$25.00

BALDOR®
MOTORS AND DRIVES

SERIES 14
VECTOR DRIVE
CONTROL

OPERATING & TECHNICAL MANUAL

BEC-914 MARCH, 1992

BALDOR

SERIES 14

AC VECTOR CONTROL

MANUAL 7736-BV

FOR CONTROL MODEL NO.
ZD14XXX

Software Version 1.36
May also be used with 1.31 through 1.35
with modifications per "Software Revisions," page 1-8, 1-9.

03/92

TABLE OF CONTENTS

1. GENERAL INFORMATION

FACTORY ASSISTANCE

Should it be 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

CAUTION

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 motor electrical connection without insuring no high voltage is 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.

WARRANTY

BALDOR warrants that the products sold will be free from defects in material and workmanship and perform to Seller's applicable published specifications for a period of two (2) years from date of shipment from Seller's plant. Seller extends this limited warranty to each buyer of the drive for the purpose of resale and to the original purchaser for use. (Use shall be defined as installation and application of power.) The liability of Seller hereunder shall be limited to replacing or repairing, at its option, any defective units or parts thereof which are returned F.O.B. Seller's plant, Bellevue, Washington. In no event shall Seller be liable for any consequential or incidental damages.

Equipment or parts which have been subject to abuse, misuse, accident, alteration, neglect, unauthorized repair or installation are not covered by warranty. Seller shall make the final determination as to the existence and cause of any alleged defect. No liability is assumed for expendable items such as fuses. No warranty is made with respect to custom equipment or products produced to Buyer's specifications except as specifically stated in writing by Seller in the contract for such custom equipment.

This warranty is the only warranty made by Seller with respect to the goods delivered hereunder, and may be modified or amended only by a written instrument signed by a duly authorized officer of Seller and accepted by Buyer.

Warranty of any product purchased by Seller from others is limited in time and scope to any warranty given Seller by such suppliers.

Except as hereinabove provided, SELLER MAKES NO WARRANTIES, EXPRESS OR IMPLIED, INCLUDING ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.

CONTROL DESCRIPTION

The Baldor Series ZD14 AC flux vector controls are especially adapted for high performance industrial drive systems. They operate directly from three phase 230 or 460 VAC power. They can control a 5 to 75 HP AC induction motor with encoder feedback. Operation on a single phase power source with a 40% reduction in output current is also possible. Outline and mounting dimensions of the control enclosure are specified on drawing B-0019, section 10 of this manual.

Controls rated up to 25 HP @ 230VAC and 40 HP @ 460 VAC consist of the following major elements in a compact enclosed assembly:

1. Mounting base with grounded heat sink, on which are mounted: bus capacitors, three main power transistor pair modules, output current sensing resistors R2 and R3, three phase diode bridge BR1, input filter inductor L1, soft start resistor, soft start bypass SCR module Q5, regenerated energy regulator transistor, and the power terminal block. Units rated over 20 amps rms also have a fan for circulation of cooling air.

2. Base drivers mounted over the three main power transistor modules.

3. Current feedback mod-demod assembly and power supply assembly mounted on the inside surface of the swing out door.

4. Control board mounted inside the control board cover.

5. Keypad-display mounted on control board cover.

Controls rated over 25 HP @ 230 VAC and 40 HP @ 460 VAC consist of the following major elements in an enclosed assembly.

1. Mounting base with grounded heatsink, on which are mounted: bus capacitors, six main power transistor modules, Hall current sensor assembly A4, three diode bridge pairs D1 to D 3, input filter inductor L1, soft start resistor and bypass SCR Q8, regenerated energy regulator transistor Q7, power terminal block and cooling air blower.

2. Base drivers mounted over main power transistor modules.

3. Power supply assembly mounted on inside surface of the swing out door.

4. Control board mounted inside the control board cover.

5. Keypad-display mounted on control board cover.

SPECIFICATIONS

Output Voltage	230, 400, 460 VAC
Output Current	Per Rating Table
Speed loop bandwidth	Adjustable to 60 Hz
Current loop bandwidth	Adjustable to 400 Hz
Maximum output frequency	500 Hz standard
Current ripple frequency	5 KHz standard 10 KHz optional

MOTOR AND ENCODER REQUIREMENT

Motor poles	2, 4, 6, or 8
Incremental encoder	Mounted on motor
Pulses/rev	60 to 9999 selectable
Voltage outputs	2 channel quadrature 5 VDC, differential
Marker pulse	Required for position orientation
Power input	+5 VDC, 300 ma Max.
Maximum frequency	500 KHz

ANALOG AND CONTROL I/O

Buffered speed/torque input	
Common mode rejection	40 db
Full scale range	± 5 VDC, ± 10 VDC, 4-20 ma
Selectable resolutions	12 bits + sign below ±1V 9 bits + sign above ±1V 2.6 ms update (1.3 ms in torque mode)
Other analog inputs	2 assignable
Full scale range	± 5.0 V
Resolution	9 bits + sign
Update rate	2.6 ms
Analog outputs	2 assignable
Full scale range	0 to + 5 VDC
Resolution	8 bits
Update rate	2.6 ms
Opto-isolated logic inputs	5 assignable
Rated voltage	10 to 30 VDC
Input impedance	6.8K ohms
Update rate	8 ms
Opto-isolated logic outputs	3 assignable
ON state	2.0 VDC @ 75 ma Max
OFF state	30 VDC Max
Update rate	8 ms

RS232C SERIAL PORT

Selectable Modes	Computer Interactive terminal, CNC/PLC supervisor
Functions	Parameter load/display Digital control Auto tuning

KEYPAD DISPLAY

Keys	Up, Down, Enter/Reset
Display	4 character LED
Functions	Diagnostic display Digital speed control Parameter load/display Auto-tuning

SELECTABLE OPERATING MODES

Front panel potentiometer speed control
Front panel digital speed control
Analog speed or torque control
Speed control with 4 parameter sets
Up to six digital preset speeds
Homing (Orient to marker)
RS232C serial control

DIAGNOSTIC INDICATIONS

Ready
On
Control power failure
Watchdog timer
Overvoltage
Undervoltage
Overtemperature (motor or control)
Overload
Over speed
Instantaneous over current or ground fault (each phase)

SERVICE CONDITIONS

Rated Input Voltages	3 phase 50/60 Hz
230 VAC Models	190 to 253 VAC
400 VAC Models	330 to 440 VAC
460 VAC Models	380 to 506 VAC
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

RATINGS

VAC	CONSTANT TORQUE RATINGS				CATALOG NO.	SIZE	VARIABLE TORQUE RATINGS	
	MAX HP	AMPS CONT	AMPS 1 MIN	AMPS 3 SEC			MAX HP	AMPS CONT
230	5	18	27	35	ZD14205-E	A	7.5	25
	7.5	25	37	50	ZD14207-E	A	10	35
	10	35	52	70	ZD14210-E	A	15	45
	15	50	75	100	ZD14215-E	A	20	55
	25	68	102	135	ZD14225-E	A	25	70
	40	104	156	200	ZD14240-E	C	50	130
	50	135	202	270	ZD14250-E	C	60	145
460	5	10	15	20	ZD14405-E	A	7.5	15
	10	18	27	35	ZD14410-E	A	15	25
	15	25	37	50	ZD14415-E	A	25	35
	25	35	52	70	ZD14425-E	B	30	45
	30	45	68	100	ZD14430-E	B	40	55
	50	70	102	135	ZD14450-E	C	60	80
	75	100	150	200	ZD14475-E	C	100	125

Drives are UL Listed - File No. 6J32.

KEYPAD - DISPLAY FUNCTIONS

The keypad and display provide convenient front panel operation, monitoring and setup of the drive.

FOUR CHARACTER DISPLAY

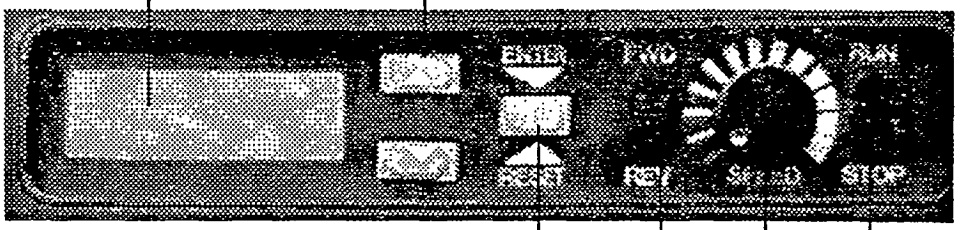
- Displays drive speed, load, frequency or voltage during operation.
- Displays command speed in front panel digital control mode
- Displays drive status

rdy	= Ready to Operate	PH-1	= Output Phase 1 Fault
OH E	= External (Motor) Overheat	PH-2	= Output Phase 2 Fault
OH C	= Controller Overheat	PH-3	= Output Phase 3 Fault
OL	= Current Overload	F.Err	= Following Error Fault
OSP	= Overspeed	I LO	= Torque Proving Fault
dcHI	= DC Bus Overvoltage	PAr	= Invalid Parameters
dcLO	= DC Bus Undervoltage	uP	= Microprocessor Fault
15dc	= 15 Volt supply Fault	Prog	= Eprom Fault

- Displays parameter number and value during setup
- Displays Good/Fail during auto-tuning

UP & DOWN PUSHBUTTONS

- Set front panel mode command speed
- Select display output during operation
- Select operating mode, parameter settings and optional inputs and outputs during setup



ENTER/RESET PUSHBUTTON

- Enters selected speed command input or display during operation
- Enters operating mode and parameter during setup
- Starts auto-tuning tests in Auto-Tune mode
- Resets drive faults

FWD/REV SWITCH

- Selects direction of motor rotation in front panel control modes only

SPEED POT

- Sets motor speed in front panel potentiometer input control mode only

RUN/STOP SWITCH

- Active in front panel control modes only

USING THE KEYPAD-DISPLAY

"Parameters" numbered 00 through 99 define the operating selections and adjustments which set up the drive for a particular application. The three-button keypad allows you to display any drive parameter in the Operate (OP) mode or display and change any drive parameter in the Parameter (Pr) mode. The displayed parameter number is indicated by:

OPxx	in Operate mode
Prxx	in Parameter mode

When power is applied, the motor speed, frequency, current or voltage as selected will be displayed, unless a fault condition exists. A fault will cause one of the fault codes on the facing page to be displayed.

SETTING THE DISPLAY MODE

Push ENTER to obtain any OPxx .
Push ▲ or ▼ to obtain OP01 .
Push ENTER to display the code for the present display.
Push ▲ or ▼ to display the code for the variable to be displayed.

- 0 = Speed in RPM
- 1 = Current in Amps RMS
- 2 = Frequency in Hertz
- 3 = Output Voltage in Volts

Push ENTER to select, OP01 will appear.
Push ▼ to obtain OP00 .
Push ENTER to display the selected output.

DISPLAYING A PARAMETER IN OPERATE MODE

Push ENTER if needed to display any OPxx .
Push ▲ or ▼ to obtain desired parameter number (e.g. OP12).
Push ENTER to display the parameter value (e.g. 1024).

DISPLAYING THE FAULT LOG

The drive retains up to 15 previous faults for display upon operator command. To view the fault log:
Push ENTER if needed to display any OPxx .
Push ▲ or ▼ to obtain OP02 .
Push ENTER to display present status (e.g. rdy). Push ▲ to display the previous fault (e.g. OSP).
Repeat ▲ to display each of 13 prior faults successively.
Push ENTER to return to OP02 .

ENTERING AND EXITING THE PARAMETER MODE

Push ENTER if needed to display any OPxx .
Push ▲ to obtain OP99 .
Push ENTER to obtain 9999 .
Push ▼ to obtain your previously selected security code, 9999 is preset at the factory.
Push ENTER to obtain Pr99 .

All parameters may now be displayed or changed, even with drive operating.

Exit the parameter mode by obtaining Pr99 .
Push ENTER to obtain your security code.
Push ENTER again to obtain OP99 .

CHANGING A PARAMETER IN THE PARAMETER MODE

Push ENTER if needed to display any Prxx .
Push ▲ or ▼ to obtain the desired parameter number (e.g. Pr84).
Push ENTER to display the present parameter value.
Push ▲ or ▼ to obtain the desired parameter value.
Push ENTER to enter the displayed value. The parameter number will be re-displayed.

SOFTWARE REVISIONS

This manual has been prepared for software version 1.36. It may also be used with previous versions 1.31 through 1.35 with the following changes:

1.31 Home command not operable in RS232 mode.
Analog output 16, Bipolar Speed not available
Keypad power-up 8.8.8.8 per page 2-12 doesn't occur.
Baldor 25 HP rating listed as 20 HP
Opto-isolated outputs 9 & 10, "Drive On" and "Input Direction" not available
"Following Error" cannot be selected with Pr29.
Pr24, 25 and 26 Selection 7- Following error causes drive fault with F. Err display when
At-Speed tolerance Pr42 is exceeded.
OL (Inverse Time Overload) not operational.
Additional limitations per 1.34 below.

1.32 Baldor 25 HP rating listed as 20 HP
Opto-isolated outputs 9 & 10, "Drive Enabled" and "Input Direction" not available
"Following Error" cannot be selected with Pr29.
Pr24, 25 and 26 Selection 7- Following error causes drive fault with F. Err display when
At-Speed tolerance Pr42 is exceeded.
OL (Inverse Time Overload) not operational.
Additional limitations per 1.34 below.

1.33 OL (Inverse Time Overload) not operational.
Additional limitations per 1.34 below.

1.34 Speed and Torque command inputs applied through RS232 input are not limited to selected Max Speed (Pr13) and Current Limit (Pr30) values.
"Control E" RS232 input will enable drive operation without Run input J1-10 closed.

Upload and Download of files through RS232 does not require security code.
Security code not listed in the upload file.
Overload Foldback and Torque Rate Limiting selections not available with Pr29.
Operating Mode 8 not available.
Rate controller integral gain (Pr 85) is automatically reduced to zero above Constant Power Speed (Pr 44), which results in speed droop with load.
Selection of S Curve Time (Pr58) greater than zero causes both Accel Time and Decel Time to be set to the (Pr56) Time.
Voltage output may not reach maximum available and loss of current control may occur above Constant Power Speed (Pr 44).
Mode 2-Direction not reversible from front panel switch.
Digital display of PWM frequency is 0 or 1 rather than 2500 or 5000.

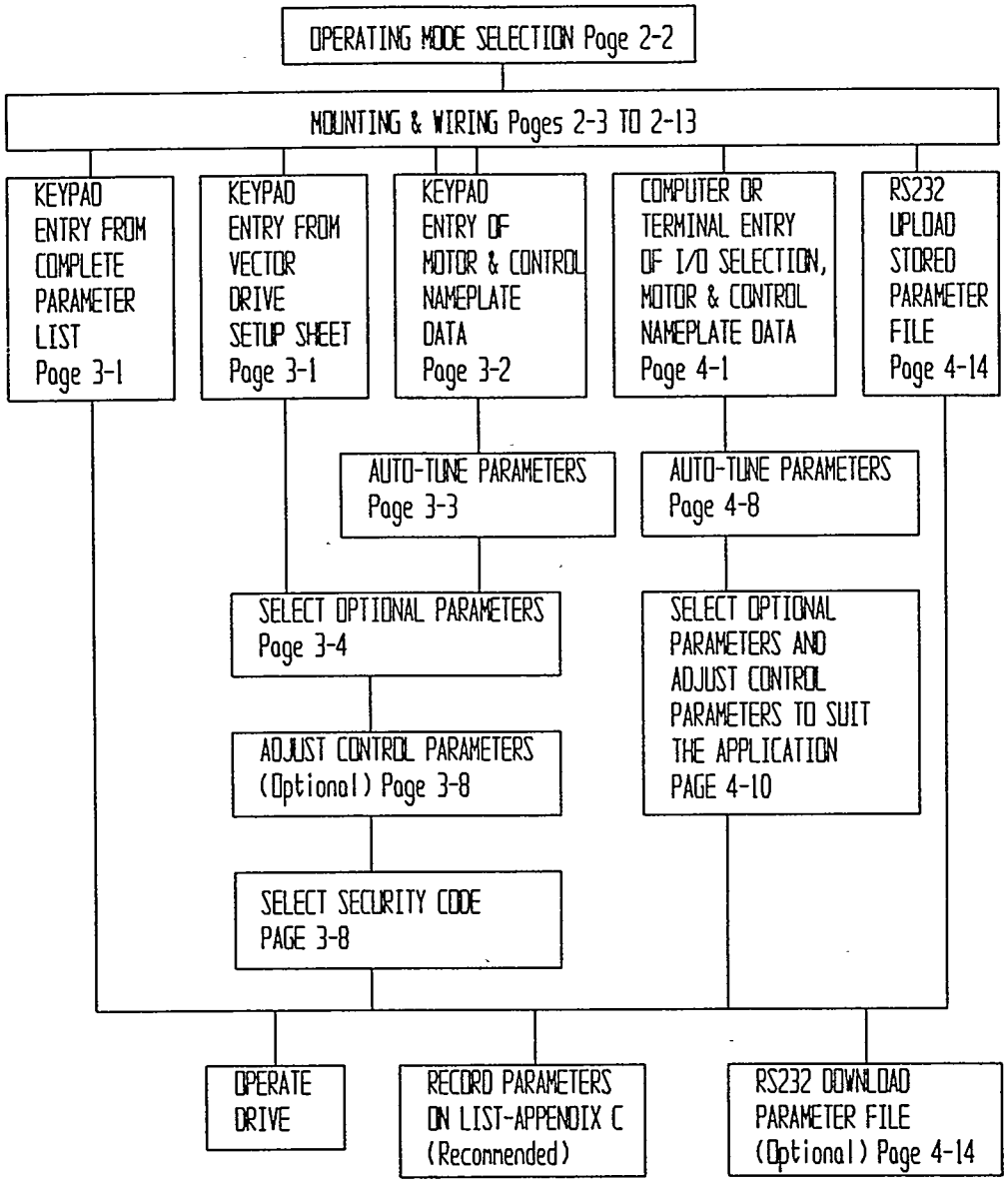
1.35 "S-Curve" performance not optimized for long Accel and Decel times.
Less than optimal speed regulation above base speed.
Changing Pr29 from the keypad does not allow the selection of all possible choices.
BALDOR ZD14425 model number not available.
Direct entry to RS232 mode from the Password Entry Screen not available.
"Control E" RS232 modes "R" (status) command will not allow individual status selections. Sequence error in Default calculation under the control N menu.

2. INSTALLATION AND STARTUP

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.

SUMMARY

The following flow diagram is a guide to the available methods for setting up the control to match the motor and the intended application. Manual pages are listed for each section of the setup procedure.



OPERATING MODE SELECTION (Parameter Pr14)

Select one of the eight operating modes to suit your application. Refer to Figures 1 through 6 for typical power and control connections for each mode. Refer to Figure 7 for use of contactor to provide positive disconnection of power from the motor. In a later step of the setup procedure parameter (Pr14) will be set to the code defined below.

An RS232 control mode is also provided and may be used with any of these basic operating modes. See page 4-16 for RS232 command set.

CODE OPERATING MODE

0 = FRONT PANEL POTENTIOMETER SPEED CONTROL - Drive operates from front panel speed potentiometer, Run/Stop and Fwd/Rev switches. This mode also includes logic inputs for Forward/Reverse selection, three digitally preset speeds and homing to an index mark. See Figure 1.

1 = FRONT PANEL KEYPAD ENTERED SPEED CONTROL - Drive operates from Keypad selected speed command (Pr 03) with resolution of 1.0 RPM and Front panel Run/Stop and Fwd/Rev switches. This mode also includes logic inputs for Forward/Reverse selection, 3 preset speeds and homing to an index mark. See Figure 1.

2 = FRONT PANEL INCREMENT/DECREMENT SPEED CONTROL - Drive increments speed upward at parameter (Pr 56) rate in response to front panel Up input, decrements speed at parameter (Pr52) rate in response to Down input. Front Panel Run/Stop and Fwd/Rev switches select Run and direction of rotation. This mode also includes three preset speeds and homing to an index mark See Figure 1.

3 = UNIPOLAR ANALOG SPEED CONTROL - Front panel is disabled. Drive follows speed command from selectable 0-10V, 0-5V, 4-20 mA analog input with logic inputs for Run/Stop, Forward/Reverse selection, Home to an index mark, Fault Reset, and one digitally preset speed. (Preset Speed #1) See Figure 2.

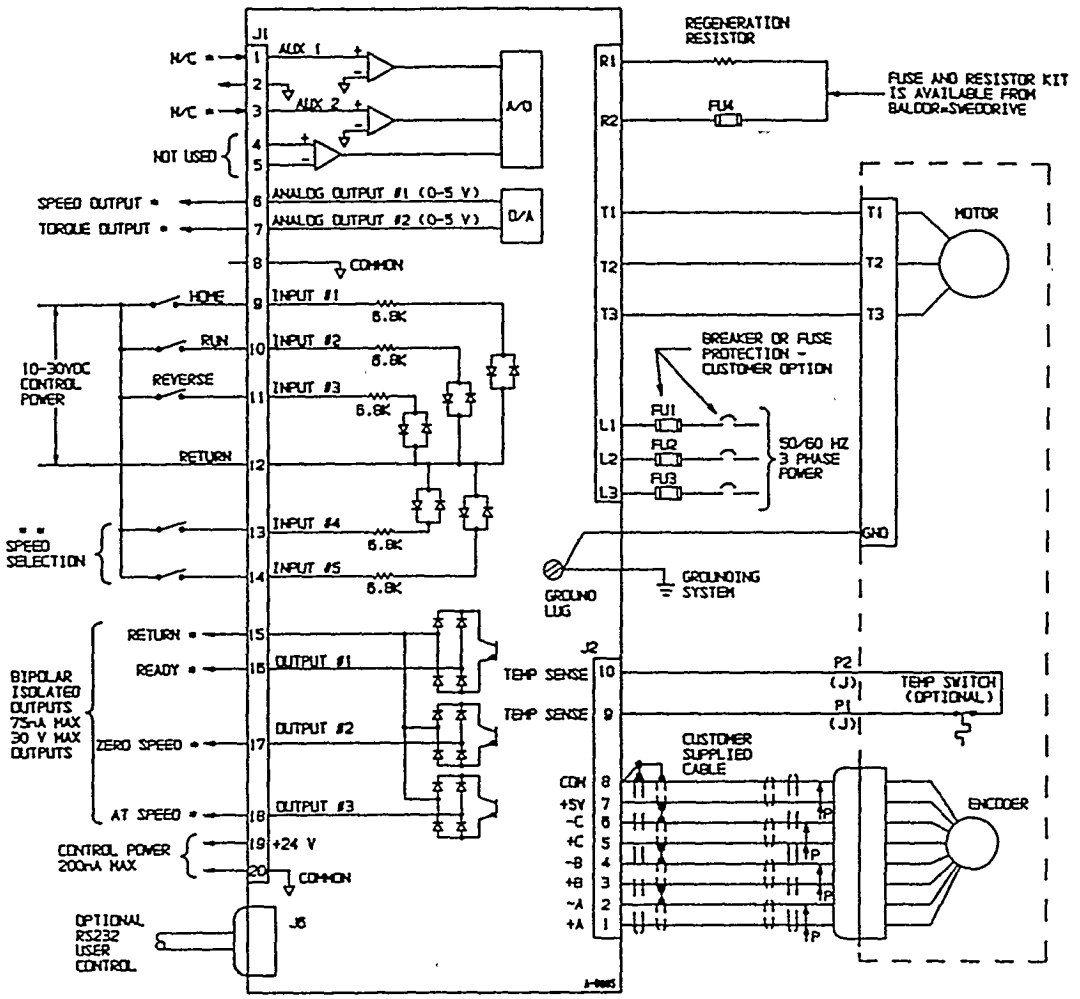
4 = BIPOLAR ANALOG SPEED OR TORQUE CONTROL - Front panel is disabled. Drive follows command from selectable ±5V or ±10V analog input with logic inputs for Forward and Reverse Enable (provides simple travel limit protection), Home, Fault Reset and Speed or Torque Control selection. See Figure 3.

5 = ANALOG SPEED CONTROL WITH FOUR PARAMETER TABLES - Front panel is disabled. Drive follows selectable ±5 or ±10V analog speed command input with logic inputs for Run, Home, Fault Reset and four complete parameter tables. This mode allows setup for multiple motors, motor winding connections or mechanical ratios. See Figure 4.

