Dynamatic®
DRIVE SOURCE INTERNATIONAL, INC.

Instruction Manual
Model EC-2000-HP Controller
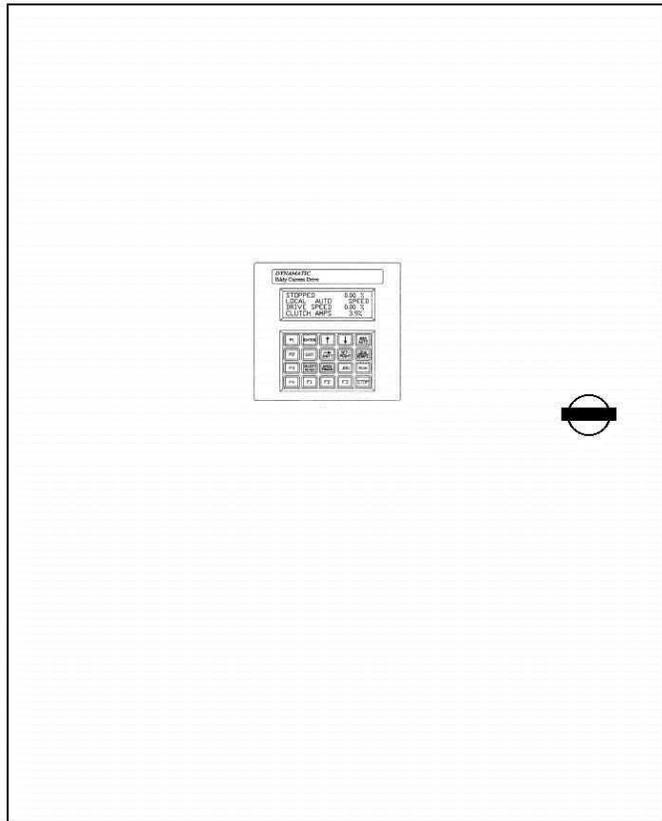
(NEMA 12 Enclosure Version Shown)

EC-2000-HP Software Version 1.38
Hardware Version 0012

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INTRODUCTION

The EC-2000-HP is a version of the EC-2000 controller that is designed to fulfill applications that require more voltage or current than 90VDC at 8 amps, which is the maximum rating of the standard EC-2000. These high outputs are required on applications such as large vertical pumps, stamping presses, brakes, test stands and other machine drives, usually delivering outputs greater than 100 horsepower. The EC-2000-HP can easily replace all of the existing Mark-III high power controls as well solve any new applications that require voltage from 100 to 200VDC and dc current up to 32 amp. Higher outputs are possible and can be engineered on request.

The EC-2000-HP high power control is a modular expansion of the standard EC-2000. It therefore shares some of the hardware and is driven by the same software as the standard control. Larger SCR's, contactors, current feedback and a number of other support devices are added to support the larger outputs. The standard software allows customers easy installation and start up as the programming, start up and maintenance of the two versions are very similar. The high power control is built and stocked in standard designs. See chart below. The chart shows the standard chassis mount high power controls along with recommended transformers. The EC-2000-HP can also be engineered to any application requirement such as a drop in replacement panel for the Dynamatic Mark III or other manufactures designs. While the special controls may have additional features, they will still have the same hardware and software base as the standard controls.

The EC-2000-HP control is an extension of the EC-2000 control. Using the standard controller's on board SCRs an output of 8 amps @ up to 90VDC is possible. To obtain higher outputs larger componenets are needed. The three major components of the EC-2000 8 Amp control are:

1. The Display Keypad – This is the programmer and display unit. It is needed to program the control and display data. Once the controller is programmed, the display keypad is not required for operation.
2. The Logic Board – This board contains the microprocessor, memory and analog to digital interface. It is the brain of the control.
3. The Driver Board. This contains about everthing else, SCR's, relays, power supplies, terminals and pulse transformers

The High Power Control adds some components:

1. (2) Surge protector, pulse transformer modules.
2. (2) Dual SCR Modules – Various Ratings
3. Power Contactor – Sized to Control Rating
4. Off Board LEM Current feedback mesuring devices
5. Large Heatsinks
6. Larger Terminals

The driver board has a number of jumpers. Two of these, J11 & J13, are used to configure on board or off board LEMs and SCRs. On board jumpers are used in the standard control. Off board LEMs and SCR's are used in the high power control. A third jumper, J5 is used to scale the current feedback for 5.5, 8, 11, 16, 24, or 32 Amps. These are the standard control ratings. 5.5, 8.0, 11.0 use the onboard LEM circuit. These are used in the 8 amp control and the 200V controls up to 11 Amp output. The off Board LEMS are used for 16, 24, 32 and Higher amps. See the chart below.

Power Board Programmable High Power Control Jumpers (Table 4)

JUMP	PARAMETER	POSITION "A"	POSITION "B"	POSITION "C"
J2	Follower Operation	Pulse Pickup (TB2-17)	Tach. Generator (TB2-18 & 19)	N/A
J3	Process Feedback	0 TO ±20VDC	0 TO ± 5, ±10V	N/A
J4	Speed Control Feedback	Pulse Pickup (TB2-2)	Tach. Generator (TB1, G1 & G2)	N/A
J5	Clutch Current Feedback Scaling	16.0 AMP (or less) Output	24 Amp Output 48 Amp Output	32 Amp Output No Jumper
J6	Brake Current Feedback Scaling	16.0 AMP (or less) Output	24 Amp Output 48 Amp Output	32 Amp Output No Jumper
J7	Gating Pulse Train	Standard & High Power Control	CES Control	N/A
J8	Synk bias	Standard & High Power Control	CES Control	N/A
J11	Clutch Gating Circuit	Standard Control On Board Pulse Xfmr	High Power Control Off Board Pulse Xfmr	High Power Control Off Board Pulse Xfmr
J13	Clutch Current Feedback Circuit	Standard Control On-Board LEM's	High Power Control Off-Board LEM's	High Power Control Off-Board LEM's
J14	Brake Current Feedback Circuit	Standard Control On-Board LEM's	High Power Control Off-Board LEM's	High Power Control Off-Board LEM's
J15	Sync Bandwidth	Standard & High Power Control	CES Control	N/A
J16	Synk Bandwidth	Standard & High Power Control	CES Control	N/A

Figure 10 Locations of Potentiometers and Jumpers on the driver board. Note that Jumpers J3 & J6 are located underneath the logic board if it is installed
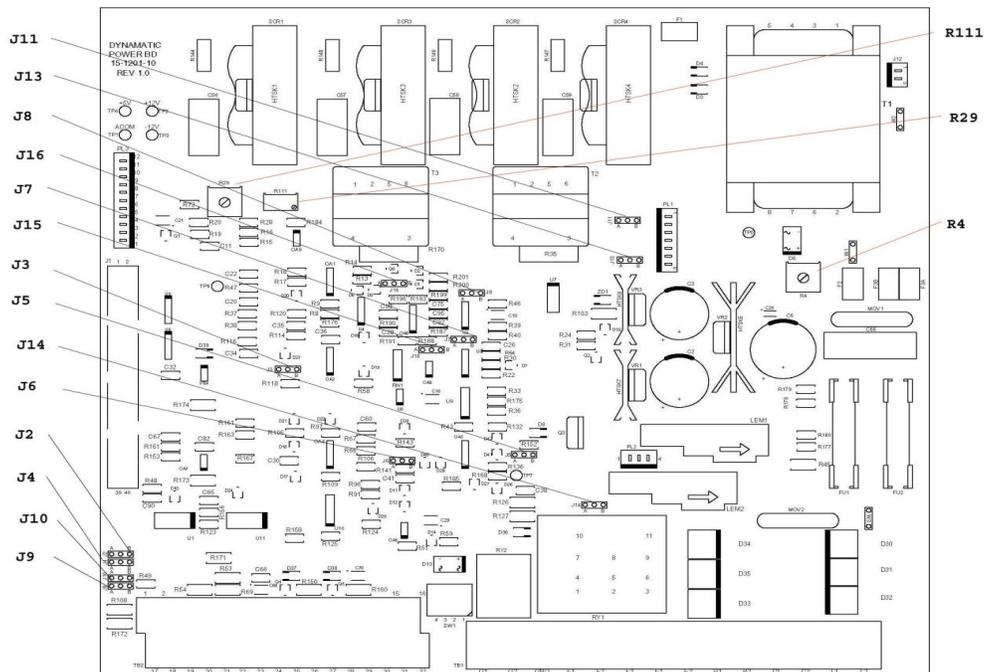

Figure 1: Location of Jumpers on the Power Board

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All the standard high power controls use 3 turns in the LEM current feedback circuit. The software and hardware jumpers are programmed to scale for the precise value of amperage at the factory. In the larger controls , greater than 32 amps, different turns will be used. The EC-2000 High power control is built around the standard control using the same display, driver board, logic board and programed firmware as the standard control. Larger SCR's, contactors, fuses, LEM circuits and terminals are needed for the higher ampacities.

Installation & Startup

All EC-2000-HP Control are supplied with connection diagrams and schematics from the factory.
The high power control uses some different terminal designations than the standard EC-2000. Please refer to the documentation packet that shipped with your control. The sections that follow describe the software programming for both the standard and high power control. The only parameters that are treated differently on the high power unit are the Control Rating, the Clutch Current Rating and the Current Scale Factor. These parameters are preset at the factory and should not need to be adjusted in the field. Please consult DSI / Dynamatic should you have questions or concerns about the programming or startup of this control. DSI / Dynamatic maintains a staff of inside and field service engineers that will be happy to assist you.

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Section 1 - GENERAL THEORY OF OPERATION

In general, the eddy current drive system consists of a prime mover (AC induction motor, usually a NEMA B type), an AC motor starter, the eddy current coupling, a speed feedback device and a controller with an operator interface. The sketch below depicts the standard type of control scheme normally used with Dynamatic eddy current drives.

Dynamatic typically does not provide the motor starting equipment; these are optional and a matter of the customer's preference. Normally all else is supplied: the integrated mechanical unit consisting of motor, eddy current clutch, and tach generator, and the separate electronic controller.

The drive system is relatively simple; the AC motor is started under no load and allowed to reach full speed before the controller is energized. The output of the control is determined by reference setting and feedback magnitude with drive speed and torque being based on the operational mode and load requirements. Speed control mode with tach feedback will regulate within 0.5% of set speed, while approximately 5% regulation is possible in torque mode using the internal clutch current loop as feedback. Preset speeds, jog, thread, and external reference inputs are available as standard parameter selections with the EC-2000control.

The EC-2000uses microprocessor technology to provide a flexible low noise control for today's high tech industrial environment. It provides setup and programming via a digital keypad and an easy to read alphanumeric display; drive parameters may be programmed and displayed by the customer to activate the many built-in features.
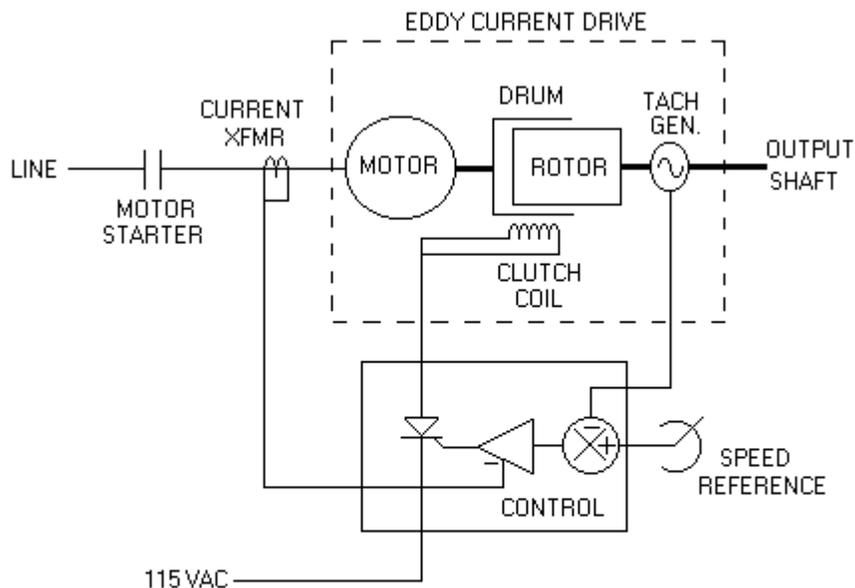

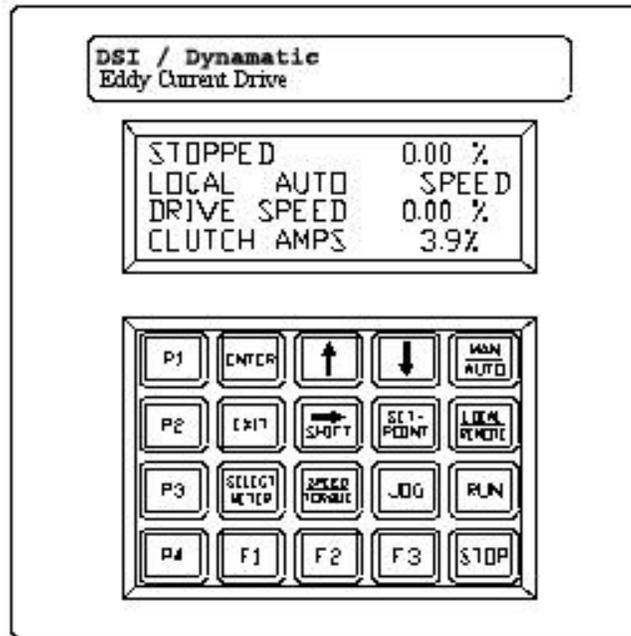Figure 1: Eddy Current Drive / Control Block Diagram

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Figure 2: EC-2000Keypad / Display

Section 2 - SPECIFICATIONS

The EC-2000-HP Control is offered in panel mount, NEMA 1, and NEMA 12 versions. The standard EC-2000 control produces an adjustable output voltage from 0 to 180 VDC with current capabilities up to 48 amps, making it an ideal control unit for most 45-, 75-, 90- 180-volt drives. Higher voltage and current units are available. An RS232 serial communications port for connection to a PC will be available in the future.

The user may select from these control types: speed, or torque (current). Speed regulation is provided using a G-2 tachometer or digital pulse pickup located on the EC mechanical unit. True current regulation results from using an isolated internally generated current feedback signal.

Features:

True current feedback control with isolated electronic measurement of coil current, voltage forcing and inversion for fast response, 115 or 230V VAC power input (480-575 V is also available) to allow running on standard lighting circuits, surface mount components to minimize PCB "real estate", combination LED "power on" with indication of the +/- 12V supplies being within range, simple and rugged linear power supplies for reliable, noise free operation and a back-lit, super-twist liquid crystal four-line display with soft touch keypad, NEMA 4 rated.

The output of the EC-2000is fuse protected against short circuits or shorts to ground. If 115VAC is not available and/or additional line noise suppression is desired, an isolation transformer may be used.

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2.1   Power Input/Output:
        Input voltage: 120, 230 VAC, ± 10%, 50/60Hz, center tap and full wave bridge units.
        Input line current: 50.0A RMS at 48.0A DC output. 200VDC Max. Inversion and field forcing
        available to 100VDC
        Output Voltage-Current 50,100 & 200VDC -- 16,24,32 & 48 Amp Standard
        Run Contact: (N.O.) 115VAC or 24V DC at 5A (Resistive), 150VA pilot duty
        Programable F relay 2A @ 115 VAC

        Load Regulation: -.25% load change from 25% to full load
        Line Regulation: ± 1% of rated speed for ± 10% change in line voltage

        Thermal Drift ± .05% of rated speed per °C
        Linearity ± 2% of maximum rated speed

        Minimum Regulated Speed: 25 RPM
        Linear Acceleration and Deceleration range: 1% to 200% of top speed per second

        Fuses 60 A max, 250VAC (Varies by rating)

2.2   Environmental Ratings:
        Operating temperature range: 0° to 40°C (enclosed or panel mount)
        Storage temperature: -10° to 75°C maximum
        Humidity: 95% non-condensing
        Elevation: to 1500 meters without derating

2.3   Electrical Noise: The control is immune to showering arc noise as specified by NEMA 519 test
        procedures. Operation will not be affected by a 5 watt, 2-way radio transmission with the
        enclosure door closed. Noise Immunity and Radiation: The controller complies with FCC, part
        15B, of federal regulation #47 as a Class A digital device when operated in a defined enclosure
        and installed in accordance with our instructions; third party verification is required. EMI
        Susceptibility: The controller will comply with IEC 801(1984)-3, class 2. The controller will operate
        without fault or disturbance under the specified level of radiated EMI (Performance Criteria 1).

Mechanical Characteristics

2.4   Enclosures: NEMA 1 standard.
        NEMA 4, NEMA 12 and Panel Mount optional.

2.5   Weight Panel Mount controller - 5 pounds.
        NEMA 4 Enclosed - 115VAC no isolation transformer - 18 pounds.
        NEMA 12 Enclosed -115VAC no isolation transformer - 22 pounds.

2.6   Dimensions: Panel - 18.5"H x 11.5 x 10"D   Sizes Can Vary
        Keypad - 4.875"H x 4.875"W x 1.375"D
        NEMA 1 Enclosure – 36 "H x 36 "W x 16"D
        NEMA 12 Enclosure – 36 "H x 36"W x 16 "D   (Fan Filtered)

2.7   Packaging: All Controls will be packaged in a cardboard shipping container. Enclosed versions
        will include the keypad mounted on the door of the enclosure. For keypad panel mount versions,
        the keypad will be packaged separately including mounting hardware. Panel mounts without
        keypads will be programmed for external control at the factory. Final programming will be the
        responsibility of the customer. Any damage to packaging discovered during receiving must be
        reported promptly to the carrier.

2.8   Reliability: The MTBF (mean time between failures) is 50,000 hours minimum calculated. Field failure rates should be less than 1% in 36 months. An actual MTBF will be reported when available.

2.9   Codes and Standards: The controller is designed to conform to the currently accepted standards for industrial electronic controls; consult the factory for details on applicable markings.

2.10   Hardware Description and Miscellaneous Information: The power PCB 15-1201-12 is mounted on six standoffs with # 6-32 screws. Piggybacked on this board is the logic board assembly 15-1200-1, the interconnect is via a 40-pin ribbon cable. The third major control element is the keypad/display which is mounted either on the enclosure door or is shipped loose for mounting by the customer. The keypad cable consists of a pair of wires for the power supply and a shielded pair for serial data; it connects to the logic board at PL2. A latching resistor is chassis or panel mounted and plugged into the power board. Two terminal blocks at the bottom of the power board comprise all of the customer connections with the exception of optional communication interfaces or connections to Relay Mod(s), if used. The right hand "power" terminal block, TB1, is for input and output power, run relay and fault contacts, and G2 Generator connections.   External references, operator elements, current transformer, pulse pickups and follower
signals connect to TB2 or TB depending on design.

Most of the modifications are built into the software; consult Section 8 on programming and the appropriate parameters to implement them.

The panel mount version of this control is available for customer mounting within an existing enclosure with the keypad (if used) either bracket mounted or enclosure door mounted. The maximum length for the keypad cable is 6' and the wires should be at least AWG 26; it is advised to keep the cable as short as possible.

The customer is responsible for operator element and other control input wiring. All signal input connections should be made with shielded cable, grounded (to common) at the control end only. The control may be operated solely from the keypad, if desired.

Two communication interfaces and a Two Relay Modification are available for use with the control. The control can accommodate up to five relay outputs (F relay plus two mods); further details follow in this manual. When the controller is shipped with a modification board, a separate instruction sheet is provided that includes the mounting and wiring instructions as well as the schematic and connection diagrams for the complete controller.

Pages 13, 14 and 15 of this manual contain internal connection diagrams. Externail connections are furnished with each control.   Sections 5 and 8 contain information for operational modifications; note that parameter programming will be required to activate the mods
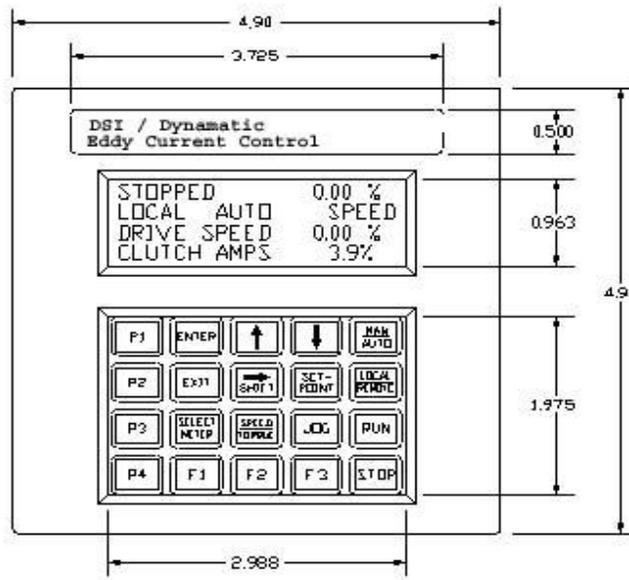
Figure 3: Keypad Dimensions (inches)

Section 3 - GENERAL OPERATION MODE AND INPUT/OUTPUT INFORMATION

Three control modes will be available and selectable from the keypad:

> Speed Control
> Torque (current) Control
> Speed/Torque

Other modes of operation can also be provided, some of which are dependent on the control type selected:

> Local/Remote
> Jogging
> Manual/Follower-tachometer or low signal
> Two Wire or Three Wire Start/Stop
> Preset Set points
> PLC Run
> Auto Restart on power
> Auto Restart after Fault
> Adjustable Braking
> Coast to Stop.
> Ramp Control (separate rates)
> Loss of Follower
> Torque Limit (requires optional CT)
> User Process Units
> Forward / Reverse Speed Control

3.1   Input/Output Connections:
        Most inputs/outputs will be provided via terminal blocks (sometimes abbreviated "TB"). Some functions may be programmed to be controlled by either a terminal block input, by the keypad, or both.

Analog Inputs

3.2   Reference Voltage (Set point):
This input, when programmed, determines the desired speed or torque. Programming usually configures this input as a 0-10 volt analog signal from a remote pot or a programmable controller, computer or other source.

3.3   Auto Reference Signal (Follower Input) (Set point):
This input provides the drive reference when in the Auto Mode.   Parameters are used to scale this signal. The follower signal is isolated and input level jumper selectable for either 4-20ma or 0-10VDC.

3.4   Motor Current Feedback Input (For Torque limit):
This signal is to be used by the Torque Limit function, motor amps display and other control functions. Software and hardware are used to scale this signal. This function requires the use of a Dynamatic 15-203-3 for motor currents up to 70-amps, 15-203-125 for motor currents of 55- to 125-amps, 15-203-250 for motor currents of 110- to 250-amps, or 15-203-500 for motor currents of 220- to 500-amps. The older 15-18-* current transformer assemblies may also be used.

