MANUAL 7122

AC VECTOR DRIVE

MODEL 714-510-170

DRIVE PART NO. 0714620

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1.0 GENERAL INFORMATION

1.1 INTRODUCTION

The purpose of this manual is to provide installation, start-up, operating and maintenance instructions for a Model 71x-xx-170 SWEODRIVE Flux Vector Drive. The 170 series drives are expressly designed to drive ac induction motors equipped with encoders.

Manual Sections 1 through 4 contain a general explanation for a BALDOR SWEODRIVES flux vector drive. The Title page, Fuse List, (section 5) and Drawing list (section 6) contain information specific to this drive system.

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1.2 SAFETY NOTICE

WARNING

This equipment contains voltages which may be as high 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:

1. *USE EXTREME CAUTION, DO NOT TOUCH any circuit board, power device or motor electrical connection without insuring unit is properly grounded and no high voltage is present. DO NOT apply ac power before grounding per instructions herein. DO NOT open cover for 2 minutes after removing ac power to allow capacitors to discharge.*

2. *BE CERTAIN that possible violent motion of motor shaft and driven machinery due to improper control operation will not cause injury to personnel or damage to equipment. Peak torques of several times rated motor torque can occur during a control failure.*

3. *Motor circuit may have high voltage present whenever ac power is applied, even when motor is not rotating.*

1.3 DRIVE DESCRIPTION

The 71x series drives are especially adapted for high performance industrial servo control systems. They operate directly from three phase 240/460 VAC power and can control a 5 to 40 HP ac induction motor. Operation on a single phase power source with reduced performance is also possible. Outline and mounting dimensions of the drive enclosure is specified on drawing 7153.

The drive consists of the following major elements in a compact enclosed assembly:

1. Mounting base with grounded heat sink, on which are mounted: bus capacitors C1 through C6, the main power transistors Q1, Q2, and Q3, output current sensing resistors R2 and R3, three phase diode bridge BR1, input filter inductor L1, soft start resistor R1, soft start bypass SCR (part of Q5 module), regenerated energy regulator transistor Q4 and the power terminal block. Units rated over 20 amps rms also have a fan for circulation of cooling air.

2. Base drivers A5, A6 and A7 mounted over the three main power transistor modules.

3. Swing-out circuit mounting plate with mod-demod assembly A4 and power supply assembly A3 mounted on the inside surface.

4. Control board A1 mounted on the outside surface of the swing-out plate.

1.4 INTERCONNECTIONS

Figure 1 illustrates typical connections from a drive to: ac power, customer I/O signals and a motor. The interconnection diagram specific to this particular drive system is among the drawings included at the end of this manual (see Section 6). All power connections are made to the terminal block at the end of the drive. All signal connections are made to plug-in terminal strips J1 and J2 on control board A1.

