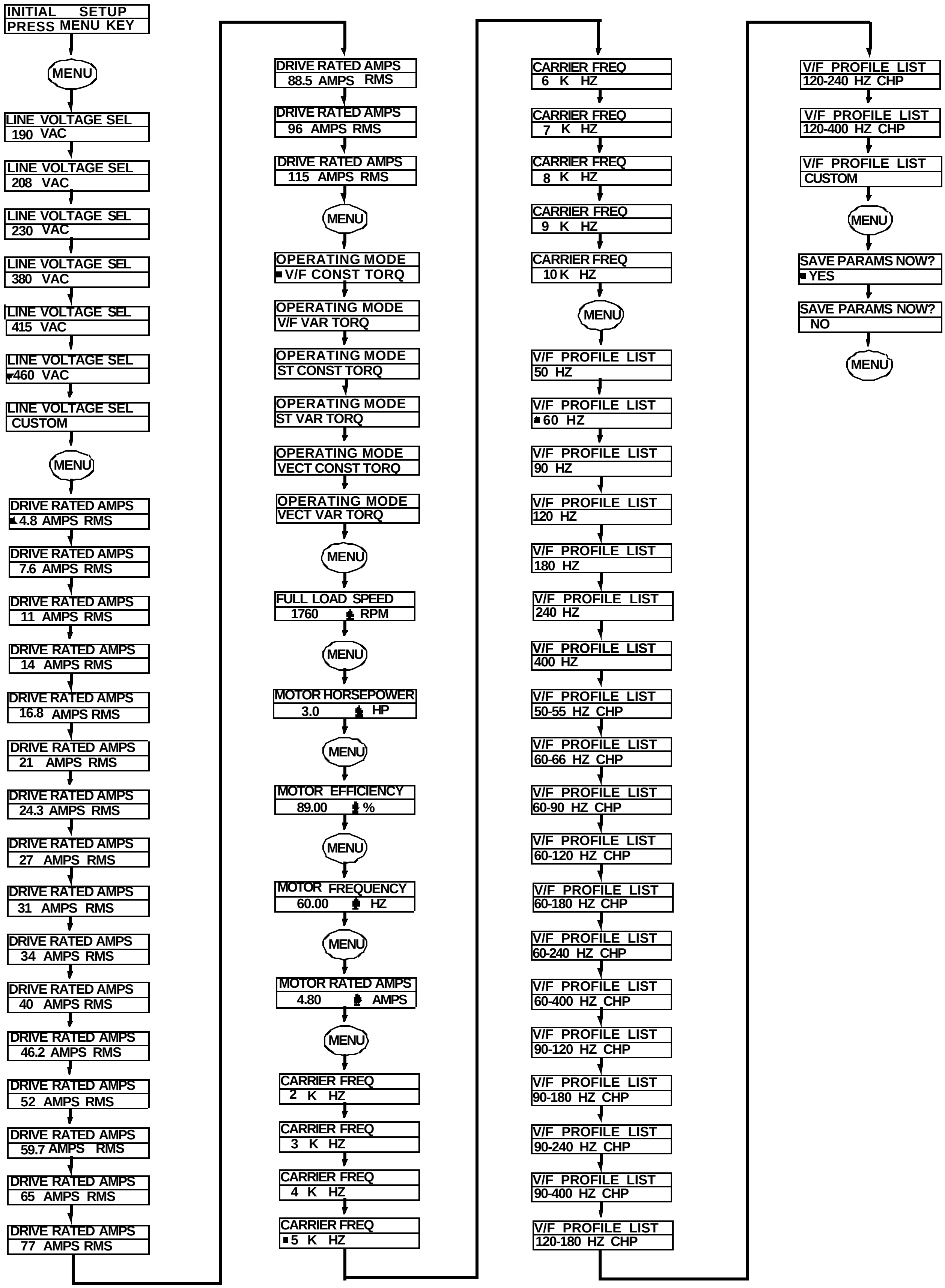


FIGURE 11 - 1. INITIAL SETUP FLOWCHART

Table 11 - 1: DRIVE CURRENT SETTINGS[a, b]

VOLTAGE RATING (VAC)	RATED HORSEPOWER	DRIVE RATED AMPS	MOTOR RATED AMPS[c]
460	1	4.8	2.1
	1.5	4.8	3.0
	2	4.8	3.4
	3	4.8	4.8
	5	7.6	7.6
	7.5	11	11
	10	14	14
	15	21	21
	20	27	27
	25	34	34
	30	40	40
	40	52	52
	50	65	65
	60	77	77
	75	96	96
208/230	1	11	4.6 (208V)/4.2 (230V)
	1.5	11	6.6 (208V)/6.0 (230V)
	2	11	7.5 (208V)/6.8 (230V)
	3	11	11 (208V)/9.6 (230V)
	5	16.8	16.8 (208V)/15.2 (230V)
	7.5	24.3	24.3 (208V)/22 (230V)
	10	31	31 (208V)/28 (230V)
	15	46.2	46.2 (208V)/42 (230V)
	20	59.7	59.7 (208V)/54 (230V)
	25	77	75.2 (208V)/68 (230V)
	30	88.5	88.5 (208V)/80 (230V)

a. Table 11-1 is important for the correct setting of MOTOR RATED AMPS (see step 10, page 11-3) and DRIVE RATED AMPS (see step 4, page 11-2).
b. See Table 1-1, page 1-3.
c. The choice of a correctly sized drive is based on the MOTOR RATED AMPS column. Current ratings listed are the maximum continuous (RMS) rating at 100% rated load. The MOTOR RATED AMPS setting must be less than or equal to DRIVE RATED AMPS.

The V/F profile is a curve that represents the relationship between voltage and frequency (Hertz). It is desirable to set the V/F profile so that rated motor voltage is achieved at rated motor frequency. The factory preset V/F profile is 60 HZ .

Notes:
1. CHP = Constant Horsepower
2. The controller output voltage is proportional to the controller input voltage.
3. Above base frequency, the torque and horsepower characteristics will change.

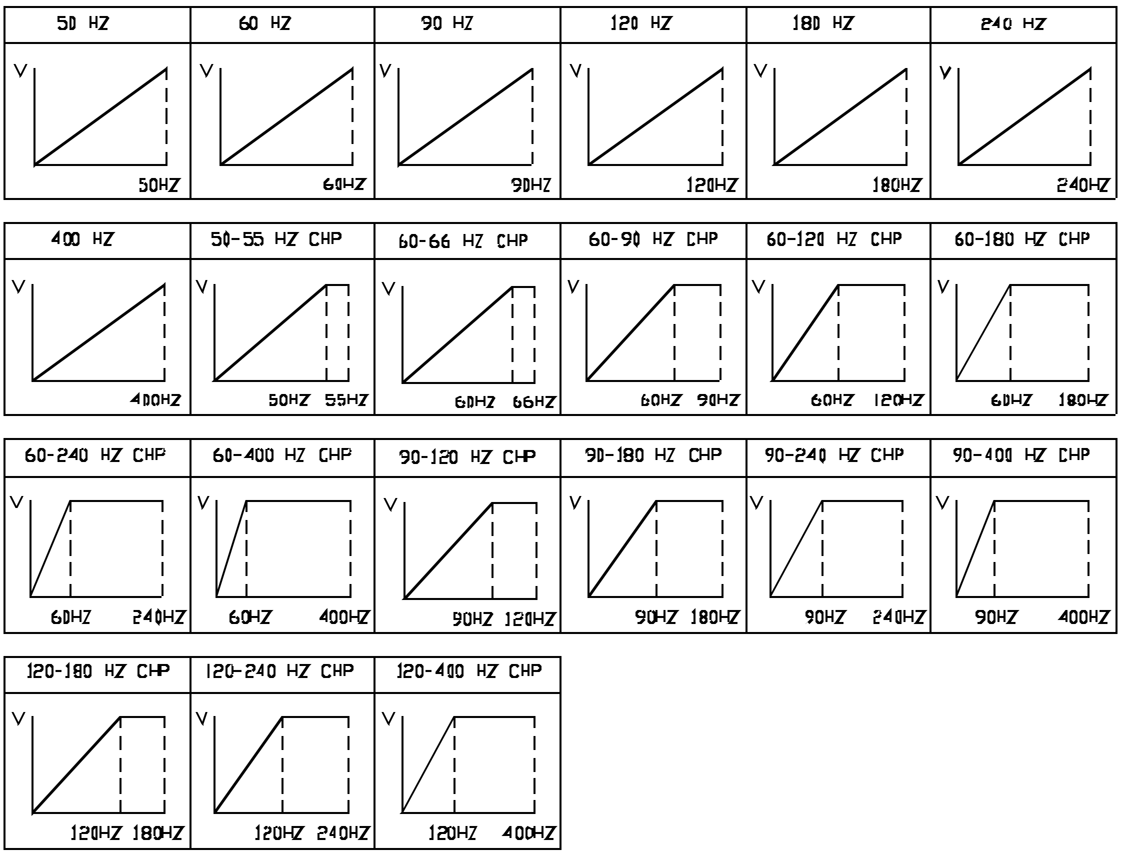


FIGURE 11 - 2. V/F PROFILES

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SECTION XII

MAINTENANCE AND REPAIR

1. Comply with the **WARNING** on page x near the front of this manual
2. Keep the ADX controller dry and free of dust, dirt, and debris. No parts require periodic replacement.
3. Periodically turn-off the AC line supply to the ADX controller and check all wire terminations to be sure they are tight.
4. Visually check components for damage due to overheating or breakage. All damaged and/or faulty components must be replaced for satisfactory operation.
5. Maintain the motor according to maintenance instructions supplied by the motor manufacturer.

