DENISON HYDRAULICS
GoldCup Digital HI-IQ Control

Electronic Control Card User Manual
Software Version 2.2b

ISO 9001

DNV

DNV Certification, Inc.
REGISTERED FIRM

DENISON | **Hydraulics**

Internet: http://www.denisonhydraulics.com

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DESCRIPTION OF GOLDCUP DIGITAL HI-IQ PUMP CONTROL SYSTEM

The Denison GoldCup Digital HI-IQ transmission pump is an electronically controlled hydraulic transmission pump capable of precise, high speed, quiet, efficient, closed-loop positioning of a hydraulic cylinder. A typical control system is shown in the following circuit diagram.
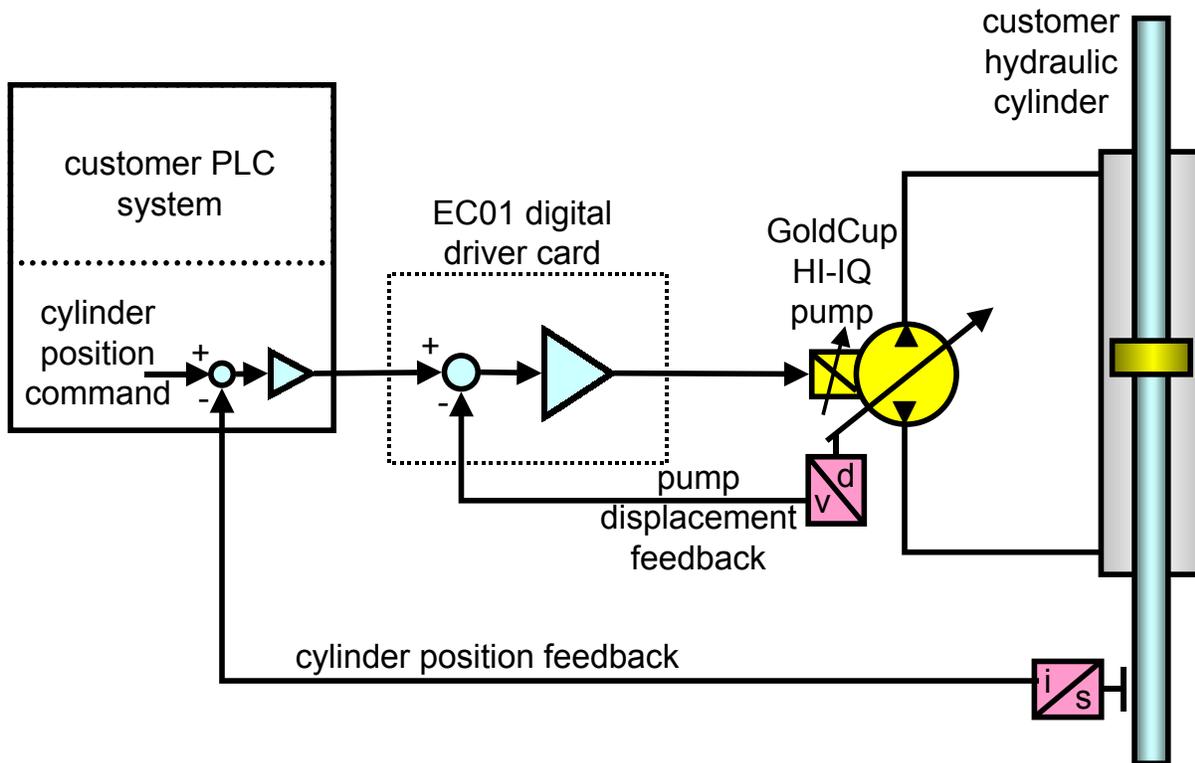
The GoldCup pump's 350 bar maximum pressure capability provides exceptionally high power density in a rugged, compact, and efficient package. The pump also performs the dual role of the *flow source* and the *flow control* for the hydraulic cylinder. The Denison GoldCup Digital HI-IQ transmission pump provides smooth, controlled acceleration and deceleration of the hydraulic cylinder without the throttling power losses and heat generation associated with conventional servo or proportional valve cylinder positioning systems. It is also capable of regenerating the hydraulic power needed to decelerate the cylinder and converting it into electrical power through the primary drive electric motor. This significantly reduces heat generation in the hydraulic fluid; increasing the hydraulic fluid life and reducing the size and operating cost of the fluid cooling system. The regenerated power can be used to drive other mechanical and electrical devices in the system.

Denison GoldCup pumps have earned a global reputation for their quiet reliability. This control system strategy further reduces the overall hydraulic system noise by eliminating the throttling of the main system flow. The fluid throttling noises associated with conventional valve controlled cylinder positioning systems have been completely eliminated. Shock induced noises are also avoided when the cylinder motion is accurately and smoothly controlled. Smooth cylinder motion control also reduces wear, extending the service life of the customer's machine. Eliminating shocks also helps to prevent costly and troublesome hydraulic fluid leaks. The GoldCup Digital HI-IQ transmission pump truly represents a quantum leap forward in hydraulic cylinder motion control technology.

The design of the Digital Electronic Driver Card is the key to making the GoldCup Digital HI-IQ system easy to use. The EC01 DC2 driver card employs advanced digital technology providing unmatched ease-of-use, performance, and reliability. The cards are shipped from Denison with all of the customer control system parameters preset and stored in the memory of the card. This dramatically reduces new machine commissioning time and saves time in servicing existing machines. The digital electronic controller also provides the ability to monitor the operation of the system and to diagnose and solve problems before they result in machine downtime. Access to all of the critical control system parameters is provided through a Windows-based Denison User Interface Software package that can be installed on your PC. This PC software adjustment system for the electronic driver card prohibits unauthorized personnel from making changes to critical control system parameter settings. A Denison supplied password is required to make any changes to the driver card settings. Only authorized users with the Denison User Interface Software properly installed on their PC and supplied with the appropriate Denison password are able to make adjustments to the control system parameter settings.

This User Manual describes the general operation of the digital electronic driver card and the hardware, software, and procedures to evaluate the performance of the pump. It also describes how to make adjustments to the pump electronic control system parameters in the field.

EC01 DRIVER CARD CODE NUMBERS

The control system parameters are stored in the EC01 card memory customizing each card for the particular GoldCup pump model and configuration that it operates. The following table provides the existing standard EC01 Card Code Numbers. The EC01 Card Code Number is displayed on a printed label located on the side of the rear electrical connector of the card. Two cards are shown at the bottom of the table that have zero values stored in the memory. These two cards can be configured to operate with any pump model and configuration using the Denison GoldCup Digital HI-IQ User Interface Software version 2.2b to manually set the control system parameters and store them in the card memory. Contact Denison for the EC01 Card Code Numbers for pumps that operate with with a servo pressure higher than 41 bar.

GoldCup Pump Model	Pump Displacement Sensor Type	Input Command	Nominal Servo Pressure	EC01 Card Code Number
P6, P7, or P8	potentiometer	±10 vdc	41 bar	726-00030-3
P6, P7, or P8	DC RVDT	±10 vdc	41 bar	726-00031-3
P11 or P14	potentiometer	±10 vdc	41 bar	726-00034-3
P11 or P14	DC RVDT	±10 vdc	41 bar	726-00035-3
P24 or P30	potentiometer	±10 vdc	41 bar	726-00038-3
P24 or P30	DC RVDT	±10 vdc	41 bar	726-00039-3
P6, P7, or P8	potentiometer	4-20 mA	41 bar	726-00100-3
P11 or P14	potentiometer	4-20 mA	41 bar	726-00102-3
P24 or P30	potentiometer	4-20 mA	41 bar	-
undefined	undefined	±10 vdc	undefined	726-00020-3
undefined	undefined	4-20 mA	undefined	726-00050-3

INSTALLATION AND WIRING OF THE EC01 DRIVER CARD

Connect the electronic driver card, pump, and control valve as described in the SK-16101 electrical connection diagram for a ±10 vdc input command for pump displacement. Connect the system as described in the SK-16099 for a 4-20 mA input command.

SK-16101   B

SK-16101   B

Title block:

DENISON Hydraulics — MARYSVILLE, OHIO

DIAGRAM-STANDARD HI/IQ
EC01 WIRING

SK-16101   B

DES.	RUS
DR.	RUS
CK.	

DATE: 10/12/01
SCALE: NONE=1"
EST. WT.

SHEET 1 OF 1

ACAD94 DRAWING
USED ON
LAST REV.
ECN NO.
DATE:

Diagram labels:

24V @ 500mA MAX (EXTERNAL SUPPLY)

LOAD

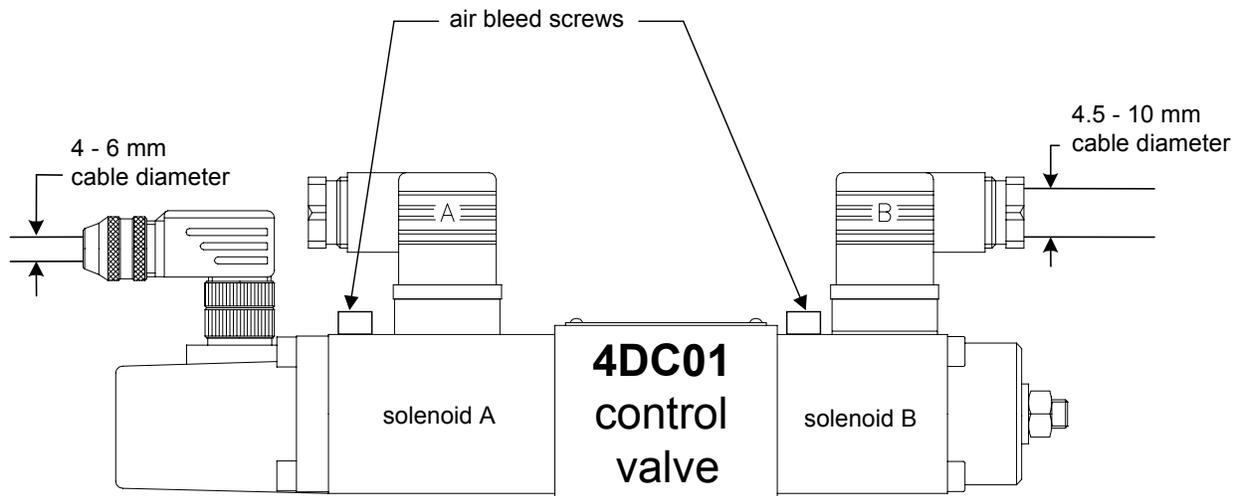COILS ARE NOT POLARITY SENSITIVE

SOL. B
SOL. A
FDBK

GOLD CUP PUMP SERIES

PUMP POSITION FEEDBACK

OPTIONAL
+15V   B
SIG   C   DC RVDT   A   +22mA
−15V   D
GND   F

DC RVDT FEEDBACK ASSEMBLY DHI P/N S23-03278

CLOSE SWITCH TO REVERSE POLARITY (SEE PHASING CHART)

+15V (B2)
B
CW
C   10K OHMS
D
F   OPTIONAL

STANDARD WIRING FOR FEEDBACK ASSEMBLY S23-02345

EC01 DC2
701-00801-8

Terminal labels (right side):
- B32 +V EXT DIG OUT
- Z18 CONTROL ERROR
- B30 0Vsupply
- B22 DIG OUT GND
- Z24 / Z26 SOL. B + −
- B24 / B26 SOL. A + −
- D14 4-20mA SPOOL VALVE FEEDBACK
- D32 +24V OUT
- B6/Z28/Z30 GND
- D16 PUMP FEEDBACK POLARITY REVERSAL
- D2 +10V
- B8 PUMP DISPL FEEDBACK
- D4 −10V
- B6 GND

FOR EXTERNAL USE ±50mA MAX
+15V B2
GND B6
−15V B4

Z2/Z32 EARTH REQUIRED FOR EMC COMPLIANCE NOT THE SAME AS GND OR 0V SUPPLY

Terminal labels (left side):
- D28 +Vsupply
- B28 +Vsupply   POWER IN
- D30 0Vsupply
- B30 0V
- D2 +10V Ref. @ 10mA (MAX) POWER IN
- B6 GND
- D12 MAIN COMMAND
- D4 −10V Ref. @ 10mA (MAX)
- B16 EC01 ENABLE OUTPUT
- B18 RAMP ENABLE
- B10 + SINGLE POLARITY INPUT
- D10 − AMPLIFIER
- B6 GND   INVERTS POLARITY OF COMMAND FROM B10/D10
- D20 X-CMD INVERT   INVERTS THE SUM OF ALL COMMANDS @ X-CMD LOGIC BLOCK
- D18 X-CMD LOGIC BLOCK
- B20 Dig. In GND
- Z28 GND

AC/DC POWER SUPPLY 24VDC@2 AMPS

AC INPUT

PUMP DISPL COMMAND   10K OHMS

PUMP DISPL COMMAND
+15V (B2)
CLOSE SWITCH TO ENABLE
+10V MAX   5K OHMS   CW
SEE MANUAL PUBLICATION 9-EN6060-A FOR OTHER OPTIONS

+15V (B2)
CLOSE SWITCH TO ENABLE

+15V (B2)
B10/D10 POLARITY INVERT

+15V (B2)
COMMAND POLARITY INVERT

GROUND TERMINALS MUST BE CONNECTED

NOTES:

1. The '0v line of the power supply is not the same point as the signal 'GND'. They are separated via a current compensation coil.

2. The "DigIn(B16,D16)" & "DigIn GND(B20)" are electrically isolated inputs. For electrical isolation, the DigIn signal-reference potential must be connected to DigIn GND(B20). If isolation is not required the DigIn Gnd must be connected to signal GND (B6,Z28 or Z30), as shown in this wiring diagram. DigIn current consumption is 3mA @ 15V each.

3. The Control Error Signal DigOut (Z18) & DigOut GND (B22) are electrically isolated outputs. If electrical isolation is not required the +Vext DigOut terminal (B32) can be connected to the +Vsupply (D28) and the DigOut GND (B22) must then be connected to 0Vsupply (B30) as shown in the diagram.

HIGH IQ W/ECO1
WIRING DIAGRAM

DENISON Hydraulics MARYSVILLE, OHIO

SK-16099   B

DES. RUS
DR. KJM
CK.
DATE: 7-2-99
SCALE: NONE=1"
EST. WT.
DATE:

SHEET 1 OF 1

ACAD94 DRAWING
USED ON   ECN NO.   LAST REV.

NOTES:

1. The '0'v line of the power supply is not the same point as the signal 'GND'. They are seperated via a current compensation coil.

2. The "DigIn(B16,D16)" & "DigIn GND(B20)" are electrically isolated inputs. For electrical isolation, the DigIn signal-reference potential must be connected to DigIn GND(B20). If isolation is not required the DigIn Gnd must be connected to signal GND (B6,Z28 or Z30), as shown in this wiring diagram. DigIn current consumption is 3mA @ 15V each.