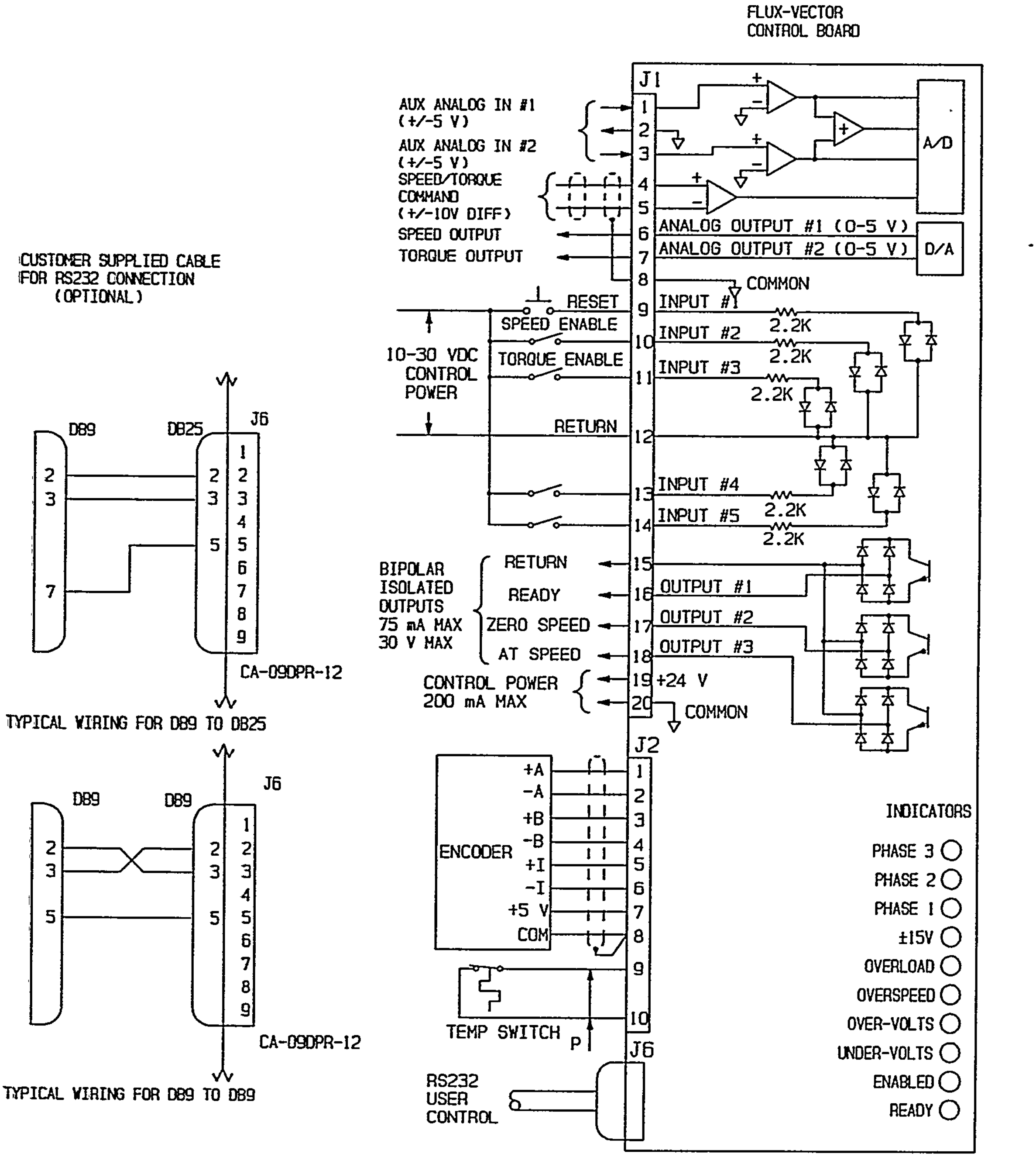

FIGURE 1: TYPICAL INTERCONNECTIONS FOR FLUX VECTOR CONTROLLER

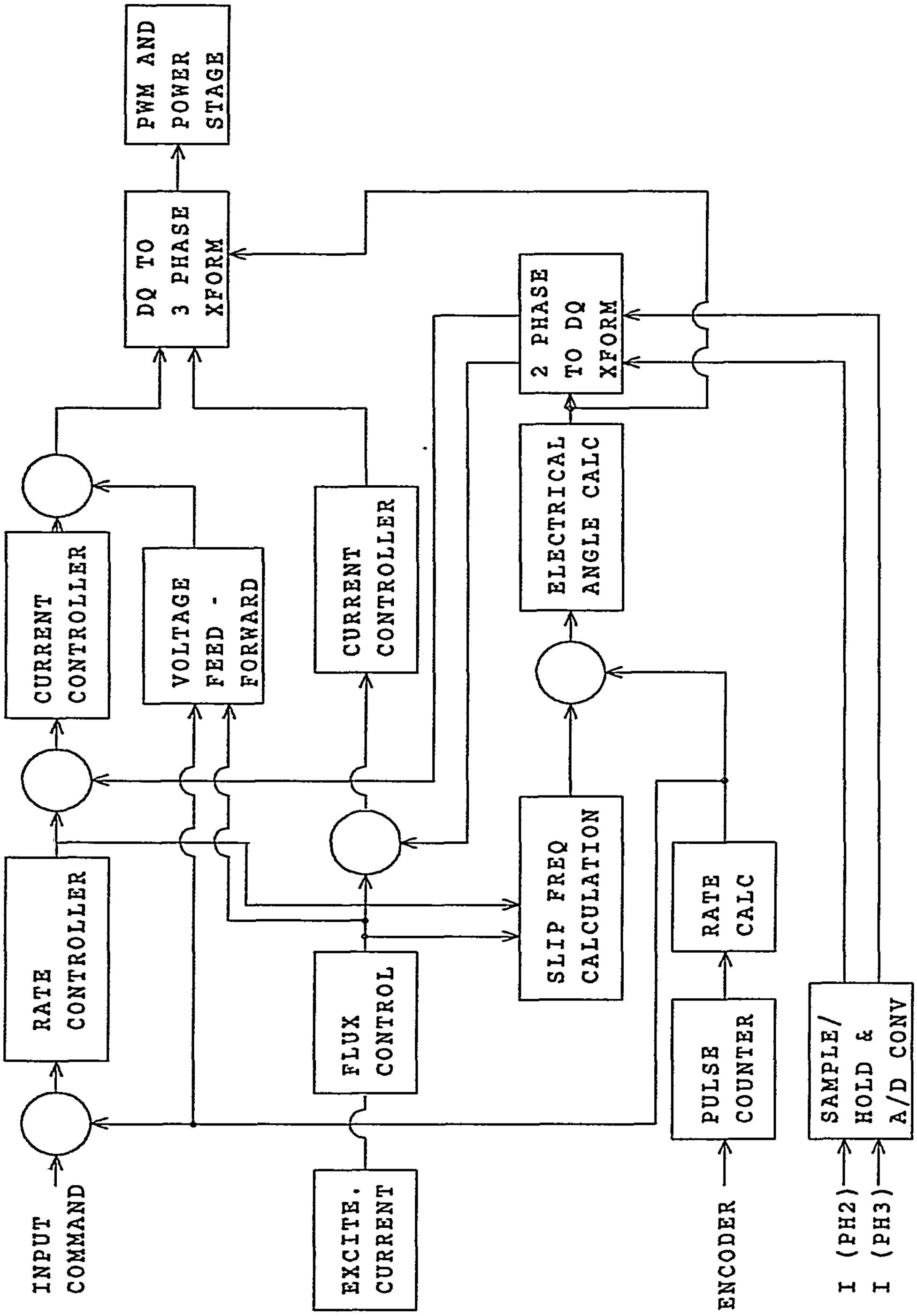

FIGURE 2: FLUX VECTOR BLOCK DIAGRAM

1.5 INDICATORS, ADJUSTMENTS AND TEST POINTS

Drive status and fault LED indicators are located on control board, A1. All adjustments may be made via the RS232 port on connector J6.

1.5.1 HARDWARE TEST POINTS

The hardware test points are placed at various locations on the control board. The user will most likely never need to observe any of the signals in a normal set up or running environment.

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

1.6 DRIVE CIRCUIT FUNCTIONAL DESCRIPTION

The voltage and frequency for the motor are generated by the three main power transistor pairs Q1, Q2 and Q3. The transistors convert dc voltage to three phase ac voltage by means of pulse width modulation (PWM). The dc bus voltage is provided by the three phase diode bridge BR1, inductor L1 and bus capacitors C1 through C6. Three phase ac power is supplied to bridge BR1 through drive terminals L1, L2 and L3. Power Supply Board, A3 is powered directly from the dc bus.

Power Supply Assembly, A3 furnishes several functions:

1) Controls the soft start circuit which limits charging current to the bus capacitors. This prevents excessive inrush currents when ac power is applied.

2) Controls the shunt regulator transistor Q4 to prevent an over voltage condition on the bus supply by dissipating regenerated energy through an external resistor.

3) Develops regulated control power to operate the other circuit boards in the system.

4) Enables drive operation if power conditions are proper.

5) Connects a safety bleed resistor across the capacitor bank when ac line power is removed.

Each main power transistor pair is controlled and monitored by its associated Base Driver Assembly A5, A6 or A7. These base drivers amplify the PWM control signals and monitor the operation of the power transistors for fault conditions. In the event of an overload condition, the transistors are shut off, internally protecting the drive against short circuits between phases and between a phase and ground.

Motor currents through terminals T2 and T3 are sensed with shunt resistors and Mod-Demod assembly A4. The Mod-Demod isolates the power circuit from the control circuits and provides gain and offset trimming of the current feedback signals.

Transistor base signals are produced by modulating the outputs of the direct and quadrature current regulators with the triangle wave generated by the PWM oscillator. The fault disable logic suppresses transistor base signals when a fault occurs. The encoder output provides both rate feedback and current phasing information necessary to perform the flux vector algorithm.

1.7 PROTECTIVE FEATURES

This drive includes extensive fault monitoring circuits to insure safe reliable operation and to aid in troubleshooting. The following latching red LED fault indicators are supplied:

Ø1 (D1) Fault at output T1 latches and lights this indicator. Fault may be loss of adequate transistor base drive, output short or ground fault.

Ø2 (D2)	Fault at output T2 latches and lights this indicator. Fault may be loss of adequate transistor base drive, output short or ground fault.
Ø3 (D3)	Fault at output T3 latches and lights this indicator. Fault may be loss of adequate transistor base drive, output short or ground fault.
±15 (D4)	Latches and lights upon low or missing +15V or -15V control power.
OL (D5)	Lights when the drive output current exceeds the drive continuous current ratings for long time periods.
OS (D6)	Latches and lights upon motor overspeed, independent of tachometer voltage. Overspeed setting is user adjustable.
UV (D7)	Lights when a dc bus undervoltage condition occurs.
OV (D8)	Lights when a dc bus over voltage condition occurs.
OT (D7 & D8)	The two LEDs D7 and D8 will simultaneously latch and light when the motor thermostat opens.
ALL LEDS FLASHING	A memory failure in the microprocessor has occurred (ROM, RAM, or Watchdog Reset).

All faults indicated by these indicators may be reset either by removing and reapplying ac power (power-up reset) or by applying a reset input to J1-9.

1.8 STATUS INDICATORS AND OUTPUTS

The following green LED indicators show drive status:

READY (D10)	Lights when power is applied, no fault conditions exist and reset is not applied. Normally lights 3 seconds after ac power is applied or reset is removed.
ENABLE (D11)	Lights when the drive is enabled and no faults are present.

There 5 opto-isolated inputs; an optional fault reset and 4 programmable selections used for enables and operating modes. There are 2 auxiliary analog inputs, 2 analog outputs, 3 opto isolated outputs, and 2 potentiometers, all of which may be set to various states. The inputs and outputs may be changed while the drive is operating so caution must be used. Figure 1 shows the typical connections.

1.9 ADJUSTMENTS

1.9.1 CONTROL BOARD A1

All normal user adjustments may be made via the RS232 port per setup instructions in section 2. There are also the two programmable potentiometers, R9 and R10, located on the edge of the control board which may or may not be used.

1.9.2 MOD-DEMOD A4

These adjustments are factory preset and normally require no field adjustment.

R14	T3-OFFSET	Adjusts offset of T3 current signal.
R15	T3-SCALE	Adjusts scale factor of T3 current signal.
R30	T2-OFFSET	Adjusts offset of T2 current signal.
R29	T2-SCALE	Adjusts scale factor of T2 current signal.

2.0 INSTALLATION AND START-UP

Check motor nameplate and power source voltage to insure they match the drive nameplate and information contained in this manual. DO NOT USE THIS DRIVE ON ANY OTHER VOLTAGES without factory approval.

2.1 MOUNTING

This drive is designed for panel mounting. Mount in a clean dry enclosure with an internal ambient temperature of not greater than +50 degrees C. DO NOT mount drive above transformer or other heat source. DO provide 2" minimum clear area above and below the drive to allow free flow of air over heat sink on the back of the enclosure.

Mounting dimensions are shown in drawing 7153. Note that both power and signal connections are made at the end of the drive. Provide access to the front of the module to adjust potentiometers and to observe indicators. Allow room for swinging the hinged circuit board panel out to gain access to the power components.

2.2 WIRING

All wiring shall be in accordance with the National Electric Code and applicable local codes. Install wiring as shown in the Interconnect Diagram included in the Drawings section (Section 6) of this manual.

2.2.1 POWER WIRING

This drive requires input power protection in the form of either a circuit breaker or fuses. Recommended sizes and types of circuit breakers and fuses for this particular drive are given in section 5.0.

Connect drive terminals L1, L2 and L3 to the load side of the customer supplied protective device. The drive may be powered with nominal 240/460 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. Note that drive capacity is restricted to 60% of normal when operated on single phase power.

Wire the three phase motor stator to drive terminals T1, T2 and T3 using appropriately sized wire. Connect the drive to the motor either directly or indirectly through a dc rated contactor. A motor circuit contactor is recommended whenever a positive disconnection is required to prevent motor motion which could pose a safety hazard to personnel or equipment.

Ground **<u>both</u>** the chassis ground lug and motor frame to machine or plant ground with the same sized wire used for the ac connections.

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 must be rated at 800 VDC minimum with sufficient capacity to interrupt, in the event of a control failure, a continuous connection of the resistor across the dc bus. BALDOR SWEODRIVES supplies a number of kits for this purpose, see section 5 for recommendations. Connect regeneration resistor and associated fuse or breaker between drive terminals R1 and R2.

