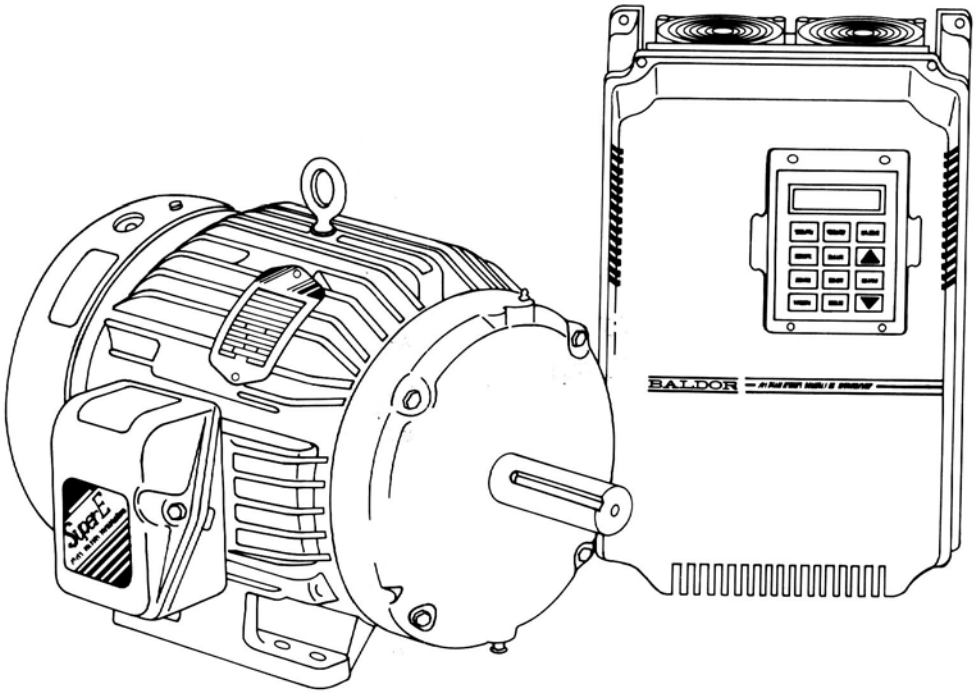
BALDOR®
MOTORS AND DRIVES

900 SERIES
AC VECTOR CONTROL



INSTALLATION & OPERATING MANUAL

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REV: E

SOFTWARE VER: 2.04
MANUAL 9270-SV

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Introduction

Purpose

The purpose of this manual is to provide installation, setup, operation, reference and troubleshooting information for the 91X series IGBT Encoder Vector Controllers

If you are experienced with the installation and set-up of drives motors and control equipment you may wish to skip ahead to the flowchart at the beginning of Chapter 2 Each block of the flowchart represents the title of appropriate sections of this manual including elevator applications

About This Manual

This manual uses the following icons to highlight points of interest

Indicates a note of interest.

Indicates a safety warning, read the comments before continuing

Indicates possible high voltage present Always insure that AC line voltage is off and that DC Bus Voltage is below 10 volts by measuring with a voltage meter before proceeding

Indicates instructions for factory support

NOTE The words Controller and Drive are used interchangeably throughout this manual

For Additional Information or Assistance

If you require assistance or information please contact Baldor Motors and Drives at

15000 Woodinville-Redmond Rd
Bldg B, suite 800
Woodinville, WA 98072
(206) 486-3101 (7 00AM - 5 00PM Pacific Standard Time)
Fax (206) 485-0209

Please have drive and motor information available when you call

Chapter 1
General Information

Factory Assistance

Should it become necessary to contact the factory for assistance please have the following information and Control Nameplate Data on hand when you call

Control Model Number _____

Control Serial Number _____

The Application of the Control _____

Safety Notice

WARNING This equipment contains voltages which may be as high as 800 volts and rotating parts on motors and driven machines High voltage and moving parts can cause serious or fatal injury Only qualified personnel familiar with this manual and any driven machinery should attempt to start-up or troubleshoot this equipment. Observe these precautions

- **USE EXTREME CAUTION, DO NOT TOUCH ANY CIRCUIT BOARD, POWER DEVICE OR ELECTRICAL CONNECTION WITHOUT INSURING THAT HIGH VOLTAGE IS NOT PRESENT**
- **THE UNIT MUST BE PROPERLY GROUNDED DO NOT APPLY AC POWER BEFORE FOLLOWING GROUNDING INSTRUCTIONS**
- **DO NOT OPEN COVER FOR 2 MINUTES AFTER REMOVING AC POWER, TO ALLOW CAPACITORS TO DISCHARGE**
- **IMPROPER CONTROL OPERATION MAY CAUSE VIOLENT MOTION OF MOTOR SHAFT AND DRIVEN EQUIPMENT BE CERTAIN THAT UNEXPECTED MOTOR SHAFT MOVEMENT WILL NOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT PEAK TORQUES OF SEVERAL TIMES RATED MOTOR TORQUE CAN OCCUR DURING A CONTROL FAILURE**
- **MOTOR CIRCUIT MAY HAVE HIGH VOLTAGE PRESENT WHENEVER AC POWER IS APPLIED, EVEN WHEN MOTOR IS NOT ROTATING**

Limited Warranty

For a period of two (2) years from date of original purchase, BALDOR will repair or replace without charge controls which our examination proves to be defective in material or workmanship This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied This warranty is in lieu of any other warranty or guarantee expressed or implied BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply) In any event, BALDOR's total liability, under all circumstances, shall not exceed the full purchase price of the control Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data encountered No liability is assumed for expendable items such as fuses

Good may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid

Control Description

The Baldor 900 Series AC flux vector controls are especially adapted for high performance industrial drive systems They operate directly from three phase 230,400 or 460 VAC power (50/60Hz) They can control AC induction motors with encoder feedback The 900 series drives use Insulated Gate Bipolar Transistors (IGBT's) Operation on a single phase power source with a 40% reduction in output current is also possible Outline and mounting dimensions of the drive enclosure are specified in Chapter 10 of this manual

Figure 1-1 900 Series Drive

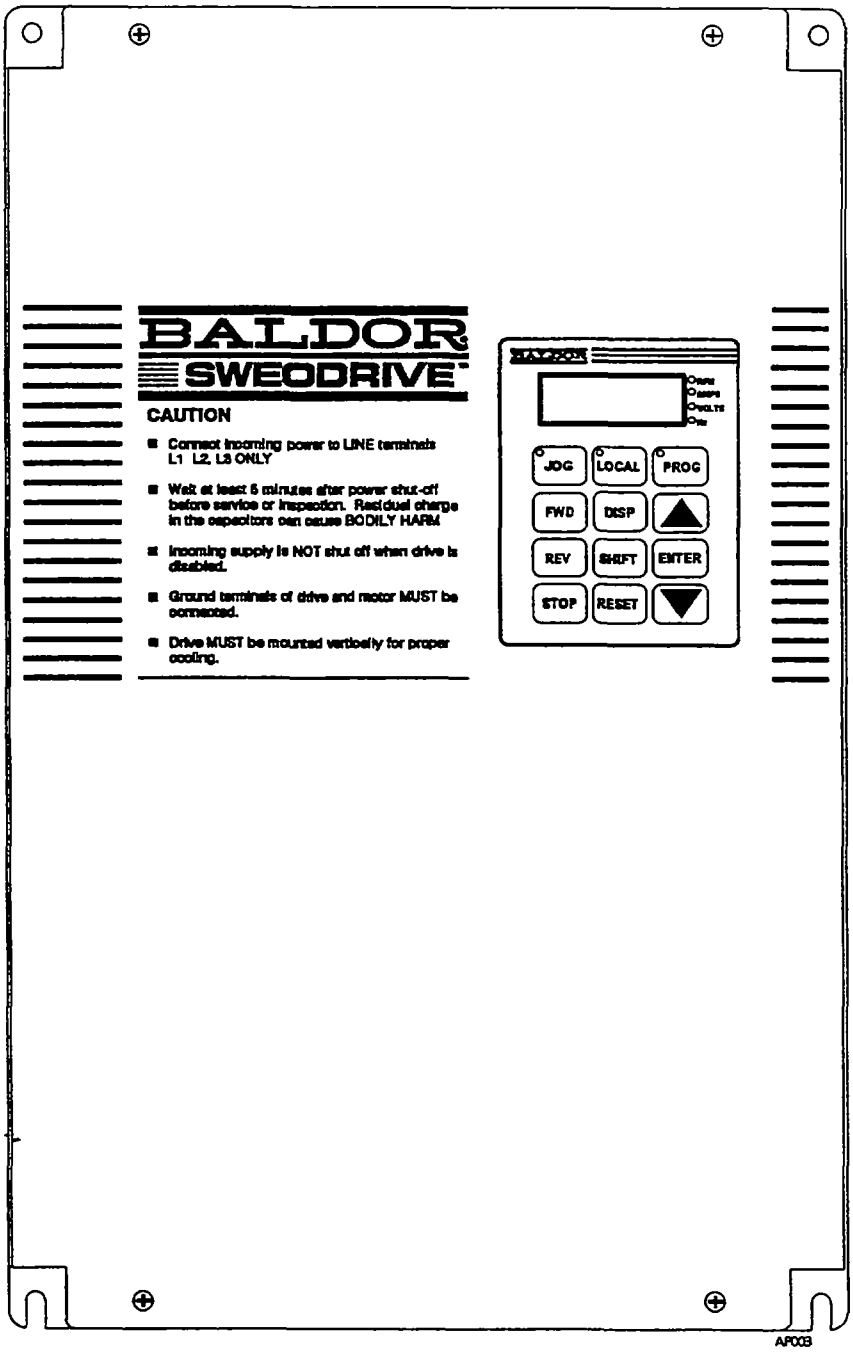
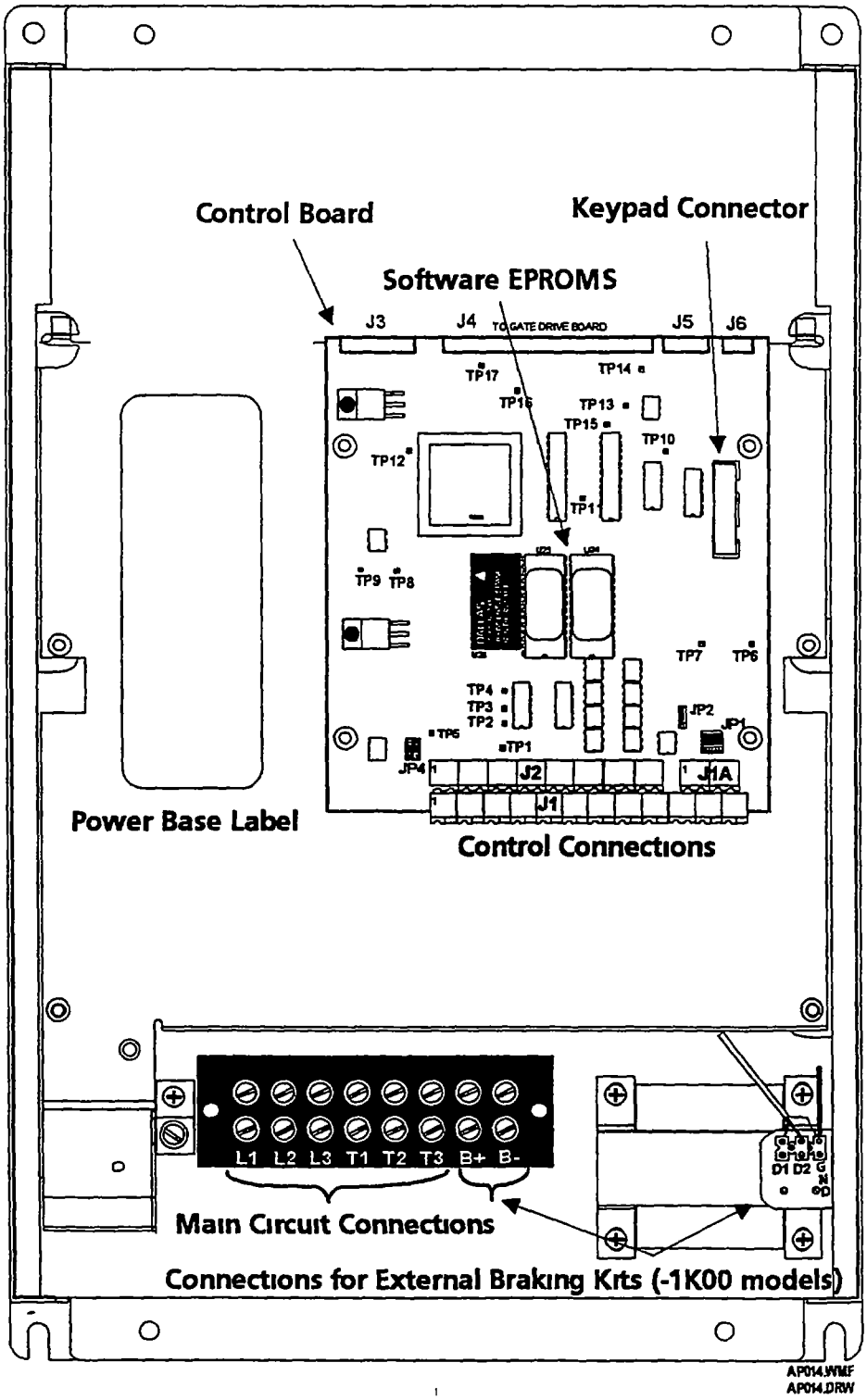


Figure 1-2 900 Series Drive With Cover Removed



The 900 Series controls consist of the following major elements in a compact enclosed assembly

1 Mounting base with grounded heat sink on which are mounted bus capacitors IGBT power transistor modules output hall effect current sensor bus current sensor three phase diode bridge soft start resistor soft start bypass contactor circulating fans and the power terminal block Optional dynamic braking transistor / resistor assembly

2 Gate driver board mounted over the IGBT power transistor modules

3 Control board and power supply mounted on a swing out plate

4 Front panel Keypad and LED display

Standard Features

- IGBT Power devices with a selectable ripple frequency up to 20Khz on Q and E models
- Microprocessor controlled PWM output frequency from 0 - 500 Hz
- Non-volatile memory for fault storage and parameter setup
- Continuous full rated torque from base speed down to and including zero speed
- Automatic tuning to the motor ensures easy and reliable set up
- Stable drift less velocity and torque regulation (analog and digital formats)
- 230 400 460 VAC versions available
- Compact NEMA 1 enclosure standard
- 15 Adjustable preset speeds
- 2 programmable linear or S-Curve acceleration and deceleration ramps
- Keypad and LED display
- 2 assignable buffered analog outputs for metering and troubleshooting
- RS232 / 422 / 485 communications
- Buffered encoder output signal
- Optional dynamic braking

Specifications

Ratings	3 to 50 HP
Constant HP range	Above base speed
Output Voltage	230 400 460 VAC
Output Current	Per Rating Table at standard current ripple frequency 10% derate at maximum current ripple frequency
Current ripple frequency	
High frequency version	16 KHz standard Adjustable 2 20 Khz
Low frequency version	4 KHz standard Adjustable 2 8 Khz
Velocity loop bandwidth	Adjustable to 60 Hz
Current loop bandwidth	Adjustable to 400 Hz
UL Listing	File No E128059

SERVICE CONDITIONS

Rated Input Voltages	3 phase 50/60 Hz single phase 50/60 Hz operation at 60% of rating
230 VAC Models	190 to 253 VAC
400 VAC Models	330 to 440 VAC
460 VAC Models	340 to 506 VAC
AC line reactance	3% of rated input KVA minimum
Rated overload current	
Quiet 16 kHz version	180 to 200% for 3 sec 150% for 60 seconds
Low Frequency version	150% for 60 seconds
Ambient temperature	Operating 0 to +40°C Storage 30 to +65°C
Humidity	10% to 90% non-condensing
Altitude	Sea level to 3,300 feet without derating
Enclosure	NEMA 1 with conduit entry knockout plate

MOTOR AND ENCODER REQUIREMENT

Motor poles	2 4 6 8 10 12
Incremental encoder	Mounted on motor
Pulses/rev	60 to 15 000 selectable
Voltage outputs	2 channel quadrature 5 VDC differential
Marker pulse	Required for position orientation
Power output	+5 VDC 300 ma Max.
Maximum frequency	1 MHz

DIAGNOSTIC INDICATIONS

Current Sense fault
Following Error
Ground fault
Instantaneous over current
Line power loss
Microprocessor failure
Over speed
Overload
Overtemperature (motor or control)
Overvoltage
Parameter Loss
Power Base ID fault
Ready
Regeneration Overload (dynamic braking)
Soft Start Fault
Torque Proving fault
Undervoltage

ANALOG AND CONTROL I/O

Buffered speed/torque input	
Common mode rejection	40 db
Full scale range	± 5 VDC ± 10 VDC 4-20 mA
Auto-selectable resolutions	12 bits + sign below ±1V 9 bits + sign above ±1V
Update rate	2 0 ms in speed mode 1 0 ms in torque mode
Other analog input	1 assignable
Full scale range	± 10 V
Resolution	9 bits + sign
Update rate	2 0 ms
Analog outputs	2 assignable
Full scale range	0 to + 5 VDC
Resolution	8 bits
Update rate	2 0 ms
Opto-isolated logic inputs	9 assignable
Rated voltage	10 to 30 VDC (closed contacts standard)
Input impedance	6 8K ohms
Update rate	8 ms
Opto-isolated logic outputs	4 assignable
ON current sink	60 mA Max
ON voltage drop	2VDC Max
Update rate	8 ms

RS232C / 422 / 485 SERIAL PORT

Functions	Parameter load / display Digital control Auto tuning Positioning Commands
Addressable	Up to 31 controls
Baud Rate	1200 19 2K Baud

SELECTABLE OPERATING MODES

Standard run
PLC interface with 15 preset speeds
Analog speed or torque control
Serial control

KEYPAD DISPLAY

Keys	12
Display	4 character LED
Functions	Motor Output Monitoring Diagnostic display Digital speed control Motor Jog Parameter load/display Auto-tuning

Ratings

Table 1 1 230VAC Drive Ratings

			CONSTANT TORQUE				VARIABLE TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK	HP	KW	AMPS CONT	AMPS PEAK
912L 22 270	C	208	4 5	3 3	16	24	6 7	4 9	22	22
		230	**5**	**3 7**			**7 5**	**5 5**		
912Q-23-270	C	208	4 5	3 3	16	31	6 7	4 9	22	22
		230	**5**	**3 7**			**7 5**	**5 5**		
912L 23-270	C	208	6 7	4 9	22	33	9	6 7	28	28
		230	**7 5**	**5 5**			**10**	**7 4**		
912Q-24-270	C	208	6 7	4 9	22	44	9	6 7	28	28
		230	**7 5**	**5 5**			**10**	**7 4**		
912L 34-270	C	208	9	6 7	28	42	13 5	10	42	42
		230	**10**	**7 4**			**15**	**11 1**		
912Q-36-270	C	208	9	6 7	28	56	13 5	10	42	42
		230	**10**	**7 4**			**15**	**11 1**		
912L-46-270	C	208	13 5	10	42	63	18	13 4	54	54
		230	**15**	**11 1**			**20**	**14 9**		
912Q-48-270	C	208	13 5	10	42	84	18	13 4	54	54
		230	**15**	**11 1**			**20**	**14 9**		
912L 58-270	C	208	18	13 4	54	81	22 6	16 8	68	68
		230	**20**	**14 9**			**25**	**18 6**		
912Q-511 270	C	208	18	13 4	54	108	22 6	16 8	68	68
		230	**20**	**14 9**			**25**	**18 6**		
912L 710-270	C	208	22 6	16 8	68	102	27 1	20 2	80	80
		230	**25**	**18 6**			**30**	**22.3**		
912Q-712 270	C	208	22 6	16 8	68	122	27 1	20 2	80	80
		230	**25**	**18 6**			**30**	**22.3**		
912L-812 270	D	208	27 1	20 2	80	120	36 1	26 9	104	104
		230	**30**	**22 3**			**40**	**29 8**		
912Q-816-270	D	208	27 1	20 2	80	160	36 1	26 9	104	104
		230	**30**	**22.3**			**40**	**29 8**		
912L 1016-270	D	208	36 1	26 9	104	156	45 2	33 7	130	130
		230	**40**	**29 8**			**50**	**37.2**		
912Q-1021 270	D	208	36 1	26 9	104	208	45 2	33 7	130	130
		230	**40**	**29 8**			**50**	**37 2**		

230V (continued)			CONSTANT TORQUE				VARIABLE TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK	HP	KW	AMPS CONT	AMPS PEAK
912L 1320-270	D	208	45 2	33 6	130	195	N/A	N/A	N/A	N/A
		230	50	37 2			N/A	N/A		
912Q-1325-270	D	208	45 2	33 6	130	250	N/A	N/A	N/A	N/A
		230	50	37 2			N/A	N/A		

Table 1.2 460VAC Drive Ratings

			CONSTANT TORQUE				VARIABLE TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK	HP	KW	AMPS CONT	AMPS PEAK
914L 11 270	C	400	4 1	3 2	8	12	6 5	4 7	11	11
		460	5	3 7			**7 5**	**5 5**		
914Q-11 270	C	400	4 1	3 2	8	15	6 5	4 7	11	11
		460	5	3 7			**7 5**	**5 5**		
914L 12 270	C	400	6 5	4 7	11	17	8 6	6 4	14	14
		460	7 5	5 5			**10**	**7 4**		
914Q-12 270	C	400	6 5	4 7	11	22	8 6	6 4	14	14
		460	7 5	5 5			**10**	**7 4**		
914L 13-270	C	400	8 6	6 4	14	21	13	9 6	21	21
		460	**10**	**7 4**			**15**	**11 1**		
914Q-13-270	C	400	8 6	6 4	14	28	13	9 6	21	21
		460	**10**	**7 4**			**15**	**11 1**		
914L 23-270	C	400	13	9 6	21	32	17 3	12 9	27	27
		460	**15**	**11 1**			**20**	**14 9**		
914Q-24-270	C	400	13	9 6	21	42	17 3	12 9	27	27
		460	**15**	**11 1**			**20**	**14 9**		
914L 34-270	C	400	17 3	12 9	27	41	21 7	16 1	34	34
		460	**20**	**14 9**			**25**	**18 6**		
914Q-35-270	C	400	17 3	12 9	27	54	21 7	16 1	34	34
		460	**20**	**14 9**			**25**	**18 6**		
914L 35-270	C	400	21 7	16 1	34	51	26	19 3	40	40
		460	**25**	**18 6**			**30**	**22.3**		
914Q-36-270	C	400	21 7	16 1	34	61	26	19 3	40	40
		460	**25**	**18 6**			**30**	**22 3**		
914L-46-270	C	400	26	19 3	40	60	34 7	25 9	52	52
		460	**30**	**22 3**			**40**	**29 8**		
914Q-48-270	C	400	26	19 3	40	80	34 7	25 9	52	52
		460	**30**	**22 3**			**40**	**29 8**		

460V (con't)			CONSTANT TORQUE				VARIABLE TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK	HP	KW	AMPS CONT	AMPS PEAK
914L 58-270	D	400	34 7	25 9	52	78	43 4	32 3	65	65
		460	**40**	**29 8**			**50**	**37.2**		
914Q-510-270	D	400	34 7	25 9	52	104	43 4	32 3	65	65
		460	**40**	**29 8**			**50**	**37 2**		
914L 710-270	D	400	43 4	32 3	65	98	52 1	38 8	80	80
		460	**50**	**37 2**			**60**	**44 7**		
914Q-712 270	D	400	43 4	32 3	65	122	52 1	38 8	80	80
		460	**50**	**37 2**			**60**	**44 7**		
914L-812 270	D	400	52 1	38 8	80	120	65	47	100	100
		460	**60**	**44 8**			**75**	**56**		
914Q-816-270	D	400	52 1	38 8	80	160	65	47	100	100
		460	**60**	**44 8**			**75**	**56**		
914L 1015-270	E	400	65	47	100	150	87	65	125	125
		460	**75**	**56**			**100**	**75**		
914Q-1020-270	E	400	65	47	100	200	87	65	125	125
		460	**75**	**56**			**100**	**75**		
914L 1319-270	E	400	87	65	125	190	108	80 3	160	160
		460	**100**	**75**			**125**	**93**		
914Q-1325-270	E	400	87	65	125	250	108	80 3	160	160
		460	**100**	**75**			**125**	**93**		
914L 1624-270	E	400	108	80 8	160	240	130	96	180	180
		460	**125**	**93**			**150**	**112**		
914L 1827-270	E	400	130	96	180	270	N/A	N/A	N/A	N/A
		460	**150**	**112**			**N/A**	**N/A**		

Table 1 3 230VAC Elevator Ratings

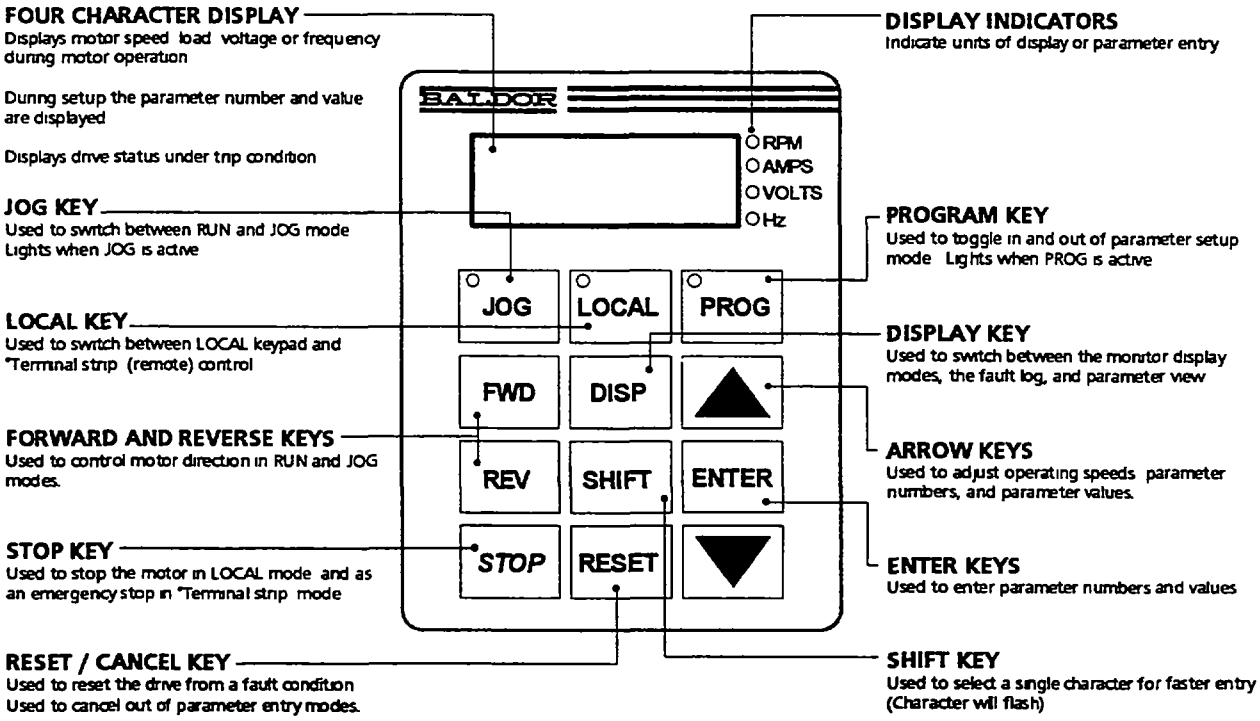
			CONSTANT TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK
912E-24-270	C	208	4 5	3 3	16	46
		230	**5**	**3 7**		
912E 26-270	C	208	6 7	4 9	22	61
		230	**7 5**	**5 5**		
912E-38-270	C	208	9	6 7	28	85
		230	**10**	**7 4**		
912E-412 270	C	208	13 5	10	42	122
		230	**15**	**11 1**		
912E-516-270	C	208	18	13 4	54	162
		230	**20**	**14 9**		
912E-718-270	C	208	22 6	16 8	68	183
		230	**25**	**18 6**		
912E-824-270		208	27 1	20 2	80	240
		230	**30**	**22.3**		
912E-1031-270	D	208	36 1	26 9	104	312
		230	**40**	**29 8**		

Table 1 4 460VAC Elevator Ratings

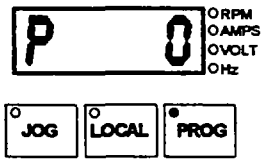
			CONSTANT TORQUE			
MODEL	SIZE	VAC	HP	KW	AMPS CONT	AMPS PEAK
914E 12 270	C	400	4 1	3 2	8	24
		460	**5**	**3 7**		
914E 13-270	C	400	6 5	4 7	11	31
		460	**7 5**	**5 5**		
914E 14-270	C	400	8 6	6 4	14	42
		460	**10**	**7 4**		
914E 26-270	C	400	13	9 6	21	61
		460	**15**	**11 1**		
914E 38-270	C	400	17 3	12 9	27	81
		460	**20**	**14 9**		
914E 39-270	C	400	21 7	16 1	34	92
		460	**25**	**18 6**		
914E-412-270	D	400	26	19 3	40	120
		460	**30**	**22.3**		
914E-516-270	D	400	34 7	25 9	52	156
		460	**40**	**29 8**		
914E 718-270	D	400	43 4	32 3	65	183
		460	**50**	**37.2**		
914E-824-270	E	400	52 1	38 8	80	240
		460	**60**	**44 7**		

Using The Keypad

Keypad Overview

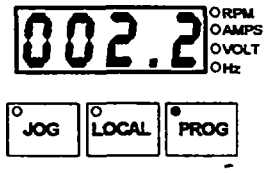


Changing Parameters



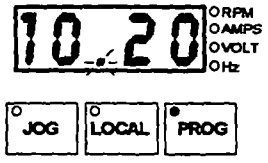
To change parameters the keypad must be in *Program Mode* Pressing the PROG key enters and exits the program mode A lit LED in the PROG key will indicate that the drive can be programmed

If security system is being used the display will alternately flash SEC and CODE Press the ENTER key and use the up and down arrow keys with the shift key to select the security code Press enter When the code is correct the controller will switch to the program mode and the LED will be lit Prog LED flashing (allows user to enter SEC code once remember to "Reset" to secure the drive



Use the UP and DOWN arrow keys to select the desired parameter number and press ENTER The parameter *value* will now be displayed If the value is in units that can be indicated (i e RPM AMPS VOLTS or Hz) then the appropriate LED will be lit Use the UP and DOWN arrow keys to scroll to the desired value (NOTE pressing RESET will cancel changes and return to displaying the parameter number)

Pressing the SHIFT key allows a single character to be changed at a time for faster entry The character selected for adjustment will flash Repeated presses of the SHIFT key will move the active character from right to left across the display and then return the display to normal adjustment



NOTE When numbers larger than 9999 are entered the display will switch to displaying "extended" numbers The display will then show "thousands" of units with the decimal point flashing This allows for motor operation above 9999 RPM as well as parameter entry

Press ENTER to enter the new parameter value Press RESET to cancel and return to displaying parameter *numbers* To exit the program mode press the PROG or DISP keys

LOCAL Keypad Control

Running the Motor

To operate the motor from the keypad the drive must be in LOCAL mode This is done by pressing the **LOCAL** key The local LED will be lit when the drive is in LOCAL keypad control The drive will ignore all input connections on the J1 terminal strip except the external motor temp input

The motor can now be controlled by the FWD REV STOP JOG and arrow keys Make sure the PROG LED is not lit The FWD and REV keys control the direction of motor rotation while the arrow keys are used to adjust the speed

There are three ways to control the motor in local keypad control They are Increment Entered Speed and Preset speed Parameter P38 KEYPAD SPEED CONTROL determines which one is active The factory preset is Increment (Refer to Chapter 3 for more information on setting P38)

Increment Mode (P38 = 0 or 1) (Factory Preset)

Use the arrow keys to ramp the motor speed at the defined ACC / DEC rate

EXAMPLE Press FWD Power will be applied to the motor and a small amount of audible noise may be heard Press the UP arrow momentarily, the drive will accelerate toward the defined max speed Press the DOWN arrow momentarily the drive will decelerate toward zero speed Press STOP to disable the drive

To adjust motor speed more precisely press the ENTER key after pressing the FWD and before using the arrow keys The RPM LED will flash and you can use the arrow keys and shift key to adjust motor speed Press Enter again and the RPM LED will adjust motor speed Press Enter again and the RPM LED will stop flashing and the arrow keys will work as described above

EXAMPLE Press FWD to enable the drive Press ENTER The RPM LED will now flash Press the SHIFT key until the "tens" position flashes Now repeatedly press the UP arrow key the drive speed will advance in increments of 10 RPM Press the SHIFT key again the "hundreds" position will now flash Repeated presses of the UP arrow key will now advance the speed by 100 RPM Press STOP to disable the drive

Entered Speed Keypad Control (P38 = 2 or 3)

Use the arrow and shift keys to enter an exact digital speed command NOTE This differs from the Increment control described above in that the desired command is not acted upon until the ENTER key is pressed

EXAMPLE Press FWD to enable the drive Press ENTER UP or DOWN the display will change to RPM will the RPM LED flashing Use the arrow and shift keys to select the desired speed Press ENTER the drive will now command the entered speed and return to viewing the selected output condition (the RPM LED will stop flashing) Press STOP to disable the drive

Preset Speed Keypad Control (P38 = 4 or 5)

Operate the motor at from the defined preset speeds (Parameters P11 P25)

EXAMPLE Press FWD to enable the drive Press ENTER UP or DOWN the display will change to RPM will the RPM LED flashing Use the arrow and shift keys to select the desired preset speed number (1 15) Press ENTER the drive will now command the preset speed and return to viewing the selected output condition (the RPM LED will stop flashing) Press STOP to disable the drive

Jog Keypad Control

When the JOG and LOCAL LED's are Lit the motor will run at a predetermined speed as long as the FWD or REV key is held When the key is released the motor decelerates to a stop and holds zero speed

Note Jog mode can only be activated when the motor is at zero speed.