TROUBLESHOOTING

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

If the ADX controller shuts down, check the display on the keypad for a fault message. If a fault message is displayed, refer to the message listed in the following table (Table 12-1), diagnose the problem, and correct the fault.

After the fault has been corrected, the controller must be reset, either by pushing the STOP key or a remote STOP button, or by removing and reapplying the AC line supply to the ADX controller. The controller **cannot** be reset with an EMERGENCY STOP button connected to TB1 Terminals 1 and 2.

Table 12 - 1: FAULT MESSAGES

FAULT		
DISPLAY MESSAGE	**DESCRIPTION**	**REMEDY**
10V POWER LOSS	10 VDC power loss at Terminal TB1A-19	Check wiring to all devices connected to TB1A-19.
24V POWER LOSS	24 VDC power loss at Terminal TB1-1	Check wiring to device connected to TB1-1.
ANALOG INPUT1 FLT	Analog Input #1 out of the range set in Parameters 443 and 446	Check wiring connected to analog input.
ANALOG INPUT2 FLT	Analog Input #2 out of the range set in Parameters 453 and 456	
ANALOG INPUT3 FLT	Analog Input #3 out of the range set in Parameters 463 and 466	
BUS OVERCURRENT	Excessive DC bus current	1. Check for excessive load connected to the motor. 2. Check for shorted motor wiring. 3. Check for shorted motor. 4. Check for a shorted IGBT.
BUS OVERVOLTAGE	Excessive voltage on the DC bus	1. Check that the AC line supply voltage is not higher than the controller rating. 2. The load may be decelerating too quickly. Extend the deceleration time to accommodate the high inertia load. Optional electronic braking may be required to dissipate excessive voltage. 3. Eccentric and regenerative loads may cause over voltage trips. Optional electronic braking or a higher rated controller may be required to accommodate the load requirement.
CARRIER FREQ FLT	Carrier frequency set too high	Select a lower carrier frequency in Parameter 600. See step 11 on page 11-3.
EXTERNAL FLT	A user connected fault has tripped	Check all devices connected to TB1A Terminals17 and 18.

Table 12 - 1: FAULT MESSAGES

FAULT		
DISPLAY MESSAGE	**DESCRIPTION**	**REMEDY**
FDBK LOSS FLT	Feedback loss fault. Loss of speed feedback signal	1. Check for open wiring to DC tachometer or encoder. 2. Change Operating Mode Parameter 513 to selection other than VECT CONST TORQ or VECT VAR TORQ.
GROUND FLT	A ground fault occurred in the controller or motor	1. Determine if the ground is in the controller or in the motor by disconnecting the motor from the controller, and then turn-on the AC line supply to the controller. 2. If ground fault recurs, check all wiring to the controller and internal components for grounds. 3. If the ground fault does not occur with the motor disconnected, repair or replace the motor.
MTR CONFIG FLT	Motor configuration fault. Controller parameters not set to comply with the motor being used. The motor HP and current parameters are not compatible. Motor HP too large for controller rating.	If the controller control board is replaced or if the motor is replaced with a different type, the parameters in the Setup Group menu must be set to match the motor nameplate ratings. See Section XI, page 11-1.
	Motor configuration fault. Full Load Speed Parameter 590 set to synchronous speed (i.e., 600, 900, 1200, or 3600 RPM) instead of rated motor full load speed	Set Parameter 590 to the rated full load speed on the motor nameplate. Normal Ranges: 500-595 RPM, 800-890 RPM, 1100-1190 RPM, 1700-1790 RPM, 3450-3580 RPM.
MOTOR CURRENT FLT	Motor current fault. Motor may be overloaded or shorted, or the V/Hz ratio or voltage boost may not be set correctly for the application.	1. Check for mechanical problems that may have caused the overload. 2. If the load is cyclical, a higher rated controller may be required. 3. Disconnect the motor from the controller, and check the resistance between motor leads. If windings are shorted, repair or replace the motor. 4. Increase the Boost Level in the User Group menu. 5. If necessary, readjust the V/Hz ratio to 100% in the User Group menu.

Table 12 - 1: FAULT MESSAGES

FAULT		
DISPLAY MESSAGE	**DESCRIPTION**	**REMEDY**
MOTOR OVERLOAD	Excessive motor current	1. Check for mechanical problems that may be causing the overload. 2. If the overload is continuous, a higher rated controller and motor may be required. 3. Disconnect the motor from the controller, and check the resistance between motor leads. If motor windings are shorted, repair or replace the motor. 4. If necessary, readjust the V/Hz ratio to 100% in the User Group menu.
NO ENCODER OPT	Encoder option not installed	1. Check wiring to encoder option. 2. If encoder option is not used, set Encoder Mode Parameter 750 to NO ENCODER.
OUT PHASE LOSS	No current or incorrect current in one phase of the motor	1. Check for a loose connection between the controller and motor. 2. Check for shorted motor.
OVERTEMP FLT	Over temperature fault. Controller heat sink is too hot	1. Check that the fan(s) are running on the controller. 2. Be sure the ambient temperature does not exceed 48^{o} C (118^{o} F).
PHASE IMBALANCE	Three-phase AC line supply currents not balanced	Be sure all three phases of the AC line supply voltage are balanced.
	If the AC line supply is single-phase, the current rating of the controller was exceeded	Reduce the torque limit (Parameter 150) to keep motor current less than the maximum single-phase controller current rating.
PHASE LOSS FLT	Loss of an AC line supply phase	Check for a blown line fuse or a faulty line supply connection.
POWER LOSS FLT	Interruption of the AC line supply for a time period greater than 60 to 80 milliseconds	Check that rated line voltage is applied to the controller.

Table 12 - 1: FAULT MESSAGES

FAULT		
DISPLAY MESSAGE	**DESCRIPTION**	**REMEDY**
PRECHARGE FLT	Precharge voltage too low	1. Check for a blown DC bus fuse. 2. Check that the line voltage is not lower than the controller rating. 3. A controller filter capacitor or the controller power board may be faulty.
RATING MISMATCH	Drive Rated Amps Parameter 512 set incorrectly	Be sure Parameter 512 and Line Voltage Select Parameter 510 are set to match the nameplate rating of the controller.
USER MEMORY FAULT	User parameter values are corrupted	Select LOAD FACTORY in Program Manager Parameter 850, and then perform the Initial Setup starting on page 11-1.

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SECTION XIII

PARTS LIST

Table 13 - 1: PARTS LIST, 230V CONTROLLERS

PART	PART NUMBER					
	1 - 3HP	5HP	7.5 - 10HP	15HP	20HP	25 - 30HP
Control Board	1065021	1065021	1065021	1065021	1065021	1065021
Fan	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00
IGBT	CM30MD1-12H	CM50MD1-12H	CM100TU-12H	CM150TU-12H	CM200TU-12H	CM300DU-12H
Input Rectifier	NA	NA	MEB0806	SKKT72/08D	SKKT72/08D	SKKT106/08D
Keypad/Display Board	1065187	1065187	1065187	1065187	1065187	1065187
Power Board	1065010	1065010	1065184	1065855	1065855	1065859

Table 13 - 2: PARTS LIST, 460V CONTROLLERS

PART	PART NUMBER								
	1 - 3HP	5HP	7.5 - 10HP	15HP	20HP	25HP	30HP	40 - 50HP	60 - 75HP
Control Board	1065021	1065021	1065021	1065021	1065021	1065021	1065021	1065021	1065021
Fan	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00	4710NL-05W-B50-D00
IGBT	CM15MD1-24H	CM25MD1-24H	CM50TF-24H	CM75TU-24H	CM100TU-24H	CM100DU-24H	CM150DU-24H	CM200DU-24H	CM300DU-24H
Input Rectifier	NA	NA	ME701602	ME501606	ME501606	SKKT42/16E	SKKT42/16E	SKKT106/16E	SKKT162/16E
Keypad/Display Board	1065187	1065187	1065187	1065187	1065187	1065187	1065187	1065187	1065187
Power Board	1065028	1065028	1065018	1065863	1065863	1065867	1065867	1065871	1065875

SECTION XIV

OPTIONS

Options are available for ADX controllers, which increase the functional use of the basic controller. Table 14-1 lists all available options and allowable option combinations.

Options can be added to the basic controller at any time. Each user installed option consists of all required components, installation hardware, and instructions.