3.5   Four Speed Feedback Inputs (selectable):
These inputs are used by the control: (one of two) to close the speed loop and as an indication of output speed and, (one of two) as a follower signal. Programming will allow the user to scale these signals as necessary and jumpers are used to select between the different types (on different terminals) of feedback. A +12V supply terminal is also provided for customer use if the speed feedback source requires it.

3.6   Clutch Current Feedback:
This is an internal signal used by the processor for current control logic, stability purposes and the clutch amps or "percent excitation" display. Software and hardware settings must be made (and be in agreement) to scale this signal based on coil rating.

3.7   Brake Current Feedback:
This is the same as for the clutch above, but is separate and only for the brake output.

Discrete Digital Inputs

3.8   These are defined as inputs from customer supplied switches or hardware contacts (not solid state) wired to the terminal block. All the inputs listed are available, but may not all be used at the same time. Usage is dependent on the control type and functions selected; the Control Mode will automatically program the inputs to the necessary function. Programming will also direct some operator functions to be controlled by either the terminal block or keypad, for instance, "Local/Remote". Other inputs:

E-Stop – N.C.	Preset 1 or 2
Stop – N.C.	Preset 3 or 4
Start - N.O.	Manual or Auto
Jog - N.O.	Speed or Torque
PLC Run N.O.	Speed/Torque Mode Select

Analog Outputs

3.9   Programmable Analog Outputs (2). These signals are intended for customer use. All of the outputs listed are available, but only two are available at any one time, and the selection may be dependent upon the control type selected. The output level is selectable from 0-10VDC or 4-20ma (minimum load 500 ohms), isolated. Select outputs from:

Motor Amps	Drive Output Speed (rpm)
Process	Clutch Amps
Feedback	Brake Amps
Reference	Set point
Drive Output Speed (rpm)	Set point Deviation

3.10   Run Signal (or "Drive Run" signal): Normally open E relay contact rated 2A, 115VAC.

3.11   F Relay (Fault Output): Form C contact rated 2A, 115VAC. Fault indication was the intended use for this relay output; however it may be reprogrammed for the other conditions listed under 3.13. As a fault relay, it is de-energized in the non-faulted condition and pulls in on any fault.

3.12   Four (4) User Programmable Relay Drivers: Drivers for up to four additional relays are provided. The use of the relay mod(s) requires an external 12VDC power supply. Each relay may be programmed as status indicator, trip o, or trip off relay function. Optional relay modification boards are available from the factory, two relays per board. Each relay has (2) Form C Contacts rated 2 Amp, 115VAC. The relays can indicate any of the following conditions:

Speed Mode	Run
Torque Mode	Run 0
Local Mode	Coasting
Remote Mode	Jogging
Manual Mode	Fault
Auto Mode	Restart
Stopped	Torque Limit
Stopping	At Set point
E-Stop	Loss of Follower
	Loss of Feedback

3.13   Keypad/Display: The EC-2000keypad/display unit is used for monitoring and setup of the drive. This unit is usually mounted on the enclosure door or remotely up to 6 ft from the control. The keypad has dedicated command keys as well as scrolling and programmable presets. Each control may use only one keypad and the keypad may be removed and the control run without it. The control will automatically display the parameters that are appropriate to the selected modes or functions. Some parameters will require the drive be stopped before a change can be entered. Access to certain commands and parameters may be denied by locking the keypad with a password. In order to extend the lifetime of the display backlight, it is programmed to go off after several minutes during which no key has been operated. The LCD display is legible in normal room lighting and the backlight turns back on as soon as any key is pressed, including the blue (normally unused) function keys.

To prevent damage to the controller or keypad, always remove power from the controller before connecting or disconnecting the keypad/display from the unit. The keypad connector to the digital control card is polarized. Install the connector in the proper position and orientation. Failure to do so will destroy the keypad/display unit.

Section 4 - INSTALLATION

4.1   Location: In an effort to reduce costs and minimize enclosure volume, the EC-2000standard enclosure is a modified NEMA 1 with hidden, drip-proof air vents, intended for inside use only, and requiring a relatively clean and dry environment. If this cannot be provided, an alternative method of mounting the control should be arranged. Remember that evidence of condensation caused corrosion or substantial dirt build up on failed circuit boards will invalidate the warranty. The area selected should have an ambient temperature of 40°C (104°F) or less, and have at least 12" of clearance above and below the enclosure so that the cooling air will not be impeded. Mounting surfaces with substantial vibration or mechanical shock must be avoided.

Knockouts are provided for conduit entrances at the top and bottom of the enclosure. Remember that the area selected for mounting should be convenient for reading the display and entering command or parameter changes on the keypad.

The mounting surface for the control should be flat; refer to the outline dimension print or use the enclosure to make a paper template for hole locations. Use ¼ - 20 hardware for mounting; be sure to leave enough room to the left of the enclosure so that the door can be fully opened (see the dimension drawing for minimum left side clearance).

4.2   Wiring: This basic instruction manual and modification instruction sheets includes connection diagrams (see pages 13 – 15), which are in simplified block form with the terminal blocks shown, numbered and lettered exactly as they appear on the controller. The devices that may have to be wired are shown graphically on the diagram with the heavy solid lines representing the wire connections.

Since the drive uses a standard AC induction motor, it must be connected with the proper branch circuit protection, motor starter and overload devices (not normally supplied as a part of the control package). The minimum requirements are specified in the National Electrical Code and other local regulations may also apply. If there are any questions, consult with the supplier of the equipment or the local code authorities.

Wire size, the number of conductors in a conduit or the NEC and other applicable local regulations also specify raceway and grounding techniques; it is important to meet the minimum requirements of these codes. Consult the nameplate on your drive for full load current at the line voltage you will be connected to. Controller 115VAC input wiring current capacity is equal to the output rating for the EC-2000control; in most cases, the minimum conductor size allowed by code will suffice. To avoid stray signal interference, do not run the signal wires in the same conduit as the power wiring and note that is necessary to use shielded conductors for the generator leads and all signal wiring, both for runs to the controller and to any other devices that may be used. The shielded conductor should be a twisted, insulated pair with a continuous metallic shield and an outer insulation. It is generally accepted that the best practice is to ground the shields only at the control end to avoid making "ground loops". Be sure to tape or otherwise insulate exposed shielding which could short to other conductors or terminals. The generator leads need not be shielded if the run is short, up to 15' or so, and is either in a separated conduit or dressed away from power wiring. If shielded cable is used for the generator leads, it may be run in the same conduit with the other drive wires.

After pulling the proper size conductors, connect each terminal at the drive to the corresponding controller terminal of the same designation. For example, C1 at the drive unit should be connected to terminal C1 at the controller. Be sure to properly strip the wires so that the insulation is not crimped under the terminals or that excessive bare wire is showing. Also make sure that no strands of wire are outside the terminal where they may short out. When all wiring is completed, recheck all connections again to insure they are correct and that each is tight. Once you have assured yourself that the wiring is exactly as shown on the connection diagram, you may proceed to the next step.

4.3   Hardware Programming: There are a number of programmable jumpers and other devices that must be set properly in order to be able to run the EC2000.

E-stop jumper: Check terminals 31 and 32 on TB2, either normally closed pushbuttons (in series) or a wire jumper must be installed between these points for the control to run.

Remote normal stop terminal: TB2-24, also must either be wired to a remote normally closed pushbutton (to COM TB2-22) or a wire jumper must be installed in order to run. This is because all "Stop" inputs to the logic are always active for safety purposes.

Trim pots: R4 is a factory set + 5V adjustment; do not change the setting unless the + 5V is out of range. R111 is the Torque Limit gain adjustment, which is covered under setup for that function. R29 Is gating advance. This is set at the factory.

Programmable Jumpers:

J2 and J4: These two jumpers have similar purposes; J4 is for speed control to select between tach generator feedback ("B" position) at G1 and G2 on TB1 or pulse pickup speed feedback connected to TB2-2 ("A"). J2 is for the same selection of inputs for tach follower.

J3: This is set in "A" for $\pm$ 20V process feedback; "B" is for $\pm$ 5 or $\pm$ 10V. The feedback may be of either polarity because the process feedback circuit includes an absolute value function.

J5 and J6: Are used to correctly scale the clutch and brake current feedbacks for the logic/software. "B" position is for 8A, the maximum control rating. Since there are many clutches and brakes that are rated at or less than 5.5A, the feedbacks may be scaled to be 100% at 5.5A for better resolution by selecting position "A". These jumpers must be in agreement with the "Control Rating" parameters.

J7 Gating Pulse Train Enables Gating Pulse Train in A Position. Disables in B Position. Set in A Position for Standard and High Power control.

J8 Synk Bias Set in A Position on Standard and High Power Control .

J9 and J10: Are for analog follower operation type and gain selection and are covered by the section dealing with follower setup.

J11 & J13 Are for selecting the standard controller 5.5 & 8.0 amps (Position A, both jumpers) or high power controls 16 to 100 Amp (Position B, both jumpers). J11 controls the LEM current feedback and J13 Controls the out put gating Circuit. These jumpers are set at the factory. See the High Power control Manual for more information.

J14 Is for selecting the Mutuatrol Braking Output. This requires an additional module. Please refer to supplied prints if this option has been provided. Position A is normal braking Position B is Mutuatrol.

J15 and J16: Sync Bandwidth Set both in A Position for Standard and High Power Control.

R111 Torque Limit Current Adjustment – This potentiometer is used to adjust and scale the value of the motor feedback amps viewed on the display used in the torque limit function. An external current transformer is required for this.

R29 SCR gating angle adjustment – This potentiometer is used to adjust the minimum SCR firing angle. Set at the factory. Do not adjust in the field.

R4 5V Power Supply Adjustment – This potentiometer is used to adjust the logic board 5V power supply. Set at factory. Should not need field adjustment

SW2 Torque Limit Programming: If the torque limit function is to be used, a properly sized motor current transformer must be wired to terminals TB2-14 and 15. SW2 is then set based on the motor full load current rating per the Table 1 on page 12. Gain pot R111 adjustment and calibration is covered in Section 5-20. For further detailed information refer to the EC-2000Parameter List, Section 6.

Table 1: SW2 Programming vs. I XFMR Assembly

CURRENT XFMR ASSEMBLY	RATED MOTOR CURRENT	SW2		CONT ACTS		TRANSFORMER LEAD CONNECTIONS
		1	2	3	4	
15-203-3	0 – 3A	X	X	X	X	Tape Orange Lead (Not Used)
	3 – 4^A	X	O	O	O	
	4 – 5^A	O	O	X	O	
	5 – 10^A	O	O	O	X	
	10 – 20^A	X	X	X	X	Connect Orange and Black Leads Together
	20 – 35^A	X	O	O	O	
	35 – 50^A	O	O	X	O	
	50 – 70^A	O	O	O	X	
15-203-*	55 – 500^A	X	X	X	X	

X = Indicates closed contact; O = Open

* Use 15-203-125 for 55-125A, 15-203-250 for 110-250A, and 15-203-500 for 220-500A

Table 2: Drive Tach Generator and Pulse Pick Up -- Pulses/Rev. (PPR) (or Pole Pairs)

Drive	PPR
Obsolete Drives ACM's	10
AS-14 / 25 – Fractional "FD"	12
Salient Pole Drives	14
AS-27 / AT-320	16
Salient Pole Drives	24
VT-320 P-base, AT-360, AT-440	30
Pulse Pickup, Gear	30,60,120,180

Pulse pick-ups: The pulse counts naturally are dependent on the gear used, with the most common being 60 tooth (60 PPR).

EC-2000Set Up			
	Speed	**Torque**	**Speed / Torque**
Process Units	Choices are: Percent RPM User	Percent only	Choices are: Percent RPM User
Feedback Source	Automatically set to speed, parameter is locked	Automatically set to clutch current, parameter is locked	Automatically set to speed when speed is selected, clutch current when torque is selected. Locked.
Select Input ½ Function	Parameter is enabled and displayed	Parameter is enabled and displayed	Parameter is disabled and not displayed
Preset Command Source	Parameter is enabled and displayed	Parameter is enabled and displayed	Parameter is enabled and displayed
Speed / Torque key	Key is not functional	Key is not functional	Key is functional

Table 3
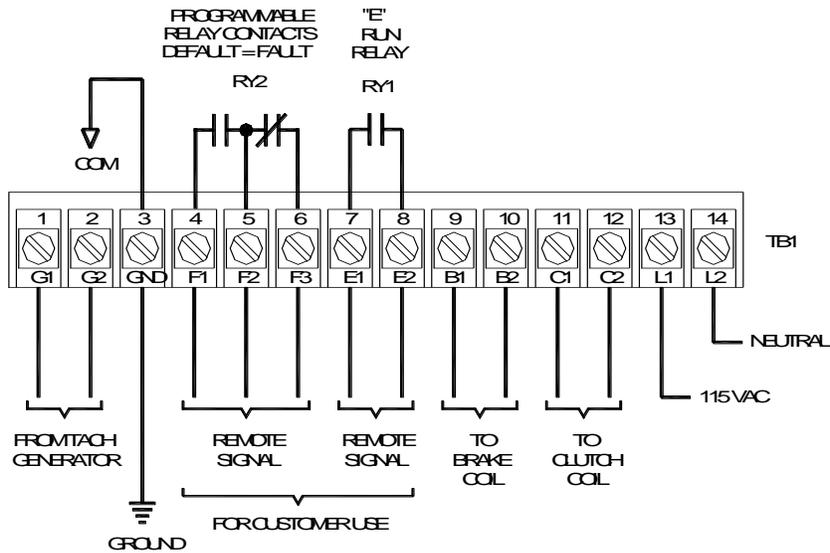
Figure 4: Customer Power Terminal Block Connections

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NOTE: START AND JOG CONTACTS ARE ACTIVE ONLY
DURING "REMOTE" OPERATION
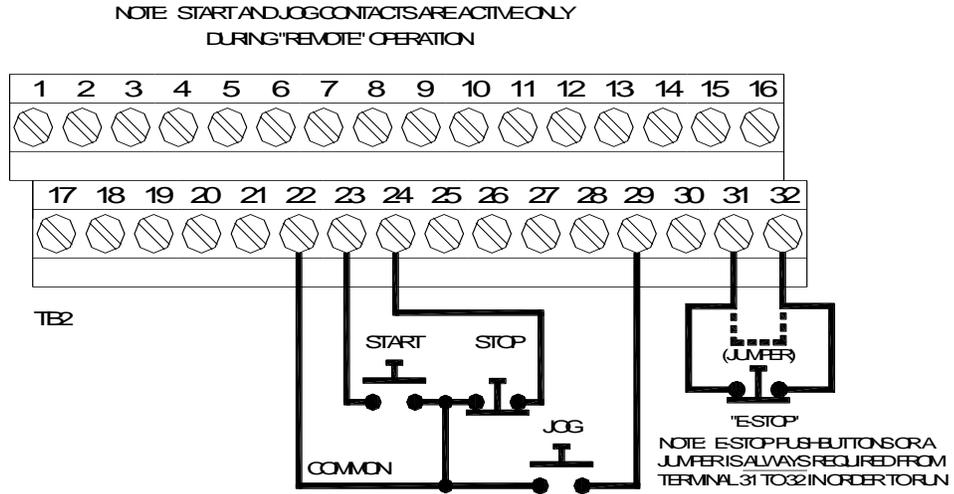
Figure 5: Three Wire Start / Stop Connections with Jog Pushbutton
For two wire control, jumper 22 & 23 and toggle 22 & 24.
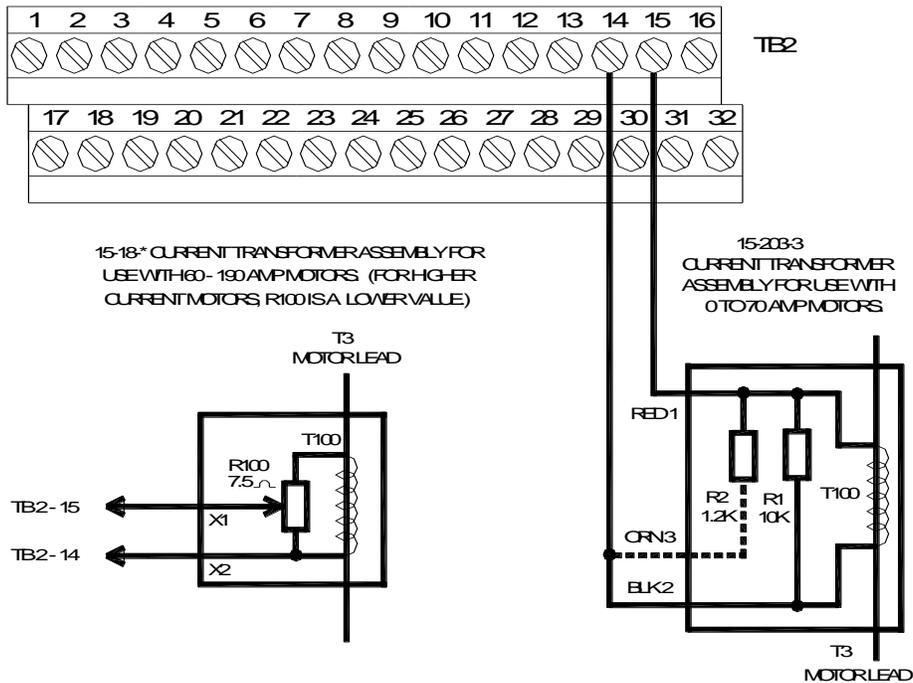
Figure 6: Torque Limit and Motor Current Indication Connections
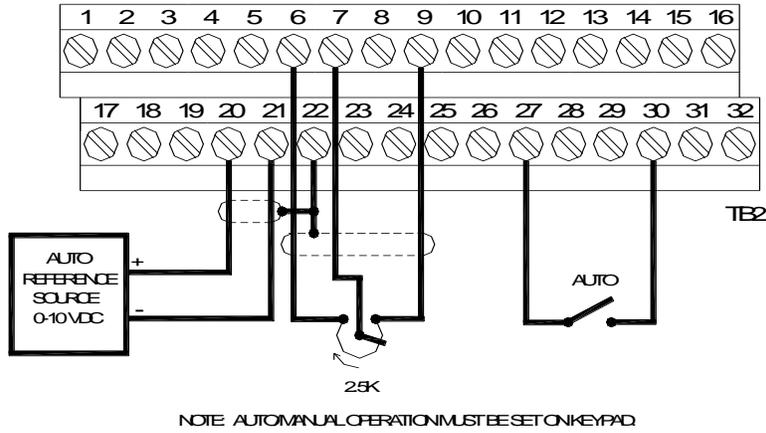
Figure 7: Follower Auto Signal and Pot Connections

SPEED FEEDBACK OPTION: ZERO VELOCITY HALL EFFECT PULSE PICKUP
NOTE: SET J4 ON THE POWER PCB TO THE "A" POSITION.

PULSE PICKUP IS P/N 63-52-1 OR EQUIVALENT. THE COLORS
REFER TO THE PICKUP WIRES. THE USE OF SHIELDED CABLE
IS RECOMMENDED.
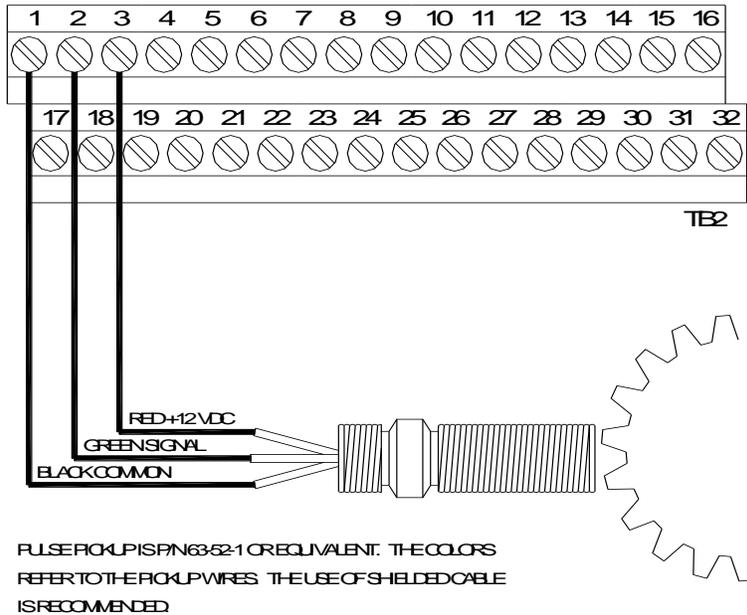
Figure 8: Pulse Pickup Connection Details

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NOTE: 0 - 10V OR 4 - 20MA (MAX) OUTPUTS ARE DETERMINED
BY THE VALUE OF THE LOAD TERMINATIONS.

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |

| 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |

TB2

500 OHM TERMINATION RESISTORS
FOR 4-20 MA OUTPUTS

Figure 9: Analog Output Connections

Section 5 - INITIAL CONTROLLER SETUP

This section covers in detail the fundamental programming required to optimize the operation of the EC-2000control on your drive; Section 8 covers some of the more specialized features. Since we realize that the average person does not have the patience in the beginning to wade through all of the fine aspects, please go to "**Section 9 - Quick Startup with Programming Examples**" for nearly instant gratification. Once familiarized and desiring other features or optimization, then consult Sections 4, 5, and 6. Although the information is presented roughly in order of the menus and parameters, sometimes it is given in order of apparent importance to the operation, and it may be necessary to deviate from the flow of items as presented in the parameter list of Section 7.

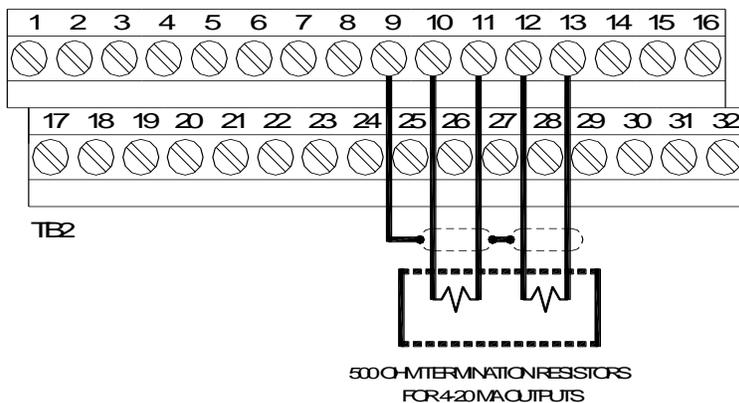This section describes the functions and parameters in the order presented in **Section 7: Parameter List** beginning on page 52. Programming may require jumping to another part of the list and then back again to achieve the proper effects. The reader will be advised of such situations. Programming examples are given in Section 9: Quick Startup with Programming Examples beginning on page 62.

5.1   Menu A: CONTROL SETUP:

PROGRAMMING CONTROL TYPE AND DRIVE CHARACTERISTICS:

To enable the control to operate properly, minimal information about the application and the eddy current drive must be entered. The "A CONTROL SETUP" menu is used to enter the required information as follows: (Note: if the mechanical unit is equipped with a brake, also see "Menu D. BRAK PERFORMANCE" in Section 5.4 for additional set up requirements.)