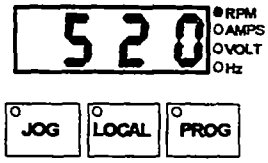
This is useful in applications such as a machine tool where the drive is used to control an axis of the table The drive can be used to "jog" the table around manually before returning it to automatic control when the JOG and LOCAL LED's are Lit, the motor will run at a predetermined speed as long as the FWD or REV key is held When the key is released the motor decelerates to a stop and holds zero speed

Four Jog parameters (P0 - P3) are available to control the jog speed accel rate decel rate and "s-curve"

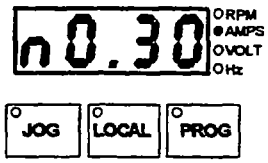
EXAMPLE While in LOCAL mode Press JOG to place the drive in JOG mode (the JOG LED will be lit) The FWD and REV keys are used to jog the motor in the appropriate direction Press and hold the FWD key The motor will rotate in the forward direction at the Jog speed (P0) Release the FWD key the motor will decelerate to zero speed Press JOG to exit JOG mode and disable the drive

Changing the Display

While the motor is in operation seven different output conditions can be monitored by pressing the display key NOTE The decimal point is not displayed for whole numbers For numbers larger than 9999 the display will switch to extended numbers showing 'thousands' of units with the decimal point flashing Pressing the DISP key will toggle through the following display modes

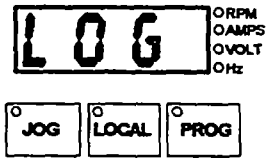


Motor Speed in RPM
Motor Current in amps
% of Rated Load
Output Voltage in volts
Output Frequency in Hertz
Fault Log
Parameter View



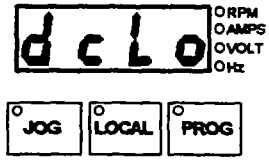
When motor data is displayed an indicating LED will be lit to show the appropriate units In the case of % Rated load the display will be normalized so that 1 00 = 100% motor rated amps The Amps LED will be lit and the display will begin with an "n" (i e n0 30 = 30% rated load)

Fault Log



The drive retains up to 15 of the most recent faults for display To view the fault log, press the DISP key until LOG is displayed Press the ENTER key and the present drive status will be displayed Use the arrow keys to scroll through the previous faults While scrolling the display will momentarily show the log position (1-15) before displaying the fault code

Refer to Chapter 6 for a complete list of faults



Pressing the SHIFT key will momentarily display the elapsed time in minutes between the selected fault and the previous fault (If pressed while viewing the current status the elapsed run time in hours will be displayed)

To exit the fault log press either the DISP key of the RESET key

Parameter View

The drive can display any parameter during operation Press the display key until the display reads PXXX where XXX is the parameter number Press ENTER to see the value for the selected parameter The PROG LED will not be lit since the user cannot change parameter values while in this mode

Fault Condition Mode

If a fault condition exists the display will show one of the fault codes automatically Pressing RESET will clear the fault as long as the condition that caused the fault no longer exists

Refer to Chapter 6 for a complete list of fault codes and troubleshooting flowcharts

Software Revisions

This manual has been prepared for software version 2 04 but can be used on prior versions with the following exceptions

Ver 2 01

Fault log recorded power loss and undervoltage faults on turn off
After fault reset dcLo dcHi or REG sometimes remained on the display
Regen still active during an ID SSF or CUr fault
During a fault condition the keypad does not allow programming
RPM display not consistent with digital speed command
The serial commands "O6" and "O7" are not supported
Drive allows upload of incompatible software versions
Serial command "B" does not work properly
PWM ratings for 91XL models were limited to 2 5Khz
Serial commands Velocity report torque report and position report did not terminate with a CR / LF with ECHO disabled
4-20 mA command input does not work properly

Ver 2 02

60 - 120HP Controls not supported
Variable torque ratings not included
Low line operation parameter not supported (P96)
Default setting of P44 is ON
Foldback of torque above max speed not supported
Keypad Frequency display in-accurate above 300Hz
Polarity of STOP input in mode 0 is inverted (closed = stop)
Switching from Analog speed to preset speed in mode 0 requires a FWD or REV command
Responses to Serial commands not optimized
Drive does not wait for Valid "V" "T" or "M" serial command before accepting a serial enable
Drive does not automatically initialize the positioning speed serial command ("v") to 0
Positioning speed command "v" is reset when a parameter is changed
Drive allows JOG Mode to be entered while the motor is running
Drive allows the "AU ALL" serial command which is no longer supported
Drive allows the "L-ON" and "L-OFF" serial commands which are no longer supported

Ver 2 03

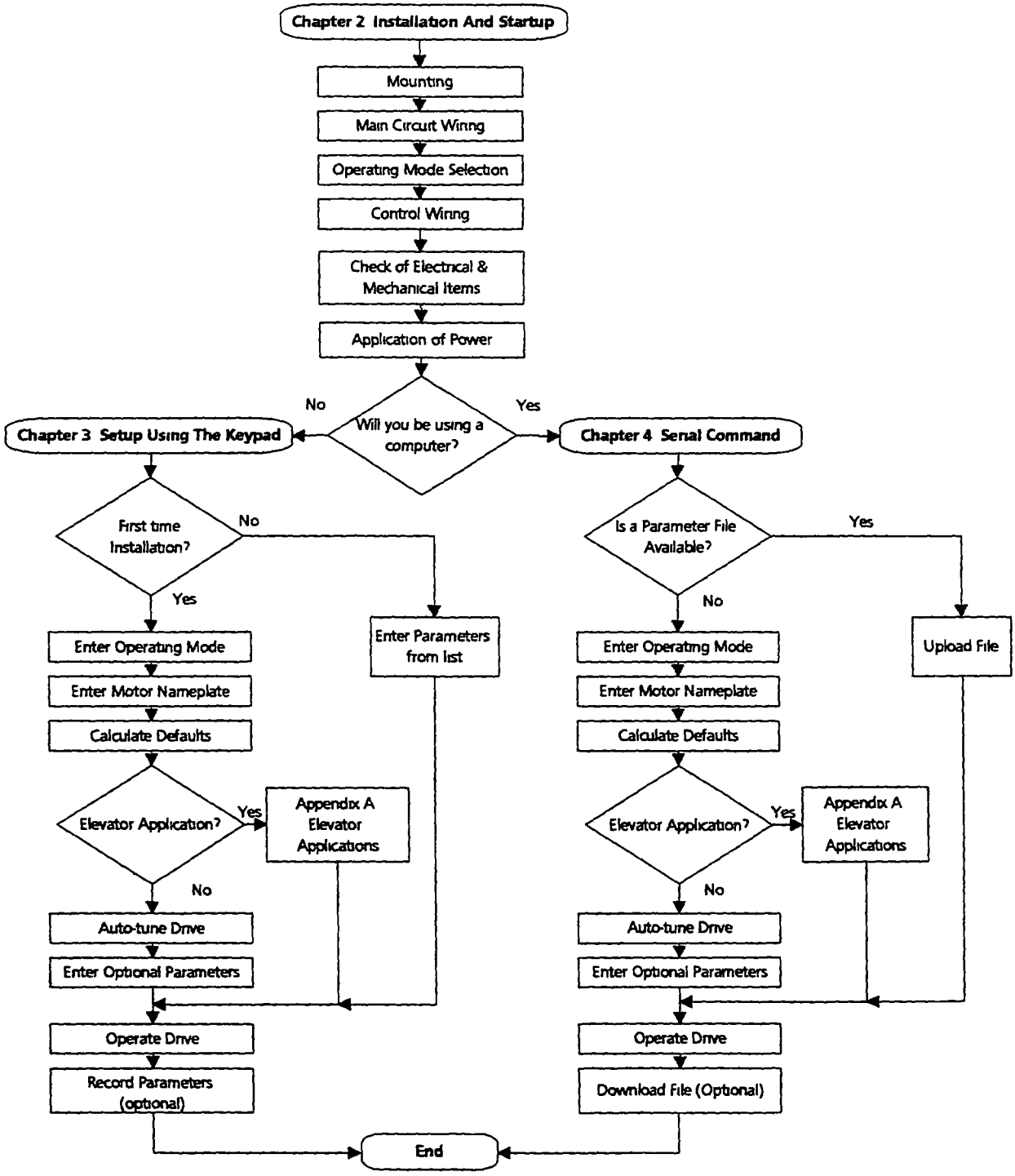
230VAC 50HP controllers not supported
460VAC 125HP controllers not supported
Dynamic brake wattage limitedto 9 999kw (P35)
Serial report (8) for absolute position not supported
Following error and at speed not valid when controller is disabled

Chapter 2
Installation and Setup

Introduction

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

Figure 2-1 Installation and Setup Flow Diagram



Mounting

(Refer to Chapter 10 for appropriate mounting drawings)

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

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

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

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

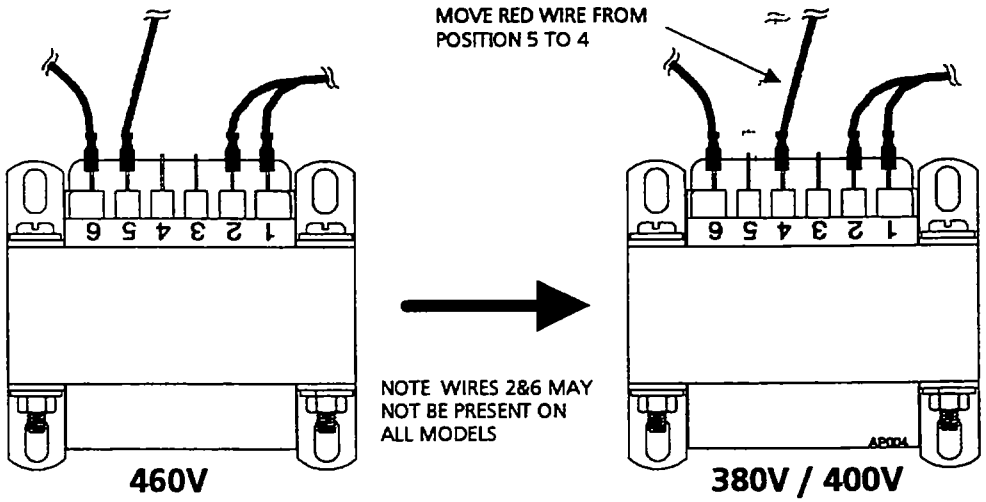
Remove the top cover (if supplied) Locate control transformer T1 (next to the main circuit terminal block TB1) Refer to Figure 1 2 for a picture of a 900 series drive with the cover removed

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

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

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

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



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

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

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

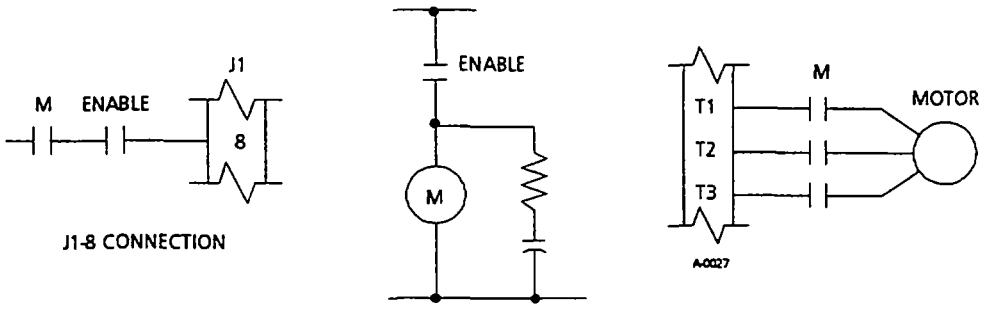
Connect control terminals L1 L2 and L3 to the load side of the customer supplied protective device The control may be powered with AC three phase power or single phase power NOTE Apply only line voltage for which the controller is rated Phase sequence of incoming power is not important If single phase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

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

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

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

Figure 2-3 Typical Connections for Output Contactor



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

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

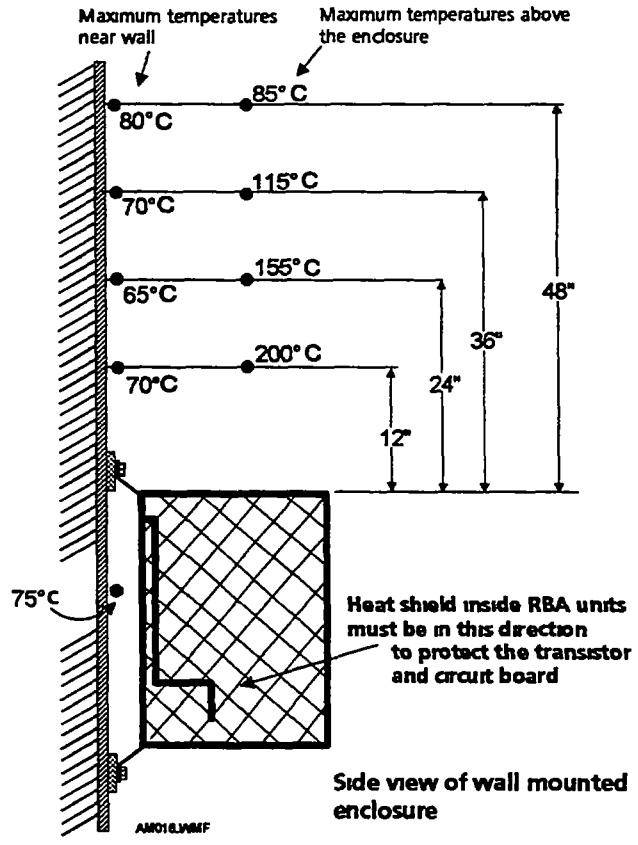
Installation

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

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

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

Figure 2-4 Temperatures Maximum Expected, Side View



Dynamic Braking Wiring

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

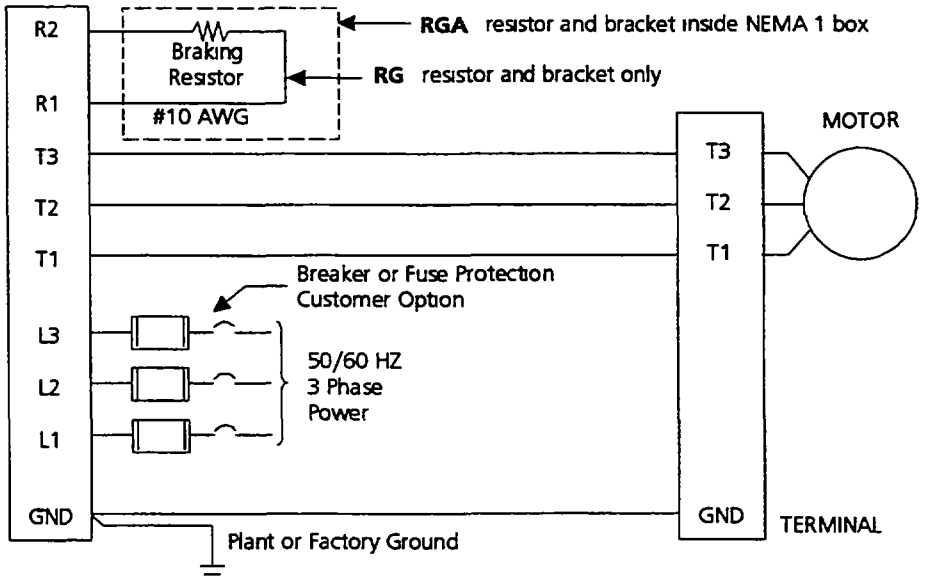
All wiring shall be in accordance with the National Electric Code and applicable local codes Install wiring as shown in Figure 2 5 through 2-6

Models with -1KBO suffix

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

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

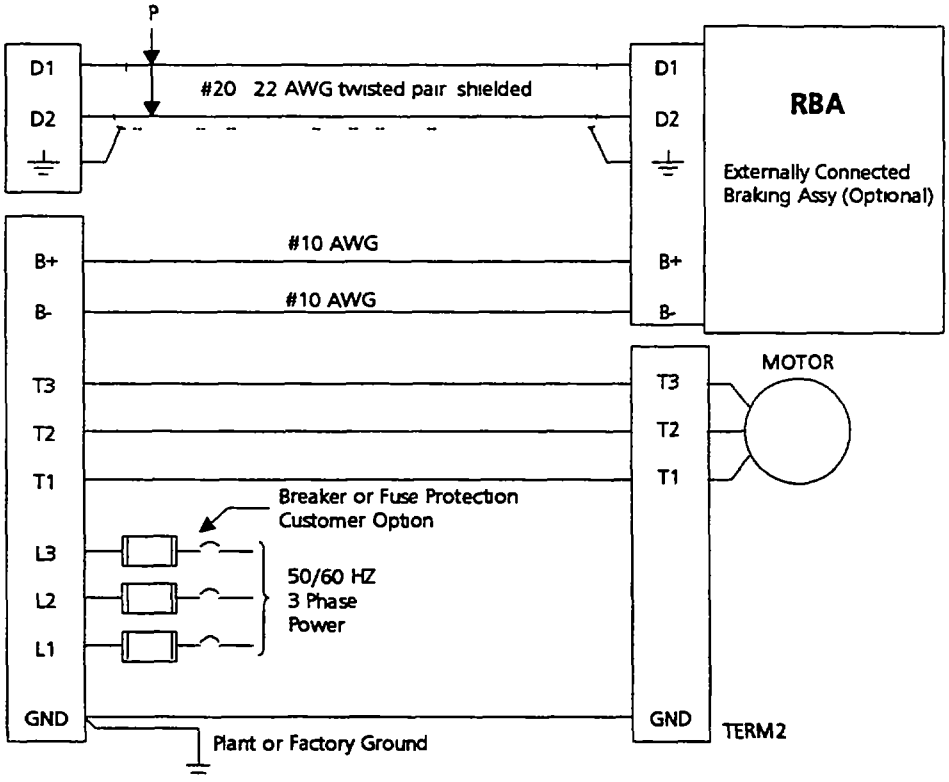
Figure 2-5 Wiring for Models with -1KBO suffix



Drives with -1KOO suffix

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

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



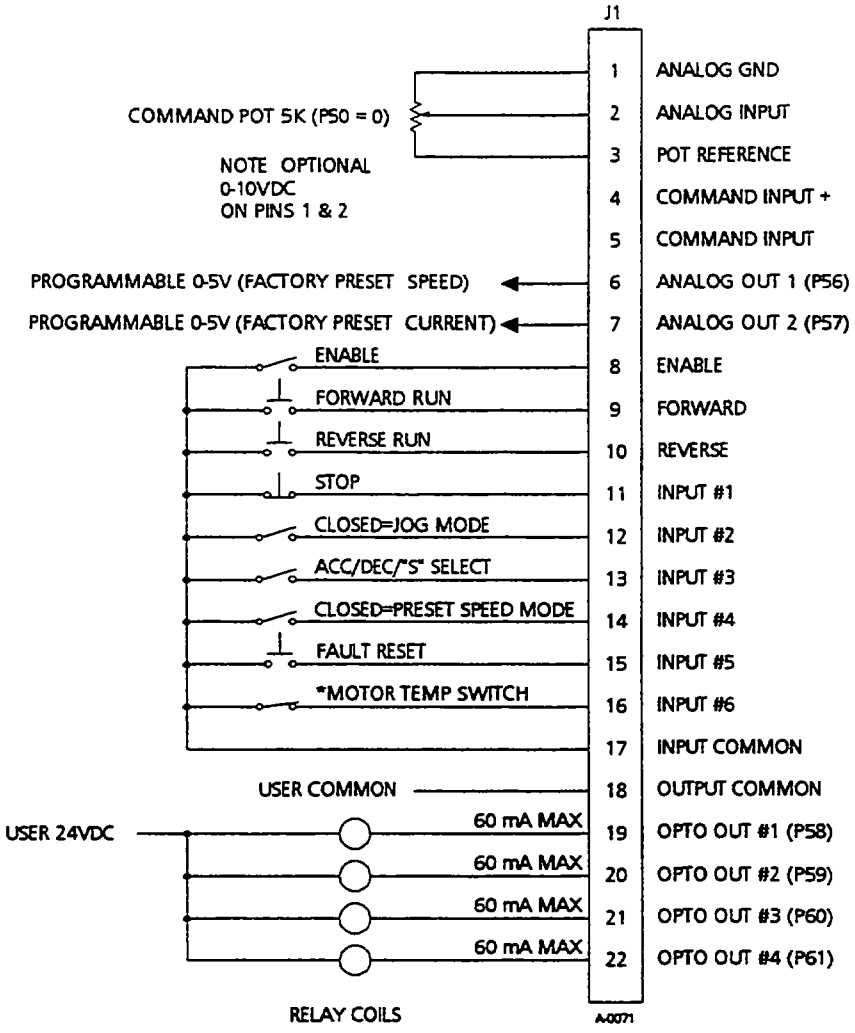
Operating Mode Selection

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

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

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

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



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

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

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

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

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

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

J1-14 CLOSED selects preset speed #1 Parameter P11

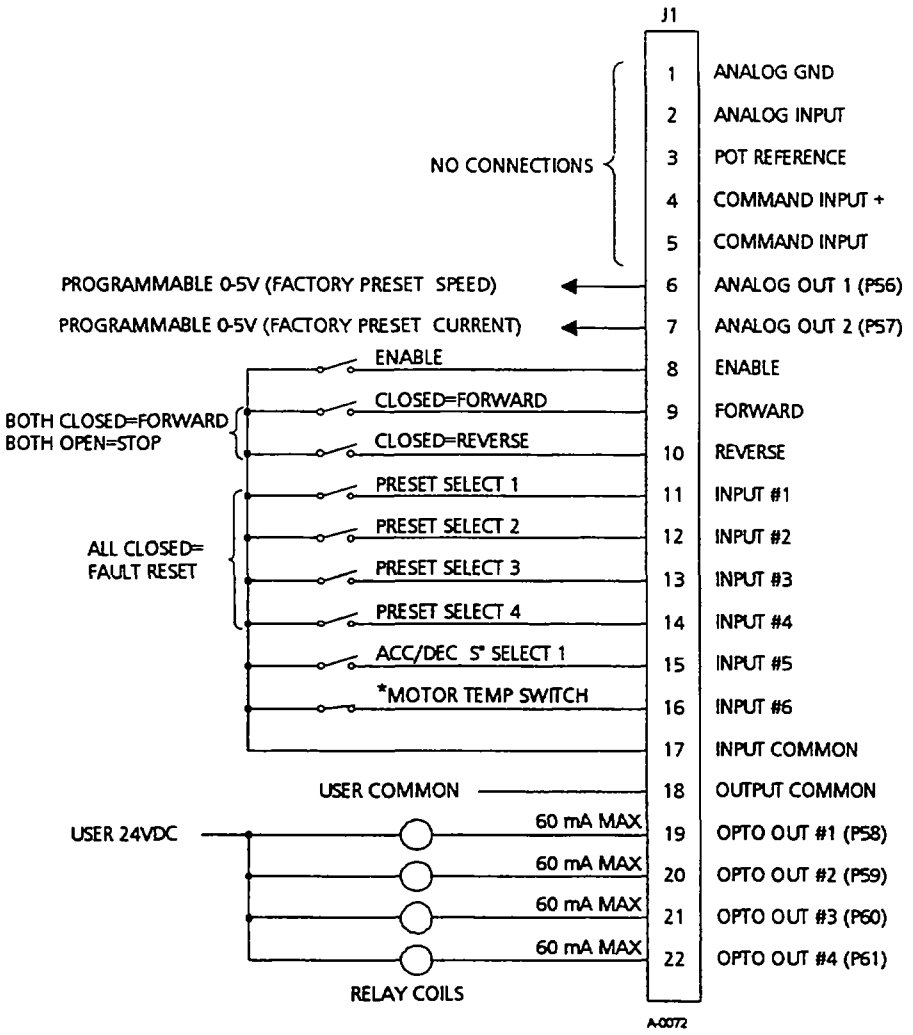
OPEN allows speed command from Pot input

Jog mode (J1 12) will override this preset speed

J1 15 OPEN to run CLOSED to reset fault condition

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

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



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

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

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

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

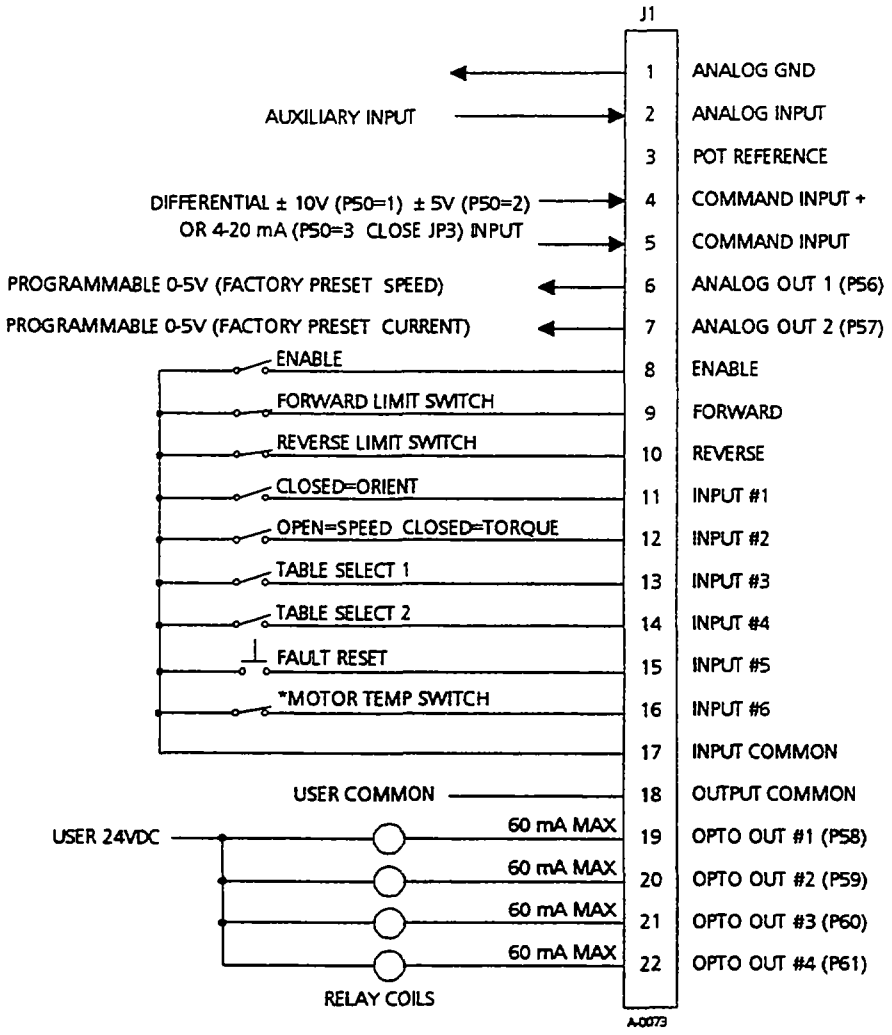
J1 11 14 Selects preset speeds (see table left)

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

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

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

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



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

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

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

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

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

J1 12 OPEN for Speed control CLOSED for Torque Control

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

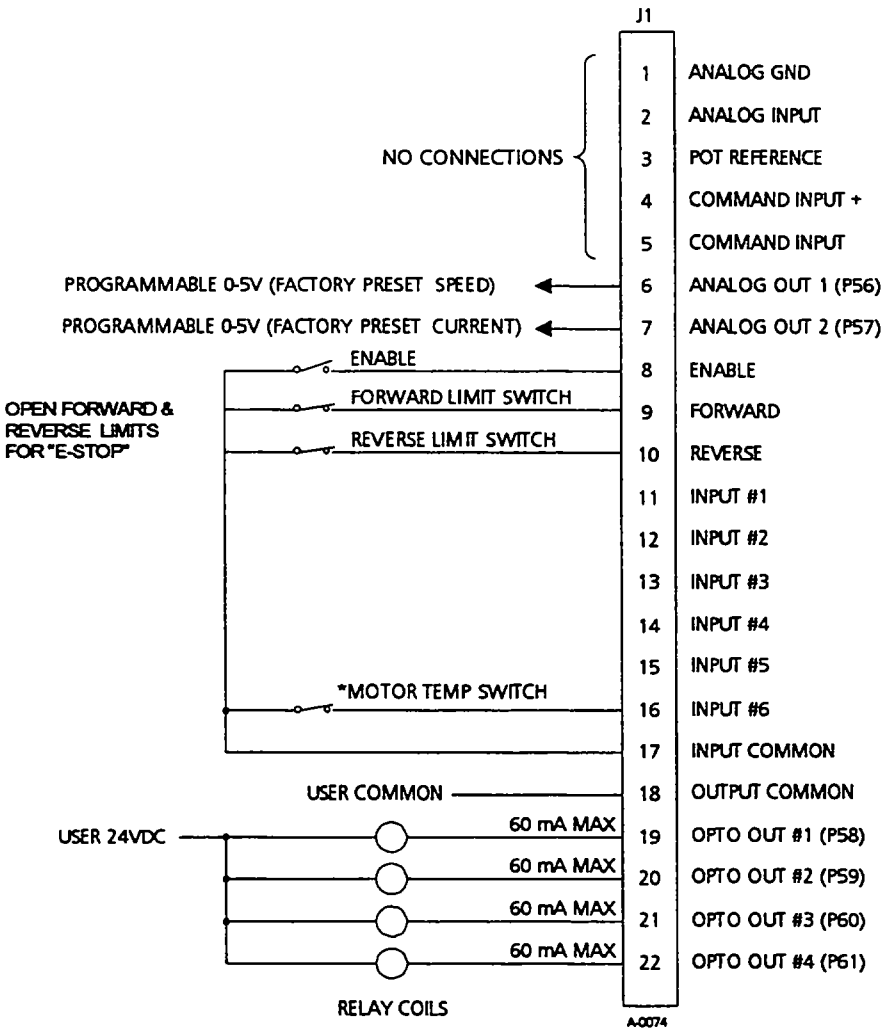
J1 15 OPEN to run CLOSED to reset fault condition

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

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

*This input is optional and is controlled by P80

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



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

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

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

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

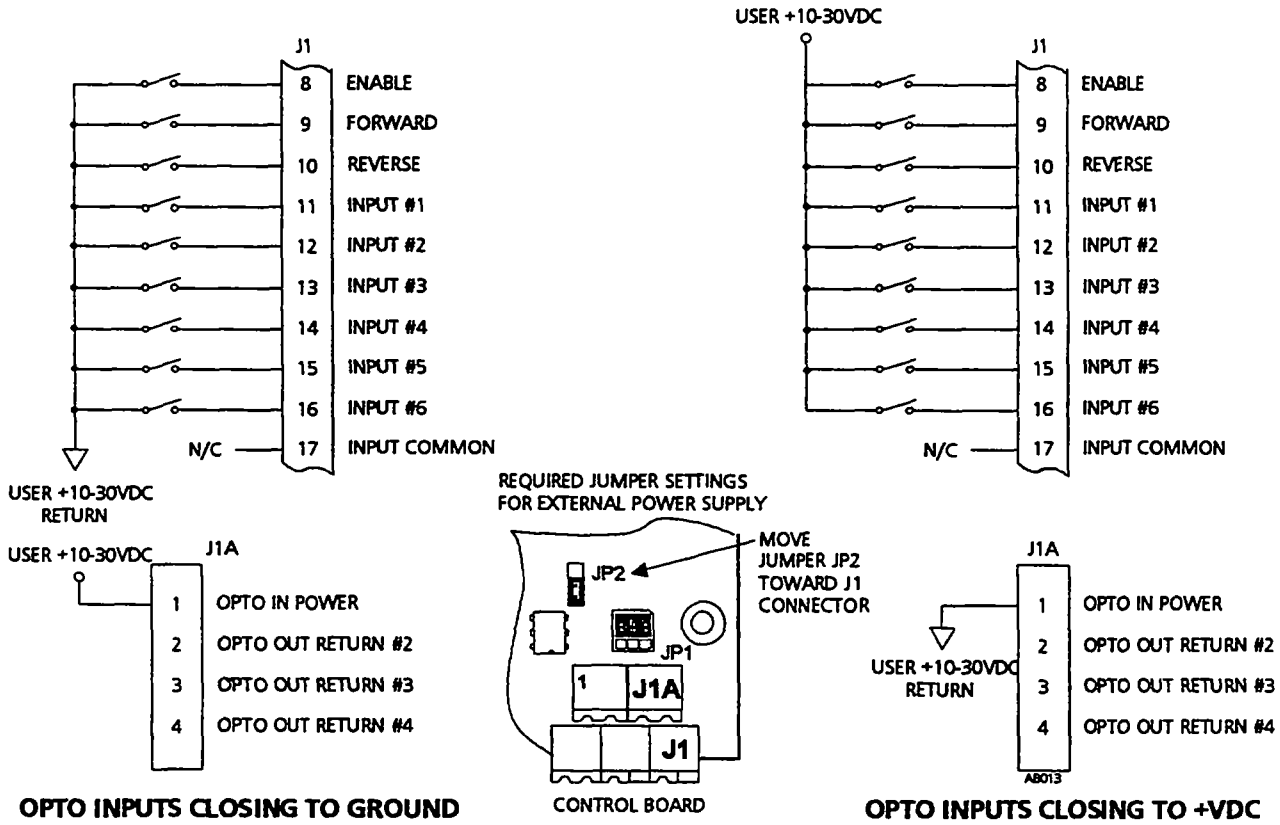
Control Wiring (J1)

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

Opto-Isolated Inputs

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

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



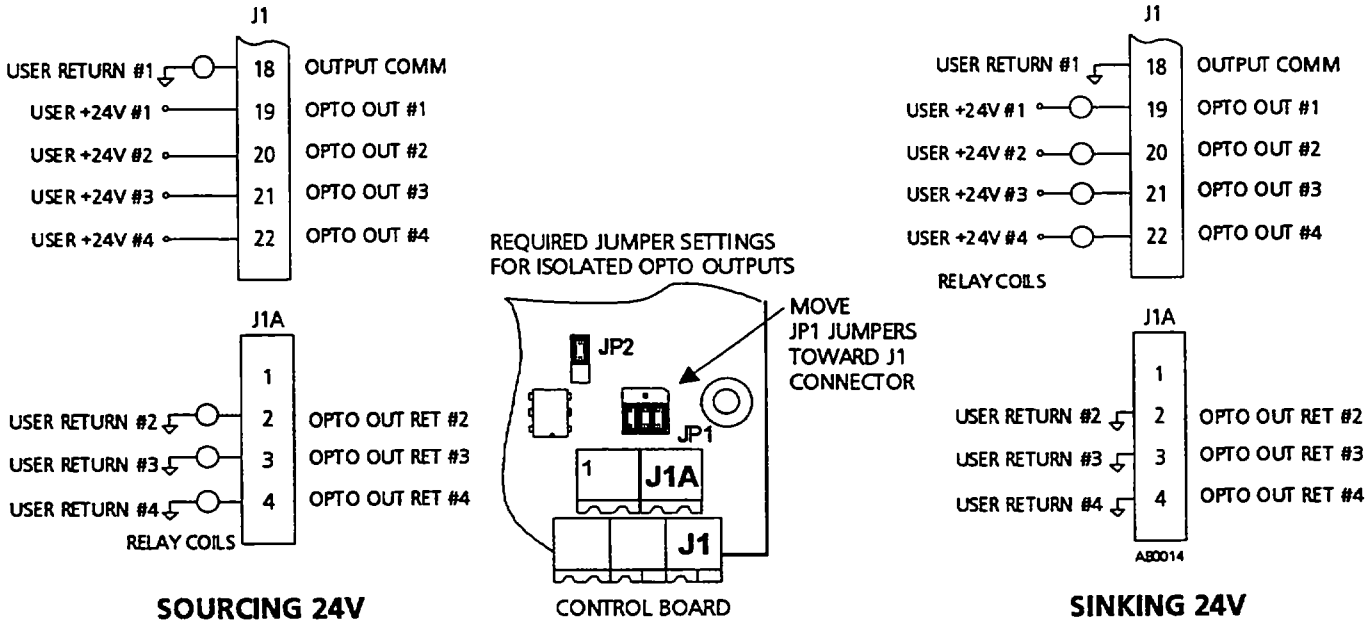
Opto-Isolated Outputs

Four programmable opto-isolated outputs are provided on J1 (J1 19 to J1-22) These outputs can be used to provide indications of various drive conditions The source of these outputs is programmed with parameters P58 P61 The opto-isolated outputs will sink up to 60 mA of current The minimum voltage from opto output to common when active is 2 5 VDC (this is not TTL compatible) Their factory preset connection with common emitters (Jumpers on JP1 set towards J1) is shown in the appropriate connection diagram (Figures 2 7 through 2-10) See appendix B for complete schematic diagram

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

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

Figure 2-12 Using isolated supplies with the opto outputs



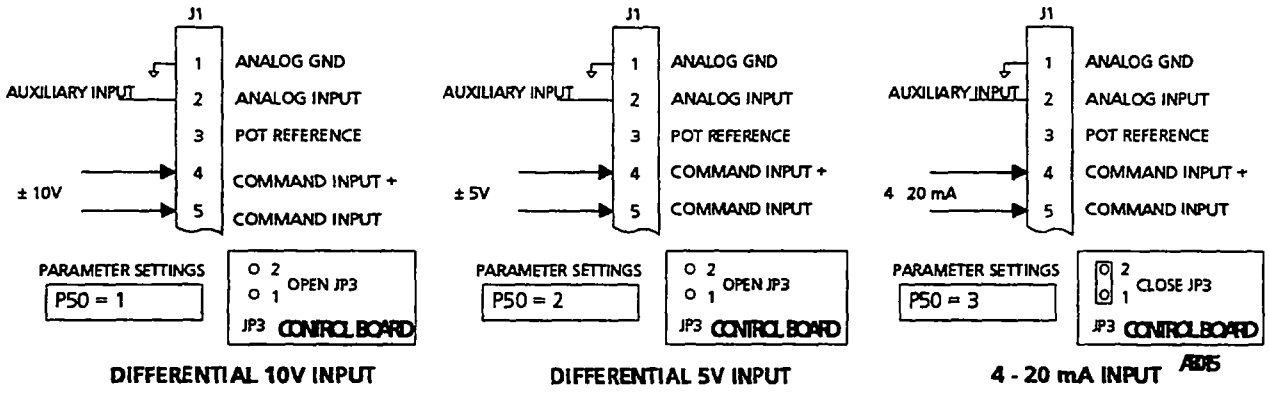
Analog Inputs

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

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

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

Figure 2-13 Analog Input Options for Mode 2



Analog Outputs

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

Encoder Wiring (J2)