6 = SIX PRESET SPEED CONTROL - Front panel is disabled. Drive operates in response to logic inputs for Run, Forward/Reverse selection, Fault Reset and six digitally preset speeds plus zero speed (holds position). See Figure 5.

7 = Not used.

8 = BIPOLAR ANALOG SPEED OR TORQUE CONTROL WITH RUN/STOP - Front panel is disabled. Drive follows command from selectable ±5V or ±10V analog input with logic inputs for Run/Stop, Home, Fault Reset, Speed or Torque Control selection and one digitally preset speed. See Figure 6.



* All J1 connections are optional, the drive will operate in the front panel mode without J1. Programmable inputs and outputs are shown with typical assignments.

* * SPEED SELECTION

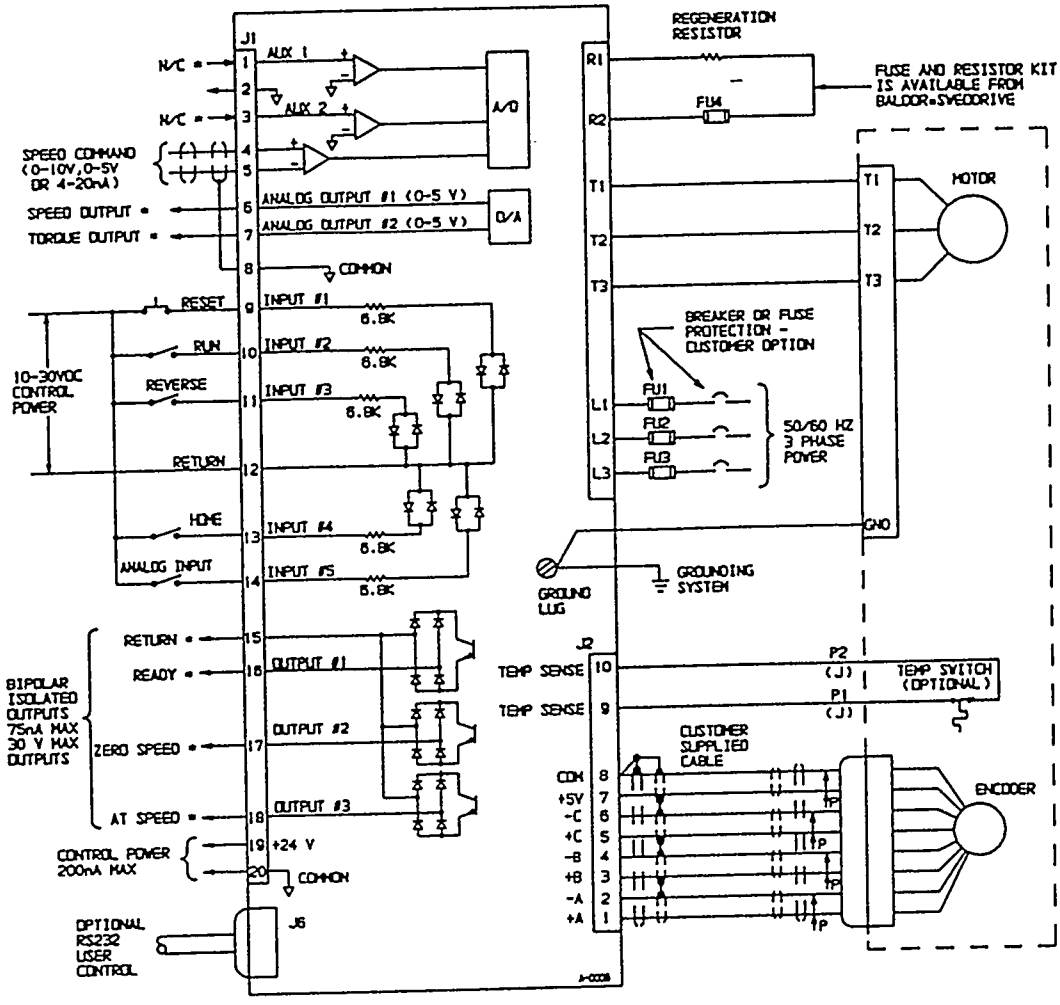
J1-13	J1-14	SPEED COMMAND
OPEN	OPEN	FROM KEY PAD
OPEN	CLOSED	PRESET SPEED 1 (Pr50)
CLOSED	OPEN	PRESET SPEED 2 (Pr51)
CLOSED	CLOSED	PRESET SPEED 3 (Pr52)

J1-9 OPEN for speed control, CLOSED to stop motor at predefined HOME position.

J1-10 OPEN causes motor to coast to a stop when front panel RUN/STOP is switched to STOP, CLOSED causes regenerative stop and hold position when RUN/STOP switched to STOP. This input does not affect operation when front panel Run/Stop is in the Run position.

J1-11 OPEN allows front panel FWD/REV to select direction of motor rotation, CLOSED causes reverse rotation.

FIGURE 1
MODES 0, 1 & 2 INTERCONNECT DIAGRAM
FRONT PANEL OPERATION



•Programmable inputs and outputs. Typical assignments shown.

J1-9 OPEN to run, CLOSE to reset fault.

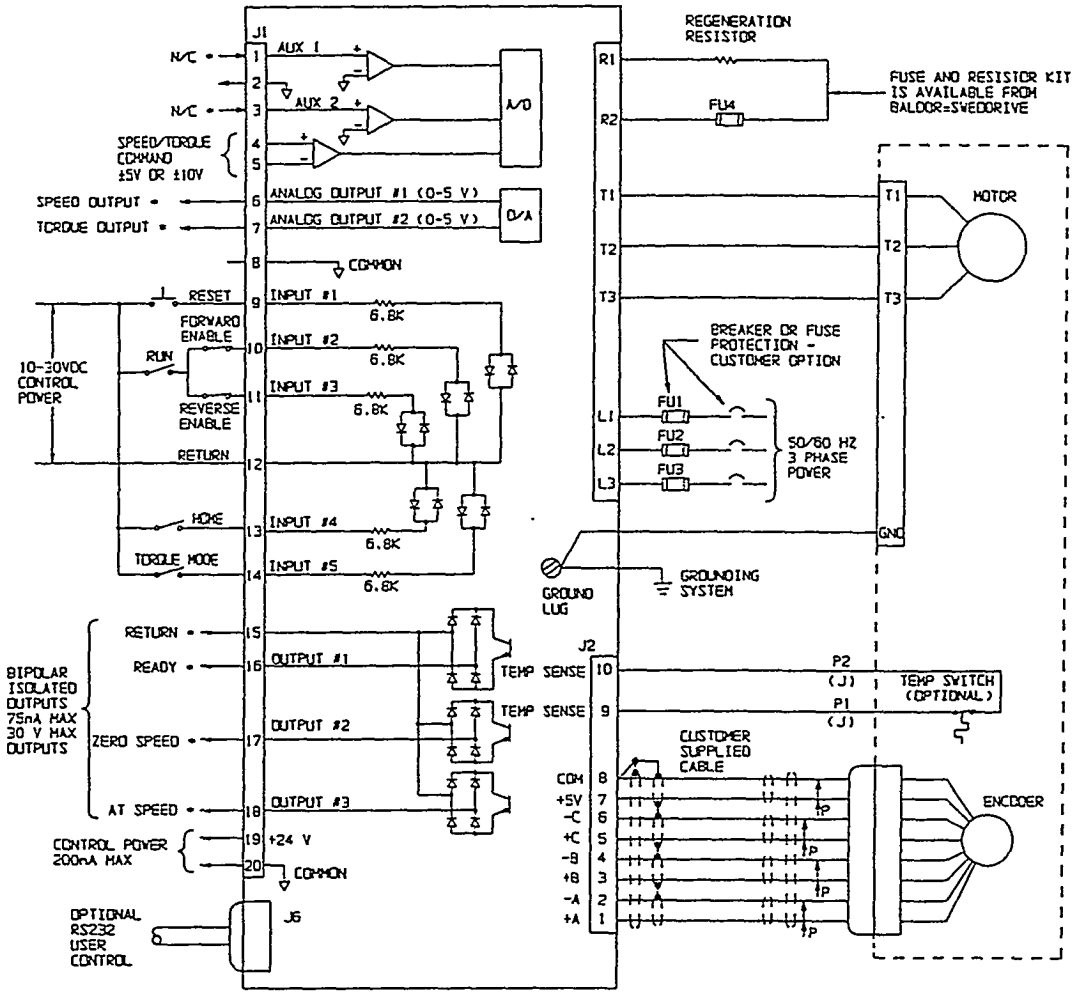
J1-10 OPEN disables drive & motor coasts to a stop, CLOSED allows current to flow in motor and produce torque.

J1-11 OPEN for forward motor rotation, CLOSED for reverse rotation.

J1-13 OPEN for speed control, CLOSED to stop motor at predefined HOME position.

J1-14 OPEN to select preset speed #1, (Pr50) CLOSED to select analog speed command input.

FIGURE 2
MODE 3 INTERCONNECT DIAGRAM
UNIPOLAR ANALOG INPUT SPEED CONTROLLER



* Programmable inputs and outputs. Typical assignments shown.

J1-9 OPEN to run, CLOSE to reset fault.

J1-10 CLOSED allows forward speed command and torque in speed mode, forward torque in torque mode.

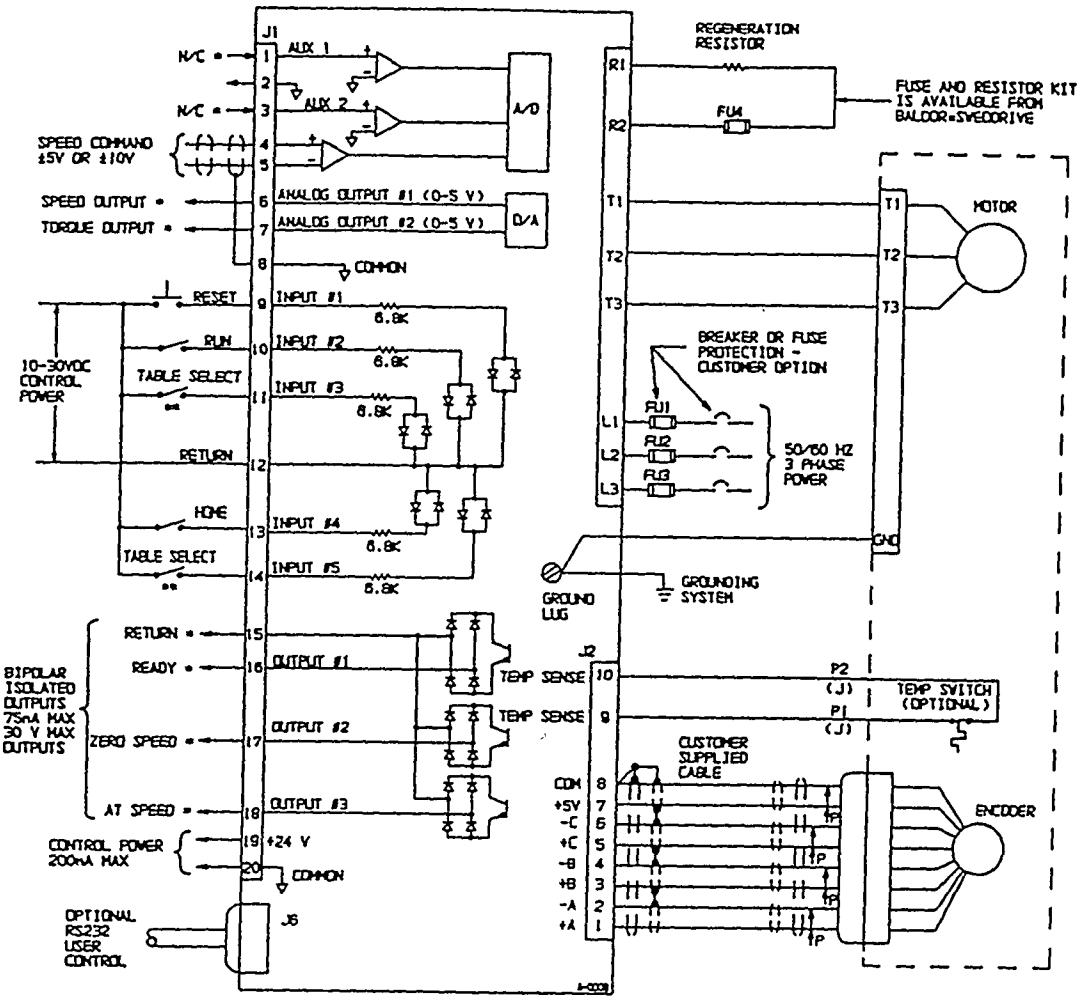
J1-11 CLOSED allows reverse speed command and torque in speed mode, reverse torque in torque mode.

J1-10 & 11 CLOSED allows bidirectional speed and torque. Open disables drive and motor coasts to stop.

J1-13 OPEN for speed or torque control, CLOSED to stop motor at predefined HOME position.

J1-14 OPEN for speed control mode, CLOSED for torque control mode.

FIGURE 3
MODE 4 INTERCONNECT DIAGRAM
BIPOLAR ANALOG INPUT SPEED OR TORQUE CONTROLLER



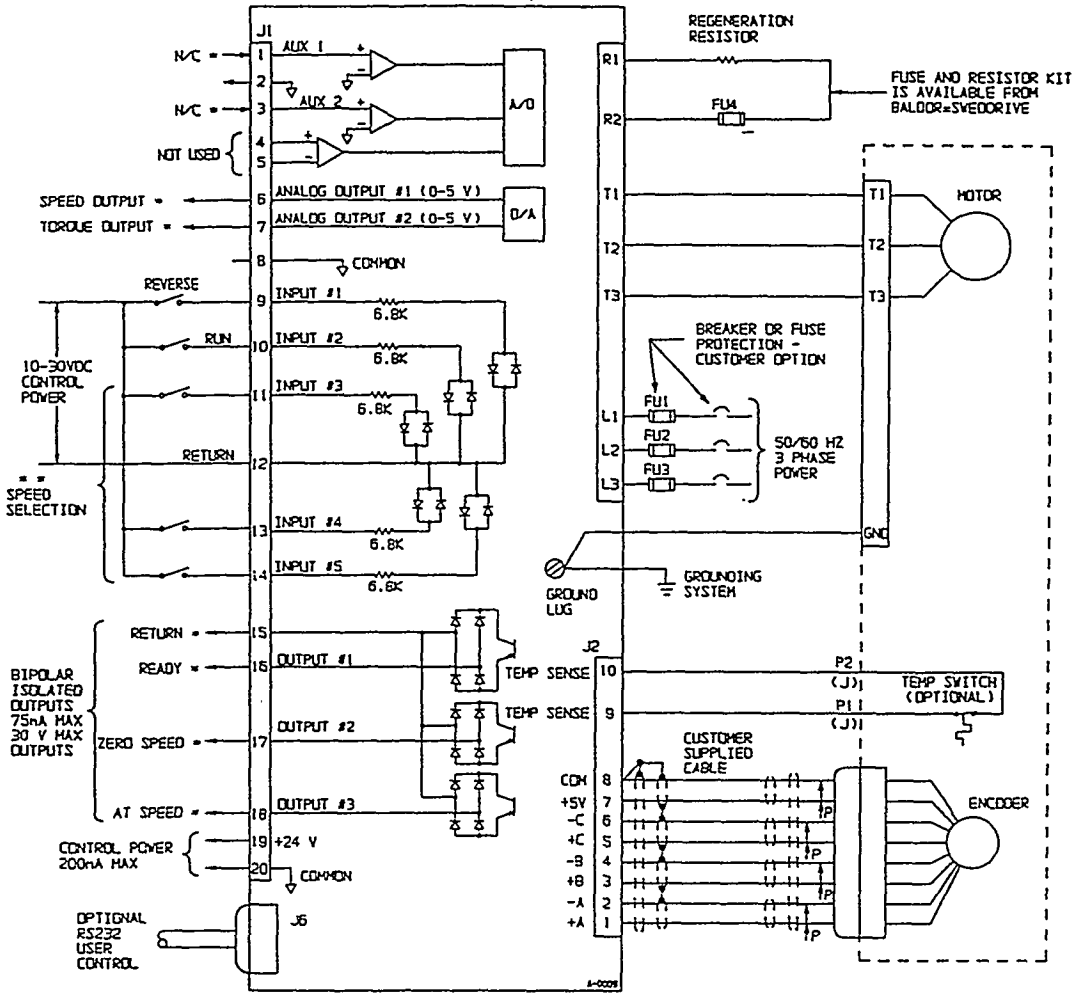
*Programmable inputs and outputs. Typical assignments shown.

**TABLE SELECT

J1-11	J1-14	Parameter Table
OPEN	OPEN	0
OPEN	CLOSED	1
CLOSED	OPEN	2
CLOSED	CLOSED	3

J1-9	OPEN to run, CLOSE to reset fault.
J1-10	OPEN disables drive, motor coasts to a stop, CLOSED allows current to flow in motor and produce torque.
J1-13	OPEN for speed control, CLOSED to stop motor at predefined HOME position.
J1-11&14	Select parameter table.

FIGURE 4
MODE 5 INTERCONNECT DIAGRAM
BIPOLAR ANALOG INPUT SPEED CONTROLLER WITH 4 PARAMETER TABLES



* * SPEED SELECTION

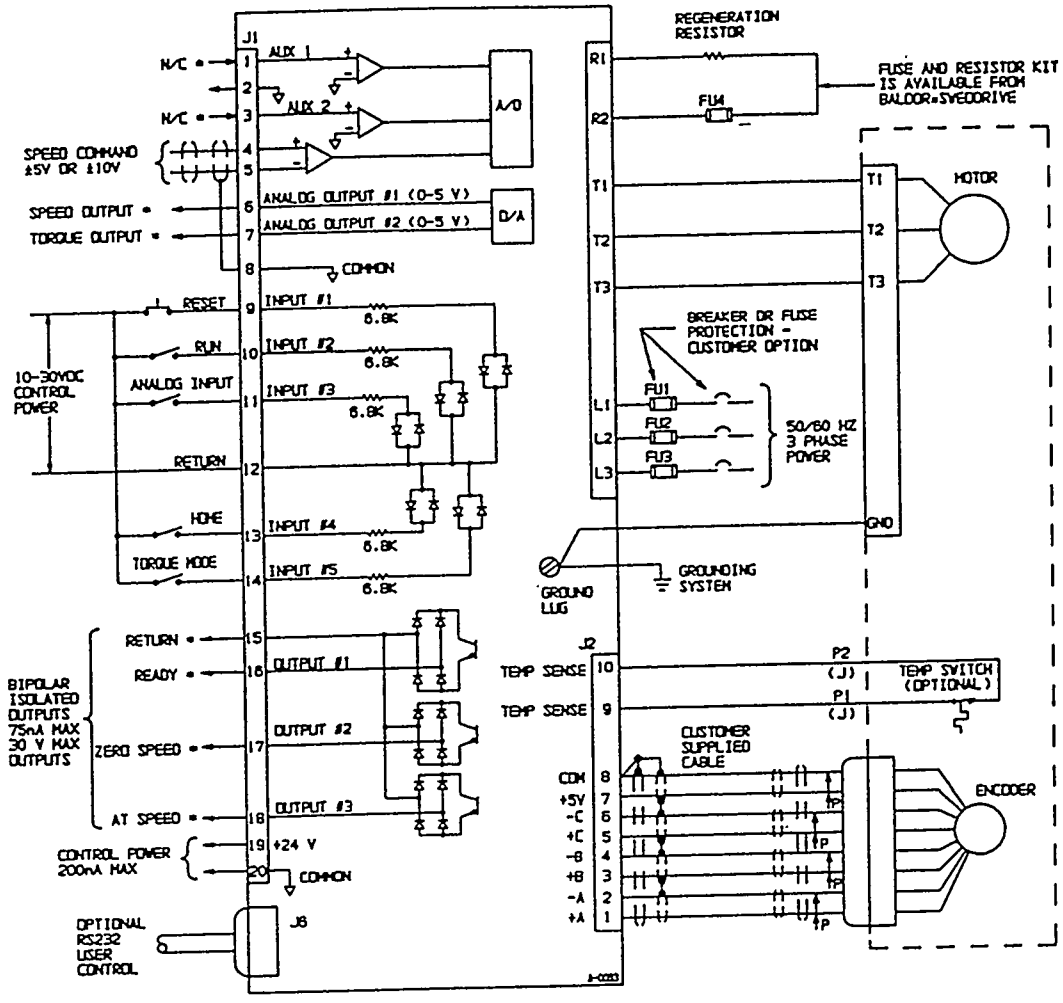
J1-11	J1-13	J1-14	FUNCTION
OPEN	OPEN	OPEN	STOP
OPEN	OPEN	CLOSED	PRESET SPEED 1 (Pr50)
OPEN	CLOSED	OPEN	PRESET SPEED 2 (Pr51)
OPEN	CLOSED	CLOSED	PRESET SPEED 3 (Pr52)
CLOSED	OPEN	OPEN	PRESET SPEED 4 (Pr53)
CLOSED	OPEN	CLOSED	PRESET SPEED 5 (Pr54)
CLOSED	CLOSED	OPEN	PRESET SPEED 6 (Pr55)
CLOSED	CLOSED	CLOSED	RESET

*Programmable inputs and outputs. Typical assignments shown.

J1-9 OPEN for forward motor rotation, CLOSED for reverse rotation.

J1-10 OPEN disables drive, motor coasts to a stop; CLOSED allows current to flow in motor and produce torque.

FIGURE 5
MODE 6 INTERCONNECT DIAGRAM
SPEED CONTROLLER WITH 6 PRESET SPEEDS



*Programmable inputs and outputs. Typical assignments shown.

J1-9 OPEN to run, CLOSE to reset fault.

J1-10 OPEN disables drive & motor coasts to a stop, CLOSED allows current to flow in motor and produce torque.

J1-11 OPEN to select preset speed #1 when in speed mode, CLOSED selects analog speed command.

J1-13 OPEN for speed or torque control, CLOSED to stop motor at predefined HOME position.

J1-14 OPEN for speed control, CLOSED for torque control.

FIGURE 6
MODE 8 INTERCONNECT DIAGRAM
BIPOLAR ANALOG SPEED OR TORQUE CONTROL WITH RUN/STOP

MOUNTING (See Drawing B-0019)

These controls are wall mounting NEMA 1 enclosed. Mount in a clean dry area 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 drawing B-0019 in section 10. Note that both power and signal connections are made at the top of the control. Provide access to the front of the enclosure to adjust parameters and to observe indicators. Allow room for swinging the hinged circuit board panel and power base cover out to gain access to the power components.

MAIN CIRCUIT WIRING

All wiring shall be in accordance with the National Electric Code and applicable local codes. Install wiring as shown in the appropriate interconnect diagram Figure 1 through 6 for your selected mode of operation per page 2-2. External or remote motor overload protection must be provided in accordance with the National Electrical Code or equivalent.

This control 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 section 5 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 nominal 230 or 460 VAC line-line three phase power or single phase power. 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.

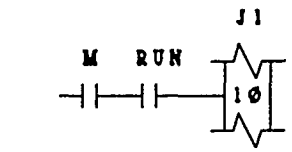
Wire the three phase motor stator to control terminals T1, T2 and T3 using appropriately sized wire per table, Section 7. Connect the control to the motor either directly or through a contactor as shown in Figure 7. A motor circuit contactor is recommended whenever a positive disconnection must prevent motor motion which could pose a safety hazard to personnel or equipment.

Ground both the chassis ground lug and motor frame to machine or plant ground. Use the same size wire used for the AC connections.

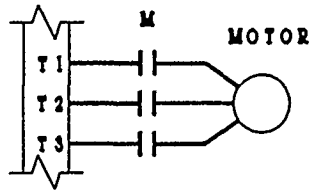
These controls include an internal resistor rated to absorb 20% of the motor HP rating as a minimum during short deceleration periods. Continuous ratings of these resistors are:

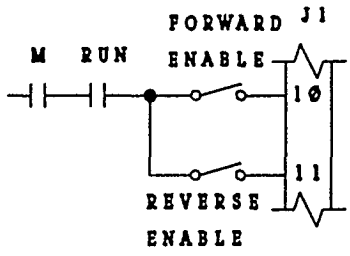
Drives to 20 HP	350 watts
Drives to 40 HP	700 watts
Drives to 75 HP	1050 watts

High inertia and overhauling loads require an external regeneration resistor with suitable fuse or breaker protection. Minimum resistor resistance is limited by the regeneration capacity of the drive. Dissipation rating of the resistor must be selected to suit the average regeneration of overhauling load. The protective fuse or breaker for the regen resistor must be rated at 400 VDC minimum for 230V drives and 800 VDC minimum for 460 V drives. It must be of sufficient capacity to interrupt a continuous connection of the resistor across the dc bus, should a control failure occur. Baldor Sweodrive supplies several kits for this purpose, see Section 8 for available regeneration resistors. Connect regeneration resistor and associated fuse or breaker between control terminals R1 and R2 after removing wires to internal regeneration resistors.