3. The Control Error Signal DigOut (Z18) & DigOut GND (B22) are electrically isolated outputs. If electrical isolation is not required the +Vext DigOut terminal (B32) can be connected to the +Vsupply (D28) and the DigOut GND (B22) must then be connected to 0Vsupply (B30) as shown in the diagram.

air bleed screws

4 - 6 mm cable diameter

4.5 - 10 mm cable diameter

A
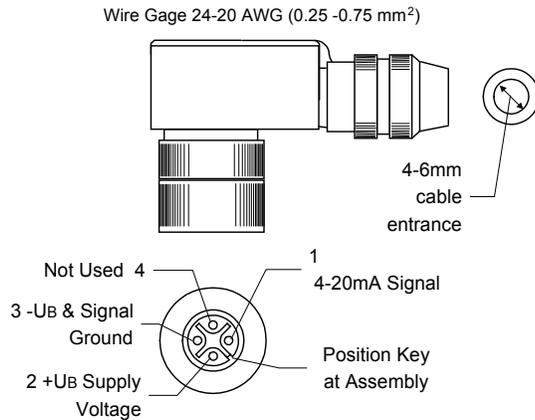
B

4DC01 control valve

solenoid A

solenoid B

The above figure shows the location of the connectors on the 4DC01 control valve and the recommended cable diameters. The solenoid connectors are marked A and B and are color coded gray and black respectively. Maintain this convention to help identify the proper solenoid cables during routine maintenance. The pump control system will not operate properly if the solenoid cables are reversed.

O-Ring 9x1,5

shielding ring

seal

pinch ring

pressing screw
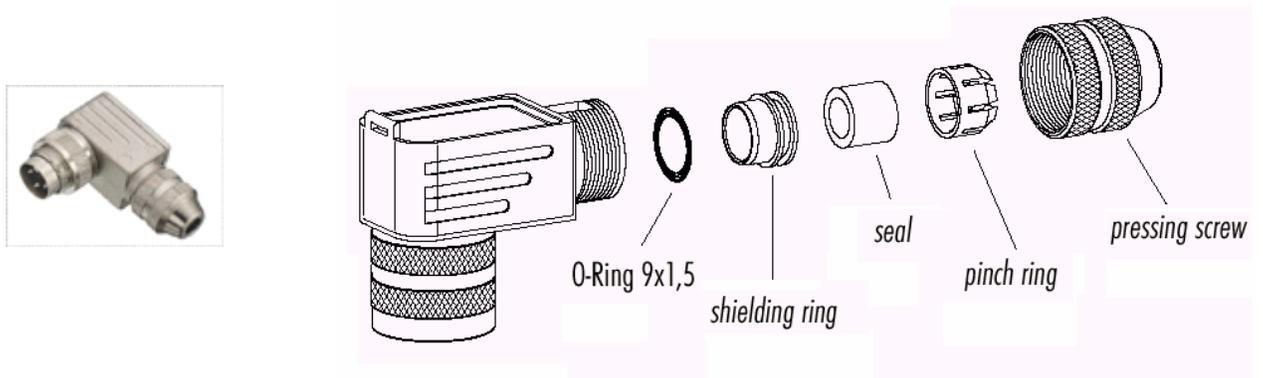
The proper parts orientation for the cable strain relief and seal is shown above. Do not connect the cable shield at the connector end. Connect the shield to the earth ground only at the control card. The housing cover with the o-ring seal is not shown. Make sure the housing o-ring is in place.

Wiring of the control valve spool position sensor mating connector. Refer to installation drawing SK-16099 or SK-16101 to wire from this connector to the EC01 driver card.

Wire Gage 24-20 AWG (0.25 -0.75 mm^2)

4-6mm cable entrance

Not Used 4

1
4-20mA Signal

3 -U$_B$ & Signal Ground

2 +U$_B$ Supply Voltage

Position Key at Assembly

Wiring of the valve solenoid coil mating connectors. Refer to installation drawing SK-16099 or SK-16101 to wire from this connector to the EC01 driver card. Assemble the parts on the cable as shown. The rubber seal has removable concentric rings to accommodate larger cable sizes. Do not connect the cable shield at the connector end.

Seal, adjust to fit cable dia.

Cable Dia. Range

B

4.5-10mm

16AWG Max

Metal Washer
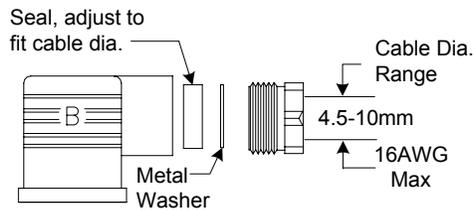
Wiring of the pump displacement sensor mating connector. Refer to installation drawing SK-16099 or SK-16101 to wire from this connector to the EC01 driver card. Do not allow the cable shield to contact the connector. Use shrink tubing at the solder joints to avoid short circuits and to provide additional strain relief for the wires.

Key at PinA

Grommet

.19

B

Cable Dia.

Use shrink-tubing at solder-joints

DHI P/N 721-30059-0
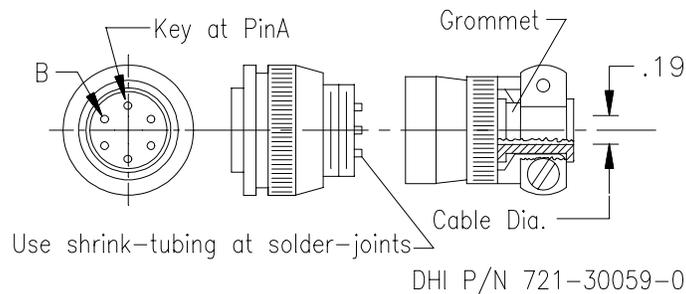
DIP SWITCH, JUMPER, AND POTENTIOMETER SETTINGS FOR THE EC01 DRIVER CARD

The following information is for reference only. The EC01 driver card hardware is factory set for the GoldCup Digital HI-IQ application. No user adjustment of the hardware settings is required. Refer to this information to verify settings or to restore an altered card to the original factory settings.

JUMPERS:
JP1- Programming-bootstrap jumper for downloading software program to micro-controller FLASH memory. The link should be stored on one of the JP1 pins when not in use.

JP2- Not used. Factory use only. No link provided.

JP3- Not used. Factory use only. No link provided.

JP4, JP5- Not used in the HI-IQ application. One link supplied and stored on one pin when not in use. These settings configure the D12/B12 inputs for a 0/4-20mA command signal. See Publication 9-EN 6060-A for detailed information.

JUMPERS ON DIGITAL SUB-BOARD
The 5-position Jumper JP2 on the digital sub-board makes connection to a ROM / RAM emulator. This jumper is only for certain test and development purposes and should not be changed by the user. Normally there must be no link fitted.

POTENTIOMETERS:

RTR1- Factory set. The associated circuit is not used in the HI-IQ application.

RTR2- Factory set. The associated circuit is not used in the HI-IQ application.

RTR3- Factory set. Sets the over-current limit for both A and B solenoid of the proportional control valve. The setting is determined by the specifications of the valve used in the application. The proportional valve used for the HI-IQ application is the 4DC01.

RTR4- Sets the variable dither frequency. The hardware dither has been disabled on the latest version of the EC01 card by removing the dither amplitude potentiometer RTR5.   RTR5 was used on older versions of the EC01 card. If RTR5 is present, adjust RTR4 to the maximum clockwise position for maximum frequency and RTR5 to the maximum clockwise position for minimum amplitude. These settings will minimize the effect of the hardware dither.

RTR5- Not installed on the latest version of the EC01 card used for the HI-IQ application. This potentiometer was used on earlier versions of the EC01 card.   The RTR5 potentiometer was used to set the amplitude of the hardware-generated dither. If RTR5 is present, turn potentiometer to the maximum clockwise position for minimum amplitude. The EC01 card now uses software-generated dither for the HI-IQ application.

DRIVER CARD DIP SWITCH SETTINGS:

SW1 (1,2,3,4)- Factory set SW1(2,3) = on and SW1(1,4) = off. Do not change. The 4 poles of switch SW1 must be set as shown in the picture on the right. The SW1 switch configures the input impedance of the D8 and B8 inputs. This is not a user selectable option for the HI-IQ application.
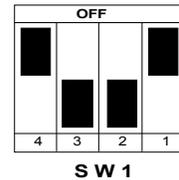
SW2 (1,2,3,4,5,6,7,8)- Factory set SW2(4) = on and SW2(1,2,3,5,6,7,8) = off. TheSW2 switch is used to configure the D12/B12 input for various command signals. It is a user selectable option. See Publ. 9-EN6060A for complete details.
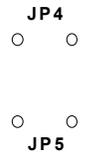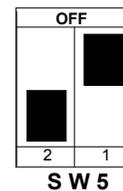
SW3 (1,2,3,4)- Factory set SW3(4) = on and SW3(1,2,3) = off. The SW3 switch sets the 4DC01 control valve A-solenoid maximum operating current.
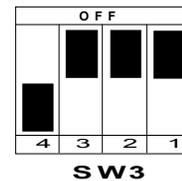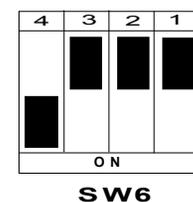
SW4 (1,2,3,4)- Factory set SW4(4) = on and SW4(1,2,3) = off. The SW4 switch sets the 4DC01 control valve B-solenoid maximum operating current.
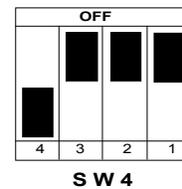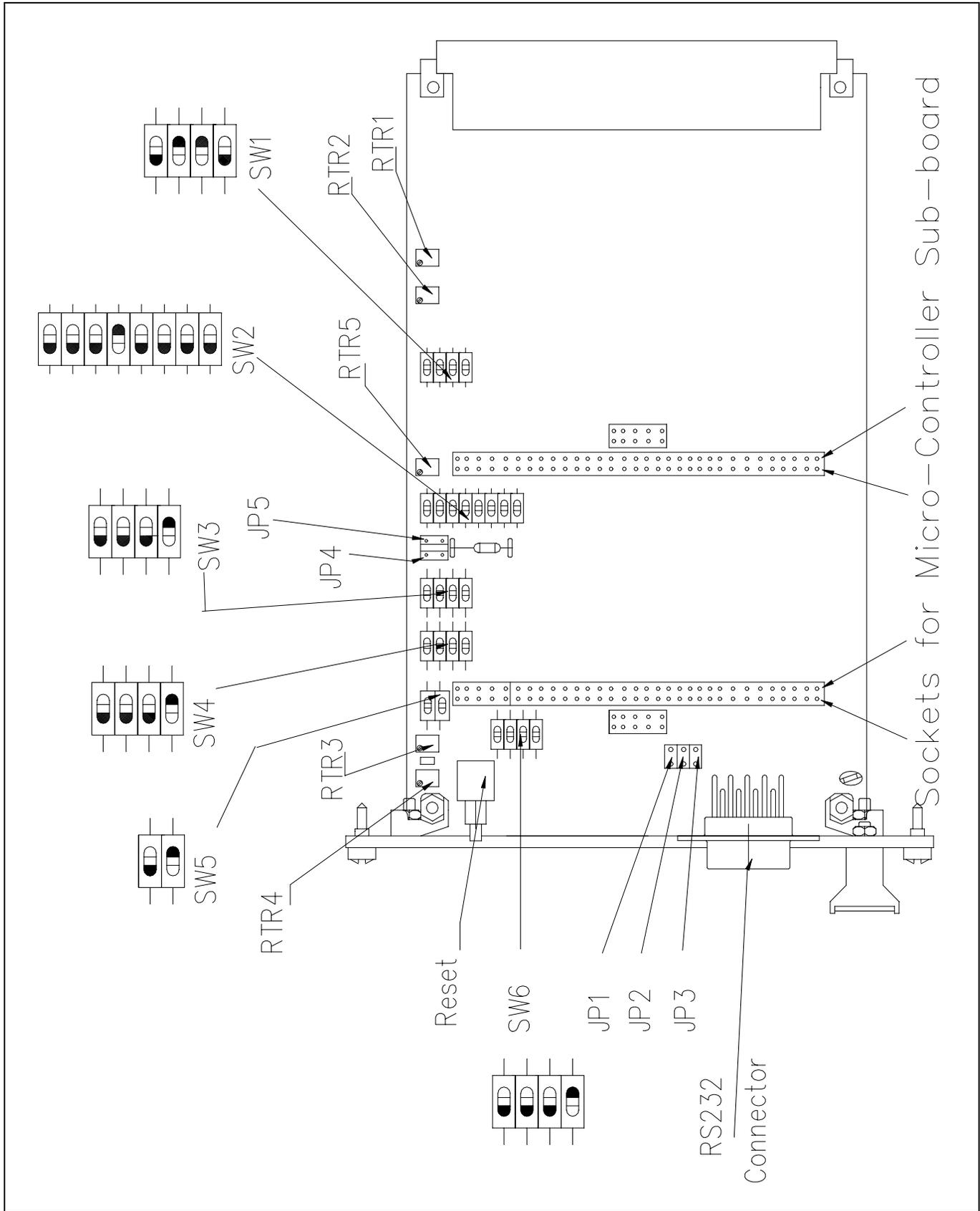
SW5 (1,2)- Factory set SW5(2) = on and SW5(1) = off. SW5(1) changes the over-current adjustment range of RT3. SW5(2) changes the hardware dither frequency range of adjuster RT4. This setting is not used in the HI-IQ application .

SW6 (1,2,3,4)- Factory set SW6(4) = on and SW6(1,2,3) = off. Selects the frequency of the dither. Only one switch must be on. When RTR5 is not installed the SW6 setting is not relevant.

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Sockets for Micro-Controller Sub-board

SW1

RTR2
RTR1

SW2

RTR5

JP5
JP4

SW3

SW4

RTR3

RTR4

SW5

Reset

SW6

JP1
JP2
JP3

RS232
Connector

13

EC01 DRIVER CARD WIRING NOTES:

1. The driver card has two electrical connectors. The main input/output connector is located at the rear of the card and the serial port connector is located on the front panel. The rear connector is a heavy duty DIN 41612, Type 'F' 48 pin and the serial port connector is a standard 9-pin 'D' type.

2. The '0' V (zero volt) line of the power supply (pins D30 and B30) is not the same as the signal 'GND' (ground) at pins B6, Z28, and Z30. A current compensation coil separates them.

3. The Digital Inputs connected to pins B16 (enable), D16 (pump feedback polarity reversal), and B20 (digital input ground) can be wired as electrically isolated inputs. The Digital Input signal reference potential must be connected to pin B20 (digital input ground) to obtain electrical isolation of the digital input signals. Pin B20 (digital input ground) must be connected to the signal ground using either pin Z28, Z30, or B6 as shown in the above wiring diagram when electrical isolation is not required.

4. The current consumption for each Digital Input is 3 mA @ 15 vdc.

5. The Digital Output signals at pin Z18 (control error signal) and B22 (digital output ground) are shown in the above wiring diagram with no electrical isolation. Connect pin B32 (+Vext digital output) to pin D28 and also connect pin B22 (digital output ground) to pin B30 (0 V supply) to provide electrical power to the digital outputs when electrical isolation is not required.

6. The total current consumption for all Digital Outputs must be less than 80 mA.

7. The Digital Output signals can also be wired as electrically isolated outputs. The Digital Output signal reference must be connected to pin B22 (digital output ground) to obtain electrical isolation of the digital outputs. If higher currents are required (up to 125 mA per output, 500 mA total); an external voltage supply with corresponding current ability must be connected to pins B32 as indicated in the above text.

8. The 'EARTH' connection at pins Z2 and Z32 is required for EMC (electromagnetic compatibility) protection and compliance to regulations. The 'EARTH' pins Z2 and Z32 are not connected to pins B6, Z28, and Z30 (ground) or to pins D30 and B30 (0 V supply) on the driver card.