Table 14 - 1: ALLOWABLE OPTION COMBINATIONS

OPTION TYPE	OPTION GROUP	OPTION NUMBER	OPTION CODE	OPTION
Braking Options. Use EB With EBR Or User Furnished Resistor Assembly. May Be Used In Combination With Options From Any Other Group.	A	EB	X	Braking, Electronic
		EBR	XK	Braking, Resistor Assembly
Digital Operator Panel Options. Option LSP May Be Used With Any Other Option. Option MBC May Be Used With ADX Controllers Furnished Less Operator Panel.	B	LSP	XK	Potentiometer (Motor Speed)
		MBC	X	Digital Operator Panel (Unenclosed, Separate Mounting)
Options Selected From This Group May Be Combined With Any Other ADX Option.	C	MCI	XK	115V Pushbutton Interface
		ILF	XK	Fuses, Current Limiting AC Line
		EB	See Group A	Braking, Electronic
		PS	XK	Transducer Power Supply
		PSF	XK	Follower, Pneumatic Control Signal
		RO	XK	Output Relays
Enclosure Option. See Table 14-2.	D	AH	X	Auxiliary Enclosure

CODES: X = Factory Installed Only. XK = Factory Or Field Installed

Table 14 - 2: ADX OPTION AH ENCLOSURE MATRIX[a]

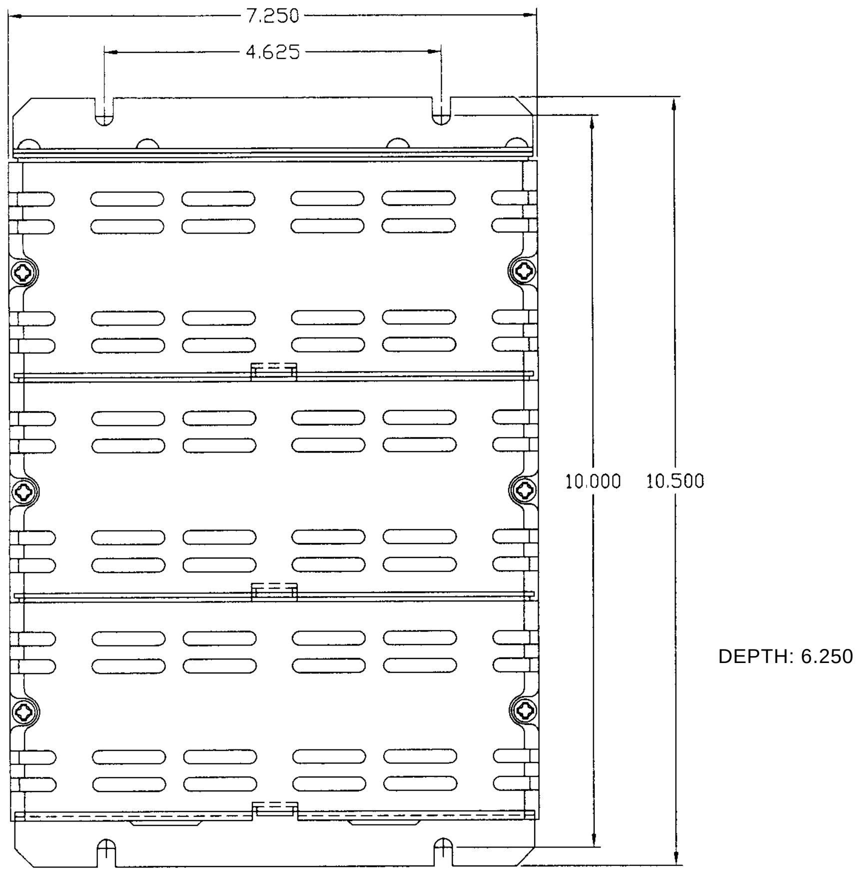
OPTION NUMBER	OPTION NAME	115V KIT REQUIRED
EP	Encoder Feedback	No
LON	LONworks	Yes
MCI	Magnetic Control Interface (115V)	Yes
PS	Transducer Power Supply	Yes
RO	Relay Output	No

a. A maximum of three options can be installed in the enclosure. However, Options EP and PS cannot be mounted in the same enclosure.

OPTION DESCRIPTIONS

AH - ENCLOSURE, AUXILIARY

Consists of a NEMA Type 1. It has ample space for mounting various options as shown in the following drawing.



OPTION AH DIMENSIONS

BMC - BLOWER MOTOR CONTROL

Includes a three-pole AC motor starter with 3-leg overload protection and integral circuit breaker to control and protect an AC force-ventilation blower, mounted on the main drive motor. The blower is energized whenever power is applied to the ADX controller and the optional AC line switch or circuit breaker is closed. This option requires the 115 VAC Control option (not included).

Motor blower is not included with this option.

BMF - BLOWER MOTOR FUSES

Includes three-pole line fuses to protect an AC force-ventilation blower, mounted on the main drive motor. The blower is energized whenever power is applied to the ADX controller and the optional AC line switch or circuit breaker is closed.

Motor blower is not included with this option.

CBH - AC LINE CIRCUIT BREAKER

Provides a 3-pole, magnetic only, fast-trip circuit breaker as a means of manually disconnecting the ADX controller from the AC line.

CCI - CRANE CONTROL JOYSTICK INTERFACE

Provides a method of interfacing a joystick to the 6500 controller. This option allows speed control by either an analog speed potentiometer mounted in the joystick, or by up to five speed selection contacts.

EB - BRAKING, ELECTRONIC

The braking capability of the standard ADX controller is approximately 15-20% (depending on motor characteristics) of rated load torque. This option includes supplemental circuitry which increases the braking capability to 100% of rated torque at motor base speed. This provides faster deceleration and improved control for overhauling loads.

The braking rate is established by the standard deceleration control, effective under the following conditions:

- On a pushbutton stop command or a stop command from external control logic.
- Whenever the speed reference is reset to command a reduction in speed.
- With an overhauling load.

See Option EBR for standard braking resistor packages furnished in a NEMA 1 ventilated enclosure, or the user may provide an assembly in accord with the listed specifications.

EBR - BRAKING, RESISTOR ASSEMBLY

Option EB braking modules can be used with either an Option EBR Braking Resistor package or with user supplied resistors. The following table gives the required electronic braking resistance values and wattage ratings to provide 100% braking torque with standard 460V and 208/230V ADX controllers.

CONTROLLER RATING		RESISTOR RATING		ENCLOSURE DIMENSIONS (Inches (mm))		
VOLTS	**HP**	**TOTAL OHMS**	**TOTAL WATTS**	**H**	**W**	**D**
460	1 - 3	167	150	6.62 (168.2)	9.5 (241.3)	3.54 (89.9)
	5	125	200			
	7.5	83.3	300			
	10	62.5	400			
	15	40.5	510			
	20	30.0	840			
	25	25.8	1260			5.66 (143.8)
	30	22.0	1380			
	40	15.0	1680			
	50	12.9	2520			9.20 (233.7)
	60	10.0	2520			
	75	7.5	3360			11.32 (287.5)
208/230	1 - 3	50.0	150	6.62 (168.2)	9.5 (241.3)	3.54 (89.9)
	5	30.0	250			
	7.5	21.4	350			
	10	13.5	700			
	15	11.0	690			
	20	8.0	1540			
	25	6.5	1680			5.66 (143.8)
	30	5.5	1380			

This option includes a NEMA Type 1 ventilated metal enclosure designed for separate mounting.

The braking circuit is rated for stopping a typical load a maximum number of two stops per minute from motor base speed. A typical load is defined as:

- Not exceeding rated-load torque
- External load inertia (beyond the motor shaft) not exceeding that of the motor rotor. High inertia loads may extend braking times beyond the wattage rating of the power dissipation resistor. The braking circuit is not rated for continuous regeneration and should be used only where intermittent control of overhauling loads is required. The braking circuit is not a holding brake; it will not prevent a motor at rest from rotating.

EP - ENCODER FEEDBACK

Provides a means of interfacing a quadrature encoder or proximity sensor (pulse tachometer generator) for use as speed feedback or as a master speed reference. This option provides improved speed regulation with load changes, and reduced sensitivity to operating conditions such as line voltage variations, ambient temperature changes, motor heating, and other variables as shown in Table 16-2, page 16-4. Using an encoder or proximity sensor (pulse tachometer generator) for a master speed reference allows the speed of the AC motor to follow the speed of another motor or other rotating equipment.

HO - HAND/OFF/AUTO SWITCH

See Option MB.

HP - HAND/OFF/AUTO SWITCH WITH POTENTIOMETER

Includes Option HO and a Speed/Ratio potentiometer.

ILF - FUSES, CURRENT LIMITING

Provides three-pole current limiting, Class J fuses with a clearing capacity of at least 100,000 symmetrical RMS amperes for protection of the plant power bus from fault conditions.

LCE/LCO - REACTORS, AC LINE INDUCTORS

Includes an assembly with three AC line reactors (chokes rated 3% impedance) connected in series with the AC supply lines. The assembly is furnished for separate mounting. These reactors oppose rapid line current changes and surges and help protect the ADX controller from transients.

Option LCE/LCO is not normally needed when the ADX controller is connected to the AC supply through an isolation transformer. However, Option LCE/LCO is suggested whenever:

- The KVA of the AC power supply is greater than three times the horsepower rating of the ADX controller.

- Additional transient voltage surge protection is required.

- It is desirable to isolate inverter ripple currents from the AC line.

- Harmonic distortion must be reduced.

Option LCE/LCO should not normally be used in combination with Option LFE/LFO (Output Filter).

LFE/LFO - OUTPUT FILTER

Filters the AC output of the ADX controller to provide the following benefits:

- Quiet motor operation a low carrier frequencies.
- Elimination of ground fault due to DV/DT.
- Reduced DV/DT stress on motor windings at higher carrier frequencies.
- Reduced electrical interference.

Since this option represents a 3% output impedance, it may not be acceptable in applications characterized by low line voltage, heavy loading, and high speeds, or in combination with AC Line Inductors (Option LCE/LCO).

LON - LONWORKS INTERFACE

Provides a LonWorks port, which conforms to the LonWork profile for variable speed motor drives. An external LonMark complaint device can then control the ADX drive. Additional access, beyond the LonMark profile, is provided to all ADX parameters.

LSP - POTENTIOMETER (Motor Speed)

Includes a single turn, 5K ohms, 2W potentiometer and dial for mounting in a dedicated area in the ADX controller keypad operator panel. The potentiometer is used instead of the FASTER-SLOWER keys to set the desired motor speed.

MB - BYPASS, MAGNETIC (MANUAL SELECTION)

Enables the transfer of the drive motor from the ADX controller to the three-phase AC line for constant speed operation under emergency conditions. Provided is a door mounted HAND/OFF/AUTO switch, magnetic contactors and other components which are furnished in an auxiliary enclosure.

MBC - DIGITAL OPERATOR PANEL (Unenclosed, Separate Mounting)

Provides the standard keypad operator panel furnished with a 10 foot (3.05m) cable and connector for plug-in connection to the ADX controller.