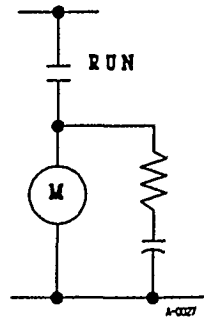


J1-10 CONNECTION FOR MODES 0,1,2,3,5,6 & 8



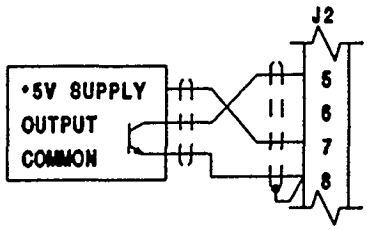


J1-10 & 11 CONNECTIONS FOR MODE 4

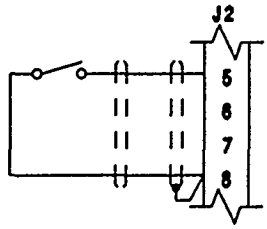


Open Run input to J1 at least 20 msec before main M contacts to prevent arcing at contacts. This greatly increases contactor life and allows use of IEC rated contactors.

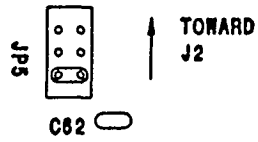
TYPICAL CONNECTIONS FOR OUTPUT CONTACTOR
FIGURE 7



5VDC PROXIMITY SENSOR



LIMIT SWITCH (OPEN AT HOME)



INSTALL CONTROL BOARD JP5 JUMPER WHEN OPEN COLLECTOR OUTPUT PROXIMITY SENSOR OR LIMIT SWITCH AS SHOWN IS USED.

TYPICAL HOME OR ORIENT SWITCH CONNECTIONS
FIGURE 8

ENCODER AND MOTOR THERMAL SWITCH WIRING (J2)

The encoder and motor thermal switch are connected to plug-in terminal strip J2. When a motor thermal switch is available, connect with twisted pair to J2-9 & 10 per figure 1 through 6. If not used, install jumper J2-9 to J2-10.

Encoder wiring must be in twisted shielded pairs per Figures 1 through 6, #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 (50pf/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 output.

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

NOTE: Encoder wiring must be segregated 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.

Differential inputs from 5VDC encoder as shown in Figures 1 to 6 are highly recommended for best noise immunity. If only open collector non-differential encoder signals are available, connect these to +A, +B and +C on the plug-in terminal strip J2 and install jumpers on all three positions of JP5 (near terminal strip J2). The drive is shipped without these JP5 jumpers installed, placing it in the differential encoder input mode.

NOTE: Contact factory if encoder output has any connections (eg, a pull-up resistor or high voltage line driver) to voltage higher than +5VDC. Special connections are required to prevent damage to the encoder input circuit when this type of encoder is used.

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 C (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 C channel. Wire non-differential solid state switch or limit switch per Figure 8 and install JP5 jumper as shown in Figure 8.

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.

CONTROL WIRING (J1)

All user control connections are made to the flux-vector control board plug-in terminal strip J1. This strip contains chassis ground referenced analog I/O circuits, opto isolated discrete I/O circuits and a chassis ground referenced +24 VDC control supply.

The opto-isolated inputs will operate with either positive or negative polarity inputs of 10 to 30 VDC. All switches shown in Figures 1 through 5 may be replaced by static logic outputs from a PLC, CNC or computer. They can be powered by an external supply or the internal supply available at J1-19 and 20. **DO NOT GROUND J1-19 OR CONTROL MAY BE DAMAGED.**

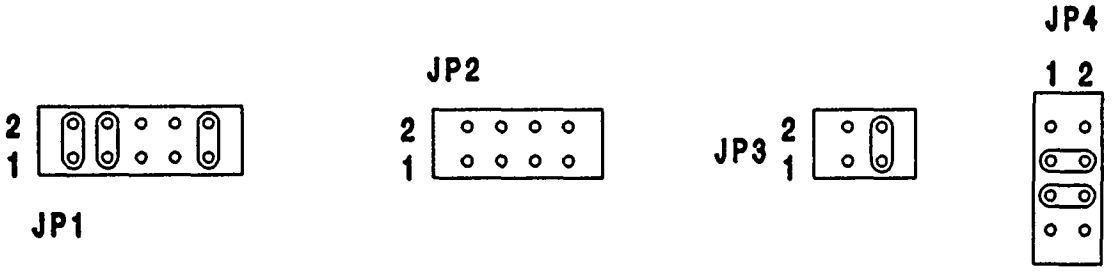
The opto-isolated outputs will either sink or source up to 75 ma of current. Maximum On state voltage is 2.5 VDC (Not TTL compatible). These outputs can be powered from an external supply or the internal supply to drive static logic, relays or lamps within their rating.

The analog input is applied at terminals J1-4 to J1-5. This input is buffered to provide 40 db minimum 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.

Make control connections per the appropriate Figure 1 through 6 for your selected operating mode.

CONTROL BOARD JUMPER AND DIP SWITCH SELECTION

The only user selectable jumper is JP5 located near connector J2. The drive is shipped without these jumpers installed. Install jumpers in all three positions for single ended encoder signals (differential inputs are highly recommended). Install JP5 jumper per Figure 8 for single ended Home or Orient switch input. DO NOT CHANGE JUMPERS JP1 TO JP4 FROM THE FOLLOWING FACTORY PRESET POSITIONS:



Dip switch SW1 allows the user to change from the factory preset ±10 V input to J1 pins 4 to 5 to either ± 5 V or 4-20 mA inputs.

ANALOG INPUT	SW 1 POSITION				
	1	2	3	4	
+/- 10V	OFF	OFF	OFF	OFF-}	factory setting
0V - 10V	OFF	OFF	OFF	OFF-}	" "
+/- 5V		ON	ON	OFF	OFF
0V - 5V		ON	ON	OFF	OFF
4 - 20 mA	ON	ON	ON	OFF	

CHECK OF ELECTRICAL 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.

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 front panel Run switch and any Run or Enable inputs to J1 are off.

Temporarily apply power and observe that display flashes 8.8.8.8 and then indicates **0 (zero)**. If this indication doesn't occur, double check all connections and verify input voltage and refer to section 6 "Troubleshooting". If fault indication occurs, refer to Section 6.

3. SETUP USING FRONT PANEL KEYPAD AND DISPLAY

See page 1-6 and 1-7 for keypad and display functions and operation. See page 2-1 for flow diagram illustrating the three available front panel setup procedures:

1. Enter full drive data from vector drive parameter list as shown in Appendix C. This is the simplest procedure for repeat applications.

2. Enter vector drive setup sheet data and select any optional parameters desired. Setup sheets are available for all Baldor standard vector motors.

3. Enter motor and control nameplate data, use auto-tuning procedures to develop vector control parameters and select optional parameters as desired.

DRIVE SETUP FROM VECTOR DRIVE SETUP SHEET

Where motor and control setup parameters are known, they can be simply entered with the keypad-display. Setup sheets listing the required data are available for all Baldor standard vector drive motors. Enter the parameters in the Parameter (Pr) mode as follows:

PARAMETER	PROCEDURE
Pr05	LINE VOLTAGE Enter nominal no load AC line-line voltage.
Pr06 to Pr12	MOTOR AND CONTROL NAMEPLATE DATA Check motor and control nameplates to be sure they match the setup sheet. Then enter parameters Pr06 to Pr12 directly from the setup sheet.
Pr13	DESIRED MAXIMUM MOTOR SPEED Enter desired maximum motor speed in RPM. **NOTE: MUST NOT EXCEED MOTOR NAMEPLATE MAXIMUM SPEED.**
Pr14	OPERATING MODE Enter desired operating mode from "Operating Modes" table.
Pr15	CALCULATE AND LOAD FACTORY PRESET DATA Enter 1 to calculate flux vector control parameters and load parameters Pr27 to Pr60 with factory preset data. This step eliminates all previously entered data except parameters Pr05 to Pr26. **NOTE: ANY PARAMETERS PR27 AND UP YOU WISH TO RETAIN MUST BE RE-ENTERED AFTER THIS STEP.**
Pr80 to Pr86	FLUX VECTOR CONTROL PARAMETERS Enter parameters Pr80 to Pr86 directly from the setup sheet.
Pr27 to Pr60	SELECTION OF OPTIONAL PARAMETERS Parameters Pr27 to Pr60 are all restored to the factory preset values in Pr15 step above and need not be revised unless desired for the application. Any changes from the factory preset values may be entered through the keypad. See parameter list in Appendix C and "Selection of Optional Parameters", Page 3-4.

DRIVE SETUP FROM MOTOR AND CONTROL NAMEPLATE DATA

When setup parameters are not available, they may be calculated by the control from nameplate data and "Auto-Tuned" to tailor the flux vector control parameters Pr80 to Pr86 to the motor and load. Enter nameplate data, calculate flux vector control parameters and auto-tune in the Parameter (Pr) mode as follows:

NAMEPLATE DATA ENTRY

PARAMETER	PROCEDURE
Pr05	LINE VOLTAGE Enter nominal no-load AC line-line voltage. **NOTE: AN INCORRECT VALUE (eg, 240V WHEN LINE IS ACTUALLY 208V) MAY CAUSE MOTOR TO BE OVER-OR UNDER EXCITED.** Drive will not accept values above or below rated input voltage per ratings table, Page 1-4.
Pr06	DRIVE MODEL NUMBER - FIRST DIGITS The drive model number from the nameplate is entered in parameters Pr06 and Pr07. For drive model numbers beginning with ZD14 enter 2d14 in Pr06 and the following 3 digits (eg, 420 for Model ZD14420) in Pr07. For drive model numbers beginning with 6xx or 7xx enter the first three digits in Pr06 and the digits between the first and second dash (eg, 24 for Model 714-24-170) in Pr07.
Pr07	DRIVE MODEL NUMBER - SUCCEEDING DIGITS See procedure under Pr06 above
Pr08	MOTOR RATED CURRENT Enter the rated full load current of the motor in RMS amps from the nameplate.
Pr09	MOTOR RATED VOLTAGE Enter the rated voltage of the motor in RMS volts from the nameplate.
Pr10	MOTOR RATED SPEED Enter the rated or base speed of the motor in RPM exactly as shown on the nameplate. **NOTE: DO NOT ENTER DESIRED OR RATED MAXIMUM SPEED OR ROUND OFF THE RATED NAMEPLATE SPEED**
Pr11	MOTOR RATED FREQUENCY Enter the rated or base frequency in Hertz from the motor nameplate.
Pr12	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. Encoders with over 9999 lines per revolution must be entered through RS232 interface.
Pr13	DESIRED MAXIMUM MOTOR SPEED Enter desired maximum motor speed in RPM. **NOTE: MUST NOT EXCEED MOTOR NAMEPLATE MAXIMUM SPEED.**

Pr14 OPERATING MODE
Enter desired operating mode from "Operating Modes" page 2-2.

Pr15 CALCULATE AND LOAD FACTORY PRESET DATA. Enter 1 to calculate flux vector parameters and load parameters Pr20 to Pr60 with factory preset data. This step eliminates all previously entered data except parameters Pr05 to Pr26. NOTE: ANY PARAMETERS PR27 AND UP YOU WISH TO RETAIN MUST BE RE-ENTERED AFTER THIS STEP.

Pr31 NUMBER OF PARALLEL CONTROLS. No entry normally required. See Pr31, Page 3-5 before auto-tuning if more than one control is operated in parallel.

AUTO-TUNING THE DRIVE

Automatic tuning of the control to the motor is accomplished by running a six step tuning procedure, one procedure each at parameters Pr90 through Pr95. The resulting parameters Pr80 through Pr86 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 1 through 5. 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 Pr90 to Pr95.

These procedures are usually most easily run in the front panel mode 0, 1, or 2. Select operating mode 0,1 or 2 in Pr14 prior to running the procedures as described below.

To run each procedure, select the desired parameter (eg, Pr90), press Enter once to display the procedure number (AU01 for Pr90), then press Enter again to start. When complete, the display will indicate either "good" or FAIL" to announce whether or not the procedure has run successfully. Press Enter again, parameter number (eg Pr90) will be displayed, then go on to the next procedure.

Pr90 ANALOG INPUT OFFSET CALIBRATION
Required only if drive is to be used in mode 3,4, or 5; skip this procedure for other modes. Apply input command to J1-4 and 5 corresponding to zero speed, switch Run/Stop to Stop, select Pr90 and run the procedure as described above. IF PROCEDURE FAILS, J1-4 to 5 input is too high to trim out. Measure voltage J1-4 to 5 and command voltage near zero before re-running.

Pr91 ENCODER DIRECTION
Switch Run/Stop to Run, select Pr91 and run procedure. This procedure accelerates motor, detects phasing of encoder feedback and automatically switches phasing to attain proper phasing to match motor rotational direction. IF PROCEDURE FAILS OR DRIVE APPEARS UNSTABLE, check motor and drive grounding, encoder coupling, Pr12 encoder lines selection, wiring and shielding and then repeat test. If test still fails, switch Run/Stop to Stop, set Pr01 to 0 and observe RPM on Pr00 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 display is OK, manually change Pr86 from 1 to zero or vice-versa and retry.

Pr92 CURRENT CONTROLLER PROPORTIONAL GAIN
Switch Run/Stop to Run, select Pr92 and run procedure. This procedure measures current response to pulses of 1/2 rated motor current and normally takes only a few seconds. If this procedure fails, retry once before consulting factory for assistance.

Pr93 FLUX CURRENT SETTING
Switch Run/Stop to Run, select Pr93 and run procedure. This procedure runs motor near rated speed for up to several minutes and sets flux current based on line voltage and motor nameplate data. IF PROCEDURE FAILS, switch Run/Stop to Stop and check Pr05 through Pr13 entries, encoder coupling, wiring and shielding, motor grounding. Check for proper voltage at L1, L2, L3.

Pr94 SLIP GAIN CALCULATION
Switch Run/Stop to Run, select Pr94 and run procedure. This procedure repeatedly accelerates motor and will yield errant results if there are significant windage or friction loads on the motor. IF PROCEDURE FAILS, manually enter in Pr81 the value calculated by the Pr15 calculation or the value calculated from motor parameters per procedure for Pr81, Appendix B, page B-1.

Pr95 SPEED CONTROLLER PROPORTIONAL GAIN
Switch Run/Stop to Run, select Pr95 and run procedure. This procedure repeatedly accelerates the motor to 400 RPM and adjusts speed loop proportional gain parameter Pr84 for minimum rise time and overshoot. This procedure will generally set Pr85 too high for high inertia motors and loads if current limit Pr30 is set too low. Set current limit per procedure of Page 2-18 and rerun this procedure if drive is too responsive. IF THIS PROCEDURE FAILS or drive is still too responsive, adjust Pr84 manually as discussed in Appendix B, Page B-2.

SELECTION OF OPTIONAL PARAMETERS Pr20 to Pr60

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 function selections to suit the application.

PARAMETERS DESCRIPTION AND PROCEDURE

I/O PARAMETERS

Pr20 **D/A OUTPUT #1**, Connector J1, Pin 6. Enter the selection number for the desired output selected from ANALOG OUTPUTS, Appendix A, pages A-1, 2.

Pr21 **D/A OUTPUT #2**, connector J1, pin 7. Same procedure as Pr20.

Pr22 **AUXILIARY A/D #1**, connector J1, pin 1. Enter the selection number for the desired input selected from ANALOG INPUTS, Appendix A, page A-1.

Pr23 **AUXILIARY A/D #2**, connect or J1, pin 3. Same procedure as Pr22.

Pr24 **OPTO OUTPUT #1**, connector J1, pin 16. Enter the selection number for the desired output selected from OPTO ISOLATED OUTPUTS, Appendix A, page A-3.

Pr25 **OPTO OUTPUT #2**, connector J1, pin 17. Same procedure as Pr24.

Pr26 **OPTO OUTPUT #3**, connector J1, pin 18. Same procedure as Pr24.

Pr27 **AUTO RESET - NUMBER OF FAULTS/HOUR** This parameter allows the user to select automatic reset of up to 5 faults per hour. A 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 for observation to aid in troubleshooting.

Pr28 **AUTO RESET TIME DELAY** This parameter sets the time delay in seconds before the controller will auto reset a fault. It is settable 0 to 300 seconds.

Pr29 **TORQUE PROVING/FOLLOWING ERROR/OL FOLDBACK/TORQUE RATE LIMIT** These control features may be selected with Pr29. See Appendix A, page 5 for descriptions and method of selection.

DRIVE CONTROL SELECTIONS

Pr30 **CURRENT LIMIT** Sets maximum current in amps the control will supply to the motor. This parameter is automatically set to the lesser of motor or control rated currents when the motor and control parameters are entered. Pr30 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.

Pr31 **NUMBER OF PARALLEL CONTROLS** Normally Pr31 = 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.

Pr32 **PWM FREQUENCY** Normally Pr32 = 2500 for 2500 Hertz PWM switching frequency, allowing full current rating of the control. For reduced audio noise or output frequencies above 250 Hertz, Pr32 = 5000 may be selected, resulting in 30% control rated current derating and a 5000 Hertz PWM switching frequency.

Pr33 **ENCODER FILTER** This speed feedback filter frequency in Hertz is automatically set to suit the encoder resolution. The preset filter frequency may be reduced to obtain smoother low speed operation.

I/O THRESHOLD PARAMETERS

Pr40 **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 modes 0, 3, 4 and 5. This "dead zone" allows the drive to hold zero speed for small offsets or drifts in the speed command input. (Example - Pr40 = 30 RPM will cause the drive to hold zero speed for

analog inputs commanding less than 30 RPM.) Set Pr45 = 0 whenever Pr40 is non-zero.

Pr41 **ZERO SPEED OUTPUT THRESHOLD (RPM)** This threshold sets the dead zone for the zero speed logic output in RPM. Speeds 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 A, Page A-3.

Pr42 **AT SPEED TOLERANCE (PERCENT)** 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 A, Page A-3.

Pr43 **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 A, Page A-3.

Pr44 **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 gives maximum output torque in the top constant HP region speeds.

Pr45 **MINIMUM SPEED (RPM)** This parameter sets the offset applied to analog speed commands in modes 0, 3, 4, 5 only. A positive setting sets the minimum speed command in RPM which will occur with zero volts input. A negative setting sets the minimum speed command in RPM which must be applied to just cause rotation. The usual reason for setting a negative Pr45 is to set zero RPM for 4 mA when 4-20 mA input is selected. Pr40 should be set to zero whenever Pr45 is non-zero.

SYSTEM CONTROL PARAMETERS

Pr50 **PRESET SPEED #1** This speed setting in RPM commands the drive when Preset Speed #1 input (as defined by the logic for each mode) is applied.

Pr51 **PRESET SPEED #2** This speed setting in RPM commands the drive when Preset Speed #2 input (as defined by the logic for each mode) is applied.

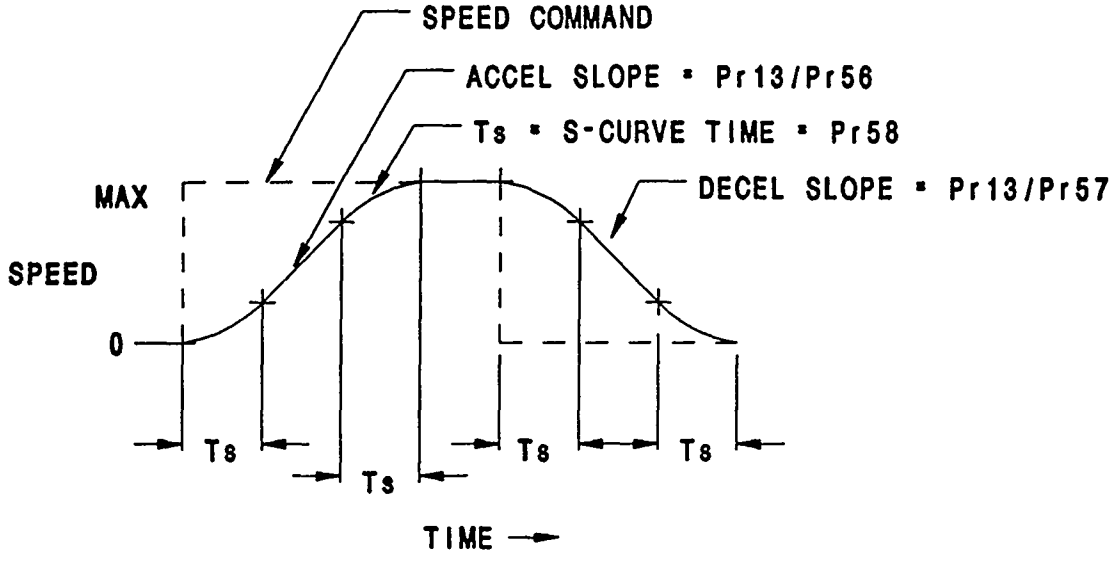
Pr52 **PRESET SPEED #3** This speed setting in RPM commands the drive when Preset Speed #3 input (as defined by the logic for each mode) is applied.

Pr53 to Pr55 **PRESET SPEED #4,5,6** These speed settings in RPM command the drive when Preset Speed inputs #4, #5, and #6 respectively are applied in Mode 6.

Pr56 **ACCELERATION TIME** Sets the time in seconds for the speed command to rise linearly from zero to the maximum speed (set with Pr13.) Adjustable from zero to 300 seconds with resolution of 0.01 second below 100 seconds.

Pr57 **DECELERATION TIME** Sets the time in seconds for the speed command to fall linearly from the maximum speed set with Pr13 to zero. Adjustable from zero to 300 seconds with resolution of 0.01 seconds below 100 seconds.

Pr58 **S-CURVE TIME** Sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum value set with Pr56 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.



TYPICAL S-CURVE LIMITED VELOCITY PROFILE

Pr59 **HOMING SPEED (RPM)** Sets the command speed in RPM for the drive when Home logic input is applied. Upon a Home input the drive will accelerate or decelerate to this speed in the forward direction with no minus sign before the displayed number; in the reverse direction when a minus sign is set before the number by incrementing downward from zero. The drive will rotate at this speed until the Home (or Orient) marker input is received, then will position as described below.

Pr60 **HOME OFFSET (IN ENCODER COUNTS AFTER X4 MULTIPLICATION)** Sets the distance past the Home marker input at which the drive 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 with overshoot past the stop position.

ADJUST CONTROL PARAMETERS TO SUIT THE APPLICATION

The factory preset parameters or auto-tuned parameters set up the drive 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 Pr80, 81, 82 or 83. These are normally automatically set near-ideal. See Appendix B for methods of calculating flux vector parameters if auto-tuning cannot be used.

2. The speed loop parameters Pr84 and 85 can often be manually adjusted to better suit the application. See Appendix B for PI (proportional plus integral) controller background and setup procedures. The Pr33 encoder filter may also be used to smooth the speed loop response--See page 3-5.

3. The constant power speed Pr44 may need adjustment for ideal high speed performance. See page 3-6.

4. If homing is used, the homing speed and offset may require adjustment to suit the application. See page 3-7 for explanation of these adjustments.

5. Preset speeds and accel, decel and S-curve as described on pages 3-6 and 3-7 should be adjusted to suit the application.

6. Current limit Pr30 is adjusted to limit maximum torque the motor will apply to the load. See page 3-5.

SELECT SECURITY CODE

The security code is an optional entry. It prevents keypad users from entering the Parameter mode where variables may be altered but does allow the user to view any variable. The factory preset value is 9999 which is always shown when pushing keypad ENTER with OP99 displayed.

The security code value may be set only once by obtaining parameter Pr99, pushing ENTER to display 9999, and using the UP or DOWN keys to select a security code. Once the number is selected, record in a safe place and then press the ENTER key to return to the Operate mode. The display will read OP99.

To enter the Parameter mode thereafter, obtain OP99, push ENTER to display 9999, change the value to the security code using the UP or DOWN keys and press the ENTER key. A Pr99 will now be displayed and you may once again alter parameters.