9. The complete GoldCup Digital HI-IQ transmission pump control system may be powered up electrically but not hydraulically to check the wiring of the driver card, control valve solenoids, control valve LVDT sensor, and the pump displacement sensor. Do not start the electric motor that drives the pump until all of the driver card wiring has been checked and is operating correctly.

EC01 DRIVER CARD WIRING CHECK POINTS:

1. Check that all 0 V, GND, and EARTH connections are wired correctly.

2. Check that the card output signals are connected to the correct solenoids A and B.

3. Check that all cables are soldered correctly with no short circuits on the terminations.

4. Check that the valve spool position sensor is wired correctly.

5. Check that the pump displacement sensor is wired correctly.

6. Check that the +24 VDC / 3 A power supply is stable and smooth.

EXTERNAL DC POWER SUPPLY REQUIREMENTS

The power supply for the electronic driver card must provide DC voltage only. The DC voltage supplied to the card must be between 20 and 32 VDC for proper operation. The reverse polarity protection diode on the card ensures there will be no damage if the supply voltage is connected with reverse polarity. The driver card operates with a DC/DC converter module supplying control valve solenoid power from the card. The voltage applied to the solenoids is actually higher than the supply voltage to the card with the DC/DC converter maintaining nearly equal input and output power. The input current to the card is less than the current supplied to the solenoids by a factor approximately equal to the voltage amplification ratio of the DC/DC converter.

DRIVER CARD POWER SUPPLY REFERENCE VOLTAGES

There are several power supply voltages available on the driver card that can be used to supply low current external command potentiometers, external transmitters, or external electronic units (e.g. a 5-channel command card). The available power supply voltages are ±15 V and ±10 V. They are generated on the driver card with an internal switched-mode DC/DC converter. The supply voltages are available at the following connector pins.

B2	=	+15 V unregulated	50 mA maximum
B4	=	-15 V unregulated	50 mA maximum
D2	=	+10 V regulated	10 mA maximum
D4	=	-10 V regulated	10 mA maximum

'ENABLE' DIGITAL INPUT

The driver card must be enabled to activate the card for normal operation of the pump controller. Applying a +15 vdc signal to pin B16 enables the driver card. Removing the +15 vdc digital input signal disables the driver card. The pump displacement input command is internally set to a zero value when the driver card is disabled. The driver card continues to provide electrical power to all external devices and all sensor and diagnostic information remains available when the driver card is disabled.

'READY' DIGITAL OUTPUT

The **READY** digital output on pin Z16 is not used for the GoldCup Digital HI-IQ pump application.

'CONTROL ERROR' DIGITAL OUTPUT

The **CONTROL ERROR** digital output is on pin Z18. Pin Z18 operates at +24 vdc when no errors are present in the pump controller. Pin Z18 operates at approximately 0 vdc when an error is present. ***It is the responsibility of the user to determine the actions that are taken when a control error is detected.*** (For example: The user may decide to illuminate an 'error lamp' when an error is detected. The user may also decide to remove the **ENABLE** signal to pin B16 when a pump controller error is detected. The user must determine the consequences of the control error and decide what action is best for the overall operation of their machine.)

DRIVER CARD *'RESET'* SWITCH

A red LED (light emitting diode) located on the front panel of the driver card flashes at 2 Hz when the driver card is operating correctly. There is a problem with the internal operation of the driver card when the red LED remains continuously illuminated. The driver card has a *Reset* switch located behind the front panel that can be accessed through a small hole to the left of the red LED. This switch is not intended for normal use and should only be operated when there is a problem with the card. The *Reset* switch is a momentary switch that requires only a light push, hold for 2 seconds, and then release for the *Reset* to occur. Follow this *Reset* procedure when the red LED is illuminated continuously.

ESTABLISHING COMMUNICATIONS BETWEEN THE EC01 DRIVER CARD AND YOUR PC.

The overall operation of the GoldCup Digital HI-IQ pump can be monitored and the control system parameter settings can be examined and changed using a personal computer (PC) that has the Denison GoldCup Digital HI-IQ User Interface Software installed on the hard drive. Contact Denison Hydraulics for a copy of the GoldCup Digital HI-IQ User Interface Software and the installation instructions.

The computer serial COM PORT (9-pin D-connector) must be connected to the driver card with a standard serial port "extension" cable. There are two standard types of serial port cables; one that reverses the connection between pins 2 and 3 and a second "extension" cable that passes all pin connections directly through the cable with no pins reversed as shown below. It is recommended that the shortest available "extension" type cable be used to communicate with the driver card.

<table>
<tr><th>Computer</th><th></th><th>Driver Card</th></tr>
<tr><td>2</td><td>————</td><td>2</td></tr>
<tr><td>3</td><td>————</td><td>3</td></tr>
<tr><td>5</td><td>————</td><td>5</td></tr>
<tr><td>6</td><td>————</td><td>6</td></tr>
</table>

<table>
<tr><th colspan="2">Computer (socket)</th></tr>
<tr><th>Pin No.</th><th>Function</th></tr>
<tr><td>2</td><td>RxD</td></tr>
<tr><td>3</td><td>TxD</td></tr>
<tr><td>5</td><td>GND</td></tr>
<tr><td>6</td><td>DTR</td></tr>
</table>

<table>
<tr><th colspan="2">EC01 Card (Pins)</th></tr>
<tr><th>Pin No.</th><th>Function</th></tr>
<tr><td>2</td><td>TxD</td></tr>
<tr><td>3</td><td>RxD</td></tr>
<tr><td>5</td><td>GND</td></tr>
<tr><td>6</td><td>DTR</td></tr>
</table>

Note:

The complete GoldCup Digital HI-IQ transmission pump system may be powered up electrically but not hydraulically to check the wiring of the driver card, control valve solenoids, control valve LVDT sensor, pump displacement sensor, and the serial communications between the PC and the driver card.

**OPERATION OF THE GOLDCUP DIGITAL HI-IQ USER INTERFACE SOFTWARE**

Apply 24 VDC power to the driver card. Connect a PC containing the Denison GoldCup Digital HI-IQ User Interface Software to the driver card using a serial port "extension" cable as previously described and run the program named **726000072.exe** on the PC.

COM PORT SETUP

When running this program for the first time on a PC, the serial communication port address must be established before communication can occur between the PC and the driver card. The word **OFFLINE** will appear next to the Denison logo and a red box will be displayed until the serial communications port address is assigned. A window will also appear warning that "Communication is offline". This indicates that the PC has not established communication with the EC01 driver card.
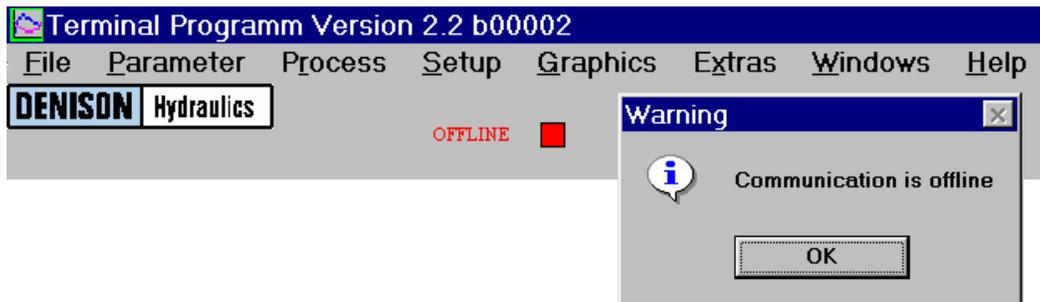
The User Interface Software will automatically try to establish communication with the driver card and will display the following window if it has been successful. This process will take a few seconds.
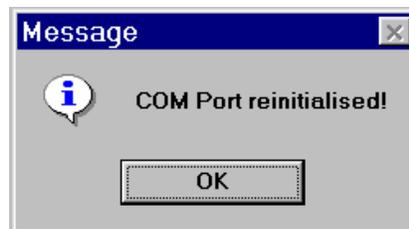
The serial communication port address of the PC may have to be manually selected if communications with the card has not been automatically established within a few seconds. To select the serial communications port address of the PC, select the **Setup** option on the menu bar to open the following window:


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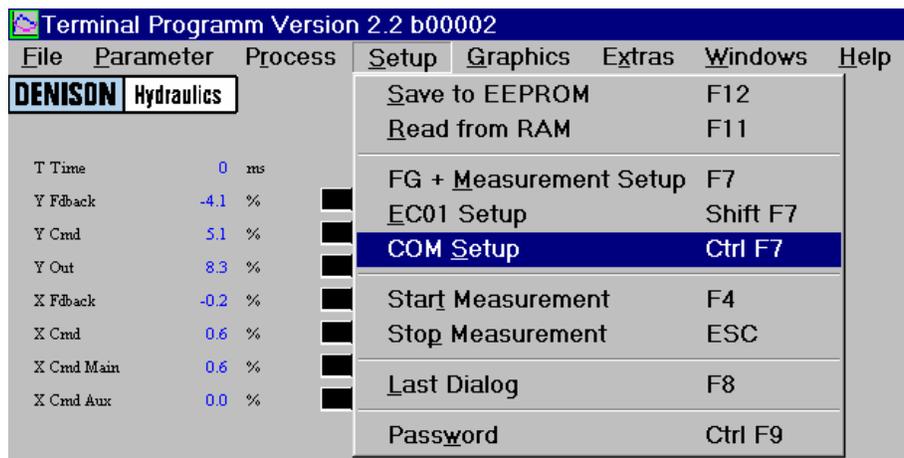
Select the *COM Setup* option by a left click of the mouse button or by holding the *Ctrl* key and pressing the *F7* function key.
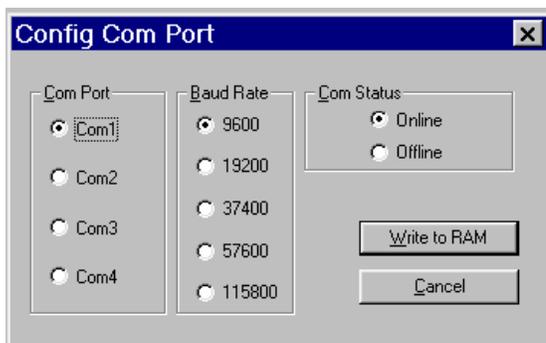
The serial communication port on your PC that is connected to the driver card has an address defined by the internal configuration of the PC. The **COM** port selected on this menu must be a physical port with a hardware connector and not an internal port. It must also be available on the PC and not in use by external modems, plotters, or any other equipment. Select a suitable **COM** port address for your PC. If you don't know the address of the **COM** port, use a trial and error process starting with **Com1,** trying each of the four menu choices until communication is established. Select an initial **Baud Rate** (data transfer speed) of 9600 bps (bits per second). A low **Baud Rate** will result in the most reliable comunications. You can try to increase the **Baud Rate** later to determine if higher communication speed is possible with your PC. Click the **Write to RAM** button on the menu. A message box will appear on the PC screen with the words **Com Port new initialised!** when the communications port address has been chosen correctly**.**
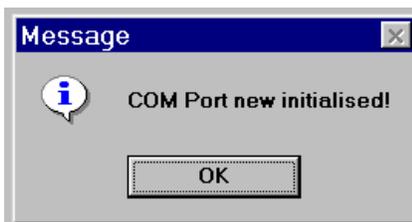
This message indicates the PC is communicating with the EC01 driver card and the Denison GoldCup Digital HI-IQ User Interface Software is operational. The word **ONLINE** should appear next to the Denison logo and a green box should be displayed.   The screeen should display several new windows as shown below:
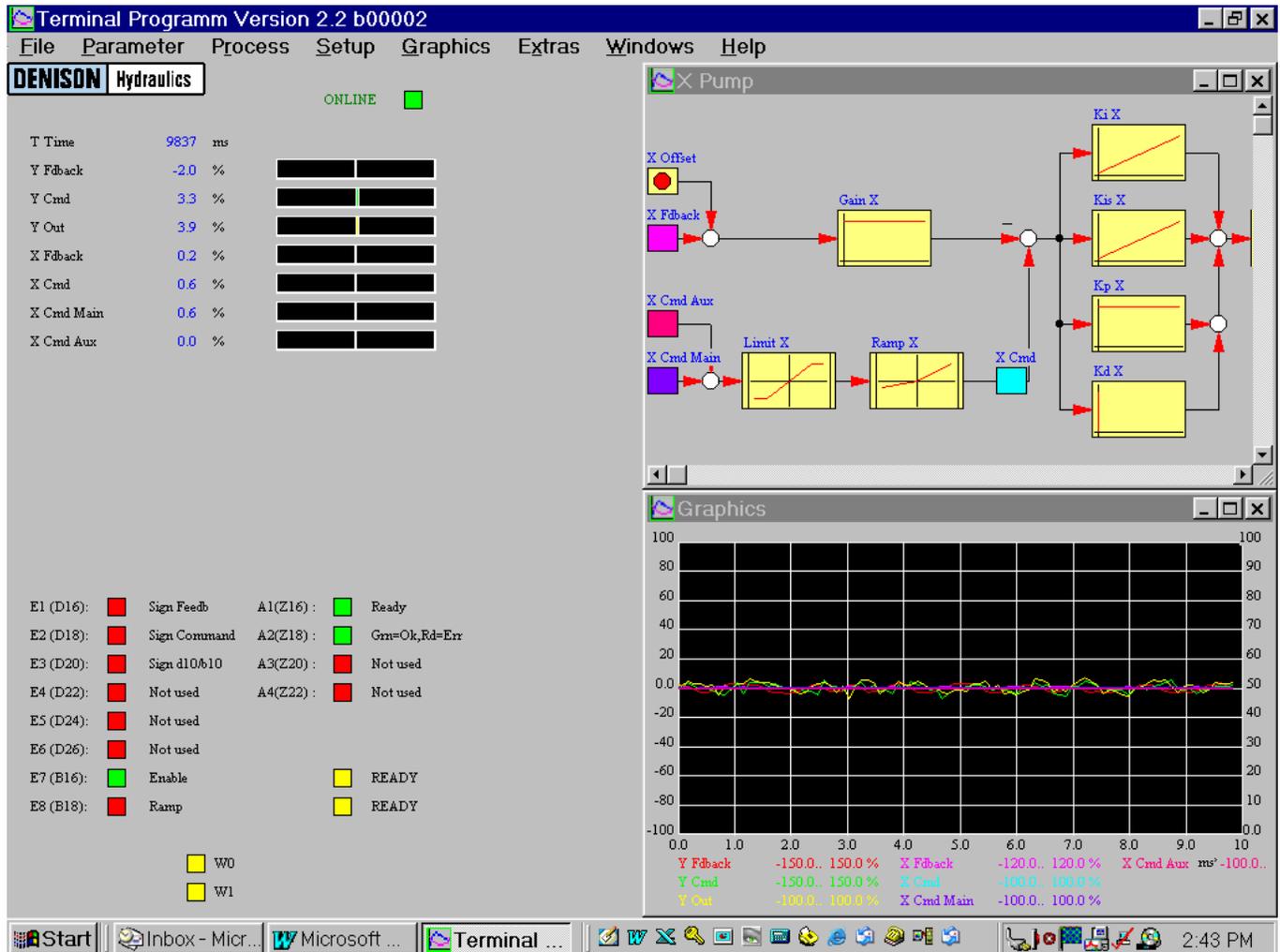
The *Master Layout*, *X Pump*, and *Graphics* windows can be minimized using the standard windows icons located in the upper right-hand corner of each window.   Use the *Windows* menu option to redisplay the windows after they have been minimized.