MC - MOTOR CONTACTOR

Provides an AC output contactor that is coordinated with the controller electronics to ensure a safe, reliable shutdown and a positive disconnection of the motor from the ADX controller. This option also ensures that when a Start command is given, the contactor is energized before the motor is permitted to run.

MCI - MAGNETIC CONTROL INTERFACE (115V)

The standard magnetic control run logic excitation in the ADX controller is 24 VDC, obtained from a self-contained power supply in the controller. This option provides a means of interfacing the controller with pushbuttons or external logic powered by a 115 VAC excitation source. The interface circuit includes six relays, which can be used to control Forward, Reverse, Jog Forward, Stop, and two programmable Digital Inputs. The Digital Inputs can control Faster, Slower, Auto/Manual, Preset Speed, and Jog Reverse. This option requires the Auxiliary Enclosure Option (AH).

MDS - MULTI DRIVE SEQUENCING

Provides the necessary logic to coordinate the operation of up to four ADX drives powering pumps or fans in a sequentially additive manner for the control of a common system parameter such as temperature, pressure, flow, liquid level, etc. A typical system utilizes a number of ADX drives, each sized to handle a percentage of the total system load. If more than four drives are to be sequenced, contact the factory. The benefits of this method include:

- Improved efficiency and reduced power consumption, since only the drives necessary to satisfy the system demand will be energized at any given time.

- Reduced and/or equalized wear of the individual drives, and fans or pumps.
- Enhanced system reliability since the total system demand is distributed among multiple drives. Inherent backup is provided by the remaining drives if any drives malfunction.

Typical operation with minimal system demand causes the lead drive to modulate its pump or fan speed in accord with system demand. If the lead drive reaches maximum speed and system demand continues to increase, the next drive would be called upon to modulate its pump or fan speed. Both drives will then operate at a common speed to provide maximum wire to air or water efficiency. This sequence would continue as demand increases until all of the drives in the system are operating. As the system demand reduces, the drives will sequence in the opposite direction.

This option includes a switch to allow selection of the lead/lag operating sequence of the drives in the system. The option does not include a time clock for automatic, periodic selection of the operating sequence to equalize wear of the drives. If a time clock is required, contact the factory.

OR - OVERLOAD RELAY

Includes a standard NEMA rated 3-pole overload relay. Motor full-load current must match listed adjustment range.

PS - TRANSDUCER POWER SUPPLY/ISOLATOR

Permits the use of L91B resistive or LVDT type pressure transducers widely used in the pumping industry. These transducers may be connected directly to the ADX controller without an intermediate signal conditioning process controller, since the unit includes a standard integral PID control feature. This option includes a transducer power supply, rated $\pm$5 VDC at 90 mA. The circuit is rated for short circuit current to protect the ADX controller from an accidentally grounded transducer. This option requires the Auxiliary Enclosure Option (AH).

PSF - FOLLOWER, PNEUMATIC CONTROL SIGNAL

Converts a 0-15 PSI pneumatic process air signal into an electrical signal which the ADX drive can follow. Other pressure ranges are available upon special order.

RO - RELAY OUTPUT OPTION

Provides three relays with Form C contacts rated 5 amps at 250 VAC or VDC for customer use to annunciate the digital control outputs provided on the ADX controller control board. Option RO allows these outputs to be used with warning devices such as bells, buzzers and indicator lights or other monitoring devices. This option requires the Auxiliary Enclosure Option (AH).

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SECTION XV

PARAMETER LISTS

This section provides data on all parameters. For each parameter, the range of adjustment has been determined based on a wide variety of application demands, and in some cases, nonstandard drive configurations. This occasionally leads to adjustment values that exceed the specified performance of the ADX drive. Therefore, the range of parameter adjustment should never be taken as a measure of drive capability. While there is no risk of harming the drive through programming, the extremes of certain adjustments may not produce the intended result.

REFERENCE GROUP 000 - 199

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
000	RUN SPEED CMD	%	0	100	0	
001	JOG SPEED CMD	%	0	100	0	
010	PRESET #1	%	-100	100	0	
011	PRESET #2	%	-100	100	0	
012	PRESET #3	%	-100	100	0	
013	PRESET #4	%	-100	100	0	
014	PRESET #5	%	-100	100	0	
015	PRESET #6	%	-100	100	0	
016	PRESET #7	%	-100	100	0	
020	AUTO SPEED	%	-100	100	0	
025	SPEED TRIM	%	-30	30	0	
030	SPEED RATIO	%	0	300	100	
120	MINIMUM SPEED	%	0	75	0	
121	MAXIMUM SPEED	%	50	100	100	
150	TORQUE LIMIT	%	20	200	150	
152	AUTO TORQUE LMT	%	20	200	150	
160	TAPER #1 SPEED	%	0	100	0	
161	TAPER #1 SLOPE	%	0	300	0	
162	TAPER #2 SPEED	%	0	100	0	
163	TAPER #2 SLOPE	%	0	300	0	
170	PID SETPOINT	%	-100	100	0	

CONTROL GROUP 200 - 359

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
200	PID MODE		0	1	0 (Cmd/ Fdbk Input)	
201	PID PROP GAIN	%	0	300	0	
202	PID INT GAIN	%	0	300	0	
203	PID DERIV GAIN	%	0	300	0	
204	PID MAX OUTPUT	%	-200	200	100	
205	PID MIN OUTPUT	%	-200	200	0	
250	RUN ACCEL	SEC	0.1	1900	10	
251	RUN FWD ACCEL	SEC	0.1	1900	10	
252	RUN REV ACCEL	SEC	0.1	1900	10	
253	JOG ACCEL	SEC	0.1	1900	10	
254	JOG FWD ACCEL	SEC	0.1	1900	10	
255	JOG REV ACCEL	SEC	0.1	1900	10	
256	PRESET ACCEL	SEC	0.1	1900	10	
257	PRESET FWD ACCEL	SEC	0.1	1900	10	
258	PRESET REV ACCEL	SEC	0.1	1900	10	
259	RUN DECEL	SEC	0.1	1900	10	
260	RUN FWD DECEL	SEC	0.1	1900	10	
261	RUN REV DECEL	SEC	0.1	1900	10	
262	JOG DECEL	SEC	0.1	1900	10	
263	JOG FWD DECEL	SEC	0.1	1900	10	
264	JOG REV DECEL	SEC	0.1	1900	10	
265	PRESET DECEL	SEC	0.1	1900	10	
266	PRESET FWD DECEL	SEC	0.1	1900	10	
267	PRESET REV DECEL	SEC	0.1	1900	10	
270	RAMP TYPE		0	1	0 (Linear)	
271	RAMP CONTROL		0	1	1 (Non-Directional)	
300	SPEED PROP GAIN	%	1	327.67	50	
301	SPEED INT GAIN	%	0	327.67	10	
302	SPEED DERIV GAIN	%	0	300	0	
303	ZERO SPD TORQUE		0	1	0 (Disabled)	
305	RESPONSE	%	0.1	100	100	
335	FIELD TRIM	%	50	150	100	
340	BOOST LEVEL	%	0	200	10	
342	MAX BOOST SPEED	%	0.5	15	2	
343	VOLTS PER HERTZ	%	80	120	100	
344	SLIP COMP	%	0	100	0	
346	BRAKING MODE		0	3	0 (Disabled)	
347	BRAKING LEVEL	%	0	100	0	
348	BRAKING TIME	SEC	0	25.5	0	
350	DWELL SPEED	%	0	100	0	
351	DWELL TIME	SEC	0	25.5	0	
352	BAND #1 SETPOINT	%	0	100	0	
353	BAND #1 WIDTH	%	0	20	0	
354	BAND #2 SETPOINT	%	0	100	0	
355	BAND #2 WIDTH	%	0	20	0	
356	BAND #3 SETPOINT	%	0	100	0	
357	BAND #3 WIDTH	%	0	20	0	

STATUS GROUP 360 - 499

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
380	AOUT1 MONITOR		0	1	0	
381	AOUT1 STATUS		0	131	128	
382	AOUT1 VALUE	%	-327.67	327.67	0	
383	AOUT2 MONITOR		0	1	0	
384	AOUT2 STATUS		0	131	128	
385	AOUT2 VALUE	%	-327.67	327.67	0	
386	AOUT3 MONITOR		0	1	0	
387	AOUT3 STATUS		0	131	128	
388	AOUT3 VALUE	%	-327.67	327.67	0	
440	AIN1 MONITOR		0	31	0	
441	AIN1 STATUS		0	255	128	
442	ANALOG INPUT #1	%	-327.67	327.67	0	
443	AIN1 LO ALARM	%	-327.68	327.67	-327.68	
444	AIN1 LO WARNING	%	-327.68	327.67	-327.68	
445	AIN1 HI WARNING	%	-327.68	327.67	-327.68	
446	AIN1 HI ALARM	%	-327.68	327.67	-327.68	
447	AIN1 OVERRIDE	%	-327.67	327.67	0	
448	AIN1 DIFFERENTIAL	%	0	327.67	5	
449	AIN1 LOSS		0	2	0 (Disabled)	
450	AIN2 MONITOR		0	31	0	
451	AIN2 STATUS		0	255	128	
452	ANALOG INPUT #2	%	-327.67	327.67	0	
453	AIN2 LO ALARM	%	-327.68	327.67	-327.68	
454	AIN2 LO WARNING	%	-327.68	327.67	-327.68	
455	AIN2 HI WARNING	%	-327.68	327.67	-327.68	
456	AIN2 HI ALARM	%	-327.68	327.67	-327.68	
457	AIN2 OVERRIDE	%	-327.67	327.67	0	
458	AIN2 DIFFERENTIAL	%	0	327.67	5	
459	AIN2 LOSS		0	2	0 (Disabled)	
460	AIN3 MONITOR		0	31	0	
461	AIN3 STATUS		0	255	128	
462	ANALOG INPUT #3	%	-327.67	327.67	0	
463	AIN3 LO ALARM	%	-327.68	327.67	-327.68	
464	AIN3 LO WARNING	%	-327.68	327.67	-327.68	
465	AIN3 HI WARNING	%	-327.68	327.67	-327.68	
466	AIN3 HI ALARM	%	-327.68	327.67	-327.68	
467	AIN3 OVERRIDE	%	-327.67	327.67	0	
468	AIN3 DIFFERENTIAL	%	0	327.67	5	
469	AIN3 LOSS		0	2	0 (Disabled)	
470	LOAD MONITOR		0	31	0	
471	LOAD STATUS		0	255	128	
472	MOTOR LOAD	%	-327.67	327.67	0	
473	LOAD LO ALARM	%	-327.68	327.67	-327.68	
474	LOAD LO WARNING	%	-327.68	327.67	-327.68	
475	LOAD HI WARNING	%	-327.68	327.67	-327.68	
476	LOAD HI ALARM	%	-327.68	327.67	-327.68	
477	LOAD OVERRIDE	%	-327.67	327.67	0	
478	LD DIFFERENTIAL	%	0	327.67	5	
480	FIELD MONITOR		0	31	0	
481	FIELD STATUS		0	255	128	
482	MOTOR FIELD	%	-327.67	327.67	0	