To begin, enter the control type:

> The parameter "1 CONTROL TYPE"
Select from "SPEED", "TORQUE", "SPD/TRQ", or "EXTERNAL"; the default is speed control. This parameter automatically selects the correct feedback source. The EC-2000control is designed to use speed feedback, coil current, or an external analog signal source, which is the "process feedback". The selected control mode may also change the default performance gains; if Speed is selected, the feedback source is defined by the "Speed Feedback Scale" parameter, and if Torque is selected, the (current) feedback is provided internally from the power board. At the same time, it disables the speed feedback parameters and automatically displays "Clutch Current" as the feedback. If External is selected, a separate analog signal connected to the terminal block is used as defined by the External Feedback parameters. If "SPD/TRQ" mode is selected, then the control type is selected via the terminal block input or Keypad "Speed/Torque" key and the "Input 1/2 Function" parameter is not displayed since these inputs are replaced by the speed/torque command inputs. If the "SPD/TRQ" selection is not made, the "Speed/Torque" key on the keypad is not functional and the "Control Type" source parameter is not displayed. This information is summarized in Table 3 on page 12.

Now enter the controller current rating:

> The parameter "2 CONTRLR CURRENT" is used to select the output range of the controller. The choices are 5.5 or 8.0 amps. Choose the lowest value above or equal to the coil rating of the EC unit being used. Note: Jumper J5 (and J6 for the brake) on the power PCB must be in the correct position for the current level setting. Position A = 5.5 Amps, B = 8 Amps (Default).

Next the EC coil rating must be entered:

> The parameter "3 CLUTCH COIL RATING" is used to enter the coil rating. Locate the coil current rating on the nameplate of the mechanical unit and enter this value. Note that the value should be equal to or less than the controller rating (Parameter 2) entered above. Default is 8.0 Amps.

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Determine if the coil current limit to be used will be less than rated:

> The parameter "4 CLUTCH CURNT LIM" is used to set the coil current limit to a value equal to or less than its rating. Limiting the coil current to less than rated reduces the amount of torque; in some applications this may be desirable, however for most applications this parameter should be set at the same value as the clutch coil rating. The default value is 8 Amps.

Set the speed feedback frequency:

➤ **The parameter "5 TACH PULSES/REV"** is used to set this rate. In most applications the AC generator located inside the mechanical unit is used to provide the speed feedback signal. Alternatively, an external generator or pulse pick up may be used. If the generator PPR rate is unknown, check Table 2 on page 12 to see if your drive size is listed or check the nameplate on newer units; it may also be obtained by consulting the factory. If an external generator or pickup is used, enter the PPR rate. The available choices are: 10, 12, 14, 16, 24, 30, 60, 120 and 180. If none of the choices is correct, the Clutch PPR Scale factor may be used. Enter the closest number. The actual drive speed may be trimmed by applying a Clutch PPR Scaling factor as described in Menu "A 17. CLUTCH PPR SCALE" below. Note: Jumper J4 on the power board must be in the correct position; if an AC tach generator is used, wire to terminals TB1-1 and 2 (G1 and G2) on the power PCB, and set the jumper to the "B" position (default). If a pulse pickup is used, wire to TB2-1 (COM), TB2-2 (sig.) and TB2-3 (+12V) and set the jumper in the "A" position.

➤ **The parameter "6 TORQ PULSES/REV"** is used to set an alternate ppr rate for certain applications that may use more than one transducer in different situations. The ppr rate can be changed from using parameter 5 above to this parameter by enabling parameter 18 below (Closed Loop Torq) and closing Terminal 25.

Enter the clutch speed range:

> The parameter "7 CLUTCH MIN RPM" sets the low speed thermal rating (from unit nameplate) if any. Slower speeds are possible, but may require reduced torque. Default is 0 RPM.

> The parameter "8 CLUTCH MAX RPM" is used to set the max speed of the clutch (again from the nameplate). **These two parameters set the limits for the max and min process**.
IMPORTANT: The min and max clutch rpm parameters set the overall speed range limits for drive operation. The correct values are essential for drive thermal protection particularly in applications requiring rated torque at slow speeds and it also ensures the EC-2000control will remain in regulation at high speed applications. If application speed or full load torque is required outside the nameplate capacity, consult the factory. Default is 1660 RPM.

CAUTION: Clutch min and max RPM parameters affect the range and setting of other parameters (i.e. min/max process and preset parameters) and may cause other parameters to be automatically rescaled. **Always set these parameters first and then reset or verify the other parameters in other menu sections before continuing.**

The motor current rating must now be entered:

> The parameters "9 MTR NO LOAD AMPS" and "10 MTR FULL LOAD A" are used to scale the motor current signal for proper operation and are necessary only if the torque limit mode of operation is to be used or if the motor current is to be monitored. The motor Full Load amps are listed on the nameplate of the motor. For proper scaling, both the full load and no load motor currents are required. If the no-load motor amps are not listed on the nameplate, this current must be measured. For more information on Torque Limit see the "Section 6 - Other Operating Functions and Features" on page 48.

Select the stopping mode:

> The parameter "11 COAST ENABLE" is a feature that bypasses the programmed deceleration rate while stopping. If this parameter is enabled, when a stop command is issued, the output is immediately inhibited and the output contactor drops out; the drive output shaft will then coast to a stop. If the coast to stop feature is desired, set parameter "10 COAST ENABLE" to "ENABLE". When the stop command is given, the drive status display will show "COASTING" until the output speed sensed by the tach is at zero, at which time the status display will change to "STOPPED". If this feature is selected, it also works in the jog mode. When the jog button is released, the drive will coast to a stop. The default condition is DISABLED.

Enter the control mode to be used:

> The parameter "12 LOCAL/REM EN" is used to select the local or remote control mode. This determines if the control is to be operated from the keypad (local), or from externally wired switches (remote), or both. This feature is not required for most applications but is shipped ENABLED, and the factory default mode for this function is for local operation from the keypad.

The EC-2000has two modes of operation, LOCAL or REMOTE. The local/remote mode selection determines the source of the START, JOG, and MANUAL/AUTO, PRESET(s) 1-4 and SPD/TORQUE commands. Each command has a dedicated key on the keypad and a terminal block input for remote wired switches or pushbuttons.

In local mode, the above commands are executed only from the keypad. **In remote mode** the commands are executed via elements wired to the terminal block inputs.

As a safety feature, the **local/remote select** command may be executed **only from the keypad**. In order to switch between the two modes by using the LOCAL/REMOTE key on the keypad, the "LOCAL/REMOTE ENABLE" parameter must be set to "ENABLE". If the local/remote command is disabled, the source for each command must be set individually. See Menu "K 7. START SOURCE" for more information on the Start Source.

Start Command:

1. If LOCAL/REMOTE is ENABLED and START SOURCE is set to TERMINAL: when in LOCAL, the keypad RUN key starts the drive and the TB (terminal block) start inputs are disabled. When in REMOTE, the start input on the TB starts the drive. The start input could be either the start input TB2-23 or the PLC run input TB2-28 (depending on whether the PLC run function is enabled). The keypad RUN key is disabled.

2. If LOCAL/REMOTE is ENABLED and START SOURCE is set to KEYPAD: when in local **or** remote, the keypad RUN key starts the drive; the TB start inputs are disabled.

Speed/Torque Command:

1. If LOCAL/REMOTE is ENABLED and CONTROL TYPE SOURCE is set to TERMINAL: when in local, the keypad SPD/TRQ key selects the control type and the TB input is disabled. When in remote, the control type input at TB2-25 selects the control type and the keypad SPD/TRQ key is disabled. Note that terminal TB2-25 has multiple purposes and its function will depend upon the functions programmed. When the SPD/TRQ function is enabled, TB2-25 selects the SPD or TRQ state. The Speed mode is selected when this terminal is open, and the Torque function is selected when TB2-25 is connected to analog common, TB2-27.

2. If LOCAL/REMOTE is ENABLED and CONTROL TYPE SOURCE is set to KEYPAD: then in local **or** remote, the keypad SPD/TRQ key selects the control type and the TB input is disabled.

Manual/Auto Command:

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1. If LOCAL/REMOTE is ENABLED and AUTO/MAN SOURCE is set to TERMINAL: when in local, the keypad MAN/AUTO key selects the mode and the terminal block auto input is disabled; in remote, the auto input at TB2-30 sets the mode and the keypad MAN/AUTO key is disabled.

2. If LOCAL/REMOTE is ENABLED and AUTO/MAN SOURCE is set to KEYPAD: when in local **or** remote, the keypad MAN/AUTO key selects the mode and the TB auto input is disabled.

Preset Commands:

1. If the control type is SPEED, TORQUE, or EXTERNAL, and if LOCAL/REMOTE is ENABLED and PRESET SOURCE is set to TERMINAL: in local, the keypad P1, P2, P3, and P4 keys select the set point and the TB inputs are disabled. In remote, the preset inputs at TB2-25 and TB2-26 select the set point and the keypad P1, P2, P3 and P4 keys are disabled.

2. If LOCAL/REMOTE is ENABLED and PRESET SOURCE is set to KEYPAD: in local **or** remote, the keypad P1, P2, P3, and P4 keys select the set point and the TB inputs are disabled.

3. If the CONTROL TYPE is SPD/TRQ, and if the LOCAL/REMOTE is ENABLED, (preset parameter is not displayed in spd/trq mode) in local **or** remote, the keypad P1, P2, P3, and P4 keys select the set point and the TB inputs are disabled.

Automatic protection features when using the Local/Remote mode:

If the drive is running in the Local mode when the Remote command is executed, the drive will perform a normal stop before changing modes. If the drive is equipped with a PLC Run input and the PLC Auto Start (PLC AS) logical is enabled, the drive will start (or remain running) when the transition from the Local mode to the Remote mode is made, and the PLC Run contact is closed. If the drive is operating in Remote and in the Auto mode, and the local command is executed, the Manual mode is automatically selected. If the Auto mode is required in local operation, then the Auto command must be executed after the control has been switched from Remote to Local operation. Refer to Manual and Auto commands for more information. If the drive is running in the remote mode when the Local command is executed, the drive will stop. The Start key on the keypad must be pressed to restart the drive. If the drive is equipped with a PLC Run input, the "PLC AUTOSTART" does not affect operation in the Local mode.

Other useful information:

Relay outputs to indicate the local or remote modes can be set up; see the relay output section. A status display on the keypad indicates the local/remote operation. Speed/Torque selection from the terminal block is available and the parameter is displayed only if the control type parameter is set to "SPD/TRQ". If Speed/Torque control is selected, presets 1-4 are not available from the terminal blocks as these terminal inputs are redefined as speed/ torque inputs, (the speed/torque source parameter in the source menu must also be set to "term"). See Menu "K 5. PRESET SOURCE".

END "LOC/REM"

Changing the filter command:

Filter values found under this menu normally should be left at the defaults; consult the factory before changing. These parameters are not "stop" protected so they may be changed while running.

> **The parameter "13 FILTER 1"** affects the inner current loop feedback signal only (clutch amps). The default for this parameter is 16 (min filtering).

> **The parameter "14 FILTER 2"** affects the outer control loop. In speed control mode, it filters the speed feedback, and in the external control it filters the process feedback signal, the default being zero (no filtering).

Using the memory reset function:

> **The parameter "15 MEMORY RESET EN"** is used to reset all parameters to the factory default settings stored in memory.

CAUTION: Enabling this command will change all stored parameters back their factory default values and all previously programmed data will be lost!

The EC-2000logic uses PROM memory to provide flexibility. Upon power up or reset of the drive, the parameters, values, and states will be the same as when the drive was last powered on. Included in PROM memory is a set of parameter values called "defaults". In the event that the processor memory was to be corrupted, or the need was felt to start over on programming, the default values are available. Enabling the Menu "A 14. MEMORY RESET EN" command (Select YES) will cause all the parameters to be reset to the default values. Operation is as follows:

If the reader is not familiar with navigating the keypad, please refer to **Section 9 "Quick Start with Programming Examples"** for a short instruction for using the keys to enter the menu and change the parameters and settings.   For clarification, some specific key strokes for this operation are shown below.

Select Menu "A 14. MEMORY RESET EN". The state of this command is always "NO" unless it is changed. The bottom two lines of the display will indicate the following:

    [KEY]   **DISPLAY READOUT**

                        Line 3:   A CONTROL SETUP
                        Line 4:   14. MEMORY RESET EN

Press the [ENTER] key to select this parameter:

    [ENTER]>   Line 3:   14. MEMORY RESET EN
                        Line 4:   NO   NO (FLASHING)

On line 4, the quantity on the left indicates the current command status, and the flashing quantity on the right indicates where the new command value will appear. To change the Memory Reset Enable from No to Yes, press either the [DOWN arrow] or [UP arrow] key to select the alternate option:

    [Up arrow] >   Line 3:   14. MEMORY RESET EN
                        Line 4:   NO   YES (FLASHING)

The new command is displayed in the flashing window. To lock this value, press the [ENTER] key:

    [ENTER] >   Line 3:   14. MEMORY RESET EN
                        Line 4:   YES   YES (FLASHING)

The new command moves to the current value position on the left. At this point, the command is locked and ready to execute, but the data stored in memory will remain unchanged until the

power is turned off and cycled back on. The command may be changed back to "NO" as long as power is not removed, if a change of mind occurs. When power is again cycled on, the unit will display "LOADING DEFAULTS" for a few seconds. This indicates to the user that all previously programmed values have been deleted and the default values are now being loaded to memory. These parameters and their defaults may be found in Section 7: PARAMETER LIST.

It is also possible to reset memory through the use of the terminals in the event that the control will not boot up due to a software upgrade or some programming error. To use this function, remove power from the control unit. Open terminals TB2-30 & -31 (Emergency Stop), open terminals TB2-22 & -24 (Stop) and jumper terminals TB2-22 & -29 (Jog). Turn the power on. The control will display "LOADING DEFAULTS" and the factory defaults will be restored. Note: all previously programmed data will be lost.

➤ **The parameter "16. REVERSE CONTROL EN"** is used to control downwards in speed instead of upwards. That is to say that as the speed reference is increased, the drive speed will actually decrease instead of increase. This function is rarely used, but is the operating mode of choice in centrifuge applications. The default condition is NO.

➤ **The parameter "17. REV CONTRL REM EN"** is used to switch the controller mode from forward to reverse from the terminal strip. If this parameter is enabled and terminal 25 is closed the controller will change from forward to reverse mode or reverse to forward mode depending on the state of parameter 16 Reverse Control Enable.

➤ **The parameter "18 CLOSED LOOP TORQ EN"** is used to enable tach feedback parameter switching through the closure of terminal 25. When enabled closing terminal 25 will cause the control to use the parameters listed in parameter 6 (Torq PPR Feedback) instead of parameter 5 Tach Pulses Per/Rev.

➤ **The parameter "19. CLUTCH CURRENT SCALE"** is used to adjust the difference between indicated and actual Clutch Current. If, after start up, the clutch current display is inaccurate, that difference may be corrected with this parameter. Raise the number to increase the reading. Only a small adjustment should be necessary. Default is 100%.

➤**The parameter "20. CLUTCH PPR SCALE"** is used to adjust for speed feedback pulse rates not included in Menu "A 5. TACH PULSES/REV" above. Set the Tach Pulses/ Rev to the nearest unit 10, 12, 14, etc, and adjust upward or downward until an accurate display reading is obtained. Default factor is 100%.

➤**The parameter "21. TORQ PPR SCALE"** is used to adjust for speed feedback pulse rates not included in Menu "A 6. TORQ PULSES/REV" above when the alternate feedback parameter set is used.. Set the TORQ Pulses/ Rev to the nearest unit 10, 12, 14, etc, and adjust upward or downward until an accurate display reading is obtained. Default factor is 100%.

➤**The parameter "22. PULSE MAX FREQ"** is used to scale the pulse follower input when pulse is selected for preset 1 source In the sources menu. (item 6). This allows a pulse input to be used for a high resolution set point or a tach feedback follower.

➤**The parameter "23. BOOT UP DELAY"** is used to delay the controller boot up sequence when used on a power supply that is unstable when first powered up. This allows the power to stabilize before the controller initializes. This will avoid startup errors. Rarely needed. Factory set at zero sec delay.

The following is a brief example of how to set control parameters with application data given:

AS 20 hp unit with the following nameplate ratings: min rpm 440, max rpm 1660, clutch amps hot 4.18A and motor amps 27.5 @ 460V. The application is to be speed control with a decel ramp required on stopping. Local/Remote operation is not needed. Set the following parameters in the "A CONTROL SETUP" menu:

1	CONTROL TYPE set to "SPEED"
2	CONTROL CURRENT set to "5.5A" (Change J5 jumper to position A)
3	CLUTCH COIL RATING set to "4.18A"
4	CLUTCH CURNT LIMIT set to "4.18A"
5	TACH PULSES/REV leave at or set to "12"
7	CLUTCH MIN RPM set to "440 rpm"
8	CLUTCH MAX RPM set to "1660 rpm"
9	MTR NO LOAD A set to Set from Measured value or value in table
10	MTR FULL LOAD AMPS 27.5
11	COAST ENABLE leave in "DISABLE"
12	LOCAL/REM ENABLE leave in "ENABLE" and set keypad to "LOCAL" or disable
13	FILTER 1 leave at "16"
14	FILTER 2 leave at "0"
15	MEMORY REST leave at "NO"
16	REVERSE CONTROL leave at "DISABLE"
19	CLUTCH CURRENT SCALE leave at 100%
20	CLUTCH PPR FDB SCALE leave at 100%

All else may be left at the factory default settings for the initial running tests.

5.2   Menu B: CLUTCH PERFORMANCE:

These parameters fine-tune the response of the (PID) control loops. If the performance is satisfactory, it should not be necessary to change the preset general purpose values which are expressed in percent. These default values may automatically change depending upon which control mode is selected.

> **Parameters**
> | | |
> |---|---|
> | 1. CURR PROP GAIN | 4. SPEED PROP GAIN |
> | 2. CURR INTGRL GAIN | 5. SPEED INTGRL GAIN |
> | 3. CURR DIFF GAIN | 6. SPEED DIFF GAIN |

The relatively high inertia of the machine rotor and long clutch coil time constant of the eddy current drive tend to make a high gain system somewhat under damped if there is little or no shaft load. The EC-2000 may be tuned to compensate for a variety of machine and load conditions. The defaults for the PID parameters under Menu B: CLCH PERFORMANCE offer the most usual settings for good response consistent with critical damping and tight speed regulation for the average application.

The inner current control loop stability is a function of the Clutch Coil Time Constant and its interaction with the break frequency of the load inertia. The current loop must be stable to insure overall good speed response and stability. It is suggested that for fully loaded systems that the default values be used for Current PROPORTIONAL and INTEGRAL Gains be used. Lightly loaded systems will be more stable with lower values. For most processes Current DIFFERENTIAL Gain is not required and should be left at zero unless an extremely slow response time is encountered.

For the speed loop, increasing the speed PROPORTIONAL gain provides for tighter regulation and faster response, while decreasing this values will result in poorer regulation and more

sluggish response. However, high gain can also result in instability, causing the drive to overshoot or oscillate. The INTEGRAL gain affects the long term overall regulation or accuracy of the output after the initial change takes place in the control correction cycle, but again, high values can cause oscilation. DIFFERENTIAL gain can sometimes help stabilize the system by anticipating overshoots, but too much DIFFERENTIAL gain will prevent the output from changing and cause a loss of control. All of these parameters are interactive and require judicious manipulation for proper response and performance.

If instability occurs, try decreasing speed INTEGRAL gain gradually to see if the performance is improved; if not, try slowly reducing speed PROPORTIONAL.gain In most cases, the speed DIFFERENTIAL gain should not be required unless the process has a very slow response. On all of these adjustments, if performance becomes noticeably worse, adjust the parameter in the opposite direction (increase rather than decrease, for instance).

Settings will be different for different applications. High inertia loads such as stamping presses may require lower PROP and INTGRL gain and a bit more DIFF gain, while loads with less inertia and higher static loading such as pumps may be able to endure higher PROP and DIFF gains. Changes to the default settings for the current, B1, B2, and B3, and for the Torque Limit, B8 and B9, should be avoided. If performance is still unsatisfactory, contact the factory.

> Parameter 7 ENABLE CURRENT LOOP Enable / Disable - The EC-2000 has two PID control loops when operating in speed mode. The speed loop calculates an output and feeds it to the current loop. Very rarely stability can be improved by eliminating the current loop. The default is Enabled.

Settings will be different for different applications. High inertia loads such as stamping presses may require lower PROP and INTGRL gain and a bit more DIFF gain, while loads with less inertia and higher static loading such as pumps may be able to endure higher PROP and DIFF gains. Changes to the default settings for the current, B1, B2, and B3, and for the Torque Limit, B8 and B9, should be avoided. If performance is still unsatisfactory, contact the factory.

➢ **Parameter 8 TORQUE LIMIT -** % OF Programmed Motor amps where torque limit acts
➢ **Parameter 9 TRQL PROP GAIN   -** Torque Limit Proportional Gain
➢ **Parameter 10 TRQL INTGRL GAIN   -** Torque Limit Integral Gain.

Also under this menu are the torque limit parameters, which are not used unless a motor current transformer is supplied and wired. Be sure to set SW2 on the power board per Table 1 on page 12 and enter the desired level of motor current limit under "7 TORQUE LIMIT". Then, adjust R111 on the power board while using a clamp on ammeter to calibrate the torque limit. This should be done as close to the desired limit level as possible because the current metering scheme is not linear. "TRQL PROP GAIN" and "TRQL INTGRL GAIN" are used to adjust the stability of operation but only when actually in torque limit; they have no effect during normal operation. The Torque Limit does not require high Proportional or Differential gains, and for most applications, the default values should perform well. If much overshoot is experienced in the motor current when entering the Torque Limit region, the TRQL PROP GAIN may be increased to 30% or 40%. If the motor current is under damped, the TRQL DIFF GAIN should be increased.

5.3   Menu C: ACCEL/DECEL SETUP:

The following parameters determine the set point ramp times: "NORMAL ACCEL RATE" is used to enter the desired ramp rate for manual operation; similarly, "NORMAL DECEL RATE" is also for manual only. "AUTO ACCEL RATE" and "AUTO DECEL RATE" are only for Auto Mode, and finally, "JOG ACCEL RATE" and "JOG DECEL RATE" is only for the Jog Mode operation. These parameters set the rate from 0 to max process in percent per second with the range being 0.25% to 250%. The default is 10% except for the jog parameters, which are 100%. The jog

parameters are not displayed in either torque or external mode. Note that these are RATES and not TIMES, so the higher the number, the faster the drive will accelerate or decelerate.

5.4   Menu D. BRAKE PERFORMANCE: (Note Requires Addition Module)

These parameters set up the adjustable braking option, which will put a programmed value of voltage on the brake coil when the E relay drops out. PID parameters may be adjusted to improve the stability of the brake current similar to the clutch current PID parameters above. However, the brake current loop does not require a lot of gain, and the default values should suffice for most applications.