RECORD PARAMETERS

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

4. OPTIONAL USE OF A COMPUTER OR TERMINAL WITH THE DRIVE

A computer or CNC that provides an RS232 serial port with ANSI terminal emulation or a "dumb" terminal such as the Heath/Zenith H/Z19 or Z29 may also be used to set up and operate the drive.

The terminal or computer and software must provide true ANSI cursor addressing on an 80x25 screen. PROCOMM PLUS is a popular and readily available communications software package for MS-DOS based computers. The RS232 cable must be wired as shown in Figure 9, page 4-2 and should be connected to the control board on the control before applying power. Plug one end of the communications cable into the DB9 connector on the Sweodrive and the opposite end into the DB9 or DB25 serial plug on the computer or terminal. After completing all wiring and safety checks per page 2-9 to 2-13, apply power to the drive.

The following example demonstrates how to set up the communications parameters using PROCOMM PLUS TEST DRIVE software on an MS-DOS based computer. The actual keystrokes depend upon your communications software package. Make a working diskette of the communications software (refer to your MS-DOS manual for instructions on how to copy diskettes). Do not use the master disk. Do not defeat the write-protection of the master disk. Turn the computer on and boot it up. Place your working copy of the communications software disk into the "A" drive (assuming that you are running your software from drive "A").

Step 1. Type "A:" and press the RETURN or ENTER key to access the "A" drive.
Step 2. Type "PCPLUSTD" and the RETURN or ENTER key. After a few seconds you will have a screen display that instructs you to "press any key to begin". Press the RETURN or ENTER key.
Step 3. At the next screen (which displays PROCOMM) press the RETURN or ENTER key.

Press and hold the "Alt" button and toggle (press and release) the "P" on the keyboard. The "pop-up menu" will show your current communication settings. You must set:

Baud rate = 9600	Data Bits = 8
Parity = None	Stop Bits = 1

The port (Com 1, Com2, etc.) must be set to match the computer or terminal port you are connected to, usually Com1. Save and exit by typing ALT-S (hold the "alt" key and strike the "S" key simultaneously).

Exit to the terminal mode by pressing 'Esc' (Escape).

You should now see the Security Code display on the screen. If not, press "CTRL-Z". (Make sure power is applied to the drive).

If you still have no data on the screen, you are probably experiencing one of the following problems:

1. Defective or mis-wired RS232 cable. Possibly the pins #2 & #3 are not exchanged as required. See figure 9, page 4-2.
2. Wrong baud rate, parity, or set up not saved when exiting the communication software settings screen. Rekey data and save it by typing ALT-S simultaneously.
3. Defective Input/Output port on the computer.

Once communication is established, follow the START UP PROCEDURE which follows.

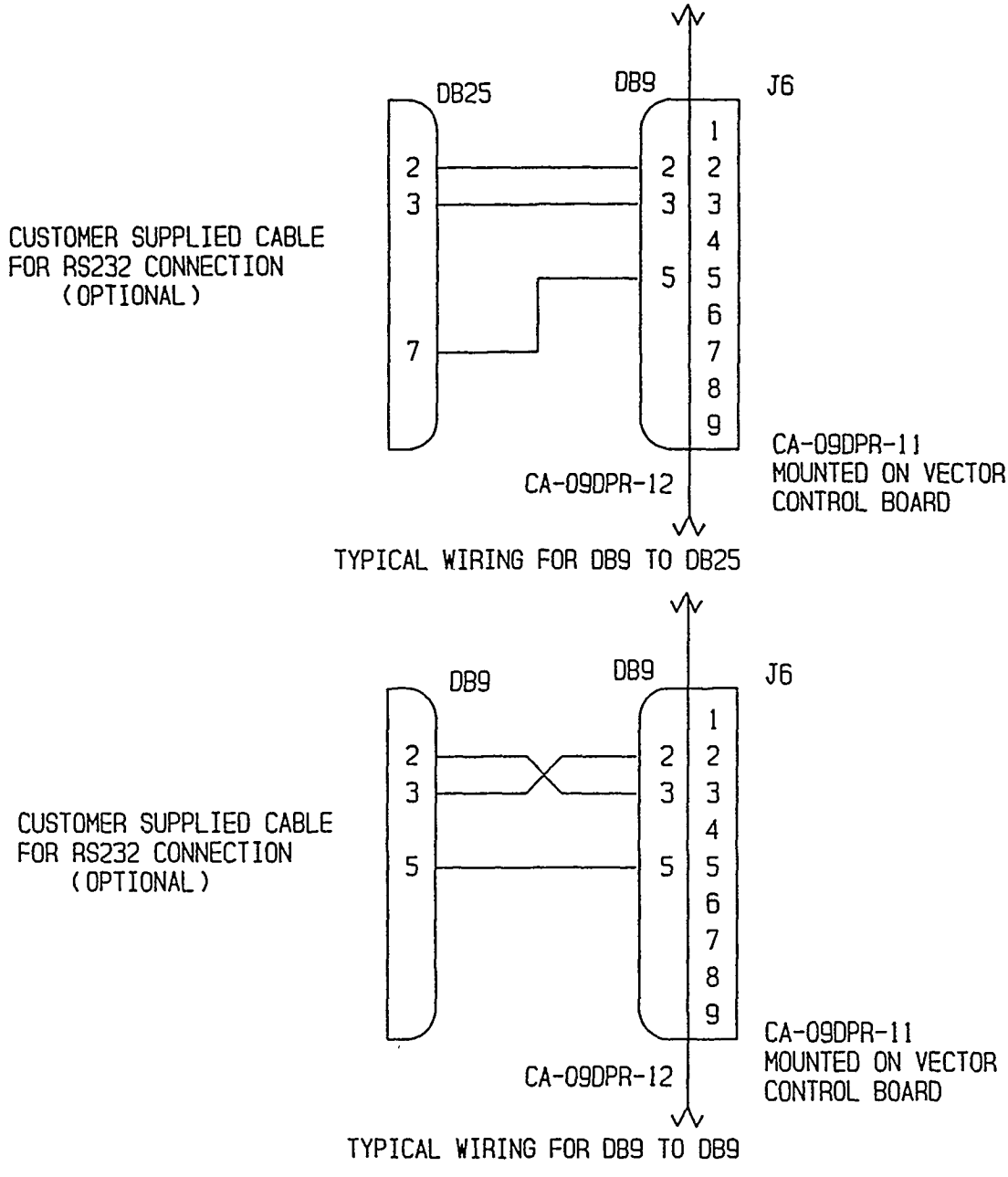
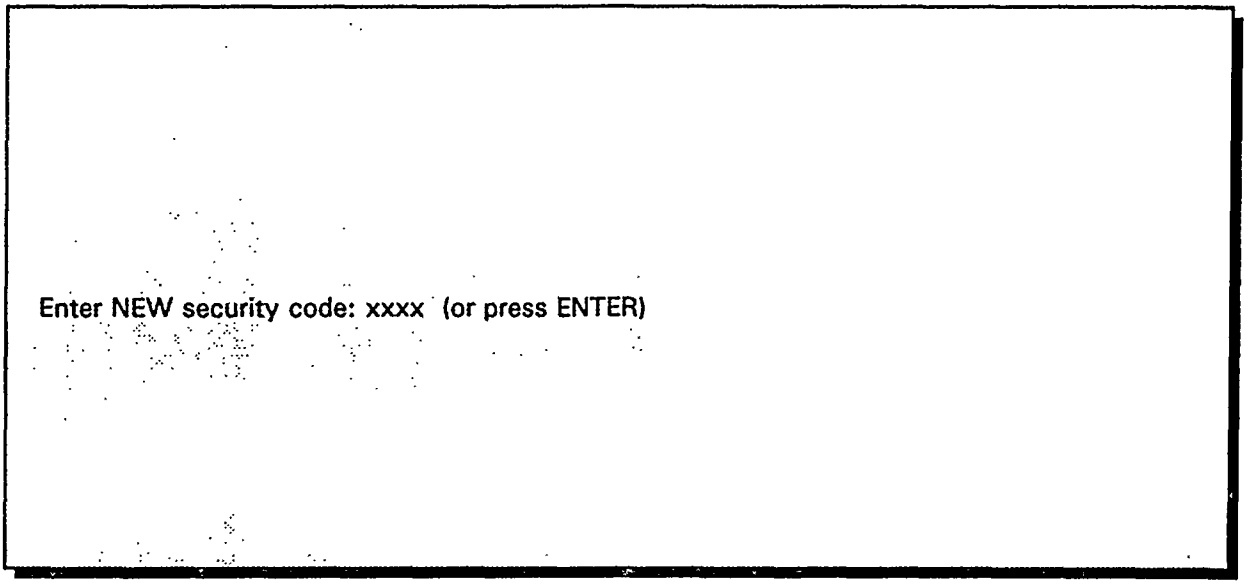


FIGURE 9
CABLE FOR RS232 CONNECTION-CUSTOMER SUPPLIED

SECURITY CODE ENTRY (Control Z)

When power is applied and RS232 communications are first established, you will see a screen as illustrated below:



The security code will prevent parameter changes by unauthorized personnel. If no security code has been entered and you do not wish to use one, press ENTER at this screen. If a security code is desired enter any 4 digit number as your security code and press ENTER on the keyboard. Record your security code in a safe place as you MUST enter this code in the future to make any changes in parameters. (Note: Pressing CTRL-E at this time will enter the RS232 mode directly).

NOTE: The security code may be entered only once. Be sure to record it in a safe place.

On all future power applications, the screen will provide space to enter the 4 digit security code which gives access to parameter changes. Pressing the ENTER key without entering the security code will give the user access to display all parameter and operating data, but will prevent any change to parameters or upload or download of files to the control. Pressing the ENTER key after entering the security code will give the user access to all parameters, file upload and download.

MAIN MENU (Control C)

From this menu each of the RS232 controlled procedures are accessed. When a procedure is completed you will be returned to this menu. This menu also allows you to monitor the current status of the drive.

```
                    FLUX VECTOR MOTOR CONTROL
          Version 1.35 (C) Copyright 1991 SWEO Controls, Inc.

TITLE: DEFAULT PARAMETERS

AMPLIFIER MODEL # : 712-  24

MAX LIMITS (CONT/PEAK):  12/  24 A rms  PRESENT LIMITS:  12/  24 A rms

STATUS:   298 RPM        9.9 Hz        34 V RMS        11.5 A RMS

CTRL O - Configure I/O                 CTRL N - Nameplate & Drive data
CTRL T - Auto Tune (disable drive)     CTRL D - Miscellaneous data
CTRL F - File data (disable drive)     CTRL L - Read fault log
CTRL E - RS232 speed/torque control    CTRL C - Repaint screen
CTRL Z - Exit
```

WARNING: All parameters may be changed while the drive is operating to permit maximum utility. DUE CARE SHOULD BE TAKEN WHEN CHANGING ANY CONFIGURATION OR PARAMETER WHILE A DRIVE IS ENABLED.

SELECT THE OPERATING MODE AND I/O CONFIGURATION (Control O)

Hold the CTRL key down while striking the letter O. The screen should immediately change to that shown below.

```
INPUT / OUTPUT SELECTION

OPERATING MODE    =  0) SPEED CONTROLLER - KEYPAD POT INPUT

D/A output #1     = SPEED
D/A output #2      = ABS MOTOR CURRENT

AUX A/D input #1 = NOT USED
AUX A/D input #2 = NOT USED

OPTO OUTPUT #1   = READY
OPTO OUTPUT #2   = ZERO SPEED
OPTO OUTPUT #3   = AT SPEED

ADDITIONAL FAULTS: OVERLOAD


To change a connection:  Use the TAB key to highlight the proper field,
then use the up/down arrows to scroll through the available settings.




CTRL C-exits, CTRL S - Save changes.
```

Select the appropriate operating mode using the UP/DOWN keys (refer to OPERATING MODE SELECTION, page 2-2 for an explanation of the available modes). Use the TAB or ENTER key to change fields and the UP/DOWN keys to select the D/A outputs, the auxiliary A/D inputs, the opto-isolated outputs and enable or disable additional fault logic as described in Appendix A. (The TAB key will highlight the field that can be changed and the UP or DOWN arrows allow you to scroll through the available settings within each field in the configuration.)

To reset all selections to default values, type CTRL O. (Hold CTRL key and strike O)

To save any changes, type CTRL S (hold the CTRL key and strike S for "save").

Return to the main menu by typing CTRL C (hold the CTRL key and strike C.)

NAMEPLATE DATA ENTRY (Control N)

The next step in setting up the drive to match the motor is to complete the "Nameplate Data Entry Menu". To start the menu hold down the CTRL key and strike the N key. The screen will look like the one below.

```
          NAMEPLATE AND DRIVE SETTINGS

TITLE :DEFAULT PARAMETERS                 use keyboard to enter data

AMPLIFIER DATA

        Model # : 712-  24
        Nominal Line Voltage :208 Vrms

MOTOR NAMEPLATE DATA

        Current : 24 Arms
        Voltage :210 Vrms
        Speed : 1900 RPM
        Frequency : 65 Hz          4 poles

ENCODER : 1024 Lines Per Revolution

MAXIMUM OPERATING SPEED : 2000 RPM


CTRL C-exit, CTRL S-Save changes, TAB-new field
```

The TAB key or the ENTER key will move the cursor to each underlined field. On the screen the active field will be highlighted. When entering data, use the 'space bar' or 'right arrow' to move the cursor to the proper position within the field. (Example: if motor rated speed is 1755 RPM then the proper keystrokes upon entering the field are "space", "1", "7", "5", "5".) **IMPORTANT:** Double check all entries before saving the data. The data is entered in the following order:

TITLE - is an optional entry to help the user identify useful information. It will also be displayed on the Main Menu. It is suggested that this field be used to identify the installation and unit.

AMPLIFIER DATA:

MODEL NUMBER - is entered in two fields, the series and rating. (Pr06 and 07) It is found on the label of the control and is used to set the protective current levels, the feedback scaling, etc. Use the UP or DOWN arrow keys to scroll through the available settings.

NOMINAL LINE VOLTAGE - Enter nominal no-load AC line-line voltage (Pr05).**NOTE: An incorrect value (i.e. 240V when the line is actually 208V) may cause the motor to be over- or under-excited.** The controller will not allow voltages above or below the acceptable voltages labeled on the amplifier (and shown in Specifications, Page 1-4) to be stored.

MOTOR NAMEPLATE DATA: (all data should be found on motor nameplate)

CURRENT - Enter the rated full load current of the motor in RMS amps. (Pr08)

VOLTAGE- Enter the rated voltage of the motor in RMS volts. (Pr09)

SPEED - Enter the rated or base speed of the motor in RPM exactly as shown on nameplate (Pr10).

NOTE: DO NOT ENTER DESIRED OR RATED MAXIMUM SPEED OR ROUND OFF THE RATED NAMEPLATE SPEED.

FREQUENCY - Enter the rated or base frequency of the motor in Hz (Pr11).

POLES- The number of poles is calculated by the control when CTRL S is entered. No entry required.

ENCODER:

LINES PER REVOLUTION - Enter directly from the encoder data sheet or nameplate for direct coupled encoder (Pr12). Geared or belted encoders are not recommended, if used they must have a positive ratio with no slippage and encoder lines per motor revolution must be entered here.

MAXIMUM OPERATING SPEED:

MAXIMUM RPM - Enter the desired maximum operating speed in RPM (Pr13).

NOTE: MUST NOT EXCEED MOTOR NAMEPLATE MAXIMUM SPEED.

Save these parameters by typing CTRL S (hold the CTRL key and strike S) then type Y to save. Type N to abort or X to save and calculate flux vector parameters and load factory preset data for optional parameters Pr27 through Pr60.

Type CTRL C to return to the main menu.

NUMBER OF AMPLIFIERS:

No entry required for all standard systems where each motor is controlled by a single control. On special systems employing multiple amplifiers to attain adequate current capability, this parameter must be entered as described in the Control D menu, page 4-13 before auto tuning.

AUTO-TUNING THE DRIVE AND MOTOR (Control T)

The automatic tuning menu is entered by typing CTRL T. It is a six step process which will automatically tune the drive to the motor under normal conditions in approximately 15 minutes.

> 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 1 through 6. 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.

These tests are usually most easily run in the front panel mode 0, 1 or 2. Select operating mode 0, 1 or 2 in I/O menu prior to running the procedures as described below.

```
                          AUTO TUNING MENU


Run the procedures in order!  Use the TAB key to select test.


1) INPUT OFFSET CALIBRATION              4) FLUX CURRENT CALIBRATION
2) ENCODER DIRECTION                     5) SLIP GAIN CALCULATION
3) CURRENT LOOP ADJUSTMENT               6) SPEED LOOP SET UP

This procedure will trim the input A/D's to read zero for the present input
value.  Command zero volts to the input (J1-4 TO J1-5) before running!

Presently trimming 0 mv from the input.


RETURN/ENTER to start procedure.


For procedures 2 - 5 there should be no external load on the rotor!

CTRL C - EXITS
```

To run any procedure except (1) the 'Run' input must be on, all other inputs are ignored. The ENTER (marked RETURN on some keyboards) key will start each procedure. Use the TAB once a procedure is finished to go on to the next procedure (the procedures must be run sequentially). The 6 procedures are:

1) ANALOG INPUT OFFSET CALIBRATION:
Required only if drive is to be used in mode 3,4, or 5; skip this procedure for other modes. Apply input command to J1-4 and 5 corresponding to zero speed, switch Run/Stop to Stop, select Procedure 1 and run as described above. IF PROCEDURE FAILS, J1-4 to 5 input is too high to trim out. Measure voltage J1-4 to 5 and command voltage near zero before re-running test.

2) ENCODER DIRECTION:
Apply "Run" input, run procedure. This procedure accelerates the motor, detects phasing of encoder feedback and automatically switches phases to attain proper phasing. IF PROCEDURE FAILS OR THE DRIVE SEEMS UNSTABLE: Check the motor and drive grounding, the encoder coupling, the lines per rev of the encoder, the power to the encoder, the wiring and shielding, and repeat the test. If procedure still fails, disable the drive and return to the main menu by typing CTRL C. Turn the rotor by hand and watch the RPM display on the screen. Zero or erratic display indicates malfunctioning encoder, wiring incorrect, or damaged control board encoder line receiver. If the display looks correct, manually reverse the encoder polarity as instructed under "Manual Parameter Entry" page 2-30 and run the procedure again.

3) CURRENT CONTROLLER PROPORTIONAL GAIN:
This procedure measures current response to pulses of 1/2 rated motor current and normally takes only a few seconds. If the procedure fails, retry once before consulting the factory for assistance.

4) EXCITATION CURRENT SETTING:
This procedure runs the motor near rated speed for up to several minutes and sets excitation based on line voltage and motor nameplate data. IF PROCEDURE FAILS: Disable the drive and type CTRL C to exit the auto test menu. Enter the CTRL N Nameplate Data menu and double check EVERY entry. If all are correct, check the encoder is wiring and shielding, motor and drive grounding per appropriate Figure 1 to 5. If these are correct, then check the encoder's mechanical coupling to the motor.

5) SLIP GAIN CALCULATION:
This procedure repeatedly accelerates and decelerates the motor and will yield errant results if there are significant windage or friction. IF PROCEDURE FAILS use the default value (which has been calculated from the rated speed and frequency of the motor) or set the value manually as described in Appendix B, page B-1.

6) SPEED CONTROLLER PROPORTIONAL GAIN:
This procedure repeatedly accelerates the motor to 400 RPM and adjusts speed loop proportional gain for minimum rise time and overshoot. This procedure will generally set Pr85 proportional gain too high for high inertia motors and load if current limit Pr30 is set too low. Set current limit per procedure of page 3-5 and rerun this procedure if drive is too responsive. IF PROCEDURE FAILS or still results in too responsive performance, adjust rate controller proportional gain manually as discussed in Appendix B, page B-2.

Disable the drive and type CTRL to end the automatic tuning session. The motor will now respond according to the user defined mode and input enables.

OPTIONAL MANUAL PARAMETER ENTRY (Control D)

```
                    MANUAL PARAMETER ENTRY MENU

CONTROL PARAMETERS (set by auto tuning)
      Encoder direction (0/1):0
      Current loop - proportional gain:  24, integral gain: 50 Hz
      Flux current: 11.46 A RMS
      Slip gain :100
      Speed loop  - proportional gain:  15, integral gain: 3  Hz
OPTO OUTPUT TOLERANCES
      Zero speed: 10 RPM     At speed:10 %   Set speed: 1000 RPM
ORIENT (HOME) PARAMETERS
      Speed:100 RPM          Offset: 1000 Counts (1 rev =  4096 counts)
SPEED COMMAND PROFILES
      Accel (0 to 2000 RPM):  0.20 sec       Decel time:  2.20 sec
      S-Curve time:  0.00 sec                Minimum Speed:  0 RPM
PRESET (JOG) SPEEDS
      #1:  0 RPM    #2: 125 #3: 250 #4: 500 #5:1000 #6:2000
MISCELLANEOUS
      Constant Hp Speed: 1796 RPM    Encoder filter:  40 Hz
      Current limit:  24 A RMS       # of Amplifiers:1
      PWM Freq(2500/5000):5000 Hz    Zero input deadband:  0 RPM
AUTO FAULT RESET:      0 faults/hr    delay:  0 seconds

CTRL C-exits, CTRL S-Save changes
```

The "Manual Parameter Entry" menu (CTRL D) exhibits the values which were set by the automatic tuning menu. It also contains optional parameters which set up the drive to suit the application.

CONTROL PARAMETERS:

ENCODER DIRECTION (Pr86) is set by the automatic tuning procedure. To set this value manually apply a moderate speed command to the drive (400 RPM or so). If the motor follows the command then encoder direction is correct. If the drive moves at a slow constant rate or oscillates then the encoder direction is incorrect should be changed from 1 to 0 or 0 to 1.

CURRENT LOOP PROPORTIONAL GAIN (Pr82) is normally set by the auto-tuning procedure. See Appendix B, page B-1 for method of calculating this parameter.

CURRENT LOOP INTEGRAL GAIN (Pr83) should be left at 50. It allows the controller to reject low frequency distortion.

FLUX CURRENT - in Amps RMS x 100. (Pr80) is normally set by the automatic tuning procedure. It is also called the magnetizing, idle, or no-load current. This value is generally about 40% of the motor rated current.

SLIP GAIN - (Pr81) value is normally set by the auto-tuning procedure. See Appendix B, page B-1 for methods to calculate this parameter.

SPEED LOOP PROPORTIONAL GAIN - (Pr84) is normally set by the auto-tuning procedures. See appendix B, page B-2 for a discussion of the rate loop controller and suggested manual setting procedure.

SPEED LOOP INTEGRAL GAIN - (Pr85) is automatically set by the auto-tuning procedures. It will give the system stiffness at zero speed and no steady state error to a speed command. See Appendix B, page B-2 for suggested manual setting procedure.

OPTO OUTPUT TOLERANCES:

ZERO SPEED TOLERANCE (RPM) (Pr41) sets the dead zone for the zero speed logic output in RPM. Speeds 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.

AT SPEED TOLERANCE (PERCENT) (Pr42) 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.

SET SPEED (RPM) (Pr43) 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.

ORIENT OR HOME PARAMETERS:

ORIENT OR HOME SPEED (RPM) (Pr59) sets the command speed in RPM for the drive when Home logic input is applied. Upon a Home input the drive will accelerate or decelerate to this speed in the forward direction unless a -sign is entered before the speed, in which case the speed will be in the reverse direction. The drive will rotate at this speed until the Home (or Orient) marker input is received then will position as described below.