STATUS GROUP 360 - 499

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
483	FIELD LO ALARM	%	-327.68	327.67	-327.68	
484	FIELD LO WARNING	%	-327.68	327.67	-327.68	
485	FIELD HI WARNING	%	-327.68	327.67	-327.68	
486	FIELD HI ALARM	%	-327.68	327.67	-327.68	
487	FIELD OVERRIDE	%	-327.67	327.67	0	
488	FLD DIFFERENTIAL	%	0	327.67	5	
490	DC BUS MONITOR		0	31	0	
491	DC BUS STATUS		0	255	128	
492	BUS VOLTAGE	VOLTS	0	900	325	
493	BUS LO ALARM	VOLTS	-3276.8	3276.7	-3276.8	
494	BUS LO WARNING	VOLTS	-3276.8	3276.7	-3276.8	
495	BUS HI WARNING	VOLTS	-3276.8	3276.7	-3276.8	
496	BUS HI ALARM	VOLTS	-3276.8	3276.7	-3276.8	
497	BUS OVERRIDE	VOLTS	0	900	0	
498	BUS DIFFERENTIAL	VOLTS	0	3276.7	50	

SETUP GROUP 500 - 699

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
500	QUADRANT SELECT		0	15	9 (Quadrants 1 & 4)	
504	OVERLOAD THRESH	%	20	115	115	
505	OVERLOAD TIME	SEC	1	60	60	
510	LINE VOLTAGE SEL		0	6	5 (460)	
511	CUSTOM LINE VOLT	VOLTS	0	506	460	
512	DRIVE RATED AMPS		0	18	0 (4.8 Amps RMS)	
513	OPERATING MODE		0	5	0 (V/F Const Torq)	
515	PHASE LOSS		0	3	1 (In Loss Enable)	
517	PWR SUPPLY LOSS		0	1	1 (Enabled)	
518	OVERTEMPERATURE		0	1	1 (Enabled)	
520	DIG OUT1 SOURCE		0	23	3 (At Speed)	
521	DIG OUT2 SOURCE		0	23	22 (Zero Speed)	
522	DIG OUT3 SOURCE		0	23	12 (Motor Overload)	
528	DOUT FLT ENABLE		0	1	0 (Disabled)	
529	DIG OUT INVERT		0	7	7 (Invert All)	
530	ANLG OUT1 SOURCE		0	19	9 (Output Freq)	
531	ANLG OUT1 INVERT		0	1	1 (Normal)	
533	ANLG OUT1 OFFSET	%	-300	300	0	
534	ANLG OUT1 SCALE	%	0	327.67	100	
536	ANLG OUT2 SOURCE		0	19	0 (Actual Speed)	
537	ANLG OUT2 INVERT		0	1	1 (Normal)	
539	ANLG OUT2 OFFSET	%	-300	300	0	
540	ANLG OUT2 SCALE	%	0	327.67	100	
542	ANLG OUT3 SOURCE		0	19	6 (Motor Load)	
543	ANLG OUT3 INVERT		0	1	1 (Normal)	
545	ANLG OUT3 OFFSET	%	-300	300	0	
546	ANLG OUT3 SCALE	%	0	327.67	100	
550	DIGITAL INPUT #1		0	5	2 (None)	
551	DIGITAL INPUT #2		0	5	2 (None)	
552	DIGITAL INPUT #3		0	5	2 (None)	
560	ANLG IN1 INVERT		0	1	1 (Normal)	
561	ANLG IN1 OFST MODE		0	1	0 (Zero Below)	
562	ANLG IN1 OFFSET	%	-300	300	2	
563	ANLG IN1 SCALE	%	0	327.67	100	
564	ANLG IN1 FILTER	%	0.1	100	5	
565	ANLG IN2 INVERT		0	1	1 (Normal)	
566	ANLG IN2 OFST MODE		0	1	0 (Zero Below)	
567	ANLG IN2 OFFSET	%	-300	300	20	
568	ANLG IN2 SCALE	%	0	327.67	123.58	
569	ANLG IN2 FILTER	%	0.1	100	5	
570	ANLG IN3 INVERT		0	1	1 (Normal)	
571	ANLG IN3 OFST MODE		0	1	0 (Zero Below)	
572	ANLG IN3 OFFSET	%	-300	300	2	
573	ANLG IN3 SCALE	%	0	300	100	
574	ANLG IN3 FILTER	%	0.1	100	5	
578	DELAYED START		0	1	0 (Disabled)	
579	START INPUTS		0	3	1 (Keypad Only)	
580	STARTING MODE		0	3	0 (Normal)	
581	RESTART TRIES		0	5	0	
582	RESTART WINDOW	SEC	300	65535	300	

SETUP GROUP 500 - 699

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
583	RESTART DELAY	SEC	3	60	5	
584	TURN ON DELAY	SEC	0.5	25.5	3	
585	STOPPING MODE		0	1	0 (Controlled Stop)	
590	FULL LOAD SPEED	RPM	350	24000	1760	
591	MOTOR HP	HP	1	75	3	
592	MOTOR EFFICIENCY	%	60	99	89	
593	MOTOR FREQUENCY	Hz	25	600	60	
594	MOTOR RATED AMPS	AMPS	1	115	4.8	
595	MANUAL MODEL	%	0	1	0 (Disabled)	
596	STATOR RESISTANCE	%	0	20	2	
597	ROTOR RESISTANCE	%	0	20	2	
598	STATOR INDUCTANCE	%	20	300	150	
599	SIGMA	%	1	50	5	
600	CARRIER FREQ	KHz	0	8	3 (5 KHz)	
601	V/F PROFILE LIST		0	21	1 (60 Hz)	
602	FREQUENCY RANGE	HZ	25	600	60	
603	VOLTAGE KNEE	%	10	100	100	
604	V/F CURVE SHAPE		0	1	0 (Linear)	
605	NON-LINEARITY	%	10	100	100	
680	RUN SPEED SOURCE		0	5	3 (Local Digital)	
681	JOG SPEED SOURCE		0	5	3 (Local Digital)	
682	TRQ LIMIT SOURCE		0	5	3 (Local Digital)	
683	PID REF SOURCE		0	4	3 (Local Digital)	
684	PID FDBK SOURCE		0	3	1 (Analog Input #2)	
685	PID ERROR SOURCE		0	3	1 (Analog Input #2)	
686	RATIO SOURCE		0	5	3 (Local Digital)	
687	SPD TRIM SOURCE		0	5	3 (Local Digital)	
688	AUTO CONTROL		0	2	0 (Speed Command)	
689	AUTO SPD SOURCE		0	5	0 (Analog Input #1)	
690	AUTO TRQ SOURCE		0	5	1 (Analog Input #2)	
691	SPD FDBK SOURCE		0	4	0 (Sensorless)	
695	SETUP NUMBER		0	13	0 (No Special Setup)	

OPTIONS GROUP 700 - 799

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
700	EB SETUP		0	1	1 (EB Disabled)	
703	EB REGEN LIMIT	%	-150	10	-100	
720	TORQUE LEVEL	%	0	100	20	
721	FWD BRAKE SPEED	%	0	20	4	
722	REV BRAKE SPEED	%	0	20	4	
740	SERIAL SETUP		0	4	3 (9600 Baud)	
741	NETWORK ADDRESS		1	255	1	
750	ENCODER MODE		0	5	0 (No Encoder)	
751	FEEDBACK SCALING	LINES	0	30000	1024	
752	FEEDBACK FILTER	%	0.1	100	100	
753	MASTER SCALING	LINES	0	30000	1024	
754	MASTER FILTER	%	0.1	100	100	