2.2.2 SIGNAL WIRING

All motor signal and control wires are terminated on plug-in terminal strip J2. Use twisted shielded pairs and triplets as shown in Figure 2, with shields terminated on drive end only. Maximum cable length between J2 and the ac motor is 150 feet using shielded cable with 22 AWG minimum wire size and maximum wire to wire capacitance of 60 pf/foot.

All customer control and signal wiring are terminated on the plug-in terminal strip J1. Common on this terminal strip is isolated from the power circuits and grounded to the chassis. All signal and control inputs are relative to chassis common except the Buffered Speed/Torque Command Input, the five opto-isolated inputs, and the three opto-isolated outputs.

The opto isolated inputs may be powered by an external 10V to 30V supply or by the 24V supply provided on J1-19 and J1-20. To use the internal 24V supply tie J1-19 to J1-12 and then close a switch from J1-20 to the appropriate input.

The opto isolated outputs when active will appear as a closed condition from that output to J1-15. The outputs will allow 75 mA current flow in either direction. The maximum voltage in the ON state is 2.5V (not TTL compatible).

The speed (or torque) Command is applied at terminals J1-4 & J1-5. Standard scaling for this signal is: 10V = Max Speed (or max torque if in torque control mode). This input is buffered to provide 40 db minimum common mode isolation up to ±15 volts common mode input relative to common. Either input may be grounded at the signal source so long as the common mode range is not exceeded.

2.3 CONTROL BOARD JUMPER SELECTION

The user should never need to change any hardware jumpers as most have additional hardware or software considerations which will need to be addressed. For completeness, the description of the jumpers is given below:

JUMPER	PINS	DEFINITION
JP1	1-2	256K EPROM
	3-4	2K x 8 RAM
	5-6	8K x 8 RAM
	7-8	8K x 8 RAM
	9-10	2K x 8 RAM
JP2	1-2	PARAMETER TABLE SELECTION
	3-4	PARAMETER TABLE SELECTION
	5-6	SPARE
	7-8	MANUFACTURING TEST MODE
JP3	1-2	TACHOMETER PULSE ON J1-6
	3-4	D/A OUTPUT ON J1-6
JP4	1-2	NOTCH FILTER - PHASE 2 CURRENT
	3-4	LOW PASS FILTER - PHASE 2 CURRENT
	5-6	LOW PASS FILTER - PHASE 1 CURRENT
	7-8	NOTCH FILTER - PHASE 1 CURRENT
JP5	1-2	NON DIFFERENTIAL ENCODER INDEX
	3-4	NON DIFFERENTIAL ENCODER PHASE B
	5-6	NON DIFFERENTIAL ENCODER PHASE A

2.3.1 PARAMETER TABLE SELECTION

The flux vector control board has the ability to store up to four complete parameter tables in memory. This gives the user the ability to use one board for several motors without the need for reprogramming. The table is chosen by the first two positions of jumper number JP2. The board is sent without any jumpers; the remaining three tables may be chosen by placing a jumper on JP2 1-2, on JP2 3-4, and on both JP2 1-2 and JP2 3-4.

2.4 ADJUSTMENTS AND SET UP PROCEDURES

To set up the drive, use an MS-DOS based computer with a commercially available communication software that provides ANSI terminal emulation with true cursor addressing on an 80x25 screen. PROCOMM PLUS is a popular and readily available selection; it must be set at 9600 Baud, 8 bit, 1 stop bit, no parity. The only "dumb terminal" that is known to work is the Heath/Zenith H/Z19 or Z29. The RS232 cable must be wired as shown on the interconnect drawing in section 6. The cable may be connected to the control board before applying power.

As a minimum, the external hardware necessary to set up the drive is the torque enable, see figure 1. The user may simply place a SPDT switch between pins J1-11 and J1-19, and directly connect pin J1-12 to J1-20.

To accurately set up the parameters, the motor must be disconnected from any external loads or sources of windage and friction. The rotor may either be free or have a fly wheel attached to it..

2.4.1 TURN ON POWER

Make sure the torque enable switch is open and apply power to the drive. The drive will send the main menu display to the computer screen, see appendix page A1. If there is no display check the RS232 cable and the settings of the communication software. Once communication is achieved, follow the start up procedures listed on the screen.

2.4.2 STEP 1: SELECT THE I/O CONFIGURATION

CAUTION : All programmable items may be set to various states even 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.

Hard wired non-assignable circuits such as reset, power, commons, and returns as listed below:

Circuit	Function
J1-2)	COMMON

J1-4)	Analog INPUT COMMAND +
J1-5)	Analog INPUT COMMAND -
J1-8)	COMMON
J1-9)	FAULT RESET
J1-12)	OPTO INPUT RETURN
J1-15)	OPTO OUTPUT RETURN
J1-19)	+24V DC OUTPUT
J1-20)	24V COMMON

FAULT RESET

The "FAULT RESET" will reset an intermittent fault (see TROUBLE SHOOTING). This input is ignored if the drive is enabled and has no faults.

The user must first determine how he would like the system to operate. Hold the CTRL key down while striking the letter O. The screen should immediately change to that shown on page A2 of the appendix. The TAB key will change the configuration of the drive and the paragraph at the bottom of the screen will give a detailed explanation.

Once the user has highlighted the appropriate setting then press the ENTER (RETURN on some keyboards) key. The screen will immediately change to that shown on page A3 of the appendix. The underlined values are the inputs which may further be changed from their default settings. Figure 1 shows a schematic type drawing of the J1 connector. The TAB key will highlight the field that can be changed. Use the up or down arrows to scroll through the available settings. To save any changes hold the CTRL key while striking the letter S and then CTRL C. To reset all selections type CTRL A. If the user does not wish to change any selections type CTRL C.

0) SPEED DRIVE WITH SPEED/TORQUE ENABLE

This is the default selection configuration. The drive will operate as a speed drive (move at a speed proportional to the analog input voltage).

J1-10) The 'speed enable' is used to command the motor to stop regardless of the input speed voltage when disabled. The drive will still produce torque until 'torque enable' is removed.

J1-11) The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'orient select' is used to orient to one of the two rotor positions for an application with two gear settings. (If not using this function leave open).

1) SPEED CONTROL WITH FWD/REV ENABLE

This selection should be used in applications that use mechanical limit switches to inhibit the motor from driving into or past a "stop". The drive operates as a speed drive with directional enables. The "FORWARD ENABLE", when active, allows torque and speed in the positive direction and the "REVERSE ENABLE" in the negative direction. Both enables must be opened to completely disable current in the motor.

J1-10) The 'forward enable' when disabled, will not allow torque or motion in the positive direction. To completely disable the drive both the forward and reverse enables must be disabled.

J1-11) The 'reverse enable' when disabled, will not allow torque or motion in the negative direction.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'orient select' is used to orient to one of the two rotor positions for an application with two gear settings. (If not using this function leave open).

2) SPEED CONTROL FOR BIPOLAR OPERATION WITH 0 - +10V INPUT

This selection should be used for applications requiring forward and reverse direction control and only a positive input voltage is available for the rate command such as 0V to 10V (-10V to +10V is normal). (Negative voltages are ignored). The direction enable input determines rotation direction. The "TORQUE ENABLE" turns on the drive.

J1-10) The 'direction enable' determines whether the input voltage command is to cause positive (active) or negative (open) rotation direction. To completely disable the drive, remove 'torque enable' signal.

J1-11) The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'orient select' is used to orient to one of the two rotor positions for an application with two gear settings. (If not using this function leave open).

3) SWITCHABLE SPEED OR TORQUE CONTROL

This is the selection for any application which switches from torque to speed control. When in torque control the drive produces torque proportional to the input voltage and when in speed control, the drive will run at a speed proportional to the input voltage. If an emergency stop is needed in torque drive mode, leave the 'speed enable' open and switch from torque to speed mode. This input is also useful in some test modes.

J1-10) The 'speed enable' is only active in the speed control mode and is used to command the motor to stop regardless of the input speed voltage when disabled. The drive will still produce torque until 'torque enable' is removed.

J1-11) The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'orient select' is used to orient to one of the two rotor positions for an application with two gear settings. (If not using this function leave open).

4) SWITCHABLE SPEED OR TORQUE CONTROL USING AUXILIARY INPUTS

This is a nonstandard selection which uses combinations of input switches and auxiliary analog inputs to switch from torque to rate mode. If selection #3 above cannot be used then contact the factory for the connection diagram.

Firmware Assigned I/O

Circuit	Function
J1-10)	SPEED ENABLE
J1-11)	TORQUE ENABLE
J1-13)	AUX(1)/NORMAL(0)
J1-14)	AUX TORQ(1)/RATE(0)

5) TORQUE CONTROL

This selection will place the drive in the torque control mode. It is normally used when an external rate loop is controlling the system. The analog signal on J1-4 to J1-5 is the torque reference and scaled such that +10V commands full positive torque and -10V commands full negative torque as set by the CURRENT LIMIT parameter. The response time to a step input of the torque drive may be as fast as 2 to 3 msec depending on the torque servo loop gain.