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

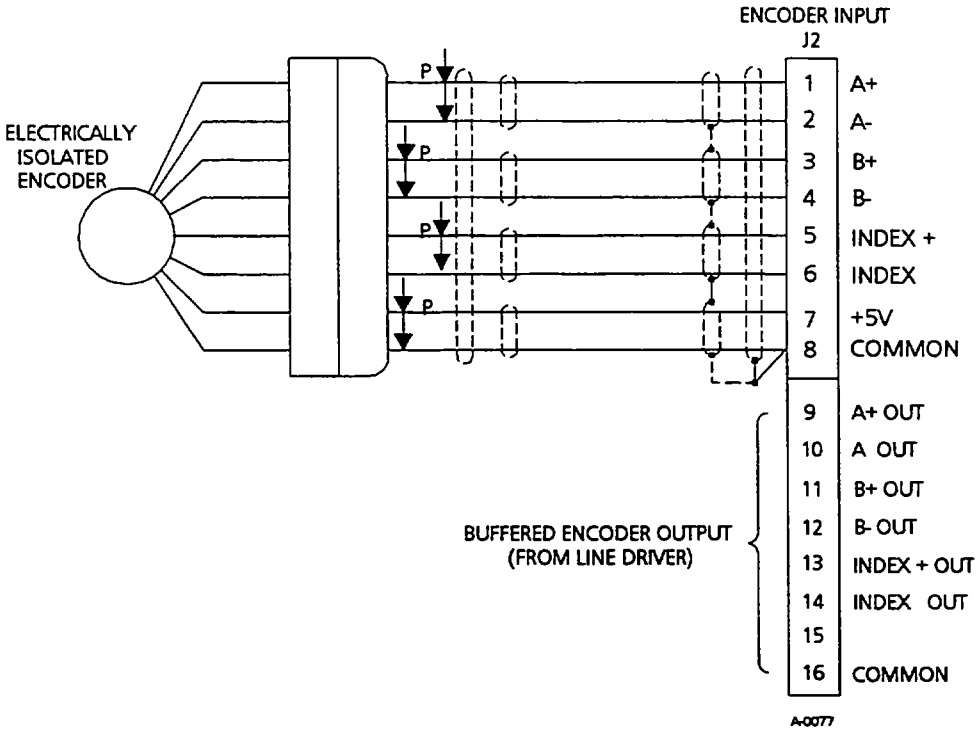
NOTE: When installing the encoder take note of the number of counts per revolution, this number will be used later in Chapter 3 to set parameter P95

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

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

NOTE Encoder wiring must be separated from power wiring Separate parallel runs of encoder cable by at least 3" from power wires cross power wires at right angles only Insulate or tape off ungrounded end of shields to prevent contact with other conductors or ground

Figure 2-14 Encoder Connections



Drfferentral rnputs from 5VDC encoder as shown rn Frgure 2 13 are highly recommended for best noise rmmunrty If only non-drfferentral encoder srgnals are avarlable connect these to +A +B and +INDEX on the plug-rn terminal strrp J2 NOTE The encoder srgnals can be open collector however thrs rs not recommended

NOTE Contact factory rf encoder output has any connections to voltage higher than +5VDC (eg a pull-up resistor or high voltage line driver) Specral connections are required to prevent damage to the encoder rnput crrcurt when thrs type of encoder rs used

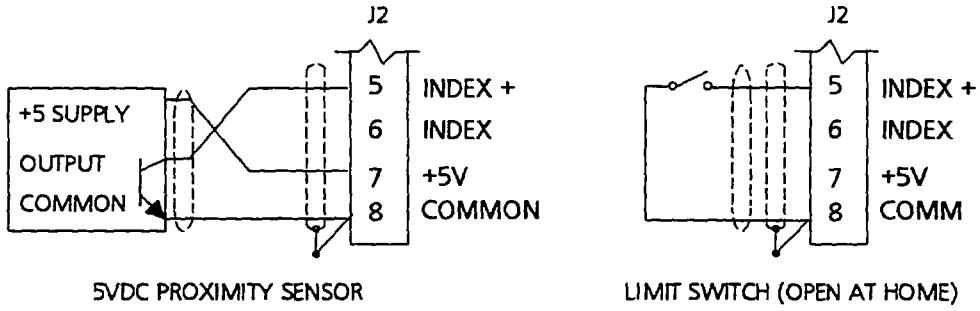
Buffered Encoder Output

The controller provides a buffered encoder output (from line drivers) on terminal strrp J2 prns 9 - 16 (Refer to frgure 2-14) Thrs output can be used by external hardware which needs to monitor the encoder srgnals Splrttrng the encoder output rs not recommended

Home or Orient Switch Input (J2)

A machine mounted switch may be used to define the Home or Orient position in place of the encoder index channel A differential line driver output from a solid state switch is preferred for best noise immunity Connect this input to J2 5 and J2-6 replacing the encoder INDEX channel Wire the non-differential solid state switch or limit switch per Figure 2-15

Figure 2-15 Typical home or orient switch connections



The logic input defining Home is a rising edge at J2 5 Regardless of the type of switch used clean rising and falling edges at J2 5 are required or erroneous positioning will occur

Check of Electrical Items

CAUTION: After completing all the installation steps outlined in this Chapter and before applying line power to the system double check the following items

Verify AC line voltage at source matches rating control

Inspect all power terminations for workmanship and tightness

Verify control and motor are grounded to each other and the control is connected to supply ground

Check incoming signal and encoder wiring for accuracy

Be certain all brake coils contactors and relay coils have noise suppression This should be R C filters for AC coils and reverse polarity diodes for DC coils MOV type transient suppression is not adequate

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

Check of Motors / Couplings

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

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

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

Momentary Application of Power

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

Verify that Enable input to J1-8 is off

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

Chapter 3
Setup Using the Keypad

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

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

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

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

Drive Setup From Motor Nameplate Data

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

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

Setup Parameters

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

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

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

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

Calculate Control Parameters

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

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

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

Auto-Tuning the Drive

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

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

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

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

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

Enabling the Drive

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

Running the Tests

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

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

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

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

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

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

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

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

AU05 **SLIP FREQUENCY TEST**

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

AU06 **SPEED CONTROLLER COMPENSATION**

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

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

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

Selection of Optional Parameters (P0 - P65)

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

System Control Parameters

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

NOTE Although the Accel / Decel ramps are defined as having a maximum value of 999 9 this is dependent on the max speed of the motor The slowest profile the drive can apply to a command is 3 25 RPM per second For example if 1000 RPM is max speed then maximum Acc / Dec would be 307 sec, 2000 RPM = 615 sec and 3000 RPM = 923 sec

P1 **JOG ACCEL** (0 TO MAX SPEED) (SEC) Sets the time in seconds for the Jog command to rise linearly from zero to the maximum speed (set with P30) Adjustable from zero to 999 9 seconds with resolution of 0 1 seconds

P2 **JOG DECEL** (MAX SPEED TO 0) (SEC) Sets the time in seconds for the jog command to fall linearly from the maximum speed (set with P30) to zero Adjustable from zero to 999 9 seconds with resolution of 0 1 seconds The drive will follow this rate if a braking option is used otherwise the drive will take longer to decelerate

P3 **JOG "S" CURVE** (TIME TO MAX ACCEL) (SEC) Sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum speed set with P30 or fall from the maximum speed to zero Adjustable from zero to 99 99 seconds with a resolution of 0 01 seconds Increasing the S-Curve time softens the acceleration transient the drive will apply to the driven equipment and lengthens the time required to change speed Refer to Figure 3 1

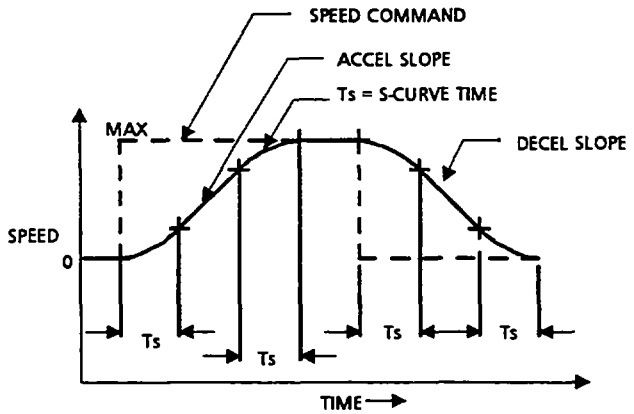
P4 & P7 **ACCEL #1 and #2** (0 TO MAX SPEED) SEC Sets the time in seconds for the speed command to rise linearly from zero to the maximum speed (P30) Adjustable from zero to 999 9 seconds with resolution of 0 1 seconds Two independent Acc / Dec / S-curve groups are available

P5 & P8 **DECEL #1 and #2** (MAX SPEED TO 0) (SEC) Sets the time in seconds for the speed command to fall linearly from the maximum speed (P30) to zero Adjustable from zero to 999 9 seconds with resolution of 0 1 seconds Two independent Acc / Dec / S-curve groups are available The drive will follow this decel rate if a braking option is used otherwise the drive will take longer to decelerate

P6 & P9 **"S" CURVE #1 and #2** (TIME TO MAX ACCEL) (SEC) Sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum value set with P30 or fall from the maximum to zero Adjustable from zero to 99 99 seconds with a resolution of 0 01 seconds Increasing the S-Curve time softens the acceleration transient the drive will apply to the driven equipment and lengthens the time required to change speed Two independent Acc / Dec / S-curve groups are available Refer to Figure 3-1

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

Figure 3-1 Typical S-Curve Limited Velocity Profile



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

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

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

Misc Operating Parameters

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

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

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

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

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

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

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

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

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

Increment Control (P38 = 0 or 1)

Described in Chapter 1 Using the Keypad

Entered Speed Control (P38 = 2 or 3)

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

Preset Speed Control (P38 = 4 or 5)

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

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

P39 = 0

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

P39 = 1

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

P39 = 2

A security code is required from keypad only

P39 = 3

A security code is required from serial port only

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

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

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

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

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

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

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

I/O Parameters

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

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

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

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

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

I/O Threshold Parameters (For Opto Outputs)

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

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

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

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

Flux Control Parameters

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

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

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

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

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

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

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

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

Operate the Drive

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

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

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

Adjust Control Parameters to Suit the Application

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

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

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

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

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

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

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

Select Security Code

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

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

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

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

Record Parameters

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

Chapter 4
Serial Command

A computer or CNC that provides an RS232 / 422 / 485 serial interface may be used to set up and operate the controller A Serial Command Language is built into the controller for this purpose The Serial Command Language accepts commands in the form of ASCII characters and can control any aspect of the controller including running the motor changing parameters and viewing output conditions Some control features are unique to serial control such as positioning and file transfer commands

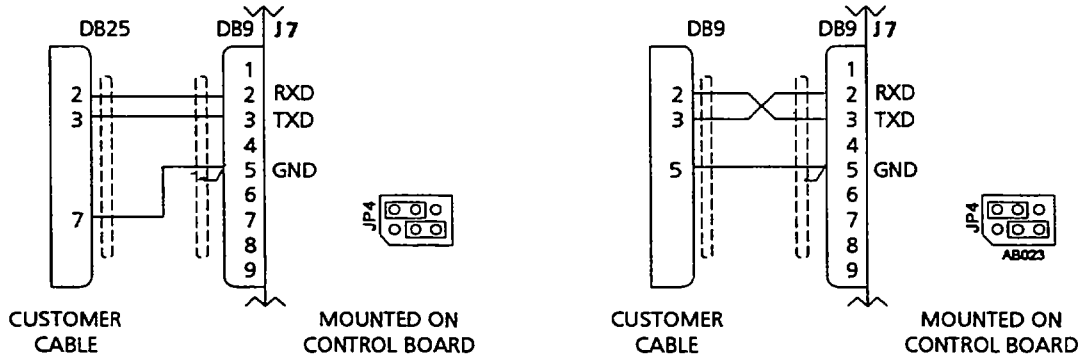
Serial Connections

To use the serial commands requires the use of a computer or terminal capable of serial communications using the standard ASCII character set (A typical system consists of an MS-DOS compatible laptop running communications software) The controller supports RS-232 RS-422 RS-485 (4 wire) multi-drop and RS-485 (2 wire) multi-drop The factory preset communications settings are RS-232 9600 baud no parity 8 data bits 1 stop bit If your system requires a different baud rate you must change Parameter P40 from the **keypad** before continuing Refer to Chapter 1 for information on using the keypad

RS-232 Operation

The serial cable (customer supplied) must be wired as shown in Figure 4-1 and should be connected to the control board on the controller and the host computer before applying power **Shielded wire MUST be used, with the shield connected to ground at the control board** Plug one end of the communications cable into the DB9 connector on the controller (J7) and the opposite end into the DB9 or DB25 RS-232 serial port on the computer or terminal Make sure the JP4 jumpers on the control board match the settings in Figure 4-1

Figure 4-1 RS-232 Serial Connections



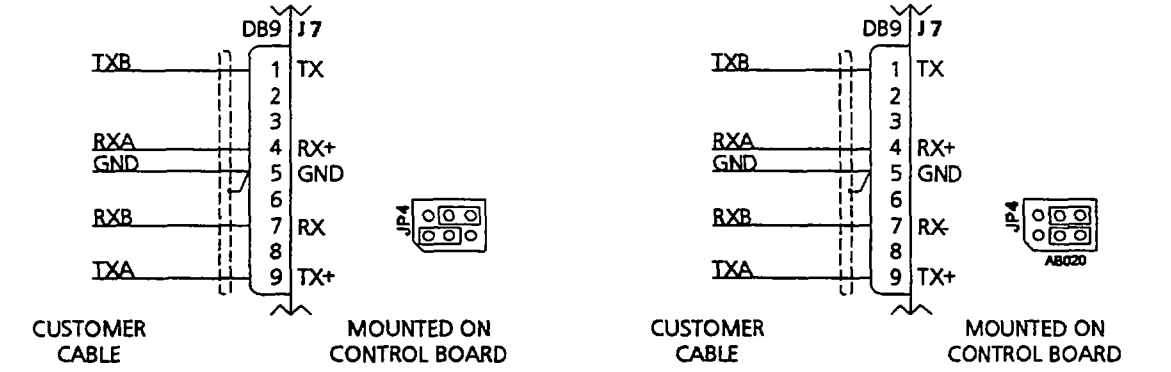
RS232 DB25 TO DB9 CONNECTIONS

RS232 DB9 TO DB9 CONNECTIONS

RS-422 / RS-485 Operation

The RS-422 and RS-485 interfaces use differential signals providing increased noise immunity The connections are shown in Figure 4-2 The cable should be connected to the control board on the controller and the host computer before applying power **Shielded wire MUST be used, with the shield connected to ground at the control board** Make sure the JP4 jumpers on the control board match the appropriate settings in Figure 4-2

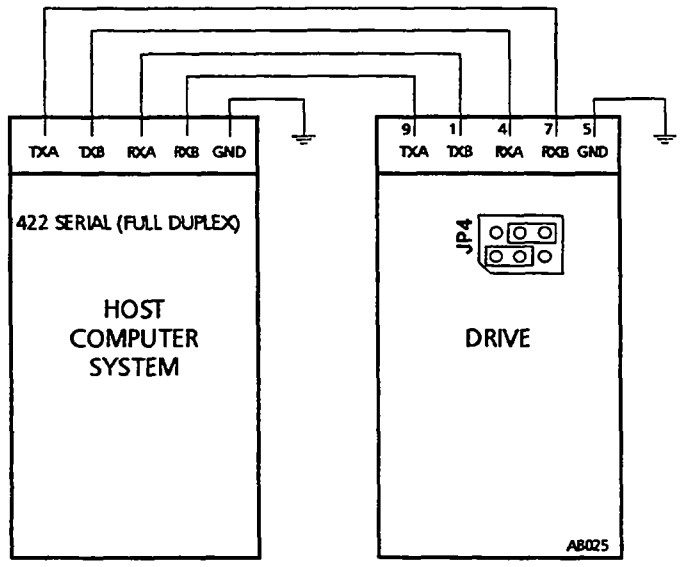
Figure 4-2 RS-422 / RS-485 Connections



RS-422 Point To Point

A typical RS-422 system is shown in Figure 4-3 RS-422 allows full duplex (4-wire) operation between one host computer and one controller (unlike RS-485)

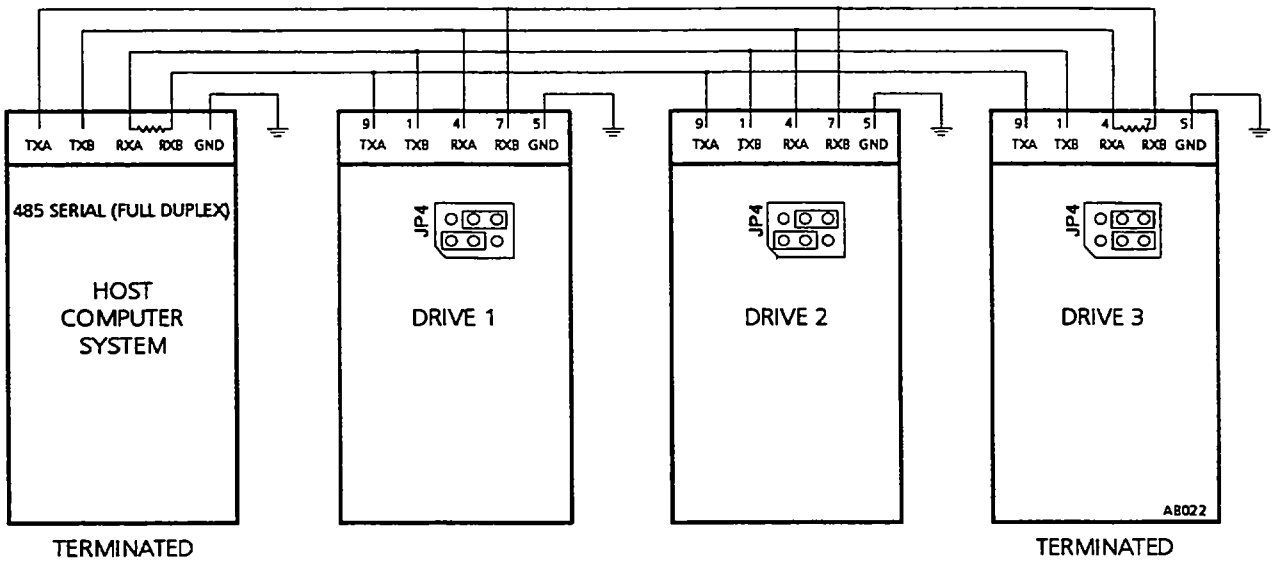
Figure 4-3 RS-422 Point to Point System



RS-485 4-Wire Multi-Drop

RS-485 4-wire allows up to 31 controllers to be connected (full duplex) to a host computer through a multi-drop or "party lined" cable A typical RS-485 4 wire system is shown in Figure 4-4 Note the last controller in a multi-drop system MUST be terminated by setting the JP4 jumpers accordingly refer to Figures 4-4 and 4-2 The host computer must also be configured with a terminating resistor In multi drop operation each controller must be configured with a different controller address (P41)

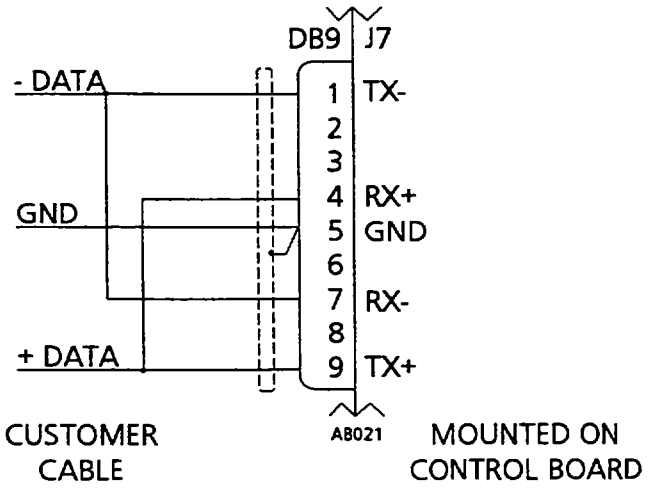
Figure 4-4 RS-485 4-Wire Multi Drop System



RS-485 2-Wire Multi Drop

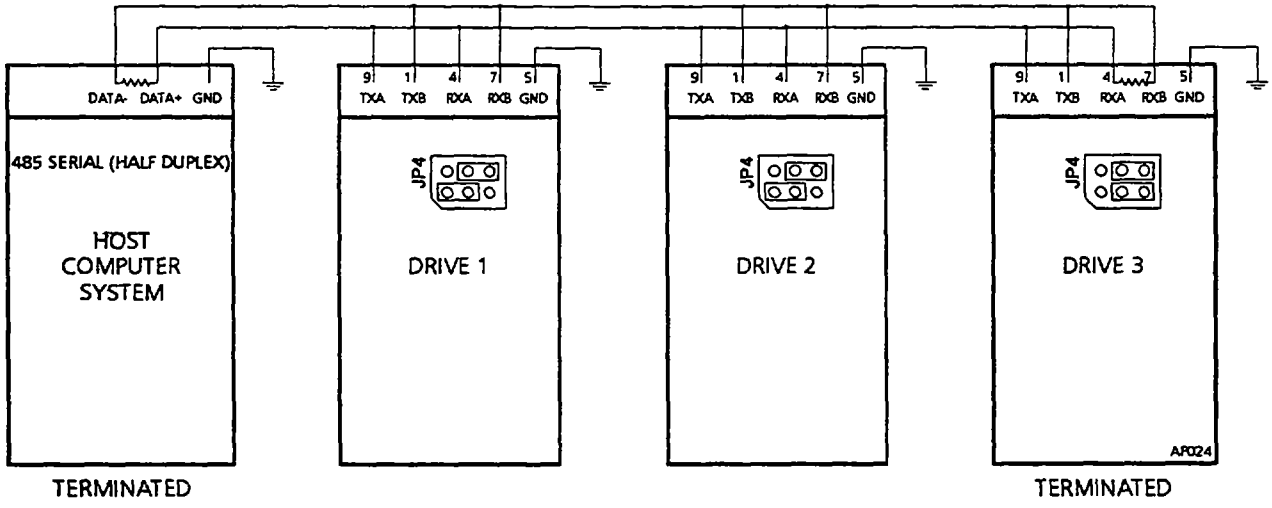
RS-485 2-wire (half duplex) communication is possible by connecting the cables as shown in Figure 4-5 Note in this configuration the host computer **MUST** disable its transmitter after **each** transmission

Figure 4-5 RS-485 2-Wire Connections



RS-485 2 wire allows up to 31 controllers to be connected (half duplex) to a host computer through a shielded twisted pair cable A typical RS-485 2 wire system is shown in Figure 4-6 Note the last controller in a multi-drop system MUST be terminated by setting the JP4 jumpers accordingly refer to Figure 4-6 The host computer must also be configured with a terminating resistor In multi drop operation each controller must be configured with a different controller address (P41)

Figure 4-6 RS-485 2-Wire Multi Drop System



Controller Setup from Serial Command

After completing all wiring and safety checks per Chapter 2 and connecting the serial cable apply power to the controller

NOTE If you have a correct Parameter file available for your application and you are familiar with entering serial commands you may skip ahead to the section entitled FILES TRANSFER COMMANDS to upload your file to the controller After your file has been uploaded you should proceed to the section entitled OPERATE THE Controller

Using the Serial Command Language

This section describes the setup and tuning of the controller from serial commands The Sweodrive serial command language provides a comprehensive set of instructions for configuration and operation that are listed later in this chapter A brief list of the commands required for setup will be given below

The serial command language can be used with any of the operating modes described in Chapter 2 as long as the user can assert control over the Enable line (J1-8) Forward Limit (J1-9) and Reverse Limit (J1 10) These inputs function as emergency stop lines and must be maintained closed to allow control serial operation Once under serial local control the controller will ignore all J1 logic inputs except the enable and forward/reverse limit inputs (J1-8 9,10 and the motor temp input J1-16 if active)

Once the proper cable has been installed power has been applied to the controller and the computer or terminal is configured and operational type **STATUS** and press Enter (Return on some keyboards) A few lines of text should appear on your screen

Commands Required for Setup

(Commands are case sensitive)

V0 Puts the drive in Velocity mode with a 0 command

E Enables the controller to produce torque (J1-8 must be closed J1 9 must be closed for forward operation, J1 10 for reverse)

D Disables the controller

Pxxx or **Pxxx nnnn** Change or view parameters where xxx is the parameter number and nnnn is desired value for the parameter Typing Pxxx alone displays the current value Typing P will display all parameters

AUx - Runs an auto tuning test where x is the test number

STATUS Returns the current status of the controller

Vxxxx Gives the controller a velocity command xxxx is the desired velocity (signed) in RPM

The following procedure assumes that the controller has no security code defined (factory preset) If your controller has already been programmed with a security code you will need to enter that number To enter the security code Type **SCxxxx** (press ENTER) Where xxxx is your four digit security code For example if your security code is 1234 you would type **SC1234** and press the ENTER key

The following procedure also assumes that you have successfully completed the installation of the controller as outlined in Chapter 2 and have successfully established serial communications between the controller and your system

To enter the parameters that follow you must use the change / view parameters command **Pxxx** or **Pxxx nnnn** For example to change P0 to 3 you would type **P0 3** (press ENTER) NOTE the space between "P0" and "3" is required

Setup Parameters

PARAMETER	DESCRIPTION AND PROCEDURE
P90	**OPERATING MODE** Enter the mode number chosen in Chapter 2 (Figures 3 -6)
P91	**MOTOR RATED VOLTAGE** Enter the rated voltage of the motor in RMS volts from the motor nameplate
P92	**MOTOR RATED CURRENT** Enter the rated full load current of the motor in RMS amps from the motor nameplate
P93	**MOTOR RATED SPEED** Enter the rated or base speed of the motor in RPM exactly as shown on the motor nameplate **NOTE DO NOT ENTER DESIRED OR RATED MAXIMUM SPEED OR ROUND OFF THE RATED NAMEPLATE SPEED**
P94	**MOTOR "RATED" OR "BASE" FREQUENCY** Enter the rated or base frequency in Hertz from the motor nameplate
P95	**ENCODER LINES PER MOTOR REVOLUTION** Enter directly from encoder nameplate or data sheet for direct coupled encoder Geared or belt coupled encoders are not recommended if used they must have positive ratio with no slippage and encoder lines per motor revolution must be entered here

Calculate Default Parameters

This procedure uses the nameplate data to compute default values for various remaining parameters NOTE Parameters with their factory preset marked as CALC or referenced to another parameter in the parameter list (Appendix D) will be overwritten by this procedure

P99 CALCULATE AND LOAD FACTORY PRESET DATA Enter **1** to calculate flux vector parameters and load parameters with factory preset data NOTE MANUALLY CALCULATED PARAMETERS THAT YOU WISH TO RETAIN MUST BE RE-ENTERED AFTER THIS STEP The controller will reset the P99 value to 0 after it has completed calculations and entered parameters

Auto-Tuning the Drive

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

Automatic tuning of the controller to the motor is accomplished by running a six step tuning procedure activated through **AUx** auto-tuning commands The resulting parameters P72 through P78 selected by the microprocessor may be manually changed if required to suit the application Refer to Appendix C for more information on manually adjusting gain parameters

WARNING These procedures may rotate the motor up to maximum speed Do not perform auto tuning unless it is safe to rotate the motor under automatic control of the controller

These procedures require the motor and encoder (if used) to be properly wired shielded and grounded per Figures 2 2 through 2 12 They also require that the motor rotor be free to rotate with no external load or source of significant windage or friction The tests must be run in sequence from AU1 to AU6

To run each procedure first put the controller in Serial Control mode by setting P90=3 Next activate the enable inputs (J1 8 9 & 10) but **do not** enable the controller with an **"E"** command Type **AUx** where x is the desired test number press ENTER to start the test When complete the controller will echo back either "PASS" or "Fail" to announce whether or not the procedure has run successfully Repeat the procedure for the next test number until all tests have been run

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

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

AU1 **COMMAND OFFSET TRIM**
Trims out any offsets on the differential command input (J1-4 & J1-5) It does not trim the Analog (POT) input (J1 1 2 3) This test is required only if the controller is to be used in mode 2 you can skip this procedure for other modes Apply input command to J1-4 and J1-5 corresponding to zero speed select AU01 and run the procedure as described above IF THE PROCEDURE FAILS J1-4 to J1 5 input is too high to trim out Measure voltage J1-4 to J1 5 and command voltage near zero before re-running

AU2 **CURRENT LOOP COMPENSATION**
This procedure measures current response to pulses of 1/2 rated motor current The test sets the values for Parameters P73 - Current Controller Proportional Gain and P74 - Current Controller Integral Gain If this procedure fails retry once before consulting factory for assistance

AU3 **FLUX (EXCITATION) CURRENT SETTING**
This procedure runs the motor near rated speed for up to several minutes and sets flux current (P72) based on line voltage and motor nameplate data IF PROCEDURE

FAILS remove the Enable (OPEN J1 8) and check P90 through P95 entries motor grounding and proper voltage at L1 L2 L3

AU4 **ENCODER TESTS**
This procedure checks the values entered in Parameters P95 Encoder lines per revolution and P71 Encoder alignment direction This is accomplished by accelerating the motor "open loop" detecting the phasing of encoder feedback and counting the number of encoder pulses per revolution of the motor The test will automatically switch the phasing of P82 to match motor rotational direction IF THE PROCEDURE FAILS OR THE CONTROLLER APPEARS UNSTABLE check motor and controller grounding encoder coupling P95 encoder lines selection wiring and shielding and then repeat the test If the test still fails Open the Enable input (J1-8) to disable the controller put the keypad in Display RPM mode (Press the DISP key until the RPM indicator is lit) and observe RPM on the display while rotating motor rotor by hand Zero RPM or erratic display indicates malfunctioning encoder power supply encoder wiring error or damaged control board encoder line receiver If the display seems OK, manually change P71 from 1 to zero or vice-versa and retry

AU5 **SLIP FREQUENCY TEST**
This procedure repeatedly accelerates motor to test Parameter P78 and will yield erratic results if there are significant windage or friction loads on the motor IF THE PROCEDURE FAILS, manually reset P78 to the value calculated from the CALCULATE DEFAULT PARAMETERS section above

AU6 **SPEED CONTROLLER CALCULATION**
This procedure accelerates the motor to measure the current to acceleration ratio (P75) It also adjusts Parameters P76 Speed Controller Integral Gain and P77 Speed Controller Differential Gain Because the auto-tune is usually done at no load it will generally set P76 too high for high inertia motors and loads if current limit P33 is set too low If the controller is too responsive when the drive is loaded set current limit to the proper value and rerun this procedure NOTE This auto-tune procedure can be run with the drive loaded IF THIS PROCEDURE FAILS or controller is still too responsive adjust P75 manually as discussed in Appendix C

Enter Optional Parameters

NOTE: Entering the optional parameters is not required for the initial setup of the controller If your application does not require any of the parameters described below you can skip ahead to the section entitled OPERATE THE DRIVE

Parameters P0 through P65 are used to specify analog and digital inputs outputs and other functions to suit the application A complete list of the optional parameters with descriptions exists in Chapter 3 If your application requires some of these parameters to be changed please refer to the section entitled SELECTION OF OPTIONAL PARAMETERS in Chapter 3 and use the "Pxxx nnn" command to change parameters

Operate the Drive

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

Make sure the controller is in Serial Local Control (P90=3)

Close the enable and forward/reverse limit inputs (J1 8 9 & 10)

Set the controller to Velocity with a 0 RPM Command type **V0** (press ENTER)

Enable the controller type **E** (press ENTER)

Current should now be flowing in the motor (you may hear some audible noise)

Enter a Velocity command **Vxxxx** (press ENTER) (use the desired speed instead of xxxx)

The motor should now run at the desired speed

Disable the controller type **D** (press ENTER)

Adjust Control Parameters to Suit the Application

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

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

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

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

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

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

6 Current limit P33 is adjusted to limit maximum torque the motor will apply to the load

Select Security Code

The security code (P101) is an optional entry It works with Parameter P39 to prevent keypad or serial users from entering the Program mode where Parameter variables may be altered but does allow users to view any variable The factory preset value is 9999

The security code value may be set by changing parameter P101 to the desired value Once the number is selected record it in a safe place Next P39 will need to

be changed to select the desired security mode (see discussion of P39 in chapter 3 or Appendix D for more information)

After a security code is entered and P39 is set for serial security code you must first enter the security code to access security lockable commands (described later in this chapter)

type **SCxxxx** (press ENTER) (Use the desired code instead of xxxx)

You can now access the security lockable and local mode commands The STATUS command can be used to determine the present state of the security code

Record Parameters

If you wish to save the parameters you have entered you may copy down parameters from the keypad display for future reference The vector controller parameter sheet in Appendix D provides a convenient form for the data Parameter data may also be stored in a computer file by the procedure given below

File Transfer Commands

The serial command language supports the transfer of parameter files using the standard XMODEM protocol

To UPLOAD a file FROM a remote computer TO the controller

Type **UL** (press ENTER)
Then start your remote UPLOAD procedure using XMODEM To cancel type CTRL X

To DOWNLOAD a file FROM the controller TO a computer

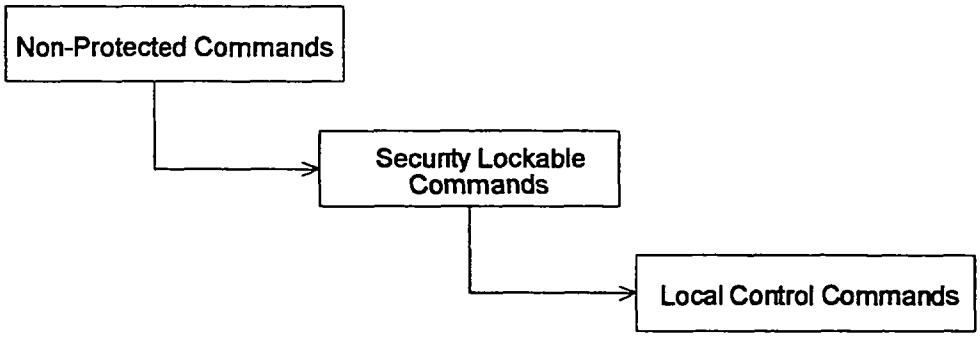
Type **DL** (press ENTER)
Then start your remote DOWNLOAD procedure using XMODEM To cancel type CTRL X

Serial Command Language Reference

The following instruction set has been incorporated in into the controller software The use of the command set is optional for operation and set up of the drive but allows enhanced computer digital control through the Serial communications port running from 1200 19 2K baud

All commands consist of ASCII characters followed by a CR (carriage return hex 0D) The CR is used as the "End of Line" character and prompts the controller to process the command The BACKSPACE character (hex 08 or control H) cancels the previous character The Control X keystroke(hex 18) cancels the current line

The commands are organized in nested levels



To access commands in a lower level you proceed through the level above it

Non-Protected Commands

These commands do not require a security code The only requirement to access these commands is that in a multi-drop system the controller must be addressed (In a non-multi-drop system addressing is not required)

Ax (Address) (used in multi-drop systems) where x = 1 to 32

The Address command is used to select the controller identified by x for communication Commands will be received and processed by the controller with x address until another address is called for or a global Address All (**AA**) command is given The controller address is set (if used) in the Controller address parameter P41 The controller defaults to an address of 0 until another is selected The controller with the address of 0 defaults to receiving and processing commands until another address is called for This command is used in multi-drop systems where many controllers share a common serial connection

When the controller receives an address command it echoes back its controller address to acknowledge that it is now on line

AA (Address All) (used in multi-drop systems)

This is the Address All command it is used to direct the following command to ALL controllers on a multi-drop system regardless of their individual Controller ID The Address All remains active until another address is selected

ECHO_ON Turns on the echo character function (Default when not in multi-drop)

ECHO_OFF Turns off the echo character function (Default when in multi-drop)

L (Log) Sends a report of the last 15 faults with time stamps with the most recent first The fault numbers displayed correspond to the following fault codes found in the troubleshooting chapter

ST (Status) This returns the current controller status in the form of
0 = DISABLED
1 = ENABLED
2 = FAULT

STATUS (Full Status) This returns a listing of serial mode variables and their status

TP (Test points) This command prints out a list of captured test points The test point recorder is made up of two channels When the controller is enabled the recorder continuously captures data when the controller becomes disabled or faults the data capture stops and the controller retains the last 32 points of data per channel The channels can be set to record internal variables by setting P105 (ch1) and P106 (ch2) according to the following list

0 = Velocity
1 = Electrical Angle
2 = Absolute Value Command
3 = Voltage magnitude for PWM
4 = Direct Current
5 = Direct Current Command
6 = Quad Current
7 = Quad Current Command
8 = Voltage Regulator
9 = Speed Following Error
10 = Quad Controller
11 = Direct Controller
12 = AC Voltage Out
13 = Bus Voltage
14 = Voltage Vector Out
15 = Power
16 = Speed Command
17 = Overload Accumulator
18 = I Phase 2
19 = I Phase 3
20 = Position counter

ID (Power base ID) This returns a listing of power base settings and the controller Line volts

IO (IO Status)

This returns the current state of all J1 connections this is useful for troubleshooting The output is as follows Pins 2 4 and 5 give the status of the analog inputs A value of 512 represents 0 V 1024 = 10 V 0 = 10 V Pins 6 & 7 are the analog outputs they are scaled 0-256 where 256 = the maximum value

PIN 2 505
PIN 4 5 505
PIN 6 88
PIN 7 34
PIN 8 On
PIN 9 Off
PIN 10 Off
PIN 11 Off
PIN 12 Off
PIN 13 Off
PIN 14 Off
PIN 15 Off
PIN 16 Off
PIN 19 On
PIN 20 Off
PIN 21 On
PIN 22 Off

F (Fault)

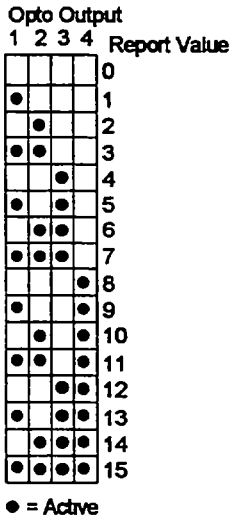
This returns the current FAULT code Returns 0 if no fault condition exits

Oxx (Report)

If entered without arguments it returns a report of the current output RPM Hz Vrms and Arms Arguments are used to return a specific operating value according to the following table

1 = RPM	5 = % Rated Load
2 = Hz	6 = Analog Input (± 4096)
3 = Motor Vrms	7 = Opto Outputs (0-15)
4 = Motor Arms	8 = Absolute Value

Note the Opto Output (7) report represents a 4 bit word



TAR Xxxx (target register)

where Xxxx is any serial command in its normal format

Stores the command after the space in a target register This

command is stored and processed when a **GO** command is given This is useful when synchronizing multiple controllers on a common mark For example on a 3 axis system each controller could be given a "target" position and all three could be started at the same time with a global **GO**

GO (process target command) The command stored in the target register will be processed Note although **TAR** and **GO** are non - protected commands the command stored in the target register is still subject to its appropriate access level

SCxxxx (Security Code) Locks and unlocks serial commands where xxxx is the Security Code (parameter 101)

If entered with xxxx this command unlocks the serial commands that follow This is only active if serial locking is turned on by parameter #39 Entering **SC** alone locks up the serial commands again

Security Lockable Commands

These commands require the entry of the Security Code if this option is turned on in the parameter list (P39) They also require an address command in a multi-drop system

File Transfer Commands·

UL (Upload) *Begins the Upload procedure*

The controller will then receive a parameter file uploaded using the standard XMODEM protocol Control-X can be used to cancel If the XMODEM procedure is not started within 60 seconds the command aborts

DL (Download) Begins the Download procedure

The controller will then send a parameter file to be downloaded using the standard XMODEM protocol Control-x can be used to cancel If the XMODEM procedure is not started within 60 seconds the command aborts

Control Commands.