Check to insure the hardware jumper positions and settings have been made before entering the "D BRAK PERFORMANCE" menu for programming as follows:

Brake set up jumpers: The EC-2000is capable of two levels of current and up to 90VDC; check that Jumper J6 on the power PCB is in the correct position. Use Position A for 0 to 16 Amps and Position B for 24 Amps.

Braking must be enabled by setting the "ADJ BRAKING ENABL" parameter to "ENABLE" and entering an appropriate level using the "ADJ BRAKE AMPS" parameter.

The braking performance is adjusted if necessary using the PID parameters, "BRAKE PROP GAIN", "BRAKE INTGRL GAIN", and "BRAKE DIFF GAIN". The default values for these parameters should be satisfactory for most braking conditions.

Example: AS unit, 20 hp with an eddy current brake is required to quickly slow the process when a stop command is given. (The brake current rating is obtained from the drive nameplate).

Set the following parameters in the D BRAK PERFORMANCE menu:

   1   BRAK COIL RATING set to 3.8A (rated) (Jumper J6 in position A)
   2   ADJ BRAKING ENABL set to ENABLE
   3   ADJ BRAKE AMPS set to 3A
   4   BRAKE PROP GAIN set to 30%
   5   BRAKE INTGRL GAIN set to 10%
   6   BRAKE DIFF GAIN set to 10%

The brake current, "3 ADJ BRAKE AMPS", may be set higher for faster stopping or lower for slower stopping.

5.5   Menu E. FOLLOWER SETUP:

The follower parameters scale the auto input signal; the (DC) signal can be either voltage or current depending on hardware jumpers. The default is for a 4-20ma current signal. There are four parameters to define two points on the set point/follower signal curve. "FOLLOWER MINIMUM" and "FOLLOWER MAXIMUM" are the set points for SPEED or TORQUE, while "FOLLOWER MIN REF" and "FOLLOWER MAX REF" set the corresponding follower input signal values in %. The default value for "FOLLOWER MIN REF" is 20% because the usual 4-20ma signal input usually requires zero output at 4ma. If a 0 to 10 volt remote signal is selected, the "FOLLOWER MINIMUM" and "FOLLOWER MIN REF" would normally be set to 0 and 0% respectively. Again the minimum and maximum set point values are bounded by the process limits set elsewhere.

NOTE: It may be necessary to change the L. PROCESS menu first to effect a change in the E. FOLLOWER MINIMUM parameter.

Auto Signal Scaling

The type and range of the applied auto signal must be known as well as the desired process range ratio. The power PCB can accept voltage signals of 0-10 or 0-5V and current signals of 4-20ma or 8-40ma on TB2-20 & 21. Jumpers J9 and J10 set the follower signal type:

0-10V	J9 in "A" and J10 in "A"
0-5V	J9 in "A" and J10 in "B"
4-20ma	J9 in "B" and J10 in "B"
8-40ma	J9 in "B" and J10 in "A"

Example 1: Control mode is Speed; Process units are in rpm. The auto signal is 0-10VDC where zero represents 500 rpm speed and 10 volts represents 1600 rpm speed. Loss of follower option is not required.

Set jumpers J9 and J10 on PCB to correct settings for 0-10V, J9 in "A" and J10 in "A" and set the following parameters in the "E FOLLOWER SETUP" menu:

1. FOLLOWER MINIMUM to 500 rpm (in process units)
2. FOLLOWER MAXIMUM to 1600rpm (in process units)
3. FOLLOWER MIN REF to 000.0%
4. FOLLOWER MAX REF to 100.0%
5. FOLLOWER LOST LEVEL to 000.0%

When the drive is set to auto mode, the process should change to 500-1600 rpm when the 0-10 VDC auto signal is applied. The set point displayed should be 500-1600 rpm.

Example 2: Control mode is Speed; Process units are in rpm. The auto signal is 4-20ma, where 4ma represents 600 rpm and 20ma represents 1200 rpm. Lost of follower option is not required.

Set jumpers J9 and J10 on PCB to correct settings for 4-20ma, J9 and J10 both in "B" and set the following parameters in the "E FOLLOWER SETUP" menu:

1. FOLLOWER MINIMUM to 600 rpm (in process units)
2. FOLLOWER MAXIMUM to 1200 rpm (in process units)
3. FOLLOWER MIN REF to 020.0%
4. FOLLOWER MAX REF to 100.0%
5. FOLLOWER LOST LEVEL to 000.0%

When the drive is set to auto mode, the process should change to 600 to 1200 rpm when the 4-20ma-auto signal is applied. The set point displayed should be 600 to 1200 rpm. Signals less than 4ma will be clamped at 600 rpm and signals above 20ma will be clamped at 1200 rpm.

Loss of Follower Signal:

The parameter, "FOLLWER LOST LEVEL", sets the level of follower signal that below which, it will be considered lost. If the signal falls below the selected level the drive will do one of two things as set in the "FOLLWR LOST FLAG" parameter; it will either hold at the present set point (LAST), or change the set point (FLSET) to the value entered in the "FOLLOW LOST STPT" parameter. Once a loss of follower condition has occurred, the drive must be stopped to restore normal follower operation. The loss of follower option is disabled by setting the level parameter at 0%. The follower lost parameters are active only in auto mode; it is helpful to set a relay output to alert to the loss of follower condition.

Loss of Follower option setup:

Determine the point at which a loss of follower condition will be considered to exist and what action is desired when this occurs.

Example 1: Using a 2-10 volt auto signal. If the follower signal falls to or below 10%, (1V or less), the drive is to sense this and set a relay output and run at 500 rpm.

Set the following parameters in the "E. FOLLOWER SETUP" menu:

- 6   FOLLOWER LOST LEVEL to 010.0%
- 7   FOLLOWER LOST STPT to 500rpm (in process units)
- 8   FOLLWR LOST FLAG to FLSET

Set the following parameter in the "G RELAY OUTPUT" menu, "2 RELAY 1" set to "STATUS", "FOL LOST".

Example 2: Using a 4-20ma-auto signal. If the follower signal falls below 4ma, the drive is to sense this and set a relay output and run at 700 rpm.

Set the following parameters in the "E FOLLOWER SETUP" menu,

- 6   FOLLOWER LOST LEVEL to 020.0%
- 7   FOLLOWER LOST STPT to 700 rpm (in process units)
- 8   FOLLWR LOST FLAG to FLSET

Set the following parameter in the "G RELAY OUTPUT" menu, "2 RELAY 1" set to "STATUS", "FOL LOST".

Other Useful information:

1. When the auto mode is selected, the status display changes from "MANUAL" to "AUTO".
2. When in auto mode, the ramp is determined by the **auto** accel/decel parameters.
3. The loss of follower feature is disabled by setting "FOLLOWER LOST LEVEL" to 000.0%.
4. When the loss of follower condition exists, the status display changes to "FOL LOST" and the set point goes to the "follower lost set point".
5. Relay outputs may be setup to indicate when the drive is in Auto/Manual or Follower Lost modes. See relay output section.

See LOCAL/REMOTE and AUTO/MAN sections for more information.

5.6   F. ANALOG OUTPUTS:

The drive has two analog outputs which can be either voltage or current signals, depending on the load connected. If 4-20ma output is desired, a minimum 500 ohm load should be connected; for voltage output, higher resistances should be used such as 1K to 10K ohms.   ANALOG 1 SELECT is Channel 1 and ANALOG 2 SELECT is Channel 2; the choices for output are identical. Note that if the hardware is set up for 0-20ma with the min signal set for 20% and the max signal set for 100%, then this channel should never output less than 4ma (20% of 20ma) or more than 20ma (100% of 20ma). Using the scaling parameters located in the "F. ANALOG OUTPUT" menu, both signals can be set up to indicate the drive processes listed below. The output level is buffered but non-isolated. Select outputs from:

NONE (no output)
DRIVE SPEED (rpm)
REFERENCE (process units)
SET POINT (process units)
MOTOR AMPS (CT required)
CLUTCH AMPS
BRAKE AMPS
FEEDBACK (process feedback units)

The following parameters are used to program the minimum and maximum value as well as the percent of full analog output range for each signal:

        ANA 1(2) MIN SIGNAL
        ANA 1(2) MAX SIGNAL
        ANA 1(2) MIN OUTPUT
        ANA 1(2) MAX OUTPUT

The method used for scaling is similar to that used for the speed pot and follower inputs on the drive where two points on the curve are described by the above four points. The min and max signals are given in percentage from 0 to 100% and the output is expressed in RPM, AMPS or as whatever the selected signal units are displayed. All of these signal outputs are for customer use and are available assuming the signal exists, for instance, motor amps requires the use of an optional current transformer.

Note: These analog signals are output in a delayed fashion and do not occur in real time.

5.7   **G. RELAY OUTPUT:**

This controller has 4 relay driver outputs and one on-board "F" (Fault) relay that may be set to indicate status or be used for on/off trip functions. All of the outputs and the F relay have the same setup choices. "STATUS" is used to indicate drive condition status, the "TRIP ON" function energizes above the programmable trip point and "TRIP OFF" de-energizes the relay above the trip point.

The following table lists the relay output functions which may be programmed; the relay driver outputs are of the open collector type, the outputs being pulled low for an active signal at the "PL1 RLY" connector on the Digital Control (smaller) circuit board. The parameters for these outputs are located in the "G. RELAY OUTPUT" menu; where the five outputs are listed as:

        1 F RELAY
        2 RELAY1
        3 RELAY2
        4 RELAY3
        5 RELAY4

Each of the outputs has the identical command set below:

NONE   - No function, relay remains de-energized at all times.

STATUS - The relay condition changes when:

        NONE - (relay will not function)
        SPD MODE - the control is in speed mode
        TRQ MODE - Is in torque mode
        EXT MODE - is in external mode
        LOCAL - local mode is selected
        REMOTE - remote mode is selected
        MANUAL - manual mode is selected
        AUTO - auto mode is selected
        STOPPED - the drive is stopped
        STOPPING - while the drive is stopping
        ESTOP - an E-stop condition exists
        RUN - the drive is running
        RUN0 - the drive is in Run mode but there is no set point reference
        COASTING - the drive is coasting
        JOGGING - the drive is in Jog mode
        FAULT - the drive is faulted

RESTART - the drive is in restart mode
TRQ LIM - the drive is in torque limit
AT SETPNT - the drive is at set point
FOL LOST - the follower signal is lost (auto mode only)
FB LOST- speed feedback is lost

These conditions may be programmed to determine relay action when the given status condition changes; when the item is selected with the [ENTER] key, the appropriate value entry line is presented so that the trip point may be set:

TRIP ON - The relay is normally de-energized and energizes when:

SET POINT - the set point is at or above a programmed value
REFERENCE - the reference is at/above set value
FEEDBACK - the feedback is at/above set value
SPEED - the drive speed is at/above set value
MTR AMPS - the motor amps are at/above set value
CLUT AMPS - the clutch amps are at/above set value
BRAK AMPS - the brake amps are at/above set value

TRIP OFF - The same as above except that the relay is normally energized and will de-energize when the programmed value is reached or exceeded.

Functions requiring numerical values will need to be programmed.

Example: Relay 1 is to be normally energized and open when the drive speed is at 500 RPM or above.

Enter the menu and go to the relay menu:

[KEY]   **DISPLAY READOUT**

Line 3:   PICK PARAMETER MENU:
Line 4:   G. RELAY OUTPUT>

Select this option:

[ENTER] >   Line 3:   G RELAY OUTPUT
                   Line 4:   1 F RELAY >

Press [UP ARROW] key to select Relay 1:

[UP ARROW] >   Line 3:   G RELAY OUTPUT
                   Line 4:   2 RELAY 1>

Press [ENTER] key to select this function:

[ENTER] >   Line 3:   2 RELAY 1
                   Line 4:   NONE   NONE (FLASHING)

Press [UP arrow] three times to select "TRIP OFF":

[UP arrow] >   Line 3:   2 RELAY 1
                   Line 4:   NONE   STATUS (FLASHING)

[UP arrow] >   Line 3:   2 RELAY 1

	Line 4:	NONE	TRIP ON (FLASHING)
[UP arrow] >	Line 3:	2 RELAY 1	
	Line 4:	NONE	TRIP OFF (FLASHING)

Press [ENTER] key to select this function:

[ENTER] >	Line 3:	TRIP OFF	
	Line 4:	NONE	NONE (FLASHING)

At this point, Relay 1 will energize. Press [UP arrow] four times to select "SPEED":

[UP arrow] >	Line 3:	TRIP OFF	
	Line 4:	NONE	SETPOINT (FLASHING)
[UP arrow] >	Line 3:	TRIP OFF	
	Line 4:	NONE	REFERENCE (FLASHING)
[UP arrow] >	Line 3:	TRIP OFF	
	Line 4:	NONE	FEEDBACK (FLASHING)
[UP arrow] >	Line 3:	TRIP OFF	
	Line 4:	NONE	SPEED (FLASHING)

Press [ENTER] key to select this function:

[ENTER] >	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	**0**0000 RPM

The quantity on the left is the current SPEED trip value, while the quantity on the right has the left most digit flashing to indicate the current location of the cursor. Press the [SHIFT arrow] key twice to move the cursor right to the third position. The cursor moves only right. If the operator should overshot the position, it will be necessary to continue on with the [SHIFT] key until the cursor wraps around again:

[SHIFT arrow] >	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	0**0**000 RPM
[SHIFT arrow] >	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	00**0**00 RPM

Now, use the [UP arrow] to increment the SPEED to 500 RPM:

[UP arrow]>	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	00**1**00 RPM
[UP arrow]>	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	00**2**00 RPM
[UP arrow]>	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	00**3**00 RPM
[UP arrow]>	Line 3:	TRIP OFF	
	Line 4:	00000 RPM	00**4**00 RPM

| [UP arrow]> | Line 3: | TRIP OFF | |
| | Line 4: | 00000 RPM | 00**5**00 RPM |

Press the [ENTER] key to lock this entry:

| [ENTER] > | Line 3: | TRIP OFF | |
| | Line 4: | 00500 RPM | 00**5**00 RPM |

Press the [EXIT] key three times to exit the menu:

[EXIT] >	Line 3:	G RELAY OUTPUT	
	Line 4:	2 RELAY 1>	
[EXIT]>	Line 3:	PICK PARAMETER MENU:	
	Line 4:	G. RELAY OUTPUT>	
[EXIT]>	Line 3:	REFERENCE	0 RPM
	Line 4:	DRIVE SPD	0 RPM

As soon as the programming function is completed, Relay 1 will remain energized until the drive speed reaches or exceeds 500 RPM, at which time it will drop out.

5.8   H. PROCESS UNITS:

These parameters should be set up after the "CONTROL SETUP" and "CLUTCH PERFORMANCE" parameters, but before any other parameters because they may affect the values displayed as well as the min/max ranges for other setup and display parameters. If the "Control Type" parameter is set to speed control, the choices are "RPM, USER, and PERCENT" with RPM as the default; if RPM is selected, the Clutch Max RPM is used as the default and upper limit for the "MAXIMUM PROCESS" parameter. If torque control is selected, percent is the only choice with maximum process of 100% and a min of 0%. If "EXTERNAL" is used, the choices are "PERCENT" or "USER UNITS" with percent as the default.   If "PERCENT" is selected, 100.00% is the maximum process value and 0.00% is the minimum This number is always expressed as five significant digits with two digits to the right of the decimal point. If "USER" is selected, see user unit scaling below.

User Units:

The drive speed may be expressed in units other than RPM. This is useful to better define the actual process such as Feet Per Minute (FPM) or Strokes Per Minute (SPM). In "USER UNITS", select the most appropriate alphanumeric characters using the keypad [ARROW] and [ENTER] keys. The USER UNITS choices available are: RPM, RPS, RPH, CPM, CPS, CPH, FPM, FPS, FPH, SPM, SPS, SPH, XPM, XPS, and XPH.

User Decimal Point:

The "USER DECIMAL PNT" is used to select the number of digits to the right of the decimal point when scaling the USER functions.

> 0 - No decimal   (29999)
> 1 - One decimal place   (2999.9)
> 2 - Two decimal places   (299.99)
> 3 - Three decimal places (29.999)

Max User Value:

If USER UNITS have been selected to display the process rather than the motor rpm, the actual maximum process speed is probably going to be different than the clutch speed. For instance, on a stamping press, a maximum clutch output speed of 1600 RPM may be equivalent to 40 strokes per minute (SPM) Press Speed. For the "MAX USER VALUE", enter the number of user units that correspond to the desired top process speed. This number consists of five significant digits and these digits will be a function of the number of decimal places selected in the prior step. Leading 0's must be displayed and the maximum number that can be entered is 29999.

Example 1: In the above description requiring a maximum press speed of 40 SPM, 00400 should be entered for the "MAX USER VALUE" if the "USER DECIMAL PNT" was entered as "1" in the previous step. The resulting maximum press speed would then be displayed as **40.0 SPM**.

Example 2: Clutch Max RPM is set to 1660 rpm; the control mode is Speed. The user wants 1660 rpm output speed to be displayed as 100% on the keypad.

Set the following parameters in the "H UNITS" menu, 1 PROCESS UNITS to "PERCENT"

Actual Drive RPM	Displayed RPM
1660	100.00%
830	50.00%
415	25.00%

Other useful information:

1. If torque control is selected, the units displayed may only be in percent of coil current. The "H UNITS" menu is not displayed.
2. If Speed/Torque control is selected, the display may be rpm, percent or user units and the "H UNITS" menu is displayed while operating in speed control only.
3. If the External mode is selected, the process units displayed may only be in percent of process feedback and the "H UNITS" menu is not displayed.
4. The parameters USER UNITS, USER DECIMAL PNT, and MAX USER VALUE are displayed only when the process unit parameter is set to "USER".

5.9 J. POTENTIOMETER SETUP:

The external reference potentiometer (pot) setup is very similar to that described for the Remote Follower in menu "E. FOLLWER SETUP" on page 24. There are four parameters to define two points on the setpoint/reference signal curve. "POT MINIMUM" and "POT MAXIMUM" are the set points for SPEED or TORQUE, while "POT MINIMUM REF" and "POT MAXIMUM REF" set the corresponding Reference input control signal values, and these are expressed in %. The default values for the "POT MINIMUM" and "POT MAXIMUM" values are the same as the "CLUTCH MINIMUM RPM" and "CLUTCH MAXIMUM RPM" respectively. The default values for the "POT MINIMUM REF" and "POT MAXIMUM REF" are 000.00 % and 91.00 % respectively. Again the minimum and maximum set point values are bounded by the process limits set elsewhere. The default value for Pot Max Reference is set to 91% because the internal pot reference voltage is 9.1-volts and the controller reference gains are scaled for a 10-VDC signal.

NOTE: It may be necessary to change the L. PROCESS menu first to effect a change in the J. POT MINIMUM parameter.

Internal Signal Source:

An internal reference source of +9.1-VDC is available for the POT on the main power board. The Pot is connected to terminals TB2-6 (100 end), TB2-7 (wiper arm), and TB2-8 (0 end). **To use**

this internal source, it is also necessary to reference the "0 end" of the pot connection to circuit common by connecting TB2-8 to TB2-9 (Analog Common).

External Signal Source:

An **ISOLATED** external reference source of 10-VDC may be used for the POT. In this case, the Pot "100 end" terminal is connected to the (+) terminal of the external supply, and the Pot "0 end" is connected to the (-) terminal of the supply. The pot "wiper arm" must be connected to TB2-7. **It is also necessary to reference the (-) terminal of the external supply to circuit common by connecting it to TB2-9 (Analog Common).**

Pot Signal Scaling:

The Reference Potentiometer input is permanently scaled for 0 to 10 VDC only. The Remote Auto Signal input must be used for reference signals of other magnitudes. Please call the factory for more assistance in this matter.

5.10   K. SOURCE SELECT:

The SOURCE SELECT parameters determine from where the Run, Jog, and Preset references and the Start and Stop commands originate.

1. Auto/Man Source:

The controller reference source may be from the (manual) keypad or (remote) pot, or it may be from an automatic follower voltage or current signal. The type of reference is selected from either the "MAN/AUTO" key on the keypad or from a switch wired to the terminal block at TB2-30. The selection of the "AUTO/MAN SOURCE" command is also dependent on the state of the "LOCAL/REM ENABLE" command parameter. If the "LOCAL/REM ENABLE" parameter is set to "DISABLE" and the "AUTO/MAN SOURCE" is set to keypad, the MAN/AUTO command can only be executed from the keypad; when it is set to "TERM" it can only be executed from the terminal block. If the "LOCAL/REM ENABLE" parameter is set to "ENABLE" and the "AUTO/MAN SOURCE" is set to "TERM", the source of the MAN/AUTO command is automatically switched between the terminal block and the keypad when the LOCAL/REMOTE key on the keypad is actuated. If the "AUTO/MAN SOURCE" is set to "KEYPAD", the AUTO/MAN command will be active only from the Keypad.

Please see Menu "A. 11 LOCAL/REMOTE ENABLE" on page 18 for details concerning the Local/Remote function.

2. Jog Source:

The operating source for the JOG function is also dependent upon the state of the "LOCAL/REM ENABLE". If the "A 11. LOCAL/REM ENABLE" parameter is set to DISABLE and the JOG SOURCE is set to KEYPAD, the jog command can only be executed from the JOG key on the keypad. When JOG SOURCE is set to TERMINAL, it may only be executed from the terminal block. If the "A 11. LOCAL/REM ENABLE" is set to ENABLE and the JOG SOURCE is set to TERMINAL, the Jog command is available at the Keypad in the Local mode and at the Terminal Block in the Remote mode. If the JOG SOURCE is set to KEYPAD, the Jog command will be active only from the Keypad.

3. PLC Auto Start:

The default setting for this parameter is DISABLE. This parameter, when set to ENABLE, allows for AUTO START of the drive by means of the PLC start input on TB2-28 as well as some other unique operating conditions.

For this operating mode to function:

1. **Set "K 4. PLC RUN ENABLE" to ENABLE.**
2. **Connect the normal Start terminal TB2-23 to TB2-22 (LOW). This mode will not function if this terminal is left open.**
3. **Normal Run and Stop functions occur when the PLC input, TB2-28 is High, not Low.**
4. **Auto Start operates only in the REMOTE mode.**

If: "A 11. LOCAL/REMOTE" is DISABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is ENABLE and
    "K 4. PLC RUN ENABLE" is ENABLE, then

1. Drive will Auto Start on power up. Keypad Start will be inactive.
2. If the drive was AUTO STARTED and the PLC contact is open (high), the drive will stop only if power is removed OR the PLC contact is cycled: close - open. In the Auto Start mode, Stop occurs on the PLC input going high..
3. If the drive was AUTO STARTED and the PLC contact is closed (low), the drive will stop only if power is removed OR the PLC contact is cycled: open - close - open.
4. If the drive was AUTO STARTED and the drive was Stopped using the PLC contact, subsequent drive Starts will occur on a closure of the PLC contact, and drive Stops will occur on an opening of the PLC contact.