J1-10) N/C Leave open.

J1-11) The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'orient select' is used to orient to one of the two rotor positions for an application with two gear settings. (If not using this function leave open).

6) INVERTER RETROFIT

This selection is intended be used as a directed replacement for a SWEO INVERTER induction motor drive. It will provide forward and reverse direction control with a 0 to 10V input. When both directions are disabled the drive will regenerate to zero speed and then disable.

J1-10) The 'forward enable' will command a positive rate proportional to the input voltage any time it is enabled.

J1-11) The 'reverse enable' will command a negative rate proportional to the input voltage when enabled and the 'forward enable' is disabled.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'torque enable' allows current to flow in the motor. The drive may be turned off by disabling this input OR disabling both the forward and reverse enable.

7) SPEED CONTROL WITH SELECTABLE PARAMETER TABLES

This configuration will override the normal selection of parameter tables, see section 4.3.3. The user has the ability to select one of only two parameter tables by the state of the opto-isolated input on J1-14. The drive will operate as a speed drive (move at a speed proportional to the analog input voltage).

J1-10) The 'speed enable' is used to command the motor to stop regardless of the input speed voltage when disabled. The drive will still produce torque until 'torque enable' is removed.

J1-11) The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.

J1-13) The 'orient' input when active will bring the motor to a stop at a predefined position. (If not using this function leave open).

J1-14) The 'parameter table select' is used to select which of the two parameter sets will be used for the drive.

8) SPEED CONTROL WITH FOUR ORIENT POSITIONS

This configuration will allow the user to orient the rotor to one of four positions depending upon the state of the inputs on J1-13 and J1-14. If both are open then the rotor may be oriented to position number 1, if J1-14 is closed then position number 2, if J1-13 is closed then position number 3, and if both are closed then position number 4.

J1-10)	The 'orient' input when active will bring the motor to a stop at a predefined position.
J1-11)	The 'torque enable' allows current to flow to the motor to produce torque. It is used to electronically turn power on and off to the drive.
J1-13)	The 'orient position select' is used with J1-14 to select one of four orient positions.
J1-14)	The 'orient position select' is used with J1-13 to select one of four orient positions.

2.4.2.1 AUXILIARY ANALOG INPUTS

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 from the main user menu or as specified as a numeric value, 0 through 4, in the down loaded configuration file under AUX INPUT 1 SELECTION or AUX INPUT 2 SELECTION. Listed below are the selection number followed by the selection name:

Number	Name	Description
0)	NOT USED	DEFAULT.
1)	CURRENT LIMIT	This external current limit adjusts the torque producing component of the current from 0 to 100% of the value entered as the current limit in the data entry menu.
2)	OVERSPEED	The overspeed setting is varied from 0 to 110% of the Max Speed entered.
3)	RATE COMMAND	Not standard. Consult factory for connections.
4)	TORQUE COMMAND	Not standard. Consult factory for connections.

2.4.2.2 ANALOG OUTPUTS

There are two programmable 0 to +5V full scale analog outputs updated every 2 msec available on pins J1-6 and J1-7 to monitor various internal digital flux-vector variables. Assignment may be from the main user menu or as specified as a numeric value, 0 through 18, in the down loaded configuration file under DAC 1 SELECT or DAC 2 SELECT. Listed below are the selection number followed by the selection name:

No.	Name	Description
0)	ABS VALUE VELOCITY	Absolute value of velocity with full scale = MAXIMUM RPM.
1)	ABS VALUE TORQUE	Absolute value of torque with full scale = CURRENT LIMIT.
2)	ABS VELOCITY CMND	Absolute value of the commanded velocity with full scale = MAXIMUM RPM.
3)	VOLTAGE MAGNITUDE	Magnitude of the voltage sent to motor, full scale = line voltage.
4)	DIRECT I FDBK	Direct axis feedback current. Useful with #5 to determine current loop performance. (updated 0.5 ms)
5)	DIRECT I CMND	Commanded direct axis current.
6)	QUAD I FDBK	Quadrature axis feedback current. Useful with #7 to determine torque loop response. (updated 0.5 ms)
7)	QUAD I CMND	Commanded quadrature axis current.
8)	ABS MOTOR CURRENT	Motor current: 2.5 V = rated current.
9)	ABS TORQUE CURRENT	The torque producing motor current: 2.5V = rated current.

10)	QUAD CNTRLR	Quadrature compensation output. Useful in diagnosing drive problems and manual setting of feed forward.
11)	DIRECT CNTRLR	Direct axis compensation output.
12)	SAMPLED CURRENT	Sampled AC motor current. Assignment to DAC 1 monitors phase 2; assignment to DAC 2 monitors phase 3.
13)	PWM VOLTAGE	PWM control voltage which is proportional to AC line to line motor terminal voltage. Used to set excitation current value.
14)	HOMED(5V)	Motor oriented. 0V normally, +5V when the motor is in orient position (HOME).
15)	TORQUE	Bipolar torque output. Scale is -Max specified current = 0V to +Max specified current = +5V.
16)	POWER	Motor power output, bipolar. Full scale = Max specified power (Max current x base rpm).
17)	VELOCITY	Bipolar velocity. Scale is -Max RPM = 0V, +Max RPM = +5V.
18)	I^2 t	I^2 t overload. Displays the inverse time overload accumulator; fault trip occurs at +5V.

2.4.2.3 OPTO ISOLATED OUTPUTS

There are three opto isolated 24 VDC outputs on connector J1 pins 16, 17, and 18. Assignment of these to discrete variables may be made from the main user menu or as a numeric value, 0 through 5, in the down loaded configuration file listed under OPTO 1 SELECT, OPTO 2 SELECT, or OPTO 3 SELECT. Listed below are the configuration selection number followed by the name and description:

No. Name Description

0)	READY	Active (closed) when no faults are present, NO (Normally Open).
1)	ZERO SPEED	Active when the motor speed is less than the user specified speed threshold, NO. If 'orient' is enabled, this output is active when the motor speed is less than the specified speed threshold AND the motor shaft is within 0.5 degrees of the predetermined position.
2)	AT SPEED	Active whenever the motor speed is within the user specified tolerance band of the commanded speed, NO.
3)	OVERLOAD	Active when an inverse time overload (I^2t) has not occurred, NC (Normally Closed).
4)	PWR AMP OT	Active when an over-temperature fault has not occurred, NC.
5)	SET SPEED	Active whenever the rotor speed is above the user specified "set speed", NO.
6)	FAULT	Active whenever a FAULT is present.

2.4.2.4 **USER POTENTIOMETERS**

There are two 25 turn user potentiometers labeled POT 1 (R9, lower) & POT 2 (R10, upper) located near the flux-vector board edge above connector J2 which are monitored by the A/D converter. These pots have an output voltage range of 0 to +5 volts and the setting may be measured at TP13 (POT 1) and TP14 (POT 2) with a voltmeter and may be assigned as inputs to the following functions from the main user menu or as specified as a numeric value, 0 through 3, in the down loaded configuration file under USER POT 1 SELECTION or USER POT 2 SELECTION. Listed below are the selection number followed by the selection name:

No.	Name	Description
0)	NOT USED	OFF (DEFAULT)

1)	RATE GAIN	Sets the gain term in the rate compensation. The pot sets the first term in the rate compensation expression from 0 to 64.
2)	INPUT SCALING	Attenuates the input signal down stream of the ADC. Reduces the rate scaling so that +10V commands from 0 to 100% of max RPM entered.
3)	OFFSET TRIM	Used to provide an analog adjustment in place of the automatic offset calibration. About $\pm$ 3 % adjustment of max RPM is provided.

2.4.3 STEP 2: NAMEPLATE DATA ENTRY

After selecting and saving the I/O the user will be back at the main menu (page A1 of the appendix). The second step to setting up the motor is to complete the 'Nameplate Data Entry Menu'. The menu is initiated by holding down the CTRL key and striking the N key. The screen will now look similar to shown in the appendix page A4. The TAB key or the ENTER key will change the field to those shown underlined on page A4; 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. (Example: if motor rated speed is 1755 RPM then the proper keystrokes upon entering the field are "**space**", "1", "7", "6", "5".) **IMPORTANT**: double check all entries before saving the data. If the user wishes to reset all factory defaults type CTRL X (this clear the I/O settings as well). The CTRL A key will remove any changes made since last saving the parameters. 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.

AMPLIFIER DATA:

AMPLIFIER MODEL NUMBER - is entered in two fields, the series and rating. It may be found on the label of the amplifier 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 - is the customer supplied 3 phase voltage under no load conditions (i.e. 208, 240, 460, etc). The drive will not allow voltages above or below the acceptable voltages labeled on the amplifier to be stored.

 # OF PARALLEL AMPLIFIERS - In some applications two or more amplifiers are used in parallel to drive motors larger than the highest rated amplifier. This requires an additional parallel control board and the accompanying interconnect cables. For normal applications only 1 amplifier is used.