C (Clear) This command clears and existing fault returning the controller to operation if an enable is still present

Pxxx or **Pxxx nnnn** (Parameter) where xxx is a value from 0 - 999 and nnnn is a value from 0 - 9999

When the command is **Pxxx** the current value of parameter xxx is returned When the command is followed by a space & nnnn parameter xxx is changed to the value of nnnn **P** entered with no arguments lists all parameters

Serial Control Commands

These commands require the controller to be under Serial Control Mode (P90=3) When in this mode the controller locks out the external I/O (except enables) and the keypad The controller must be addressed in multi-drop systems If the security code has been turned on for serial control it must be entered

AUx (Tune) This command starts the motor tuning procedure The controller must be externally enabled by either the keypad or external I/O

H (Home) Commands the controller to go the predefined home position at the predefined homing speed NOTE this is not the same as the **W** (Position to zero command) and is not meant to be used in conjunction with positioning commands

V or **Vnnnn** (Velocity command) where nnnn is a numeric value

When the **V** command is alone it enters velocity control and returns the last velocity command When followed by a numeric value it commands that value Note negative velocities are denoted by nnnn (positive values may be entered by +nnnn but this is optional) **V+** or **V-** (depending on the current direction) will cause the controller to reverse direction using the last commanded velocity value

T or **Tnnnn** (Torque command) where nnnn is a numeric value

When the command is alone it enters torque control and returns the last torque command When followed a numeric value it commands that value Note negative torques are denoted by a -nnnn (positive values may be entered by +nnnn but this is optional) **T+** or **T-** will (depending on the present torque direction) will cause the controller to reverse direction using the last commanded torque value

E (Enable) Enables the controller Note the current status of the controller can be retrieved by using the **ST** (STATUS) command Note For saftey reasons the controller will not enable unless a valid **"V" "T"** or **"M"** command previously been given

D (Disable) Disables the controller Note the current status of the controller can be retrieved by using the **ST** (STATUS) command

Jx (Jog) arguments + - S (stop)

Jogs the motor at the rate set by the JOG SPEED parameter (P0) The argument determines the direction or stops the jog

S (Stop) Issues an ALL STOP to the drive The KEYPAD SPEED CONTROL parameter determines whether the motor coasts to a stop or decels to a stop

Positioning Commands

NOTE Position commands can only be used with a braking option installed Refer to Chapter 8 for information on braking options

M or **Mxxxxx** (Absolute move) where xxxxx is an absolute position (signed) in encoder counts X 4

When M is passed followed by a carriage return (without xxxxx) it returns the absolute position of the motor in encoder counts from the **Z** (zero) position When followed by xxxxx the drive will move to absolute position of xxxxx encoder counts relative to the **Z** position at the rate defined with the **v** (Positioning Speed) command Note positions negative to the ZERO position must be entered using -xxxxx

m or **mxxxxx** (Relative Position) where xxxxx is a (signed) position relative to the current position in encoder counts X 4

When passed with xxxxx the drive will then move xxxxx encoder counts relative to the current position at the rate defined with the **v** (Positioning Speed) command (note negative direction is denoted by -xxxx)

vxxxx (Positioning Speed) where xxxx is a velocity value Note this value is preset to 0 upon drive power-up

This command changes the maximum of speed used to achieve positioning commands

W (Position to Zero) This command positions the drive to the absolute ZERO position as defined with the **Z** command The command moves at the defined positioning "speed" as set be **v** NOTE this is not the same as the **H** (HOME) command

Z (Set current position to Zero) This command sets the current position to zero (To be used only with positioning commands)

See Appendix E for a Quick list of the Serial commands

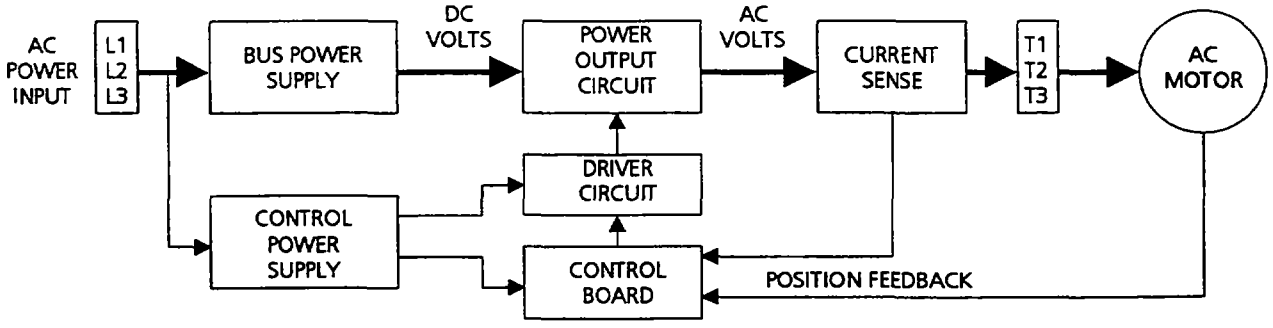
Chapter 5
Theory of Operation

Drive Overview

An AC Vector drive system consists of a 3 phase induction motor and a Flux Vector controller The Flux Vector controller converts the incoming AC line power to the appropriate motor voltage current and frequency necessary to achieve the desired motor speed and torque

In an AC vector controller the incoming AC power is first converted to DC by the bus power supply This DC voltage is converted (pulse width modulation) back to AC by the power transistors to the output circuit The control board microprocessor uses feedback from the current sensors the bus voltage and the motor position (optional) to generate the driver control signals The driver circuit uses these signals to turn on the appropriate transistors in the power output stage The control power supply converts the incoming line voltage into operating voltages used by various circuits through-out the controller

Figure 5-1 Simplified AC Vector Block Diagram



Bus Power Supply

(Refer to Drawing No 8014)

The bus power supply converts the incoming AC voltage to a DC voltage used by the Power Output section The drawing shows the interconnection of the power components The incoming AC power at terminals L1 through L3 is full-wave rectified by a diode bridge It is then filtered by bus capacitors The capacitors store DC bus energy to provide a safe operating voltage for the power transistors by absorbing a limited amount of regenerated energy Motor regeneration will increase the DC bus voltage causing operation of the braking transistor (optional) which limits the DC bus voltage to predetermined level See Table 5 1 for the appropriate bus voltage thresholds

Table 5 1 Bus Voltage Thresholds

NOMINAL LINE VOLTAGE	230 VAC	400 VAC	460 VAC
NOMINAL BUS VOLTAGE	275 350 VDC	475 590 VDC	550 695 VDC
BUS OVERVOLTAGE	386 VDC	645 VDC	772 VDC
BRAKING TRANSISTOR ON	372 VDC	620 VDC	748 VDC
BRAKING TRANSISTOR OFF	362 VDC	607 VDC	732 VDC
BUS UNDERVOLTAGE	224 VDC	400 VDC	460 VDC

Excessive current inrush upon power application is prevented by the soft start circuit This circuit is composed of a starting resistor and a relay Operation of the soft start function is controlled by the control board The relay is closed to bypass the charging resistor once the bus voltage settles out within its proper voltage range The control board will not allow the output transistors to operate if the soft start fails to function

The DC bus voltage is continuously monitored by the control board which operates the braking transistor (if provided with your model) When the bus voltage approaches its peak level the braking transistor is turned on to draw current through the external braking resistor to dissipate excess regenerated energy The peak energy that can be absorbed is limited by the maximum resistor current that can be controlled by the transistor See Chapter 8 for minimum allowable resistance for each controller rating

Control Power Supply

The control power supply operates on 24 VAC which is provided from the AC input power via a transformer It provides the following output voltages

1) 48 kHz 24 volts AC voltage to the driver board This voltage is used by a transformer on the driver board to create 7 isolated supply voltages

2) Regulated 24 VDC to the driver board

3) Regulated 24 VDC to the control board

4) Regulated ± 15 VDC to the control board This voltage is also passed from the control board to the current sensor

5) 8 VDC to the control board's local regulators to be converted to 5 VDC This in turn supplies power to all the control board circuitry as well as the signals passed to the driver board and to the encoder power terminals

6) 24 VDC Fan power (Some models use AC fans instead of DC fans and do not make use of this output)

Control Board

The functions of the control board are

1) To provide either a speed or torque controller which responds to the user's input

2) To provide separate flux and load current loops which respond to the flux vector supplied current commands

3) To provide pulse width modulated outputs to the driver circuit in response to current loop errors

4) To provide current limiting

5) To provide latching and indication of control power failure overload bus under- and over voltages amplifier fault and drive or motor overtemp conditions

6) To provide a selection of drive and motion enables

7) To provide two programmable analog inputs two analog outputs nine opto isolated inputs and four opto isolated outputs

8) To provide simple entry storage and retrieval of control parameters

9) To provide a controller which automatically calculates servo parameters from simple nameplate data

All control boards with the same part number have identical hardware However the motor parameters stored in the battery backed RAM may be different The control boards may also have different revisions of software (noted on IC's U25 and U26) See Software Revisions Chapter 1

The control board saves all motor and control parameters in nonvolatile RAM The contents of this ram are checked upon each power up sequence for possible corruption The RS232 / RS422 / RS485 serial interface allows the user to change parameters store and retrieve file data monitor drive status or fully control the motor operation The keypad display provides metering of speed voltage current or frequency as well as parameter adjustment and monitoring The keypad also allows the user to operate the motor in several configurations

Encoder Signals

The Encoder Feedback Flux Vector control board is capable of operating with position feedback from a shaft mounted encoder

The control power supply provides a separate 5V power supply for the encoder Quadrature A and B phases are necessary for the control board to determine the direction of rotation A once per rev index pulse is optional (may be used to orient the rotor) The signal lines can be received differentially See chapter 3 Encoder Wiring for more information

The control board also provides a buffered (via line drivers) encoder output This output can be used by external hardware which needs to share the encoder signals

Outputs to Gate Drivers

The gate driver signal outputs are PWM waveforms one for each of the six power output transistors These signals are developed by the microprocessor Changes in the PWM pulse widths control the power transistors to regulate motor voltage as required by the control system

Flux Control

The flux control includes the direct current loop which regulates the direct component of motor voltage to maintain the desired motor excitation current The flux controller develops the direct current command from the flux current parameter and speed feedback Proportional and integral gains in the flux current controller provide high gain and rapid current loop response typically less than 2 milliseconds rise time

Load Current (Torque) Controller

The load current controller controls the torque producing (load) component of motor current by regulating the quadrature component of motor voltage Proportional and integral gain in the load current controller provide rapid torque response typically less than 2 milliseconds rise time

When the drive is selected to be a speed controller the speed controller output commands load current When the drive is selected to be a torque controller the input directly commands load current

Speed Controller

The speed controller sums the speed command and the digital speed feedback to command load current Proportional and integral gain in the speed controller provide accurate regulation and rapid response Typically the speed loop bandwidth can be set as high as 40 to 50 Hertz when the current controller gains are set near maximum

Current Limiter

Amplifier current is limited by restricting the current command to the current limit value The maximum current value is normally set to twice the rated motor current The controller will not allow a value above the capacity of the amplifier The smaller of the continuous current rating of the motor or amplifier is used for current overload protection The overload protection of the controller will allow the drive to operate at or below this current indefinitely at 150% of the drive rating for 80 seconds and at 200% of the drive rating for 3 seconds The elevator drive versions will allow 300% of drive rating for 3 seconds

Flux Vector Theory

The "Flux Vector" control is an algorithm for running an AC induction motor The induction motor has a 3 phase wye or delta connected stator Instead of permanent magnets the rotor has a group of shorted bars commonly referred to as a squirrel cage This makes the induction motor very rugged requiring low maintenance The goal of the control scheme is to achieve the same high performance of the more costly less robust permanent magnet motors

A standard in induction motor control has been the voltage source invertor which allows the induction motor to operate at variable speeds by controlling the voltage and frequency to the motor This type of control yields very poor performance at low speeds and under dynamic conditions

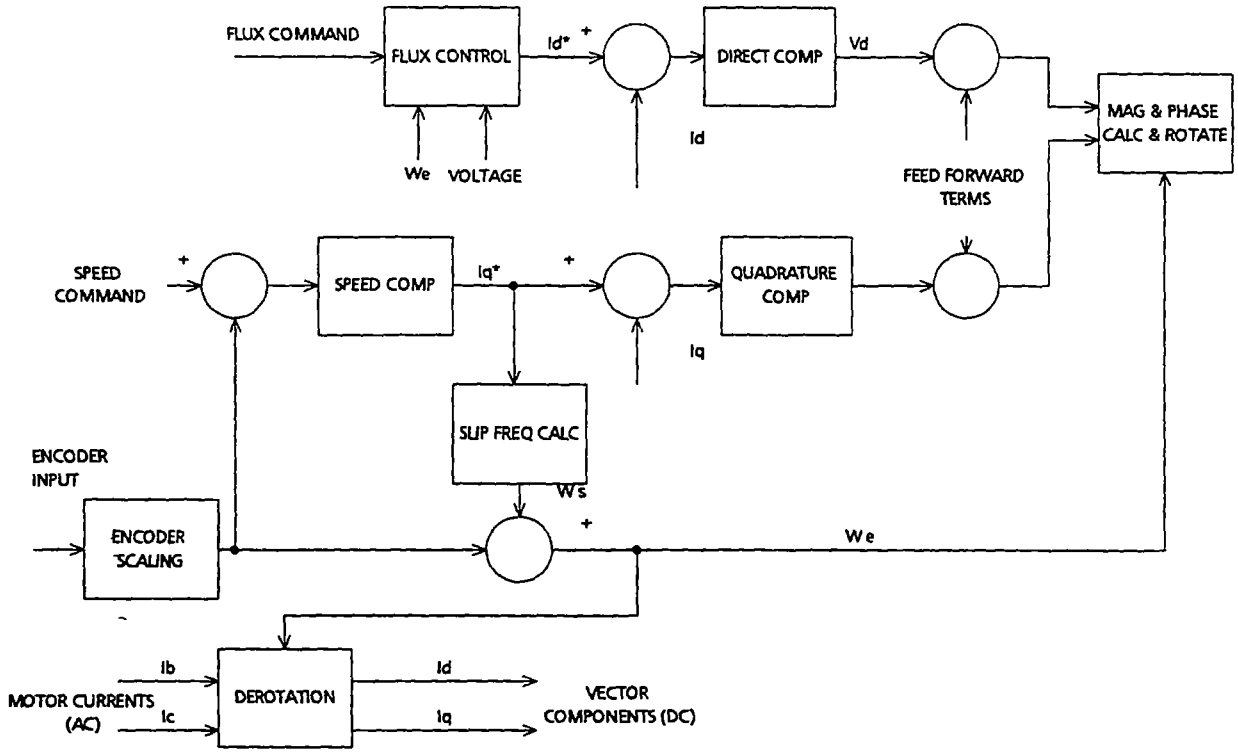
The modern approach to this problem is the "Vector" control This control scheme regulates the flux and torque producing components (or vectors) of current There are several methods of achieving this but one approach is to use the known electrical frequency of the motor to strip off the rotating portion of the sensed motor currents leaving magnitude and phase information This magnitude and phase is then used to produce a direct component (flux) and a quadrature component (torque) of current which are DC values (These currents are in fact analogous to the field and armature currents in a permanent magnet DC motor) The direct and quadrature components are then compared to the commanded components and used to create two compensating DC voltage components which in turn yield a voltage magnitude and phase Once again using the known electrical frequency of the motor a three phase AC voltage pattern is created and sent to the motor

In addition to the motor current the electrical frequency must be calculated The electrical frequency is equal to the sum of the rotating frequency and the slip frequency The slip frequency is calculated by dividing the torque producing current by the flux current times an appropriate scale factor This means that when the torque producing current is zero the slip frequency is zero and the electrical frequency equals the rotating frequency When the torque producing current is positive the electrical frequency is slightly higher than the rotating frequency Up until this point the position feedback version is identical to the sensorless version

The motor control system has a constant torque (below base speed) and a constant power (extended speed) region The flux producing current is the main contributor in setting the motor voltage With the flux current held constant the motor voltage will increase proportionally with speed When the motor voltage equals the line voltage the flux current must be reduced as the speed increases This is known as field weakening Because the torque constant (that is the amount of torque per torque producing amp) of the motor is proportion to flux the region where the flux is held constant is known as the constant torque region Since power is torque times speed the region where the flux (or torque) is reduced as the speed increases is known as the constant power region

By using a shaft position transducer (resolver optical or magnetic encoder) the rotating frequency is measured directly This term plus the calculated slip frequency give the electrical frequency The position transducer is also used to provide speed regulation and/or positioning depending upon the operating mode By supplying the controller with a marker input positioning to an index is also possible

Figure 5-2 Simplified Position Feedback Block Diagram



Power Output Circuit

The power output circuit consists of six IGBT power transistors connected in a three phase bridge configuration Clamping diodes are included on each transistor to provide a path for load current to return to the DC bus The transistors and their associated clamp diodes are contained in isolated mounting type power modules Output currents are sensed with two Hall effect feedback sensors The output transistors are driven and monitored by the gate drivers The Control board generates pulse width modulation (PWM) gate signals for control of the transistors One transistor in each pair must always be off at any given time to avoid shorting out the bus supply and damaging the output transistors

IGBT stands for Insulated Gate Bipolar Transistor These devices are a cross between a FET and a bipolar transistor They have a GATE instead of a BASE and as such are voltage controlled devices instead of current controlled IGBT's switch faster than bipolar's this reduces switching losses and allows for higher switching frequencies (currently 10Khz PWM 20Khz ripple)

Current Sensors

Phase Currents

The phase current is passed though a gapped toroid and a flux proportional to current is measured using a Hall effect sensing device located in the gap of the toroid Current variation through the toroid causes a corresponding change in the flux in the gap The flux in the gap is scaled to the appropriate Amps of phase current per volt of signal The resulting voltage signal is then passed to the control board for use in the Flux Vector algorithm and for over-current detection The drive uses a dual current sensor that is capable of sensing two independent phase currents

Bus Current

Current flowing between the bus capacitors and the output transistors is sensed by a hall effect current sensor This current information is passed to the control board and provides an OL (overload) indication upon sensing excessive current in the output stage

Gate Drivers

The gate driver circuit board consists of six independent gate driver circuits one for each power transistor It is designed specifically to drive IGBT power transistors Each channel has a transformer isolated power supply an opto-isolated gate driver and collector-emitter voltage desaturation detector

The isolated +15 -15 VDC power supplies are obtained from the 48kHz 24 volt square-wave source provided by the control power supply The supply furnishes the voltage required for turning on and off the power transistors The driver circuit also provides a -5 Volt reverse signal for fast turn off of the IGBT

Chapter 6
Troubleshooting

This chapter is divided into three sections **No Display Fault Code Present**, and **Improper Motor Operation**

No Display describes typical problems related to a "dead" drive one which does not appear to respond when AC power is applied

The section entitled Fault Code Present contains a table of possible fault indications with a description of each followed by flow charts and detailed testing procedures

Improper Motor Operation covers topics related to the operation of the motor and response to speed commands

WARNING This equipment contains voltages which may be as high as 800 volts and rotating parts on motors and driven machines High voltage and moving parts can cause serious or fatal injury Only qualified personnel familiar with this manual and any driven machinery should attempt to start-up or troubleshoot this equipment. Observe these precautions

- **USE EXTREME CAUTION, DO NOT TOUCH ANY CIRCUIT BOARD, POWER DEVICE OR ELECTRICAL CONNECTION WITHOUT INSURING THAT HIGH VOLTAGE IS NOT PRESENT**
- **THE UNIT MUST BE PROPERLY GROUNDED DO NOT APPLY AC POWER BEFORE FOLLOWING GROUNDING INSTRUCTIONS**
- **DO NOT OPEN COVER FOR 2 MINUTES AFTER REMOVING AC POWER, TO ALLOW CAPACITORS TO DISCHARGE**
- **IMPROPER CONTROL OPERATION MAY CAUSE VIOLENT MOTION OF MOTOR SHAFT AND DRIVEN EQUIPMENT BE CERTAIN THAT UNEXPECTED MOTOR SHAFT MOVEMENT WILL NOT CAUSE INJURY TO PERSONNEL OR DAMAGE TO EQUIPMENT PEAK TORQUES OF SEVERAL TIMES RATED MOTOR TORQUE CAN OCCUR DURING A CONTROL FAILURE**
- **MOTOR CIRCUIT MAY HAVE HIGH VOLTAGE PRESENT WHENEVER AC POWER IS APPLIED, EVEN WHEN MOTOR IS NOT ROTATING**

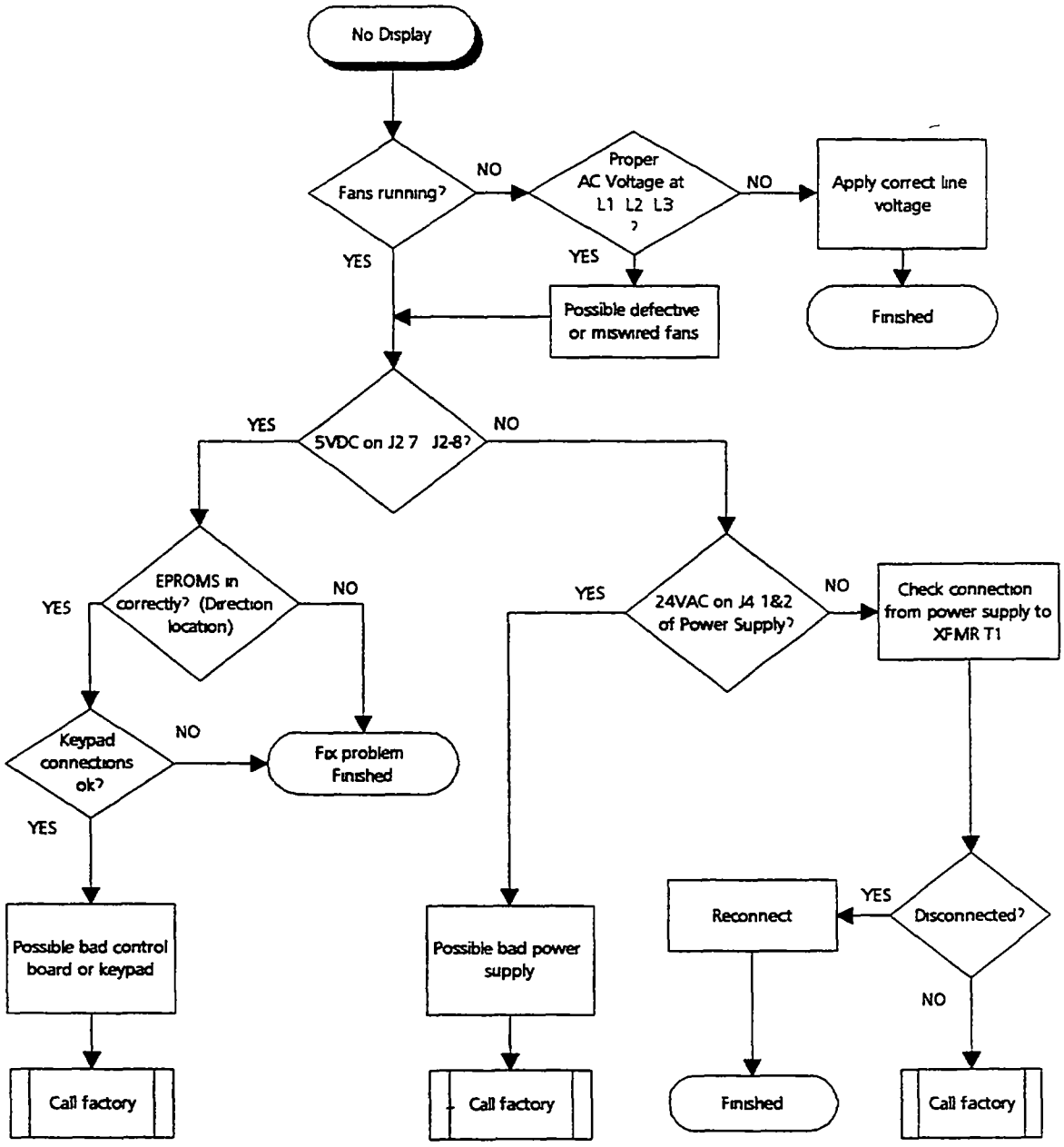
Most troubleshooting can be performed using only a digital voltmeter (DVM) having an input impedance exceeding 1 megohm In some cases however an oscilloscope with 5 mhz minimum bandwidth may be useful

Before consulting the factory double check that all power and control wiring is correct and installed per the recommendations given in this manual

No Display

When AC power is applied to the drive the keypad should display 0 (zero) or some other indication depending on the active display mode Also the fans should be running (on convection cooled models) See the flow chart of figure 6-1 for common causes and solutions

Figure 6-1 No Display With Power Applied



Fault Code Present

When a fault condition occurs motor operation halts and a fault code is displayed on the keypad Table 6-1 gives a list of possible fault codes with a description and possible cause Detailed information and flow charts for each fault are given in the remainder of this section

Table 6-1 Explanation of fault codes

INDICATION	FAULT #	DESCRIPTION	POSSIBLE CAUSE
Gnd	8	Ground fault	A low impedance path between an output phase and ground has been detected
In.AC	10	Line power fault	Incoming line power has been momentarily interrupted
OC	11	Over-current fault	An instantaneous over current condition has been detected from either an output phase or bus current sensor (where applicable) See flowchart
OCP	12	Over-current and phase fault	A simultaneous over-current and phase fault has occurred See flowchart
oc	13	Undetermined fault	A fault condition has occurred but was not sustained long enough for the control board to determine the source See flowchart
OL	16	Overload fault	Drive output current has exceeded capacity This is generally caused by excessive load on the motor (The drive current can be set to foldback instead of faulting out with P80) See flowchart
OSP	17	Overspeed fault	The motor speed has exceeded 110% of the set maximum RPM (P30) See flowchart
OH-E	18	External (Motor) over temp fault	An external over temperature or open circuit has occurred on J1-16 This fault is only active when turned on in P80 See flowchart
OH-C	19	Controller over temp fault	The controller heatsink temperature has exceeded safe levels See flowchart
PAr	21	Parameter loss fault	The battery backed-up RAM parameters have either been lost or corrupted When this fault is cleared the drive will reset itself to default parameter values Reload parameters or call factory for assistance
uP	22	Microprocessor fault	A watchdog timer error has occurred in the software This can sometimes occur if power is cycled before the bus has bled down completely Call factory for assistance
Prog	23	ROM fault	An EPROM error has occurred Call factory for assistance

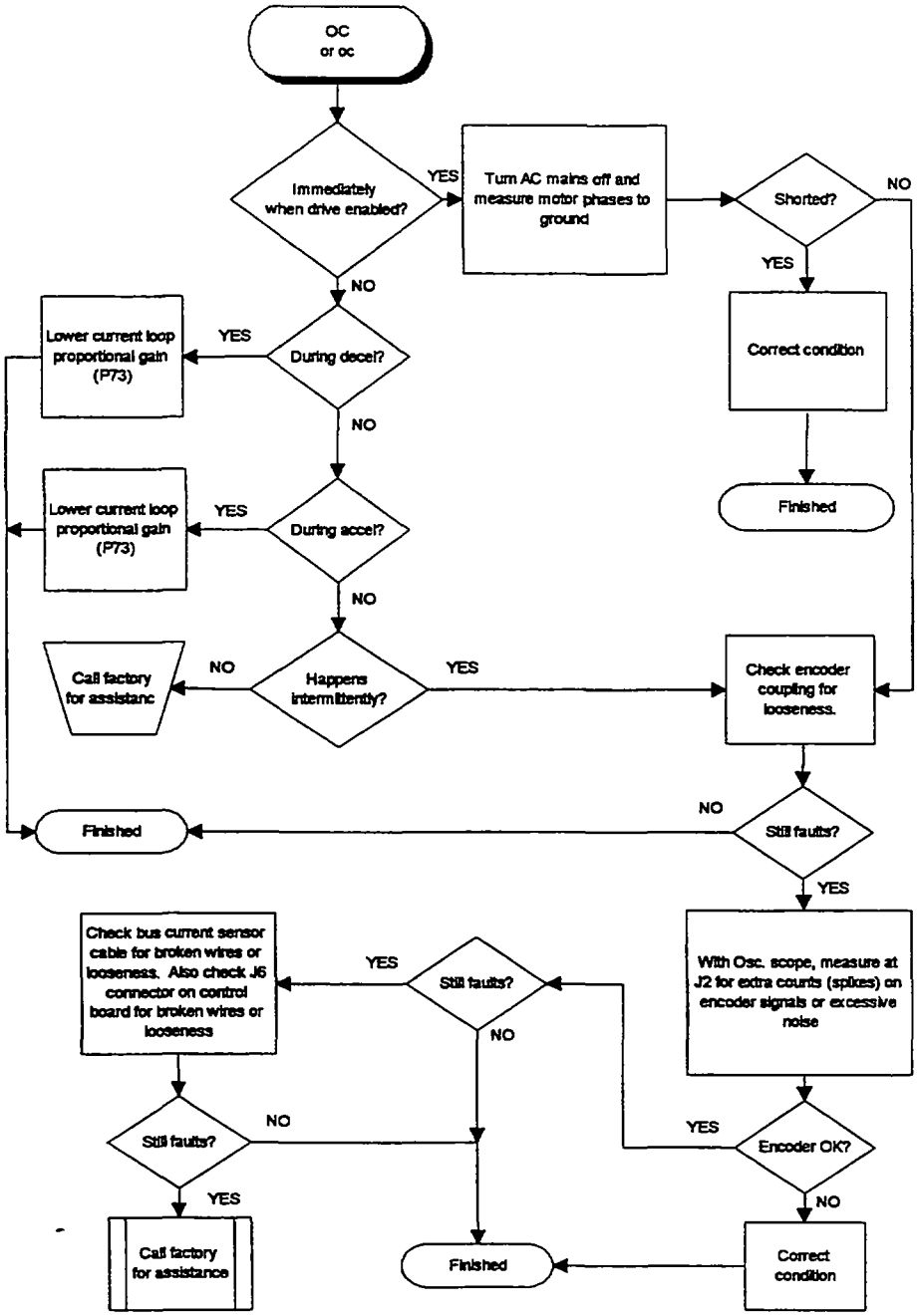
dcLo	24	Undervoltage fault	A bus undervoltage condition has occurred This can result from low line voltage a soft line or a problem with the soft start circuit See flowchart
dcHI	25	Overvoltage fault	A bus overvoltage condition has occurred (The bus voltage has risen above safe levels) This can be caused by excessive regen current during a decel an improperly sized regen resistor or a problem with the regen circuit See flowchart
FEr	26	Following error fault	An excessive following error has occurred This fault can be turned on and off with P80 See flowchart
I LO	27	Torque proving fault	The torque proving test has failed to measure adequate current in all 3 motor windings upon an enable This may indicate an open wire connection or motor winding (This feature is controlled with P80) See flowchart
Cur	28	Current sense fault	A phase current or bus current sensor is defective or an open wire condition exists between the control board and the sensor See flowchart
rES	29	Regen fault	The regeneration power has exceeded the rating of the braking resistor (as set by parameters P34 and P35) This may be caused by incorrect settings in P34 or P35 or an improperly sized braking resistor (Note the braking resistor protection may be disabled by entering a 1 for P34) See flowchart
SSF	30	Soft start fault	The bus voltage did not rise to its proper value upon start up See flowchart
Id	31	Power base ID fault	An invalid power base ID code has been read by the control board See flowchart
bAL	32	Unbalanced Parallel Amplifier	An amplifier in a parallel system is not sharing current equally