UTILITY GROUP 850 - 891

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
850	PROGRAM MANAGER		0	4	0 (No Change)	
851	CONFIG USER MENU		0	3	1 (No Change)	
853	FAULT HISTORY		0	5	0	
854	DRIVE LEGEND		0	16	????????????????	
855	CUSTOM SOURCE		0	19	0 (Actual Speed)	
856	CUSTOM SCALE	%	0	327.67	100	
857	CUSTOM OFFSET	%	-327.67	327.67	0	
858	CUSTOM UNITS		0	4	????	
860	SET PASSWORD		0	65535	0	
870	PASSWORD ENTRY		0	65535	0	
880	DISPLAY LINE #1		0	15	4 (Motor Speed)	
881	DISPLAY LINE #2		0	15	5 (Motor Load)	
882	CONFIG MONITOR		0	7	7 (Change Disp&Speeds)	
890	ELAPSED HOURS	HOURS	0	65535	0	
891	ELAPSED MINUTES	MIN	0	59	0	
892	MONTH		1	12	Varies	
893	DAY OF MONTH		1	31	Varies	
894	YEAR		0	9999	Varies	
895	DAY OF WEEK		0	8	Varies	
896	HOURS	HOURS	0	23	0	
897	MINUTES	MIN	0	59	0	
898	SECONDS	SEC	0	59	0	

REMOTE PARAMETERS FOR SERIAL PORT AND APPLICATION PROGRAMS

PARAMETER		UNIT	RANGE		FACTORY PRESET	USER SETTING
NO.	NAME		MINIMUM	MAXIMUM		
002	Run Speed	%	-100	100	0	
003	Jog Speed	%	-100	100	0	
021	Auto Speed	%	-100	100	0	
026	Speed Trim	%	-30	30	0	
031	Ratio	%	0	300	100	
151	Torque Limit	%	20	200	150	
153	Auto Torque Limit	%	20	200	150	
171	PID Setpoint	%	-100	100	0	
172	PID Feedback	%	-300	300	0	
173	PID Error	%	-300	300	0	
525	Digital Output		0	7	0	
535	Analog Output #1	%	-100	100	0	
541	Analog Output #2	%	-100	100	0	
547	Analog Output #3	%	-100	100	0	
859	Custom Parameter	%	-327.67	327.67	0	

FACTORY PARAMETERS

PARAMETER NO.	PARAMETER NAME	UNIT	RANGE MINIMUM	RANGE MAXIMUM	FACTORY PRESET	USER SETTING
800	Bus V Response	%	0	100	15	
801	Comp Response	%	1	100	5	
802	Trq Reg P Gain	%	0.1	100	15	
803	Trq Reg I Gain	%	0	100	1	
804	Cvrsn Time	USEC	-3000	3000	300	
805	Ext Mon Line 1 Prmtr No		0	999	0	
806	Ext Mon Line 2 Prmtr No		0	999	0	
808	No EB Regen Limit	%	-150	10	-15	
809	Stop Delay	SEC	0	25.5	10	
810	Search Field	%	0	150	10	
811	Search Trq Lmt	%	0	150	50	
815	Field I Gain	%	0	300	10	
817	Spd Srch Regen Lmt	%	-100	10	-10	
999	Serial Number		0	16	0	

NON-MENU READ ONLY PARAMETERS

PARAMETER NO.	PARAMETER NAME	UNIT	RANGE MINIMUM	RANGE MAXIMUM
899	Milliseconds	MSEC	0	999
900	Keypad Keys		0	255
901	Power 10VDC	VOLTS	0	12.55
902	Power 24VDC	VOLTS	0	35.31
903	Speed Cmd	%	-100	100
904	Speed Acc/Dec	%	-100	100
905	Actual Speed	RPM	0	24000
906	Motor Volts	VOLTS	0	506
907	Motor Amps	AMPS	0	300
908	Power	KW	-300	300
909	Digital Inputs		0	255
910	PID Output	%	-300	300
911	Speed Opr Control	%	-100	100
912	Overload Integ	%	-327.67	327.67
913	Drive Status		0	16
914	Run Keys		0	255
915	Custom Parameter		-3276.7	3276.7
916	Speed Ratio	%	0	300
917	Torque Limit	%	0	200
918	Restarts		0	5
919	Logic Status		0	65535
920	Present Fault		0	31
921	Max Torque Cmd	%	0	0
922	Window Timer		0	65535
923	Status Flags #1		0	65535
924	Status Flags #2		0	65535
925	PID Reference	%	-300	300
926	PID Feedback	%	-300	300

NON-MENU READ ONLY PARAMETERS

PARAMETER		UNIT	RANGE	
NO.	NAME		MINIMUM	MAXIMUM
927	PID Error	%	-300	300
928	PID Integrator	%	-300	300
929	PID Derivative	%	-300	300
930	Software Version		0	655.35
931	Load Current Cmd	%	-250	250
932	Load Current Fdbk	%	-327.67	327.67
933	Load Current Error	%	-327.67	327.67
934	Field Current Cmd	%	-250	250
935	Torque Command	%	0	200
936	Percent Amps	%	0	300
937	Field Decoupler	%	-327.67	327.67
938	Load Current Integ	%	-300	300
939	Bus Voltage Ripple	%	0	100
940	Bus Voltage	VOLTS	0	900
941	Frequency Scale		-32767	32767
942	Phase Inc		-32767	32767
943	Frequency	Hz	0	600
944	Percent Frequency	%	0	100
945	PWM Voltage		0	5188
946	Bus Volts Comp	%	100	200
947	Regen Limit Setpoint	%	-250	10
948	IDS Offset		-16383	16383
949	IQS Offset		-16383	16383
950	Speed Integ	%	-300	300
951	Speed Derivative	%	-300	300
952	Speed Reference	%	-100	100
953	Speed Feedback	%	-300	300
954	Speed Error	%	-300	300
955	Speed Trim	%	-30	30
956	Slip Comp Speed	%	-20	20
957	Encoder Feedback	%	-200	200
958	Percent Speed	%	0	300
959	Pulse Tach Status		0	65535
960	Load Voltage	%	-100	100
961	Field Voltage	%	-100	100
962	Percent Voltage	%	-100	100
963	Percent Power	%	-300	300
964	Percent Frequency	%	-100	100
970	Rotor Time Constant		0	327.67
971	Sync Speed	RPM	0	24000
972	Slip Speed	RPM	0	24000
973	Poles		0	16
974	Motor Pf	%	50	100
975	Nominal Field	%	0	100
976	Percent Slip	%	-200	200
977	Run Spd Command	%	-100	100
978	Jog Spd Command	%	-100	100
979	Auto Spd Command	%	-100	100
980	Auto Torque Cmd	%	-200	200
981	Accel Forward	SEC	0.1	1900
982	Decel Forward	SEC	0.1	1900
983	Accel Reverse	SEC	0.1	1900

NON-MENU READ ONLY PARAMETERS

PARAMETER		UNIT	RANGE	
NO.	NAME		MINIMUM	MAXIMUM
984	Decel Reverse	SEC	0.1	1900
985	IDS Stationary	%	-327.67	327.67
986	IQS Stationary	%	-327.67	327.67
987	Selected Speed	%	-100	100
988	Filter Field Trim	%	50	150
990	Scaled Analog Input #1	%	-327.67	327.67
991	Scaled Analog Input #2	%	-327.67	327.67
992	Scaled Analog Input #3	%	-327.67	327.67
997	Parameter Number		0	65535
998	Foreground Loop Time	USEC	0	6000

SECTION XVI

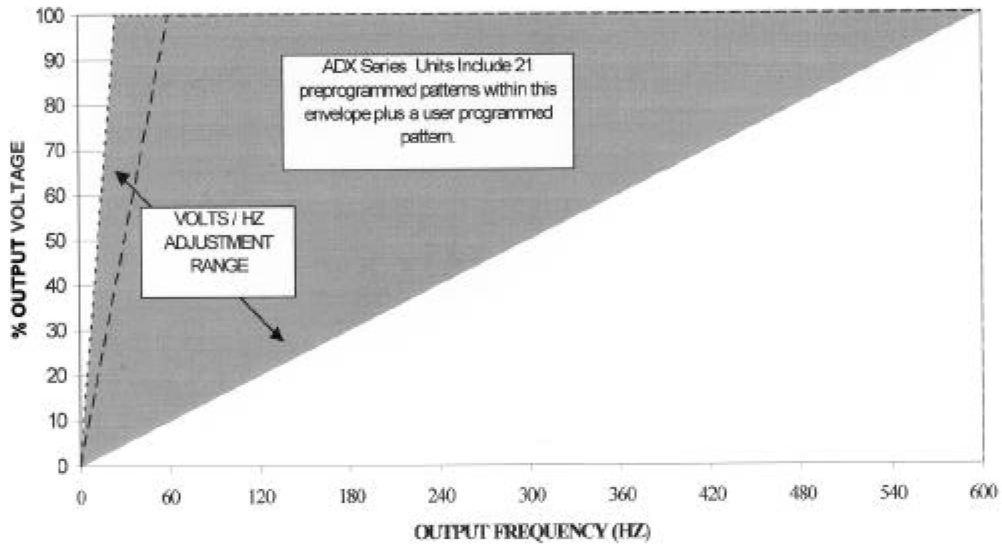
RATINGS AND FEATURES

RATINGS

- Duty . . . . Industrial, Continuous
- External Reference Source[1] . . . . 0 - 10 VDC or 2 - 10 mA, 4 - 20 mA, or 10 - 50 mA[2]
- Horsepower Range . . . . 1 - 75 HP (See Table 1-1, page 1-3)
- Line Power[3] . . . . 208/230V or 460V, Three-Phase, 50 or 60 Hz
- Linearity (Output To Input) . . . . ±0.1% Maximum
- Magnetic (Pushbutton) Control Voltage . . . . 24 VDC[4]
- Output Power (Three-Phase)
  - a. Voltage . . . . 0 - Rated Line Voltage
  - b. Frequency. . . . . 0 - 400 Hz Constant Torque (Constant V/Hz)[5]
  - c. Selectable Option. . . . . 50 - 400 Hz Constant HP (Constant V, Variable Hz)[5]
- Overload Capacity . . . . 150% for 60 seconds
- Reference Power Supply. . . . . 10 VDC @ 5 mA
- Service Factor. 1.0
- Storage Temperature. . . . . 0 - 70° C (32° F - 158° F)

---

1. Isolated reference, external control signal may be grounded or ungrounded.
2. Inputs of 2 - 10 mA and 10 - 50 mA require an external load resistor.
3. 190V, 380V, and 415V 50 or 60 Hz models are available.
4. The use 115 VAC control voltage is available (Option MCI).
5. See Figure 16-1, page 16-2. Standard range: 0 - 400 Hz. Custom range: 0 - 600 Hz



ADJUSTMENT RANGE FOR CONSTANT TORQUE APPLICATIONS.