CHOICE OF ENGLISH OR GERMAN LANGUAGE

The User Interface Software has the option of displaying the screen text in either English or German language. Select the **Extras, Options** menu option to select the language as follows.
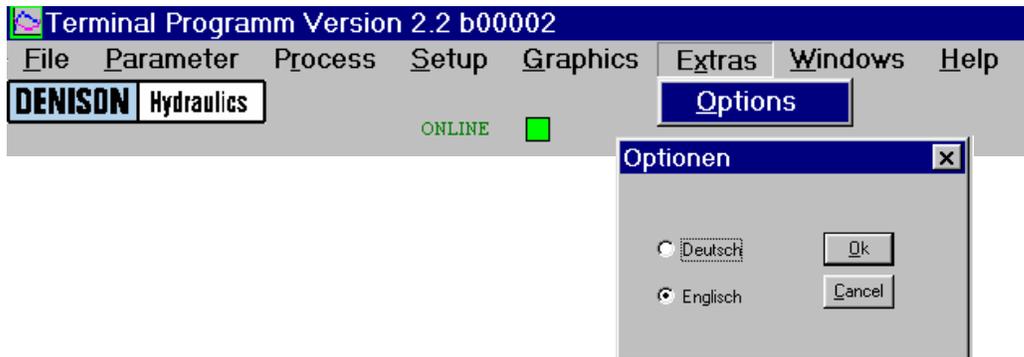
THE *'HELP'* MENU OPTION

Selecting the **Help, About** menu option displays the software version (2.2b00002) that must be used on a PC to communicate with the EC01 driver card as shown below. It also displays the PC User Interface Software file name, card model number, card hardware code number, system binary file code number, application software code number, system parameter setting file code number, and operating system kernel software code number. You must have the corresponding version of the User Interface Software to be able to communicate with the driver card using a PC. This information is helpful when ordering additional products from Denison and for diagnosing problems. These numbers uniquely describe the capability of the driver card. The control system parameters can be changed by the user as described in subsequent sections of this manual. Storage and retrieval of the control system parameter settings are described in subsequent sections of this manual.
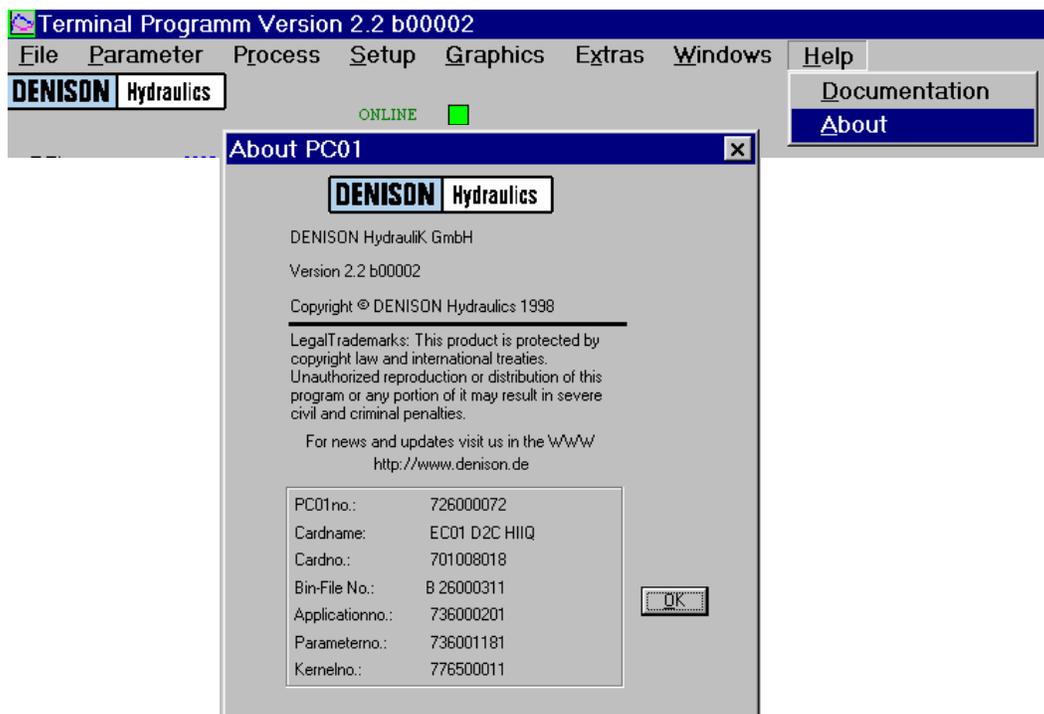
DIGITAL INPUT, DIGITAL OUTPUT, AND CONTROL LOOP STATUS INDICATORS

The lower left corner of the screen has several colored boxes that indicate the status of the digital inputs, digital outputs, proportional valve control loop, and the pump displacement control loop. The digital inputs are identified with the boxes labeled **E1** through **E8**. The digital outputs are identified with the boxes labeled **A1** through **A4**. The rear connector terminal strip number for the digital inputs and outputs is also shown in parentheses next to the indicator label .   The pump displacement control loop is identified with a colored box labeled **W1** and the proportional control valve loop is identified with a colored box labeled **W0**.   The following table identifies the functions being monitored and the signal status that they represent:

Indicator	Description	Status Box Color	
		Green	**Red**
E1	Invert sign of **X Fdback**	inverted	Not inverted
E2	Invert sign of **X Cmd**	inverted	Not inverted
E3	Invert sign of D10/B10 input	Inverted	Not inverted
E4	Not used	-	-
E5	Not used	-	-
E6	Not used	-	-
E7	Enable	X-CMD enabled	X-CMD disabled
E8	Ramp	Ramp enabled	Ramp disabled
A1	Not used	-	-
A2	Error indicator	no error	error
A3	Not used	-	-
A4	Not used	-	-

Indicator	Description	Status Box Color	
		Yellow	**Pink**
W0	Valve "watch dog" timer	no error	error
W1	Pump "watch dog" timer	no error	error

The two boxes below the *A4* box labeled *Ready* are indicators for the Graphics mode. The boxes are yellow when taking measurements in the *Online* graphics mode. They change to a pink color when collecting and storing data in the *Offline* graphics mode.

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ENTERING A PASSWORD

Access to the advanced capabilities of the GoldCup Digital HI-IQ electronic control system are protected by the use of passwords. There are three levels of passwords. At the first password level, the user can monitor the operation of the control system, change the variables and the color coding used for the Graphics display screen, change between English and German language for the screen text, and select the **COM** port . At the second password level, the user has the capability provided by the first password level and can also make changes to the electrical input and output connections to the EC01 driver card. At the third password level, the user has the capability provided by the second password level and can also make changes to the pump control system parameters, use the function generator and oscilloscope, and can monitor the control system response characteristics. You must contact Denison Hydraulics to obtain a password.

Selecting the **Setup**, **Password** menu option displays the following window.
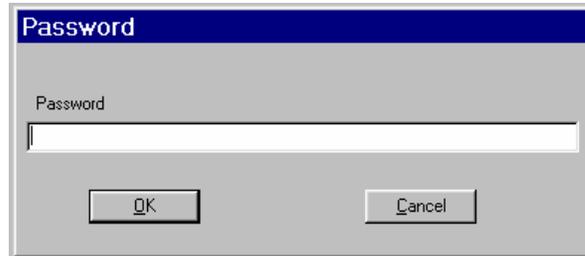
Enter a **Password** and click **OK** to provide access to the corresponding system capabilities.

PARAMETER MENU OPTION

The control system parameter screens can be accessed by double-clicking the corresponding blocks in the **Master Layout** or **X Pump** block diagrams, or they can be accessed by selecting the **Parameter** menu options **Global**, **Master Layout,** or **X Pump** as shown below.

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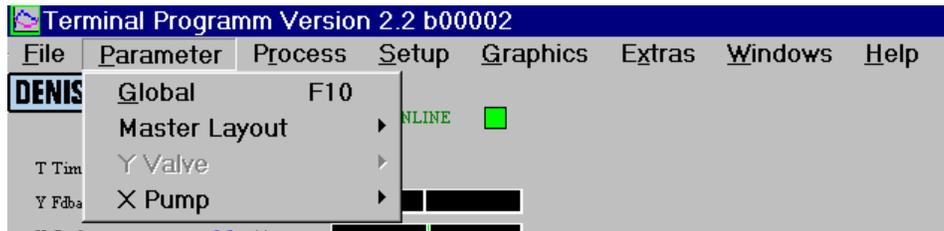
GLOBAL PARAMETER SETTING LIST – F10

All of the control system parameter settings can be viewed on a single screen using the *Parameter, Global (F10)* menu option as shown below.

GLOBAL							
2	Ki Y	Ki	75			T -Cmd	1
		Umin	-2000			T -Cmd	1
		Umax	2000	4	X Offset	Offset	0
		dX	2000	4	Overlap Y	U plus	0
2	Kp Y	Kp	400			U minus	0
2	Kd1 Y	Kd	1000			U width	0
		Tf D	1000	4	Gain X	Kp	2100
2	Dt1 U	Kd	27				
		Tf D	700				
2	Y Offset	Offset	0				
4	Ki X	Ki	5				
		Umin	-512				
		Umax	511				
		dX	2000				
4	Kis X	Ki	25				
		Umin	-200				
		Umax	200				
		dX	40				
4	Kp X	Kp	900				
4	Kd X	Kd	2000				
		Dmax	25				
4	Limit X	Uminus	100				
		Uplus	100				
4	Ramp X	T +Cmd	1				
		T +Cmd	1				

Write to RAM

Read from RAM

Cancel

The parameter settings for the pump control loop can be changed on this global screen in the same way that they are changed on the smaller individual screens. Selecting the *Write to RAM* button sends all of the new values to the driver card. The parameter settings for the valve control loop can only be viewed on this screen and cannot be changed. Changes to the valve control loop parameters can only be made by a qualified Denison Hydraulics technical service representative.

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ANALOG INPUT AND OUTPUT SIGNALS

The format of the analog input signals (e.g., 4 - 20 mA, ±10 vdc) determine the electrical connector pin assignments for the driver card. The pin assignments have been preset by Denison with the proper configuration for particular applications.   The following paragraphs describe how to view and change these pin assignments, if required. Changes to these pin assignments can dramatically affect the performance of the pump control system. Changes should only be made by trained personnel and with extreme care.

The analog input and output connector pin assignments can be accessed by selecting the *Process* menu options *Master Layout* or *X Pump* as shown below. The *Y Valve* menu option can only be accessed by an authorized Denison Hydraulics technical representative.
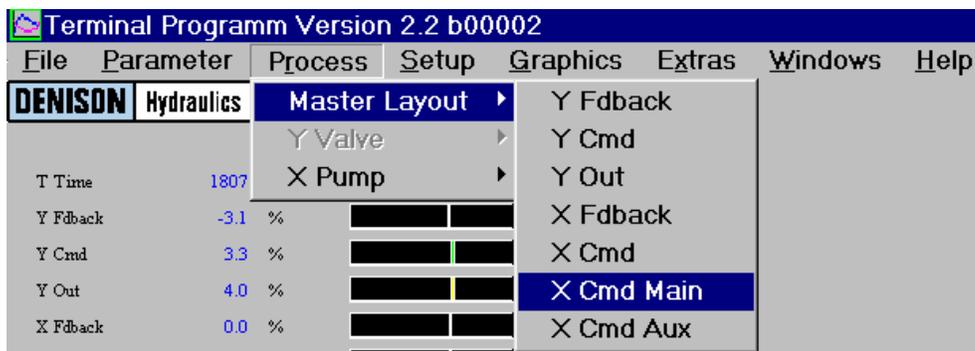

The analog input/output channel selection screens can be accessed from the *Process* menu as described above. They can also be accessed by double-clicking the color coded boxes on the block diagrams for the corresponding signals.

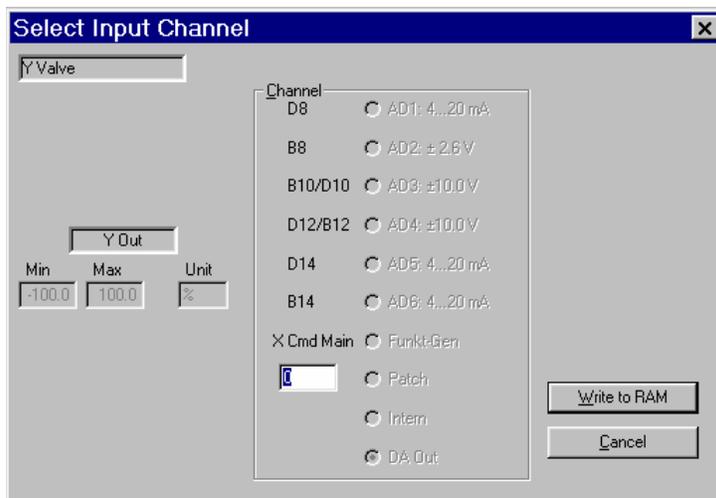Selecting the *Y Fdback* menu option displays the following screen.
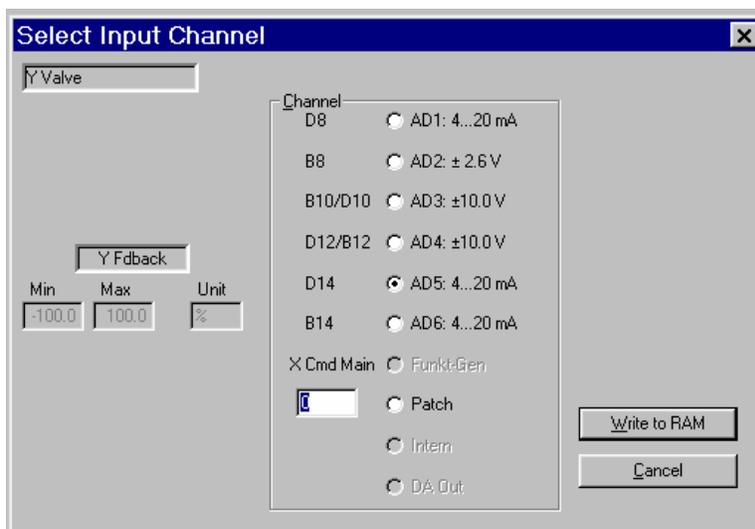
The *Y Fdback* signal is connected to the driver card rear connector pin D14 for this HI-IQ application and should not be changed. The *Min* and *Max* scaling and the *Units* are shown on this and on subsequent *Process* screens for information purposes. The *Min*, *Max*, and *Units* values only affect the display scaling of the Bar Graphs and the Graphics Screen and do not affect the operation of the pump control loops. They can not be changed on this screen and are shown in grey font. The *Graphics, Options* menu option allows these values to be changed. Adjustments for the scaling and units are provided to make the graphics display screens easier to read.