Over-current Fault

OC or **oc**

This fault indicates that an instantaneous over current condition has been detected from the bus current sensor This is usually caused by an excessive load condition Figure 6-2 gives a flow chart for common problems that can produce an OC fault

Figure 6-2 Over-current Fault Flow Chart

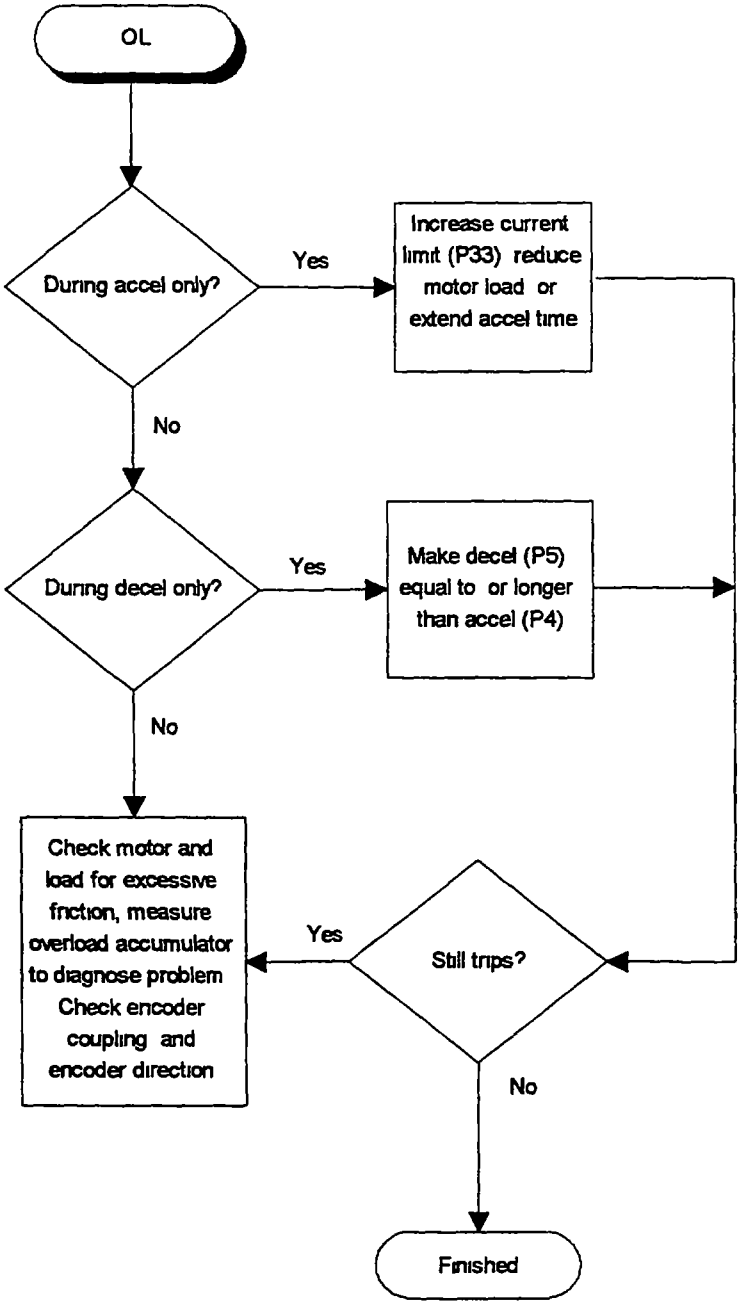


Overload Fault

OL

An overload condition is caused by load current which exceeds the rating of the drive or motor This fault may also occur from a loss of encoder signal The drive may be set to fold back current rather than trip with parameter P80 Figure 6-3 gives a flow chart for common problems that can produce an over-current fault

Figure 6-3 Overload Fault Flow Chart

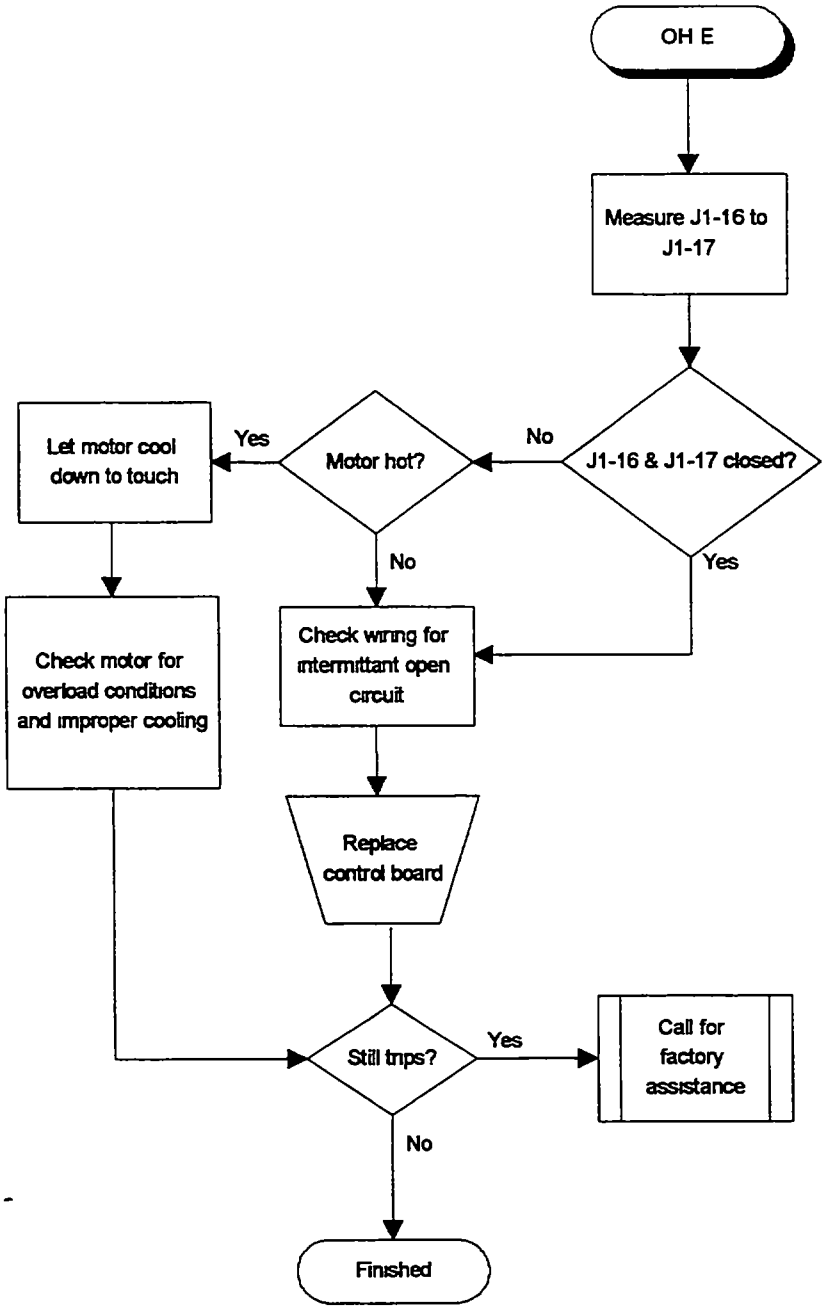


External Over Temp Fault

OH-E

This fault occurs when the input J1 16 opens indicating that an overtemp condition exists External temperature protection is enabled by parameter P80 Figure 6-4 gives a flow chart for common problems that can produce an external over temp fault

Figure 6-4 External Over Temp Fault Flow Chart

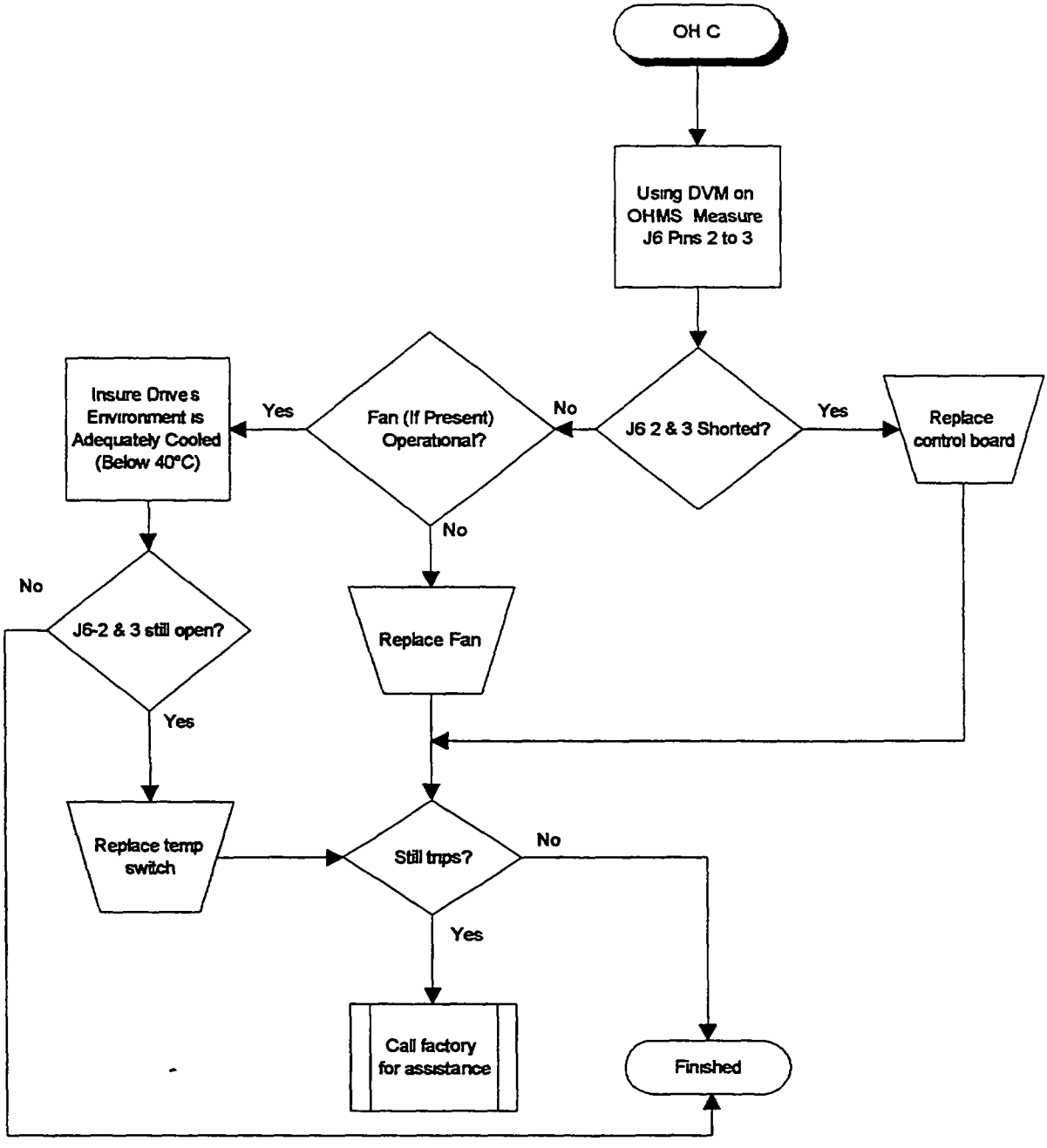


Controller Over Temp Fault

OH-C

This fault occurs when the internal temperature switch opens indicating an over temp condition Figure 6-5 gives a flow chart for common problems that can produce a controller over temp fault

Figure 6-5 Controller Over Temp Fault Flow Chart

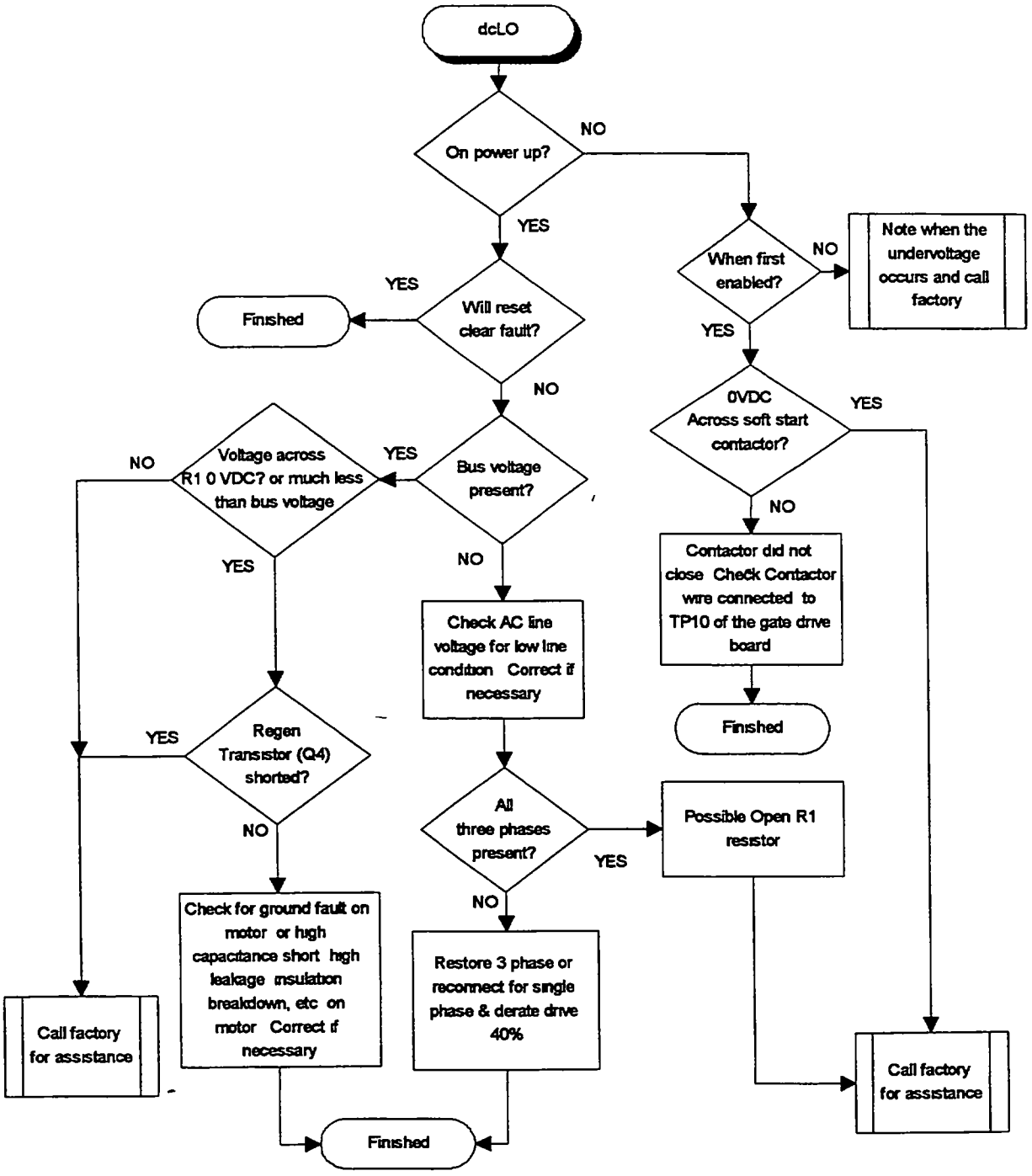


Undervoltage Fault

dcLo

Figure 6-6 gives a flow chart for common problems that can produce an undervoltage fault

Figure 6-6 Undervoltage Fault Flow Chart

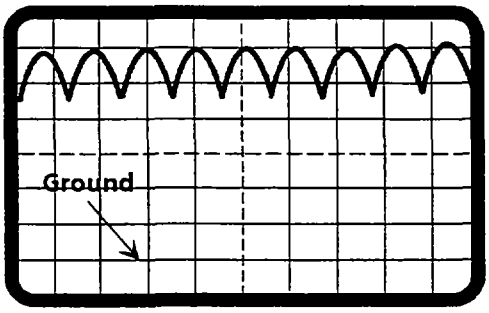


Under voltage faults are caused when the bus voltage dips below a predefined value This condition shuts down the drive and latches the fault indication Under voltage faults while the drive is enabled are usually symptoms of AC ripple problems on the DC bus supply This AC ripple can be caused by various problems with the DC bus capacitors soft start contactor soft start resistor and power supply To determine whether or not you have a high AC ripple problem you should use an isolated scope capable of measuring up to 1000 volts DC/AC (high voltage probe)

WARNING When measuring high voltage on an oscilloscope an isolation transformer MUST be used or damage to scope and personal injury may occur Always use caution when working around high voltage If properly trained personnel are not available do not attempt the following procedure

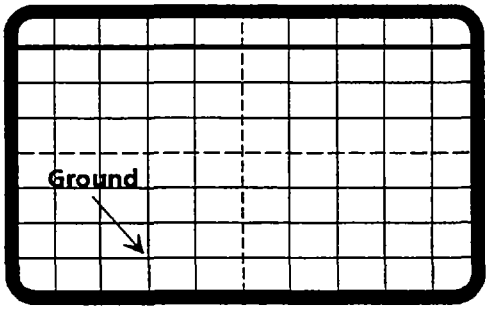
Connect the ground clip of the scope probe to the negative bridge connection on the contactor Connect the probe to the R1 connection on the drive terminal block With the scope set to 50VDC for a 230V drive (100VDC for a 460V drive) and 2mS per division apply power to the drive You should momentarily see a AC ripple as the bus begins to charge (figure 6-7) After a few seconds the contactor should turn on and the waveform on the scope should be DC or a straight line (figure 6-8)

Figure 6-7 Normal DC Bus AC Ripple Before Contactor Turn ON



DC Coupled-50V 2ms

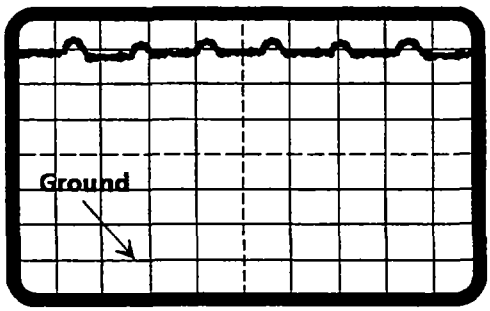
Figure 6-8 DC Bus After Contactor Turn ON (Normal Operation)



DC Coupled-50V 2ms

Figure 6-9 shows AC ripple remaining on the DC bus after the Contactor has had time to turn on This indicates a problem with the soft start circuit and can cause under voltage faults

Figure 6-9 DC Bus problem after Contactor Turn ON



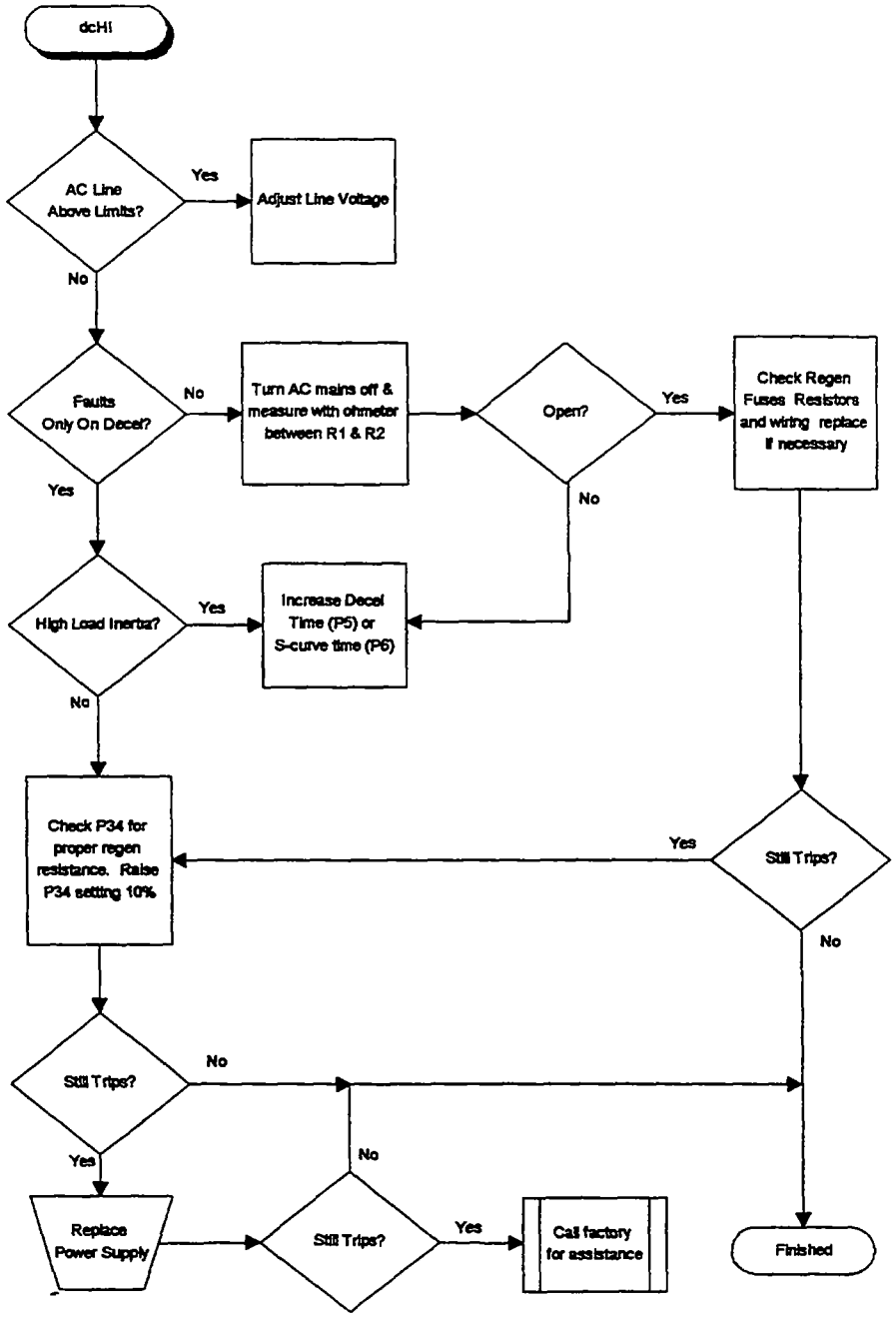
DC Coupled-50V 2ms

Overvoltage Fault

dcHI

This fault occurs when the bus supply voltage has gone to high Figure 6-10 gives a flow chart for common problems that can produce an over voltage fault

Figure 6-10 Overvoltage Fault Flow Chart

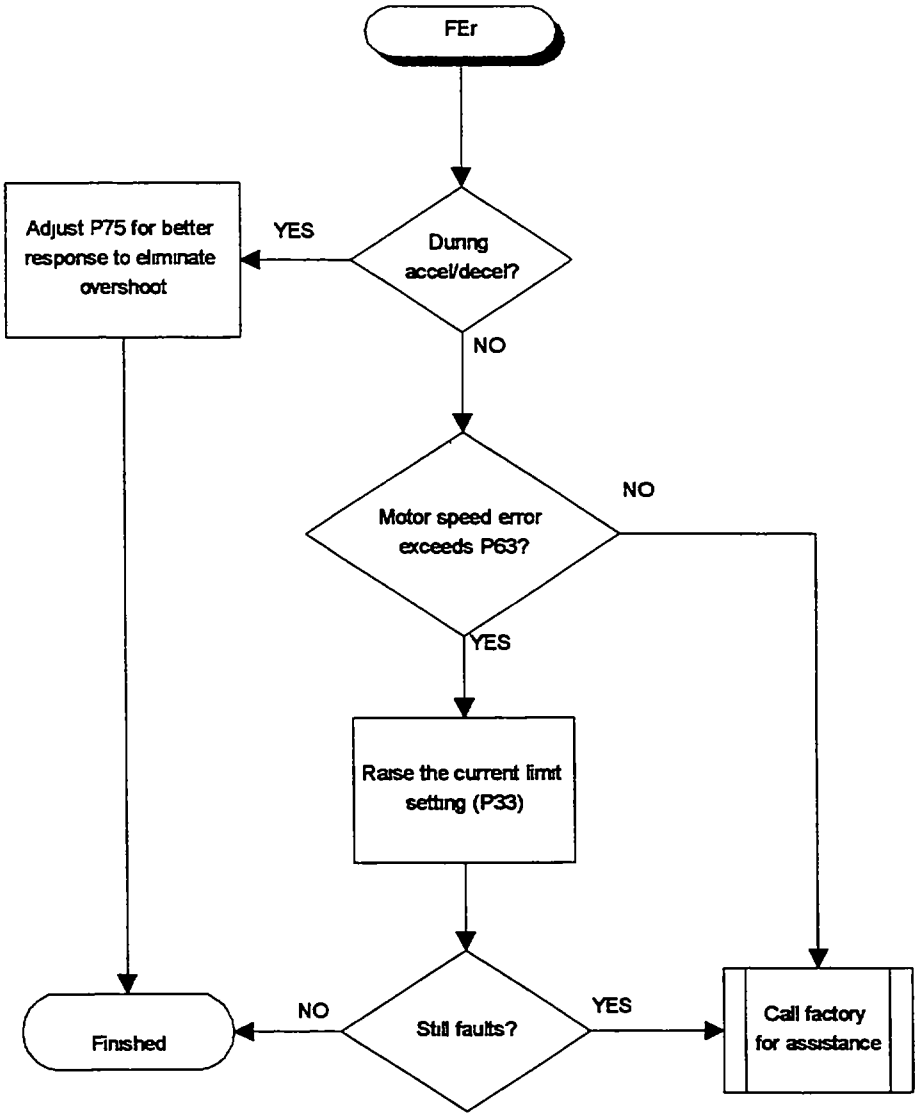


Following Error Fault

FEr

This fault indicates that the drive cannot follow the speed command within the error band set with the "at speed' parameter (P63) This fault is enabled with parameter P80 Figure 6-11 gives a flow chart for common problems that can produce a following error fault

Figure 6-11 Following Error Fault Flow Chart

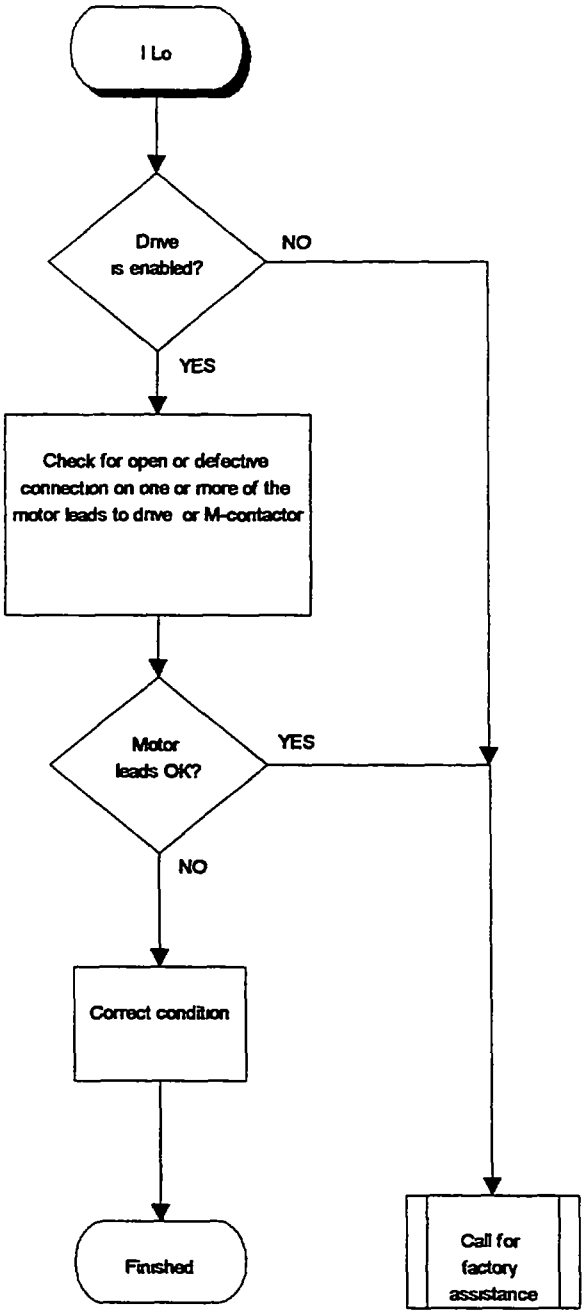


Torque Proving Fault

I Lo

This fault indicates that the drive has failed to measure adequate current in all 3 motor windings upon enable This fault is activated with P80 Figure 6-12 gives a flow chart for common problems that can produce a torque proving fault

Figure 6-12 Torque Proving Fault Flow Chart

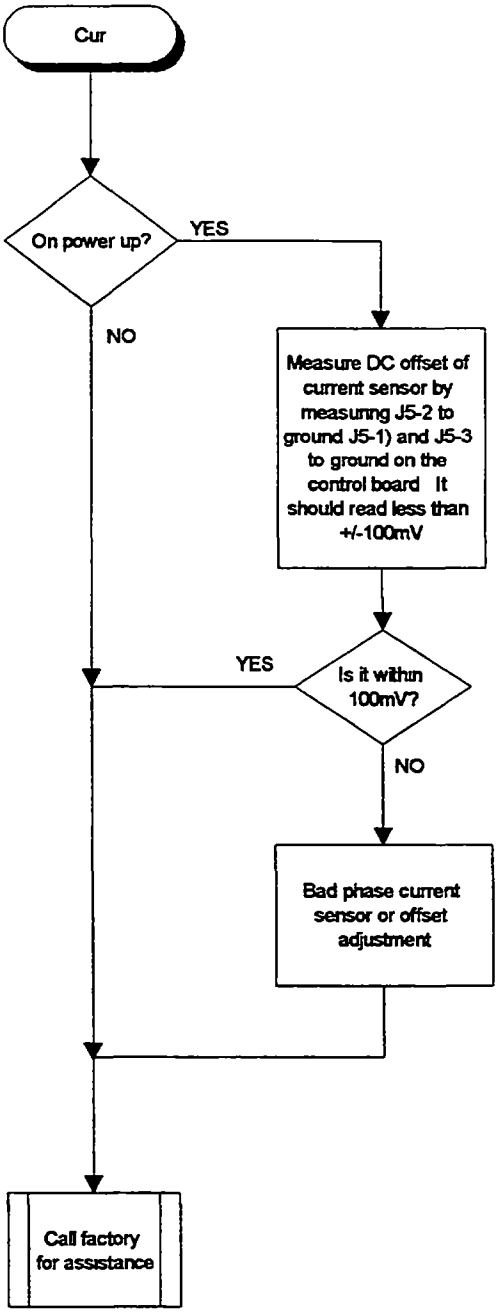


Current Sense Fault

Cur

A phase or Bus current sensor has a DC offset or an open wire condition exists Figure 6-13 gives a flow chart for common problems that can produce a current sense fault

Figure 6-13 Current Sense Fault Flow Chart



No Motor Shaft Rotation

Figure 6-14 gives a flow chart for common problems that prevent motor rotation Figure 6-15 is a continuation that covers cases when the drive will not enable

Figure 6-14 No Motor Shaft Rotation Flow Chart

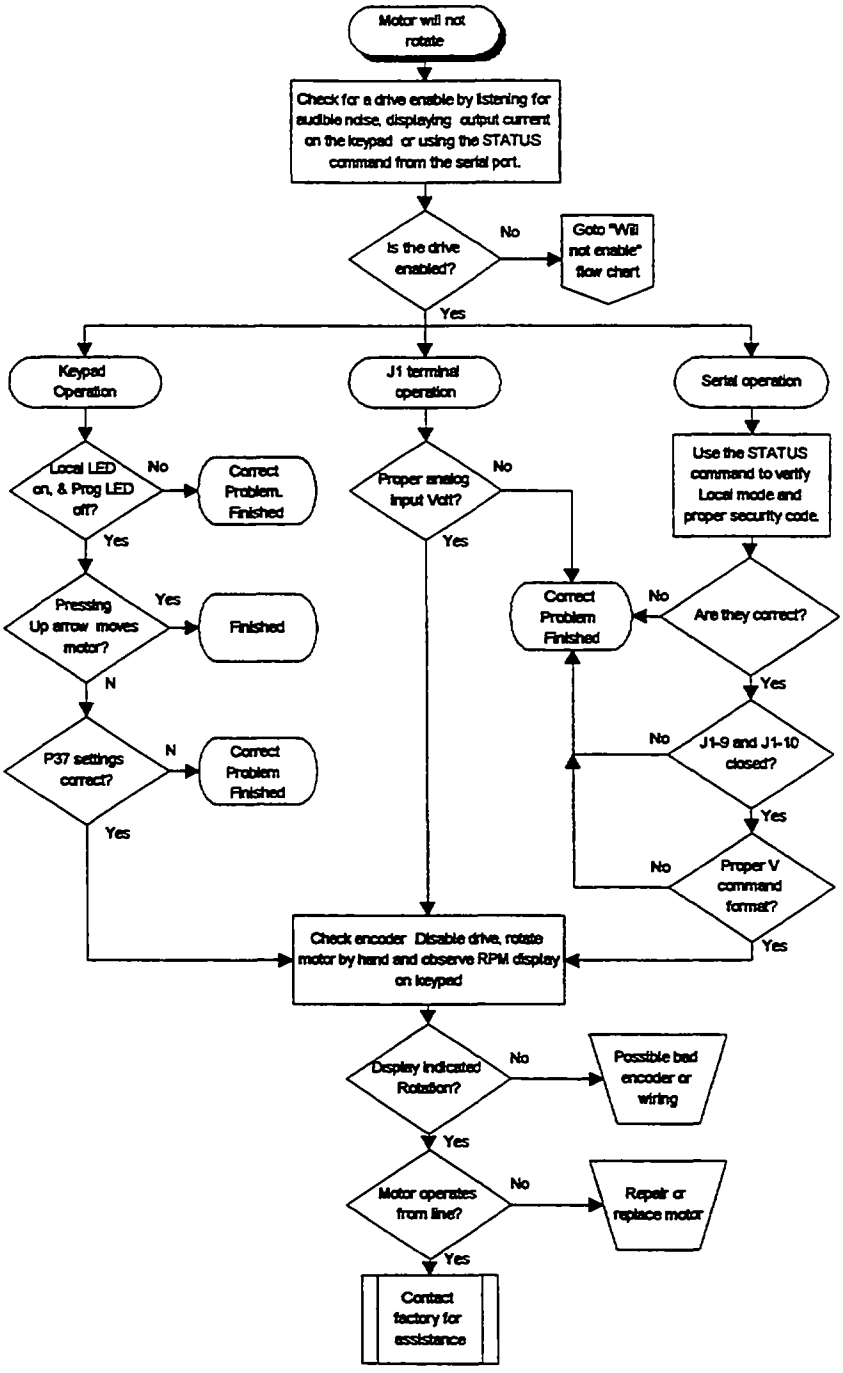
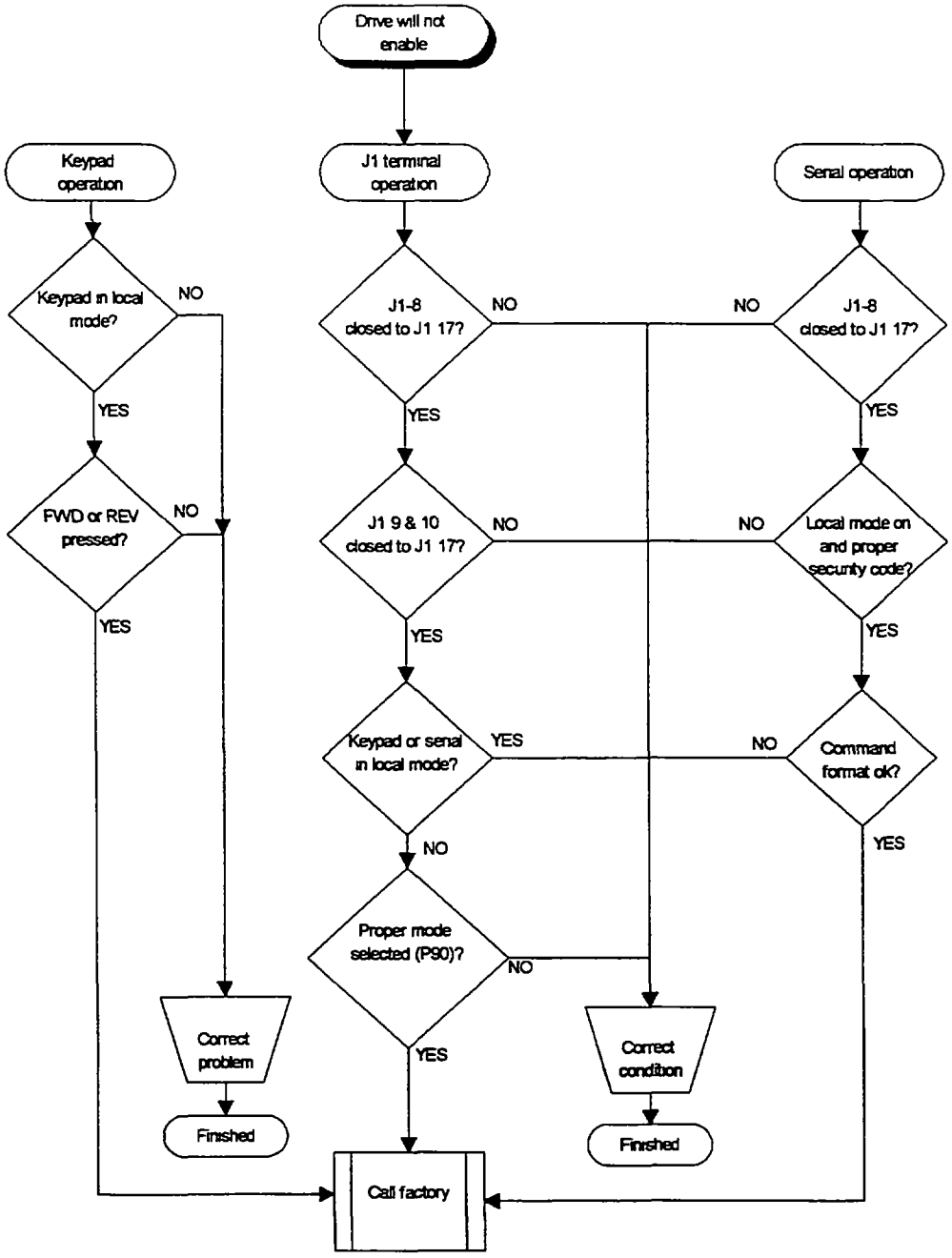