If: "A 11. LOCAL/REMOTE" is ENABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is ENABLE and
    "K 4. PLC RUN ENABLE" is ENABLE and
    State is LOCAL, then

1. Drive will run from the Keypad Start key
2. Drive will not Auto Start in LOCAL mode.
3. PLC Run is inoperative in the LOCAL mode.

If: "A 11. LOCAL/REMOTE" is ENABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is ENABLE and
    "K 4. PLC RUN ENABLE" is ENABLE and
    State is power on and LOCAL switching to REMOTE, then

If the drive was stopped AND the PLC contact is open, the drive will remain stopped.
If the drive was stopped AND the PLC contact is closed, the drive will Start and Run.
If the drive was running AND the PLC contact is open, the drive will stop.
If the drive was running AND the PLC contact is closed, the drive will continue to Run.

Since the power was already on, the drive will Stop with the PLC contact opening and Run with the PLC contact closing.

If: "A 11. LOCAL/REMOTE" is ENABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is ENABLE and
    "K 4. PLC RUN ENABLE" is ENABLE and
    State is power off and REMOTE, then

1. Drive will AUTO START on power up.
2. If the drive was AUTO STARTED and the PLC contact is open (high), the drive will stop only if power is removed OR the PLC contact is cycled: close - open. In the Auto Start mode, Stop occurs on the PLC input going high..

3. If the drive was AUTO STARTED and the PLC contact is closed (low) the drive will stop only if power is removed OR the PLC contact is cycled: open - close - open.

4. If the drive was AUTO STARTED and then the drive was Stopped using the PLC contact, subsequent drive Starts will occur on a closure of the PLC contact, and drive Stops will occur on an opening of the PLC contact.

4. PLC Run Enable:

This parameter default condition is DISABLED and Start/Stop terminal operation is available only at terminals TB2-23 & 24. A special PLC input is available on the EC-2000at terminals TB2-28 & 27 for automated control from a Programmable Logic Controller (PLC) using a single contact set.

If the "PLC RUN ENABLE" parameter is set to ENABLE, remote Run/Stop control is available only at terminals TB2-28 & 27 and the normal TB2-23 START input is inactive and may be either high or low.

PLC run may be used if the "K 7. START SOURCE" is set to "TERM" **and**:

1. The "PLC RUN ENABLE" parameter is set to ENABLE and the "LOCAL/REMOTE EN" parameter is set to DISABLE, or

2. Both the "PLC RUN ENABLE" and "LOCAL/REMOTE EN" parameters are set to ENABLE, and the state is REMOTE.

The drive will Start and Run upon contact closure. If the PLC contact is closed before switching from LOCAL to REMOTE, the unit will not start until the PLC contact is opened and then closed again.

If the unit is already running when the transition from LOCAL to REMOTE is made, the control will stop and may only be restarted by cycling the PLC contact.

If: "A 11. LOCAL/REMOTE" is DISABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is DISABLE and
    "K 4. PLC RUN ENABLE" is ENABLE, then

    Run source will be from the PLC contact only. Keypad Start will be inactive.

If: "A 11. LOCAL/REMOTE" is ENABLE and
    "K 7. START SOURCE" is TERMINAL and
    "K 3. PLC AUTOSTART" is DISABLE and
    "K 4. PLC RUN ENABLE" is ENABLE, then

    Run source will be from the Keypad when the state is LOCAL
    Run source will be from the PLC contact when the state is REMOTE

The PLC contact must be open when the change from "LOC" to "REM" is made.
If the PLC contact was closed, the PLC contact must be cycled to run.
If the drive is running when the mode is changed from LOC to REM, the drive will stop.

5. Preset Source:

This parameter determines the source of the preset commands, which may be executed from either the PRESET keys on the keypad or from switches wired to the terminal block at terminals TB2-25 & 26.   The selection of the preset source is also dependent on the state of the

Local/Remote enable. Please see Menu "A 11. LOCAL/REM ENABLE" in Section 7 for the details dealing with the LOCAL/REMOTE function.

PRESET SOURCE is not displayed when the SPD/TRQ control mode is selected because the presets are then redefined as speed/torque inputs only. Four set points may be programmed in the "L PROCESS" menu, items 3, 4, 5, and 6, which will be activated by using one of the preset keys or external contacts as described above. The "PRESET 1 SOURCE" must be set to "KEYPAD" to use all four. The terminal preset command is determined by the following inputs:

	SPD1	SPD2	SPD3	SPD4
TB2 - 25 input	high	low	high	low
TB2 - 26 input	high	high	low	low

The parameters in the "L PROCESS" menu have the following Default values:

3 PRESET 1 to 500 rpm (in process units)
4 PRESET 2 to 550 rpm (in process units)
5 PRESET 3 to 600 rpm (in process units)
6 PRESET 4 to 650 rpm (in process units)

Control mode is Speed and Process units are in rpm.

Example 1: Select four preset references from the Keypad only:

Set "K 5. PRESET SOURCE" to KEYPAD
Set "K 6. PRESET 1 SOURCE" to KEYPAD

Example 2: Select four preset references from the Terminal Block only:

Set "K 5. PRESET SOURCE" to TERM
Set "K 6. PRESET 1 SOURCE" to KEYPAD

Example 3: Select three preset references and the remote Pot from the Terminal Block only:

Set "A 11. LOCAL/REM ENABLE" to DISABLE or ENABLE, REMOTE mode
Set "K 5. PRESET SOURCE" to TERM
Set "K 6. PRESET 1 SOURCE" to TERM

PRESET 1 is the Pot
PRESET 2 to 550 rpm (in process units)
PRESET 3 to 600 rpm (in process units)
PRESET 4 to 650 rpm (in process units)

Example 4: Select three preset references and the remote Pot from the Keypad only:

Set "A 11. LOCAL/REM ENABLE" to DISABLE or ENABLE, LOCAL mode
Set "K 5. PRESET SOURCE" to KEYPAD
Set "K 6. PRESET 1 SOURCE" to TERM

PRESET 1 is the Pot
PRESET 2 to 550 rpm (in process units)
PRESET 3 to 600 rpm (in process units)
PRESET 4 to 650 rpm (in process units)

Other useful information:

1. Relay outputs to indicate the manual, auto or jog modes may be set up. See the relay output section.
2. Preset commands from the terminal block are not available if the control type is set to SPD/TRQ because the terminal block inputs are then used for switching these functions; the preset keys on the keypad are still functional.
3. When set to "Keypad", the preset set point level can be overridden at anytime by pressing the SET POINT key and using the arrows to adjust the level. This is not true in the "terminal" mode or if the parameter "Preset 1 Source" is set to "Pot".
4. If the Preset 1 Source parameter is changed, the preset 1 command must be executed by either pressing the P1 button on the keypad or by closing the appropriate switch wired to the terminal block. (Dependent on set up.)
5. The ramp is determined by the NORM ACCEL/DECEL parameters.
6. The range of the PRESET parameters is limited by the MIN and MAX PROCESS parameters.
7. In the torque and external modes, the PRESET 1 - 4 values are retained despite the mode which was selected or when they were set.
8. In the torque and external modes, the process units are always in percent.
9. If the PRESET SOURCE parameter is set to KEYPAD, the preset functions will always be activated by the keys on the keypad and not from the terminal block, even if the local/remote function is enabled.

Preset Source when Control Type is "SPEED/TORQUE":

The remote preset terminals, TB2-25 & 26, share the preset select functions with the remote SPD/TRQ control type selection and are not generally available for preset selection when the Control Type is "SPEED/TORQUE". The PRESET 1 source is not affected and the Preset 1 source will remain PRESET when the source is Keypad and will become POT when the source is POT. When the SPD/TRQ control type is selected, terminal TB2-25 becomes the remote SPEED/TORQUE select input and presets 1 and 2 are no longer available for selection at this remote terminal. Terminal TB2-26, however, is still active for preset selection and PRESET 3 may be selected from this terminal by taking it low.

If: "A 1. CONTROL TYPE is SPD/TRQ" and
If: "A 11. LOCAL/REMOTE EN" is DISABLE or ENABLE and LOCAL and
If: "K 5. CONTROL TYPE SRC" is KEYPAD and
If: "K 6. PRESET 1 SOURCE" is KEYPAD, then

Presets 1, 2, 3, and 4 are all available from the Keypad. Remote terminals are inactive.

If: "A 1. CONTROL TYPE is SPD/TRQ" and
If: "A 11. LOCAL/REMOTE EN" is ENABLE and REMOTE and
If: "K 5. CONTROL TYPE SRC" is KEYPAD and
If: "K 6. PRESET 1 SOURCE" is KEYPAD, then

Presets 1, 2, 3, and 4 are all available from the Keypad. Remote terminals are inactive.

If: "A 1. CONTROL TYPE is SPD/TRQ" and
If: "A 11. LOCAL/REMOTE EN" is ENABLE and
If: "K 5. CONTROL TYPE SRC" is KEYPAD and
If: "K 6. PRESET 1 SOURCE" is POT, then

In LOCAL: Presets 1, 2, 3, and 4 are available from the Keypad.
In REMOTE: POT and Presets 2, 3, 4 are available from the TB.

If: "A 1. CONTROL TYPE is SPD/TRQ" and
If: "A 11. LOCAL/REMOTE EN" is ENABLE and
If: "K 5. CONTROL TYPE SRC" is TERMINAL and
If: "K 6. PRESET 1 SOURCE" is KEYPAD, then

In LOCAL: Presets 1, 2, 3, and 4 are available from the Keypad.
In REMOTE: TORQUE MODE is selected when TB2-25 is LOW and Preset 3 is selected when
                 TB2-26 is LOW.

If: "A 1. CONTROL TYPE is SPD/TRQ" and
If: "A 11. LOCAL/REMOTE EN" is ENABLE and
If: "K 5. CONTROL TYPE SRC" is TERMINAL and
If: "K 6. PRESET 1 SOURCE" is POT, then

In LOCAL: POT and Presets 2, 3, and 4 are available from the Keypad.
In REMOTE: TORQUE MODE is selected when TB2-25 is LOW and Preset 3 is selected when
                 TB2-26 is LOW. The POT is the Reference source.

6. Preset 1 Source:

This parameter determines the source of PRESET 1: Preset Reference, or remote Pot reference.
As described above in "PRESET SOURCE", setting the "PRESET 1 SOURCE" to KEYPAD
assigns the Preset Reference value programmed in Menu "L 3. PRESET 1" to Preset 1 (P1).
Setting it to "POT" assigns the remote Pot reference to Preset 1.

The pot is not functional if "PRESET 1 SOURCE" is set to KEYPAD. If it is set to POT and Preset
1 is selected, the set point key on the keypad will not adjust the set point because the set point is
being provided by the Pot. However, selection of P2, P3, or P4 will allow the set point key to be
used to change the set point. If the "A 11. LOCAL/REMOTE EN" parameter is DISABLED, preset
selection will be from the Keypad only, and it will be necessary to press P1 to select the Pot.

7. Start Source:

This parameter determines whether the drive start commands will be executed from either the
start key on the keypad or from a start switch wired to TB2. If the "A 11. LOCAL/REM ENABLE"
is DISABLE and the "START SOURCE" is set to KEYPAD, only the "START" key on the keypad
will be active. If the "START SOURCE" is TERM, then the drive may be started only from the
remote terminal switches and the Keypad Start function is inactive. If both local (keypad) and
remote (external switch) are to be used, "A 11. LOCAL/REMOTE EN" must be ENABLE and the
"START SOURCE" must be set to TERM. If the start source is left in "KEYPAD" it dominates and
only the keypad start button will be active regardless of local/remote condition.

If: "A 11. LOCAL/REMOTE EN" is DISABLE or ENABLE and LOCAL and
If: "K 7. START SOURCE" is KEYPAD, then

The Start/Stop location is the Keypad and the Remote Terminals are inactive.

If: "A 11. LOCAL/REMOTE EN" is DISABLE or ENABLE and REMOTE and
If: "K 7. START SOURCE" is TERM, then

The Start/Stop location is from the Remote Terminals and the Keypad Start key is inactive.

If: "A 11. LOCAL/REMOTE EN" is ENABLE and
If: "K 7. START SOURCE" is TERM, then

In LOCAL mode: The Start/Stop function is from the Keypad. Remote Terminals are inactive.
In REMOTE mode: Start/Stop is from the Remote Terminals and the Keypad Start key is
inactive. The Keypad STOP key is always active and may be used to over ride other run
functions.

5.11   L. PROCESS:

The min and max clutch rpm parameters set the overall speed range limits for drive operation by setting the limits for the MIN and MAX PROCESS parameters. The MIN and MAX PROCESS parameters set the range for many other parameters.

1. MINIMUM PROCESS

"MINIMUM PROCESS" sets the minimum output process from the drive with the range of adjustment being from zero to the value determined by the "MAXIMUM PROCESS" parameter value, the default being 0%.

2. MAXIMUM PROCESS

MAXIMUM PROCESS sets the highest output speed from the drive and the range of adjustment. This parameter is automatically determined by the software based on the "CONTROL TYPE" and "USER" unit parameters. Note: If "USER" units are selected, values must be entered in the user units menu before the max process can be set. The output is then in the selected process units with the default being 100% of the set process maximum (this corresponds to the max clutch setting which remains in rpm).

Control Type	Process Units	Max Range of Adjustment/Units
Speed	Percent	0-100%
Speed	Rpm	0-base speed (rpm)
Torque	Percent	0-100%
Spd/Trq	Percent	0-100%
User	Programmed	0 to MAX CLUTCH RPM in process units

Example 1: The CLUTCH MIN RPM is 440 rpm and the CLUTCH MAX RPM is 1660 and process units are in RPM. The parameter ranges are as follows:

    1. MIN PROCESS - May be 440 rpm to MAX PROCESS value range; set to 440 rpm.
    2. MAX PROCESS - From MIN PROCESS value to 1660rpm range; set to 1660 rpm.
    3. PRESET 1 - Between the 440 rpm to 1660 rpm speeds.

Example 2: Same speed range as Example 1, but the process units are changed to PERCENT. 26.5% is 440/1160 rpm. The parameter ranges are as follows:

    1. MIN PROCESS - 26.5% to MAX PROCESS value range, set to 26.5%
    2. MAX PROCESS - MIN PROCESS value to 100% range, set to 100%
    3. PRESET 1 - Between 26.5% and 100%.

Example 3: Same speed range as example 1, but the process units are changed to SPM with a user value parameter of 15 and decimal parameter of 3. The max process is 15 SPM (1660 rpm) and min process of 3.975 SPM (440rpm). The parameter ranges are as follows:

    1. MIN PROCESS - 3.975 SPM to MAX PROCESS value range, set to 3.975SPM.
    2. MAX PROCESS - MIN PROCESS value to 100% range, set to 15 SPM.
    3. PRESET 1 - Between 3.975 SPM and 15 SPM.

Also note that the MIN PROCESS value cannot be set below its minimum range unless the CLUTCH MIN RPM parameter is first lowered. Similarly the MAX PROCESS value cannot be set above its range unless the CLUTCH MAX RPM parameter is increased. CAUTION: When changing the MIN or MAX CLUTCH RPM values beyond nameplate values, it may be necessary to derate in order to avoid damage to the EC mechanical unit. Consult the factory if further information is required on derating. The jog set point is not affected by the MIN PROCESS or MIN CLUTCH RPM parameters since jog is not a continuous operation.

PROCESS FEEDBACK SOURCE. Select "1 CONTROL TYPE", "EXTERNAL". This parameter selects the process feedback source. When External is selected, the feedback is defined by the "I PROCESS FEEDBACK" scaling parameters. The Following parameters are only displayed under "I PROCESS FEEDBACK" and only when "EXTERNAL" is selected as the control type:

1. EXTN F/B REF MIN 0 to external feedback ref. max
2. EXTN F/B REF MAX external feedback ref. Max to 100.0%
3. EXTN F/B MIN min process to external feedback max
4. EXTN F/B MAX external feedback min to max process
5. PROCESS PROP GAIN 1-1000%
5. PROCESS INTGRL GAIN 0-100%
7. PROCESS DIFF GAIN 0-100%

3. PRESET-1, 4. PRESET-2, 5. PRESET-3, 6. PRESET-4

These are the locations where the Preset Reference values are stored. Any Speed or Torque Reference values between the MIN PROCESS and the MAX PROCESS limits may be entered. When the Preset Select keys on the Keypad or Preset Select terminals on the remote terminal block are addressed, these preset values become the reference setpoint for the drive operation in place of the remote Pot or the local Setpoint set on the Keypad.

7. JOG SETPOINT

This parameter sets the JOG mode speed reference. Any value between the MIN PROCESS and the MAX PROCESS limits may be entered. When the JOG function is selected from the local Keypad or the remote terminals, this value become the reference setpoint for the JOG mode. The Jog mode is operational only in the Speed Control mode.

5.12   M. FAULT:

If the EC-2000logic senses a fault, and that fault is enabled, the control is programmed to stop immediately. The output to the coil is inhibited and the output relay drops out. The control will display the fault and the drive will coast to zero speed. **Exception:** The over speed and under speed faults may be programmed to annunciate the fault but not stop the drive. The following conditions may be monitored and used to operate relay functions:

1. Coil Open Fault Enable:

If this fault is enabled, and the controller senses no clutch current when output voltage is applied, after a time delay set by the "3. FDBK TEST DELAY" parameter, the fault will be set, the drive will stop, and "COIL FLT" will be displayed. The default condition for this fault is ENABLED.

2. Speed Feedback Fault Enable:

If this fault is enabled, and the Speed Feedback signal is not detected when the control is in the run mode with a reference applied, after a time delay set by the "3. FDBK TEST DELAY" parameter, the fault will be set, the drive will stop, and "SPD FDBK FLT" will be displayed. The default condition for this fault is ENABLED.

3. Fault Test Delay:

This parameter determines the delay from the time the fault is sensed to the time that the fault action is executed. The programmable range is 0- to 30-seconds, and the default value is 10 seconds.

4. Keypad Fault Enable:

If this fault is enabled and the keypad connection to the controller is lost or the keypad unit fails, the drive will fault and stop the drive. Since there is no communication between the controller and the keypad unit, there can be no display of this fault. However, if this fault condition has been assigned to a relay, this fault may be flagged by the relay trip. If the controller is to be operated without the Keypad, this fault must be disabled for the drive to run. The default condition for this fault is ENABLED.

5. Overspeed Fault:
6. Overspeed Fault Action:

If the drive speed exceeds a set limit, as defined by the parameter "7 OVERSPEED TRIP", the fault is set. The over speed condition must be present for a preset time period before the fault occurs as defined by parameter "11 SPEED TRIP TIME". It is optional as to whether the drive is shut down when a fault is sensed (as other faults do) or the drive continues to run. Parameter "6 OVSPD FT ACTION" determines whether the drive will stop or continue to run when an over speed condition is sensed. If the action is "STOP", the drive will stop. If the action is set to "RUN", the drive will continue to run. The status display will show "OVSPD FLT" if this fault is enabled. The default condition for this fault is DISABLED.

7. Overspeed Trip:

This parameter determines the drive speed at which the overspeed fault occurs. Its range is 0% to 110% of the Clutch Maximum RPM, and the default value is 110% or 1826 RPM, with the default maximum clutch speed of 1660 RPM. This value will scale automatically with changes to the Max Clutch RPM.

8. Underspeed Fault:
9. Underspeed Fault Action:

The Underspeed fault operates similar to the Overspeed fault above. The trip level is set by "10 UNDERSPEED TRIP" and the time period for the under speed condition to exist before the fault occurs is set by "11 SPEED TRIP TIME". This feature also has the option to shut down the drive when a fault is sensed or to continue to run as determined by Parameter "9 UNSPD FT ACTION". When the under speed fault occurs, the status display will show "UNSPD FLT". The default condition for this fault is DISABLED.

Other Useful Information:

1. The stop command must be toggled (press Stop button or toggle remote Stop switch) to clear the fault and restart the drive.
2. The F relay and any other relay driver outputs (if programmed) will trip on a fault.
3. The auto restart option may be used to restart the drive after a fault condition unless the fault was due to an E-stop.
4. The over speed and under speed trips are always based on output speed of the drive (rpm units) regardless of what the process units have been defined as.
5. The parameter "11 SPEED TRIP TIME" is used for both faults.

5.13   N. AUTO RESTART:

The EC-2000has two Automatic Start features: 1. Automatic start upon application of power, and 2. Automatic restart after a fault. Both functions will automatically start the drive without any operator action, and each function can be used independently or in conjunction with each other.

Both require specific operator start control schemes and have several programmable parameters that need to be set for proper operation

1. Restart Power Enable:

This function is DISABLED by default. Enabling this parameter will cause the drive to start automatically. When line power is applied, the controller logic performs a power-up routine lasting about six seconds, initializing the registers and displaying the control status. When that has completed, and if the Auto Start function has been Enabled, the "3 START DELAY-PWR" timer is initialized. During this delay, the keypad will display "RESTART". After the timer delay period has ended, the control will attempt a normal start. The drive will not Auto Start if a fault condition exists.

2. Restart Fault Enable:

This parameter controls an automatic start or restart after a shut down due to a fault. This function is DISABLED by default. Enabling this function will cause the drive to restart and run, unattended, after the drive was Stopped due to a fault condition.. The "4. START DELAY- FLT" timer allows a certain delay time to occur from the time the fault was detected to the time that the drive actually restarts.

3. Start Delay – Power:

The delay timer for auto start on power up has a range of 0 to 600 seconds (ten minutes). The default time is 10 seconds.

4. Start Delay – Fault:

The delay timer for auto start after a fault condition shut down has a range of 0 to 600 seconds (ten minutes). The default time is 10 seconds.
5. Max Fault Retrys:

A limited number of attempts to restart after a fault is allowed and this number is specified by this parameter. The range is 0 to 10 attempts with the default number being 3. If a fault occurs while the drive is running, the keypad display will show the fault type for a few seconds and then waits for a period of time determined by the parameter "4 START DELAY-FLT". During this delay, the keypad will display "RESTART" status. After the specified fault time delay, the drive will attempt a normal start. If another fault occurs, the process is repeated. Each restart attempt increments a counter until the limit set by the "5 MAX FAULT RETRYS" parameter is reached, after which the restart function is inhibited. If a fault occurs on the last allowed try, the display will show the fault until the condition is cleared.

6. Restart Timer:

The start attempts counter is automatically cleared if the drive has run and not faulted for a period of time set by this RESTART TIMER parameter. The range is 60 to 600 seconds with the default being 60 seconds. The start attempts counter is also cleared when a Stop command is issued.

Other Supporting Information for Auto Restart:

1. The control must be in remote mode if local/remote mode is enabled. If local/remote is not enabled, the start source must be set to "term" (terminal).
2. The Stop input (TB2-24) must be low (connected to common).
3. The Start input (TB2-23) must also be low.
4. If the drive faults while stopping or coasting, it will not auto restart.
5. If the drive faults while E-stopping, it will not auto restart.
6. Auto start will not work with the Jog function because jog is considered three wire control

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The auto start function will be canceled if any one of the following items occurs:

1. The start input opens.
2. The stop input opens.
3. The stop key on the keypad is pressed.
4. The drive mode is changed from remote to local.
5. The Estop interlock opens.