ADJUSTMENT RANGE FOR CONSTANT HP APPLICATIONS.

ADJUSTMENT RANGE FOR 60 HZ CONSTANT TORQUE APPLICATIONS. ADX SERIES CONTROLLERS ARE SHIPPED WITH THIS ADJUSTMENT.

FIGURE 16 - 1. VOLTS/HERTZ ADJUSTABLE RANGE

Table 16 - 1: RATINGS

COMPONENT			RATINGS														
RATED HORSEPOWER (HP)			1	1.5	2	3	5	7.5	10	15	20	25	30	40	50	60	75
RATED KILOWATTS (kW)			0.746	1.12	1.49	2.24	3.73	5.6	7.5	11.2	14.9	18.7	22.4	29.8	37.3	44.8	56.0
3-PHASE AC INPUT AND OUTPUT (FULL-LOAD)	AMPS @ 460V	INPUT[a]	2.4	3.5	4.5	6.5	10.3	15.0	19.0	28.0	37.0	46.0	54.0	71.0	88.0	105.0	131.0
		OUTPUT	2.1	3.0	3.4	4.8	7.6	11.0	14.0	21.0	27.0	34.0	40.0	52.0	65.0	77.0	96.0
	AMPS @ 230V	INPUT[a]	4.7	6.8	8.8	15.0	19.0	28.0	37.0	54.0	71.0	88.0	105.0	131.0	177.0	154.0	192.0
		OUTPUT	4.2	6.0	6.8	9.6	15.2	22.0	28.0	42.0	54.0	68.0	80.0	104.0	130.0	154.0	192.0
	AMPS @ 208V	INPUT[a]	5.2	7.5	9.7	15.0	28.0	37.0	46.0	71.0	88.0	105.0	131.0	155.0	143.0	169.0	211.0
		OUTPUT	4.6	6.6	7.5	10.6	16.7	24.2	30.8	46.2	59.4	74.8	88.0	114.0	143.0	169.0	211.0
MOTOR TORQUE (LB.-FT).	MOTOR SPEED (RPM)[b]	3500	1.5	2.2	3	4.5	7.5	11.3	15	22.5	30	38	45	60	75	90	113
		1750	3	4.5	6	9	15	23	30	45	60	75	90	120	150	180	225
		1150	4.5	6.9	9	14	23	34	45	68	91	114	137	182	228	274	342
MINIMUM TRANSFORMER KVA FOR VOLTAGE MATCHING[c]			2	3	3	5	7.5	11	11[c]	20	27	27[c]	34[c]	40[c]	51[c]	63[c]	75[c]

a. AC line currents listed are with a low impedance line without line chokes or transformer. The AC line KVA capacity should not exceed three times the drive capacity. The use of AC Line Reactors (Option LCE/LCO), DC Filter Choke (Option LFE/LFO), or an isolation transformer will reduce AC line current substantially.

b. Data listed is rated torque at or below base speed. Continuous duty application of these motors is typically limited to 100% rated torque down to 60% of base speed, or 70% of rated torque over a 10:1 speed range.

c. Transformer with a K-factor of K-4 or greater. If K-factor rating is less than K-4, use the next higher rated transformer.

Ratings

OPERATING CONDITIONS

- Altitude, Standard. . . . . 1000 Meters (3300 Feet) Maximum
- Ambient Temperature . . . . 0 - 40°C (32°F - 104°F)
- Line Frequency Variation. . . . . 50 or 60 Hz, ± 5%
- Line Voltage Variation. . . . . ±10% Of Rated
- Relative Humidity. . . . . 95% Non Condensing

PERFORMANCE CHARACTERISTICS

- Controlled Speed Range - Zero to motor base speed, constant or variable torque operation with NEMA B AC induction motors.

  Constant horsepower operation at speeds above motor base speed (with induction motors only) is a standard, selectable capability. See Figure 16-1, page 16-2. Speed range with respect to the specified speed regulation is listed in Table 16-2, page 16-4.

- Displacement Power Factor. 95%
- Efficiency (at rated speed, rated load at the specified carrier frequency)

CARRIER FREQUENCY (KHz)	2	3	4	5
Controller	97.0%	96.8%	96.6%	96.4%
Controller with 93% Efficient Motor	90.2%	90.0%	89.8%	89.7%

- Frequency Resolution (at 60 Hz)

  a. Analog Input. . . . . 0.0146 Hz

  b. Digital Input. . . . . 0.0060 Hz

- Frequency Stability. 0.005%
- Modulation Frequency . . . . .2, 3, 4, or 5 KHz
- Speed Regulation (See Table 16-2) - Regulation percentages listed are of motor rated (base) speed under steady-state operating conditions.

Table 16 - 2: SPEED REGULATION

REGULATION METHOD	MOTOR TYPE		LOAD CHANGE 95%	LINE VOLTAGE ± 10%[a]	MOTOR HEATING (COLD TO NORMAL)	TEMPERATURE ± 10° C (CONTROLLER AND MOTOR)	SPEED RANGE[b]
	INDUCTION	SYNCHRONOUS					
Volts/Hertz[c]	X	NA	3.00%	0.50%	1.00%	0.25%	30:1
	NA	X	0.00%	0.00%	0.00%	0.25%	d
Slip Comp[c]	X	NA	1.00%	0.50%	0.50%	0.25%	30:1
	NA	X	0.00%	0.00%	0.00%	0.00%	60:1
Sensorless Torque Control	X	NA	0.50%	0.50%	0.50%	0.25%	50:1
	NA	NA	NA	NA	NA	NA	NA
Encoder Feedback (Option EP)[e]	X	NA	0.02%	0.02%	0.02%	0.25%	100:1
	NA	NA	NA	NA	NA	NA	NA

a. Shown at full load, full speed. Lighter loads and/or reduced speeds are 0.0%.
b. Consult factory for speed range of specific motors.
c. Listed are average, expected values when using a wide range of standard motors. Results may vary with some makes of motors.
d. Consult factory for speed range of specific makes of motors.
e. 1000 PPR (minimum) encoder.

ADJUSTMENTS

All adjustable parameters are programmed digitally via the standard keypad operator panel or via the standard serial port. Basic adjustments that are most likely to be adjusted by the equipment operator are located in the User Group of parameters. For a description of these adjustments, see page 4-7. For instructions on how to make basic adjustments to the ADX controller, refer to “Changing User Group Parameter Values” on page 4-2.

FEATURES

- **AC Line Voltage Compensation -** Holds output voltage constant with rated line voltage variations when output voltage is less than line voltage.
- **Analog Inputs -** See page 10-2.
- **Analog Input Loss -** Detects the loss of a 4-20 mA analog input by determining if the input current drops below a user programmable level. The user has the option of generating a fault, replacing the analog input with a fixed reference, or turning on a programmable digital alarm output when the input is lost.
- **Analog Outputs -** See page 10-8.
- **Auto/Manual Modes -** See page 10-11.
- **Automatic Restart -** See page 10-12.
- **Carrier Frequency -** Selectable with Parameter 600 as listed in the following table:

CONTROLLER RATING	CARRIER FREQUENCY (KHZ)[a]								
	2	3	4	5	6	7	8	9	10
3 - 15 HP, 208/230V 3 - 30 HP, 460V	X	X	X	X	0	0	0	0	0
20 - 30 HP, 208/230V 40 - 75 HP, 460V	X	X	0	0	0	0	0	0	0

a. X indicates selection is allowed.
0 indicates selection is **not** allowed.

Lower carrier frequencies reduce power consumption of the drive, but increase the audible noise of the motor. Higher carrier frequencies provide quiter motor operation at slightly higher drive power consumption. However, if the carrier frequency is set higher than the allowable selections in the above table, a Carrier Frequency fault or controller damage may occur.

- **Control Board Terminals -** See Table 2-3 on page 2-14.
- **Custom Displays -** See page 10-14.
- **Control Power Supply -** A 24 VDC power supply isolates all magnetic control for pushbuttons and external Run-Stop logic from the AC power source for operator protection and equipment reliability.
- **DC Injection Braking -** See page 10-16.
- **Digital Outputs -** See page 10-17.
- **Dwell -** See page 10-21.

- **Fault Trip Reset -** If a fault trip occurs, the ADX controller offers two of reset modes:

  a. Disconnect and reapply power.
  b. Reset by STOP key (but not by an EMERGENCY STOP button).

- **Inverse Time Motor Overload Protection -** See page 10-22. Inverse time motor overload protection provides a programmable threshold and time-to-trip to reduce the potential of costly motor damage.

  Note: To ensure motor protection, a motor thermal switch is suggested.

- **Isolated Regulator -** Internal logic and control circuits are isolated from the AC power source and internal DC power circuitry for operator and equipment safety and for simplified application. Isolation eliminates the common condition of line voltage to ground potentials being present on the speed control potentiometer.

- **Line Starting Capability -** The ADX controller can be programmed to start when the main AC power is applied to its input terminals.

- **Multiple Motor Operation -** The ADX controller is capable of operating multiple motors at a common frequency. All motors will track the common output frequency of the controller. Synchronous motors are ideal for this purpose, since they will provide identical motor to motor shaft speeds. For multiple motor operation, only volts/Hertz operation is recommended.