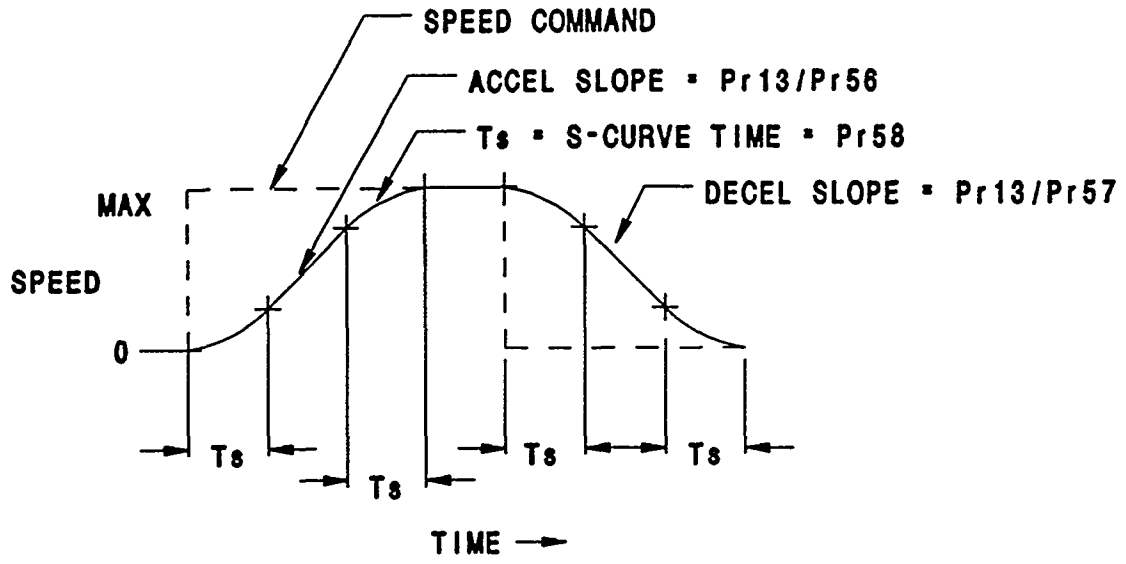
ORIENT OR HOME OFFSET (IN ENCODER COUNTS AFTER X4 MULTIPLICATION)
(Pr60) sets the distance past the Home marker input at which the drive will decelerate, stop and hold position when the Home input is applied. Resolution is four times the number of encoder lines per revolution. Home position will be at 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 with overshoot past the stop position.

SPEED COMMAND PROFILES:

ACCELERATION TIME (Pr56) sets the time in seconds for the speed command to rise linearly from zero to the maximum speed (set with Pr13). Adjustable from zero to 300 seconds with resolution of 0.01 second below 100 seconds.

DECELERATION TIME (Pr57) sets the time in seconds for the speed command to fall linearly from the maximum speed (Pr13). Adjustable zero to 300 seconds with resolution of 0.01 seconds below 100 seconds.

S-CURVE TIME Pr58 sets the time in seconds for the acceleration or deceleration to rise from zero to the maximum value set with acceleration time above or fall from the maximum to zero. Adjustable from zero to 99.99 seconds with a resolution of 0.01 second. 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.



TYPICAL S-CURVE LIMITED VELOCITY PROFILE

MINIMUM SPEED (RPM) (Pr45) sets the offset applied to analog speed commands in mode 3 only. A positive setting sets the minimum speed command in RPM which will occur with zero volts input. A negative setting sets the minimum speed command in RPM which must be applied to just cause rotation. The usual reason for setting a negative minimum speed is to set zero RPM for 4 mA when 4-20 mA input is selected. Set Zero Input Deadband (Pr40) to zero whenever minimum speed (Pr45) is non-zero.

PRESET (JOG) SPEEDS:

PRESET SPEED #1 (Pr50) This speed setting in RPM commands the drive when Preset Speed #1 input (as defined by the logic for each mode) is applied.

PRESET SPEED #2 (Pr51) This speed setting in RPM commands the drive when Preset Speed #2 input (as defined by the logic for each mode) is applied.

PRESET SPEED #3 (Pr52) This speed setting in RPM commands the drive when Preset Speed #3 input (as defined by the logic for each mode) is applied.

PRESET SPEED #4,5,6 (Pr 53, 54, 55) These speed settings in RPM command the drive when Preset Speed inputs #4, #5, and #6 respectively are applied in Mode 6.

MISCELLANEOUS

CONSTANT POWER SPEED (RPM) Pr44 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 power operation. This setting is made automatically during the setup procedure. Lowering the setting operates the motor at lower voltage in the constant power region to provide better dynamic response. Raising the setting results in maximum voltage supplied to the motor and gives maximum output torque in the top constant power region speeds.

CURRENT LIMIT (Pr30) sets maximum current in amps the drive will supply to the motor. This parameter is automatically set to the lesser of motor or drive rated currents when the motor and drive parameters are entered. (Pr30) may be set to any current within the peak rating of the drive. Settings below the peak drive current rating will allow higher continuous current for variable torque applications with maximum continuous capability equal to the drive variable torque current rating when the current limit is set to this value.

PWM FREQUENCY Normally (Pr32) = 2500 for 2500 Hertz PWM switching frequency, allowing full current rating of the drive. For reduced audio noise or output frequencies above 250 Hertz, (Pr32) = 5000 may be selected, resulting in 30% drive rated current derating and a 5000 Hertz PWM switching frequency.

ENCODER FILTER (Pr33) speed feedback filter frequency in Hertz is automatically set to suit the encoder resolution. The preset filter frequency may be reduced to obtain smoother low speed operation.

NUMBER OF AMPLIFIERS Normally (Pr31) = 1, unless multiple drive modules are connected in parallel to drive motors requiring more current than is available from a single drive module. Enter number of parallel drives for those systems which include the necessary equipment to parallel drive modules.

ZERO INPUT DEADBAND (RPM) (Pr40) sets the input threshold below which the analog input signal will result in zero speed command to the drive in modes 0, 3, 4 and 5. This "dead zone" allows the drive to hold zero speed for small offsets or drifts in the speed command input. (Example - Pr40 = 30 RPM will cause the drive to hold zero speed for analog inputs commanding less than 30 RPM.) Set minimum speed (Pr45) to zero whenever Pr40 is non-zero.

AUTO FAULT RESET:

FAULTS/HOUR (Pr27) allows the user to select automatic reset of up to 5 faults per hour. A 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 to aid in troubleshooting.

RESET TIME DELAY (Pr28) sets the time delay in seconds before the controller will auto reset a fault. It is settable 0 to 300 seconds.

SAVING OR RETRIEVING PARAMETER FILES (Control F)

```
                              FILE MENU
1)  Use TAB key to select mode and then CARRIAGE RETURN to initiate procedure.
      UPLOAD FILE MODE    Disk to Flux Vector control board.
      DOWNLOAD FILE MODE Flux Vector control board to Disk.




CTRL C-EXITS
```

A communication package which supports XMODEM protocol is required to save or retrieve data from a disk. Enter the file transfer menu by stopping (disabling) the drive and typing CTRL F.

Highlight your choice of uploading or downloading data by using the TAB key, then press the ENTER key to start the procedure. Then follow the software package directions for receiving or transmitting data (typically PAGE UP and PAGE DOWN).

A listing for a typical file saved by the download function follows. See Appendix C for parameter list providing parameter descriptions and factory preset parameter values.

PARAMETER NUMBER	PARAMETER VALUE
TITLE:	"TYPICAL PARAMETERS"
/# 1/	0
/# 5/	230
/# 6/	ZD14
/# 7/	240
/# 8/	24
/# 9/	210
/# 10/	1750
/# 11/	60
/# 12/	2500
/# 13/	2000
/# 14/	3
/# 20/	0

```
/# 21/  8
/# 22/  0
/# 23/  0
/# 24/  0
/# 25/  1
/# 26/  2
/# 27/  5
/# 28/  3
/# 29/  1
/# 30/  24
/# 31/  1
/# 32/  5000
/# 33/  200
/# 40/  0
/# 41/  10
/# 42/  10
/# 43/  1000
/# 44/  1750
/# 45/  0
/# 50/  0
/# 51/  0
/# 52/  0
/# 53/  0
/# 54/  0
/# 55/  0
/# 56/  20
/# 57/  100
/# 58/  0
/# 59/  100
/# 60/  1000
/# 80/  1100
/# 81/  110
/# 82/  30
/# 83/  50
/# 84/  30
/# 85/  5
/# 86/  0
/# 99/  9999
```

The parameters may be altered by uploading the file and using the Flux Vector software to make any changes and then resaving the file. The parameter file may also be edited off-line by using a text editor.

READING THE FAULT LOG (Control L)

The fault log is started by typing CTRL L. It will display the 15 most recent faults, the time at which the fault occurred, and the present running time of the system. To clear the latest fault, type CTRL X. Type CTRL-C to exit to the main menu.

USING THE RS232 CONTROL MODE

The RS232 control mode can be entered from any of the operating modes listed on page 2-2 at anytime after the security code has been entered. When the controller is DISABLED (Logic input J1-10 open) and the ASCII code for the key CTRL E is sent down the serial line, the controller will be in full RS232 control with no torque output. Once in RS232 control, the drive will ignore all J1 logic inputs except the run input J1-10. This input functions as the emergency stop line and must be maintained closed to allow control RS232 operation.

To exit the mode, the ASCII code for the key CTRL C must be sent. This will place the controller back in its predefined operating mode, responding to existing J1 logic inputs.

Following are command definitions. **THE COMMANDS MUST BE CAPITALIZED.**

COMMAND:	RESULT:
CTRL E	-from any mode places the controller in RS232 mode only if drive disabled (J1-10 open). The drive will be disabled.
CTRL C	-will exit the RS232 mode. Removing AC power will also exit the RS232 mode.
C<ENTER>	-clears an existing fault.
D<ENTER>	-will disable the controller, causing zero motor current and torque.
E<ENTER>	-will enable the controller to produce torque, providing J1-10 is closed.
F<ENTER>	-will read back an existing fault code.
H<ENTER>	-will command the drive to go to the home position, and remain until another command is received.
Pn<ENTER>	-displays the value for parameter number n.
R<ENTER>	-displays the status of the motor (speed, frequency, volts, amps).
Rn<ENTER>	-displays the output status variable pointed to by n, where 1 = speed, 2 = frequency, 3 = volts, 4 = amps.
Sn<ENTER>	-sets the value of the last parameter displayed (by the Pn<ENTER> command) to the value n.
T<ENTER>	-places the controller in torque control with torque equal to the last torque command.
Tn<ENTER>	-places the controller in torque control with torque ouput n. The value for n ranges from -2048 for full negative torque (current limit value) to 2048 for full positive torque. TO <ENTER> commands zero torque.
V<ENTER>	-places the controller in speed control and runs at the last command RPM.
Vn<ENTER>	-places the controller in speed control commanding a speed of n RPM. The value for n may be preceded by a "+" or "-" to select drive rotation direction. No prefix selects + rotation.

Note: <ENTER> is the carriage return or enter key on most keyboards.

Following is a typical sequence of instructions:

CTRL E	-now in RS232 control, drive disabled.
T512<ENTER>	-torque command will be 1/4 current limit. (512/2048 = 1/4)
V1800<ENTER>	-speed command will be 1800 RPM.
E<ENTER>	-enable drive (runs up to 1800 RPM).
R<ENTER>	-actual speed is displayed.
T<ENTER>	-drive switches to torque mode and provides torque equal to 1/4 of the current limit setting.
V<ENTER>	-drive switches back to speed mode and runs at 1800 RPM.
V-1800<ENTER>	-drive reverses direction and accelerates to 1800 RPM.
P57<ENTER>	-Parameter 57 (decel) is displayed.
S200<ENTER>	-Parameter 57 is changed to 200.
H<ENTER>	-drive goes to the home position.
D<ENTER>	-drive is disabled.
CTRL C	-drive returns to predefined mode.

5. THEORY OF OPERATION

The AC induction motor has a 3 phase wye or delta connected stator. The motor rotor position is sensed by an encoder mounted on the motor. Currents are induced into the rotor to produce torque. The flux vector control operates the motor as either a torque or speed controller as selected by the user.

The functions described in this section are shown in the block diagram, Figure 10, page 5-2. The flux vector algorithm uses the encoder information to control the two components of the motor current with servo loops. The flux current is the flux producing or excitation component of current and the load current is the torque producing or load component of current. The flux current is commanded to a fixed value while below the constant power speed of the motor. Above the constant power speed the flux current is reduced to progressively weaken the flux with increasing speed. The load current is proportional to the speed error when the drive is used as a speed controller or proportional to the input command when the drive is used as a torque controller.

The slip frequency of the motor is proportional to the ratio of the load current to the flux current. The slip frequency is added to the rotor frequency to determine the electrical frequency for the voltages and currents. This frequency is used in transforming the AC currents into the flux and load current components. It is also used in transforming the flux and load voltage command components into AC motor voltage commands.

The controller may also be used to orient the motor to any position. This is done by providing an index pulse from either the motor mounted encoder or from any other source (i.e. a mechanical switch, an encoder on another axis, etc.). The user may specify an offset from this pulse to provide orientation to virtually any position.

The flux vector board saves all the motor and control parameters in battery backed RAM. The contents of this ram are checked upon each power up for possible corruption. The RS232 interface to the board allows the user to change any of the motor parameters, programmable inputs, outputs, or modes of operation and monitor drive status.

The keypad-display provides user selected speed, torque, current or frequency display, drive status, parameter adjustment and monitoring and front panel control.

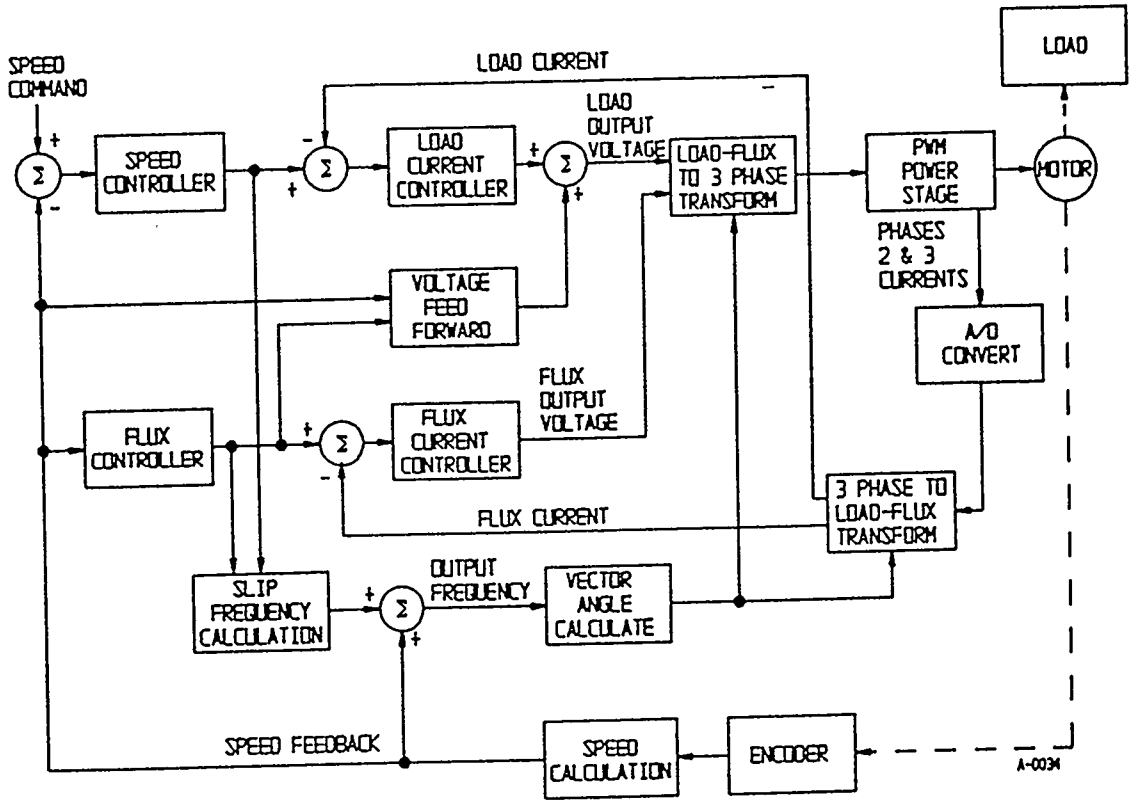


FIGURE 10: FLUX VECTOR SPEED CONTROLLER BLOCK DIAGRAM

BUS POWER SUPPLY (Drawing No. 7143 for 230 VAC/ No. 7148 for 460 VAC)

The drawings show the interconnection of the power components. Incoming ac power, at terminals L1 through L3, is full-wave rectified by a diode bridge. It is then filtered by inductor L1 and the bus capacitors. The inductor reduces current ripple on the bus capacitors, and maximizes input power factor. This minimizes EMI interference which might otherwise be conducted from the drive to the ac lines. The capacitors store dc bus energy to provide a safe operating voltage for the power transistors by absorbing a limited amount of regenerated energy. Normal bus power supply voltages range from 275 VDC @ 230 VAC / 550 VDC @ 460 VAC under heavy load at low line voltage to 350 VDC @ 230 VAC / 695 VDC @ 460 VAC with no load at high line voltage. Motor regeneration will increase the dc bus voltage causing operation of the shunt regulator which limits the dc bus voltage to less than 380 VDC for 230 VAC drive / 755 VAC for 460 VAC drive.

Excessive current inrush upon power application is prevented by the soft start circuit. This circuit is composed of a starting resistor, fuses F1-F2 and an SCR. Operation of the soft start function is supervised by the power supply. The SCR is fired to bypass the charging resistor only after its voltage drop is less than 30 VDC. The power supply is interlocked with the control board to prevent operation of the main output transistors until the capacitors are charged and the soft start SCR is turned on.

The DC bus voltage is continuously monitored by the power supply which controls the shunt regulator transistor. When the bus voltage approaches its peak level, the shunt transistor is turned on to draw current through the external regeneration resistor to dissipate excess regenerated energy. The controller will limit bus capacitor voltage to 375 VDC for the 230 VAC drive / 750 VDC for the 460 VAC drive. The peak energy that can be absorbed is limited by the maximum resistor current that can be controlled by the transistor. See section 6 for minimum allowable resistance for each controller rating.

CONTROL POWER SUPPLY

The control power supply assembly operates directly from the main DC bus derived from the full wave rectified 208-230/460 VAC line and accomplishes the following:

1) Supplies a 27 kHz, 100 volts peak to peak regulated square-wave for base drive and auxiliary loads. This supply is nominally rated at 100 Watts.

2) Supplies a precision regulated plus and minus 15.0 VDC supply at 400 ma each.

3) Supplies a regulated + 24 VDC for auxiliary relay and DC fan use. This is nominally rated at 25 watts total.

4) Delays power supply operation upon power application to ensure the DC bus capacitors have charged sufficiently to start the power supply.

5) Limits the internally regulated intermediate 180 VDC bus voltage and current levels on a pulse-by-pulse basis. Over voltage shutdown backs up the voltage limit if a regulator transistor short occurs, thus preventing excessive output voltages.

6) Provides the gate signal to the soft start bypass SCR. This signal is coordinated with AC line voltage presence, bus to line differential voltage, and bus undervoltage.

7) Generates the base drive current to the shunt regulator power transistor to regulate the DC bus voltage during motor drive regeneration.

8) Provides independent opto-isolated status signals for bus undervoltage, bus over voltage and shunt regulator transistor drive.

9) Turns on the safety bleed transistor during absence of all ac line power to connect the DC bus capacitors to an external discharge resistor.

The power supply assembly monitors the soft start resistor voltage and DC bus voltage for the following conditions:

1) Soft Start Resistor Voltage over 30 VDC, which inhibits turn on of the soft start circuit and the power output circuit.

2) DC Bus Voltage under 225/450 VDC, which inhibits turn-on of the soft start circuit and the power output circuit.

3) DC Bus Voltage over 375/750 VDC, which turns on the shunt regulator transistor Q4.

4) DC Bus Voltage over 385/770 VDC, which inhibits operation of the power output circuit.

Conductor spacings on the power supply are sufficient to provide a voltage isolation exceeding 1000 volts between the power circuit and control circuit common. This common is also connected to chassis ground.

POWER OUTPUT CIRCUIT

The power output circuit consists of six Darlington 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 current shunt resistors (R2 and R3) or Hall effect feedback sensors. The output transistors are driven and monitored by the base drivers (A5, A6 and A7). Control board A1 generates pulse width modulation (PWM) base 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.

MOD-DEMOD (230VAC drives 5-25 Hp & 460VAC drives 5-40 Hp)

The mod-demod assembly consists of two independent and identical modulator-demodulator circuits for isolating the current feedback signals from the power circuitry. A carrier frequency of approximately 500 kHz modulates the voltage developed across a current sensing resistor. The resulting ac signal is transformer coupled to a demodulator which recovers the original signal. The offset of the amplified and isolated output is trimmed with R14 for the T3 channel and R30 for the T2 channel. Gain adjustment is provided to compensate for component tolerances, (including the sensing resistor) using R15 for the T3 channel and R29 for the T2 channel. These adjustments are set at the factory and do not need to be changed. The mod-demod is operated from $\pm$15 VDC supplied by the power supply A3.

Conductor spacings on the mod-demod assembly are sufficient to provide a voltage isolation exceeding 1000 volts between the current sensing resistors and control circuit common. This common is also connected to chassis ground.

HALL CURRENT FEEDBACK BOARD (230VAC drives 40-50Hp & 460 VAC drives 50-75HP)

On drives equipped with the Hall Sensor Current Feedback Board, the current is passed though a gapped toroid and a flux proportional to current is measured using a Hall effect sensing device. The sensor is located in the gap of the toroid. Current variation through the toroid causes a corresponding change in the flux in the gap. The change in flux in the gap is sensed by a change in the signal from the Hall sensor. This signal is scaled to the appropriate Amps of phase current per volt of signal by additional circuitry on the Hall Current Feedback Board.

BASE DRIVERS

A base driver assembly consists of two independent base driver circuits, one for each power transistor pair. Each channel has a transformer isolated power supply, an opto-isolated base driver and collector-emitter voltage desaturation detector.

The isolated $\pm$8 VDC power supply is obtained from the 27kHz 100 volt square-wave source provided by power supply A3. The supply furnishes the current required for turning on and off the power transistors. The opto-isolated base driver circuit includes base current limiting which forces the Darlington transistor to pull out of saturation when its collector current exceeds the transistor's capacity. The base driver circuit also provides a high current reverse base drive for fast turn off of the power transistor. The desaturation detector monitors the power transistor's collector-emitter voltage and shuts it off when this voltage exceeds a safe level. This happens when an overload current begins to pull the transistor out of saturation. This shutdown creates an output fault signal which is opto-isolated and sent to the control board A1. Fault monitoring circuits on the control board shut down the drive, latch the fault and turn on the corresponding LED indicator.

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 servo loops which respond to the flux vector supplied current commands.

3) to provide pulse width modulated outputs to the base drivers in response to current loop errors.

4) to provide current limiting.

5) to provide latching and indication of over-temperature, control power failure, overload, bus under- and over-voltages, and amplifier fault conditions.

6) to provide a selection of drive and motion enables.

7) to provide three programmable analog inputs, two analog outputs, five opto isolated inputs, and three opto isolated outputs.

8) to provide simple entry, storage, and retrieval of parameters from an interactive menu system.

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

All A1 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 U8 and U9). See Software Revisions, page 1-8.

ENCODER SIGNALS

The flux vector board provides a separate 5V power supply for the encoder with options for 12V or 15V models. 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.

OUTPUTS TO BASE DRIVERS

The base signal outputs are PWM waveforms, one for each of the six power output transistors. These signals are developed by three independent circuits, one per output phase. The voltage command for each phase is generated in software and converted to an analog signal by DAC's 3 and 4. This analog signal is compared to a triangle wave to produce a pulse width modulated (PWM) waveform. Changes in the PWM pulse widths control the three main power transistor pairs to regulate motor voltage as required by the control system.

FLUX CONTROL

The flux control includes the flux current loop which regulates the flux component of motor voltage to maintain the desired motor flux current and the flux controller which develops the flux current command from the flux current selection and speed feedback. Proportional and integral gain 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 as shown in Figure 10. 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 (Pr30) value. The maximum RMS 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 the rated current indefinitely, at 150% of the rating for one minute, and at 200% of the rating for 3 seconds.

LATCHING FAULT PROTECTION AND INDICATION

Fault conditions are detected, latched and displayed on the front panel. The following display codes and their associated detectors are provided:

1,2,3) **PH-1, PH-2, or PH-3** Each transistor base driver fault output is monitored. The drive shuts down whenever an excessive voltage drop occurs (indicating an output overload) or driver supply failure occurs. See the section entitled Outputs to Base Drivers. The fault is latched and indicated on the display. This display indicates which output connection, transistor pair or base driver caused the fault.

4) **OL** This display indication occurs under drive overload conditions, generally caused by excessive load on motor.

5) **OSP** An overspeed detector compares the motor speed with the maximum RPM parameter (Pr13). The drive shuts down, latches and indicates whenever speed exceeds 110% of (Pr13) setting.

6) **OH E** Motor overtemperature or open circuit in motor thermostat circuit shuts down the drive and causes this display.

7) **OH C** Controller heatsink over 80°C shuts down the drive and causes this display.