Note: The above items do not disable the auto start function; they only cancel auto restart at that time. The next time the drive is started, the function (if conditions are met) will be active. If the auto start option is not to be used any longer, the "N 1. RESTART POWER EN" and/or "N 2. RESTART FAULT EN" parameters should be changed to DISABLE.

Auto Restart Relay Outputs:

In general, two relay outputs can be used with the auto restart functions, "FAULT" and "RESTART". FAULT status indicates when the drive is faulted. If Auto Restart after a Fault is ENABLED, the fault output is only active after the last start attempt. For instance, if the number of attempts were set to three, the fault indication would not be given until fault number four. RESTART Status indicates when the drive is in the Restart Time Delay condition before a restart attempt. This is a pulsed output at 2 Hz frequency, when active, in order to provide a flashing (display) indication of the impending restart. If the start delay parameter were set to 10 seconds, the output will pulse (flash) for ten seconds.

5.14   METER SELECT:

The third and fourth lines of the Display unit are used essentially for meter displays. These may be accessed at any time, and are not subject to run or stop lockout conditions. The parameters that may be displayed are: REFERENCE, MOTOR AMPS, CLUTCH AMPS, BRAKE AMPS, FEEDBACK, and DRIVE SPEED. The drive REFERENCE is the default quantity for METER 1, and DRIVE SPEED is the default display for METER 2. A programming example for this function is given in **"Section 9 - Quick Start and Programming Examples".**

Section 6 - OTHER OPERATING FUNCTIONS and FEATURES

ESTOP MODE:

All remote Estop buttons must be hard wired in series between terminals TB2-31 & 32. Upon E-stop command (this connection is open circuit), "ESTOP" is annunciated on the display and the reference is switched to zero. When the clutch current reaches a preset low value (in less than 0.5 sec.) the E relay drops out. To restart, the E-stop switches must all be closed, and the fault must be cleared by pressing the STOP key or pushbutton to reset the control. The display will change from ESTOP to STOP and the drive may now be restarted.

Other Useful Information:

1. If two wire control is employed, the run contact must be opened to clear the E-stop and then closed again to restart the drive.
2. The drive will not auto restart after an E-stop. The E-stop fault must be cleared (STOP key) and then the drive must be restarted manually.

DISPLAY VARIABLES:

In addition to the normally displayed speed or torque, the user may also monitor many other process items by using the SELECT METER and selecting the desired items for display. Regardless of the control type selected (speed, torque, external), the output speed of the EC drive can be displayed if internal tach generator of the mechanical unit is wired to the G1 & G2 terminals. Programmable items:

REFERENCE, MOTOR AMPS, CLUTCH AMPS, BRAKE AMPS, FEEDBACK, DRIVE SPD

OPERATION WITHOUT KEYPAD/DISPLAY:

This mode of operation is possible, although it will still be necessary to have a keypad available for programming and also to monitor operation if desired.

To prevent damage to the controller or keypad, always remove power from the controller before connecting or disconnecting the keypad/display from the unit. The keypad connector to the digital control card is polarized. Install the connector in the proper position and orientation. Failure to do so will destroy the keypad/display unit.

Before removing the keypad, it will be necessary to:

1. Disable the Keypad Fault in Menu "M 4."
2. Enter the POT parameters in Menu "J Potentiometer Setup"
3. Enter the proper parameters in Menu "K Source Select"

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STARTING and STOPPING THE DRIVE:

A start command may be issued through any of the ways listed below. Before a particular method will work, the drive must be wired and programmed correctly. Control logic and circuits also will vary according to how each method is implemented. A standard control is preset from the factory to operate from the local keypad or the remote terminal switches. Start command methods:

From the keypad START key
From the keypad JOG key
From a remote START pushbutton (3-wire control)
From a remote JOG pushbutton (3-wire control)
From a remote manually operated switch (2-wire control)
From a remote automatic contact (2-wire control PLC)
Automatically when power is applied (auto restart)
Automatically after a fault has occurred (auto restart)

NOTE: The drive will not start if the stop input (TB2-24), is open, the ESTOP interlock (TB2-31) is open, or the drive is in a "fault" condition.

The drive may be stopped by many different methods. Keypad, pushbuttons, interlocks, and faults are among the ways to stop the drive. All stop command methods are active at all times:

The keypad Stop key
From the keypad, when the JOG key is released
A remote Stop pushbutton (three wire control)
Releasing a remote JOG pushbutton (three wire control)
From a remote manually operated switch (2 wire control)
From a remote automatic contact (2 wire control PLC)
From the E-stop input
Drive fault

The EC-2000has two modes of running. Local mode is defined as the Start/Stop command (source) from the keypad. Remote mode uses Start/Stop commands from contacts wired to the power PCB terminal block. Both modes may be active, but only one mode can be used at a time (determined by the Local/Remote command). Local (keypad) mode is considered three-wire control and the remote mode may be either three-wire or two-wire control depending on how the contacts are wired.

JOG FUNCTION:

Jog is a momentary run function at a preset jog speed reference. When jog is commanded, the drive will start and accelerate to the jog set point and remain there as long as the jog pushbutton is pressed. When the Jog pushbutton is released, the output will stop after a deceleration to zero. The drive will remain ready for about five seconds after a jog command is removed. During this time the output contactor remains picked up and "JOG" is displayed on the alphanumeric display and the drive output is inhibited during this period. This is to give a faster drive response to jog commands by not having to pull the contactor in each time the jog button is pushed.

The Jog Source may be from either the Keypad or the Terminal Block. See Menu "K 2. JOG SOURCE" for specific programming information on this. The Jog Preset Reference may be programmed from Menu "L 7. JOG SETPOINT".

Other useful jog information:

1. Jog is not available in torque control or external control, and jog parameters are not displayed in these modes; the jog key on the keypad and the jog input on TB are not functional.
2. Relay outputs may be used to indicate the jog mode, see relay output section.
3. A status display on the keypad indicates the jog operation. The control logic provides a number of automatic protection features when using the jog mode, as listed below:
   a. The Jog mode can only be selected when the drive is in manual mode.
   b. The Jog mode may not be entered while in Run.
   c. When the drive is in the Jog mode, the Jog speed reference overrides all other speed rreferences including Auto.
4. Jog speed will be determined by the parameter "JOG SET POINT" and accel and decel rates as set by the parameters "JOG ACCEL and JOG DECEL".
5. Jog units are determined by the "PROCESS UNITS" parameter.
6. An external Jog pot is not available.
7. The jog speed range is limited by the MAX PROCESS parameter but is not affected by the "MIN PROCESS" or "MIN CLUTCH RPM" because jogging is not intended as a continuous operation.
8. If the "JOG SOURCE" parameter is set to keypad, the jog function will always be activated by the jog key on the keypad and not from the terminal block, even if the local/remote function is enabled.

SET POINT/REFERENCE:

The set point can originate from sources, digital or analog, and is dependent on the control mode. The set point is applied to a "ramp generator" to become the "reference". The ramp generator uses the accel/decel parameters to compute the reference value. The "set point" value is always shown on the top line of the display and "reference" value can be displayed by the use of the meter select function "REFERENCE". If the set point is adjusted beyond these levels the reference will be clamped. "MIN PROCESS" and "MAX PROCESS" limit the set point levels under any conditions.

The ramp rates are set by parameters located in the "C. ACCEL/DECL STUP" menu. In the Manual mode, the parameters "NORM ACCELERATION" and "NORM DECELERATION" are

used. In the Auto mode, "AUTO ACCELERATION" and "AUTO DECELERATION" serve. For Jog mode, the parameters "JOG ACCELERATION" and "JOG DECELERATION" are used. All of the rates are adjustable between 0.25 and 250% per second.

The EC-2000has the capability of accepting a set point signal from a "manual" or an "automatic" source. The logic provides MANUAL and AUTO commands to switch between these sources. In the manual mode the drive receives an analog reference from an external speed pot or from one of the preset speeds or a directly set reference (SET POINT operation from the keypad). The auto command uses an external analog reference from the follower input. The logic also provides a "loss of follower signal" function, which can be used to provide the set point if the follower signal becomes disconnected.

SET POINT MODE:

Modify the set point directly by using the "SET POINT" and arrow keys on the keypad. When in the set point mode, the set point value flashes as an indication; then the set point value may be modified up or down by using the corresponding arrow keys. When the set point key is pressed, the set point value will begin to flash; use the up/down arrows to adjust value to 1600 RPM. Push the set point key to exit the mode after the desired set point has been entered.

MANUAL SET:

A manual external 0-10V max analog signal from a potentiometer wired to the terminal block may be used for the reference set point. This source may be selected by setting parameter "Preset 1 Source" to "Pot"; an on-board +9V supply is provided. The pot voltage is profiled by parameters which will locate two points on the (straight line) curve by defining the minimum and maximum voltages and set points that correspond. For specific setup information, see Menu "J POTENTIOMETER SETUP" and Menu "K 6. PRESET 1 SOURCE"

Other useful information:

  a. If the "PRESET1 SOURCE" parameter is set to Pot, the set point key on the keypad is not functional.
  b. The range of the "POT MIN" and "POT MAX" parameters is limited by the min and max process parameters.
  c. The ramp is determined by the "NORM ACCEL RATE" and "NORM DECEL RATE" parameters.

CONTROL TYPE OPERATION:

The EC-2000internal regulators provide for speed, current and external control types. Speed control requires the use of a drive internal AC generator, a system (external) AC generator or an external pulse pickup. Torque or current control, utilizes an internal current feedback signal derived from the clutch coil current. External control uses 0-10Vdc external transducer signals such as from a torque transducer or a dancer operated pot.

The following lists features or actions that automatically happen when a control type is selected by the parameter "1 CONTROL TYPE" in the setup menu:

All Types:

1. Local/remote function is available from keypad by using local/remote key if programmed.
2. Manual auto function available from terminal or keypad as programmed.
3. Auto restart function available if programmed.
4. Analog output function available if programmed.
5. Relay output function available if programmed.

6. Presets from keypad are available if programmed.
7. Presets from terminal block depending on mode selected and if programmed.
8. The drive speed indication (meter) is always in RPM regardless of control type or the process units selected; for this indication a speed feedback signal is required although it may not be necessary for control.
9. The torque limit control loop is active in all types, however it is usually only used with speed control.
10. The filter parameter "Filter 1" is displayed and active for the clutch current feedback.
11. All faults sources are available in all types, programmed:

   Coil open Fault
   Speed Feedback Fault
   Keypad Fault
   Overpseed Fault
   Underspeed Fault

Note that speed feedback is required for feedback and over/under speed faults. If speed feedback is not used, then those faults should be disabled.

Speed Control Type:

In the Speed control mode the EC-2000regulates by controlling the clutch current based on the outer speed feedback loop. If **Reverse Control** is enabled the speed loop action is reversed causing the output to rise when the speed is above set point. Default Process units for speed control is in RPM, but other process units can be selected. See the "UNITS" section. The following parameters control the speed and current regulators:

   B CLCH PERFORMANCE menu:
   1 CURR PROP GAIN
   2 CURR INTGRL GAIN
   3 CURRENT DIFF GAIN
   4 SPEED PROP GAIN
   5 SPEED INTGRL GAIN
   6 SPEED DIFF GAIN

Example 1: The units are set to percent and the maximum clutch speed of 1660 rpm was set by parameter "7 CLUTCH MAX RPM" in the 'A CONTROL SETUP" menu, so that 100% is 1660rpm. Therefore a drive set point of 50% would cause the control to regulate at 50% rated speed or 830 rpm.

Example 2: If the clutch speed were 1750 rpm as set by parameter "7 CLUTCH MAX RPM" in the "A CONTROL SETUP" menu, then 100% would be 1750 rpm. Therefore a drive set point of 50% would cause the control to regulate at 50% rated speed or 875 rpm.

Other useful information about speed control:

1. Control loops used are current and speed. If reverse control is enabled the speed loop action is reversed.
2. The feedback variable is speed and is displayed in process units.
3. The Min and Max process range is defined by the parameters for min and max clutch rpm. 100% process equals the max clutch rpm value and so the process parameters cannot be set outside this range without changing the min/max clutch variables. The preset and jog speed defaults are specific values for speed control; changing any of these parameter while in speed control will not affect the existing parameter values for torque or external control.
4. The jog function is active and all jog parameters are displayed. Jog may be commanded from the keypad or terminal block as programmed.

5. The speed/torque key not functional.
6. The process feedback menu is not displayed.
7. The filter parameter "Filter 2" is used with the speed feedback signal.

Torque Control Type:

In the Torque control mode the EC-2000regulates by controlling the clutch current, because torque is proportional to current; the drive speed is not controlled. Process units for torque control are in percent of coil current. The following is a list of parameters that controls the current regulator:

> B CLCH PERFORMANCE menu:
> 1 CURR PROP GAIN
> 2 CURR INTGRL GAIN
> 3 CURRENT DIFF GAIN

Example 1: If the coil rating were 3 amps as set by parameter "3 CLUTCH COIL RATING" under the "A CONTROL SETUP" menu, 100% would be 3 amps. Therefore a drive set point of 10% would cause the control to regulate at 10% rated coil current or 0.3 amps.

Example 2: With the coil rating parameter "3 CLUTCH COIL RATING" in the "A CONTROL SETUP" menu set at 5 amps, (100%), then a drive set point of 50% would cause the control to regulate at 50% rated coil current or 2.5 amps. Other Useful Information about Torque Control:

1. The control loops use clutch current only.
2. The feedback variable is clutch amps, and is displayed in %.
3. The units menu is not displayed.
4. A unique set of ranges, and default values all in percentages are used for the Process menu parameters. The min process parameter may be set from 0 to the max process parameter; the max process parameter range is from min process to 100% (clutch amps). The defaults for the presets specific values for torque control. Changing any of these parameter values while in torque control will not change the existing corresponding parameter values for speed or external control.
5. The jog function is disabled and no jog parameters are displayed. The jog key and the jog TB input are not functional.
6. The speed/torque key not functional.
7. The process feedback menu not displayed.
8. The filter parameter "Filter 2" is not used.

Speed/Torque Control Type

This mode allows for switching instantly between speed and torque control types. The control type parameter in the control set up menu is set to SPD/TRQ. The type is then selected manually by using the speed/torque key on the keypad or a switch wired to the terminal block or both (if local/remote is enabled). All other rules hold true as outlined above based on which control type is active with the following exceptions:

1. The preset source parameter is replaced by a control type source parameter.
2. The Speed/Torque key is functional if programmed, based on the control type source parameter and local/remote operation.
3. Presets from terminal block are not available because it is used for speed/torque selection; the remaining TB input is not used. Presets are available from the keypad.

TORQUE LIMIT:

Certain variable speed applications can present unlimited or excessive torque requirements to the drive, which could overload the motor. The most common example is very high inertia machines

such as stamping presses. The torque limit mode of operation provides an "override" feedback signal to limit the induction motor torque, and therefore current, to a preset maximum level. Thus, motor breakdown torque is avoided during conditions such as drive output shaft "lockup", or the period when large system inertia is being accelerated. Since the torque level is adjustable between 60 and 250%, precise control of the acceleration rate versus maximum motor current can be achieved.

Torque limit requires the use of a SPECIAL external motor current transformer connected to terminals TB2-14 & 15. Since the Torque Limit circuit exhibits high input impedance, the use of "standard" instrumentation current transformers must be avoided to prevent damage to the controller due to the high voltages expressed with unloaded transformer secondary windings. **Please refer to TABLE 1 on page 11 for the proper recommended current transformer to be used.**

It is also necessary to set SW2 correctly for the combination of rated motor current and the selected current transformer. The TORQUE LIMIT trim pot, **R111** on the power board, must be adjusted in conjunction with a clamp-on ammeter to calibrate the motor current display. It is advised to make this calibration near the area of the desired limit because the sensing method is nonlinear over large ranges. The default setting for Torque Limit is 150% of rated motor amps. The parameters for setting torque limit level and stability are located in Menu "B CLUTCH PERFORMANCE". Note that these parameters only come into play while the control is actively in the process of limiting motor current. These limit values are based on the calibration of **R111**:

> 7 TORQUE LIMIT
> 8 TRQL PROP GAIN
> 9 TRQL INTGRL GAIN

PASSWORD PROTECTION:

The EC-2000has a simple password that prevents most parameters from being accidentally changed from the keypad. The password is enabled by pressing the F1, F2, and F3 keys on the keypad in succession; the status display will then briefly flash "PW ENABLED". With the password enabled, critical process parameters may no longer be changed by keypad entry, although all parameters may still be viewed. In order to disable the password, repeat the F1, F2, F3 sequence and the status display will now flash "PW DISABLED"; and once again, all parameters may be modified. The Parameter List (Section 7) shows which parameters are password protected.

PARAMETER CHANGE PROTECTION WHILE RUNNING:

Certain parameters may not be changed while the drive is running in order to protect personnel and machinery from unsafe operation. This safety feature is always present and those parameters, which may only be changed when the drive is stopped, are indicated on the Parameter List (Section 7).

Monitor Mode

When in the monitor mode (as opposed to program mode), the keypad displays the following information: The top line shows the drive "status" and the "set point" value, including the process units. The status may be:

STOPPED	The drive is stopped and the E relay is de-energized.
FDBK FLT	The drive faulted because the speed feedback signal was lost; E relay de-energized.
COIL OPN FLT	The clutch coil is open or disconnected; E relay de-energized.
STOPPING	The drive stop command has been received and is decelerating; E relay energized.
ESTOP	The ESTOP input is (or was) open; E relay de-energized.

RUN	The drive is in run state; E relay energized.
RUN0	The drive is in run state, the reference is zero; E relay energized.
COASTING	The drive is coasting to zero speed; E relay de-energized.
JOG	The drive is in jog mode at zero speed, waiting for next jog command; E relay energized.
JOGGING	The drive is in jog mode at jog speed; E relay energized.
RSTART	The drive auto restart is in progress; E relay de-energized.
TRQ LIM	The drive is in torque limit and continues to run but at reduced speed.
FOL LOST	The drive is in loss of follower mode because the auto signal dipped below the trip level. The drive continues to run but at a predetermined reference.
COIL FLT	Coil voltage was applied but no current was measured.
FDBK FLT	After a period of run time, no speed feedback voltage was detected.
OVERSPEED FLT	The drive speed went above the trip level; it continues to run or will shut down depending how it was set up.
UNDERSPEED FLT	The drive speed went below the trip level; the action is the same as for overspeed fault.

The set point has six digits (XXXXXX) which are used as required, leading zeros suppressed. Other characters may be selected for the three digit units display, see Section 5.8 H. PROCESS UNITS. (Note that the default RPM and %, (non-USER units), are referenced directly to the drive output shaft speed.)

The second display line is used to indicate the control modes; the left six digits display:

LOCAL	The local/remote feature is enabled and the drive is in Local mode. The start key on keypad is active and other keys may be active depending on set up.
REMOTE	The same as above for "LOCAL", drive is in "REMOTE" mode.
(no display)	The local/remote feature is disabled. Start may be from keypad or terminal block input depending on Start Source set up.

The center six digits display:

MANUAL	The drive set point is manually set with either keypad or a pot.
AUTO	The drive set point comes from the follower input.

The right six digits display:

SPEED	Speed control, either straight speed or speed portion of "SPD/TRQ mode.
TORQUE	Torque control mode.
EXTERN	External mode (external process control)

The third and fourth lines display drive conditions (meter):

REFERENCE   Displays the current reference value in process units.

MOTOR AMPS   This display will give an indication of motor current if a current transformer is used. It should be calibrated (gain pot R111 on the power board) for the rated or most important current of interest as the linearity error increases over the entire range.

CLUTCH AMPS   Displays the clutch current in amps or percent.

BRAKE AMPS   Displays the brake current.

FEEDBACK   This meter display depends on the type of control mode currently being used; in speed mode the meter displays the speed feedback value determined from the tach input. The units displayed are "PROCESS UNITS" as programmed under the "UNITS" menu, that is, rpm, percent or user units. In torque mode the meter will display the clutch current feedback value displayed in percent. In external mode the meter will display the external process feedback value in percent. The external feedback signal arrives at TB2-4 and 5.

DRIVE SPEED   Displays the drive output speed in rpm, (must have tach generator input).

Setup Mode

To enter the setup mode, push [ENTER] key on the Keypad. The programming Menu structure will be displayed to facilitate programming. Each menu has a letter and a name. When the desired menu is displayed, push [ENTER] again to view or change the numbered settable parameters. Note that if a menu is not applicable, such as "H UNITS" when in external mode (percent only) it will not appear in order to avoid confusion. Similarly, inappropriate parameters are not displayed. Several programming examples are demonstrated in **"Section 9 – Quick Start and Programming Examples"**. Menu List:

A   CONTROL SETUP   Parameters related to the control, the mechanical unit (motor, eddy current clutch and brake if any) and applications.

B   CLCH PERFORMANCE   Clutch PID performance parameters and torque limit.

C   ACCEL/DECEL STUP   Linear accel and decel ramp parameters.

D   BRAK PERFORMANCE   Brake setup and PID performance parameters.

E   FOLLOWER SETUP   Parameters for the auto follower mode.

F   ANALOG OUTPUT   Programming parameters for the two analog outputs.

G   RELAY OUTPUT   Parameters for the five relay outputs.

H   UNITS   Contains parameters for the display units.

J   POTENTIOMTR STUP   Scaling parameters related to the external pot.

K   SOURCE SELECT   To determine various command sources.

L   PROCESS   Parameters for min/max process, preset and jog set point.

M   FAULT   Setup parameters to activate drive faults.

N   AUTO RESTART   Parameters required for setup of the auto restart feature.
    METER SELECT   Display selected parameters.

Section 7 - PARAMETER LIST

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Note -> 🔒 Code Explanation:
A) "Control Parameter may be changed only when stopped;"
B) "Parameter is password protected."

Code	"A"	"B"
0	no	no
1	no	yes
2	yes	yes

A. CONTROL SETUP menu

	PARAMETER	🔒	RANGE	DEFAULT
1.	CONTROL TYPE	2	SPD, TRQ, SPD/TRQ	SPEED
*2.	CONTRLR CURRENT	2	5.5, 8.0,16,24,32,50,64,80,100	8.0 A
3.	CLUTCH COIL RATING	2	00.0 to CONTRLR CURRENT	8.0 A
4.	CLUTCH CURNT LIM	2	00.0 to CLUTCH COIL RATING	8.0 A
5.	TACH PULSES/REV	2	10,12,14,16,24,30,60,120,180 ppr	12 ppr
6.	TORQ PULSES/REV	2	10,12,14,16,24,30,60,120,180 ppr	12 ppr
7.	CLUTCH MIN RPM	2	0-3600	0000 rpm
8.	CLUTCH MAX RPM	2	0-3600	1660 rpm
9.	MTR NO LOAD AMPS	2	000.0 to MTR FULL LOAD A	000.0 A
10.	MTR FULL LOAD A	2	000.0 to 500.0 A	250.0 A
11.	COAST ENABLE	2	ENABLE/DISABLE	DISABLE
12.	LOCAL/REM ENABLE	2	ENABLE/DISABLE	ENABLE
13.	FILTER 1	1	16-64	16
14.	FILTER 2	1	0-16	0
15.	MEMORY RESET EN	2	NO/YES	NO
16.	REVERSE CONTROL EN	2	ENABLE/DISABLE	DISABLE
17.	REV CONTRL REMOTE	2	ENABLE/DISABLE	DISABLE
18.	CLOSED LOOP TORQ	2	ENABLE/DISABLE	DISABLE
19.	CLUTCH CUR SCALE	1	0-2500%	100%
20.	CLUTCH PPR SCALE	1	0-2500%	100%
21.	TORQ PPR SCALE	1	0-2500%	100%
22.	PULSE MAX FREQ	1	0-2500	100
23.	BOOT UP DELAY	1	0 – 30 SEC	0 SEC.