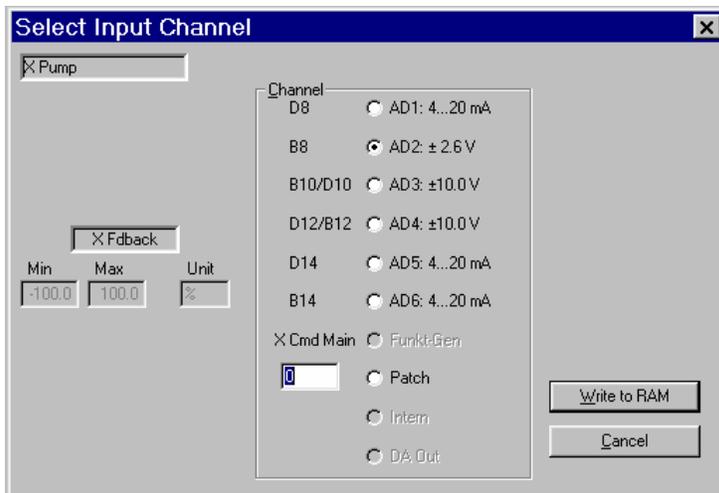Selecting the *Y Cmd* menu option displays the following screen.
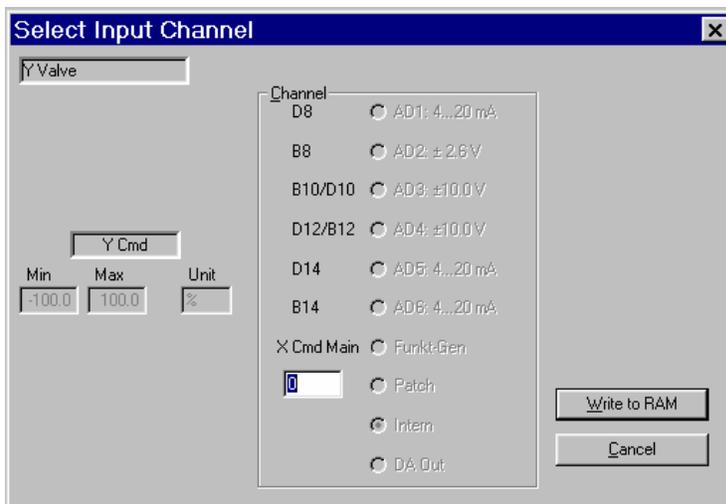
The *Y Cmd* signal is predetermined by Denison and can not be changed. Signals that can not be changed on these screens are shown in grey colored font.

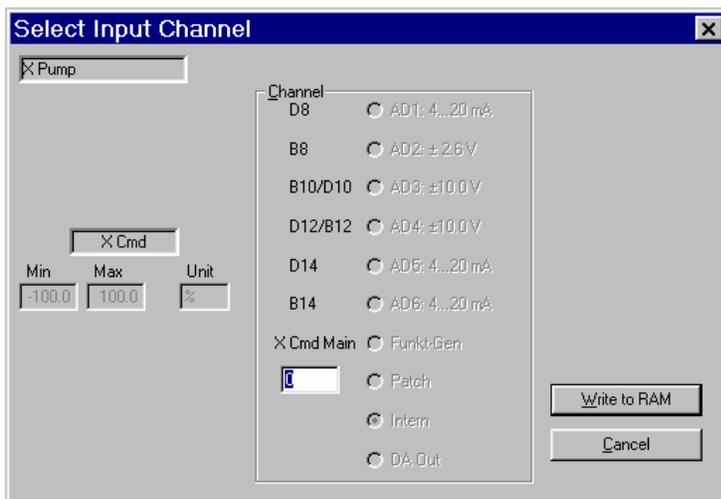Selecting the *Y Out* menu option displays the following screen.

The *Y Out* signal is predetermined by Denison and can not be changed.

Selecting the *X Fdback* menu option displays the following screen.

This screen corresponds with the wiring diagram for the pump that shows the displacement feedback signal being connected to driver card pin B8. If the pump displacement feedback sensor would be changed to a sensor with a 4 to 20 mA output, then this signal could be connected to pin B14. This screen would then be used to interpret the signal at pin B14 as the *X Fdback* signal in the control system block diagram.

Selecting the *X Cmd* menu option displays the following screen.

The *X Cmd* signal has been predetermined by Denison for this application and can not be changed.

Selecting the *X Cmd Main* menu option displays the following screen.
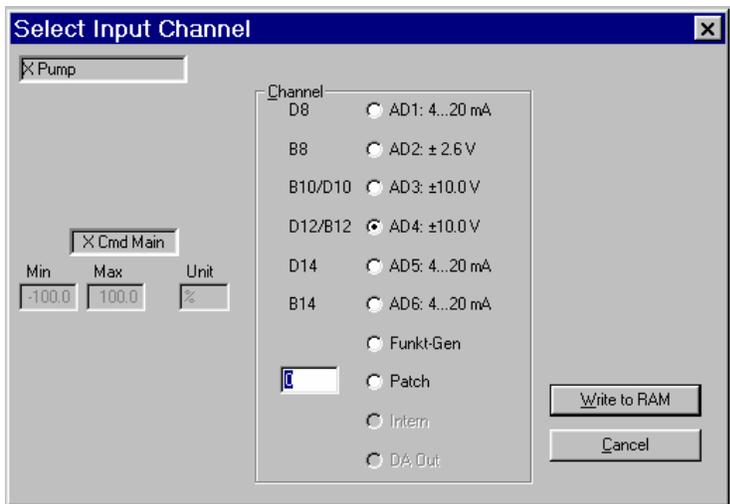
The *X Cmd Main* signal is obtained from pin D12/B12 if it is a ±10 vdc signal and from pin D8 if it is a 4-20 mA signal. This screen shows that it is also possible to connect the internal function generator to provide the *X Cmd Main* signal. For example, the pump response can be evaluated with a square wave input and displayed on the *Graphics* window using this approach.

Selecting the *X Cmd Aux* menu option displays the following screen.
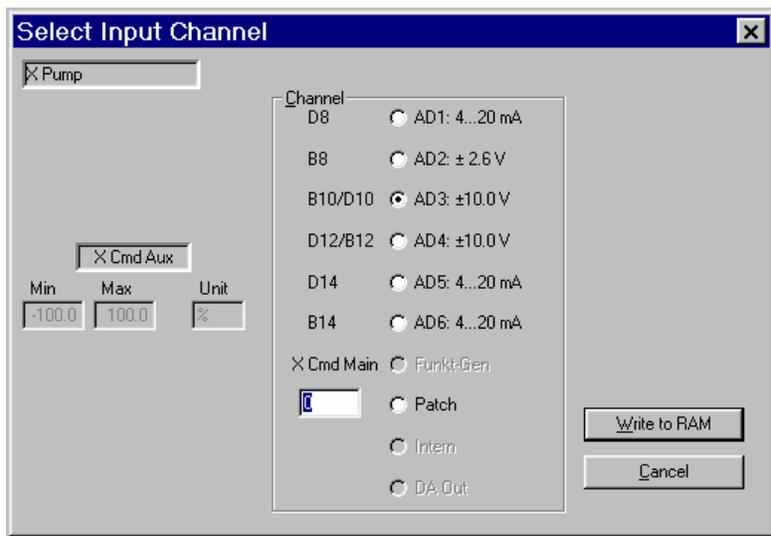
The *X Cmd Aux* is shown on the SK-16101 driver card wiring diagram connected to an optional external command input potentiometer at pin B10/D10. This external input signal is summed on the driver card with the pump displacement command to form the input command to the control system.

The *Process*, *Y Valve* menu option is shown in grey font and can not be accessed or changed.

The *X Pump* menu option displays many of the same screens described above for the *Master Layout* menu option and is shown on the following screen.
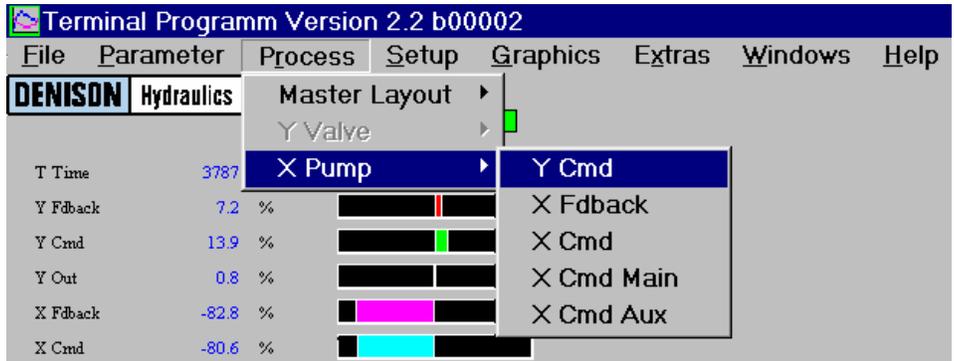
SIGNAL BAR GRAPHS AND GRAPHICS WINDOW

The magnitude and sign of seven important analog signals are always displayed in the upper-left corner of the screen as shown below.
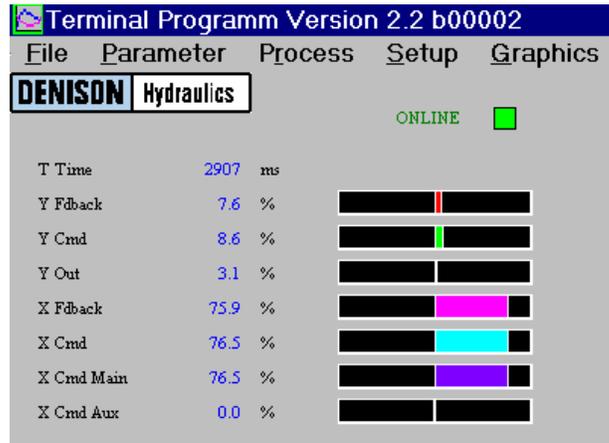
The choice of the seven signals that are displayed is fixed by the software and can not be changed. The colored bar is small and centered when the signal is zero. The colored bar increases in length in proportion to the increase in the signal. The bar moves to the right of center when it is positive and to the left of center when it is negative. The color coding of the bars correspond to the color of the box in the control system block diagram window for each of the seven signals. The same color code is used for the *Graphics* window that resembles an oscilloscope screen. This screen is used to view the various signals as a function of time. It is particularly useful in monitoring the performance of the pump control system and for tuning the control system parameters. The colors of the bars can be changed by selecting the *Graphics* menu option followed by the *Options* (or pressing *F6* function key) option as shown in the following figures.
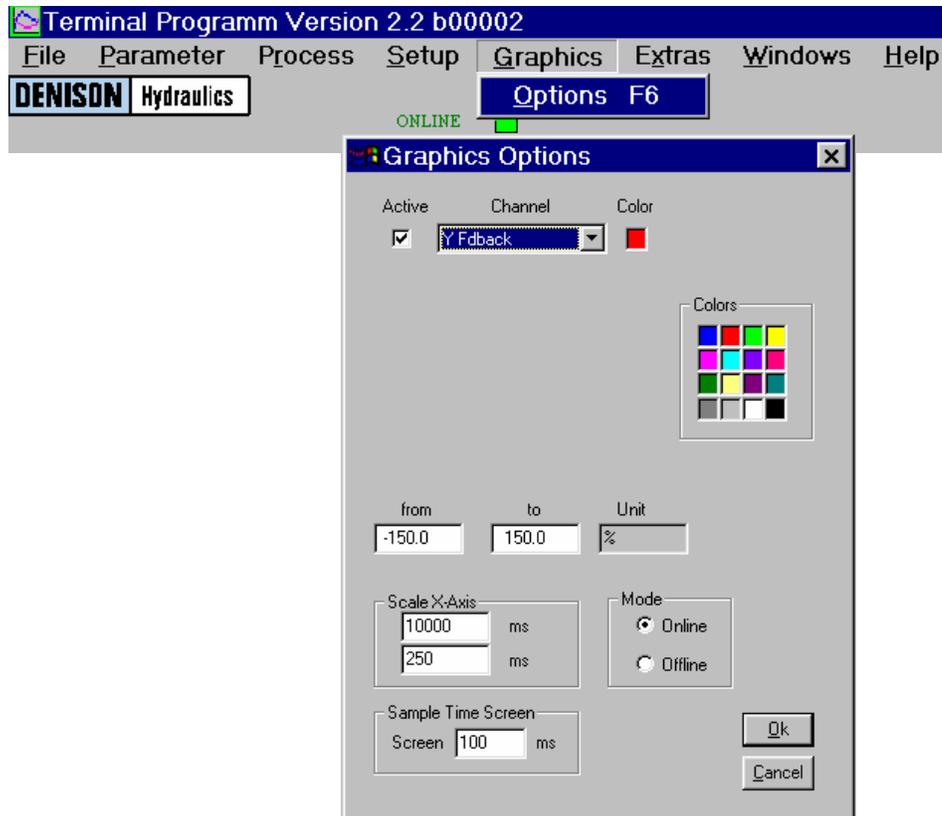
The signal can be selected from the drop-down menu labeled *Channel*. The color can be selected by placing the mouse pointer on the desired color in the 4 x 4 color pallette matrix and pressing the left mouse button. The *Active* box can be toggled from a blank to a check mark in a similar manner using the mouse. Placing a check mark in the *Active* box displays that signal on the *Graphics* window oscilloscope screen. The *Graphics* window display of the various signals can be scaled by selecting the values in the boxes labeled *from* and *to* with the mouse and entering new values. The default values are displayed in % of full scale under the *Unit* heading. The bar graph display can be customized to display other engineering units (e.g. volts, mA, cc). The scale of the horizontal (time) axis of the *Graphics* window can be adjusted by changing the values in the boxes labeled *Scale X-Axis*. The name of the signals are displayed below the horizontal axis of the *Graphics* screen, the scaling, and the color code as shown below to assist in interpreting the data.
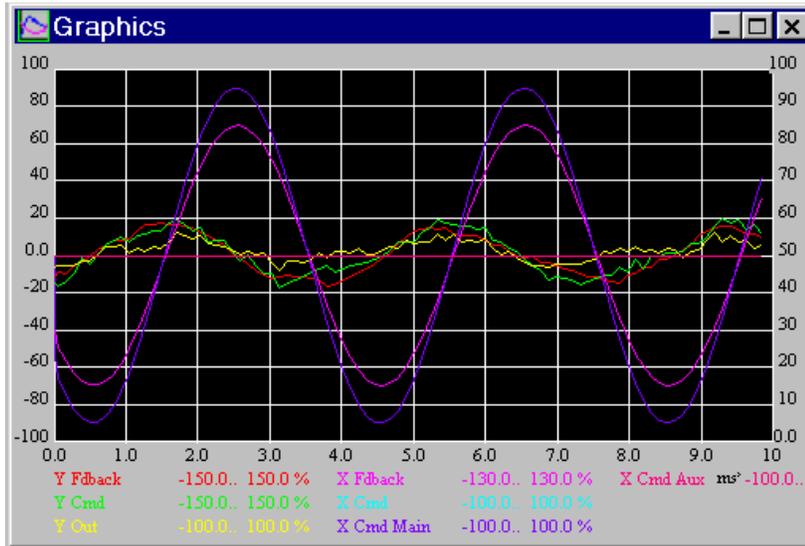

ONLINE AND OFFLINE GRAPHICS MODES

The signals selected to be shown on the graph are automatically displayed and refreshed on the *Graphics* window screen in a continuous process when in the *Online* mode. The resolution of the graphs produced in the *Online* mode is acceptable for a horizontal axis scaling of 10 seconds (i.e. 10000 ms) or greater. However, horizontal axis scaling of less than 10 seconds will have poor *Graphics* resolution because the PC and the driver card communicate at a relatively low sampling rate so that the PC does not interfere with the operation of the pump and driver card.