PWM SELECTION - The Pulse Width Modulation frequency of the power amplifier may be either 2500 Hz (standard) or 5000 Hz. If using 5000 Hz, the amplifier is automatically derated by 30%. It is normally only be used for high speed applications (operating frequencies above 300 Hz).

MOTOR NAMEPLATE DATA:

The following four entries may be found on the motor nameplate. In some instances the motor will have more than one rating (example: 240 / 460 V). In these cases, remain consistent between choosing the first or second value for all entries.

CURRENT - is the rated current of the motor in RMS amps.

VOLTAGE - is the rated voltage of the motor in RMS volts.

SPEED - is the rated speed of the motor in RPM.

FREQUENCY - is the rated frequency of the motor in Hertz. It is only used to calculate the motor poles so the value may be rounded to the nearest 1 Hz.

ENCODER DATA:

LINES PER REVOLUTION - are read directly from the encoder data sheet or nameplate. Internally the drive extracts four times the resolution by sensing the four edges of the differential signal.

MOTOR LIMIT DATA:

MAXIMUM RPM - This is the user's maximum operating speed. It sets the overspeed level at 110% of this value. For a speed control application, +10V between J1-4 and J1-5 will command this value.

CURRENT LIMIT - sets the maximum current to the motor. For most applications, use two times the motor's rated current. If this value is greater than the available amplifier current then the maximum amplifier current is automatically entered here.

MAX ACCELERATION - limits the peak acceleration of the motor to this many RPM/sec. A value of **zero** disables this function yielding maximum available acceleration.

MAX DECELERATION - limits the peak acceleration of the motor to this many RPM/sec. A value of **zero** disables this function yielding maximum available deceleration.

ORIENT PARAMETERS (optional):

If not using the orient (or homing) function then this section may be ignored.

ORIENT RATE - in RPM. Upon activation of the orient function the motor will accelerate or decelerate to this speed, read the index pulse (J2-5, J2-6), and then align to the proper position. To orient in the positive or negative direction, type in the proper sign in the left most position of the field.

ORIENT OFFSET #1 - in encoder counts (4 times the encoder lines). Sets the number of encoder counts the shaft will travel past the index mark before stopping.

ORIENT OFFSET #2 - in encoder counts (4 times the encoder lines). Sets the number of encoder counts the shaft will travel past the index mark before stopping when using multiple orient positions.

ORIENT OFFSET #3 - in encoder counts (4 times the encoder lines). Sets the number of encoder counts the shaft will travel past the index mark before stopping when using multiple orient positions.

ORIENT OFFSET #4 - in encoder counts (4 times the encoder lines). Sets the number of encoder counts the shaft will travel past the index mark before stopping when using multiple orient positions.

2.4.4 STEP 3a: AUTOMATIC TUNING OF PARAMETERS

The automatic tuning menu is entered by typing CTRL T (see A5 of the appendix). It is a six step process which will completely set all servo and operating parameters under normal conditions in roughly 15 minutes or so. The motor and encoder must be properly wired, shielded, and grounded according to figure 1. **DO NOT** run these procedures without the proper shielding and grounding. These procedures will automatically change the values which may be manually changed in step 3b.

The block diagram of the flux vector drive is shown in figure 2. The small box with a number inside corresponds to the part of the drive being set by that procedure.

To accurately set up the parameters, the motor must be disconnected from any external loads or sources of windage and friction. The rotor may either be free or have a fly wheel attached to it.

To run any procedure the 'torque enable' must be active, all other inputs are ignored. The ENTER (marked RETURN on some keyboards) key will start each procedure, use the TAB once finished to go on to the next procedure). The 6 procedures are described below:

1) INPUT OFFSET CALIBRATION: This procedure will take the present rate/torque command signal and calibrate that value to a zero input. By commanding zero from the user's system to pins J1-4 and J1-5, this procedure will eliminate any biases between the user's system and the amplifier.

2) ENCODER PHASING: This procedure applies a positive torque to the motor and reads the direction of the sensed rate. If the sensed rate is negative or below a 100 RPM, then the encoder phasing is automatically switched. If the sensed rate remains less than 100 RPM, an error message will appear on the screen. If this happens check the grounding, the encoder coupling, the lines per rev of the encoder, the power to the encoder, the shielding, etc. and repeat the test.

3) CURRENT LOOP COMPENSATION: This procedure sends steps of current (1/2 motor's rated current) and measures the response to set the proper loop gain for the direct and quadrature drives (see figure 2). The procedure should take only a few seconds. If the test cannot converge on a value in the allotted time, wait until it times out and run the test once more, then consult the factory for assistance.

4) EXCITATION CURRENT SETTING: This procedure will set the proper excitation current according to the motor nameplate data and automatically adjust the feed-forward constant. The motor will be commanded to run at 1/2 the motor's rated speed and the procedure may last several minutes.

5) SLIP GAIN CALCULATION: This procedure indirectly measures the rotor time constant by repeated accelerations and decelerations of the motor and observing

the velocity profiles. If there are significant windage or friction losses this procedure will yield errant results.

Once the value is calculated, the user may correct for the difference in rotor temperature between the "set up" conditions and the normal operating conditions. Use the up/down arrows when prompted to set the temperature difference. The default is 0 and the typical is 50 degrees C. Type CTRL S to proceed with the correction, then TAB to the next procedure.

6) RATE LOOP COMPENSATION: This procedure will automatically set the rate loop compensation. However, these settings may not be perfectly optimized to the user's desires and may be overridden in the manual parameter menu. This procedure will send steps of 400 RPM to the motor and measure the 90% rise time and the peak overshoot. For this procedure the motor may be connected to the user's system as long as it can mechanically withstand 400 RPM steps.

Disable the drive and type CTRL C to end the automatic tuning session. The motor is now in control according to the mode and input enables defined above.

2.4.5 STEP 3B: MANUAL PARAMETER ENTRY

The "Manual Parameter Entry" menu (CTRL D) has values which were set by the automatic tuning menu. It also contains some various tolerance settings for the opto-isolated outputs (see page A6 of the appendix). The first two values in this menu, amps per volt and number of motor poles, has been calculated from previous entries in the "Nameplate Menu". The block diagram in figure 2 may be useful in understanding the parameters listed below:

RATE COMPENSATOR - _10_ (s + 2 Pi * _0)/s . These values are automatically set in the auto-tuning procedures. To manually set the compensation look at the velocity output on a strip chart recorder or storage type oscilloscope and command step rate commands to the system.

This manual is not meant to be a lesson in control theory or Laplace transforms but a short discussion to help set the drive is given. The first value sets the open loop gain of the system - the bandwidth (speed of response) of the rate loop. If the system is excessively noisy it is most likely due to this value being too large.

The second value is the "corner frequency" in Hertz of the compensator and is analogous to the integral gain of the control loop. This value will set the "stiffness" of the system with little to no effect on the bandwidth. It may cause an overshoot to a step command if set too high. If zero then the compensation is strictly proportional. A rule of thumb is to set the value to 1/10 the bandwidth of the system (so a maximum of 4 or 5 Hz for a 40-50 Hz rate loop).

If the user is not familiar with setting up a rate loop one method is to set the corner frequency to 0 Hz (no integral gain) and gradually increase the proportional gain until the response is at its fastest without any noise or ringing. Then, if desired, increase the stiffness by moving the corner frequency to 4 Hz or so. Check the response to make certain the overshoot has not increased appreciably.

CURRENT LOOP FEED FORWARD GAIN - This value is necessary for the current loop to function properly. It is set by the automatic tuning procedure, however, to manually enter this value the user must know this data:

Lm =	magnetizing inductance in mH
Vac =	the nominal line voltage in volts entered in nameplate menu
A/V =	and the amps/volt scaling of the feedback displayed at the top of this screen

Feed Forward = [212 x Vac] / [(A/V) x Lm] .

CURRENT COMPENSATOR - 20 (s + 2 Pi * 30)/s . The current compensation is set by the automatic tuning procedure. The corner frequency is set to 30 Hz nominally, if this value is altered the current response could become unstable or excessively distorted. To manually set the first value, the user must know the following data:

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

Kp = [740 x L x (A/V)] / Vac .

CONTINUOUS CURRENT - in Amps RMS, it is set to the lesser of the amplifier rating and the motor rating and may be lowered by the user.

RPM FOR FIELD WEAKENING - It is the speed at which the excitation is lowered and the motor enters the constant horsepower range. It defaults to the motor base rpm.

RATE DEADZONE FOR "0" COMMAND - in RPM. It may be used in analog speed drives to allow small offsets or drifts in the input to be read as zero speed command. (Example: if set to 40 RPM, an equivalent analog command less than 40 RPM will be interpreted as a 0 RPM command).