8) **15dc** A power supply failure detector monitors the ±15 volt power supplies. The drive is shut down whenever either 15 volt supply drops below 12 volts. A complete loss of +15 volt power will not cause an indication since the logic operates on +15 volts. This condition will turn off all displays.

9) **PAr** Non-existent or lost battery backed-up RAM parameters causes this display. This indication normally occurs with new RAMs.

10) **uP** A watchdog timer error in the microprocessor shuts down the drive and causes this indication.

11) **Prog** EPROM fault.

12) **dcLO** Monitors the fault output of power supply assembly, A3, for an undervoltage fault indication. This condition shuts down the drive and displays dcLO.

13) **dcHI** Monitors the fault output of power supply assembly, A3, for an overvoltage fault indication. This condition shuts down the drive and displays dcHI.

14) **F. Err** Excess following error with this option selected shuts down the drive and causes this display.

15) **I LO** Failure of the drive to pass the torque proving test (adequate current in all 3 windings) upon startup with this option selected shuts down the drive and causes this display.

16) **I. Sen** Current sensor has excessive offset.

6. TROUBLESHOOTING

CAUTION

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 motor electrical connection without insuring there is no high voltage 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. ALWAYS check dc voltage between two bus bars on large capacitors when opening enclosure and bleed down to 10 volts maximum with resistor before servicing.

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.

INSTRUMENTS

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

TROUBLESHOOTING GUIDE

NO DISPLAY

1. Check AC power connections and line fuses or breaker. AC voltage at terminals L1-L2, L2-L3, L3-L1 must match the "input voltage" on the nameplate of the drive. If incoming power breaker or fuses are open, remove AC power and check resistance between L1, L2 and L3 terminals with ohmmeter. Low resistance may indicate either a failed diode bridge or SCR. Observe CAUTION warnings and replace the Bridge (sometimes made up of individual diode pairs) or Q5 (SCR module).

2. Check supply voltages at connector J3-4 (+15 VDC), J3-6 (-15 VDC), and J3-8 (+24V) relative to common, J3-7. All voltages must be within ± 1 volt of nominal for proper operation.

CAUTION

High voltage on large electrolytic capacitors decays slowly. DO NOT TOUCH. CHECK DC VOLTAGE BETWEEN THE TWO BUS BARS ON THE LARGE CAPACITORS WITH VOLTMETER and bleed with resistor to 10 volts dc maximum for safe servicing. DO NOT REMOVE PLUG A3P2 FROM POWER SUPPLY ASSEMBLY, A3. This will disconnect the safety bleed resistor, R5 from the DC bus.

Verify that fuses A8F1 and A8F2 are good, then re-apply input power while observing POWER SUPPLY ON light, located on power supply board, A3. If this LED does not turn on, check fuse A3F1. If A3F1 is blown, turn off power wait 2 minutes and replace fuse. If A3F1 fails a second time, replace power supply board, A3. If POWER SUPPLY ON light does not turn on and A3F1 is OK turn off input AC, disconnect plug in J3 and apply power. If POWER SUPPLY ON light does not turn on replace power supply board A3, if it does turn on inspect all other circuit boards for control power overloads.

3. Check Reset Input J1-9 to J1-12 and be sure no voltage is applied. Voltage above 10 volts at reset input will prevent Ready.

4. If AC power and resets are OK, reset power supply protection circuitry. To do this switch power OFF for 10 seconds then ON to reset power supply protection circuitry. Ready should light within 3 seconds.

5. If Ready does not occur with above steps, replace power supply A3 after observing warnings of (2) above. DO NOT remove any connectors or boards without removing power and confirming that the main bus supply voltage is less than 10 volts DC.

dcLO DISPLAY

This latching fault display occurs when main bus supply voltage has gone too low, even momentarily.

1. Push front panel Reset button or apply Reset input to reset the fault. Ready will occur within 3 seconds after Reset Input is removed if a momentary low bus caused the trip off. Momentary low bus voltage is usually caused by one AC line opening.

2. If Reset does not clear fault, check that input ac voltage is within the range 190 - 253 VAC line to line for 230 VAC units or 380 to 506 VAC line-line for 460 VAC units. If the line voltage is OK, turn off power, wait 2 minutes and check fuses A8 F1 and F2. If either are failed, replace and apply power to the drive. Repeated fuse failures indicate faulty power circuitry and the drive must be returned to the factory for repair.

dc HI DISPLAY

This latching fault display occurs when main bus supply voltage has gone too high, even momentarily.

1. Push front panel Reset button or apply Reset input to reset this fault. Ready will occur after Reset Input is removed if a momentary high bus caused the trip off. Momentary high bus voltage is usually caused by regeneration of the motor with inadequate or open regeneration resistor circuit. See section 6 for the available regeneration resistors for the drive.

2. The deceleration time Pr57 may also be increased to decrease the necessary regenerative resistor capacity.

PH-1, PH-2 OR PH-3 PHASE FAULT DISPLAY

These faults are usually a result of an excessive load on the drive output. The fault condition can be permanent, occurring when the drive is enabled, or, intermittent, occurring randomly during otherwise normal operation.

Note which display is on (PH-1, PH-2, or PH-3) and reset the drive. This is done by either removing power for 10 seconds minimum or by momentarily pressing the external reset. If, after resetting, the drive trips immediately after enabling, follow the suggestions listed under PERMANENT PH-1, PH-2, OR PH-3 FAULTS. If the drive operates normally for a period of time before tripping again, see the suggestions listed under INTERMITTENT PH-1, PH-2 OR PH-3 FAULTS.

PERMANENT PH-1, PH-2, OR PH-3 FAULTS:

1. Motor may have a short circuit. If only one indicator is on, a ground fault on that output line is possible. If two or three indicators are on, the fault is most likely line-line. Remove AC power and disconnect the T1, T2, AND T3 motor leads from the controller. Check the wiring and motor resistance line-line and line to ground.

2. Power transistor may be shorted. Remove AC power, wait 2 minutes, open enclosure observing CAUTION warnings on page 4-1, bleed capacitor DC voltage to 10 volts maximum with resistor and then shunt the transistor bus bars. Inspect power transistors and base drivers for burned components and other obvious signs of damage. To test transistors remove shunt between bus bars. Measure resistance from each bus bar to output terminals T1, T2 and T3 using ohmmeter polarity to back bias power transistor diodes. (Shown in Figure 1) Any resistance less than 500K ohms indicates fault in transistor or internal wiring. Replace power transistor and its associated base driver for any outputs showing less than 500K resistance (power transistor failure usually damages its base driver).

3. A base driver circuit board may be failed. Follow the suggestions given in steps 5 and 6 of INTERMITTENT PH-1, PH-2 OR PH-3 PHASE FAULTS, which follows immediately.

INTERMITTENT PH1, PH2, OR PH3 FAULTS:

1. The current loop gain setting may not be correct. Try running the setup procedures again.

2. Electrical noise may be disturbing the controller. Check that motor and chassis is well grounded. Check the encoder wiring to be sure wires are properly shielded with shields terminated at controller per connection diagram. Make sure signal wires are routed separately from power wires.

3. The current controllers may be saturating at high speeds due to too high a flux current or too low bus voltage. Recheck the parameters and consider lowering the Constant Power Speed (Pr44).

4. Controller may be overheating. Check that controller air inlets and outlets are unobstructed and that the incoming air temperature is less than 50 degrees C.

5. There may be intermittent connections. Remove ac power and wait 2 minutes. Open the enclosure observing CAUTION warnings. Bleed the capacitor DC voltage to 10 volts maximum with a resistor and then shunt the transistor bus bars. Inspect and tighten if necessary, all electrical connections including the 22 AWG wires between the base drivers and power transistors.

6. If the fault consistently occurs in the same phase the base driver may be faulty. Replace the suspected base driver with a known good unit. If a spare board is unavailable interchange the suspected board with one of the other phases to determine if the fault will "move" to the other phase. If the phase fault follows the base driver board it must be replaced.

7. If the fault occurs randomly in different phases or base driver replacement does not eliminate faults, replace the control board.

OH E MOTOR OVERTEMPERATURE DISPLAY

1. Check continuity of normally closed motor thermal switch input, J2-9 to J2-10. Reduce load or improve motor cooling. Jumper J2-9 to J2-10 if motor thermal switch not used.

OH C CONTROL OVERTEMPERATURE DISPLAY

1. If the controller has overheated it may be due to excessive load, failed fan or clogged cooling fins.

2. If indication persists with cool heat sink, check the continuity of normally closed switches, J4-1 and J4-2.

OSP OVERSPEED DISPLAY

1. If operating as a speed controller, an overshoot caused by an under-damped speed loop most likely caused the failure. Check speed loop compensation.

2. If operating as a torque controller, probably the overspeed setting is too low, the user's external controller has malfunctioned, or motor has become disconnected from the load.

3. Improper motor grounding will cause excessive noise leading to overspeed trips. Check that the motor and chassis are well grounded as specified in Main Circuit Wiring section, p. 2-9.

4. Check the encoder nameplate and make certain that the proper lines/rev have been entered into the parameter menu.

15dc (CONTROL POWER SUPPLY) DISPLAY

1. This latched fault indication will occur upon momentary reduction of ±15 volts below allowable levels. Apply Reset Input.

2. If Reset doesn't change 15dc display to rdY, check ±15 volts at J3-4 (+15 VDC) and J3-6 (-15 VDC) relative to common, J3-7. Voltages must be within ±1 volt of nominal.

OL INDICATION DISPLAY

1. Reduce motor load.

2. Check motor and encoder mechanical installations for binding (motor shaft) or excessive lost motion (encoder shaft and coupling).

I LO LOW CURRENT (TORQUE PROVING) DISPLAY

1) Check to make sure the motor is properly connected and that the motor contactor (if used) is closed.

2) Check to make sure the flux current (Pr80) is set to the proper value.

3) Check the current loop proportional gain (Pr82) for too low a setting.

F. Err DISPLAY

This fault display indicates drive cannot follow the speed command within the error band set with At Speed (Pr42) when Following Error trip is enabled with (Pr29) following error selection.

1. Check motor and driven load for mechanical obstruction or brake preventing motion.

2. Check setting of At Speed Tolerance (Pr42) to determine if error band has been set too narrow.

PAr DISPLAY

1. Normally occurs if RAM chips are replaced. Load parameters to return to operation.

2. Will occur every time power is removed and reapplied if a RAM battery has failed. Replace RAMs and reload parameters.

3. May occur if Auto-Tune test is interrupted. Reload parameters.

uP DISPLAY

1. Power interruption may cause this display. Reset to restore operation.

Prog DISPLAY

1. EPROM fault. Replace EPROMS.

NO MOTOR SHAFT ROTATION

1. DISPLAY must indicate 0 or rdY. If not, refer to previous section NO DISPLAY.

2. Run or Enable input per appropriate Figure 1 to 6 for your selected mode may be missing. Check voltage from appropriate J1 Run or Enable input to J1-12. Minimum input voltage is 10VDC, either polarity.

3. Current limit may be set too low to move load. Check current limit (Pr30) setting.

4. Speed command may be zero.

5. The encoder power or signals may be lost. Remove Run or Enable input to disable drive, rotate motor shaft by hand and observe RPM display. If no display, check encoder and wiring to J2 connector.

6. Discontinuity may exist between drive output and motor terminals. Check all wiring.

7. Defective motor.

ERRATIC OR JITTERY SHAFT ROTATION

1. The encoder may be improperly grounded or shielded. Check the interconnect diagram for proper wiring.

2. Motor may be connected with opposite phase rotation to that of the encoder. Reverse the encoder direction per setup instruction, section 3 or 4.

3. Speed loop compensation may be incorrect. Consider lowering the speed controller proportional gain (Pr84).

4. The encoder coupling may be loose or defective.

5. Defective motor or encoder.

WRONG RESPONSE TO SPEED COMMANDS

1. Input common mode voltage may be exceeded. Maximum common mode at J1-4 & -5 is $\pm$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 per startup instructions, section 2.

HARDWARE TESTPOINTS

TP1	DIGITAL GROUND
TP2	DIGITAL GROUND
TP3	TIMING FOR SAMPLE AND HOLD SIGNAL
TP4	PHASE 2 CURRENT (UNFILTERED)
TP5	ANALOG GROUND
TP6	PHASE 3 CURRENT (UNFILTERED)
TP7	DIGITAL GROUND
TP8	PHASE 1 VOLTAGE
TP9	PHASE 2 VOLTAGE
TP10	ENCODER PHASE B
TP11	ENCODER PHASE A
TP12	ENCODER INDEX
TP13	VOLTAGE PROPORTIONAL TO DC BUS
TP14	POT #1
TP15	POT #2
TP16	SPARE DIGITAL I/O PIN, USED IN TIMING TESTS
TP17	DIGITAL GROUND
TP18	ANALOG GROUND

7. PROTECTIVE DEVICES

CONSTANT TORQUE APPLICATION

This control 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.

CATALOG NO.	MAX. HP	INPUT WIRE (AWG)	INPUT BREAKER	INPUT FUSES		OUTPUT WIRE (AWG)
				FAST ACTING	TIME DELAY	
ZD14205-E	5	10	230V/30A	250V/40A	250V/30A	10
ZD14207-E	7.5	8	230V/40A	250V/60A	250V/40A	8
ZD14210-E	10	8	230V/50A	250V/70A	250V/50A	8
ZD14215-E	15	4	230V/70A	250V/90A	250V/70A	4
ZD14225-E	25	3	230V/100A	250V/125A	250V/100A	3
ZD14240-E	40	1	230V/150A	250V/200A	250V/150A	1
ZD14250-E	50	3/0	230V/200A	250V/250A	250V/200A	3/0
ZD14405-E	5	12	460V/20A	600V/30A	600V/20A	12
ZD14410-E	10	10	460V/30A	600V/40A	600V/30A	10
ZD14415-E	15	8	460V/40A	600V/60A	600V/40A	8
ZD14425-E	25	8	460V/50A	600V/70A	600V/50A	8
ZD14430-E	30	6	460V/70A	600V/90A	600V/70A	6
ZD14440-E	40	4	460V/70A	600V/90A	600V/70A	4
ZD14450-E	50	3	460V/100A	600V/125A	600V/100A	3
ZD14475-E	75	1/0	460V/150A	600V/200A	600V/150A	1/0

VARIABLE TORQUE APPLICATIONS SUCH AS FANS AND CENTRIFUGAL PUMPS.

This control 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 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.

CATALOG NO.	MAX. HP	INPUT WIRE (AWG)	INPUT BREAKER	INPUT FUSES		OUTPUT WIRE (AWG)
				FAST ACTING	TIME DELAY	
ZD14205-E	7.5	8	230V/40A	250V/40A	250V/30A	8
ZD14207-E	10	8	230V/50A	250V/70A	250V/50A	8
ZD14210-E	15	6	230V/70A	250V/70A	250V/70A	6
ZD14215-E	20	4	230V/80A	250V/100A	250V/80A	4
ZD14225-E	25	3	230V/100A	250V/125A	250V/100A	3
ZD14240-E	50	2/0	250V/225A	250V/225A	250V/175A	2/0
ZD14250-E	60	3/0	230V/200A	250V/250A	250V/200A	3/0
ZD14405-E	7.5	12	460V/20A	600V/30A	600V/20A	12
ZD14410-E	15	8	460V/40A	600V/60A	600V/40A	8
ZD14415-E	25	8	460V/50A	600V/70A	600V/50A	8
ZD14425-E	30	6	460V/70A	600V/90A	600V/70A	6
ZD14430-E	40	4	460V/80A	600V/100A	600V/80A	4
ZD14440-E	50	3	460V/90A	600V/125A	600V/90A	3
ZD14450-E	60	2	460V/110A	600V/150A	600V/110A	2
ZD14475-E	100	2/0	460V/175A	600V/225A	600V/175A	2/0

INTERNAL FUSE LIST - MODEL ZD142XX (230 VAC)

QTY	RATING	SWEODRIVE P/N	COMMERCIAL EQUIV.	REF. DES.
2	2A, 250VAC	4392000	Buss FNM 2	A8F1, A8F2
1	1 1/2A, 600VAC	4331500	Buss KTK 1 1/2 Littlefuse KLK 1 1/2	A3F1

INTERNAL FUSE LIST - MODEL ZD144XX (460 VAC)

QTY	RATING	SWEODRIVE P/N	COMMERCIAL EQUIV.	REF. DES.
2	2A, 500VAC	4342000	Buss FNQ 2 Littlefuse FLQ 2	A8F1, A8F2
1	1 1/2A, 600VAC	4331500	Buss KTK 1 1/2 Littlefuse KLK 1 1/2	A3F1

8. REGEN RESISTOR ASSEMBLIES

For 100% regeneration capability, disconnect internal 20%, regeneration resistor and connect appropriately rated externally mounted regeneration resistor assembly from table below.

REGENERATION RESISTOR ASSEMBLIES

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

- XX — EQUIVALENT RESISTANCE IN OHMS
- (X OR XX) — WATTS/100
- R — REGEN RESISTOR DESIGNATOR

WATTS	300	600	900	1200	1800	2400	3600	4800
BALDOR CATALOG NO.								
ZD14205-E	RG310	RG610	RG910	RG1210	RG1810	RG2410	RG3610	RG4810
ZD14205-E	RG310	RG610	RG910	RG1210	RG1810	RG2410	RG3610	RG4810
ZD14210-E	RG310	RG610	RG910	RG1210	RG1810	RG2410	RG3610	RG4810
ZD14215-E	-	RG606	RG906	RG1206	RG1806	RG2406	RG3606	RG4806
ZD14225-E	-	RG606	RG906	RG1206	RG1806	RG2406	RG3606	RG4806
ZD14240-E	-	-	RG903	RG1203	RG1803	RG2403	RG3603	RG4803
ZD14250-E	-	-	-	RG1202	RG1802	RG2402	RG3602	RG4802
ZD14405-E	-	RG620	RG920	RG1220	RG1820	RG2420	RG3620	RG4820
ZD14407-E	-	RG620	RG920	RG1220	RG1820	RG2420	RG3620	RG4820
ZD14410-E	-	RG620	RG920	RG1220	RG1820	RG2420	RG3620	RG4820
ZD14415-E	-	RG620	RG920	RG1220	RG1820	RG2420	RG3620	RG4820
ZD14440-E	-	-	RG912	RG1212	RG1812	RG2412	RG3612	RG4812
ZD14450-E	-	-	-	RG1210	RG1810	RG2410	RG3610	RG4810
ZD14475-E	-	-	-	-	RG1806	RG2406	RG3606	RG4806

9. RENEWAL PARTS

CATALOG NO. ZD142XX (230 VAC)

Catalog No.	ZD14205-E		ZD14207-E		ZD14210-E		ZD14215-E	
	QTY	PART #	QTY	PART #	QTY	PART #	QTY	PART #
Power Supply	1ea	0070871	1ea	0070871	1ea	0070871	1ea	0070871
Fans/Blowers			1ea	6950010	1ea	6950010	1ea	6950010
Elect. Caps	1ea	7417825	2ea	7417825	2ea	7417825	2ea	7417825
Diode Bridge	1ea	3710608	1ea	3710608	1ea	3710608	1ea	3710608
DC Link Ind.	1ea	2050020	1ea	2050019	1ea	2050019	1ea	2050019
Base Drivers	3ea	0070086	3ea	0070087	3ea	0070088	3ea	0070085
Power Trans.	3ea	3605005	3ea	3607505	3ea	3610005	3ea	3615005
SCR	1ea	3750608	1ea	3750608	1ea	3750608	1ea	3750608
Snubber Brd.	1ea	1070841	1ea	1070841	1ea	1070841	1ea	1070841
Cur. Sensor	2ea	8387!10	2ea	8387!10	2ea	8387!05	2ea	8387!05
MOD/DEMOD	1ea	0072001	1ea	0072001	1ea	0072001	1ea	0072001
R1	1ea	8344027	1ea	8344027	1ea	8344027	1ea	8344027
R5	1ea	8364224	1ea	8364224	1ea	8364224	1ea	8364224
Control Board	1ea	0075008	1ea	0075008	1ea	0075008	1ea	0075008
Connector P1	1ea	6020120	1ea	6020120	1ea	6020120	1ea	6020120
Connector P2	1ea	6020110	1ea	6020110	1ea	6020110	1ea	6020110
Regen Trans.	1ea	3505005	1ea	3505005	1ea	3505005	1ea	3510005
Display board	1ea	0077202	1ea	0077202	1ea	0077202	1ea	0077202
Knob	1ea	1077341	1ea	1077341	1ea	1077341	1ea	1077341
NEMA 1 cover	1ea	0077504	1ea	0077504	1ea	0077504	1ea	0077504
Cable, Display	1ea	1077881	1ea	1077881	1ea	1077881	1ea	1077881

CATALOG NO. ZD142XX (230 VAC)

Catalog No.	ZD14225-E		ZD14240-E		ZD14250-E			
	QTY	PART #	QTY	PART #	QTY	PART #		
Power Supply	1ea	0070871	1ea	0070875	1ea	0070875		
Fans/Blowers	2ea	6950010	1ea	1003035	1ea	1003035		
Elect. Caps	3ea	7417825	4ea	7417825	4ea	7417825		
Diode Bridge	1ea	3711008	3ea	3701008	3ea	3701608		
DC Link Ind.	1ea	2050019	1ea	2050024	1ea	2050024		
Base Drivers	3ea	0070089	3ea	0070090	3ea	0070093		
Power Trans.	3ea	3620005	6ea	3530005	6ea	3540005		
SCR	1ea	3750908	1ea	3751608	1ea	3752512		
Snubber Brd	1ea	0070841	1ea	0076351	1ea	0076351		
Cur. Sensor	2ea	8387!05	1ea	0076508	1ea	0076509		
MOD/DEMOD	1ea	0072001						
R1	1ea	8344027	2ea	8344050	2ea	8344050		
R5	1ea	8364224	1ea	8364224	1ea	8364224		
Control Board	1ea	0075008	1ea	0075008	1ea	0075008		
Connector P1	1ea	6020120	1ea	6020120	1ea	6020120		
Connector P2	1ea	6020110	1ea	6020110	1ea	6020110		
Regen Trans.	1ea	3510005	1ea	3520005	1ea	3520005		
Display board	1ea	0077202	1ea	0077202	1ea	0077202		
Knob	1ea	1077341	1ea	1077341	1ea	1077341		
NEMA 1 cover	1ea	0077504	1ea	0077504	1ea	0077504		
Cable, Display	1ea	1077881	1ea	1077881	1ea	1077881		

CATALOG NO. ZD144XX (460 VAC)

Catalog No.	ZD14405-E		ZD14410-E		ZD14415-E		ZD14425-E	
	QTY	PART #	QTY	PART #	QTY	PART #	QTY	PART #
Power Supply	1ea	0070872	1ea	0070872	1ea	0070872	1ea	0070872
Fans/Blowers					1ea	6950010	1ea	6950010
Elect. Caps	2ea	7417825	2ea	7417825	2ea	7417825	4ea	7417825
Diode Bridge	1ea	3710616	1ea	3710616	1ea	3710616	1ea	3710616
DC Link Ind.	1ea	2050017	1ea	2050017	1ea	2050017	1ea	2050013
Base Drivers	3ea	0725221	3ea	0725222	3ea	0725223	3ea	0725216
Power Trans.	3ea	3603112	3ea	3605112	3ea	3607612	3ea	3610112
SCR	1ea	3750612	1ea	3750612	1ea	3750612	1ea	3750612
Snubber Brd.	1ea	0170842	1ea	0170842	1ea	0170842	1ea	0170842
Cur. Sensor	2ea	8398003	2ea	8387!10	2ea	8387!10	2ea	8387!05
MOD/DEMOD	1ea	0072001	1ea	0072001	1ea	0072001	1ea	0072001
R1	1ea	8344047	1ea	8344047	1ea	8344047	1ea	8344047
R5	1ea	8364236	1ea	8364236	1ea	8364236	1ea	8364236
Control Board	1ea	0075008	1ea	0075008	1ea	0075008	1ea	0075008
Connector P1	1ea	6020120	1ea	6020120	1ea	6020120	1ea	6020120
Connector P2	1ea	6020110	1ea	6020110	1ea	6020110	1ea	6020110
Regen Trans.	1ea	3505010	1ea	3505010	1ea	3505010	1ea	3505010
Display board	1ea	0077202	1ea	0077202	1ea	0077202	1ea	0077202
Knob	1ea	1077341	1ea	1077341	1ea	1077341	1ea	1077341
NEMA 1 Cover	1ea	0077502	1ea	0077502	1ea	0077502	1ea	0077502
Cable, Display	1ea	1077881	1ea	1077881	1ea	1077881	1ea	1077881