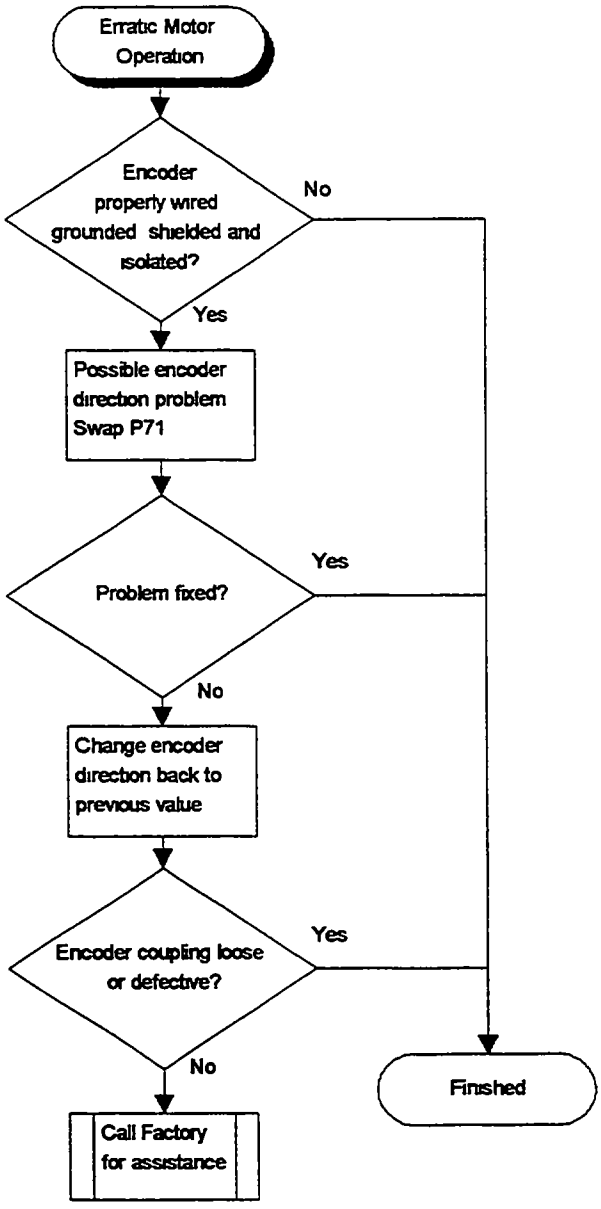
Figure 6-15 Drive will not enable Flow Chart



Erratic or Jittery Shaft Rotation

This condition is usually caused by problems with the encoder Figure 6-16 gives flow chart for typical problems

Figure 6-16 Erratic Shaft rotation Flow Chart



Wrong Response to Speed Commands

1 Input common mode voltage may be exceeded Maximum common mode at J1-4 & -5 is ±15 volts relative to chassis common Connect control input source common to the drive common to minimize common mode voltage

2 Encoder polarity may be wrong Reverse the encoder direction P71

Chapter 7
Wiring and Protective Devices

This controller must be provided with a suitable input power protective device Use the recommended fuses or circuit breaker from the tables below Input and output wire size is based on use of 75° C rated copper conductor wire

Circuit Breaker - 3 phase thermal magnetic Equal to GE type THQ or TEB for 230 VAC or GE type TED for 460 VAC
Fast Acting Fuses - Buss KTN on 230VAC or Buss KTS on 460VAC or equal
Time Delay Fuses Buss FRN on 230VAC or Buss FRS on 460VAC or equal

Table 7 1 Wiring and Protection Devices, 230 VAC

CATALOG NO	MAX HP	INPUT WIRE (AWG)		INPUT BREAKER	INPUT FUSES		OUTPUT WIRE (AWG)	
		Cu	Al		FAST ACTING	TIME DELAY	Cu	Al
912L-22	5	10	8	240V/30A	250V/25A	250V/20A	10	8
912Q-23	5	10	8	240V/30A	250V/25A	250V/20A	10	8
912L-23	7 5	10	8	240V/40A	250V/40A	250V/30A	10	8
912Q-24	7 5	10	8	240V/40A	250V/50A	250V/30A	10	8
912L-34	10	8	6	240V/40A	250V/50A	250V/40A	8	6
912Q-36	10	8	6	240V/50A	250V/60A	250V/40A	8	6
912L-46	15	6	4	240V/50A	250V/70A	250V/60A	6	4
912Q-48	15	6	4	240V/70A	250V/90A	250V/60A	6	4
912L-58	20	4	4	240V/70A	250V/90A	250V/80A	4	4
912Q-511	20	4	4	240V/80A	250V/125A	250V/80A	4	4
912L-710	25	4	4	240V/100A	250V/125A	250V/80A	4	4
912Q-712	25	4	4	240V/100A	250V/125A	250V/80A	4	4
912L-812	30	3	3	240V/120A	250V/125A	250V/125A	3	3
912Q-816	30	3	3	240V/120A	250V/175A	250V/125A	3	3
912E-824	30	3	3	240V/150A	250V/250A	250V/125A	3	3
912L-1016	40	1	1	240V/150A	250V/175A	250V/150A	1	1
912Q-1021	40	1	1	240V/150A	250V/175A	250V/150A	1	1
912L-1320	50	1	1	240V/175A	250V/200A	250V/150A	1	1
912L-1320	50	1	1	240V/175A	250V/200A	250V/150A	1	1

Table 7.2 Wiring and Protection Devices, 460 VAC

CATALOG NO	MAX HP	INPUT WIRE (AWG)		INPUT BREAKER	INPUT FUSES		OUTPUT WIRE (AWG)	
		Cu	Al		FAST ACTING	TIME DELAY	Cu	Al
914L 11	5	10	10	480V/20A	600V/20A	600V/15A	10	10
914Q-11	5	10	10	480V/20A	600V/20A	600V/15A	10	10
914L 12	7 5	10	10	480V/30A	600V/25A	600V/15A	10	10
914Q-12	7 5	10	10	480V/30A	600V/25A	600V/15A	10	10
914L 13	10	10	10	480V/40A	600V/40A	600V/30A	10	10
914Q-13	10	10	10	480V/40A	600V/40A	600V/30A	10	10
914L-23	15	10	8	480V/40A	600V/40A	600V/30A	10	8
914Q-24	15	10	8	480V/50A	600V/50A	600V/30A	10	8
914L 34	20	8	6	480V/50A	600V/50A	600V/40A	8	6
914Q-35	20	8	6	480V/60A	600V/60A	600V/40A	8	6
914L-35	25	6	6	480V/60A	600V/60A	600V/40A	6	6
914Q-36	25	6	6	480V/70A	600V/75A	600V/40A	6	6
914L-46	30	6	4	480V/70A	600V/75A	600V/50A	6	4
914Q-48	30	6	4	480V/80A	600V/100A	600V/50A	6	4
914L-58	40	4	4	480V/100A	600V/100A	600V/60A	4	4
914Q-510	40	4	4	480V/125A	600V/125A	600V/60A	4	4
914L-710	50	3	1	480V/125A	600V/125A	600V/60A	3	1
914L-812	60	1	1	480V/150A	600V/150A	600V/100A	1	1
914Q-816	60	1	1	480V/175A	600V/200A	600V/100A	1	1
914L-1015	75	1	1	480V/175A	600V/200A	600V/125A	1	1
914Q-1020	75	1	1	480V/200A	600V/250A	600V/125A	1	1
914L-1319	100	1/0	1/0	480V/200A	600V/200A	600V/150A	1/0	1/0
914Q-1325	100	1/0	1/0	480V/250A	600V/300A	600V/150A	1/0	1/0
914L-1624	125	3/0	3/0	480V/250A	600V/250A	600V/175A	3/0	3/0

Chapter 8
Braking Options Information

There are three options available for dynamic braking They include

RG braking resistors mounted in racks with no enclosure for drive models with the suffix XXBX

RGA braking resistors mounted in racks with a NEMA 1 enclosure for models with the suffix XXBX

RBA braking transistor transistor control board and braking resistors in racks all mounted in a NEMA 1 enclosure for models with the XX0X suffix

WARNING The resistors MUST ONLY be used on controls with the braking transistor installed (models with -XXBX suffix)

Table 8 1 Braking Resistor, 230 VAC

BRAKING RESISTOR ASSEMBLIES

P/N MATRIX R XX (X OR XX) XX

- XX — EQUIVALENT RESISTANCE IN OHMS
- (X OR XX) — WATTS/100
- XX — G=KIT, without NEMA 1 enclosure; GA=assembly in NEMA 1 enclosure
- R — BRAKING RESISTOR DESIGNATOR

HP	WATTS DRIVE MODEL NO MUST HAVE -XXBX SUFFIX	600	1200	2400	4800
5	912L-22 270 912Q-23-270 912E-24-270	RG610 RGA610	RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810
5	912L-23 270 912Q-24-270 912E-26-270	RG610 RGA610	RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810
10	912L-34-270 912Q-36-270 912E 38-270	RG610 RGA610	RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810
15	912L-46-270 912Q-48-270 912E-412-270	RG606 RGA606	RG1206 RGA1206	RG2406 RGA2406	RG4806 RGA4806
20	912L-58-270 912Q-511-270 912E-516-270	RG606 RGA606	RG1206 RGA1206	RG2406 RGA2406	RG4806 RGA4806
25	912L-710-270 912Q-712-270 912E-718-270	RG604 RGA604	RG1204 RGA1204	RG2404 RGA2404	RG4804 RGA4804
30	912L-812 270 912Q-816-270 912E-824-270	RG604 RGA604	RG1204 RGA1204	RG2404 RGA2404	RG4804 RGA4804
40	912L-1016-270 912Q-1021 270 912E-1031-270		RG1203 RGA1203	RG2403 RGA2403	RG4803 RGA4803

WARNING The resistors MUST ONLY be used on controls with the braking transistor installed (models with -XXBX suffix)

Table 8.2 Regen Resistor Assemblies, 460 VAC

BRAKING RESISTOR ASSEMBLIES

P/N MATRIX R XX (X OR XX) XX

- XX — EQUIVALENT RESISTANCE IN OHMS
- X — WATTS/100
- XX — G=KIT, without NEMA 1 enclosure; GA=assembly in NEMA 1 enclosure
- R — BRAKING RESISTOR DESIGNATOR

HP	WATTS DRIVE MODEL NO MUST HAVE -XXBX SUFFIX	600	1200	2400	4800
5	914L 11 270 914Q-11 270 914E 12-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
7 5	914L-12 270 914Q-12-270 914E-13-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
10	914L-13-270 914Q-13-270 914E-14-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
15	914L 23-270 914Q-24-270 914E 26-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
20	914L-34-270 914Q-35-270 914E 38-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
25	914L 35-270 914Q-36-270 914E-39-270	RG620 RGA620	RG1220 RGA1220	RG2420 RGA2420	RG4820 RGA4820
30	914L-46-270 914Q-48-270 914E-412-270	-	RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810
40	914L-58-270 914Q-510-270 914E-515-270		RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810
50	914L 710-270 914Q-712 270 914E-718-270	-	RG1210 RGA1210	RG2410 RGA2410	RG4810 RGA4810

WARNING These braking transistor/resistor assemblies may only be used on controls with the -XXOX suffix

Table 8.3 Braking Transistor/Resistor Assemblies, 230 VAC

BRAKING TRANSISTOR/RESISTOR ASSEMBLIES				
Ex for a 20HP drive (e g 912Q-511-270-1K00) and 90% braking torque requirement select RBA2-610				
	RESISTANCE (OHMS)	10Ω	6Ω	4Ω
	WATTS	600	1800	4000
	BRAKING ASSEMBLY NO	RBA2-610	RBA2-1806	RBA2-4004
HP	**DRIVE MODEL NO MUST HAVE SUFFIX -XXOX**	**MAXIMUM BRAKING TORQUE IN % OF MOTOR RATING**		
5	912L 22-270 -XXOX 912Q-23-270 -XXOX 912E-24-270 -XXOX	150%	150%	150%
7 5	912L-23-270 -XXOX 912Q-24-270 -XXOX 912E-26-270 -XXOX	150%	150%	150%
10	912L-34-270 -XXOX 912Q-36-270 -XXOX 912E-38-270-XXOX	150%	150%	150%
15	912L-46-270 -XXOX 912Q-48-270 -XXOX 912E-412-270 -XXOX	120%	150%	150%
20	912L-58-270 -XXOX 912Q-511-270 -XXOX 912E 516-270 -XXOX	90%	150%	150%
25	912L-710-270 -XXOX 912Q-712-270 -XXOX 912E-718-270 -XXOX	75%	125%	150%
30	912L-812-270 -XXOX 912Q-816-270 -XXOX 912E-824-270 -XXOX	60%	100%	150%
40	912L-1016-270 -XXOX 912Q-1021-270 -XXOX 912E-1031-270 -XXOX	45%	75%	115%

WARNING These braking transistor/resistor assemblies may only be used on controls with the -XXOX suffix

Table 8 4 Braking Transistor/ Resistor Assemblies, 460 VAC

BRAKING TRANSISTOR/RESISTOR ASSEMBLIES				
Ex for a 40HP drive (e g 914L 58-270-1K00) and 45% braking torque requirement select RBA4-640				
	RESISTANCE (OHMS)	40Ω	20Ω	10Ω
	WATTS	600	1800	4000
	BRAKING ASSEMBLY NO	RBA4-640	RBA4-1820	RBA4-4010
HP	**DRIVE MODEL NO MUST HAVE SUFFIX -XXOX**	**MAXIMUM BRAKING TORQUE IN % OF MOTOR RATING**		
5	914L-11-270 -XXOX 914Q-11 270 -XXOX 914E-12-270 -XXOX	150%	150%	150%
7 5	914L-12 270 -XXOX 914Q-12-270 -XXOX 914E-13-270 -XXOX	150%	150%	150%
10	914L-13-270 -XXOX 914Q-13-270 -XXOX 914E-14-270-XXOX	150%	150%	150%
15	914L-23-270 XXOX 914Q-24-270 -XXOX 914E-26-270 -XXOX	120%	150%	150%
20	914L-34-270 -XXOX 914Q-35-270 -XXOX 914E-38-270 -XXOX	90%	150%	150%
25	914L-35-270 -XXOX 914Q-36-270 -XXOX 914E-39-270 -XXOX	75%	150%	150%
30	914L-46-270 -XXOX 914Q-48-270 -XXOX 914E-412-270 -XXOX	60%	120%	150%
40	914L 58-270 -XXOX 914Q-510-270 -XXOX 914E-515-270 -XXOX	45%	90%	150%
50	914L-710-270-XX0X 914Q-712 270-XXOX 914E 718-270-XXOX	36%	72%	150%

Chapter 9
Renewal Parts

Table 9 1 Renewal Parts Model No 912-XXXX-270 Part 1

Model No	912L 22 (5HP)	912Q-23 (5HP)	912E 24 (5HP)	912L 23 (7 5HP)	912Q-24 (7 5HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192001	3192001	3192001	3192001	3192001
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081607	0081607	0081610	0081607	00816010
Diode Bndge	3710316	3710316	3710316	3710616	3710616
Elect Caps	7416813	7416813	7416813	7417825	7417825
Fans	6950022	6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260031	3260031	3260031	3260031	3260031
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3652050	3652050	3652075	3652050	3652075
Power Trans Assy	0652050	0652050	0652075	0652050	0652075
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505005	3505005	3505005	3505005	3505005
Brake Trans Base Drive Board	0080531	0080531	0080531	0080531	0080531
Snubber Brd	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351
Soft Start Contactor	4001403 -	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9 1 Renewal Parts Model No 912-XXXX-270 Part 2

Model No	912E 26 (7 5HP)	912L 34 (10HP)	912Q-36 (10HP)	912E 38 (10HP)	912L-46 (15HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192002	3192001	3192002	3192002	3192002
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081613	0081610	0081613	0081620	0081613
Diode Bridge	3710616	3710616	3710616	3710616	3710616
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950022	6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260031	3260031	3260031	3260031	3260031
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3652110	3652075	3652110	3652115	3652110
Power Trans Assy	0652110	0652075	0652110	0652115	0652110
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505005	3505005	3505005	3505005	3507505
Brake Trans Base Drive Board	0080531	0080531	0080531	0080531	0080531
Snubber Brd	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082352
Soft Start Contactor	4001403	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9 1 Renewal Parts Model No 912-XXXX-270 Part 3

Model No	912Q-48 (15HP)	912E-412 (15HP)	912L 58 (20HP)	912Q-511 (20HP)	912E 516 (20HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192002	3192003	3192002	3192002	3192003
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081620	0081627	0081620	0081620	0081640
Diode Bridge	3710616	3710616	3710616	3710616	3710616
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950022	6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260031	3260031	3260031	3260031	3260031
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3652115	3652120	3652115	3652120	3652130
Power Trans Assy	0652115	0652120	0652115	0652120	0652130
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3507505	3507505	3507505	3507505	3507505
Brake Trans Base Drive Board	0080531	0080531	0080531	0080531	0080531
Snubber Brd	1081701 1082352	1081701 1082352	1081701 1082352	1081701 1082352	1081701 1082352
Soft Start Contactor	4001403	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9 1 Renewal Parts Model No 912-XXXX-270 Part 4

Model No	912L 710 (25HP)	912Q-712 (25HP)	912E 718 (25HP)	912L-812 (30HP)	912Q-816 (30HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192002	3192003	3192003	3192003	3192003
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081620	0081627	0081640	0081627	0081640
Diode Bridge	3711016	3711016	3711016	3711016	3711016
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950022	6950022	6950022	6950023	6950023
Gate Driver Brd	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260031	3260031	3260031	3260031	3260031
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3652120	3652120	3652130	3652120	3652130
Power Trans Assy	0652120	0652120	0652130	0652120	0652130
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3510005	3510005	3510005	3510005	3510005
Brake Trans Base Drive Board	0080531	0080531	0080531	0080531	0080531
Snubber Brd	1081701 1082352	1081701 1082352	1081701 1082352	1081751 1082353	1081751 1082353
Soft Start Contactor	4001403	4001403	4001403	4001451	4001451
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9 1 Renewal Parts Model No 912-XXXX-270 Part 5

Model No	912E-824 (30HP)	912L 1016 (40HP)	912Q-1021 (40HP)	912E 1031 (40HP)	
	PART #	PART #	PART #	PART #	
Bus I Sensor	3192004	3192003	3192003	3192004	
Connector P2	6020116	6020116	6020116	6020116	
Connector P1	6020122	6020122	6020122	6020122	
Connector P1A	6020104	6020104	6020104	6020104	
Control Board	0077003	0077003	0077003	0077003	
Cur Sensor	0081653	0081640	0081640	0081660	
Diode Bridge	3711016	3711616	3711616	3711616	
Elect Caps	7417825	7417825	7417825	7417825	
Fans	6950023	6950023	6950023	6950023	
Gate Driver Brd	0081081 0822001	0081081 0822001	0081081 0822001	0081081 0822001	
Gnd Flt C.T	2070002	2070002	2070002	2070002	
Keypad board	1080907	1080907	1080907	1080907	
Keypad Overlay	1080931	1080931	1080931	1080931	
MOV	3260031	3260031	3260031	3260031	
Power Supply	0080151	0080151	0080151	0080151	
Power Trans	3652120	3652130	3652140		
Power Trans Assy	0652120	0652130	0652140		
R1	8362050	8362050	8362050	8362050	
Brake Trans	3510005	3515005	3515005	3515005	
Brake Trans Base Drive Board	0080531	0080531	0080531	0080531	
Snubber Brd	1081751 1082353	1081751 1082353	1081751 1082353	1081751 1082353	
Soft Start Contactor	4001451	4001451	4001451	4001451	
Transformer T1	2100014	2100014	2100014	2100014	

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 1

Model No	914L 11 (5HP)	914Q-11 (5HP)	914E 12 (5HP)	914L 12 (7 5HP)	914Q-12 (7 5HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192001	3192001	3192001	3192001	3192001
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081604	0081604	0081607	0081604	0081607
Diode Bridge	3710316	3710316	3710316	3710316	3710316
Elect Caps	7416813	7416813	7416813	7416813	7416813
Fans		6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260032	3260032	3260032	3260032	3260032
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3655025	3655025	3655050	3655025	3655050
Power Trans Assy	0655025	0655025	0655050	0655025	0655050
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505010	3505010	3505010	3505010	3505010
Brake Trans Base Drive Board	0080532	0080532	0080532	0080532	0080532
Snubber Brd	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351
Soft Start Contactor	4001403	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 2

Model No	914E 13 (7 5HP)	914L 13 (10HP)	914Q-13 (10HP)	914E 14 (10HP)	914L 23 (15HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192001	3192001	3192001	3192001	3192001
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081607	0081604	0081607	0081610	0081607
Diode Bndge	3710316	3710316	3710316	3710316	3710616
Elect Caps	7416813	7416813	7416813	7416813	7417825
Fans	6950022	6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260032	3260032	3260032	3260032	3260032
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3655050	3655050	3655050	3655075	3655050
Power Trans Assy	0655050	0655050	0655050	0655075	0655050
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505010	3505010	3505010	3505010	3505010
Brake Trans Base Drive Board	0080532	0080532	0080532	0080532	0080532
Snubber Brd	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351
Soft Start Contactor	4001403	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 3

Model No	914Q-24 (15HP)	914E 26 (15HP)	914L 34 (20HP)	914Q-35 (20HP)	914E 38 (20HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192001	3192001	3192001	3192002	3192002
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081610	0081613	0081610	0081613	0081620
Diode Bridge	3710616	3710616	3710616	3710616	3710616
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950022	6950022	6950022	6950022	6950022
Gate Driver Brd	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050
Gnd Flt C T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260032	3260032	3260032	3260032	3260032
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3655075	3655110	3655075	3655110	3655115
Power Trans Assy	0655075	0655110	0655075	0655110	0655115
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505010	3505010	3505010	3505010	3505010
Brake Trans Base Drive Board	0080532	0080532	0080532	0080532	0080532
Snubber Brd	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351	1081701 1082351
Soft Start Contactor	4001403	4001403	4001403	4001403	4001403
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 4

Model No	914L35 (25HP)	914Q-36 (25HP)	914E39 (25HP)	914L-46 (30HP)	914Q-48 (30HP)
	PART #	PART #	PART #	PART #	PART #
Bus I Sensor	3192001	3192002	3192002	3192002	3192002
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081610	0081613	0081620	0081613	0081620
Diode Bridge	3710616	3710616	3710616	3710616	3710616
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950022	6950022	6950022	6950023	6950023
Gate Driver Brd	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260032	3260032	3260032	3260032	3260032
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3655110	3655110	3655115	3655110	3655115
Power Trans Assy	0655110	0655110	0655115	0655110	0655115
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3505010	3505010	3505010	3510010	3510010
Brake Trans. Base Drive Board	0080532	0080532	0080532	0080532	0080532
Snubber Brd	1081701 1082352	1081701 1082352	1081701 1082352	1081751 1082353	1081751 1082353
Soft Start Contactor	4001403	4001403	4001403	4001451	4001451
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 5

Model No	914E-412 (30HP)	914L 58 (40HP)	914Q-510 (40HP)	914E 515 (40HP)	914L 710 (50HP)
	PART #	PART #	PART #	PART #	PART#
Bus I Sensor	3192003	3192002	3192003	3192003	3192003
Connector P2	6020116	6020116	6020116	6020116	6020116
Connector P1	6020122	6020122	6020122	6020122	6020122
Connector P1A	6020104	6020104	6020104	6020104	6020104
Control Board	0077003	0077003	0077003	0077003	0077003
Cur Sensor	0081627	0081620	0081627	0081640	0081620
Diode Bridge	3710616	3710616	3710616	3710616	3711616
Elect Caps	7417825	7417825	7417825	7417825	7417825
Fans	6950023	6950023	6950023	6950023	6950023
Gate Driver Brd	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050	0081081 0822050
Gnd Flt C.T	2070002	2070002	2070002	2070002	2070002
Keypad board	1080907	1080907	1080907	1080907	1080907
Keypad Overlay	1080931	1080931	1080931	1080931	1080931
MOV	3260032	3260032	3260032	3260032	3260032
Power Supply	0080151	0080151	0080151	0080151	0080151
Power Trans	3655120	3655115	3655120	3655130	3655115
Power Trans Assy	0655120	0655115	0655120	0655130	0655115
R1	8362050	8362050	8362050	8362050	8362050
Brake Trans	3510010	3510010	3510010	3510010	3510010
Brake Trans Base Drive Board	0080532	0080532	0080532	0080532	0080532
Snubber Brd	1081751 1082353	1081751 1082353	1081751 1082353	1081751 1082353	1081751 1082353
Soft Start Contactor	4001451	4001451	4001451	4001451	4001451
Transformer T1	2100014	2100014	2100014	2100014	2100014

Table 9.2 Renewal Parts Model No 914-XXXX-270 Part 6

Model No	914Q-712 (50HP)	914E 718 (50HP)			
	PART #	PART #			
Bus I Sensor	3192004	3192004			
Connector P2	6020116	6020116			
Connector P1	6020122	6020122			
Connector P1A	6020104	6020104			
Control Board	0077003	0077003			
Cur Sensor	0081627	0081640			
Diode Bridge	3711616	3711616			
Elect Caps	7417825	7417825			
Fans	6950023	6950023			
Gate Driver Brd	0081081 0822050	0081081 0822050			
Gnd Flt C.T	2070002	2070002			
Keypad board	1080907	1080907			
Keypad Overlay	1080931	1080931			
MOV	3260032	3260032			
Power Supply	0080151	0080151			
Power Trans	3655120	3655130			
Power Trans Assy	0655120	0655130			
R1	8362050	8362050			
Brake Trans	3510010	3510010			
Brake Trans Base Drive Board	0080532	0080532			
Snubber Brd	1081751 1082353	1081751 1082353			
Soft Start Contactor	4001451	4001451			
Transformer T1	2100014	2100014			

Chapter 10
Drawing List

8180	Outline and Mounting C Size Controller
8181	Outline and Mounting D Size Controller
8014	Connection Diagram 230/400/460 VAC Motor Controller Size C D XXBX
8230	Connection Diagram 230/400/460 VAC Motor Controller Size C D -XXOX
8316	Outline and Mounting for E Size Enclosure

Appendix A
Elevator Applications

Elevator Setup Procedure

1) Follow the entire installation and startup procedure as outlined in the flowchart in chapter 2

2) After entering the setup (nameplate) parameters and calculating the defaults run auto tuning test AU1 (command offset trim) and AU2 (current loop compensation) as described in chapter 3 (keypad) or chapter 4 (serial) **DO NOT RUN ANY AUTO TUNING TEST OTHER THAN AU1 & AU2**

3) Setup the optional parameters in chapter 3 to match the specific application (e g Accel / Decel and S-curve ramps current limit max speed etc)

   It is recommended that the optically isolated outputs be used to indicate correct or fault conditions A possible combination could be 'READY' on output #1 'DRIVE ON' on #2 and 'DIRECTION FLAG' on #3 It is also recommended that the following protective features be enabled (P80) following error torque proving and external motor temp

4) Calculate the "slip frequency" (P78) using the formula given in Appendix C This value is typically between 1 and 3 Hz Compare the value calculated with the value set in P78 during the "calculate presets - P99" procedure and change if necessary

5) Set the encoder direction with parameter P71

   Parameter P71 aligns the direction of the encoder quadrature signal with the direction of motor rotation The value of P71 can either be a one or a zero

NOTE: NOTE The following procedure may cause erratic motor operation precautions must be taken to prevent injury to personnel or damage to equipment

   Enable the drive with a zero speed command

   Observe the shaft of the motor The motor should be at zero speed

   If the shaft is moving erratically the encoder direction is backwards Swap P71 (if it is set to 0 enter a 1 if it is set to 1 enter a 0)

   If the shaft is holding zero speed give the drive a small speed command (around 50 RPM) If the motor does not rotate smoothly swap the encoder direction

6) Run the elevator at contract speed and adjust the speed controller gains (P75 & P76) and Accel Decel S-Curve ramps for best response See appendix C for a discussion on adjusting gain values

Recommended Sequencing for Elevators or Cranes

The following is a recommended sequence for turning on and off the drive system (See chapter 2 for a wiring connections for an output "M" contactor)

1 Select the "Torque Proving" fault active (P80)

2 Select "DRIVE ON" output as one of the opto-isolated outputs on J1 (P58-P61)

3 Pull in the M-contactor

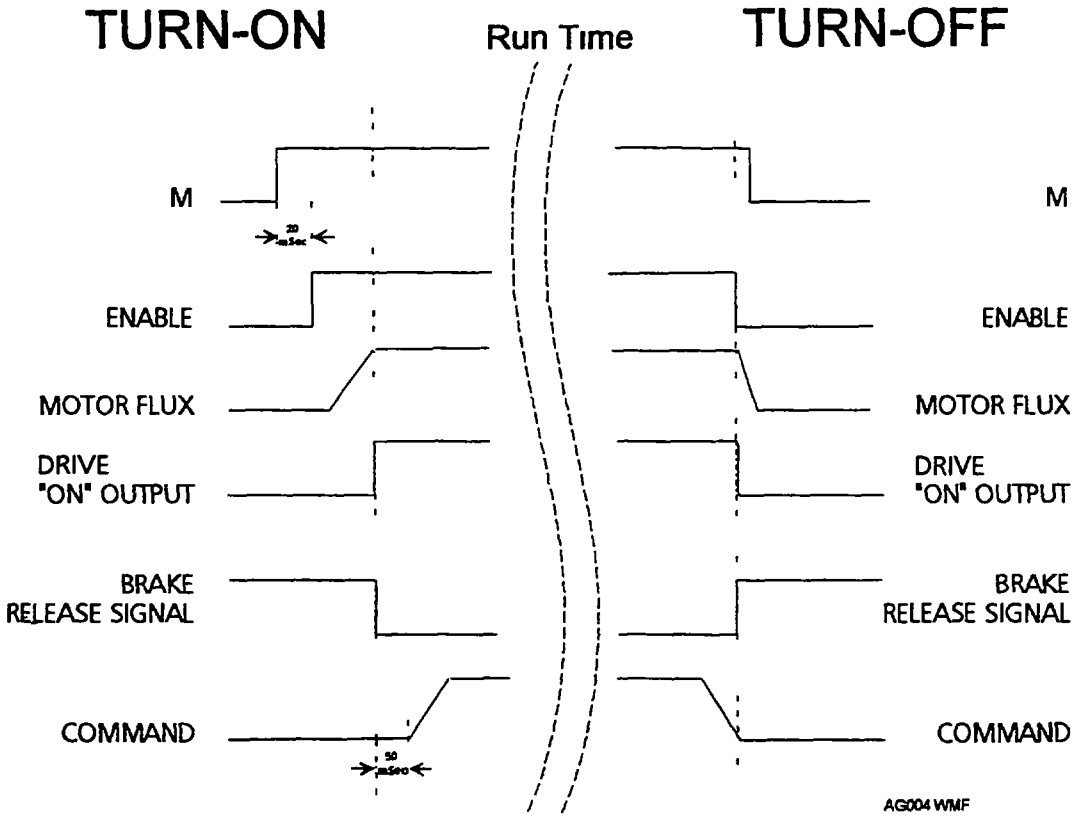
4 Close the drive "ENABLE"

5 Use the "DRIVE ON" output to energize an external coil for a relay to perform the following

Signal the PLC or equivalent controller to engage or disengage the brake and feed the speed command reference (pattern generator) signal into the drive There should be a 50 mseconds delay between the brake release signal and the speed command signal

The time between "DRIVE ON" output and the "ENABLE" signal allows flux build up in the AC motor This delay should be no less than 20 mseconds The "Torque Proving" fault will prevent a "DRIVE ON" output if the drive is not applying current to the motor due to an open contactor broken motor lead or open motor winding If during operations a fault occurs then "DRIVE ON" and "READY" both go inactive and engage the brake and open motor contactor

Figure A-1 Elevator run sequence



Appendix B
Interface I/O and Protective Features

This appendix contains a discussion on the available interface methods and additional protective features of the controller A schematic diagram for each type of I/O is given as a reference

Analog Outputs

There are two programmable 0 to +5 Vdc full scale analog outputs available on pins J1-6 and J1 7 They can be used to monitor various internal digital flux vector variables Assignment is controlled with parameters P56 and P57 The schematic is shown in Figure B-1 followed by the selection number and description