TOLERANCE FOR "0" SPEED - in RPM. This value sets the tolerance for the opto isolated "zero speed" output. If the sensed velocity is less than or equal to this value then the "zero speed" indicator is active.

AT SPEED TOLERANCE - in percent. It sets the tolerance for the "at speed" opto isolated output to a fixed value below base speed and a percentage of the command above base speed. (Example: if this value were 10% and the base speed of the motor is 1800 RPM, then for any commanded rate below 1800 RPM, the tolerance band for the opto isolated "at speed" indication is 180 rpm. For a command of 3000 RPM the tolerance band is 300 RPM.

SET SPEED VALUE - in RPM. If the absolute value of motor speed is greater than this value then the "set speed" opto isolated output is active. (Example: SET SPEED VALUE = 1000 RPM, if the sensed velocity were ± 1001 RPM then the "set speed" output would be active, if the sensed velocity were ± 999 RPM the "set speed" output would not be active.)

SLIP GAIN - this value is set by the automatic tuning procedure. If the user knows the rotor time constant then this formula may be used:
Tr = rotor time constant in msec

Slip Gain = 41,720 / Tr .

EXCITATION CURRENT - in Amps RMS x 100, this value is set by the automatic tuning procedure. If the user knows these values, the data may be calculated as follows:
Lm = magnetizing inductance in mH
Vm = rated RMS motor voltage
F = rated motor frequency in Hz

Excitation current x 100 = [9189 x Vm] / [Lm x F].

ENCODER DIRECTION - is set by the automatic tuning procedure. To manually calculate this value, place the drive in torque mode and apply a small analog command. If the drive accelerates to a high speed then the encoder direction is correct. If the drive moves at a slow constant rate then the encoder direction is incorrect.

2.4.6 STEP 4: SAVING OR RETRIEVING FILES (optional)

To save or retrieve data from a disk the user must be using a communication package which supports XMODEM protocol. If properly equipped, the user may enter the file transfer menu by disabling the drive and typing CTRL F (see A7 of the appendix).

The user will first highlight the appropriate choice of uploading or downloading data by using the TAB key, then press the ENTER key to initiate the procedure. Then follow the directions for the software package for receiving or transmitting data (typically PAGE UP and PAGE DOWN).

2.4.6.1 PARAMETER FILE

The file saved by the download function will look as follows. The parameters may be altered by either using an editor or by uploading the file and using the Flux Vector software to make any changes and then resave the file.

FILE LISTING		- DESCRIPTION	- MANUAL SECTION
TITLE:	"PARAMETER LIST"	- TITLE	- 2.4.3
/# 1/	712	- AMPLIFIER MODEL #	- 2.4.3
/# 2/	47	- AMPLIFIER MODEL #	- 2.4.3
/# 3/	1	- PWM FREQ (1=2.5 kHz)	- 2.4.3
/# 4/	1	- # OF PARALLEL AMPL.	- 2.4.3
/# 5/	208	- NOMINAL LINE VOLTAGE	- 2.4.3
/# 6/	29	- RATED MOTOR CURRENT	- 2.4.3
/# 7/	230	- RATED MOTOR VOLTAGE	- 2.4.3
/# 8/	1745	- RATED MOTOR SPEED	- 2.4.3
/# 9/	60	- RATED MOTOR FREQ	- 2.4.3
/# 10/	1024	- ENCODER LINES/REV	- 2.4.3
/# 11/	6000	- MAXIMUM RPM	- 2.4.3
/# 12/	0	- MAX ACCELERATION	- 2.4.3
/# 13/	0	- MAX DECELERATION	- 2.4.3
/# 14/	58	- CURRENT LIMIT	- 2.4.3
/# 15/	0	- I/O CONFIGURATION	- 2.4.2
/# 16/	5	- RATE COMPENSATOR LEAD	- 2.4.5
/# 17/	25	- RATE COMPENSATOR GAIN	- 2.4.5
/# 18/	97	- CURRENT FEED FORWARD	- 2.4.5
/# 19/	30	- CURRENT COMP. LEAD	- 2.4.5
/# 20/	53	- CURRENT COMP. GAIN	- 2.4.5
/# 21/	29	- CONTINUOUS CURRENT	- 2.4.5
/# 22/	1600	- FIELD WEAKENING SPEED	- 2.4.5
/# 23/	10	- RATE COMMAND DEADZONE	- 2.4.5

/# 24/	10	- ZERO SPEED TOLERANCE	- 2.4.5
/# 25/	100	- ORIENT RATE	- 2.4.3
/# 26/	1000	- ORIENT OFFSET #1	- 2.4.3
/# 27/	2000	- ORIENT OFFSET #2	- 2.4.3
/# 28/	3000	- ORIENT OFFSET #3	- 2.4.3
/# 29/	4000	- ORIENT OFFSET #4	- 2.4.3
/# 30/	100	- AT SPEED TOLERANCE	- 2.4.5
/# 31/	1000	- SET SPEED	- 2.4.5
/# 32/	207	- SLIP GAIN	- 2.4.5
/# 33/	976	- EXCITATION CURRENT	- 2.4.5
/# 34/	-1	- ENCODER POLARITY	- 2.4.5
/# 35/	5000	- FILTER CORNER FREQ	- *
/# 36/	0	- OPTO OUTPUT #1	-2.4.2.3
/# 37/	1	- OPTO OUTPUT #2	-2.4.2.3
/# 38/	2	- OPTO OUTPUT #3	-2.4.2.3
/# 39/	0	- DAC OUTPUT #1	-2.4.2.2
/# 40/	8	- DAC OUTPUT #2	-2.4.2.2
/# 41/	0	- USER POT #1	-2.4.2.4
/# 42/	0	- USER POT #2	-2.4.2.4
/# 43/	0	- AUX INPUT #1	-2.4.2.1
/# 44/	0	- AUX INPUT #2	-2.4.2.1

* Switched capacitor filter on the current feedback. Consult factor before changing.

2.4.7 STEP 5: READ FAULT LOG

The fault log is initiated by typing CTRL L, the display will be similar to that shown in the appendix, page A8. 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.

3.0 THEORY OF OPERATION

The functions described in this section may be seen on the block diagram in figure 2. The drive may be configured as either a speed or a torque regulator. The flux vector algorithm uses the encoder information to control the two components of the motor current with servo loops. The direct axis current is the flux producing or excitation component of current and the quadrature axis current is the torque producing component of current. The flux (or excitation) current is commanded to a fixed value while within the base speed of the motor. Above the base speed the flux current is reduced (field weakening). The torque producing current is proportional to the velocity error when used as a speed drive or proportional to the input command when used as a torque drive.

The slip frequency of the motor is proportional to the ratio of the quadrature axis current to the direct axis current. It 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 direct and quadrature current components and in transforming the direct and quadrature voltage components into AC motor voltages.

The drive may also be used to orient the motor to any position by providing an index pulse from either the encoder on the motor itself 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 allow for orientation to virtually any position.

The Flux Vector board saves all the motor and servo parameters in battery backed RAM, the contents of which 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, to monitor various drive states, and to change the programmable inputs, outputs, and modes of operation.

3.1 MOTOR ASSEMBLY

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 rear of the motor. The currents are induced into the "squirrel cage" type rotor to produce torque.

3.2 DRIVE BUS POWER SUPPLY (Figure 1 and Drawing 7143/7148)

Drawing 7143/7148 shows the interconnection of the power components. Incoming ac power, at terminals L1 through L3, is full-wave rectified by diode bridge BR1 then filtered by inductor L1 and bus capacitors C1 through C6. The inductor reduces current ripple on the bus capacitors, maximizes input power factor and 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. Motor regeneration will increase the dc bus voltage causing operation of the shunt regulator which limits the dc bus voltage below 375 VDC for 712 series amplifier or 755 VDC for the 714 model.

Excessive current inrush upon power application is prevented by the soft start circuit composed of R1, A8 fuses F1-F2 and the SCR in Q5. Operation of the soft start function is supervised by power supply A3. The SCR is fired to bypass charging resistor R1 only after the voltage drop on R1 is less than 30 VDC. Power supply A3 is interlocked with the control board A1 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 power supply A3 which controls the shunt regulator transistor Q4. When the bus voltage approaches its peak level, Q4 is turned on to draw current through the external regeneration resistor thus dissipating the regenerated energy. The peak energy that can be absorbed is limited by the maximum resistor current that can be controlled by Q4. The drive will limit bus capacitor voltage to 375/750 volts; for example a 20 ohm regeneration resistor connected to the drive will absorb 28 KW peak.

3.3 DRIVE POWER SUPPLY A3

The power supply assembly operates directly from the main dc bus derived from the full wave rectified 240/460 VAC line and accomplishes the following:

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

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

3) Supplies a regulated plus and minus 24 VDC for auxiliary relay and dc fan use,nominally rated at 25 watts total.