CATALOG NO. ZD144XX (460 VAC)

Catalog No.	ZD14430-E		ZD14450-E		ZD14475-E			
	QTY	PART #	QTY	PART #	QTY	PART #		
Power Supply	1ea	0070872	1ea	0070877	1ea	0070877		
Fans/Blowers	1ea	6950010	1ea	1003035	1ea	1003035		
Elect. Caps	4ea	7417825	8ea	7417825	8ea	7417825		
Bridge	1ea	3710616	3ea	3700816	3ea	3700816		
DC Lnk Ind.	1ea	2050013	1ea	2050025	1ea	2050025		
Base Drivers	3ea	0725216	3ea	0725219	3ea	0725219		
Power Trans.	3ea	3615112	6a	3520112	6ea	3530112		
SCR	1ea	3750612	1ea	3750912	1ea	3751612		
Snubber Brd.	1ea	0170842	1ea	0076351	1ea	0076351		
Cur. Sensor	2ea	8387!05	1ea	0076507	1ea	0076508		
MOD/DEMOD	1ea	0072001						
R1	1ea	8344047	1ea	8344050	1ea	8344050		
R5	1ea	8364236	1ea	8364224	1ea	8364224		
Control Board	1ea	0075007	1ea	0075007	1ea	0075007		
Connector P1	1ea	6020120	1ea	6020120	1ea	6020120		
Connector P2	1ea	6020110	1ea	6020110	1ea	6020110		
Regen Trans.	1ea	3510010	1ea	3520112	1ea	3520112		
Display board	1ea	0077202	1ea	0077202	1ea	0077202		
Knob	1ea	1077341	1ea	1077341	1ea	1077341		
NEMA 1 Cover	1ea	0077503	1ea	0077503	1ea	0077503		
Cable, Display	1ea	1077881	1ea	1077881	1ea	1077881		

10. DRAWINGS

B-0019	Outline and Mounting
7143	Connection Diagram 230V A.C. Motor Controller, Size A, B
7148	Connection Diagram 460V A.C. Motor Controller, Size A, B
7633	Connection Diagram 230 VAC Motor Controller Size C
7634	Connection Diagram 460 VAC Motor Controller Size C
7786	Flux Vector Interface

APPENDIX A

ANALOG OUTPUTS Pr20 and Pr21

There are two programmable 0 to +5V full scale analog outputs updated every 2 msec available on pins J1-6 and J1-7. These are used to monitor various internal digital flux-vector variables. Assignment may be made through the keypad as parameters Pr20 and Pr21. They may also be assigned by the optional computer or terminal input from the main user menu or in the down loaded configuration file under #20 and #21. Listed below are the selection number followed by the selection name:

Number	Name	Description
0)	SPEED	Absolute value of speed with +5V = MAXIMUM RPM (Pr13). Useful as speed meter output. Factory preset for J1-6.
1)	ABS VALUE TORQUE	Absolute value of torque with +5V = torque at CURRENT LIMIT (Pr30). Useful as load meter output.
2)	SPEED COMMAND	Absolute value of the commanded speed with +5V = MAXIMUM RPM (Pr13).
3)	VOLTAGE MAGNITUDE	Magnitude of the voltage sent to motor, full scale = line voltage (Pr05).
4)	FLUX I FDBK	Flux current feedback. Useful with #5 FLUX I CMND to determine current loop performance. (updated 0.5 ms)
5)	FLUX I CMND	Commanded flux current.
6)	LOAD I FDBK	Load current feedback. Useful with #7 LOAD I CMND to determine torque loop response. (updated 0.5 ms)
7)	LOAD I CMND	Commanded load current.
8)	ABS MOTOR CURRENT	Magnitude of motor current, scaled + 2.5V = rated motor current (Pr08). Factory preset for J1-7.
9)	ABS LOAD CURRENT	Load (torque producing) component of rated motor current (Pr08): +2.5V = rated current.
10)	LOAD CNTRLR	Load controller output. Useful in diagnosing controller problems and manual setting of feed forward.
11)	FLUX CNTRLR	Flux controller output.
12)	OUTPUT VOLTAGE	PWM control voltage which is proportional to AC line to line motor terminal voltage. Used to set flux current value. +5V = Max voltage.

13)	HOMED(5V)	Motor oriented. 0V normally, +5V when the motor is in orient position (HOME). Used as an At-Home indication.
14)	LOAD	Bipolar torque output. +2.5V = zero torque, 0V = Torque at - Current Limit (Pr30), +5V = Torque at + Current Limit (Pr30).
15)	POWER	Bipolar power output. +2.5V = zero power, 0V = - rated peak power, +5V = + rated peak power.
16)	BIPOLAR SPEED	Motor speed scaled +2.5V = zero speed, 0V = - Maximum Speed (Pr13), +5V = + Maximum Speed (Pr13).
17)	OL ACCUMULATOR	Accumulated current squared times time, OL occurs at +5V.
18)	PHASE 2 CURRENT	Sampled AC motor current. +2.5V = Zero current, 0V = -Rated peak current, +5V = + Rated peak current.
19)	PHASE 3 CURRENT	
20)	ANALOG INPUT	Commanded input on J1-4 to J1-5. +2.5V = Zero input, 0V = - Maximum SW1 selected range, +5V = + Maximum SW1 selected range.

AUXILIARY ANALOG INPUTS Pr22 and Pr23

These two inputs are on pins J1-1 and J1-3. They accept voltages from -5V to +5V DC and may be assigned to the following functions through the keypad as parameters Pr22 and Pr23. They may also be assigned by the optional computer or terminal input from the main user menu or in the down loaded configuration file under #22 and #23. Listed below are the selection number followed by the selection name:

Number	Name	Description
0)	NOT USED	Factory preset.
1)	CURRENT LIMIT	This external current limit adjusts the torque producing component of current limit from 0 to 100% of the Pr30 current limit value as the input voltage is varied from zero to +5 VDC.
2)	OVERSPEED	The overspeed setting is varied from 0 to 110% of the Pr13 Maximum Speed as the input voltage is varied from zero to +5 VDC.

OPTO ISOLATED OUTPUTS Pr 24, Pr25 and Pr26

There are three opto isolated 24 VDC outputs on connector J1 pins 16, 17, and 18. Assignment of these outputs to available drive variables may be made through the keypad as parameters Pr24, Pr25, and Pr26. They may also be assigned by the optional terminal or computer input from the main user menu or in the down loaded configuration file listed under #24, #25, and 26. Listed below are the configuration selection number followed by the name and description:

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 (Pr41) speed threshold, otherwise open. If 'orient' is enabled, this output is active when the motor speed is less than the specified (Pr41) 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 (Pr42) tolerance band of the commanded speed, open outside tolerance band.
3)	OVERLOAD	Closed when an rms current overload has not occurred, open upon overload.
4)	DRIVE OT	Closed when an over-temperature fault has not occurred, open upon overtemperature.
5)	SET SPEED	Closed whenever the motor speed is above the user specified (Pr 43) "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 (Pr42) tolerance band of the Acc-Dec and S-Curve Conditioned (Pr 56, 57, 58) 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.
10)	INPUT DIRECTION	Closed when reverse input direction command is received, open for forward.

TORQUE PROVING/FOLLOWING ERROR/OL FOLDBACK/TORQUE RATE LIMIT Pr29

When enabled, 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 Run with torque proving enabled, 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.

When enabled, the Following Error protective feature shuts down the drive and displays F.Err whenever the speed error exceeds the Pr42 At Speed Tolerance.

When enabled, the Overload Foldback prevents the drive from tripping off on an overload condition by automatically reducing the current limit (Pr30) to 90% of the motor rating (Pr08) until the overload accumulator drops below 90 %. The current limit is then automatically restored to its original setting.

When enabled, the Torque Rate Limit restricts the rate of change of torque to approximately 2.5% of peak torque (available torque with Pr30 set to maximum) capability per millisecond.

Using the computer Pr29 to:

Pr29	Feature Selection
0	None
1	Torque Proving Enabled
2	Following Error Enabled
3	Torque Proving & Following Error Enabled
4	Overload Foldback Enabled
5	Overload Foldback and Torque Rate Limit Enabled
6	Torque Rate Limit Enabled

Keypad only:

Pr29	Feature Selection
0	None
1	Torque Proving Enabled
2	Following Error Enabled
3	Torque Proving & Following Error Enabled

Using the optional terminal or computer input, use Tab or Enter Key to select Additional Faults on I/O Selection Menu for:

Screen Display	Feature Selection
OVERLOAD	None
OL/TRQ PROVING	Torque Proving Enabled
OL/FOL.ERROR	Following Error Enabled
OL/TRQ PRV/FOL ER	Torque Proving & Following Error Enable
OL FOLDBACK	Overload Foldback Enabled
FOLDBACK/dI/dt	Overload Foldback and Torque Rate Limit Enabled
dI/dt LIMIT	Torque Rate Limit Enabled

APPENDIX B

FLUX CURRENT Pr80

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.

SLIP GAIN Pr81

The slip gain is normally preset or auto-tuned. If the motor rotor time constant is known the slip gain can be calculated by:

Tr = rotor time constant in msec

$$\text{Pr81=Slip Gain=}\frac{27{,}813}{T_r}$$

The following formulas can also be used:

IR = Pr08 = Rated Current

IE = Pr80 = Flux Current

$$F_{Slip}=(\text{Syncronous RPM}-\text{Rated RPM})\ \frac{\text{NO. POLES}}{120}$$

$$\text{SlipGain}=F_{SLIP}\times 175\left[\frac{I_E}{\sqrt{I_R^2-I_E^2}}\right]\approx F_{SLIP}\times 61.7 \qquad \text{for IE = 40\% IR}$$

CURRENT CONTROLLER GAINS - Pr82 & Pr83

The current controller proportional gain Pr82 is normally preset for pretuned 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:

$$\text{Pr82}=K_p=\frac{[740\times L\times(A/V)]}{VAC}$$

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

The current controller integral gain Pr83 is factory preset at 50Hz. This setting is suitable for essentially all systems, DO NOT CHANGE WITHOUT FACTORY APPROVAL.

SPEED CONTROLLER GAINS - Pr84 & Pr85

The speed controller proportional gain Pr84 is normally preset or auto-tuned. This gain may be increased or decreased to suit the application. Increasing Pr84 will result in faster response, excessive proportional gain will cause overshoot and ringing. Decreasing Pr84 will cause slower response and decrease overshoot and ringing caused by excessive proportional gain.

The speed controller integral gain parameter Pr85 in Hertz as discussed under PI controller below may be set at any value from zero to 10 Hertz. Setting Pr85 = 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 Pr85 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 initially set Pr85 = 0 (remove integral gain), increase the Pr84 setting until adequate response to step speed commands is attained, then increase Pr85 setting to increase 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 Pr22 or 23 set to 16 (bipolar speed, 2.5 VDC = zero speed). See Appendix A discussion of analog outputs.

PI CONTROLLER

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

$$E = \text{Command} - \text{Feedback}$$

then the PI controller operates on 'E' as

$$\text{Output} = (Kp * E) + (Ki \int E\, dt)$$

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

$$\text{Output}/E = Kp + Ki / s = Kp (s + Ki/Kp) / s .$$

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

$$\text{SWEODRIVE KI} = (Ki / Kp) / (2 \Pi) \text{ Hz},$$

and the transfer function is

$$\text{Output}/E = Kp (s + 2 \Pi KI) / s.$$

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.

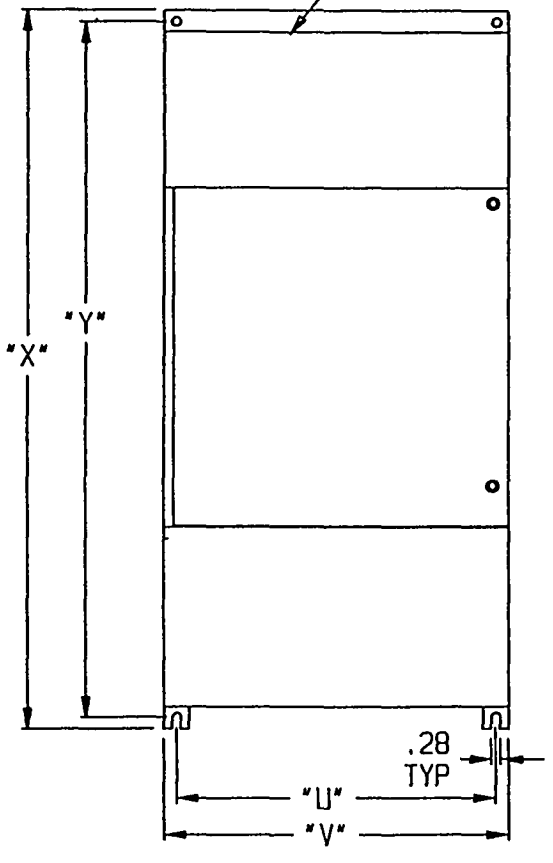
The proportional gain sets the open loop gain of the system - the bandwidth (speed of response) of the system. If the system is excessively noisy, it is most likely due to the proportional gain being set too high.

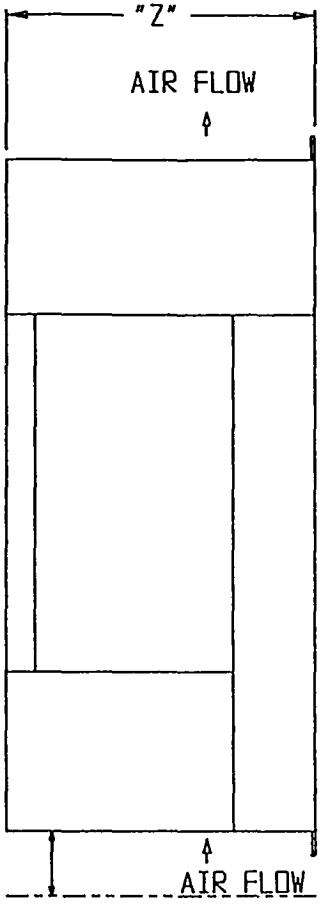
APPENDIX C

AC VECTOR DRIVE PARAMETER LIST

PARA-METER NUMBER	DESCRIPTION	FACTORY PRESET	SELECTED SETTINGS
	DISPLAY PARAMETERS IN OPERATOR MODE		
00	DISPLAY VARIABLE SELECTED BY PARAMETER 1.		
01	0=SPEED(RPM), 1=CURRENT(A RMS), 2=FREQ(HZ), 3=VOLTS	0	
02	PRESENT FAULT (ARROW SCROLLS THROUGH LAST 5 FAULTS)		
03	SPEED COMMAND (RPM)		
	ESSENTIAL USER ENTERED PARAMETERS		
05	LINE VOLTAGE (VOLTS RMS)		
06	CONTROLLER MODEL NUMBER (FIRST DIGITS)		
07	CONTROLLER MODEL NUMBER (REMAINING DIGITS)		
08	MOTOR RATED CURRENT (AMPS RMS)		
09	MOTOR RATED VOLTAGE (VOLTS RMS)		
10	MOTOR "RATED" OR "BASE" SPEED (RPM), NOT MAX SPEED!		
11	MOTOR "RATED" OR "BASE" FREQUENCY (Hz)		
12	ENCODER LINES PER REVOLUTION		
13	DESIRED MAXIMUM MOTOR SPEED (RPM)		
14	SELECT OPERATING MODE (SEE OPERATING MODES)		
15	ENTER 1 TO CALCULATE & LOAD ALL REMAINING DEFAULT PARAMETERS		
	I/O PARAMETERS (OPTIONAL)		
20	SELECTION FOR USER D/A #1 (J1-6)	0	
21	SELECTION FOR USER D/A #2 (J1-7)	8	
22	SELECTION FOR AUXILIARY A/D #1 (J1-1)	0	
23	SELECTION FOR AUXILIARY A/D #2 (J1-3)	0	
24	SELECTION FOR OPTO OUTPUT #1 (J1-15)	0	
25	SELECTION FOR OPTO OUTPUT #2 (J1-17)	1	
26	SELECTION FOR OPTO OUTPUT #3 (J1-18)	2	
27	AUTO FAULT RESET (FAULTS / HR)	0	
28	AUTO RESET DELAY TIME (SECONDS)	0	
29	TORQUE PROVING/FOLLOWING ERROR/OL FOLDBACK/ TORQUE SPEED	0	
	MISC AMPLIFIER DATA (OPTIONAL)		
30	CURRENT LIMIT (AMPS RMS)	2x Pr08	
31	NUMBER OF PARALLEL AMPLIFIERS (1 STANDARD)	1	
32	PWM FREQUENCY (Hz)	2500	
33	ENCODER FILTER (Hz)	CALC	

PARA-METER NUMBER	DESCRIPTION	FACTORY PRESET	SELECTED SETTINGS
	I/O THRESHOLD PARAMETERS (OPTIONAL)		
40	ANALOG INPUT DEADBAND FOR ZERO SPEED COMMAND (RPM)	0	
41	ZERO SPEED TOLERANCE (RPM)	10	
42	AT SPEED TOLERANCE (%)	10	
43	SET SPEED (RPM)	1000	
44	CONSTANT POWER SPEED (RPM)	CALC	
45	MINIMUM SPEED (RPM)	0	
	SYSTEM CONTROL PARAMETERS (OPTIONAL)		
50	PRESET SPEED #1, SELECTED BY EXTERNAL I/O (RPM)	0	
51	PRESET SPEED #2 (RPM)	CALC	
52	PRESET SPEED #3 (RPM)	CALC	
53	PRESET SPEED #4 (RPM)	CALC	
54	PRESET SPEED #5 (RPM)	CALC	
55	PRESET SPEED #6 (RPM)	CALC	
56	ACCEL (0 TO MAX SPEED) SEC	2.00	
57	DECEL (MAX SPEED TO 0) SEC	2.00	
58	TIME TO MAX ACCEL ("S" CURVE) SEC	0	
59	HOMING SPEED (RPM)	100	
60	HOMING OFFSET FROM INDEX MARK (ENCODER COUNTS X 4)	1000	
	FLUX VECTOR CONTROL PARAMETERS (OPTIONAL)		
80	FLUX (NO LOAD, IDLE) CURRENT (AMPS RMS)	CALC	
81	SLIP GAIN	CALC	
82	CURRENT CONTROLLER PROPORTIONAL GAIN	20	
83	CURRENT CONTROLLER INTEGRAL GAIN (Hz)	50	
84	SPEED CONTROLLER PROPORTIONAL GAIN	10	
85	SPEED CONTROLLER INTEGRAL GAIN (Hz)	1	
86	ENCODER ALIGNMENT DIRECTION (0 OR 1)	1	
	AUTO TESTS		
90	AUTO TUNING #1 (TRIM INPUT A/D 'S) (DRIVE NOT ENABLED)		
91	AUTO TUNING #2 (ALIGN MOTOR AND ENCODER) (DRIVE ENABLED)		
92	AUTO TUNING #3 (SET CURRENT LOOP COMPENSATION) (DRIVE ENABLED)		
93	AUTO TUNING #4 (SET FLUX CURRENT) (DRIVE ENABLED)		
94	AUTO TUNING #5 (SET SLIP GAIN) (DRIVE ENABLED)		
95	AUTO TUNING #6 (SET SPEED LOOP COMPENSATION) (DRIVE ENABLED)		
99	SECURITY CODE	9999	





2" MIN AIR CLEARANCE
BOTH ENDS

SIZE	"U"	"V"	"X"	"Y"	"Z"
A	10.25 (26,0)	11.00 (28,0)	23.50 (59,7)	22.75 (57,8)	10.00 (25,4)
B	10.25 (26,0)	11.00 (28,0)	27.50 (69,9)	26.75 (69,8)	10.00 (25,4)
C	13.00 (33,0)	14.50 (36,8)	50.50 (128,3)	49.50 (125,7)	11.00 (28,0)

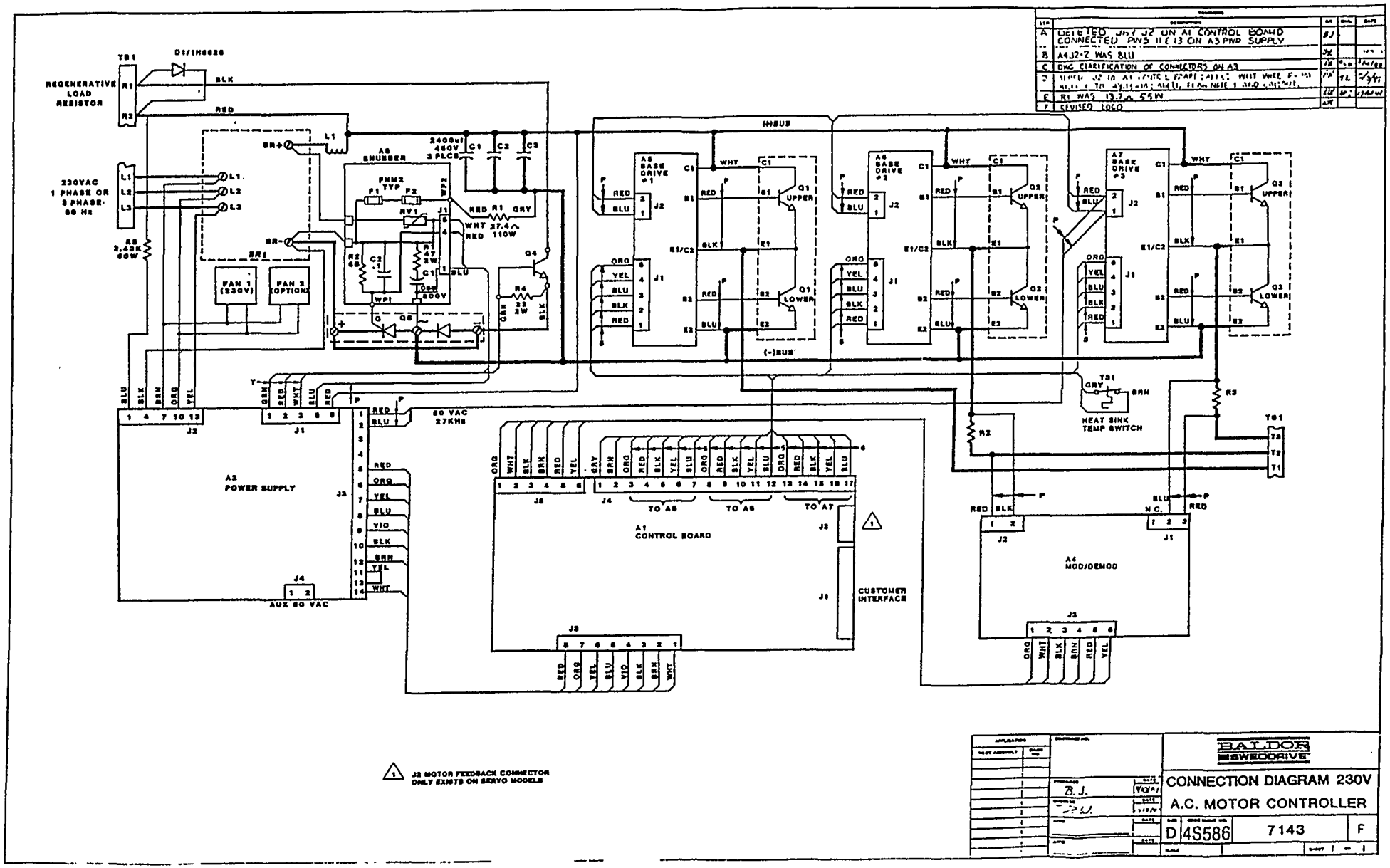
B-0019

DIMENSIONS IN INCHES (CM)