Figure B-1 Analog Outputs

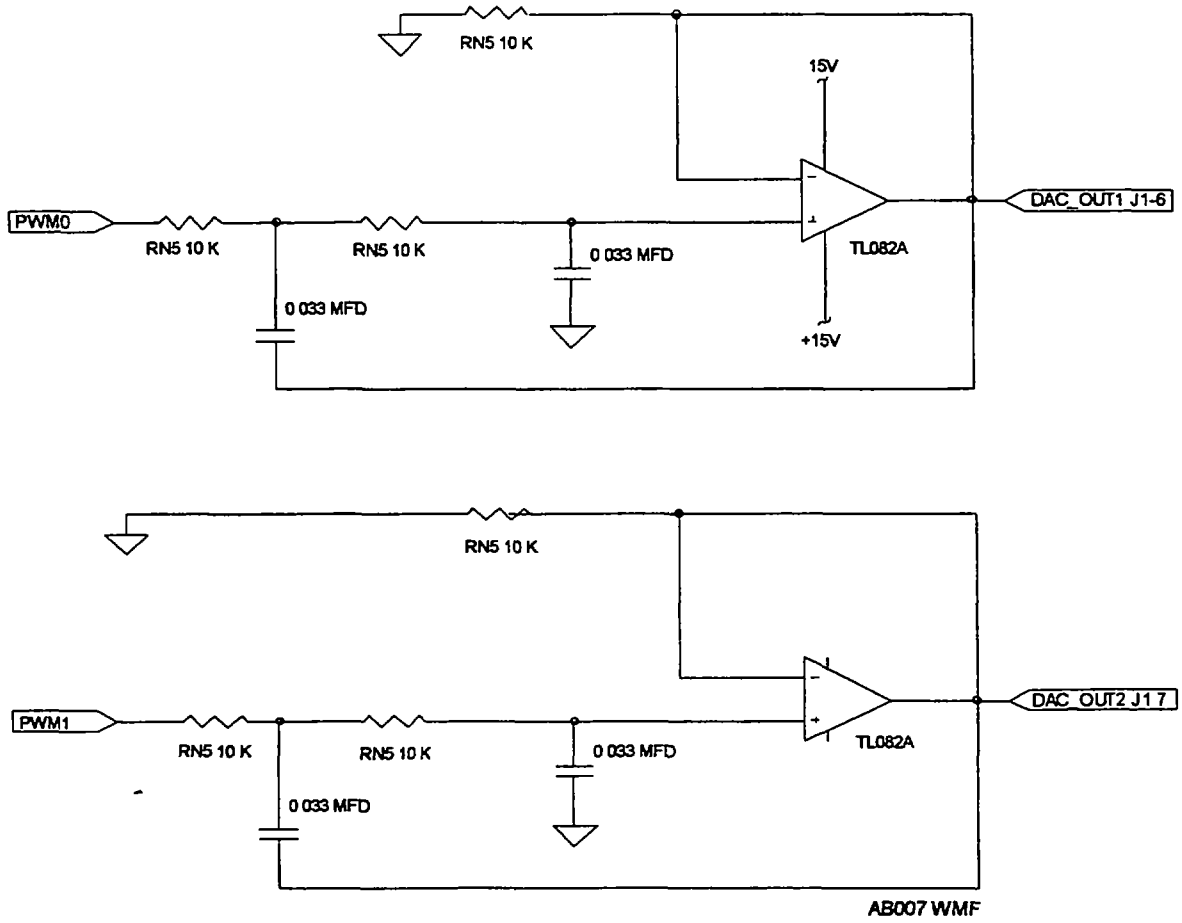


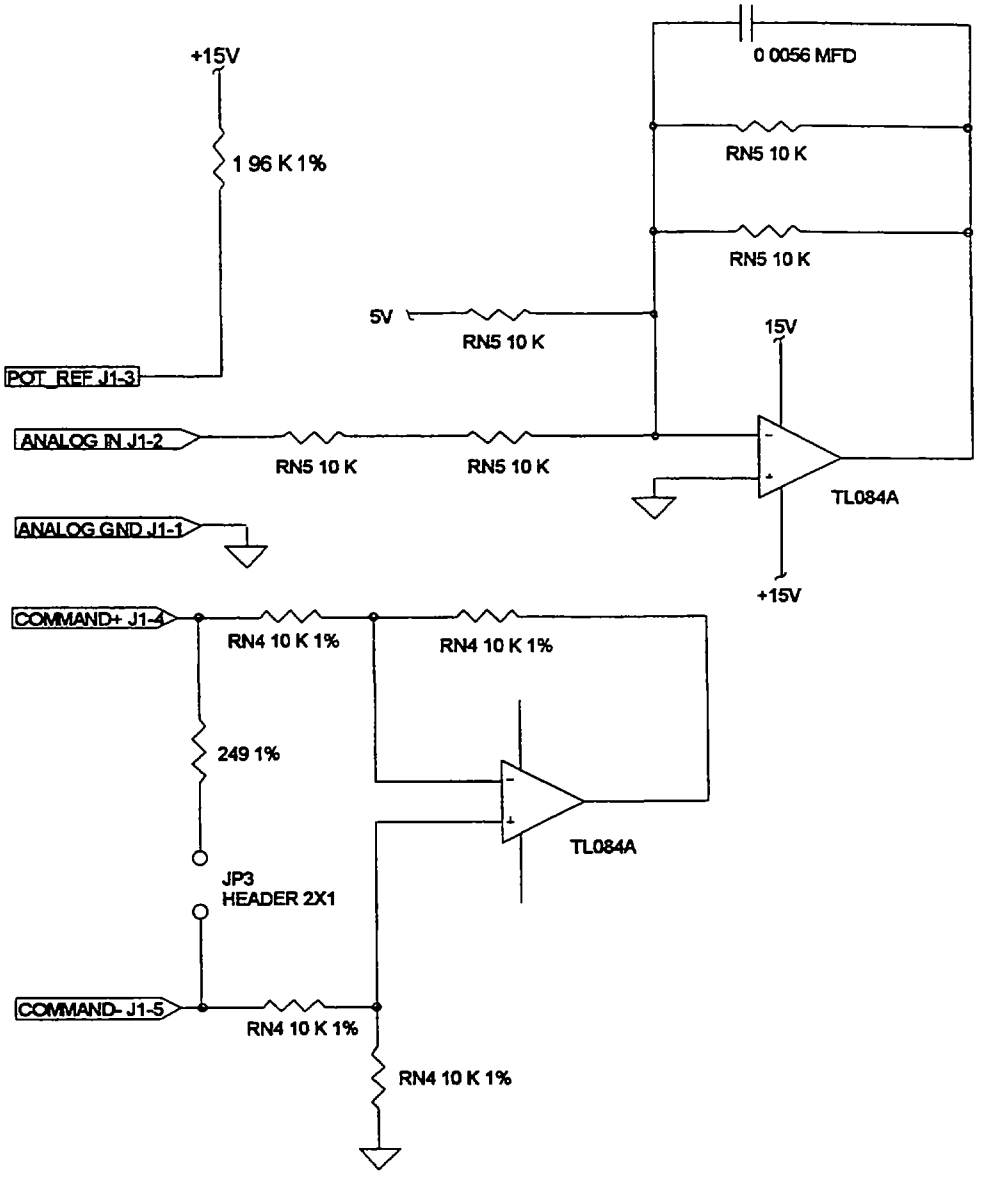
Table B-1 Analog Output Parameter Settings

Number	Name	Description
0)	SPEED	Absolute value of speed with +5 Vdc = MAX RPM (P30) Useful as speed meter output Factory preset for J1 6
1)	ABS VALUE TORQUE	Absolute value of torque with +5 Vdc = torque at CURRENT LIMIT (P33) Useful as load meter output
2)	SPEED COMMAND	Absolute value of the commanded speed with +5 Vdc = MAXIMUM RPM (P30)
3)	VOLTS DC	Amplitude of PWM voltage 0 - max AC voltage
4)	FLUX	Flux current feedback Useful with #5 FLUX COMMAND
5)	FLUX COMMAND	Commanded flux current
6)	LOAD	Load current feedback Useful with #7 LOAD COMMAND to determine torque loop response
7)	LOAD COMMAND	Commanded load current
8)	CURRENT	Magnitude of motor current scaled + 2 5V = rated motor current (P92) Factory preset for J1-7
9)	LOAD CURRENT	Load (torque producing) component of rated motor current (P92) +2 5V = rated current
10)	VOLTS QUADRATURE	Load controller output Useful in diagnosing controller problems and manual setting of feed forward
11)	VOLTS DIRECT	Flux controller output
12)	VOLTS AC	PWM control voltage which is proportional to AC line to line motor terminal voltage 2 5V centered
13)	VOLTS BUS	5V = 800 VDC (900 Series Drives only)
14)	TORQUE	Bipolar torque output 2 5V centered 5V = max pos torque 0 Vdc = max negative torque
15)	POWER	Bipolar power output +2 5V = zero power 0 V = - rated peak power +5V = + rated peak power
16)	VELOCITY	Motor speed scaled +2 5V = zero speed 0 V = negative Maximum Speed (P30) +5V = positive Maximum Speed
17)	OVERLOAD	Accumulated current squared X time OL occurs at +5V
18)	CURRENT PHASE 2	Sampled AC motor current +2 5V = Zero
19)	CURRENT PHASE 3	current 0 V = negative rated peak current +5V = positive rated peak current
20)	POSITION	Position within a single revolution 5V = 1 complete revolution (The counter will reset to 0 once every rev)

Analog Inputs

Two analog inputs are available on pins J1-4 and J1 5 Assignments of these inputs may be made through parameter P50 They accept signals in the form of ±5V ±10 VDC and 4 20 mA The schematic is shown in figure B-2

Figure B-2 Analog inputs



Selectable Parameter Tables

Selectable parameter tables allow the drive to maintain four separate tables of values for each parameter and switch between them A typical application might be a motor with windings that are automatically switched between wye and delta configurations A separate parameter table could be used for each configuration of the motor

Mode 2 is the only mode which allows different parameter tables to be selected Do not change the operating mode (P90) to anything other than 2
As shown in Figure 2-6 pins J1-13&14 select from four parameter tables Initially when setting up the drive parameter values are entered either manually by the user (such as nameplate data) or automatically by the drive (e g calculate defaults) Unless otherwise selected by pins J1-13&14 in mode 2 all parameter values will be stored in parameter table #0 by default

When setting up parameter tables that have only slight variations the following sequence is recommended

1 Set up parameter table #0 for correct operation first

2 Download the parameter file to a computer disk

3 Select a different parameter table using pins J1 13&14

4 Upload the file back into the drive

5 Make changes as desired

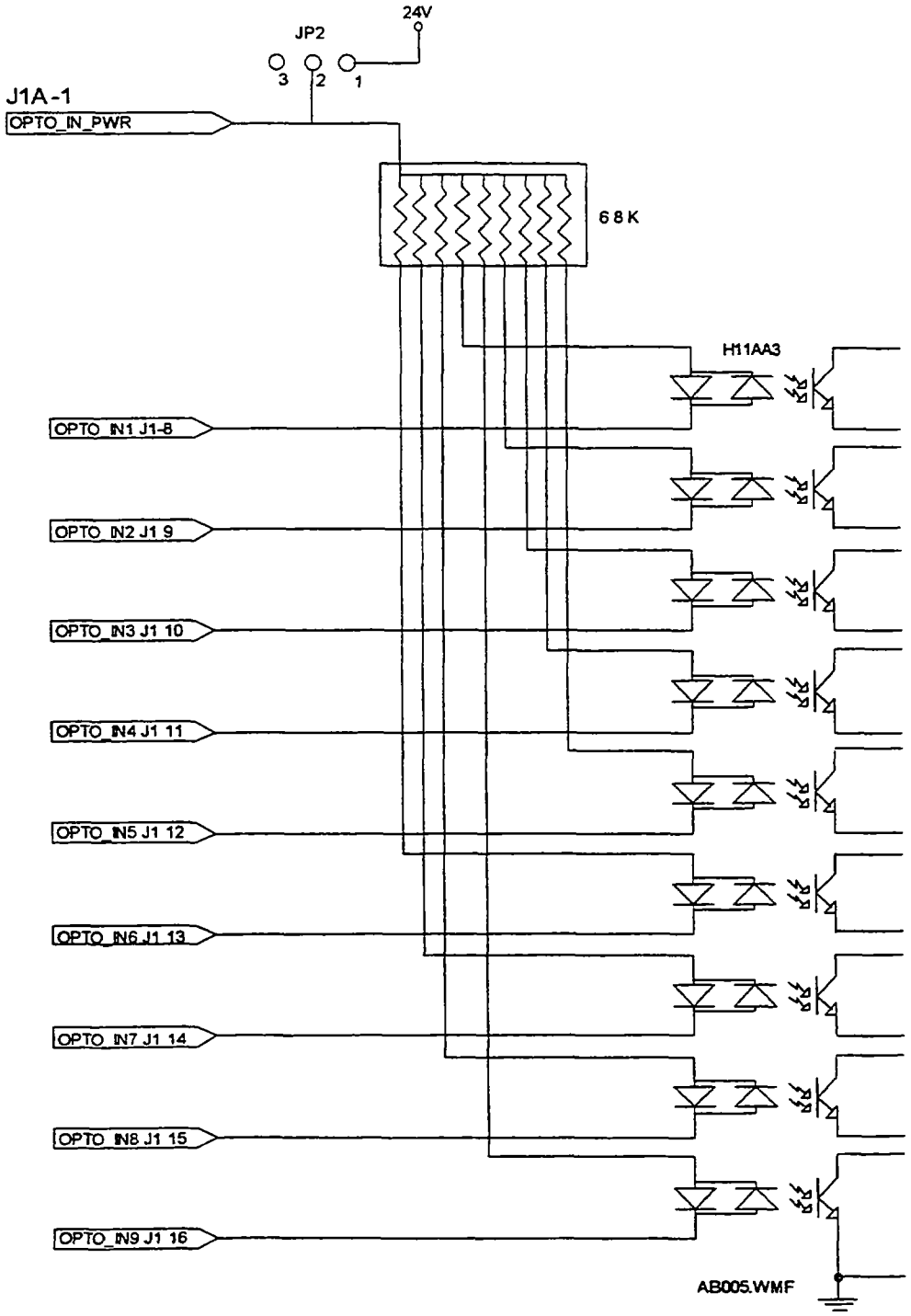
Unless otherwise specified parameter tables #1 through #3 will contain factory preset values

The active parameter table can be determined using the "P" serial command (type P and press enter)

Opto Isolated Inputs

There are nine optically isolated inputs located on J1 8 to J1-16 Three of these inputs are dedicated for specific use (J1-8 J1 10) while the functions of the remaining six can vary depending on the selected operating mode (P90) As discussed in Chapter 2 these inputs are normally powered by an internal 24 VDC supply but can optionally be powered externally be changing the jumper position of JP2 and applying a 10-30 VDC voltage to J1A 1

Figure B-3 Optically Isolated Inputs



Opto Isolated Outputs

There are four opto isolated outputs on connector J1 pins 19 through 22 Assignment of these outputs to available drive variables may be made through the keypad as parameters P58 P59 P60 and P61 The interface schematic is shown below followed by the parameter selection number and description

Figure B-4 Optically Isolated Outputs

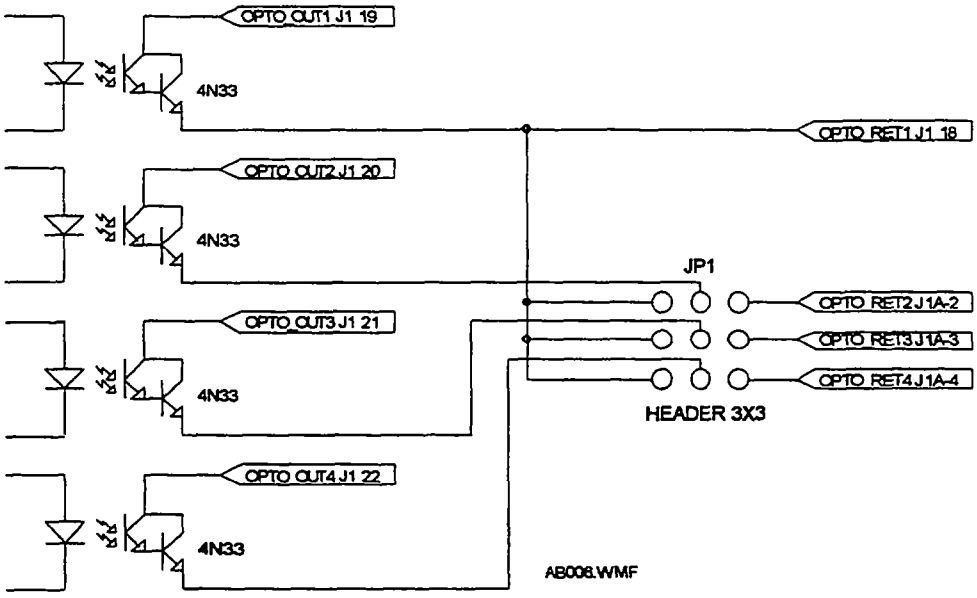


Table B-2 Opto-isolated Output Parameter Settings

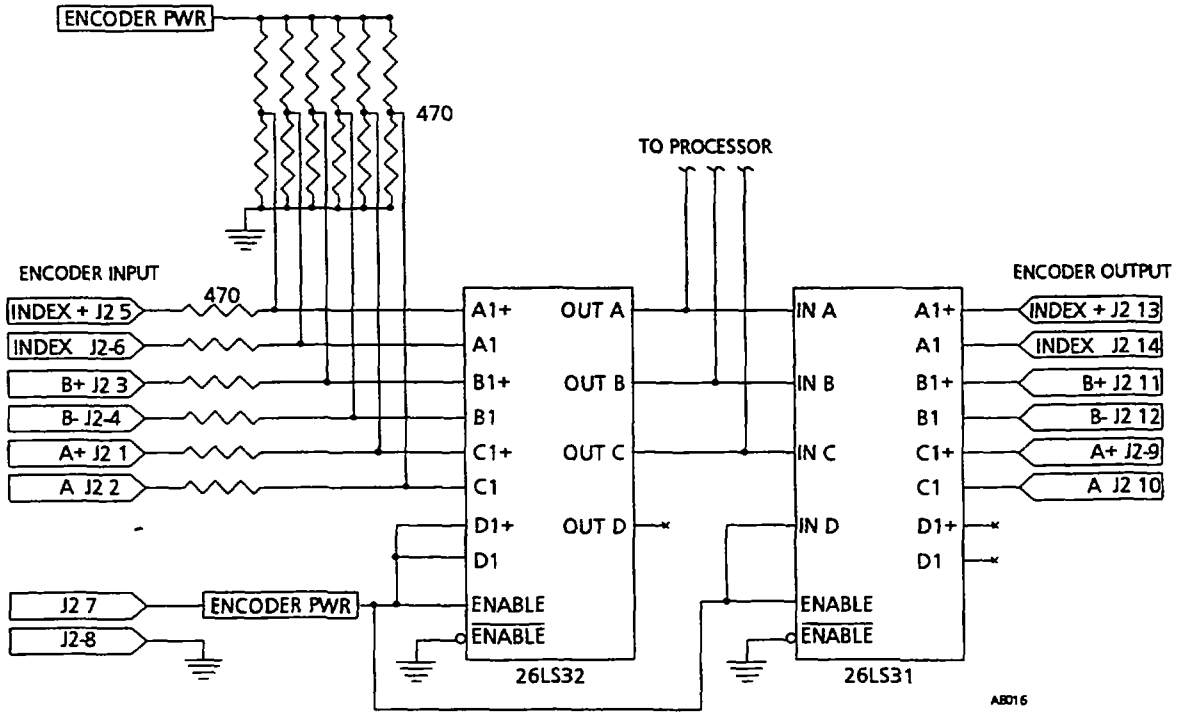
Number	Name	Description
0)	READY	Closed when no faults are present Open if fault exists or AC power not applied
1)	ZERO SPEED	Closed when the motor speed is less than the user specified (P62) speed threshold otherwise open If 'orient' is enabled this output is active when the motor speed is less than the specified (P62) speed threshold AND the motor shaft is within 5 degrees of the predetermined position
2)	AT SPEED	Closed whenever the motor speed is within the user specified (P63) tolerance band of the commanded speed open outside tolerance band
3)	OVERLOAD FOLDBACK	Closed when an RMS current overload has not occurred open upon overload
4)	KEYPAD CONTROL	Closed when the drive is under local keypad control
5)	SET SPEED	Closed whenever the motor speed is above the user specified (P65) "set speed" open below set speed

6)	FAULT	Closes when a FAULT is present open at Ready
7)	FOLLOWING ERROR	Closed when the motor speed is outside the user specified (P63) tolerance band of the Acc Dec and S-Curve Conditioned commanded speed Open when motor speed is within tolerance band of conditioned speed command
8)	LOW BUS VOLTS	Closed whenever a DC Bus undervoltage fault has occurred
9)	DRIVE ON	Closed when drive is capable of producing torque (Motor current has reached excitation level P72)
10)	INPUT DIRECTION	Closed when reverse input direction command is received *open for forward*
11)	AT POSITION	Closed during a positioning command when the drive is within the tolerance band set by P64

Encoder Interface

The encoder interface is located on the J2 (16 pin) connector The schematic is given in Figure B-5 The input (J2 1-6) accepts an incremental quadrature encoder with a "once per revolution" index pulse A differential encoder signal is recommended however an open collector or other non-differential signal can be used by connecting to the A+ B+ and INDEX+ inputs The retransmitted encoder output is from a 26LS31 line driver

Figure B-5 Encoder Interface



Additional protective features are set with parameter P80 protective feature The Factory preset is all additional faults not active

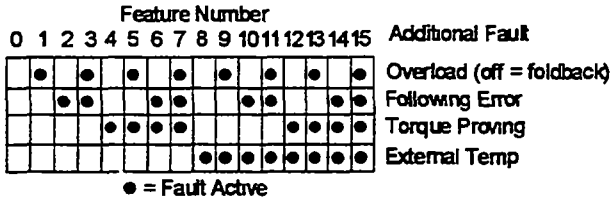
By factory preset the Overload Foldback prevents the drive from tripping off on an overload condition by automatically reducing the internal current limit (P33) to 90% of the motor rating (P92) until the overload accumulator drops below 90% The internal current limit is then automatically restored to its original setting (equal to P33 current limit) When the overload fault is active the drive will indicate an OC (over-current fault) when the current capability of the drive is exceeded

When active the Following Error protective feature shuts down the drive and displays FEr whenever the actual speed (as sensed by the encoder) differs from the commanded speed by more than the P63 value (At Speed Tolerance)

When active the Torque Proving protective feature quickly detects an open motor winding broken motor lead or open contactor upon startup shuts down the drive and displays I LO When the drive is switched to "ENABLE" with torque proving fault active the flux current is oriented to cause current to flow in all three motor phases Each phase current is monitored and an I LO (torque proving) fault occurs if all three phases do not provide adequate current After approximately 0 5 seconds the monitoring is completed and receiving a torque proving fault is no longer possible Any open wire/lead to the motor will cause a "Cur" fault (current sense fault)

When active the External Temp protective feature will detect an overtemperature condition from an external source and shut down the drive The input comes from a normally closed thermal switch on J1-6 This switch can be located on the motor or other device in the system When the switch opens an OH-E fault is indicated **Note** This feature must be activated before the drive can detect a motor overtemp condition During setup this feature should be tested by opening J1-6 to assure that the motor protection is in operation

Figure B-6 Additional Protective Features (P80) Settings



Appendix C
Discussion on Gain Parameters

Flux Current P72

The flux current is normally preset entered from nameplate data or auto-tuned If no other data is available set flux current to about 40% of the motor nameplate rated current

The following procedure should be used for setting the Flux Current with the motor coupled to the load

1. Adjust P72 to 40% of the motor nameplate full load current rating
2. Give the drive a speed command input of 80% of the Base Speed on motor nameplate
3. Select motor voltage on keypad display by pressing the DISP key until the VOLTS indicator is lit
4. Observe the motor voltage Ideally it should read 80% of motor nameplate voltage

   By raising P72 you will notice the motor voltage will raise proportionally Continuing to raise P72 will eventually saturate the motor voltage By lowering P72 the motor voltage will lower proportionally
5. While the motor is running adjust P72 until the display indicates the proper voltage (80% of motor rated)

Slip Frequency P78

The slip frequency is calculated from nameplate data or auto tuned

$$F_{Slip} = \text{Rated Freq} - \left(\text{Rated RPM} \times \frac{\text{No POLES}}{120}\right)$$

Current Controller Gains - P73 & P74

The current controller proportional gain P73 is normally preset for pre-tuned systems or auto-tuned where motor parameters aren't known Where auto-tuning can't be used the proper manual setting for the proportional gain can be calculated by

$$P73 = K_p = \frac{[740 \times L \times (A/V)]}{VAC}$$

L = line to neutral leakage inductance of the motor in mH
VAC = nominal line volts
A/V = the amps/volt scaling of the current feedback

Note Motor line to neutral leakage inductance can be obtained either from the motor manufacturer or by measuring the line to line inductance and dividing by two

For most applications a value of P73 = 20 will yield adequate performance

The current controller integral gain P74 is factory preset at 50 Hz This setting is suitable for essentially all systems **DO NOT CHANGE WITHOUT FACTORY APPROVAL**

Speed Controller gains - P75 - P77

The speed controller proportional gain P75 is normally preset or auto-tuned This gain may be increased or decreased to suit the application Increasing P75 will result in faster response excessive proportional gain will cause overshoot and ringing Decreasing P75 will cause slower response and decrease overshoot and ringing caused by excessive proportional gain If P75 & P76 are set too close together an overshoot condition can also occur

The speed controller integral gain parameter P76 in Hertz as discussed under PI controller later in this chapter may be set at any value from zero to 10 Hertz Setting P76 = 0 removes integral compensation resulting in a proportional rate loop This selection is ideal for systems where overshoot must be avoided and substantial stiffness" (ability of the drive to maintain commanded speed despite torque loads) isn't required Increasing values of P76 increase the low frequency gain and stiffness of the drive an excessive integral gain setting will cause overshoot for transient speed commands and may lead to oscillation Typical setting is 4 Hertz DO NOT SET ABOVE 10 HERTZ OR SUBSTANTIAL OVERSHOOT WILL OCCUR

To manually tune the speed controller

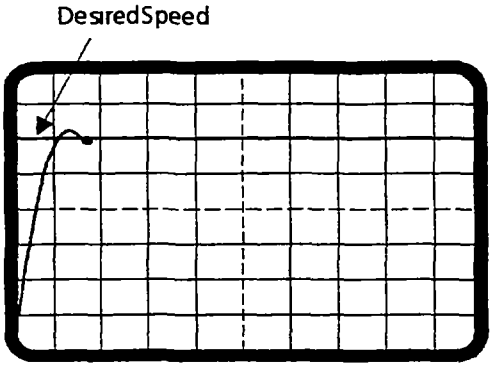
1 Set P76 = 0 (remove integral gain)
2 Increase the P75 setting until adequate response to step speed commands is attained
3 Increase P76 setting to increase the stiffness of the drive

It is convenient to monitor speed step response with a strip chart recorder or storage oscilloscope connected to J1-6 or 7 with P56 or 57 set to 16 (bipolar speed 2 5 VDC = zero speed) See Appendix B discussion of analog outputs

Examples

Figures C-1 through C-4 illustrate what the speed response would look like on an oscilloscope for various gain settings The examples show waveforms from the analog output J1-6 with "VELOCITY" selected during a stepped speed command from zero to 100 RPM

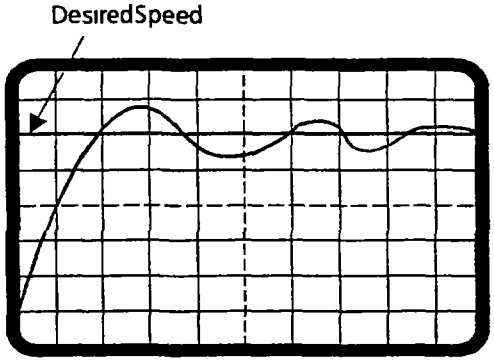
Figure C-1 Oscilloscope Response No 1



With P75 at 40 & P76 at 1

Figure C-1 shows the optimum response for this particular system (Proportional gain = 40 and integral = 1)

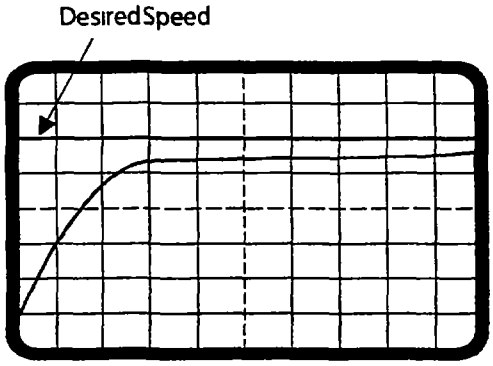
Figure C-2 Oscilloscope Response No 2



With P75 at 10 & P76 at 1

In Figure C 2 the integral gain is set too high (1) for the value of proportional gain (10) The result is an excessive overshoot and ringing Therefore raise P75 or lower P76 integral gain

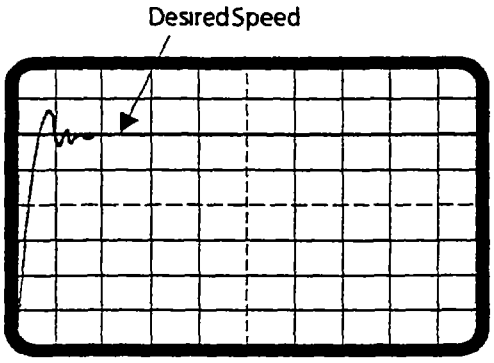
Figure C-3 Oscilloscope Response No 3



With P75 at 10 & P76 at 0

Figure C 3 shows the response of a proportional rate loop with the integral gain has been set to 0 Hz However the value of proportional gain is too low

Figure C-4 Oscilloscope Response No 4



With P75 at 100 & P76 at 1

Figure C-4 is an example of excessive proportional gain note the ringing in the speed response

PI Controller

Both the current and rate control loops are of the Proportional plus Integral type If 'E' is defined to be the error signal

E = Command - Feedback

then the PI controller operates on 'E' as

Output = (Kp * E) + (Ki $\int$E dt)

where Kp is the proportional gain of the system and Ki is the integral gain of the system

The transfer function (Output /E) of the controller using 1/s (Laplace Operator) to denote the integral

Output/E = Kp + Ki / s = Kp (s + Ki/Kp) / s

The second equation shows that the ratio of Ki/Kp is a frequency in radians/sec In the SWEODRIVE flux vector drive the integral gain has been redefined to be

SWEODRIVE KI = (Ki / Kp) / (2 Π) Hz

and the transfer function is

Output/E = Kp (s + 2 Π KI) / s

This sets the integral gain as a frequency in Hertz As a rule of thumb set this frequency about 1/10 of the bandwidth of the control loop

The proportional gain sets the open loop gain of the system - the bandwidth (speed of response) of the system If the system is excessively noisy it is most likely due to the proportional gain being set too high

Appendix D
AC Vector Drive Parameter List

FLUX VECTOR PARAMETER LIST (VER 2 03)

10//93

P #	DESCRIPTION	RANGE	FACTORY PRESET	SETTINGS
	SYSTEM CONTROL PARAMETERS			
	JOG			
0	JOG SPEED (RPM)	0-MAX SPEED	0	
1	JOG ACCEL (0 TO MAX SPEED) SEC	0 - 999.9	2 0	
2	JOG DECEL (MAX SPEED TO 0) SEC	0 - 999 9	2 0	
3	JOG TIME TO MAX ACCEL ("S" CURVE) SEC	0 - 99.99	0 00	
	ACC / DEC			
4	ACCEL #1 (0 TO MAX SPEED) SEC	0 999.9	2 0	
5	DECEL #1 (MAX SPEED TO 0) SEC	0 - 999 9	2 0	
6	"S" CURVE #1 (TIME TO MAX ACCEL) SEC	0 - 99.99	0 00	
	ACCEL #2 (0 TO MAX SPEED) SEC	0 - 999 9	2 0	
8	DECEL #2 (MAX SPEED TO 0) SEC	0 - 999 9	2 0	
9	"S" CURVE # 2 (TIME TO MAX ACCEL) SEC	0 - 99 99	0 00	
	PRESET SPEEDS			
11	PRESET SPEED #1 (RPM)	0-MAX SPEED	0	
12	PRESET SPEED #2 (RPM)	0-MAX SPEED	0	
13	PRESET SPEED #3 (RPM)	0-MAX SPEED	0	
14	PRESET SPEED #4 (RPM)	0-MAX SPEED	0	
15	PRESET SPEED #5 (RPM)	0-MAX SPEED	0	
16	PRESET SPEED #6 (RPM)	0-MAX SPEED	0	
17	PRESET SPEED #7 (RPM)	0-MAX SPEED	0	
18	PRESET SPEED #8 (RPM)	0-MAX SPEED	0	
19	PRESET SPEED #9 (RPM)	0-MAX SPEED	0	
20	PRESET SPEED #10 (RPM)	0-MAX SPEED	0	
21	PRESET SPEED #11 (RPM)	0-MAX SPEED	0	
22	PRESET SPEED #12 (RPM)	0-MAX SPEED	0	
23	PRESET SPEED #13 (RPM)	0-MAX SPEED	0	
24	PRESET SPEED #14 (RPM)	0-MAX SPEED	0	
	PRESET SPEED #15 (RPM)	0-MAX SPEED	0	

P #	DESCRIPTION	RANGE	FACTORY PRESET	SETTINGS
	HOMING / ORIENT			
26	HOMING SPEED (RPM)	0-MAX SPEED	100	
27	HOMING OFFSET FROM INDEX MARK (ENCODER COUNTS X 4)	0-9999	P95	
	MISC OPERATING PARAMETERS			
	MOTOR SPEED LIMITS			
30	DESIRED MAXIMUM MOTOR SPEED (RPM)	0-32767	P93	
31	DESIRED MINIMUM MOTOR SPEED (RPM)	0-MAX SPEED	0	
32	CONSTANT POWER SPEED (RPM)	0-MAX SPEED	CALC	
	CURRENT CONTROL			
33	CURRENT LIMIT	0-RATING	2X P92	
34	REGEN RESISTANCE (OHMS) 0 = NO REGEN 1 = FULL REGEN (MULTI-AXIS)	0-127	0	
35	REGEN RESISTOR POWER (WATTS)	0-32767	300	
36	TORQUE RATE LIMIT (mSEC)	0-9999	0	
	KEYPAD			
37	KEYPAD CONTROL Control Modes 0 1 2 3 4 5 6 7 8 9 Control Functions ● ● ● ● ● ● Jog Forward ● ● ● ● ● Jog Reverse ● ● ● ● ● Run Forward ● ● Run Reverse ● ● ● ● ● ● ● ● Stop ● = Active	0-9	0	
38	KEYPAD SPEED CONTROL Speed Modes 0 1 2 3 4 5 Active Function ● ● Increment (@ Acc / Dec) ● ● Entered Speed ● ● Preset Speed ● ● ● Regen to Stop (off = Coast) ● = Active	0-5	1	
	SECURITY CONTROL SETTINGS			
39	SECURITY CONTROL 0 = NO SECURITY CODE 1 = SECURITY CODE – KEYPAD & SERIAL 2 = SECURITY CODE – KEYPAD ONLY 3 = SECURITY CODE – SERIAL ONLY	0-3	0	
	SERIAL PORT			
40	BAUD RATE (FOR SERIAL COMMAND) 0 = 1200 4 = 19 200 1 = 2400 2 = 4800 3 = 9600	0-4	3	
41	DRIVE ADDRESS (1 - 31 FOR MULTI-DROP SYSTEMS)	0-31	0	