- **Operation -** The ADX controller provides volts/Hertz, sensorless torque, or closed loop flux vector control operation. In the Volts/Hertz mode, the volts/Hertz ratio may be trimmed ±20% of nominal. In the Torque Control or Closed Loop Flux Vector Control mode, the motor flux may be adjusted from 50 to 200% of nominal.

- **Output Contacts -** One set of Form C output contacts, rated 30 VDC at 2.0 amps or 115 VAC at 500 mA, are available for fault annunciation.

- **Output Protection -** Line-to-line and line-to-ground output fault protection is provided under every operating condition, including power-up pre-charge mode, without component failure. Programmable output phase loss protection is also provided to protect the motor from single-phase operation.

- **Over Temperature Protection -** Thermal switch in the power section will shut down the ADX controller if overheating occurs.

- **Overvoltage and Undervoltage Protection -** Electronic shutdown occurs when the line voltage exceeds approximately +10% or -30% of rated line voltage.

- **Phase-Loss Protection -** The ADX controller detects phase-loss and inhibits normal operation as necessary to prevent drive malfunctions. If the phase-loss is of short duration (less than 1 second), the ADX drive will resume normal operation when the lost phase is restored. If the phase is lost for a longer time period, the drive will shut down.

- **PID Control -** See page 8-1.

- **Power Loss Ride-Through -** The ADX controller has sufficient energy storage to maintain control of the motor for at least 1 second whenever the AC power source is interrupted. Upon reapplication of AC line power, within 1 second, the motor will resume its set speed with a minimum of disturbance. The amount of speed droop during the power outage will be determined by the actual motor loading and other mechanical time constants.

- **Power Loss Shutdown -** During power interruption, if power is lost for longer than 1 second, a Power Loss Fault will occur. If an input phase is absent that does not create the preceding conditions, a Phase-Loss Fault will occur if the drive is running.

- **Preset Speed -** See page 10-23 - 10-26.

- **Protective Features:**

  a. **Inverter Trip -** If a fault occurs due to overvoltage, overcurrent, undervoltage, controller overtemperature, ground fault, motor overtemperature, overload, or CPU error, the ADX controller will annunciate the fault with an English language word.

  b. **Trip Avoidance -** ADX controllers include sophisticated torque control circuitry to minimize nuisance tripping under conditions of rapid deceleration and/or overhauling loads, or when encountering high peak torque loads. Under these abnormal torque conditions, the circuits function much like a current limiter in a DC drive, extending programmed acceleration or deceleration times to hold motor currents within set limits without tripping.

  c. **Output Fault Protection -** ADX controllers are protected from phase-to-phase and phase-to-ground output short circuits.

- **Regeneration Limit -** Designed to eliminate drive trips when excessive braking energy is transferred from the motor to the ADX controller. Regeneration limit will perform as follows:

  a. Will extend deceleration time to prevent bus overvoltage trip with high inertia loads.

  b. Will increase output frequency to user programmed maximum frequency range during overhauling loads.

- **Resonant Frequency Avoidance -** See page 10-27.

- **Slip Compensation -** Programmable slip compensation is provided to correct for induction motor speed droop or slip, thereby improving speed regulation in the Volts/Hertz operating mode. See Table 16-2, page 16-4.

- **Standard Serial Port -** An RS485 compatible serial port is standard on the ADX controller. This port provides read/write access to all parameters available in the controller. Up to thirty-one ADX drives can be connected to a host computer with an RS485 serial port.

  The ADX controller has the capability of communicating serially with a host computer or PLC. Any parameter may be read or written via the serial port. Full communication is allowed during motor operation as well as at stop. The only exceptions to this are configuration parameters that may not be adjusted from the keypad during operation cannot be adjusted through the serial port during operation, and when the drive is faulted, no parameters may be changed through the serial port. All parameters may be read under any condition.

  Transmission speeds up to 9600 baud and an optimized machine-to-machine protocol, make the serial port suitable for low to moderate performance real time communication tasks by providing a single parameter communications bandwidth of better than 5 Hz.

- **Start Into Rotating Motor -** See page 10-30.

- **Static Braking Control -** Provides adjustable linear rate electronic braking for the three-phase AC induction drive motor. The braking rate is determined by the setting of the deceleration control.

  Braking is effective under the following conditions:

  a. **Speed Reference Change -** Whenever the speed reference is reset to command a reduction in speed. The speed reference change can originate from a manual speed setting potentiometer or an external DC analog or digital signal. This permits the ADX drive to rapidly follow a reduced speed command otherwise impossible except with heavy friction loads.

  b. **Stop Function -** When selected, the motor will brake following the deceleration ramp to zero speed. A Stop command can originate from a pushbutton or external logic. A selectable, alternate method of operation allows coast-to-stop.

  The standard ADX controller provides a typical braking torque of 20% (dependent upon motor efficiency) of rated motor torque. This is the limit of the standard braking circuit to dissipate the regenerative energy produced by the kinetic energy of the motor and connected machine load.

  Where the inertia of the load is such that the desired minimum braking time cannot be achieved with the standard ADX controller, an optional high torque circuit is also offered. See Electronic Braking Option EB, page 14-2.

- **Static Reversing Control -** Static reversing (without a contactor) is a standard capability. This feature requires only the selection of an operator station with reversing controls, or reversing may be selected by external control contacts or the REV key on the keypad. The ADX controller must be programmed to enable reverse operation.

- **Torque Boost -** Provides improved torque capability at lower speeds to produce up to 200% starting torque with most standard motors. The ADX controller torque boost provides a programmable boost level as well as a programmable frequency where maximum boost is obtained. See Figure 16-2, below.

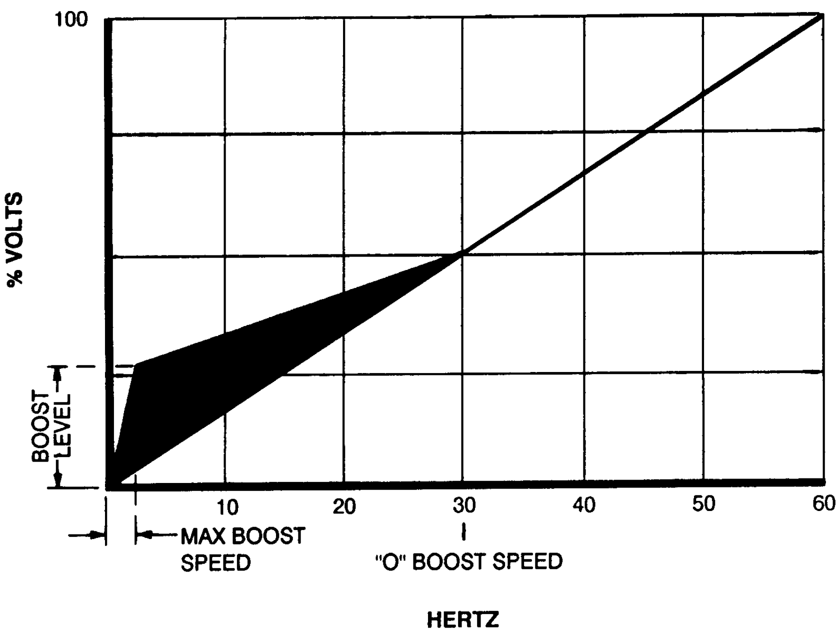


FIGURE 16 - 2. TORQUE BOOST

- **Torque Limit -** Allows the ADX controller to provide good torque control over a programmable range of 20% - 200% of rated.

- **Torque Taper -** See page 10-32.

- **Visual Indicators -** LED indicators are provided to monitor circuit operation and aid in troubleshooting. Included are individual LED's showing FWD, REV, JOG, AUTO, POWER and AT SPEED.

STANDARD DIAGNOSTIC FEATURES

The alphanumeric display provides English word messages indicating:

- **Status**

a. Acceleration
b. At Speed
c. Coasting
d. DC Braking
e. Deceleration
f. Dwelling
g. Faulted
h. Motor Overload
i. Regen Limit
j. Ride Through
k. Speed Avoidance
l. Speed Match
m. Speed Search
n. Stopped
o. Torque Limit
p. Torque & Motor Overload
q. Zero Speed

- **Test Mode Select**

  Normal self test on power-up is always performed.

- **Faults**

0. None
1. External Fault
2. Overtemperature Fault
3. Rating Mismatch (Drive Rated Amps)
4. Bus Overvoltage
5. Bus Overcurrent
6. No Encoder Option
7. Ground Fault
8. Power Loss Fault
9. Frequency Range Fault
10. Voltage Knee Fault
11. Precharge Fault
12. Motor Configuration Fault
13. Motor Overload
14. EEPROM Write Fault
15. EEPROM Read Fault
16. EEPROM Missing
17. EEPROM Acknowledge Fault
18. User Memory Fault
19. Unknown Fault
20. Phase Loss
21. Carrier Frequency Fault
22. Analog-To-Digital Fault
23. Feedback Loss Fault
24. Analog Input #1 Fault
25. Analog Input #2 Fault
26. Analog Input #3 Fault
27. Output Phase Loss
28. 10V Power Loss
29. 24V Power Loss
30. Motor Current Fault
31. Phase Imbalance

- **Fault Diagnostics -** All operating parameters are frozen on fault, providing extensive information on the conditions present at the time of fault.

  The last five fault types are saved in nonvolatile memory along with the operating hour at which it occurred.

- **Integral Elapsed Time Clock -** Continuously logs operating time up to 65,000 hours. Does not reset after a power failure, providing extensive information on the conditions present at the time of a fault.

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