BALDOR MOTION

OUTLINE AND MOUNTING
BALDOR CONTROLLER
WITH NEMA 1 CONDUIT BOX

0 4S586 B-0019

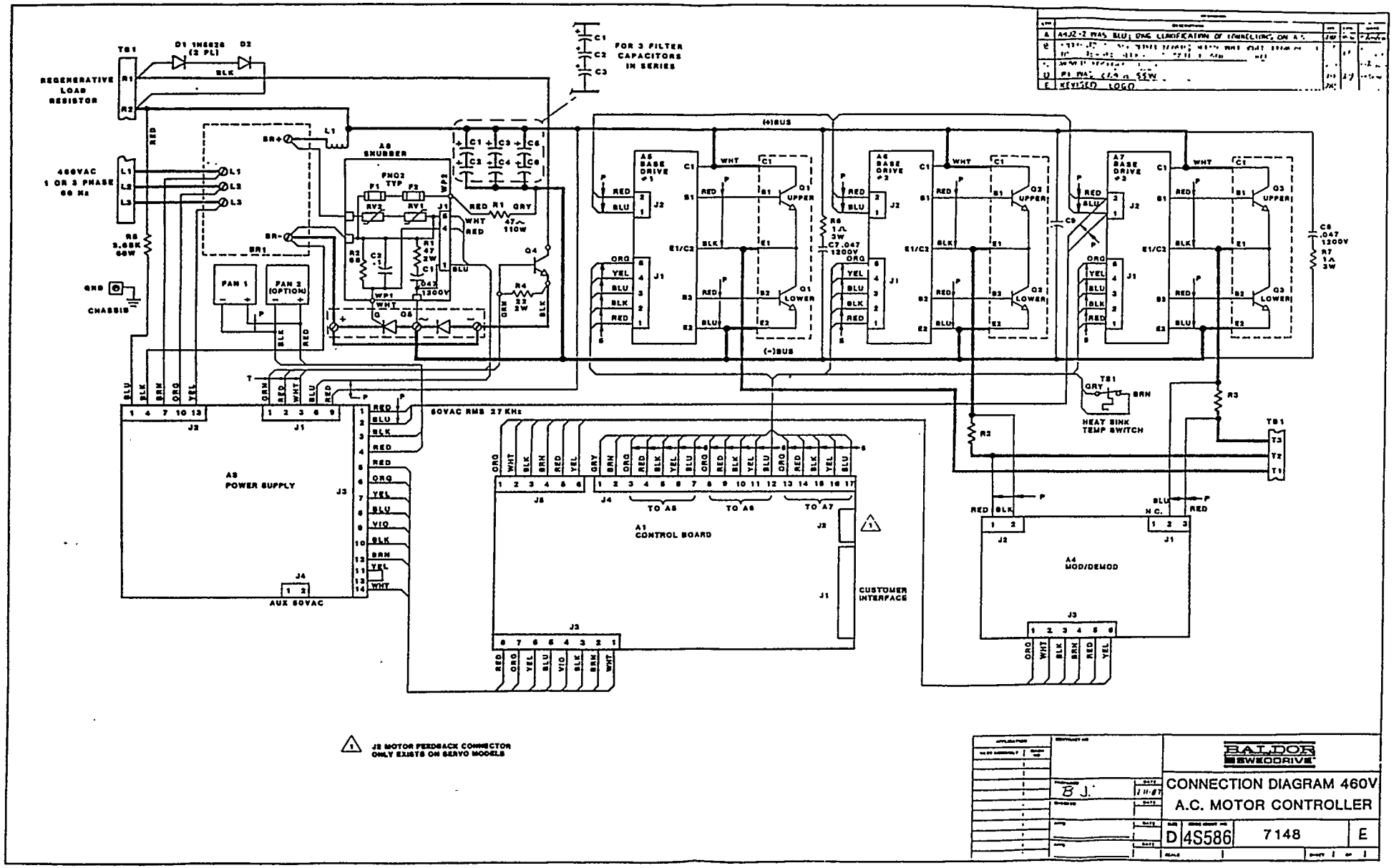


LTR	DESCRIPTION	BY	CHK	DATE
A	DELETED J4-1 J2 ON A1 CONTROL BOARD CONNECTED PINS 11 & 13 ON A3 PWR SUPPLY	BJ		
...		JK		
B	A4J2-2 WAS BLU	JK		
C	DWG CLARIFICATION OF CONNECTORS ON A3	JK		5/31/88
D	[illegible]	JK	TL	7/5/91
E	R1 WAS 13.7Ω 55W	JK	BP	1/24/94
F	REVISED LOGO	AK		

BALDOR SWEDODRIVE

CONNECTION DIAGRAM 230V
A.C. MOTOR CONTROLLER

D	4S586	7143	F



A	A4J2-2 WAS BLU; ENG CLARIFICATION OF CONNECTING ON A1		
B	[illegible]		
D	P1 WAS [illegible]		
E	REVISED LOGO		

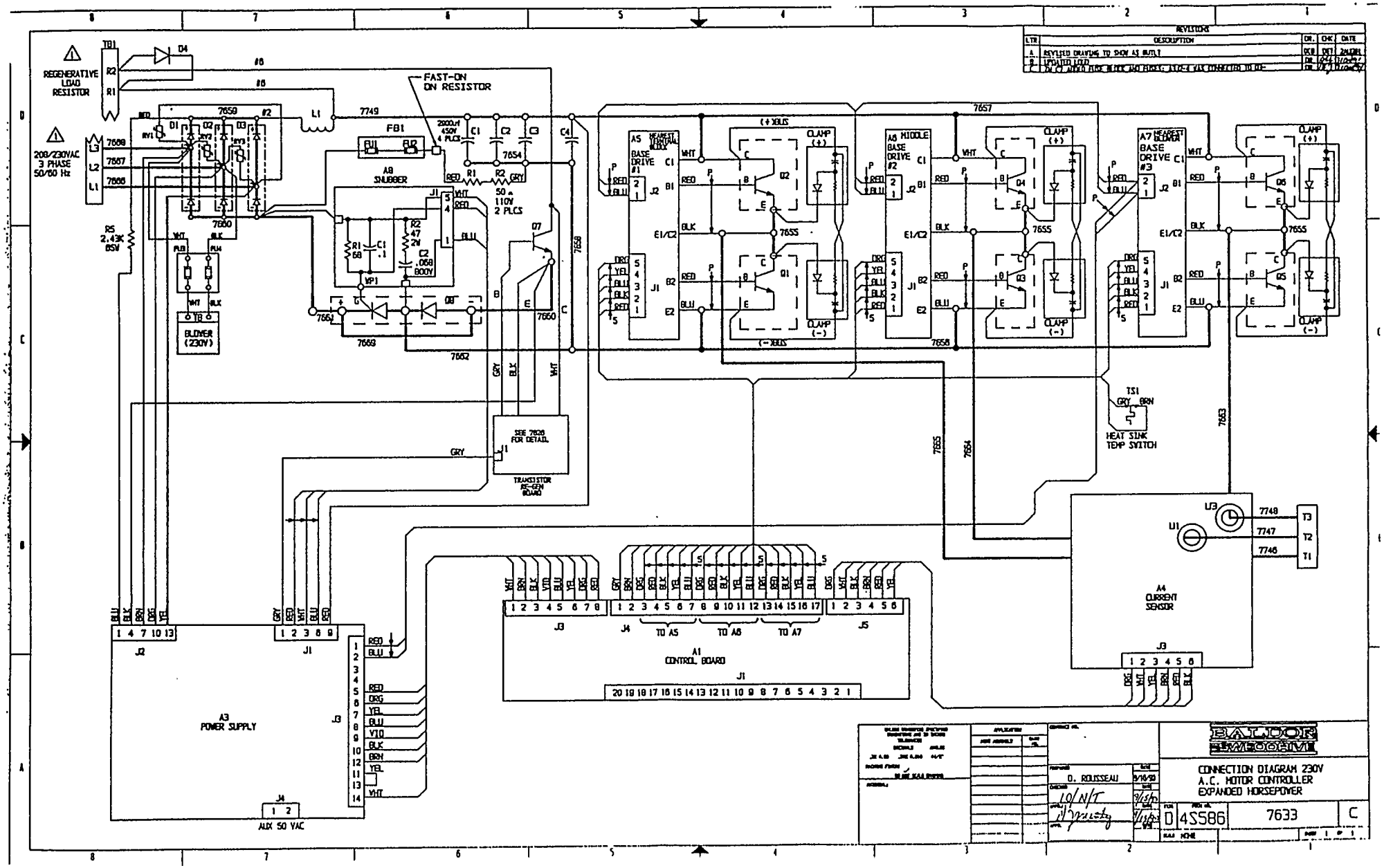
⚠1 J2 MOTOR FEEDBACK CONNECTOR ONLY EXISTS ON SERVO MODELS

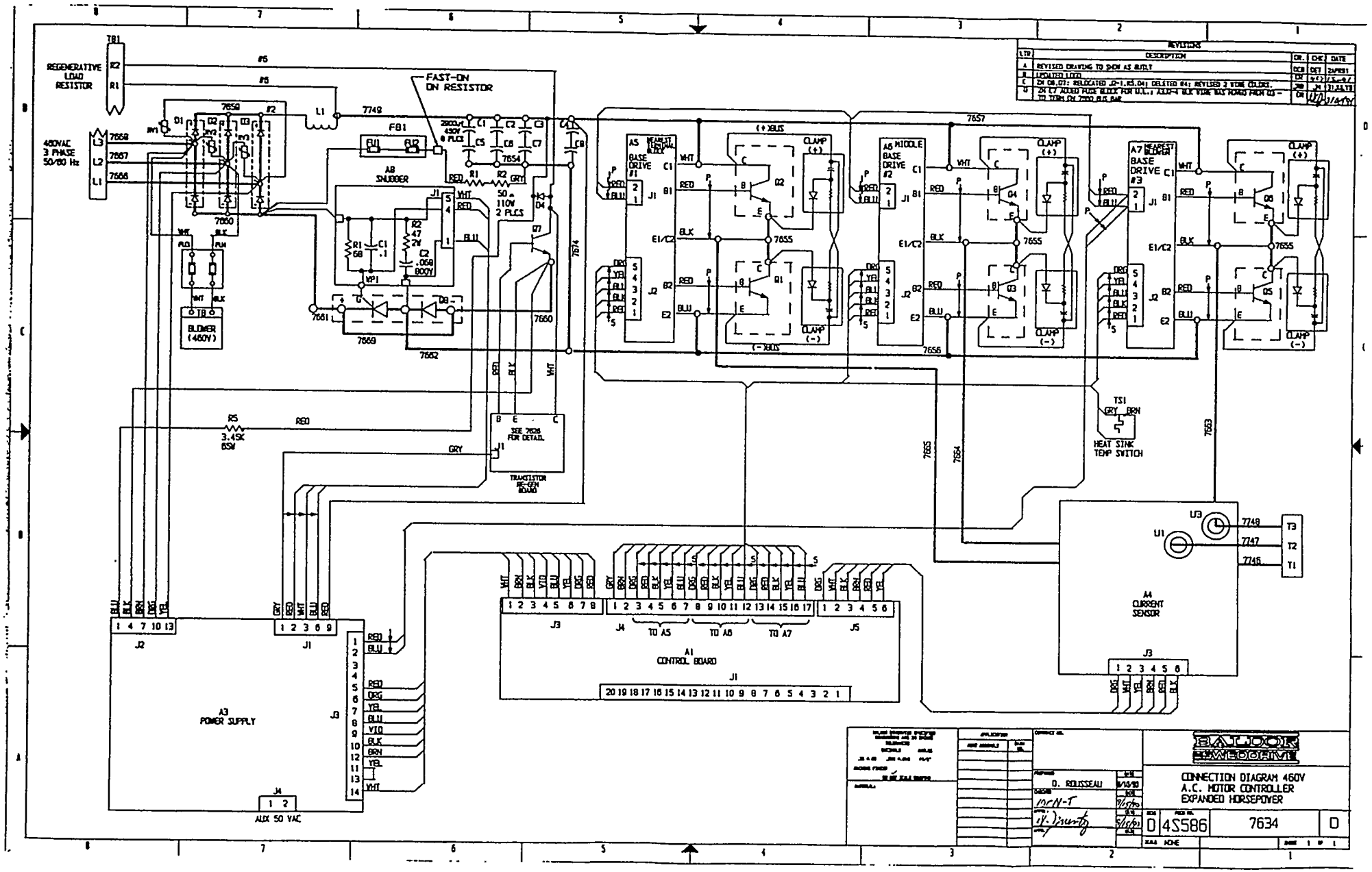
BALDOR SWECODRIVE

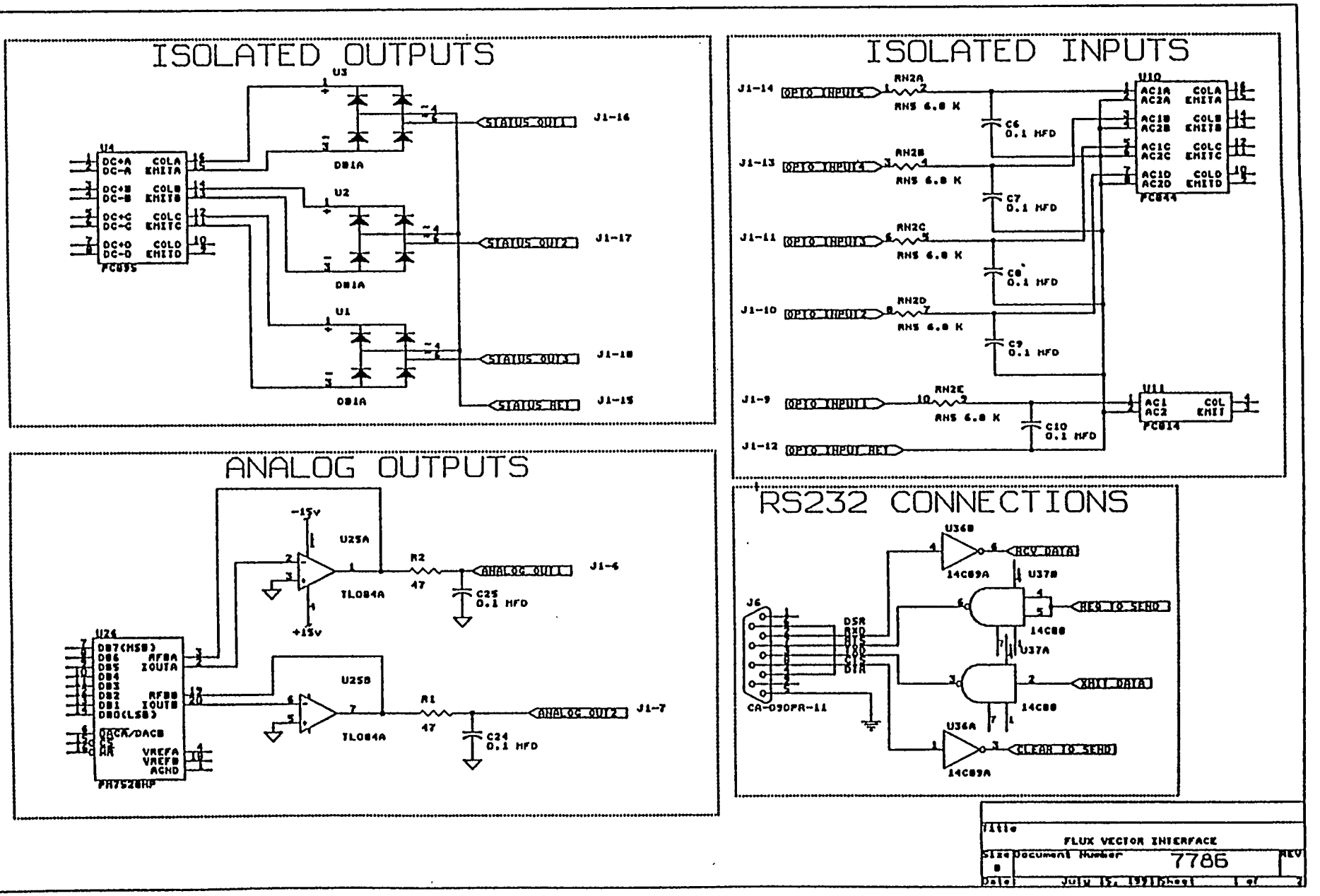
CONNECTION DIAGRAM 460V
A.C. MOTOR CONTROLLER

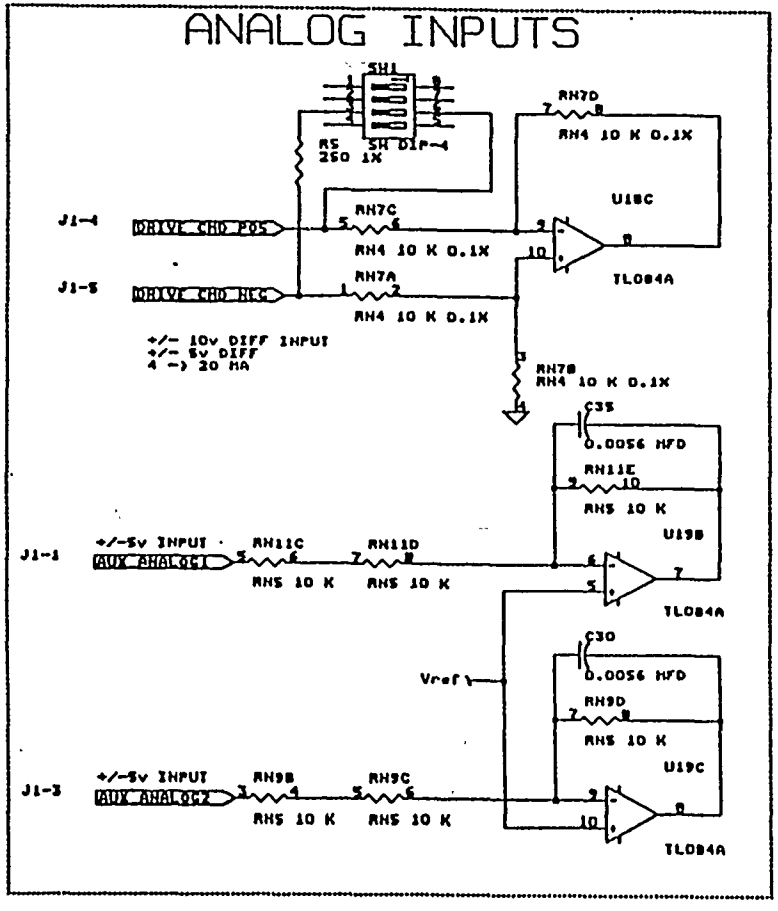
D	4S586	7148

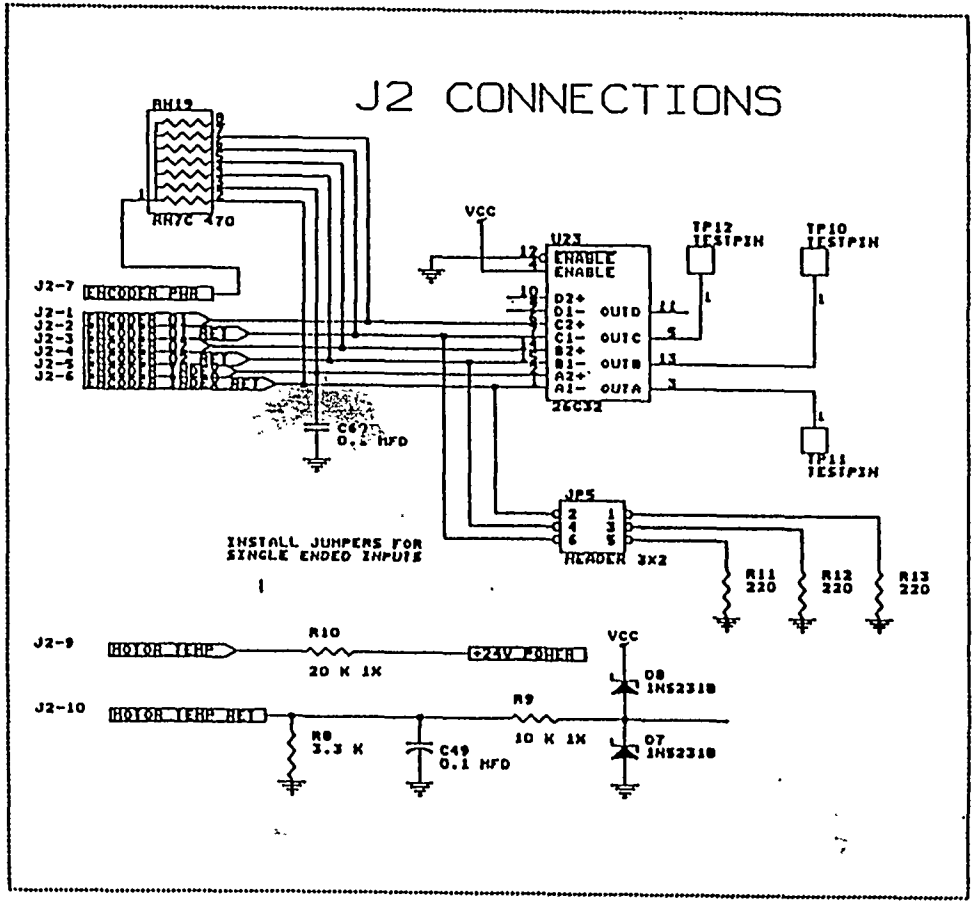
E


REGENERATIVE LOAD RESISTOR
208/230VAC 3 PHASE 50/60 Hz
FAST-ON ON RESISTOR
A3 POWER SUPPLY
A1 CONTROL BOARD
A4 CURRENT SENSOR
A5 NEAREST BASE DRIVE #1
A6 MIDDLE BASE DRIVE #2
A7 NEAREST BLOWER BASE DRIVE #3
A8 SNUBBER
BLOWER (230V)
HEAT SINK TEMP SWITCH
TRANSISTOR RG-GEN BOARD
AUX 50 VAC
TO A5
TO A6
TO A7
CLAMP (+)
CLAMP (-)
+VBUS
-VBUS
REVISIONS
CONNECTION DIAGRAM 230V
A.C. MOTOR CONTROLLER
EXPANDED HORSEPOWER
BALDOR
EM5066M
D. ROUSSEAU
D 4S586
7633
C


REGENERATIVE LOAD RESISTOR
FAST-ON DN RESISTOR
480VAC 3 PHASE 50/60 Hz
A8 SNUBBER
BLOWER (460V)
SEE 7626 FOR DETAIL
TRANSISTOR RE-GEN BOARD
HEAT SINK TEMP SWITCH
A3 POWER SUPPLY
AUX 50 VAC
A1 CONTROL BOARD
TO A5
TO A6
TO A7
A4 CURRENT SENSOR
A5 BASE DRIVE #1
A6 MIDDLE BASE DRIVE #2
A7 BASE DRIVE #3
(+)BUS
(-)BUS
CLAMP (+)
CLAMP (-)
REVISIONS
CONNECTION DIAGRAM 460V
A.C. MOTOR CONTROLLER
EXPANDED HORSEPOWER
BALDOR ELECTRIC
4S586
7634
D


ISOLATED OUTPUTS
U3
U4
DC+A
DC-A
COLA
EMITA
DC+B
DC-B
COLB
EMITB
DC+C
DC-C
COLC
EMITC
DC+D
DC-D
COLD
EMITD
FC895
DB1A
U2
U1
STATUS OUT1
STATUS OUT2
STATUS OUT3
STATUS RET
J1-16
J1-17
J1-18
J1-15
ISOLATED INPUTS
J1-14
OPTO INPUT4
RN2A
RNS 6.8 K
C6
0.1 MFD
J1-13
OPTO INPUT3
RN2B
C7
J1-11
OPTO INPUT2
RN2C
C8
J1-10
OPTO INPUT1
RN2D
C9
J1-9
OPTO INPUT RET
RN2E
C10
U10
AC1A
AC2A
AC1B
AC2B
AC1C
AC2C
AC1D
AC2D
FC844
U11
AC1
AC2
COL
EMIT
FC814
ANALOG OUTPUTS
-15v
U25A
TL084A
+15v
R2
47
C25
0.1 MFD
ANALOG OUT1
J1-6
U26
DB7(MSB)
DB6
DB5
DB4
DB3
DB2
DB1
DB0(LSB)
WR
VREFA
VREFB
AGND
AFBA
IOUTA
AFBB
IOUTB
DACA/DACB
FM7528HP
U25B
R1
C24
ANALOG OUT2
J1-7
RS232 CONNECTIONS
U36B
14C89A
RCV DATA
U37B
14C88
U37A
RTS TO SEND
XMIT DATA
U36A
CLEAR TO SEND
J6
DSR
RXD
RTS
TXD
CTS
DTR
CA-090FR-11
Title
FLUX VECTOR INTERFACE
Size
B
Document Number
7786
REV
Date
July 15, 1991
Sheet
1 of
2





Title	FLUX VECTOR INTERFACE	
Size B	Document Number 7786	REV
Date	July 15, 1991 Sheet 2 of 2	