4) Delays power supply operation upon power application to ensure the external 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 in the event of a regulator transistor short thus preventing excessive output voltages.

6) Provides the gate signal to an external soft start bypass SCR which is coordinated with ac line voltage presence, bus to line differential voltage, and bus undervoltage.

7) Generates the base drive current to an external power transistor to shunt regulate the dc bus voltage during motor drive regeneration.

8) Provide 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 220/450 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 which is connected to chassis ground.

3.4 DRIVE 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. Two transistors and their associated clamp diodes are contained in an isolated mounting type power module. Output currents are sensed with the two current shunts, resistors R2 and R3. The current sensors are 0.01 ohm on drives rated up to 75 amps peak and 0.005 ohm on drives rated above 75 amps peak.

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.

3.5 DRIVE MOD-DEMOD A4

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 factory made with the gain set for the current scale factor specified in the setup sheet of section 6. 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 which is connected to chassis ground.

3.6 DRIVE BASE DRIVERS A5, A6 & A7.

A base driver assembly consists of two independent base driver circuits, one for each transistor of a dual Darlington power transistor module. 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 50 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 transistors 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 transistors' collector-emitter voltage and shuts it off when an overload current causes this voltage to exceed a safe level. 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 shuts down the drive, latches the fault and turns on the corresponding indication.

3.7 CONTROL BOARD A1

The functions of the control board are:

1) to provide a either a speed or torque regulator which responds to the users' input,

2) to provide separate flux and torque 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 3 programmable analog inputs, two analog outputs, 5 opto isolated inputs, and 3 opto isolated outputs,

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

9) to provide a drive 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 and the control boards may have more current revisions of software (noted on IC's U8 and U9).

3.7.1 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 and a once per rev index pulse is optional (may be used to orient the rotor). The signal lines may be received either single ended or differentially.

3.7.2 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.

3.7.3 TORQUE CONTROL

If the flux vector is configured as a torque drive then the signal read from J1-4 to J1-5 is the torque reference. The input is scaled such that +10V commanded is equal to full positive torque and -10V is full negative torque set by the maximum motor current parameter. The response time to a step input of the torque drive may be as fast as 2 to 3 msec depending on the torque servo loop gain. If the flux vector is configured as a rate drive then the torque command is proportional to the error in the rate servo.

3.7.4 RATE CONTROL LOOP

If the flux vector is configured as a rate drive then the signal read from J1-4 to J1-5 is the speed command. The input is scaled such that +10V commanded is equal full positive rate and -10V is full negative rate set by the maximum RPM parameter. The bandwidth of the drive may be as high as 40 to 50 Hz depending upon the gain of the rate servo and the bandwidth of the internal torque loop. The compensation may be configured as simply a proportional or as a proportional plus integral drive.

3.7.5 CURRENT LIMITER

Amplifier current is limited by restricting the current command to the current limit value set in the motor parameters. The maximum RMS current value is normally set to twice the rated motor current. The drive 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 the inverse time overload protection. The overload protection of the drive will allow the drive to operate at or below the rated current forever, at 150% of the rating for one minute and at 200% of the rating for 3 seconds.

3.7.6 LATCHING FAULT PROTECTION AND INDICATION

Fault conditions are detected, latched and indicated by red LEDs on control board, A1. The following indicators and their associated detectors are provided:

1) PH1, PH2, or PH3: 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 section 3.6. The fault is latched and indicated on the appropriate LED indicating which output connection, transistor pair or base driver caused the fault.

2) ±15: 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 red and green LED indicators.

3) OL: This LED lights under drive overload conditions as described in 3.7.5.

4) OS: An overspeed detector compares the motor speed with the "maximum RPM" parameter. The drive shuts down, latches and indicates whenever speed exceeds 110% of that setting.

5) UV: Monitors the fault output of power supply assembly, A3, for an undervoltage fault indication. This condition shuts down the drive and turns on the UV LED.

6) OV: Monitors the fault output of power supply assembly, A3, for an over voltage fault indication. This condition shuts down the drive and turns on the OV LED.

7) OT (UV & OV): Both the UV and OV LEDs light simultaneously in the event of drive or motor overtemperature. Overtemperature is indicated by the opening of either the drive heat sink thermostat TS1 (set at 80 degrees C), or the motor winding thermostat. Shut down, latch and indication occurs when either thermostat opens.

4.0 TROUBLESHOOTING

WARNING

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

1. *USE EXTREME CAUTION, DO NOT TOUCH any circuit board, power device or motor electrical connection without insuring unit is properly grounded and no high voltage is present. DO NOT apply ac power before grounding per instructions herein. 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.*

2. *BE CERTAIN that possible violent motion of motor shaft and driven machinery due to improper control operation will not cause injury to personnel or damage to equipment. Peak torques of several times rated motor torque can occur during a control failure.*

3. *Motor circuit may have high voltage present whenever ac power is applied, even when motor is not rotating.*

4.1 INSTRUMENTS

Most troubleshooting can be performed using only a digital voltmeter (DVM) having an input impedance exceeding 1 megohm.

4.2 TROUBLESHOOTING GUIDE

4.2.1 NO READY (RDY) LIGHT AND NO RED FAULT INDICATIONS

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 WARNING precautions and replace BR1 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. Both voltages must be within ±1 volt of nominal for proper operation.

WARNING

High voltage on electrolytic capacitors C1 through C6 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 it. 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 below +10 volts, relative to common, at either input will prevent Ready.

4. If ac power and resets are OK, 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 precautions of (2) above. DO NOT remove any connectors or boards without removing power and ensuring main bus supply voltage is less than 10 volts DC.

4.2.2 "UV" FAULT INDICATION

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

1. Apply Reset input (momentary input to J1-9) to reset latch. 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 380 to 506 VAC line-line. If the line voltage is OK, turn off power, wait 2 minutes and check A8 F1 and F2. If either is failed, replace and apply power to the drive. If either fuse fails again this indicates faulty power circuitry and the drive must be returned to the factory for repair.

4.2.3 "OV" FAULT INDICATION

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

1. Apply Reset input to reset latch. 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 factory recommended regeneration resistors for the drive.

2. The "deceleration" parameter may also be lowered to decrease the necessary regenerative capacity.

4.2.4 "PH1", "PH2" OR "PH3" (PHASE) FAULT INDICATION

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.

Make note of which LED is on (PH1, PH2, or PH3) and reset the drive by either removing power or by momentarily pressing the external reset. If, after resetting, the drive trips immediately after enabling, follow the suggestions listed under PERMANENT FAULTS. If the drive operates normally for a time period before tripping again, see the suggestions listed given INTERMITTENT FAULTS.

PERMANENT PH1, PH2, OR PH3 FAULTS:

1. Power transistor may be shorted. Remove ac power, wait 2 minutes, open enclosure observing WARNING precautions, bleed capacitor dc voltage to 10 volts maximum with resistor and then shunt the two capacitor bus bars.

Inspect power transistors and base drivers for burned components and other obvious signs of damage. Test transistors by removing shunt between bus bars, then measuring 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).

2. 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, disconnect output lines from control and check wiring and motor resistance line-line and line to ground.

3. A base driver circuit board may be failed, follow the suggestions given in step 5 of INTERMITTENT FAULTS.

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

3. The current drives may be saturating at high speeds due to too high an excitation current or too low of a bus voltage. Recheck the parameters and consider lowering the "base speed" for field weakening.

4. The rate loop gain setting may be too high. Recheck the rate loop response and consider lowering the proportional gain.

5. Drive may be overheating. Check that drive air inlets and outlets are unobstructed and that the incoming air temperature is less than 50 degrees C.

6. There may be intermittent connections. Remove ac power, wait 2 minutes, open enclosure observing WARNING precautions, bleed capacitor dc voltage to 10 volts maximum with resistor and then shunt the two capacitor bus bars. Inspect and tighten if necessary, all electrical connections

including the 22 AWG wires between the base drivers and power transistors.

7. 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.

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

4.2.5 "OT" OVERTEMPERATURE FAULT INDICATION (Both UV and OV)

1. Check the Fault Log menu (CTRL L) to determine whether the overtemperature was sensed on the motor or the drive.

2. If the motor overtemperature is detected, check continuity of normally closed motor thermal switch input, at J2-9 to J2-10.

3. If the drive has overheated it may be due to excessive load, failed fan or clogged cooling fins. If indication persists with cool heat sink check the continuity of normally closed switch, J4-1 and J4-2.

4.2.6 "OS" (OVERSPEED) FAULT INDICATION

1. If operating as a rate drive then an overshoot caused by an under-damped rate loop most likely caused the failure. Check rate loop compensation.

2. If operating as a torque drive then either the overspeed setting is too low, or the users external drive has malfunctioned.

3. Improper motor grounding will cause excessive noise leading to overspeed trips. Check that the motor and chassis is well grounded per section 2.2.1.