Higher resolution of the *Graphics* window display screen can be achieved with horizontal axis scaling of less than 10 seconds using the *Offline* mode. The *Offline* time scale can be adjusted in the lower of the two boxes under the *Scale X-Axis* heading. The *Online* and *Offline* status of the *Graphics* window can be selected by toggling the buttons labeled *Mode*.

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The **Start Measurement** (or function key **F4**) option under the the **Setup** menu shown below is used to begin displaying the signals on the **Graphics** window in the **Offline** mode. You will see the display box in the lower left corner of the screen change color indicating the measurement has been started. If you need to stop the measurement before the time entered into the setup screen has elapsed, use the **Esc** (**Stop Measurement**) key. The PC mouse will respond slowly after starting an **Offline** measurement but the the **Esc** key will to stop the **Offline** measurement immediately.
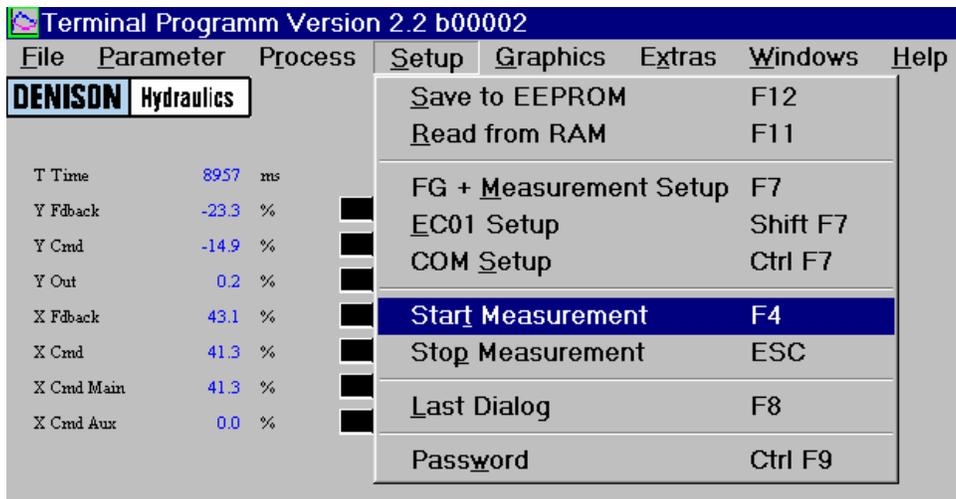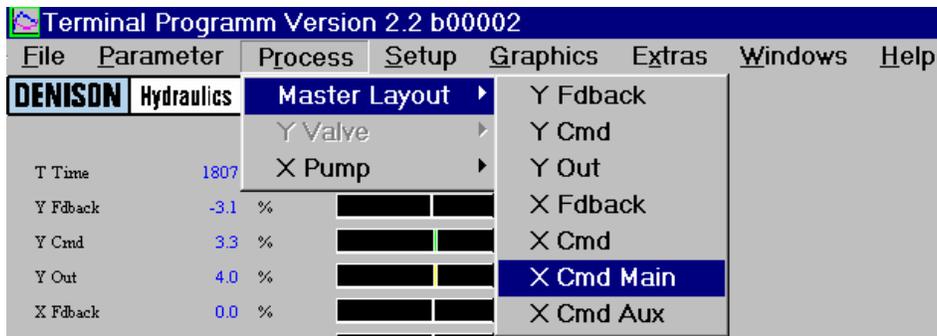
FUNCTION GENERATOR

The user interface software provides a function generator that can be connected at various points on the driver card for diagnostic testing and tuning of the control system parameters. The function generator screen shown below can be accessed from the *Setup* screen under *FG + Measurement Setup (F7)* menu option.
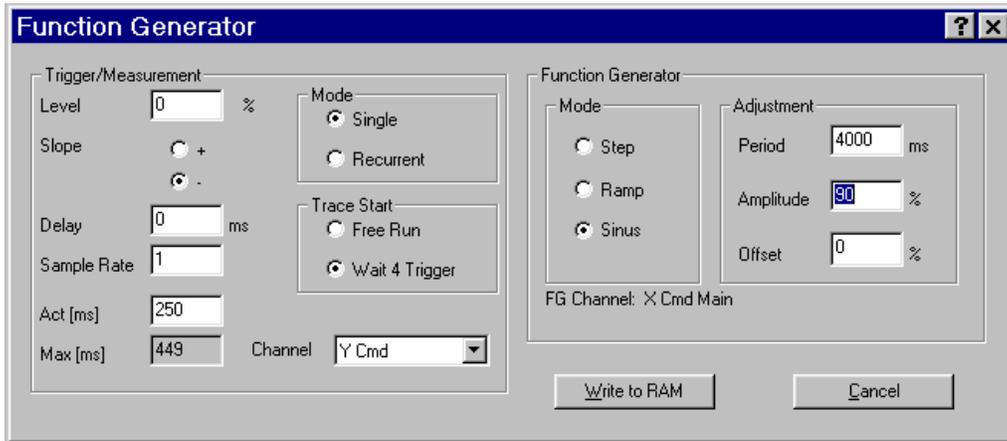

The wave form can be chosen on the right of the function generator window as either a Sine Wave (*Sinus*), Triangular Wave (*Ramp*), or a Square Wave (*Step*) under the function generator *Mode* label. The *Period*, *Amplitude*, and DC *Offset* of the wave can be adjusted by entering values into the boxes under the *Adjustment* label. The settings on the left of the window perform like the *trigger* settings of a standard oscilloscope. The trigger can be set to operate from any of the signals listed on the drop-down menu labeled *Channel*. The trigger settings can be used to adjust the appearance of the data recorded in the *Graphics* window in the *Offline* mode. The *Write to RAM* button must be selected to activate the new function generator settings on the driver card.

The function generator can be connected to the many different locations in the control block diagram. The *X Cmd Main* logic block can be connected to the function generator and disconnected from the driver card terminal B12/D12. The function generator can be connected to various block diagram locations using the *Process*, *Master Layout* or *X Pump* menu options as shown below. The same screens can also be accessed by double-clicking the corresponding colored boxes on the *Master Layout* or *X Pump* block diagram screens.

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Selecting the *X Cmd Main* option brings up the following screen.
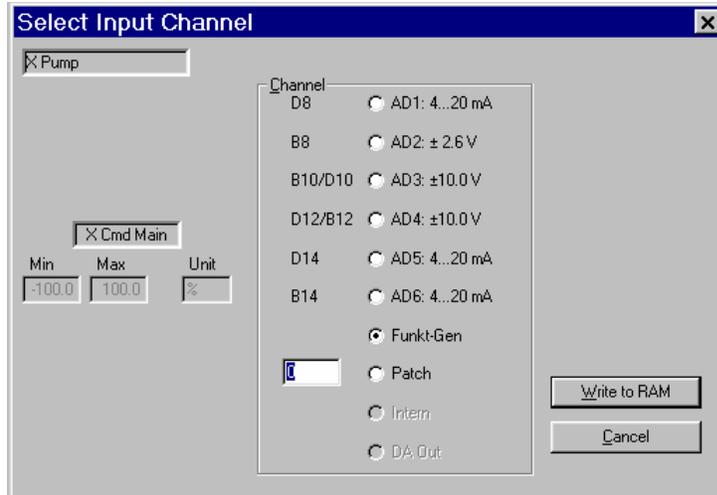
The *Funkt-Gen* option can be selected as shown above for the input to the *X Cmd Main* location of the block diagram which connects the function generator to this input command location. Selecting the *Write to RAM* button connects the function generator to the *X Cmd Main* input and disconnects the previous input.

The function generator amplitude is automatically set to zero when initially connected to the control system to avoid unintended operation of the pump. The amplitude and other function generator settings can be accessed and changed as previously described using the *Setup*, *FG + Measurement Setup (F7)* menu option.

DISPLAY OF GRAPHICS WINDOW, MASTER LAYOUT, Y VALVE, AND X PUMP BLOCK DIAGRAMS

The *Graphics* window, *Master Layout* block diagram and *X Pump* block diagram can be displayed by selecting the *Windows* menu options shown below.
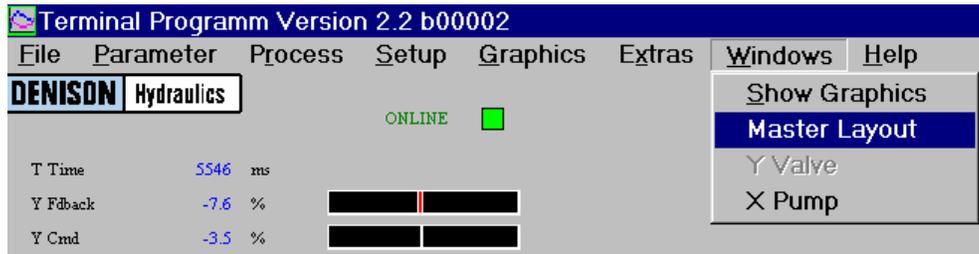
The *X Pump* block diagram can also be displayed by double-clicking on the *X Pump* box in the *Master Layout* window shown below.
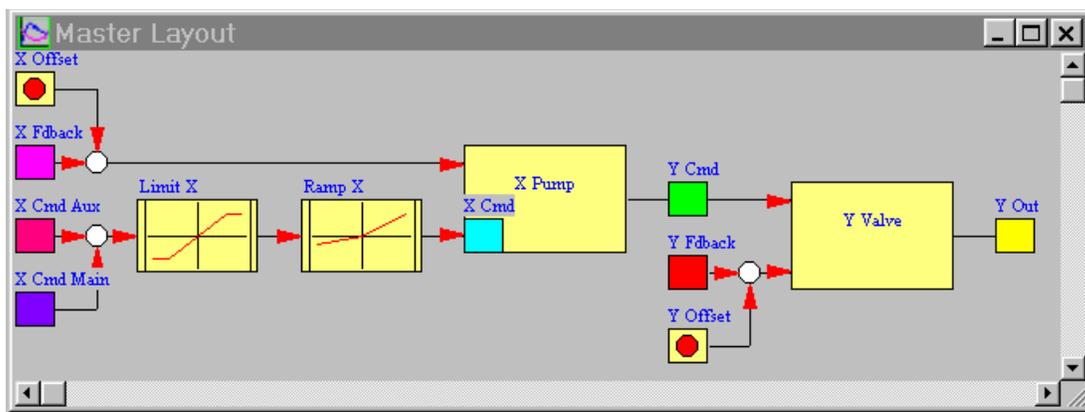
The recommended control system parameter settings for all of these blocks are stored in the card memory by Denison for the various models and configurations of GoldCup Digital HI-IQ pumps as shown in the table on page 6. The following paragraphs describe how to monitor and change these values if required. These control system parameter settings can dramatically affect the response and stability characteristics of the pump. They should only be changed by trained technical service personnel and with extreme care.

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PUMP CONTROL SYSTEM PARAMETER SETTINGS

The pump control system parameter settings can be accessed by selecting the *Parameter* menu options and either the *Global*, *Master Layout*, or *X Pump* options as shown below.
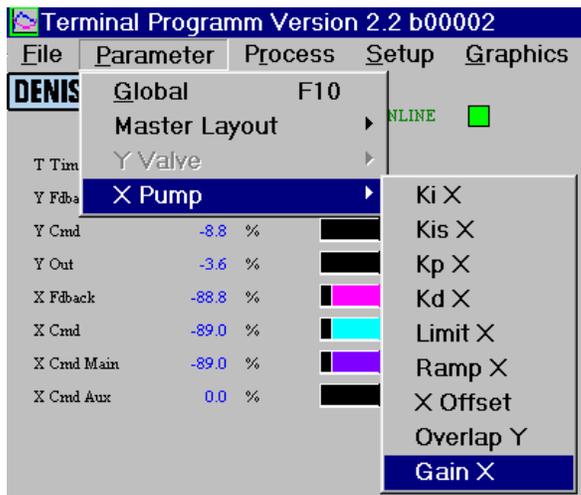
These same screens can be accessed by double-clicking the various blocks in the *Master Layout* or *X Pump* block diagrams shown below.
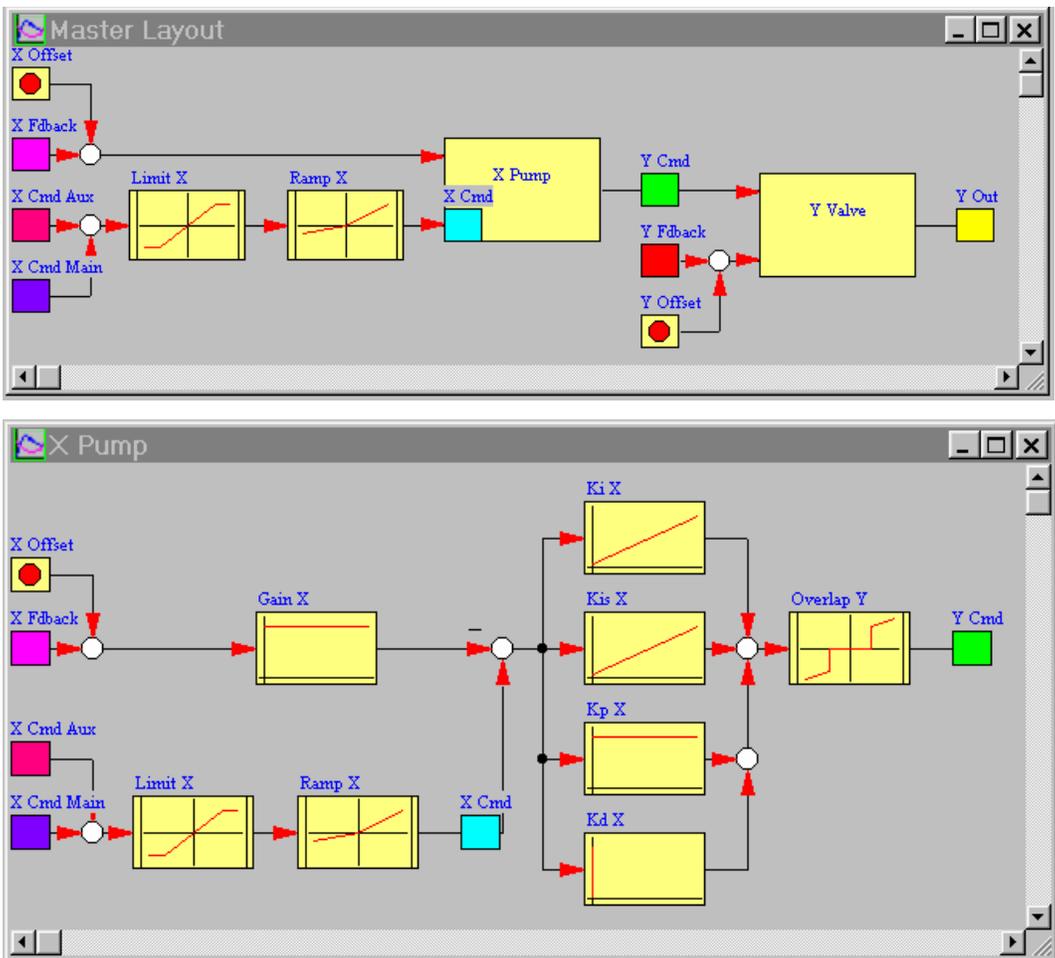
The pump operates in a PID (proportional, integral, and derivative) control configuration with a *Gain X* adjustment to scale the pump displacement feedback. There are also blocks in the control system that provide options for limiting the maximum displacement of the pump, ramps to limit the rate of change of pump displacement, and overlap compensation for the control valve. The following paragraphs describe how the parameters contained in these blocks are set.