P #	DESCRIPTION	RANGE	FACTORY PRESET	SETTINGS
	FAULT RESET			
42	AUTO FAULT RESET (FAULTS / HR)	0-5	0	
43	AUTO RESET DELAY TIME (SECONDS)	0-120	0	
44	POWER LOSS RESET 0 = OFF 1 = ON		0	
	I/O PARAMETERS			
50	SPEED INPUT SELECTION 0 = SPEED POT OR 0 - 10V (J1-1 TO J1-2) 1 = ±10V 2 = ±5V 3 = 4-20mA 4 = ±10V w/ 0-5V AUX TORQUE LIMIT (NOTE AUX TORQUE LIMIT IS ACTIVE IN SERIAL CONTROL 5 & 6 = RESERVED FOR FUTURE USE	0-6	1	
51	ANALOG INPUT DEADBAND FOR ZERO SPEED COMMAND (RPM)	0-127	0	
53	AUXILIARY ANALOG INPUT PROPORTIONAL GAIN	0-200	CALC	
54	AUXILIARY ANALOG INPUT INTEGRAL GAIN	0-999	0	
55	ENABLE POLARITY 0 = OPEN TO STOP 1 = CLOSE TO STOP		0	
56 57	SELECTION FOR USER D/A #1 (J1-6) SELECTION FOR USER D/A #2 (J1-7) 0 = SPEED 1 = ABS TORQUE 2 = SPEED COMMAND 3 = VOLTS DC 4 = FLUX 5 = FLUX COMMAND 6 = LOAD 7 = LOAD COMMAND 8 = CURRENT 9 = LOAD I 10 = VOLTS QUADRATURE 11 = VOLTS DIRECT 12 = VOLTS AC 13 = VOLTS BUS (900 senes only) 14 = TORQUE 15 = POWER 16 = VELOCITY 17 = OVERLOAD 18 = CURRENT PHASE 2 19 = CURRENT PHASE 3 20 = POSITION	0-20	0 8	
58 59 60 61	SELECTION FOR OPTO OUTPUT #1 (J1-19) SELECTION FOR OPTO OUTPUT #2 (J1-20) SELECTION FOR OPTO OUTPUT #3 (J1-21) SELECTION FOR OPTO OUTPUT #4 (J1-22) 0 = READY 1 = ZERO SPEED 2 = AT SPEED 3 = OVERLOAD FOLDBACK 4 = KEYPAD CONTROL 5 = SET SPEED 6 = FAULT 7 = FOLLOWING ERROR 8 = N/A 9 = DRIVE ON 10 = DIRECTION FLAG 11 = AT POSITION 12 -15 = RESERVED FOR FUTURE USE	0-15	0 1 2 3	
	I/O THRESHOLD PARAMETERS (FOR OPTO OUTPUTS)			
62	ZERO SPEED TOLERANCE (RPM)	0-127	10	
63	AT SPEED TOLERANCE (%)	0-100	10	
64	POSITION TOLERANCE (ENCODER COUNTS)	0-9999	CALC	
65	SET SPEED (RPM)	0-9999	P93	

P #	DESCRIPTION	RANGE	FACTORY PRESET	SETTINGS
	FLUX VECTOR CONTROL PARAMETERS			
70	ENCODER FILTER 0 = NO FILTER 7 = MAX FILTER	0-7	CALC	
71	ENCODER ALIGNMENT DIRECTION (0 OR 1)		1	
72	FLUX (NO LOAD IDLE) CURRENT (AMPS RMS)	0-CUR LIMIT	CALC	
73	CURRENT CONTROLLER PROPORTIONAL GAIN	0-200	20	
74	CURRENT CONTROLLER INTEGRAL GAIN (Hz)	0-99	50	
75	SPEED CONTROLLER PROPORTIONAL GAIN	0-200	10	
76	SPEED CONTROLLER INTEGRAL GAIN (Hz)	0-9 99	1	
77	SPEED CONTROLLER DIFFERENTIAL GAIN	0-100	0	
78	SLIP FREQUENCY (Hz)	0-10	CALC	
79	POSITION LOOP GAIN	0-9999	CALC	
80	PROTECTIVE FEATURE Feature Number 0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 Additional Fault Overload (off = foldback) Following Error Torque Proving External Temp ● = Fault Active	0-15	0	
81	NUMBER OF PARALLEL CONTROLLERS (1 STANDARD)	1-5	1	
82	PWM RIPPLE FREQUENCY (KHZ) (1 KHZ INCREMENTS) (REFER TO SPECIFICATIONS CH 1 FOR MAX RATING)	2 0 - RATING	RATED PWM	
	SETUP			
90	OPERATING MODE (See Manual) 0 = STANDARD RUN 1 = PLC INTERFACE 2 = ANALOG INPUT SPEED OR TORQUE CONTROLLER 3 = SERIAL CONTROL 4 = APPLICATION SPECIFIC 5 = RESERVED FOR FUTURE USE	0-5	2	
91	MOTOR RATED VOLTAGE (VOLTS RMS)	0-9999	CONTROL RATING	
92	MOTOR RATED CURRENT (AMPS RMS)	0-999 9	CONTROL RATING	
93	MOTOR "RATED" OR "BASE" SPEED (RPM)	0-32767	1760	
94	MOTOR "RATED" OR "BASE" FREQUENCY (Hz)	0-9999	60 0	
95	ENCODER LINES PER REVOLUTION	0-32767	1024	
96	LOW LINE OPERATION (914 DRIVE ONLY) 0 = OFF, 1 = ON This parameter lowers the overvoltage undervoltage and regen thresholds when operating a 460VAC controller on lessthan 380VAC input line voltage **WARNING DO NOT CHANGE THIS PARAMETER IF THE LINE VOLTAGE IS ABOVE 380VAC**	0-1	0	
99	CALCULATE DEFAULTS & CLEAR FAULT LOG (ENTER 1)			

P #	DESCRIPTION	RANGE	FACTORY PRESET	SETTINGS
100	AUTO TUNING (DRIVE DISABLED TO ENTER) ALL = RUN ALL TESTS AU01 = COMMAND OFFSET TRIM AU02 = CURRENT LOOP COMPENSATION AU03 = FLUX (EXCITATION) CURRENT SETTING AU04 = ENCODER TESTS AU05 = SLIP FREQUENCY TEST AU06 = SPEED CONTROLLER CALCULATION			
101	SECURITY CODE	0-9999	9999	
103	VIEW SOFTWARE VERSION			
105	TEST POINT VARIABLE CHANNEL 1	0-20	0	
106	TEST POINT VARIABLE CHANNEL 2	0-20	0	

Appendix E
Serial Command Quick List

COMMAND (CASE SENSITIVE)	DESCRIPTION	RANGE
	NON-PROTECTED COMMANDS	
Ax	ADDRESS (MULTI-DROP SYSTEMS ONLY)	x = 0 - 32
AA	ADDRESS ALL (MULTI-DROP SYSTEMS ONLY)	
ECHO_ON	TURN ON CHARACTER ECHO	
ECHO_OFF	TURN OFF CHARACTER ECHO	
L	FAULT LOG (LAST 15 FAULT CODES)	
ST	DRIVE STATUS (0 = DISABLED 1 = ENABLED 2 = FAULT)	
STATUS	FULL DRIVE STATUS	
ID	POWER BASE ID	
IO	J1 CONNECTION STATUS	
F	RETURN CURRENT FAULT CODE (0 = NO FAULT EXISTS)	
Ox	REPORT OUTPUT VARIABLES (x IS OPTIONAL)	x = 1 - 8
TP	RETURN CAPTURED TEST POINTS	
SCxxxx	SECURITY CODE	x = 0 - 9999
	SECURITY PROTECTED COMMANDS (ALL COMMANDS AFTER THIS LEVEL ARE AFFECTED)	
UL	UPLOAD PARAMETER FILE (DISK TO CONTROL BOARD)	
DL	DOWNLOAD PARAMETER FILE (CONTROL BOARD TO DISK)	
C	CLEAR FAULT (RESET)	
Pxxx or Pxxx nnnn	CHANGE / VIEW PARAMETER (P WILL SHOW ALL PARAMETERS)	xxx = 0 - 999 nnnn = 0 - 9999
	SERIAL CONTROL COMMANDS (ALL COMMANDS AFTER THIS LEVEL ARE AFFECTED)	
AUx	AUTO TUNE	x = 1 - 6
H	HOME (NOT TO BE USED WITH POSITIONING COMMANDS)	
V OR Vxxxx	VELOCITY COMMAND (V+ OR V- CHANGES DIRECTION ONLY)	xxxx = 0 - MAX SPEED (RPM)
T OR Txxxx	TORQUE COMMAND (T+ OR T- CHANGES DIRECTION ONLY)	xxxx = 0 - 2048
E	ENABLE	
D	DISABLE	
Jx	JOG COMMAND	x = + - S
S	ALL STOP	
TAR Xxxxx	TARGET REGISTER	Xxxxx IS ANY COMMAND
GO	EXECUTE TARGET COMMAND	

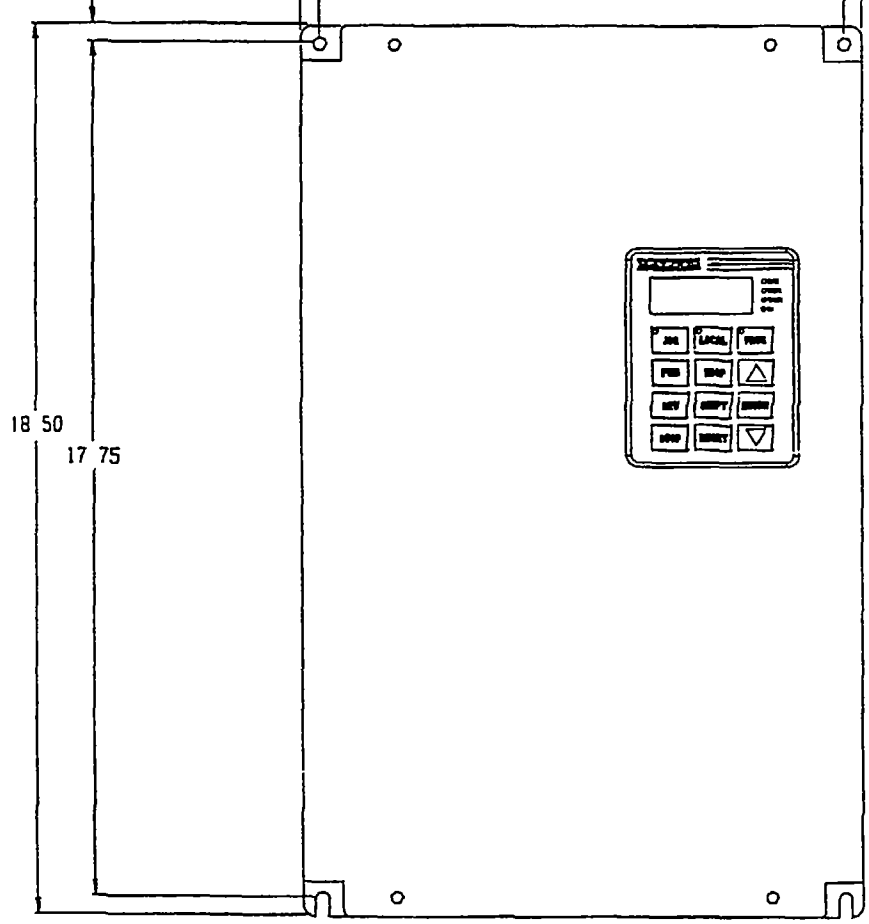
COMMAND (CASE SENSITIVE)	DESCRIPTION	RANGE
	POSITIONING COMMANDS	
M OR Mxxxxx	ABSOLUTE POSITION COMMAND (ENCODER COUNTS X 4)	
m OR mxxxxx	RELATIVE POSITION COMMAND (ENCODER COUNTS X 4)	
vxxxx	POSITIONING SPEED (RPM)	xxxx = 0 - 9999
W	POSITION COMMAND TO ZERO	
Z	SET CURRENT POSITION TO ZERO	

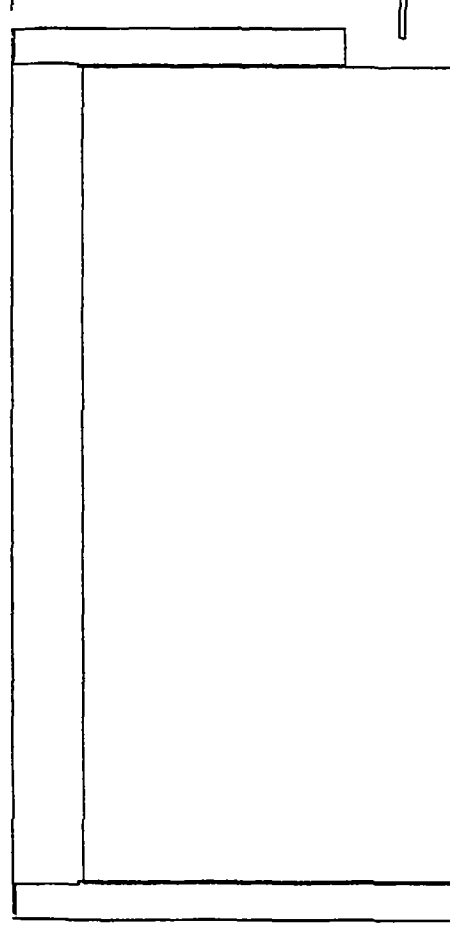
Appendix F
Recommended Tightening Torques

RECOMMENDED TIGHTENING TORQUES FOR TERMINAL BLOCKS

FOR C & D SIZE 900 SERIES AC SINGLE AXIS POWER BASES
(Use copper or aluminum conductors rated 75C or higher External or remote overload protection must be provided in accordance with the "National Electrical Code" or the like)

Drive Model Number	Wire Size And Type	Torque IN-LB
914X-11 thru 914X 14	10 AWG (CU AL)	25
912X-22 thru 912X-26 914X 14 thru 914X-26	10/8 AWG (CU/AL) 10/8 AWG (CU/AL)	30 30
912X-34 thru 912X 38 914L-34 914Q-35 914E 38	8/6 AWG (CU/AL) 8/6 AWG (CU/AL)	30 30
914L 35 914Q-36 914E-39	6 AWG (CU)	30
912X-46 thru 912X-412 914X-46 thru 914X-412	6/4 AWG (CU/AL) 6/4 AWG (CU/AL)	10 6 12 3 21 8 26 1
912X 58 thru 912X 718	4 AWG (CU)	10 6 - 12 3
912X-812 thru 912X-824	3 AWG (CU)	21 8 26 1
914X 58 thru 914X-515	4/3 AWG (CU/AL)	21 8 26 1
914X 710 thru 912X-718	3/1 AWG (CU/AL)	21 8 - 26 1
912X-1016 thru 912X 1031	1 AWG (CU)	21 8 - 26 1

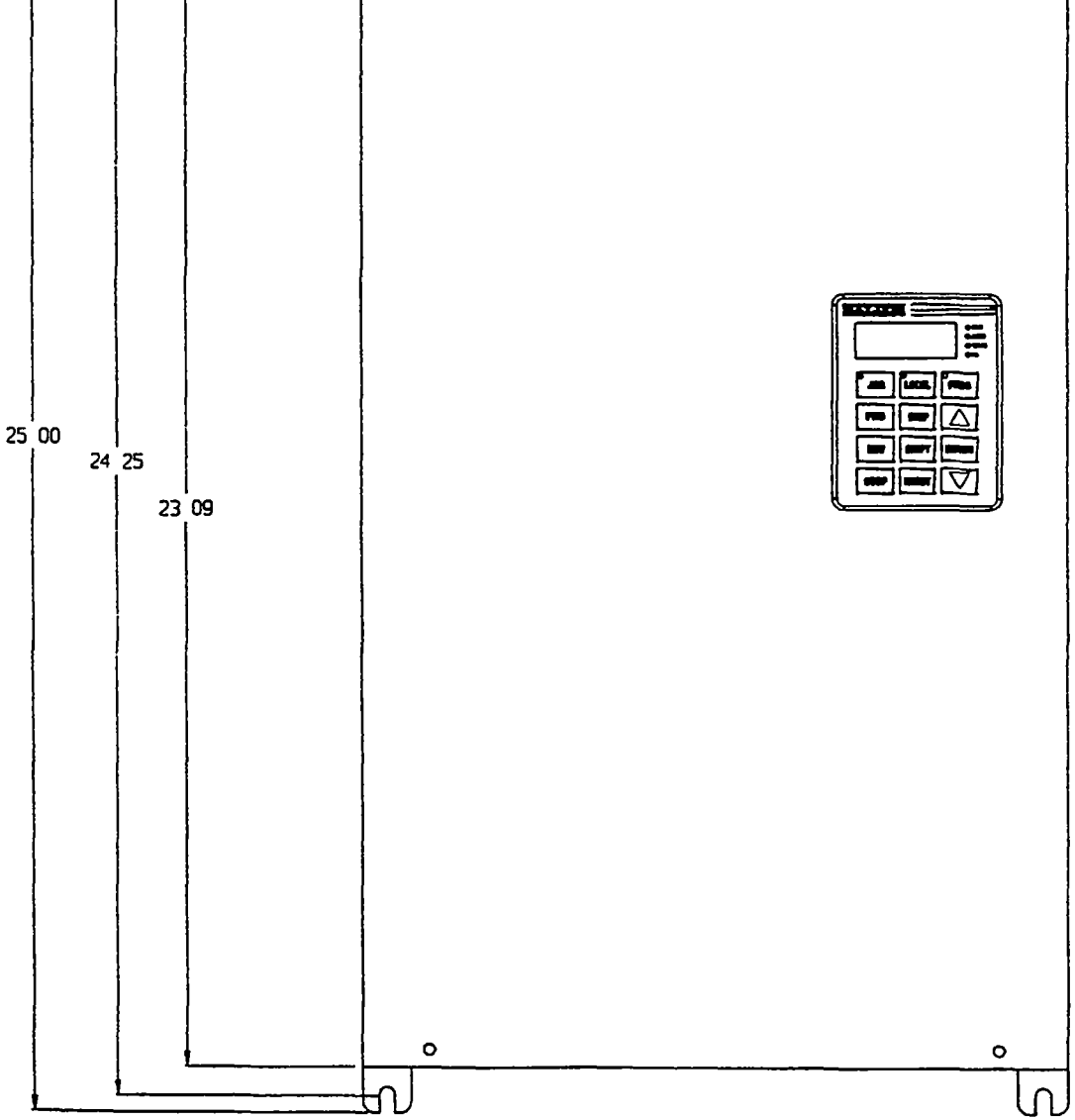


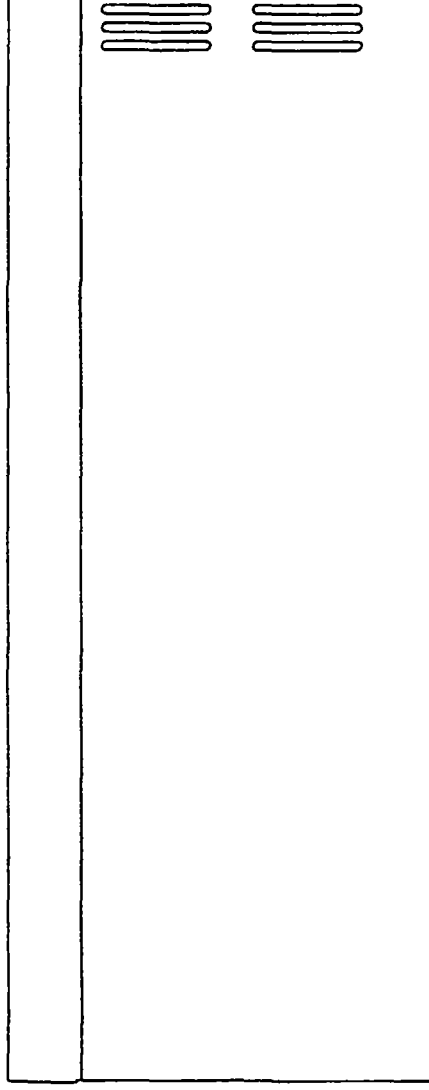


CUSTOMER
POWER
CONNECTIONS

AIR INLET

8 7 6 5 4

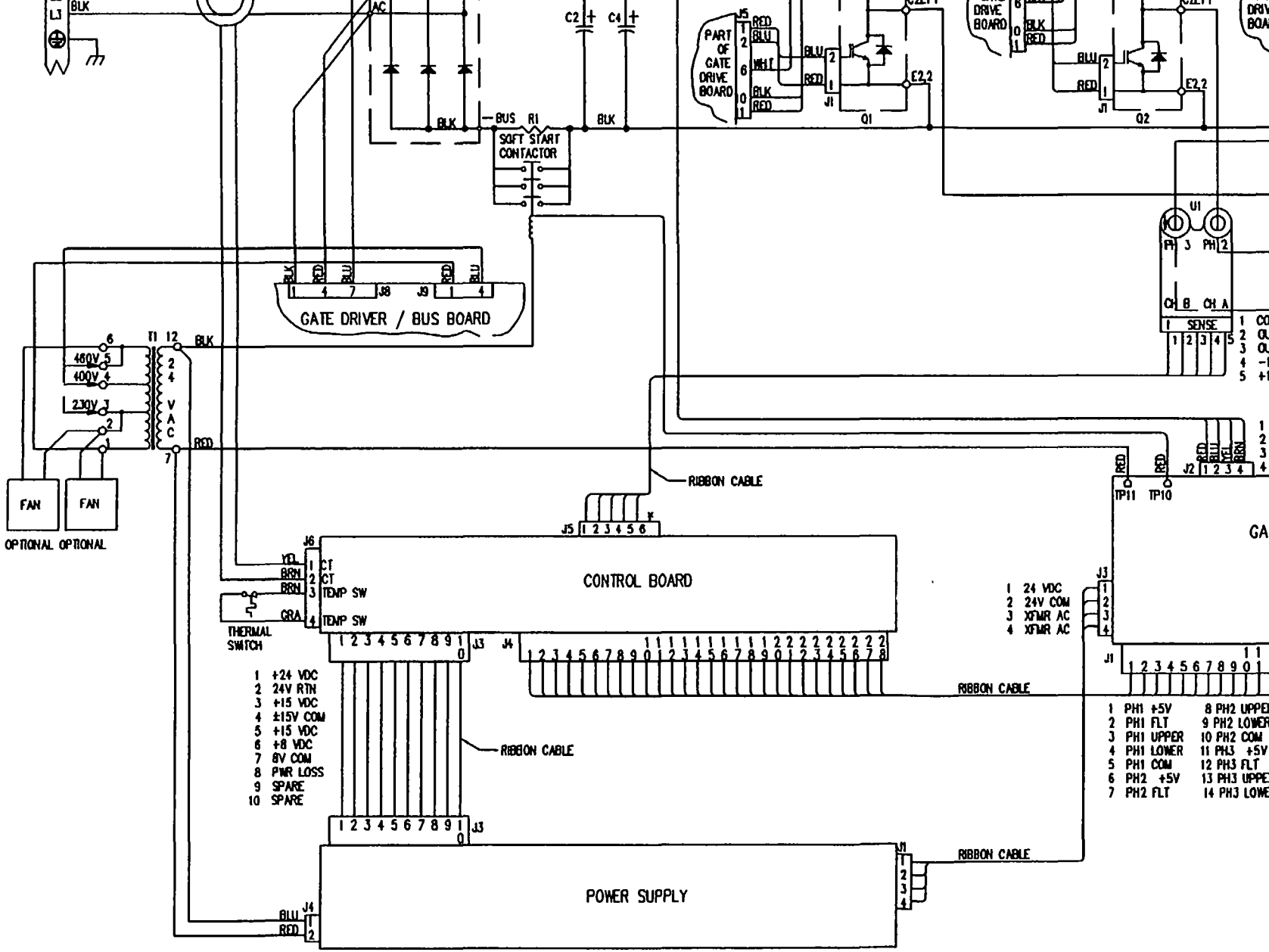




CUSTOMER
POWER
CONNECTIONS

AIR INL

8 7 6 5 4



REV	DESC	BY	DATE	TDR
G	CHANGED BRK TRANSISTOR CONN ,LOAD TO ACAD	DAX	08/17/99 10 49	0172692

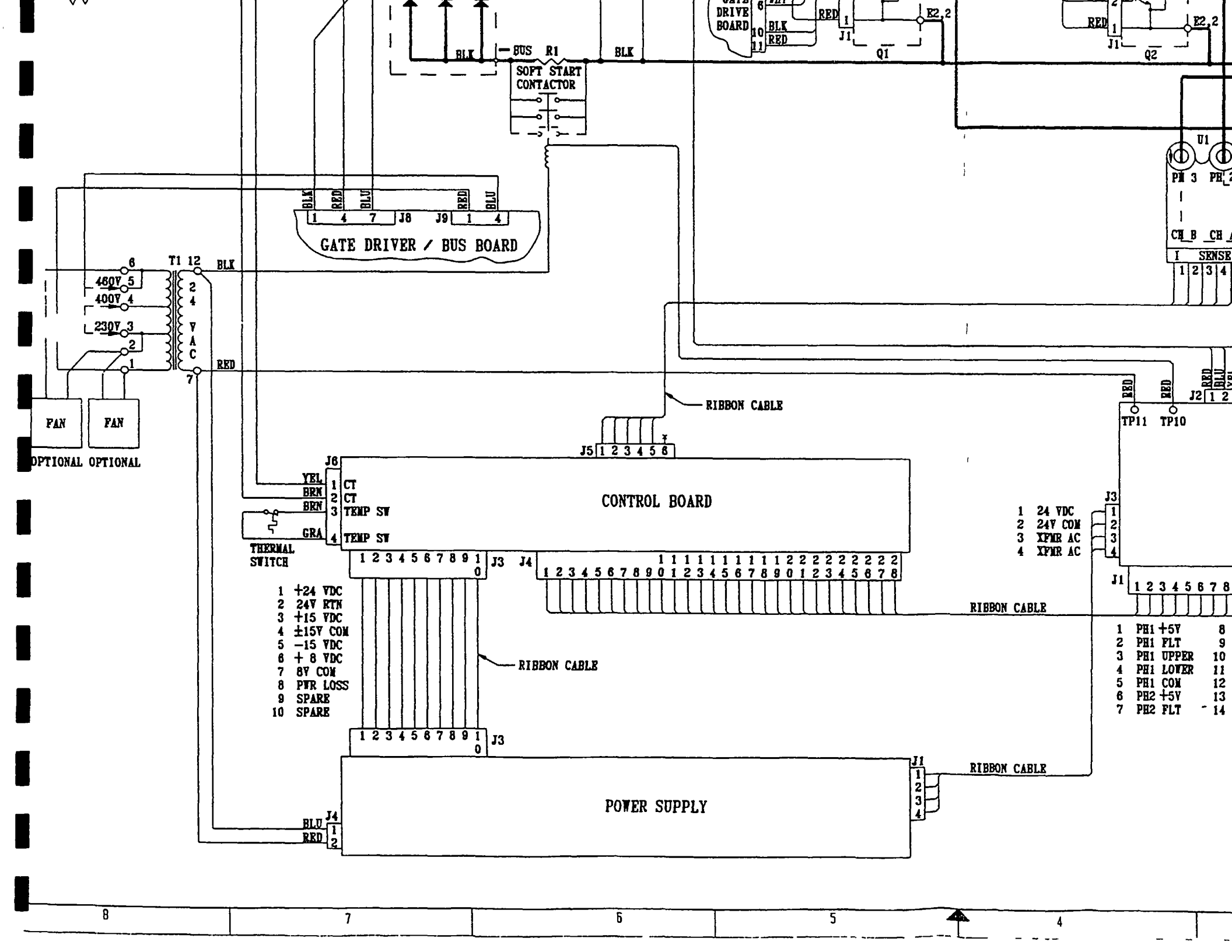
V8014

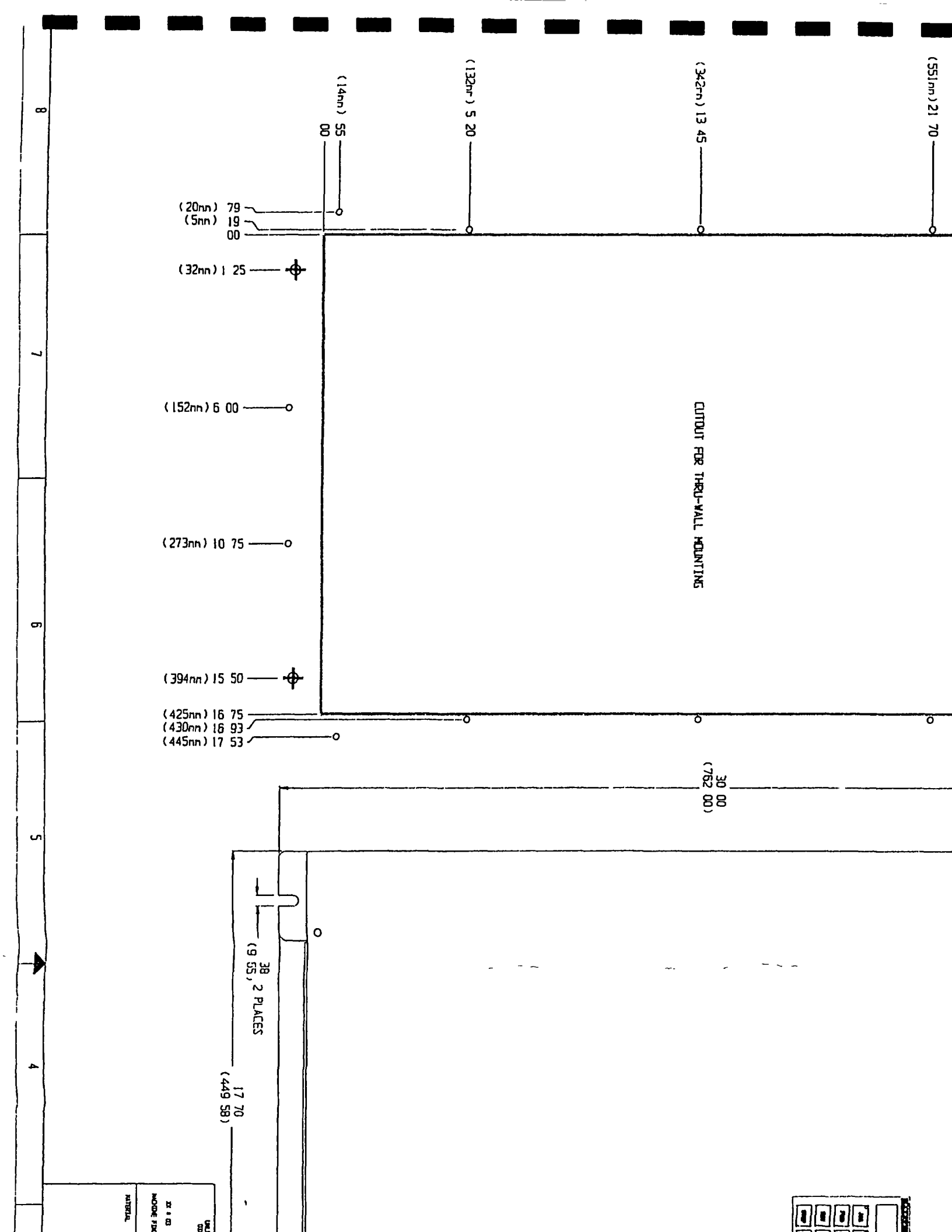
FILE AAA00067587

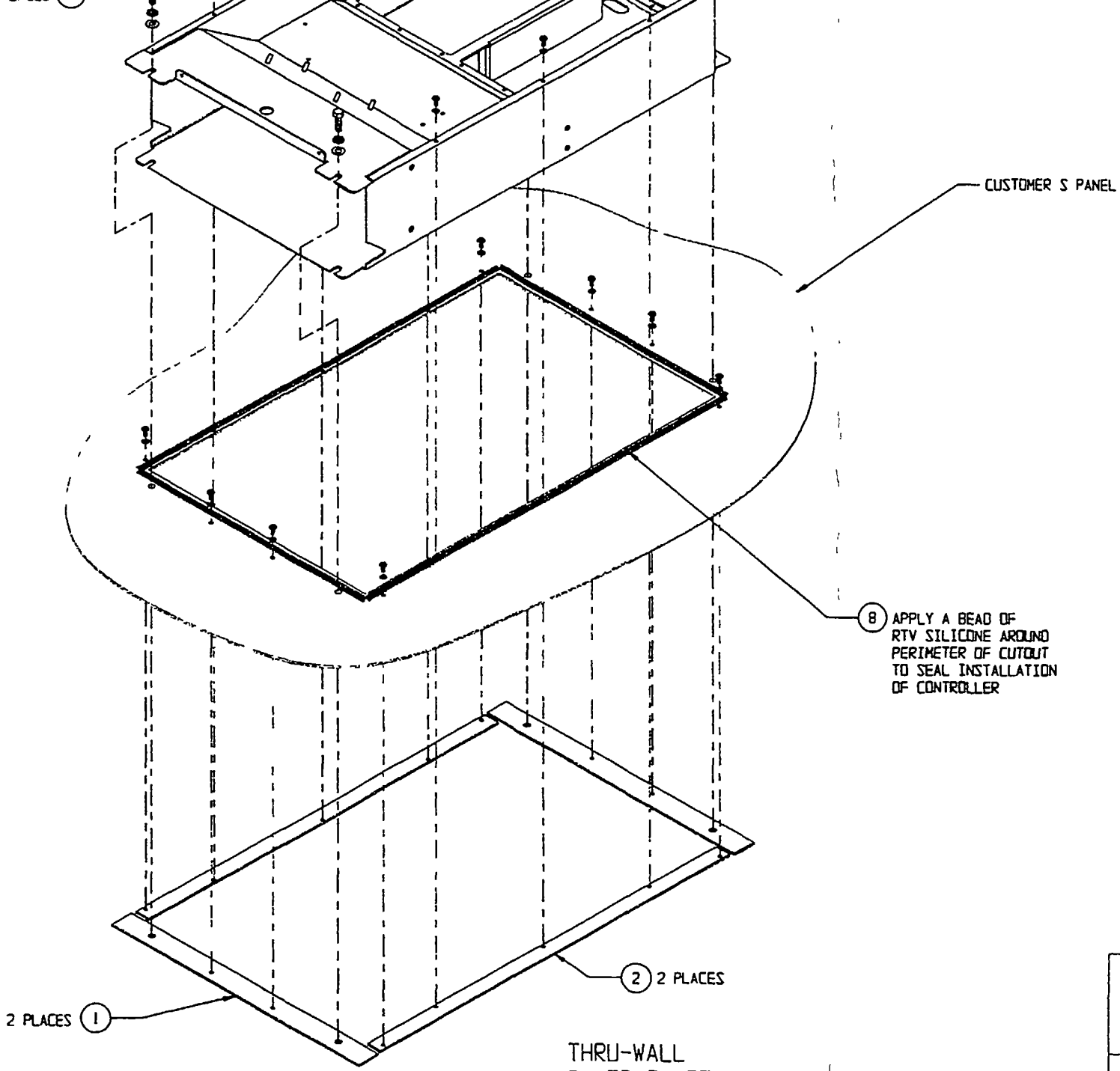
MDL –

MTL –

BALDO


BUS R1
SOFT START CONTACTOR
GATE DRIVER / BUS BOARD
J8
J9
T1
460V 5
400V 4
230V 3
2
1
6
12
2
4
VAC
7
BLK
RED
FAN
FAN
OPTIONAL OPTIONAL
RIBBON CABLE
J5
J6
YEL 1 CT
BRN 2 CT
BRN 3 TEMP SW
GRA 4 TEMP SW
THERMAL SWITCH
CONTROL BOARD
J3
J4
1 +24 VDC
2 24V RTN
3 +15 VDC
4 ±15V COM
5 −15 VDC
6 + 8 VDC
7 8V COM
8 PWR LOSS
9 SPARE
10 SPARE
RIBBON CABLE
POWER SUPPLY
J1
J4
BLU
RED
RIBBON CABLE
1 24 VDC
2 24V COM
3 XFMR AC
4 XFMR AC
1 PH1 +5V 8
2 PH1 FLT 9
3 PH1 UPPER 10
4 PH1 LOWER 11
5 PH1 COM 12
6 PH2 +5V 13
7 PH2 FLT 14
TP11
TP10
U1
Q1
Q2
J2


(14nn) 55 00
(132nn) 5 20
(342nn) 13 45
(551nn) 21 70
(20nn) 79
(5nn) 19
00
(32nn) 1 25
(152nn) 6 00
(273nn) 10 75
(394nn) 15 50
(425nn) 16 75
(430nn) 16 93
(445nn) 17 53
CUTOUT FOR THRU-WALL MOUNTING
30 00 (762 00)
38 (9 55), 2 PLACES
17 70 (449 58)
8
7
6
5
4



THRU-WALL MOUNTING KIT INSTALLATION

SEE PARTS LIST 0083991

8 | 7 | 6 | 5 | 4