Notes: Menu A2. Controller Currents above 8 Amps are not used on the standard control.

B. CLUTCH PERFORMANCE menu

	PARAMETER	🔒	RANGE	DEFAULT
1.	CURR PROP GAIN	1	0001.0-100.0%	100.0%
2.	CURR INTGRL GAIN	1	000.0-100.0%	050.0%
3.	CURRNT DIFF GAIN	1	000.0-100.0%	00.0%
4.	SPEED PROP GAIN	1	0001.0-1000.0%	020.0%
5.	SPED INTGRL GAIN	1	000.0-100.0%	005.0%
6.	SPEED DIFF GAIN	1	000.0-100.0%	00.0%
7.	ENABLE CUR LOOP	1	ENABLE/DISABLE	ENABLE
8.	TORQUE LIMIT	1	060.0% to 250.0%	250.0%
9.	TRQL PROP GAIN	1	001.0-100.0%	010.0%
10.	TRQL INTGRL GAIN	1	000.0-100.0%	010.0%

C. ACCEL / DECEL SETUP menu

PARAMETER	🔒	RANGE	DEFAULT
1. **NORM ACCEL RATE**	1	000.25 – 250.0 % /sec	010.0%/sec
2. **NORM DECEL RATE**	1	000.25 - 250 .0% /sec	010.0%/sec
3. **AUTO ACCEL RATE**	1	000.25 – 250.0 % /sec	010.0%/sec
4. **AUTO DECEL RATE**	1	000.25 – 250.0 % /sec	010.0%/sec
*5. **JOG ACCEL RATE**	1	000.25 – 250.0 % /sec	100.0%/sec
*6. **JOG DECEL RATE**	1	000.25 – 250.0 % /sec	100.0%/sec

* The JOG parameters are not displayed in torque control.

D. BRAKE PERFORMANCE menu

PARAMETER	🔒	RANGE	DEFAULT
1. BRAK COIL RATING	2	00.0 to CONTRLR CURRENT	8.0 A
2. ADJ BRAKING ENABL	2	ENABLE/DISABLE	DISABLE
3. ADJ BRAKE AMPS	1	000.0 to 100.0% of BRAKE RATING	00.0 A
4. BRAKE PROP GAIN	1	001.0-100.0%	030.0%
5. BRAK INTGRL GAIN	1	000.0-100.0%	010.0%
6. BRAKE DIFF GAIN	1	000.0-100.0%	000.0%

E. FOLLOWER SETUP menu

PARAMETER	🔒	RANGE	DEFAULT
1. **FOLLOWER MINIMUM**	1	MIN PROCESS to FOLL MAX	0000 RPM
2. **FOLLOWER MAXIMUM**	1	FOLL MIN to MAX PROCESS	1660 RPM
3. **FOLLOWER MIN REF**	1	0 to FOLLOWER MAX REF	020.0%
4. **FOLLOWER MAX REF**	1	FOLLOWER MIN REF to 100%	100.0%
5. **FOLLOWER LOST LEVEL**	1	0 to 100%	000.0%
6. **FOLLOWER LOST STPT**	1	Follower Min to FOLL MAX	0000 RPM
7. **FOLLWR LOST FLAG**	1	FLSET/LAST	FLSET

F. ANALOG OUTPUT menu

PARAMETER	🔒	RANGE	DEFAULT
1. **ANALOG 1 SELECT**	1	NONE, DRIVE SPEED, REF, SET POINT, MOTOR AMPS, CLUT AMPS, BRAK AMPS, FEEDBACK	NONE
*2. **ANA 1 MIN SIGNAL**	1	000.0 –ANA1 MAX SIGNAL	000.0%
*3. **ANA 1 MAX SIGNAL**	1	ANA1 MIN SIGNAL –100.0%	100.0%
*4. **ANA 1 MIN OUTPUT**	1	000.0 to ANA 1 MAX OUTPUT	000.0%
*5. **ANA 1 MAX OUTPUT**	1	ANA 1 MIN OUTPUT to 100%	100.0%
6. **ANALOG 2 SELECT**	1	NONE, DRIVE SPEED, REF, SET POINT, MOTOR AMPS, CLUT AMPS, BRAK AMPS, FEEDBACK	NONE
*7. **ANA 2 MIN SIGNAL**	1	000.0 –ANA 2 MAX SIGNAL	000.0%
*8. **ANA 2 MAX SIGNAL**	1	ANA 2 MIN SIGNAL –100.0%	100.0%
*9. **ANA 2 MIN OUTPUT**	1	000.0 to ANA 2 MAX OUTPUT	000.0%

| *10. ANA 2 MAX OUTPUT | 1 | ANA 2 MIN OUTPUT to 100% | 100.0% |

*These parameters are NOT displayed if the ANALOG# SELECT parameter is set to "NONE".

G. RELAY OUTPUT menu

PARAMETER	🔒	RANGE	DEFAULT
1. F RELAY	1	NONE, STATUS, TRIP ON, TRIP OFF	TRIP OFF, SPEED 100 RPM
STATUS	1	NONE, SPD MODE, TRQ MODE, EXT MODE, LOCAL, REMOTE, MANUAL, AUTO, STOPPED, STOPPING, ESTOP, RUN, RUN0, COASTING, JOGGING, FAULT, RESTART, TRQ LIM, AT SETPNT, FOL LOST, FB LOST	FAULT
TRIP ON	1	NONE, SET POINT, DEV+, DEV-, SPEED, MTR AMPS, CLUT AMPS, BRAK AMPS,	NONE
SET POINT	1	000.0 to MAX PROCESS	000 RPM
DEVIATION+	1	000.0 to MAX PROCESS	000 RPM
DEVIATION-	1	000.0 to MAX PROCESS	000 RPM
SPEED	1	000.0 to MAX PROCESS	000 RPM
MTR AMPS	1	000.0 to 250.0% of MTR FULL LOAD A	0 AMP
CLUT AMPS	1	000.0 to 100.0% of CLUTCH RATING	0 A
BRAK AMPS	1	0 to 100.0% of BRAK COIL RATING	0 A
TRIP OFF	1	NONE, SETPOINT, DEV+ DEV- SPEED, MTR AMPS, CLUT AMPS, BRAK AMPS,	NONE
SET POINT	1	000.0 to MAX PROCESS	000 RPM
DEVIATION+	1	000.0 to MAX PROCESS	000 RPM
DEVIATION-	1	000.0 to MAX PROCESS	000 RPM
SPEED	1	000.0 to MAX PROCESS	000 RPM
MTR AMPS	1	000.0 to 250.0% of MTR FULL LOAD A	0 A
CLUT AMPS	1	000.0 to 100.0% of CLUTCH RATING	0 A
BRAK AMPS	1	0 to 100.0% of BRAK COIL RATING	0 A
2. RELAY 1*	1	NONE, STATUS, TRIP ON, TRIP OFF	NONE
Same as F RELAY, see above.			
3. RELAY 2*	1	NONE, STATUS, TRIP ON, TRIP OFF	NONE
Same as F RELAY, see above.			
4. RELAY 3*	1	NONE, STATUS, TRIP ON, TRIP OFF	NONE
Same as F RELAY, see above.			
5. RELAY 4*	1	NONE, STATUS, TRIP ON, TRIP OFF	NONE
Same as F RELAY, see above.			

*Note that Relays 1 – 4 require the use of externally connected Dual Relay mod boards.

H. UNITS menu

*This menu is displayed only if SPEED control is selected.

PARAMETER		🔒	RANGE	DEFAULT
1.	**PROCESS UNITS**	2	RPM/USER/PERCENT	RPM
*2.	**USER UNITS**	2	RPM, RPS, RPH, CPM, CPS, CPH, FPM, FPS, FPH, SPM, SPS, SPH, XPM, XPS, XPH	RPM
*3.	**USER DECIMAL PNT**	2	0-3	0
*4.	**MAX USER VALUE**	2	0-29999	00000

*Displayed only if process units is set to "USER".

J. POTENTIOMETER SETUP menu

PARAMETER		🔒	RANGE	DEFAULT
1.	**POT MINIMUM**	1	MIN PROCESS to POT MAXIMUM	0000 RPM
2.	**POT MAXIMUM**	1	POT MINIMUM to MAX PROCESS	1660 RPM
3.	**POT MINIMUM REF**	1	0 to POT MAXIMUM REF parameter	000.00%
4.	**POT MAXIMUM REF**	1	POT MINIMUM REF to 100%	91.00%
*5.	**TRQ POT MINIMUM**	1	MIN PROCESS to POT MAXIMUM	000.00%
*6.	**TRQ POT MAXIMUM**	1	POT MINIMUM to MAX PROCESS	100.00%
*7.	**TRQ POT MIN REF**	1	0 to POT MAXIMUM REF parameter	000.00%
*8.	**TRQ POT MAX REF**	1	POT MINIMUM REF to 100%	91.00%

* Parameters 1 – 4 available in speed mode.   Parameters 5 – 8 available in torque mode.

K. SOURCE SELECT menu

PARAMETER		🔒	RANGE	DEFAULT
1.	**AUTO/MAN SOURCE**	2	TERM/KYPD	TERMINAL
*2.	**JOG SOURCE**	2	TERM/KYPD	TERMINAL
3.	**PLC AUTOSTART**	2	ENABLE/DISABLE	DISABLE
4.	**PLC RUN ENABLE**	2	ENABLE/DISABLE	DISABLE
**5.	**PRESET SOURCE**	2	KYPAD/TERM	TERMINAL
6.	**PRESET 1 SOURCE**	2	KYPAD/POT/PULSE	POT
7.	**START SOURCE**	2	KYPAD/TERM	TERMINAL

* Jog source parameter is shown only when "SPEED" mode is selected.

** When SPD/TRQ control mode is selected, the following parameter follows Item 5, However the parameter preset source can still be used.

5A.	**CONTROL TYPE SRC**	2	KYPAD/TERM	KEYPAD

L. PROCESS menu

If in SPEED control (default):

PARAMETER	🔒	RANGE	DEFAULT

1.	**MINIMUM PROCESS**	2	CL MIN SPD% -- MAX PROCESS	0000 rpm
2.	**MAXIMUM PROCESS**	2	MIN PROCESS -- 100% CL MAX SPD	1660 rpm
3.	**PRESET 1**	2	MIN PROCESS – MAX PROCESS	500 rpm
4.	**PRESET 2**	2	MIN PROCESS – MAX PROCESS	550 rpm
5.	**PRESET 3**	2	MIN PROCESS – MAX PROCESS	600 rpm
6.	**PRESET 4**	2	MIN PROCESS – MAX PROCESS	650 rpm
*7.	**JOG SET POINT**	2	0 – MAXIMUM PROCESS	050 rpm

If Torque Mode is Selected.

PARAMETER		🔒	RANGE	DEFAULT
1.	**MINIMUM PROCESS**	2	0% -MAXIMUM PROCESS	0%
2.	**MAXIMUM PROCESS**	2	MIN --100% CL RATING	100%
3.	**TPRESET 1**	2	MIN – MAX PROCESS	10%
4.	**TPRESET 2**	2	MIN – MAX PROCESS	20%
5.	**TPRESET 3**	2	MIN – MAX PROCESS	30%
6.	**TPRESET 4**	2	MIN – MAX PROCESS	40%

*The jog function is not available in TORQUE control.

M. FAULT menu

PARAMETER		🔒	RANGE	DEFAULT
1.	**COIL OPEN FLT EN**	2	ENABLE/DISABLE	ENABLE
2.	**SPD FDBK FLT EN**	2	ENABLE/DISABLE	ENABLE
3.	**FLT TEST DELAY**	2	0-30 sec	10 sec
4.	**KEYPAD FLT ENABLE**	2	ENABLE/DISABLE	ENABLE
5.	**OVERSPD FLT EN**	2	ENABLE/DISABLE	DISABLE
6.	**OVSPD FLT ACTION**	2	STOP/RUN	STOP
7.	**OVERSPEED TRIP**	2	0-110% of max clutch rpm	1826 rpm
8.	**UNDERSP FLT EN**	2	ENABLE/DISABLE	DISABLE
9.	**UNSPD FLT ACTION**	2	STOP/RUN	STOP
10.	**UNDERSPEED TRIP**	2	0-110% of max clutch rpm	000.0 RPM
11.	**SPEED TRIP TIME**	2	0-1000	0010 SEC

N. AUTO RESTART menu

PARAMETER		🔒	RANGE	DEFAULT
1.	RESTART POWER EN	2	ENABLE/DISABLE	DISABLE
2.	RESTART FAULT EN	2	ENABLE/DISABLE	DISABLE
3.	START DELAY – PWR	2	000 to 600 seconds	010 sec
4.	START DELAY – FLT	2	000 to 600 seconds	010 sec
5.	MAX FAULT RETRYS	2	0 to 10	3
6.	RESTART TIMER	2	60 to 600	60 sec

METER SELECT menu

Access by pressing "SELECT METER" key; then use the up/down arrows go to meter 1 or 2, then "ENTER".

PARAMETER	🔒	RANGE	DEFAULT
METER 1 SELECT	0	REFERENCE, MOTOR AMPS, CLUTCH AMPS, BRAKE AMPS, FEEDBACK, DRIVE SPEED	REFERENCE
METER 2 SELECT	0	REFERENCE, MOTOR AMPS, CLUTCH AMPS, BRAKE AMPS, FEEDBACK, DRIVE SPEED	DRIVE SPEED

Section 8 - TROUBLESHOOTING GUIDE

In general, eddy current drives are relatively simple devices for which a few meter readings will point out the problem area. The mechanical drive is repairable and supported by 90 authorized service centers located all over the lower 48 states. The control elements, keypad, and circuit boards are stocked and available through our network of distributors, also located all over the country. Technical and application assistance is also available from the factory. In the event of trouble, some of the more common symptoms are listed below along with suggested remedial action:

8.1   **The display is blank:**

1. Check the keypad display cable at both ends to see if it is seated properly and not offset. Note that the digital control circuit board KEYPAD connector at PL2 is polarized, such that the Keypad/Display cable connector will mate only with the proper orientation without being forced. If the connector is inserted backward, the Keypad/Display unit will be destroyed once power is applied, and a new keypad will be required.

2. Is the power on? Check the green LED on the power board which indicates power on and the +12V and –12V supplies are within range.

3. With a DC voltmeter, check the display power supply voltage on the logic board, PL2-1(+) to PL2-6(-); it is an unregulated DC voltage of 11.5 ±1V. (Be careful not to short the pins to any other components.) If this voltage is missing, it is likely the power board is bad where the supply originates. If it checks okay, swap keypads and/or cables to determine a possible faulty display.

8.2   **The control will not "Start":**

1. The ESTOP interlock circuit must be closed to circuit common. A jumper or N.C. switch must be connected between terminals TB2-31 and TB2-32.

2. The STOP circuit must be closed to start or run the controller. A jumper or N.C. switch must be connected between terminals TB2-22 and TB2-24.

3. Check for a FAULT condition on the top line of the Display. If no fault has been encountered, the STOPPED status will be displayed there. To clear a fault, toggle (open and then close) the Stop input. Be sure to assess the reason for the fault having occurred.

Some of the older primary field machines used slip rings and brushes on the clutch coil. Often times, high resistance paths will occur between the rings and brushes unless the output shaft is turning. This will result in a COIL OPEN fault. Should this occur, set this fault to DISABLE until the controller has been fully configured.

4. Verify that the start mode and parameter setup is correct for the desired mode(s) of operation: Local/Remote (most common), 2-wire Start, 3-wire Start, PLC Run, and Auto Start/Restart. When switching between modes, it is sometime necessary to toggle the STOP circuit to clear an internal hold. For more details on this, check the specific explanations in Section 5.

8.3   **Unit runs at top speed only - No control:**

1. Check the setting of the Fault parameter "2 SPD FDBK FLT EN". Is this parameter enabled? If not, enable it to let the controller confirm loss of feedback. Go on to the next item if a Speed Feedback fault is present. Otherwise, go on to Item 3.

2. Using an AC voltmeter, check for a voltage of 45- to 60-VAC between terminals TB1-G1 and TB1-G2. If this voltage is 0, check for generator voltage right at the drive. A voltage of 45 to 60 VAC at top speed here indicates that the wiring circuit between the mechanical drive and the

controller is open. If this voltage is low or missing, the mechanical drive is defective and needs to be repaired.

3. Check the Control setup for control type. If the control type is "Torque", speed is a function of the load and the reference set point sets the clutch current level, not the speed.. Re-adjust the reference or the load as needed. Note that the speed feedback fault should be disabled in this mode.

4. Check the Control Setup Menu "5 TACH PULSES/REV" in Section 7 on page 52 along with Table 2 on page 12 for the proper pulse scaling factor and adjust as required.

5. See if the drive still runs at top speed with the control de-energized or with the clutch wires disconnected. If so, the loss of speed control is due to a failed pilot bearing or foreign matter jammed between the rotor and drum of the mechanical unit, and the drive must be repaired.

6. If all the above tests have not located the problem, with the control energized in the run mode, set the speed reference to "0" and measure the output voltage of the controller. A voltage of approximately 40- to 100-VDC between terminals TB1-C1 and TB1-C2 may indicate shorted output devices, and the main power circuit board must be repaired or replaced.

8.4   **The fuses are blown:**

1. Check to see if the controller voltage and current ratings are compatible with those of the mechanical unit. If not, exchange the controller for the proper unit.

2. With the power off, with an ohm meter, check for shorts or low resistance paths between each of C1, C2, B1, B2 and Ground. The power converter operates directly from the power line and must not be connected to ground unless the controller is isolated from the line with an isolation transformer.

3. With the control power off, with an ohm meter, measure and record the resistance of the clutch coil between terminals TB1-C1 and TB1-C2. If there is a brake connected at terminals TB1-B1 and TB1-B2, disconnect the brake coil wires at TB1 and measure and record the resistance of the brake coil. Compare the readings with the nameplate resistance. Note that a cold coil will read 10 to 20% lower than the nameplate value. If there are slip rings and brushes on the clutch, it may not be possible to get a true reading, and the clutch coil resistance should be read directly on the slip rings. If the reading is substantially lower than the rating or is a short circuit, check at all the junction box connections to eliminate any wiring shorts. If it is still too low, the drive will have to be sent out for coil replacement.

4. Try another set of fuses with the clutch (and brake) leads disconnected. If the fuses blow again, the power board will have to be repaired or replaced.

5. Double check the clutch and brake current ratings and current limit parameters.

8.5   **The speed range is limited--can't reach minimum speed or maximum speed:**

1. Check the settings for clutch minimum and maximum RPM values in Menus A6, A7, E1, E2, J1, J2, and L1, L2. The Menu parameters must be entered in the following sequence: A, L, E, and J. Menu parameters are found in Section 7 on Page 52.

2. Check the tach PPR setting in Menu A5. Readjust parameter if needed.

3. Check the top line of the Display to determine the Controller STATUS. If a "Torque Limit" condition exists, the top speed may not be reached since the output will be limited to prevent the motor current from exceeding the designated limit. The default Torque Limit setting in Menu B7 is 150% of the Motor Full Load rating as set in Menu A9. If these two parameters are set properly,

the motor current signal from the Motor Current Transformer may be too high, and this can be adjusted for proper operation by means of the Torque Limit potentiometer, R111, located near the upper left hand corner of the main power circuit board. Turning the multi-turn pot CW will increase the torque limit. The Motor Amps may also be monitored from the display. See Meter Select menu on page 60.

4. Check the controller output voltage at terminals TB1-C1 and TB1-C2. If this voltage is above 90-VDC, the control is operating at maximum output. This condition may indicate a problem with the mechanical unit or a load condition in excess of the capability of the drive.

8.6   **The speed pot does not work:**

1. Check for proper pot wiring: "0" end of the pot goes to "P1", "100" end to "P2", and the wiper arm to "P3". Terminals TB2-8 and TB2-9 must be jumpered together.

2. Verify the control parameters.
   1. Control mode must be MANUAL for operation from the pot.
   2. Menu A11. LOCAL/REM ENABLE must be ENABLED and in the REMOTE mode.
   3. Menu K6. PRESET 1 SOURCE must be set to POT and PRESET 1 must be selected.
   4. Setting Menu K5. PRESET SOURCE to POT will automatically select Preset 1 when operating in the Remote Manual mode (Default Condition).

8.7   **The control will run but not jog; no fault is displayed:**

1.   The JOG function is operational only in the SPEED control mode, not TORQUE or EXTERNAL modes.

2. The JOG function is operational only in the MANUAL mode, not AUTO.

3. The operating mode must be LOCAL to Jog from the Keypad unit.

4. When Jogging from the Remote Jog terminals, the operating mode must be REMOTE and the JOG N.O. pushbutton must be wired between terminals TB2-29 and TB2-27. The menu A11. LOCAL/REMOTE function must be ENABLED and the JOG SOURCE in Menu K2. must be TERM.

5. Check Menu L7. JOG SET POINT for a non-zero jog speed, and Menu C5. and C6. for a high enough acceleration and/or deceleration rate. Default values are 150-rpm and 100.0%/second.

8.8   **Unstable Speed:**

Eddy current drives are not particularly easy to control. This is especially true in the case of lightly loaded systems. However the EC-2000 provides both a current loop and a speed loop with PID control that can be adjusated to handle virtually any process. In most cases the factory defaults will require little or no adjustment, but if instability results proceed as follows:

First determine if the oscillation is a problem caused by the controller response, controller feed back or issues with the process. If the process speeds up and slows down in a repeatable fashion then the problem most likely can be solved by the adjustment of parameters. If the issues with stability are erratic, then the feedback signal (the tachometer usually) should be watched. This can be brought up on the keypad (Speed). If the speed feedback number is changing abruptly without explaination then noise or a faulty tach or pulse pickup may be the problem. Also mechanical binding may be an issue.