GAIN X BLOCK – PUMP DISPLACEMENT FEEDBACK GAIN

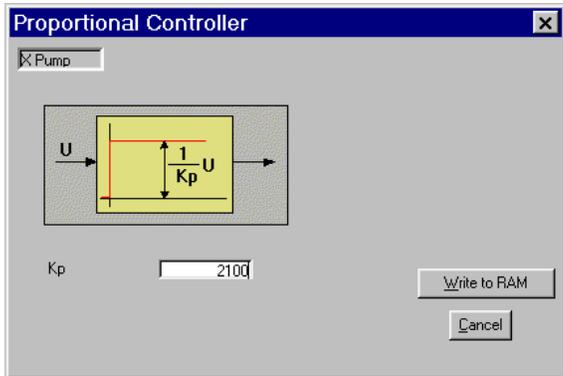The *Gain X* block calibrates the pump displacement feedback sensor signal for flow being delivered from either the A or B port of the pump. Double-clicking the *Gain X* block in the *X Pump* block diagram displays the following window.

Selecting the box labeled *Kp* allows a value to be entered to calibrate the pump displacement sensor. Selecting the *Write to RAM* button sends the new *Gain X* value to the driver card. A Kp value of 2100 mV is required to scale the optional potentiometer feedback device and a Kp value of 2400 mV is used to scale the optional DC-RVDT feedback device. The Kp value represents the full scale signal in mV and is not a true proportional gain block.

LIMIT X BLOCK – PUMP MAXIMUM DISPLACEMENT LIMITER

The *Limit X* block allows you to set a limit for the maximum displacement of the pump from either the A or B port. Double-clicking the *Limit X* block in the *X Pump* block diagram displays the following window.
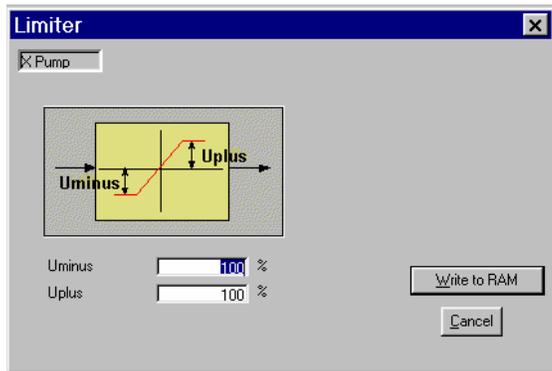
Selecting the boxes labeled *Uminus* and *Uplus* allows a new value to be entered to limit the maximum pump displacement for pump flow in either direction. Selecting the *Write to RAM* button sends the new *Uminus* and *Uplus* values to the driver card. The value entered for *Uminus* and *Uplus* is the percentage of maximum displacement to either the A or B port.

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RAMP X BLOCK – PUMP RAMP GENERATOR

The **Ramp X** block allows you to set two different ramp times in milliseconds for flow to the A or B port of the pump. Double-clicking the **Ramp X** block in the **X Pump** block diagram displays the following window.
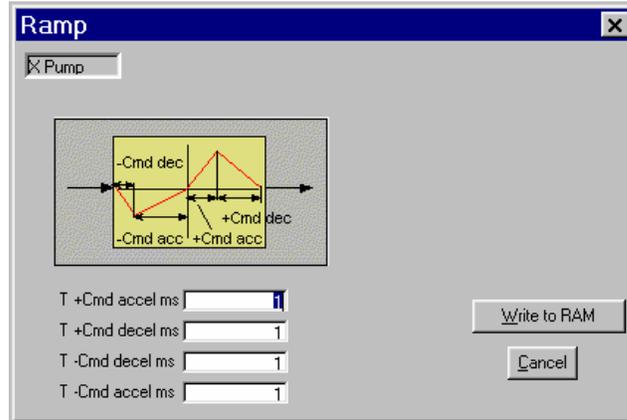
Selecting the boxes labeled **T +Cmd accel**, **T + Cmd decel**, **T – Cmd decel**, and **T – Cmd accel** allows new values to be entered to limit the maximum rate of change of the pump displacement for flow in either direction and for increasing or decreasing flow conditions. Selecting the **Write to RAM** button sends the new ramp values to the driver card. The Ramp Enable signal must be applied to pin B18 to activate the ramp. The Ramp Enable signal is identified as Digital Input E8 on the PC screen.

Ki X BLOCK – PUMP LARGE SIGNAL INTEGRATOR GAIN

There are two integrator blocks in the control loop. The **Ki X** block allows you to set an integrator that operates at low gain on large signals. The integrator improves the accuracy of the pump to follow the displacement commands.

This integrator gain **Ki** is active when **–dX< U < +dX** and is limited to **Umin < integrator output < Umax**.

Double-clicking the **Ki X** block in the **X Pump** block diagram displays the following window.
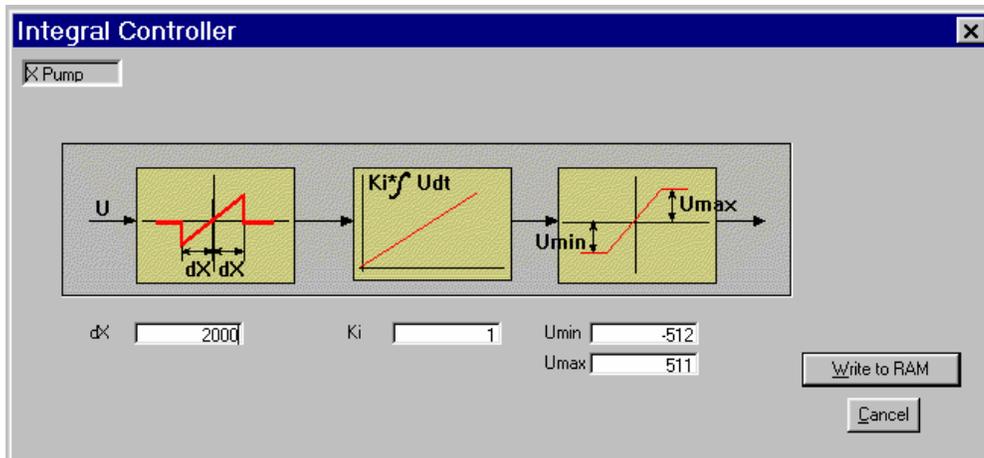
Selecting the boxes labeled **dX, Ki, Umin,** and **Umax** allows a new values to be entered for the gain of the integrator and the range over which it operates. Selecting the **Write to RAM** button sends the new values to the driver card. The **Ki** gain of the integrator has a significant influence on the stability of the control system and should be used carefully.

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Kis X BLOCK – PUMP SMALL SIGNAL INTEGRATOR GAIN

There are two integrator blocks in the control loop. The **Kis X** block allows you to set an integrator that operates at high gain on small signals. The integrator improves the accuracy of the pump to follow the displacement commands.

This integrator gain **Kis** is active when **–dX< U < +dX** and is limited to **Umin < integrator output < Umax**.

Double-clicking the **Kis X** block in the **X Pump** block diagram displays the following window.
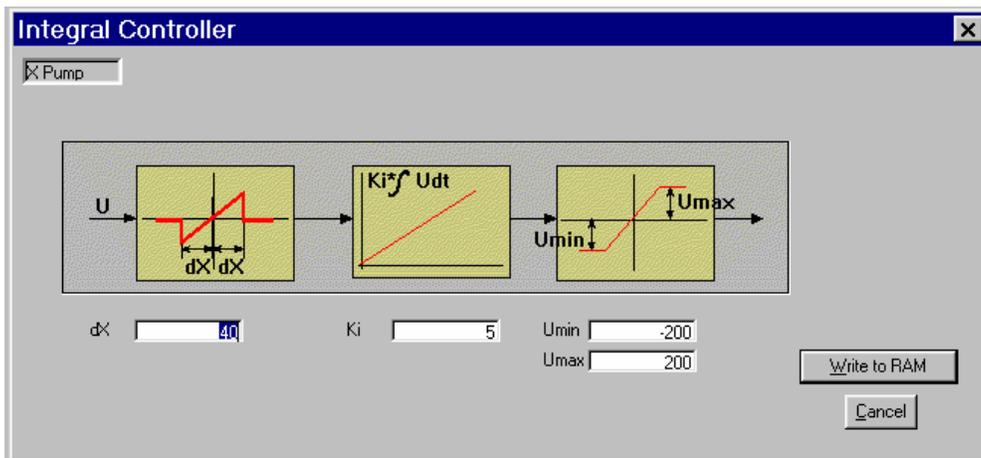
Selecting the boxes labeled **dX, Ki, Umin,** and **Umax** allows a new values to be entered for the gain of the integrator and the range over which it operates. Selecting the **Write to RAM** button sends the new values to the driver card. The **Ki** gain of the integrator has a significant influence on the stability of the control system and should be used carefully.

Kp X BLOCK – PUMP PROPORTIONAL GAIN

The **Kp X** block sets the proportional gain for the pump controller. This proportional gain has a major influence on the response and stability of the pump control system. Adjustments to **Kp X** should be made with extreme caution. Double-clicking the **Kp X** block in the **X Pump** block diagram displays the following window.

Selecting the box labeled **Kp** allows a value to be entered to set the proportional pump control gain **Kp X**. Selecting the **Write to RAM** button sends the new **Kp X** value to the driver card.

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Kd X BLOCK – PUMP DERIVATIVE GAIN

The **Kd X** block sets the derivative gain for the pump controller. This derivative gain improves the response characteristics of the pump control system. Double-clicking the **Kd X** block in the **X Pump** block diagram displays the following window.
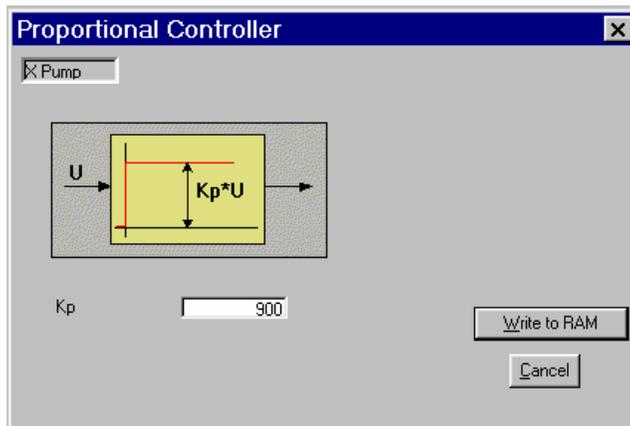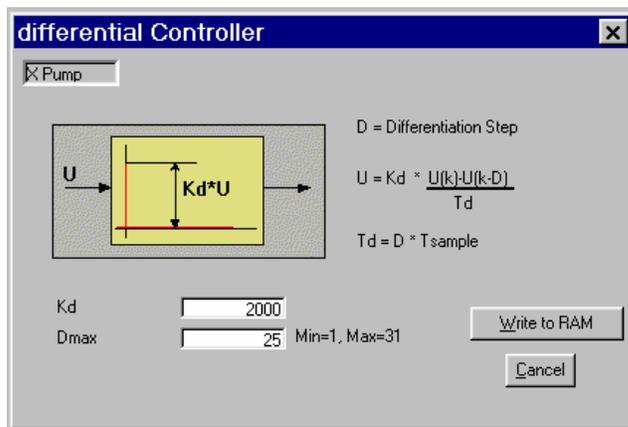

Selecting the box labeled **Kd** allows a value to be entered for the derivative gain. Selecting the box labeled **Dmax** allows a value to be entered to limit the maximum time difference used to calculate the rate of change of the input signal. Selecting the **Write to RAM** button sends the new **Kd X** and **Dmax** values to the driver card.

VALVE OVERLAP Y COMPENSATION BLOCK

The **Overlap Y** block provides an overlap compensation system that electronically avoids operation of the control valve near zero command. Overlap compensation is not required because the control valve on the GoldCup Digital HI-IQ pump has nearly zero overlap. Do not change these settings unless directed by a Denison Hydraulics technical expert.

Double-clicking the **Overlap Y** block in the **X Pump** block diagram displays the following window.
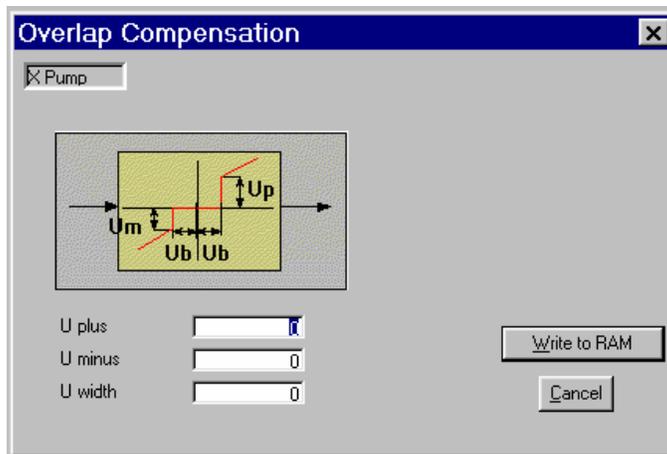
VALVE CONTROL SYSTEM PARAMETER SETTINGS

The valve control system parameter settings can not be accessed by this User Interface Software. Please contact Denison Hydraulics if you want to make changes to the parameter settings for the valve control loop.

'X OFFSET' - COMPENSATING THE ZERO DISPLACEMENT ERROR OF THE PUMP

The signal from the pump displacement sensor should be zero when the pump is at zero displacement. However, there is always a small the electrical output signal from the feedback sensor at zero pump displacement. A small zero displacement error can be eliminated on the driver card using the *X Offset* adjustment when commissioning a new pump or when servicing an existing pump.

To access the screen to adjust the *X Offset* either double-click the *X Offset* colored box on the *X Pump* block diagram screen or access it through the *Parameter*, *X Pump*, *X Offset* menu option. Double-clicking the *X Offset* colored box on the pump block diagram window will display the following screen.
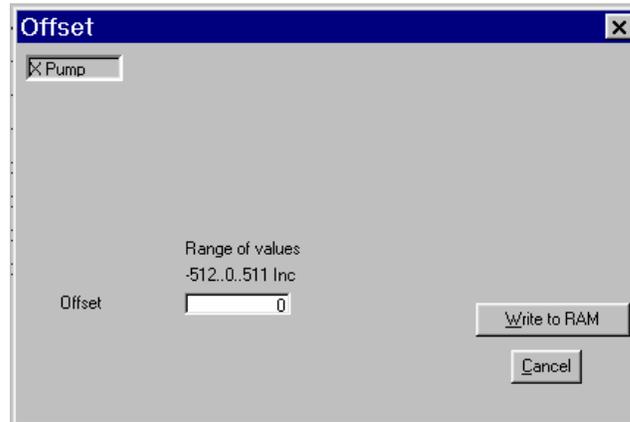
To set the *X Offset* adjustment:
- Place two throttling valves in series with the flow from the A and B ports.
- Place suitable pressure gages at both the A and B ports of the pump.
- Operate the pump at the normal idling condition on the machine.
- Send a zero displacement electrical command to the pump driver card.
- Slowly close the throttling valves in the A and B ports while observing the pressure at each port.
- Access the *X Offset* adjustment screen and adjust it to obtain equal pressures at the A and B ports.