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

4.2.7 "±15" (CONTROL POWER SUPPLY) FAULT INDICATION

1. This latched fault indication will occur upon momentary reduction of ± 15 volts below allowable levels. Apply Reset Input and if problem persists replace control board.

4.2.8 ENABLE INDICATOR OFF WITH ENABLE(S) APPLIED

1. Check voltages J1-11 to -12; these voltages must be 10 volts dc minimum with either polarity to operate the enable circuits.

2. Replace control board if the proper voltages are present.

4.2.9 NO TORQUE WITH BOTH READY AND ENABLE INDICATORS ON

1. Current Limit may be near zero.

2. Replace control board.

4.2.10 NO MOTOR SHAFT ROTATION

1. READY and ENABLE indicators must be ON, see 4.2.1 or 4.2.8 if not.

2. The encoder power or signals may be lost. Check the signals on the J2 connector. If all are present the phasing of the encoder may be incorrect (see section 2.5.4).

3. If shaft rotates with little or no resisting torque, see 4.2.9.

4. Speed command may be zero, or the "speed enable" may not be active (see section 2.4.1).

5. See 4.2.11 if erratic or jittery motion of shaft occurs in response to speed command.

6. Discontinuity may exist between drive output and motor terminals.

4.2.11 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.

3. Rate compensation may be incorrect. Consider lowering the proportional gain.

4.2.12 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.

4.2.13 ALL LEDS FLASHING

1. Check servo parameters using an IBM type terminal. If the data has been corrupted reload the data from the file or reenter the data by hand. If the condition persists, replace the control board.

4.7.14 "OL" OVERLOAD FAULT INDICATION

1. If during initial setup, check motor parameters and adjust as needed.

2. If during normal running, inverse time overload value has been exceeded, check for excessive mechanical load or low line voltage.

5.0 PROTECTIVE DEVICES - Model 714-510-170

5.1 INPUT PROTECTION

Each of these controllers must be provided with a suitable input power protective device. A listing of the suggested fuses or circuit breakers is as follows:

Circuit Breaker	-	Three phase, 480VAC, 60A, thermal magnetic. G.E. TED series are typical.
Fuses	-	600VAC, 80A fast blow type. Buss KTS 80 and NOS 80 are typical.
	-	600VAC, 60A slow-blow type Buss FRS 60 and LPS 60 are typical

Wire the controller, protective devices and motor with wire size AWG #8 wire or larger.

5.2 INTERNAL FUSE LIST

QTY	RATING	SWEO PN	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

5.3 REGEN RESISTOR KIT

The minimum resistance of the regeneration resistor is 10 ohms for this controller. Sweo Controls supplies three kits coordinated with this controller.

R3 300 watts continuous, one 12 ohm, 300 Watt resistor with Buss KLK 30 fuse and holder.

R6 600 watts continuous, two 25 ohm 300 watt resistors to be used in parallel, with Buss KLK 30 fuse and holder.

R9 900 watts continuous, three 40 ohm, 300 watt resistors to be used in parallel, with Buss KLK 30 fuse and holder.

APPENDIX

FLUX VECTOR MOTOR CONTROL

Version 1.xx (C) Copyright 1989, SWEO Controls, Inc.

TITLE: DEFAULT PARAMETERS

AMPLIFIER MODEL # : 602- 35-170

MAX LIMITS (CONT/PEAK): 35/ 50 Arms   PRESENT LIMITS: 0/ 0 Arms

DRIVE READY: OFF   DRIVE ENABLED: OFF

MODE: SPEED CONTROL   MOTOR SPEED:+0 RPM

STARTUP PROCEDURE:

1) Select the configuration of the I/O	CTRL O
2) Complete the nameplate data entry	CTRL N
3a) Run the Auto Tuning of parameters	CTRL T
3b) OR complete the manual parameter entry	CTRL D
4) Save or load file data (optional)	CTRL F (disable drive)
5) Read fault log (optional)	CTRL L

CTRL C - REPAINT SCREEN

INPUT / OUTPUT SELECTION

0) SPEED CONTROL WITH SPEED/TORQUE ENABLE.

1) SPEED CONTROL WITH FORWARD/REVERSE ENABLE.

2) SPEED CONTROL FOR BIPOLAR OPERATION WITH 0 - +10V INPUT.

3) SWITCHABLE SPEED OR TORQUE CONTROL.

4) SWITCHABLE SPEED OR TORQUE CONTROL USING AUXILIARY INPUTS.

5) TORQUE CONTROL.

6) INVERTER RETROFIT.

7) SPEED CONTROL WITH MULTIPLE PARAMETER TABLES.

8) SPEED CONTROL WITH 4 ORIENT POSITIONS.

DETAILED EXPLANATION OF SELECTED OPERATING MODE:

The drive will be configured as a speed drive, moving at a rate proportional to the input voltage. The 'torque enable' turns on the drive while the 'speed enable' when DISABLED will call for zero speed regardless of the input voltage. The rotor may be oriented to one of two positions.

CTRL C-EXITS, ENTER/RETURN-SAVES & DISPLAYS, use TAB change selection.

J1 CONNECTOR

J1-1) aux anlg in = NOT USED

J1-2) RETURN

J1-3) aux anlg in = NOT USED

J1-4) INPUT COMMAND +

J1-5) INPUT COMMAND -

J1-6) anlg out = ABS VALUE VELOCITY

J1-7) anlg out = ABS VALUE TORQUE

J1-8) RETURN

J1-9) opto input = RESET

J1-10) opto input =SPEED ENABLE

user pot #1 = NOT USED

J1-11) opto input =TORQUE ENABLE

J1-12) OPTO INPUT RETURN

J1-13) opto input =ORIENT TO INDEX

J1-14) opto input =HIGH(1)/LOW(0)

J1-15) OPTO OUTPUT RETURN

J1-16) opto output = READY

J1-17) opto output = ZERO SPEED

J1-18) opto output = AT SPEED

J1-19) +24V DC OUTPUT

J1-20) +24V RETURN

user pot #2 = NOT USED

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 A - ABORT CHANGES, CTRL S-SAVES CHANGES.

NAMEPLATE DATA ENTRY MENU

TITLE :DEFAULT PARAMETERS use keyboard to enter data

AMPLIFIER DATA

Model # :602-_35-170 #Parallel Amplifiers(1=normal):1

Nominal Line Voltage :240 Vrms PWM Frequency :2500 Hz

MOTOR NAMEPLATE DATA

Current :_0 Arms Speed :__0 RPM
Voltage :_0 Vrms Frequency :_0 Hz

ENCODER DATA

Lines Per Revolution : 1024 (internal counts/rev = 4x lines/rev)

MOTOR LIMIT DATA

Maximum Speed : _0 RPM Max Acceleration:__0 RPM/Sec
Current Limit : _0 Arms Max Deceleration:__0 RPM/Sec
(0=No Limit)

ORIENT PARAMETERS (optional) Orient rate :+100 RPM

Orient offsets from index in encoder counts

#1: 1000 #2: 2000 #3: 3000 #4: 4000

CTRL C-EXITS,CTRL S-SAVE,CTRL A-ABORT,CTRL X-LOAD DEFAULTS,TAB-NEW FIELD

AUTO TUNING MENU

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

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

This procedure will check the encoder phasing with the motor's. The rotor will move at about 100 RPM for 1/2 second.

ENCODER DIRECTION IS +1

RETURN/ENTER to start procedure.

These procedures, when run will overwrite existing parameters!

CTRL C - EXITS

MANUAL PARAMETER ENTRY MENU

Amps per volt : 10

Number of motor poles :4

Rate compensation : 10(s+2Pi* 0)/s

Current loop feed forward gain :1000

Current loop compensation : 20(s+2Pi* 30)/s

Continuous current (amps rms) : 0

RPM for field weakening : 0

Rate dead zone for "0" command (RPM) : 0

Tolerance for "0" speed (RPM) : 10

At speed tolerance (RPM) : 100

Set speed value (RPM) : 1000

Slip gain : 20

Excitation current (amps rms x 100) : 0

Encoder direction (1 or -1) :+1

CTRL C-EXITS, CTRL S-SAVE, CTRL A-ABORT.

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

FAULT LOG

FAULT DESCRIPTION	RUN TIME
Control power (15V) failure	0 Hrs 57 min
Instantaneous overcurrent on phase 2	8 Hrs 12 min
Motor overspeed	9 Hrs 7 min
PRESENT RUNNING TIME	10 Hrs 6 min

CTRL C-EXITS, CTRL X - CLEAR MOST RECENT FAULT

6.0 DRAWINGS

PL0714620	Parts List - Controller
PL0714040	Parts List - Power Assembly
7566	Interconnect Diagram
7574	Interconnect Diagram
7148	Wiring Diagram - AC Vector Drive (460 VAC)
7153	Outline and Mounting - AC Vector Drive
0700	Installation Drawing - Regen Resistor Kit