Parameter Explanations – The EC-2000 has (2) control loops when operating in Speed Mode (Speed and Current). The speed loop calculates an output based on the speed error and feeds the resulting command to the current loop. The current loop then calculates an output based on

the current parameters. This final command is then applied to the output SCR's which energize the clutch coil. When the control is operating in current (torque mode) the speed loop is not active and the setpoint results in a current command based on the current parameters only. Each loop has a proportional gain that responds to process error. An Integral gain that responds to process error and the time the error has existed and finally each has a differential gain that responds to the slope toward or away from the desired setpoint. The output at any given moment is the summation of the active parameters. Note: The torque parameters are not used in normal control. Only when the control is in torque limit.

If feedback and process problems are not suspect then try the factory default settings first. These default settings are listed in the parameter section. In most cases current and speed DIFFERENTIAL GAINS will be ZERO. If the process is lightly loaded, start by reducing the CURRENT PROPORTIONAL AND INTEGRAL gains. These values should be lowered together. If more inprovement is needed try reducing the SPEED INTEGRAL GAIN and then SPEED PROPORTIONAL GAIN. For heavily loaded processes leave the current gain parameters at the factory defaults and increase the values for SPEED PROPOTIONAL GAIN and SPEED INTEGRAL GAIN. For slow response process especially where the process variable is not the motor speed try cautiously adding SPEED DIFFERENTIAL GAIN and possibly CURRENT DIFFERENTIAL GAIN. However, be advised too much DIFFERENTIAL GAIN can stop process response and result in loss of control. Parameters will be different for different processes so a certain amount of trial and error will be required. In all cases if raising a parameters value results in more instability reduce the parameter value. The opposite is also true. If problems persist consult the factory. .

8.9 **The control will not linear decelerate upon stop command:**

1. For controlled deceleration, the Menu A10. COAST ENABLE must be disabled.

2. Check the setting of Menu C2. NORM DECEL RATE The controlled deceleration rate must be less than the normal "coast to stop" rate of the machine. Remember that these values are "RATES" and not "TIMES". The larger the rate number, the shorter the accel/decel times.

8.10 **The Local/Remote key doesn't work:**

The LOCAL/REMOTE function must be ENABLED in Menu A11. If this function is enabled and the Local/Remote key still does not operate, the Keypad/Display unit may be defective, and should be replaced. HINT: The entire row or column of keys in which the defective key occurs may be inoperative.

8.11 **Other faults and suggested action:**

Coil Open Fault: Check the coil with an ohmmeter, comparing to the nameplate resistance. If the meter reads open, check at the drive junction box to eliminate possible broken wiring. If there are slip rings and brushes, check to see that the brushes are seated properly and are not excessively worn; the slip rings should be shiny and free of oil or other contamination. If the clutch coil is open, the drive will have to be removed and sent out to have a new coil installed.

Keypad Fault: For controllers using the Keypad/Display unit, check the keypad and cable assembly and exchange with a known good keypad and/or cable. If the controller does not use a keypad unit, the Menu M4. KEYPAD FLT ENABLE must be DISABLED for the unit to run. Without a Keypad/Display unit however, this fault would not be known.

Overspeed Fault: Determine the cause of the overspeed. The overspeed trip level and other control speed programming parameters must be set correctly. Was the overspeed condition independently confirmed? See Section 8.3 above for certain conditions that may cause an overspeed condition.

Underspeed Fault: As with the overspeed, first confirm the existence of the condition, then find the cause and eliminate it. Is the drive overloaded and/or going into torque limit? Another possible cause may be the current limit level set too low.

Note: The fault menu and conditions are merely troubleshooting aids. Drive stops due to automatic Fault detection may be eliminated by disabling the respective fault(s) in Menu M. **CAUTION: The "SPD FDBK FAULT EN" is intended to prevent runaway conditions due to loss of speed feedback; if an unsafe condition may result with overspeed, do not disable this fault.** If there are questions or if additional assistance is required, please contact the factory.

Section 9 - QUICK STARTUP and PROGRAMMING EXAMPLES

All EC-2000 controllers are configured, programmed, and tested prior to shipping. Unless a controller is ordered as a custom engineered unit where application specific configuration and/or programming are required, the jumpers are placed and the functions are programmed for standard normal speed control operation. For most applications, this would suggest that the unit will operate out of the box with little or no further adjustment.

Standard Default Jumper Assignments:

J2	Position B	Speed Follower Input is Tachometer
J3	Position B	Process Feedback Signal Range is 0- to 20-volts
J4	Position B	Speed Feedback Input is Tachometer
J5	Position B	Control Clutch Current Rating is 24-amps
J6	Position B	Control Brake Current Rating is 24-amps
J7	Position A	Gating Picjket Fence Enabled
J8	Position A	Synk Bias (Standard and High Power Controls)
J9	Position B	Auto Signal Input is 4- to 20-ma
J10	Position B	Auto Signal Input Range is 0- to 5-volts
J11	Position A	Power Converter is Internal
J13	Position A	Clutch Current FB is Internal
J14	Position A	Brake Current FB is Internal
J15	Position A	Sync Bandwidth (Standard and High Power Controls)
J16	Position A	Sync Bandwidth (Standard and High Power Controls)

Note: The above settings are for the standard 24-amp controllers only. For High Power EC-2000 controllers using external power converters and current feedback transducers, the following jumper configuration is assigned as:

J5	Position A	Clutch current Rating is 16-amps
J5	Position B	Clutch current Rating is 24-amps
J5	None	Clutch current Rating is 32-amps
J6	N/A	Brake Circuit is Inactive
J11	Position B	Power Converter is External
J13	Position B	Clutch Current FB is External
J14	N/A	Brake Circuit is Inactive

NOTE: The jumper assignments for J11, J13, and J14 must remain in the positions as set by the factory,

Certain applications may require changing the position of one or more of the jumpers on the (larger) main power board. Jumpers on the smaller upper circuit board must remain in the factory assigned positions.

To prevent serious bodily injury and/or damage to the controller, always remove power from the controller before removing or installing jumper shunts on the circuit boards.

Several jumper reassignments are allowed:

Speed Follower:	The speed follower is configured for a tachometer input at terminals TB2-18 and TB2-19. If speed follower operation is desired with the use of a digital pulse pickup, **move jumper J2 from position B to position A** and connect the pickup wires to the following terminals: Black to TB2-1, White or Green to TB2-17, and Red to TB2-3. Please refer to a similar connection in Section 4.3.
Speed Feedback:	The speed feedback is configured for a tachometer input at terminals TB1-1 and TB1-2 (G1, G2). If the speed feedback transducer is to be a digital pulse pickup, **move jumper J4 from position B to position A** and connect the pickup wires to the following terminals; Black to TB2-1, White or Green to TB2-2, and Red to TB2-3 as shown in Section 4, Figure 8.
Control Clutch Current Rating:	For proper scaling, if the clutch coil rating is 16-amps or less, **move jumper J5 from position B to position A** and reprogram this parameter in Menu A2.
Control Brake Current Rating:	For proper scaling, if the brake coil rating is 16-amps or less, **move jumper J6 from position B to position A** and reprogram this parameter in menu D1.
Automatic Signal Follower Input:	The default remote automatic signal input is configured for a 4- to 20-ma signal. If this remote input signal is to be a 0- to 10-volt voltage instead, **move both jumpers, J9 and J10, from position B to position A.**

Standard Default Programmed Features:

The user is referred to the **Parameter List** in Section 7 on Page 52 for the default programmed features. These parameters may be changed by the operator to suit the needs of the application with the use of the Keypad/Display unit.

Accessing and Navigating the Keypad:

Upon power up, the controller displays the sign-on logo with the current model number and revision level of the resident operating system firmware, and initializes to a Ready-to-Run condition with the features and conditions set forth in the Parameter List Defaults in Section 7.

The keypad/display unit consists of a 20-key dedicated function keypad with integral four-line lighted LCD alphanumeric display. The top line of the display indicates the current status of the controller and the associated speed in RPM or Torque in percent of full scale. The second line indicates the control operating mode. The third and fourth lines are meter displays and may be programmed to indicate several conditions, the standard default configuration indicating the speed reference set point on the third line, and the actual drive speed on the fourth line.

The programming is accomplished with the [ENTER], [EXIT], [(UP)], [(DOWN)], [SHIFT], [SETPOINT], and [SELECT METER] keys. The remaining keys have dedicated functions and are used to start, stop, and control the drive.

Changing Programmed Parameters:

To change any of the programmed parameters, it is necessary to enter the Parameter Menu by pressing the [ENTER] key. Each time the [ENTER] key is depressed, the next deeper level of the menu will be accessed. The operator may exit the current level of the menu by pressing the [EXIT] key. Again, each time the [EXIT] key is pressed, the menu pointer will move up to the previous level. Once the proper menu level has been accessed, use the [UP arrow] or [DOWN arrow] keys to select the items at that level. Once selected, the parameter is locked with the [ENTER] key, and the menu may then be exited using the [EXIT] key. Certain operations require specific quantities to be entered. The position of the

numbers addressed is selected with the [SHIFT arrow] cursor key. **Refer to the Menu Parameter List in Section 7 for the options available and the levels at which they may be found.**

The reader is referred to **Section 5 – Initial Controller Setup** for detailed discussions on the available options and programming of parameters and functions.
If the controller was just energized, the first entry into the menu will be at level **A. Control Setup**. Otherwise, the first entry into the menu will be at the last level accessed if the operator did not completely exit the menu on a previous operation.

Example 1:   Change the CONTROLLER CURRENT RATING from 8-amps to 5.5-amps.

If the controller was just energized, the display will appear as:

        [KEY]   **DISPLAY READOUT**

                                  Line 1:   STOPPED   0 RPM
                                  Line 2:   LOCAL   MANUAL   SPEED
                                  Line 3:   REFERENCE   0 RPM
                                  Line 4:   DRIVE SPD   0 RPM

Enter the menu by pressing the [ENTER] key. The following display changes occur:

        [ENTER] >   Line 3:   PICK PARAMETER MENU:
                              Line 4:   A CONTROL SETUP

Drill down to the next level of Menu A by pressing [ENTER] again:

        [ENTER] >   Line 3:   A CONTROL SETUP
                              Line 4:   1 CONTROL TYPE >

Press [UP ARROW] key to move up from Menu A1 Control Type to A2 Contrlr Current :

        [UP ARROW] >   Line 3:   A CONTROL SETUP
                              Line 4:   2 CONTRLR CURRENT >

Press [ENTER] key to select the controller current parameter:

        [ENTER] >   Line 3:   2 CONTRLR CURRENT
                              Line 4:   8 AMPS   8 AMPS (FLASHING)

On line 4, the quantity on the left indicates the current value of the controller current, and the flashing quantity on the right indicates where the new value will appear. To change the Controller Current from 8-amps to 5.5-amps, press the [DOWN arrow] key to select the next lower value of 5.5-amps:

     [DOWN ARROW] >   Line 3:   2 CONTRLR CURRENT
                              Line 4:   8 AMPS   5.5 AMPS (FLASHING)

The new value of 5.5-amps is displayed in the flashing window. To lock this value, press the [ENTER] key:

        [ENTER] >   Line 3:   2 CONTRLR CURRENT
                              Line 4:   5.5 AMPS   5.5 AMPS (FLASHING)

The new value of 5.5-amps moves to the current value position on the left. To finish this operation, press the [EXIT] key. This will cause the operation to back out of the menu to the next level up:

        [EXIT] >   Line 3:   A CONTROL SETUP

Line 4:   2 CONTRLR CURRENT >

Press [EXIT] again. The operation is moved to the next higher level.

    [EXIT] >   Line 3:   PICK PARAMETER MENU:
                      Line 4:   A CONTROL SETUP

Press [EXIT] again to finish this operation.

    [EXIT] >   Line 3:   REFERENCE   0 RPM
                      Line 4:   DRIVE SPD   0 RPM

NOTE: Changing the Controller Current Rating will cause the Clutch Coil Rating in Menu A3. to also change.

Example 2:   Change the Clutch Current Limit from 5.5-amps to 3.8-amps.

    [KEY]   **DISPLAY READOUT**

                      Line 1:   STOPPED   0 RPM
                      Line 2:   LOCAL   MANUAL   SPEED
                      Line 3:   REFERENCE   0 RPM
                      Line 4:   DRIVE SPD   0 RPM

Press the [ENTER] key twice to Menu level A 1. The following display changes occur:

    [ENTER] >   Line 3:   PICK PARAMETER MENU:
                      Line 4:   A CONTROL SETUP

    [ENTER] >   Line 3:   A CONTROL SETUP
                      Line 4:   1 CONTROL TYPE >

Press [UP ARROW] key three times to move up from Menu A1. Control Type to A4. Clutch Current Lim:

    [UP ARROW] >   Line 3:   A CONTROL SETUP
                      Line 4:   2 CONTRLR CURRENT >

    [UP ARROW] >   Line 3:   A CONTROL SETUP
                      Line 4:   3 CLUTCH COIL RATING >

    [UP ARROW] >   Line 3:   A CONTROL SETUP
                      Line 4:   4 CLUTCH CURRENT LIM>

Press the [ENTER] key to select this function:

    [ENTER] >   Line 3:   A CONTROL SETUP
                      Line 4:   0005.5 A   **0**005.5 A

The quantity on the left is the current value of the Clutch Current Limit. The quantity on the right has the left most digit flashing to indicate the current location of the cursor. Press the [SHIFT arrow] key three times to move the cursor right to the fourth position. The cursor moves only right. If the desired location is overshot, it will be necessary to continue on with the [SHIFT] key until the cursor wraps around again:

    [ENTER] >   Line 3:   A CONTROL SETUP
                      Line 4:   0005.5 A   0**0**05.5 A

| [ENTER] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 00**0**5.5 A |

| [ENTER] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 000**5**.5 A |

The cursor is now in the desired position. Press the [DOWN arrow] key twice to lower the number to 3:

| [DOWN] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 000**4**.5 A |

| [DOWN]> | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 000**3**.5 A |

Now press the [SHIFT arrow] key to move the cursor right to the next position:

| [SHIFT arrow] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 0003.**5** A |

Press the [UP arrow] key three times or the [DOWN arrow] key seven times to change the last digit to an 8:

| [UP arrow] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 0003.**6** A |

| [UP arrow] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 0003.**7** A |

| [UP arrow] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0005.5 A | 0003.**8** A |

Press the [ENTER] key to select and lock this value:

| [ENTER] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 0003.8 A | 0003.**8** A |

Press the [EXIT] key three times to exit the menu:

| [EXIT] > | Line 3: | A CONTROL SETUP | |
| | Line 4: | 4   CLUTCH CURRENT LIM> | |

| [EXIT] > | Line 3: | PICK PARAMETER MENU: | |
| | Line 4: | A CONTROL SETUP | |

| [EXIT] > | Line 3: | REFERENCE | 0 RPM |
| | Line 4: | DRIVE SPD | 0 RPM |

The Clutch Current Limit is now set for 3.8-amps.

Example 3:   Change the Meter reading on Line 3 from Reference to Clutch Amps:

[KEY]	**DISPLAY READOUT**		
	Line 1:	STOPPED	0 RPM
	Line 2:	LOCAL MANUAL	SPEED

Line 3:   REFERENCE   0 RPM
Line 4:   DRIVE SPD   0 RPM

Enter the meter menu by pressing the [SELECT METER] key. The following display changes occur:

[SELECT METER] >   Line 3:   >METER 1 SELECT
                          Line 4:   METER 2 SELECT

The (>) indicates which meter is currently selected. The other meter may be selected by using either of the [UP] or [DOWN] arrow keys. Since METER 1 is the desired item, press [ENTER] to select that:

[ENTER]   Line 3:   >REFERENCE
                 Line 4:   METER 2 SELECT

The current parameter is displayed on Line 3. Referring to the METER 1 SELECT menu in Section 6, the REFERENCE is the first option, and the desired CLUTCH AMPS is the third option. Press [UP arrow] twice to advance the pointer to the CLUTCH AMPS option:

[UP arrow]   Line 3:   >MOTOR AMPS
                    Line 4:   METER 2 SELECT

[UP arrow]   Line 3:   >CLUTCH AMPS
                    Line 4:   METER 2 SELECT

The CLUTCH AMPS option is now selected. Press the [EXIT] key twice to exit the menu:

[EXIT] >   Line 3:   >METER 1 SELECT
                  Line 4:   METER 2 SELECT

[EXIT]>   Line 3:   CLUTCH AMPS   0.00AMPS
                 Line 4:   DRIVE SPEED   0 RPM

Most parameters can be changed only when the drive is in the "stopped" condition. Refer to the "lock" symbol between the PARAMETER and RANGE items in the Parameter List in Section 7.

Below is a list of Quick Start references for dealing with changes to the most common parameters to facilitate proper control operation. These may be helpful for modifications to the factory preprogrammed functions and parameters, or when reprogramming from a memory reset condition.

The reader is referred to **Section 5 – Initial Controller Setup** on page 16 for detailed discussions on the available options and programming of parameters and functions. Choose remote or local operation from the keypad. If no keypad is present, external control by means of switches has been preprogrammed and the operation requires operator controls, Run and Stop pushbuttons, and a Speed potentiometer or external reference. The balance of this section assumes a keypad/display is available at least for startup programming. If the keypad/display unit is to be removed after programming for security reasons, it will be necessary to disable the Keypad Fault in Menu M4. to run.

To prevent damage to the controller, always remove power from the controller before connecting or disconnection the keypad/display from the unit. The keypad connector to the digital control card is polarized. Install the connector in the proper position and orientation. Failure to do so will destroy the keypad/display unit.

9.1   The control type must be selected from the following choices (menu/parameter "A 1"):
        A.) Speed
        B.)Torque (current) control
        C.)Speed/Torque
        D.)External Control

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9.2   The controller current output must now be set. The parameter is "A 2" and is used to set the output rating of the controller. Use 5.5A unless the mechanical unit coil is rated between 5.5 and 8 amps (then select 8A). Note: The jumper J5 must also be positioned correctly, "A" for 5.5A or "B" for 8.0A.

9.3   Set the coil rating using the actual value from the motor nameplate in "A 3; this value is to be equal to or less than "A 2 CONTROL CURRENT".

9.4   The "A 4" CLUTCH CURRENT LIMIT is designed to limit output from the control, which will then limit torque. Unless full time current/torque limiting is desired, this parameter should be set to the "A 3" value.

9.5   The internal tach generator or pulse pickup frequency must be entered in "A 5 TACH PULSES/REV" and the number to be set is the pulses per revolution. The most common generator pulse rate is 12, but the larger units use other values. If a pickup is used, the limit is 180 PPR. The unit value can also be scaled by use of the clutch scale factor in the A MENU (Control Setup) Note: The jumper J4 on the power PCB must be set to "A" for pulse pickup [TB1(com), TB2(Signal) and TB3(+12 Volts)] or to "B" for tach generator input.

9.6   The clutch speed range is set by setting the minimum and maximum RPM in parameters "A 6" and "A 7". These will be set to nameplate minimum and maximum RPM's to keep the mechanical unit within its design thermal operating and regulated control ranges.

9.7   Stopping mode programming. The parameter "A 10 COAST ENABLE" is used to choose the coast function. If a controlled decel stop is selected, it will require that the decel time be set longer than the normal coast to stop time, unless a brake is used, then the decel time will be controllable to any desired value within the limits of the braking torque.

9.8   Now decide if Local/ Remote operation is to be used; Local/Remote may be enabled by using parameter "A 11 LOCAL/REM ENABLE". It is best to enable this to be sure which mode the control is in. If you are planning to run from the terminals (remote) go to Menu K SOURCE SELECT and set Items 1 Auto/Man Source = KPAD , 2 Jog Source = TERM, 5 Preset Source = TERM, 6 preset 1 Source = POT, and 7 Start Source = TERM. Now, the control will need a start/stop circuit on terminals TB2-22, 23, & 24. It will need a potentiometer on terminals TB2-6, 7, 8, & 9 for manual mode and a voltage or current on the auto input, terms TB2-20 & 21. See figures 5 & 7 for detailed wiring. The user can switch from AUTO to MANUAL with the kepad or by means of the AUTO switch between terminals TB2-30 & 32. If you are planning to run only from the keypad, then set above items 1, 2, 5, 6, 7 all to keypad. Terminals TB2-22 & 24 must be jumpered for this as the stop circuit is always active. Note, for operation from the auto or manual inputs, the control must be in remote mode. Once set, the control will remember it's operating mode even if power is removed.

9.9   Should the control programming become corrupted or if it is desired to start over, it is possible to reset the control to the default settings. To do this, go into the programming mode item "A 14 MEMORY RESET EN", and set it to "YES". WARNING: If you change your mind, be sure to reset the "A 14" parameter back to "NO" before turning off the power. Exit the programming mode and remove power from the control for 10 seconds; this will reset the parameters to their default settings on the next power up and all of the "tailored" parameters required for running the particular system will have to be re-entered. It is also possible to reset the controller to factory defaults through use of the terminals. This could be necessary in the event the controller will not boot up due to a software upgrade or a programming error. To enable the terminal reset, open terminals TB2-30 & 31 (EMERGENCY STOP), open terminals TB2-22 & 24 (STOP), and jumper terminals TB2-29 & 32 (JOG). Then cycle the power. The control will reload factory defaults, so all programming data previously in memory will be lost.

Table 4: Power Board Programmable Jumpers

JUMPER	PARAMETER	POSITION "A"	POSITION "B"	POSITION "C"
J2	Follower Operation	Pulse Pickup (TB2-17)	Tach. Generator (TB2-18 & 19)	N/A
J3	Process Feedback	0 TO ±20VDC	0 TO ± 5, ±10V	N/A
J4	Speed Control Feedback	Pulse Pickup (TB2-2)	Tach. Generator (TB1, G1 & G2)	N/A
J5	Clutch Current Feedback Scaling	16.0 AMP (or less) Output	24 Amp Output 48 Amp Output	32 Amp Output No Jumper
J6	Brake Current Feedback Scaling	16.0 AMP (or less) Output	24 Amp Output 48 Amp Output	32 Amp Output No Jumper
J7	Gating Pulse Train	Standard & High Power Control	CES Control	N/A
J8	Synk bias	Standard & High Power Control	CES Control	N/A
J11	Clutch Gating Circuit	Standard Control On Board Pulse Xfmr	High Power Control Off Board Pulse Xfmr	High Power Control Off Board Pulse Xfmr
J13	Clutch Current Feedback Circuit	Standard Control On-Board LEM's	High Power Control Off-Board LEM's	High Power Control Off-Board LEM's
J14	Brake Current Feedback Circuit	Standard Control On-Board LEM's	High Power Control Off-Board LEM's	High Power Control Off-Board LEM's
J15	Sync Bandwidth	Standard & High Power Control	CES Control	N/A
J16	Synk Bandwidth	Standard & High Power Control	CES Control	N/A

Table 5: Process Feedback Signal Programming

For Special Uses Only, (such as Dancer Position)

SIGNAL	JUMPER	
	J9	J10
0 –10 VDC	A	A
0 -5 VDC	A	B
4 – 20 maDC	B	B
8 – 40 maDC	B	A

Figure 10: Location of Jumpers and Potentiometers on the Power Board
Note that Jumpers J3 and J6 are located under the logic circuit board, if it is installed.

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