SETUP MENU

SETTING PARAMETERS FOR THE CONTROL ERROR SIGNAL DIGITAL OUTPUT Z18

The driver card continuously monitors the performance of the pump displacement control loop. The digital output at pin Z18 will be set to 0 vdc indicating a **Control Error** if the difference between the commanded pump displacement and the actual pump displacement exceeds **Error1** for a time duration longer than **TimeErr1.** Select the **Setup, EC01 Setup** menu options to set these parameters as shown below.
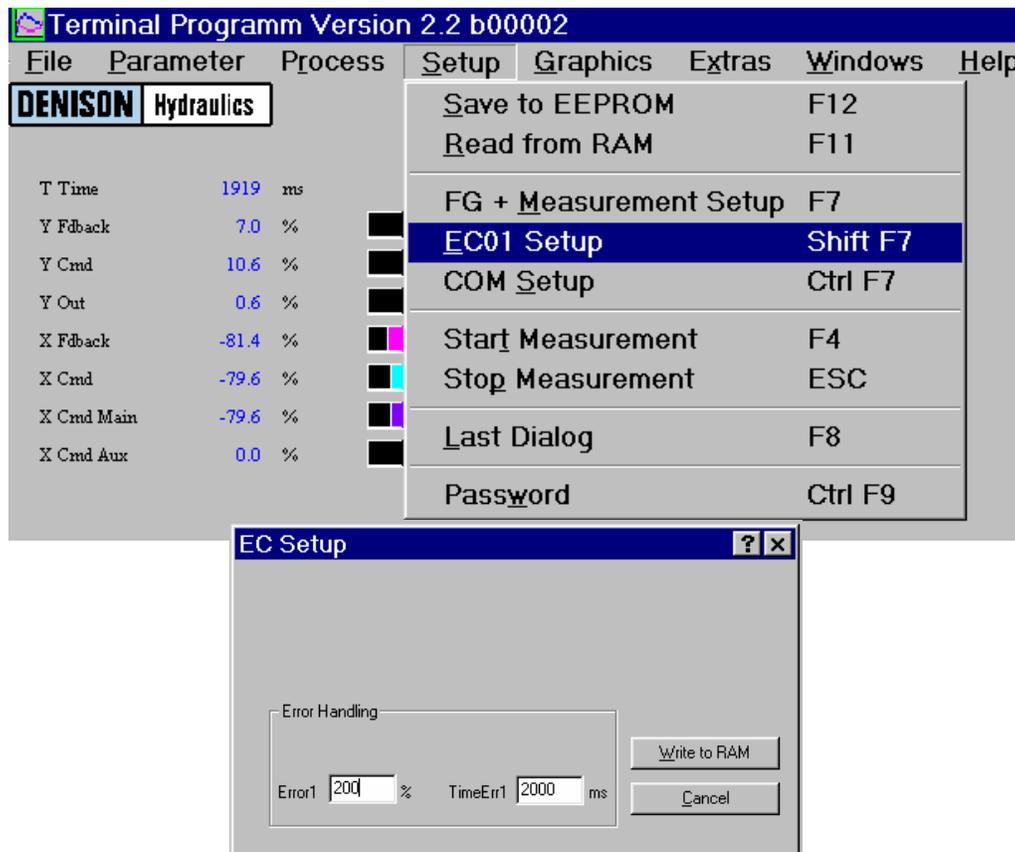
PARAMETER SETTINGS STORED IN RAM AND EEPROM ON THE DRIVER CARD

There are two types of memory storage areas for the driver card parameter settings; **RAM** (random access memory) and **EEPROM** (electrically eraseable programmable read-only memory). All of the parameter settings stored in RAM are erased when the main electrical power is removed from the card. The RAM is volatile memory that is lost when electrical power is removed. All of the parameter settings are read from the EEPROM into the RAM when the main electrical power is applied to the card. The EEPROM is non-volatile memory that is retained when electrical power is removed from the card. The parameter settings stored in the RAM can be changed with a PC that contains the Denison GoldCup Digital HI-IQ User Interface Software. This allows the user to evaluate various control system parameter settings in the RAM until the parameter settings are optimized. The optimized settings must then be stored in the EEPROM on the card to be sure that these values are restored when the main electrical power is removed and then reapplied to the card.

SAVING SYSTEM PARAMETER SETTINGS IN EEPROM

Select the **Save to EEPROM** option from the **Setup** menu, as shown below, to store the parameter settings in EEPROM. This procedure transfers the parameter settings from the card RAM into the EEPROM.
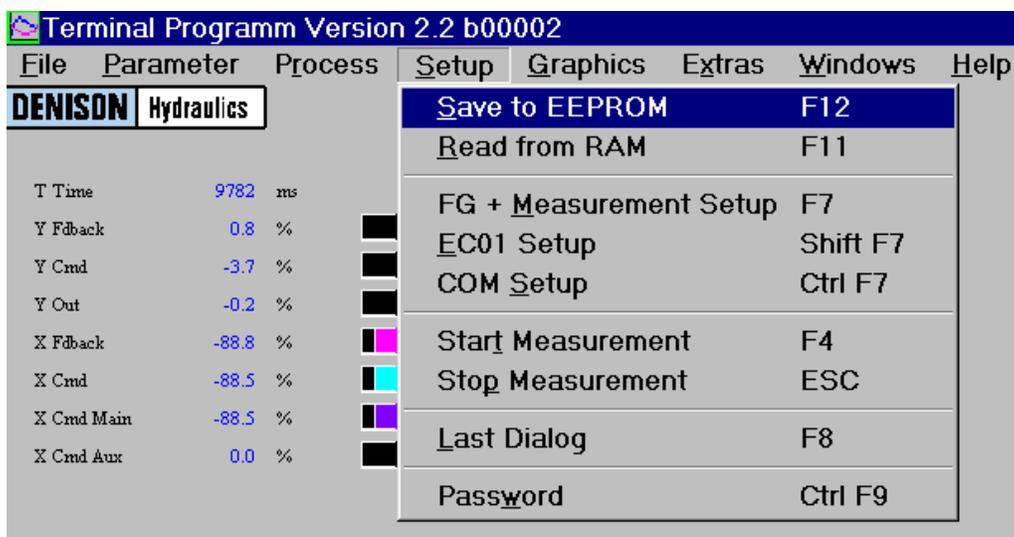
RETRIEVING SYSTEM PARAMETER SETTINGS FROM DRIVER CARD RAM

Select the **Read from RAM** option from the **Setup** menu, as shown above, to retrieve the settings from the driver card RAM. This procedure transfers all parameter settings from the driver card RAM into the PC User Interface Software. This allows the parameter settings to be examined on the PC.

SAVING SYSTEM PARAMETER SETTINGS IN A PC FILE

Select the *File, Save* menu option, as shown below, to transfer the parameter settings currently active in the Denison User Interface Software into a file stored on the PC hard drive, floppy disk, CD, or any other file storage device connected to your PC.
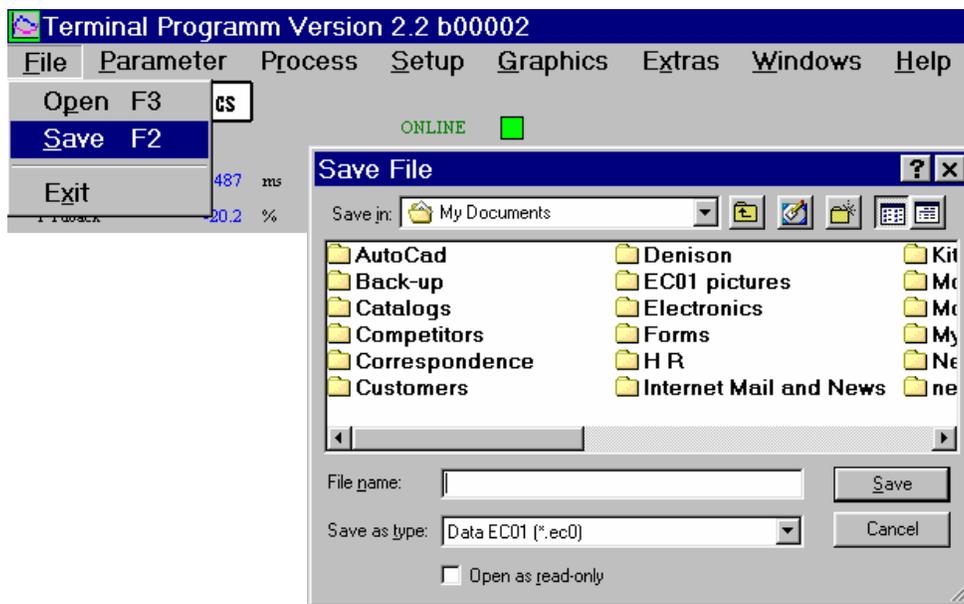
The file can be saved in the same manner as any standard PC file. It must be saved with the default *.ec0* file extension to be compatible with the Denison User Interface Software. This feature allows archive copies to be stored of various versions of the control system parameter settings. This file storage option is useful when maintaining special control system parameter settings that are different from the Denison GoldCup Digital HI-IQ pump default settings.   This feature permits storing control system parameters that are uniquely adjusted for a particular customer machine.

RETREIVING SYSTEM PARAMETER SETTINGS FROM A PC FILE

Select the **File, Open** menu option, as shown below, to transfer an ***.ec0** file from your PC into the Denison GoldCup HI-IQ User Interface Software.
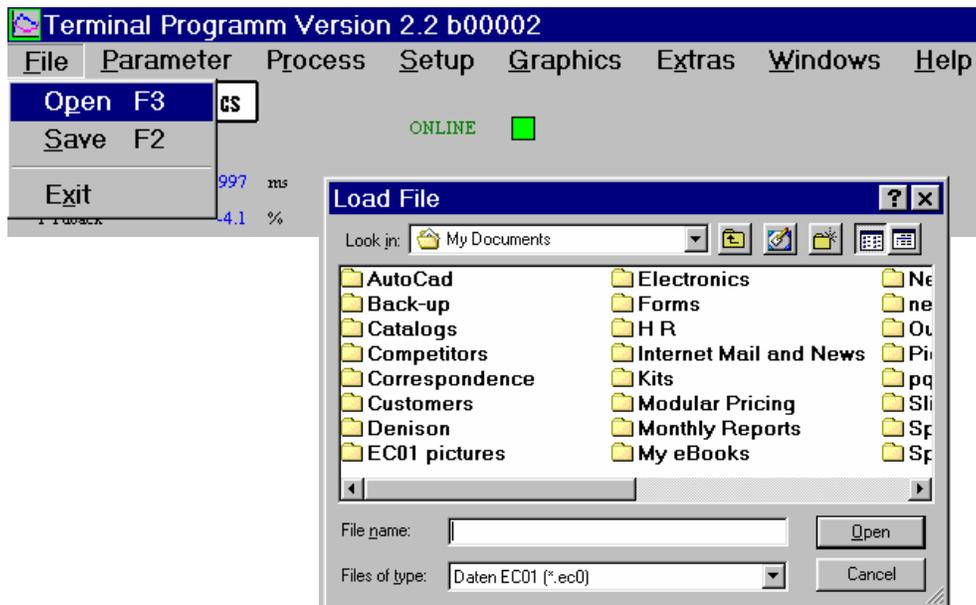
LOADING THE GOLDCUP DIGITAL HI-IQ CONTROL ALGORITHM INTO THE DRIVER CARD

The software that has been uniquely developed to control the Denison GoldCup HI-IQ pump is stored in the digital driver card EEPROM in a **.bin file.** The software in the ***.bin** file contains the control system algorithm responsible for the closed-loop PID control of the GoldCup pump. Contact a Denison Hydraulics technical service representative to install the correct ***.bin** file on your driver card.

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CONNECTOR PIN I/O DETAILS

EC01 HI/IQ PIN ASSIGNMENT

d	b	z	
+10V Ref.	+15V Ref.	⏚	2
−10V Ref.	−15V Ref.	○	4
+24Vout	GND	○	6
AD1 MAIN PUMP CMD — 4…20mA	AD2 Pump Displmnt — 0…±2.6V	○	8
AD3 ⊖ ⊕ DIFF. I/P NOT USED		○	10
AD4 ⊕ 10V I/P Diff ⏚ AUX PUMP CMD		Analog1_OUT — Not Used	12
AD5 Valve Spool — 0/4…20mA	AD6 Opt I/P — 0/4…20mA	Analog2_OUT — Not Used	14
E1 Dig1_In SignFeedbk	E7 Dig7_In Enable	A1 Dig1_Out Not Used	16
E2 Dig2_In Sign Command	E8 Dig8_In Ramp	A2 Dig2_Out No Error	18
E3 Dig3_In Sign D10/B10	DigInGND	A3 Dig3_Out Not Used	20
E4 Dig4_In Not Used	DigOutGND	A4 Dig4_Out Not Used	22
E5 Dig5_In Not Used	SOL A+	SOL B+	24
E6 Dig6_In Not Used	SOL A−	SOL B−	26
+Vsupply	+Vsupply	GND	28
0Vsupply	0Vsupply	GND	30
+24Vout	+Vext DIG OUT	⏚	32

EC01 DC2 BLOCK DIAGRAM

FAULT FINDING GUIDE

Fault	Possible Reason	Recommendation
Front panel LED 'CPU active' is not lit and not flashing and LED on sub-board is not lit	Power supply not properly connected	Check power supply
	Power supply not within the specified range	Check power supply
	Short-circuit of valve connection	Check wiring and/or resistance of the solenoid
	Short-circuit at the reference voltage outputs	Check external devices (transmitter, electronic cards, potentiometer)
	DC/DC converter on the board defective	Send the driver card back to Denison for repair
	No program installed on EC01 card	Send the driver card back to Denison for repair
	EC Burn boot-strap jumper J1 installed	Remove and store on only one pin
Front panel LED 'CPU active' is lit and flashing but card does not respond to command signal.	'Enable' digital input not connected correctly	Check wiring of 'Enable' digital input.
	Sub-board defective	Send the driver card back to the Denison for repair
	Incorrect wiring	Check all wiring at EC01 card connector, pump, valve, and related electrical components. Most start-up problems are caused by wiring problems.
No current to valve solenoids	Wrong wiring from driver card to solenoids	Check solenoid wiring
	Sub-board defective	Send the driver card back unit to Denison for repair
	EC01 card valve driver output stage defective	Send the driver card back unit to Denison for repair

Fault	Possible Reason	Recommendation
Digital output A2 is Red, pin Z18 is low, and pump loop indicator W1 is Pink	Pump control loop error. Bar graphs out of phase or too much amplitude difference.	Check phase relationship tables and set digital input E1 (sign pump feedback) as required. Check EC01 Setup Error Handling settings.
	Pump in pressure compensation mode.	Check pressure compensator setting and system load pressure.
	Reference voltages to pump feedback sensor are missing or unbalanced.	Remove wiring at EC01 card and check reference voltages. Replace EC01 card if faulty. If OK, check wiring at connectors.
	Too much error between valve command and valve feedback.	Check the valve loop error indicator W0. If it is Pink, the control valve may be sticking. Return the control valve to Denison.
	EC01 card not securely plugged into mating connector.	Remove any obstruction and then insert the card until the connector is fully engaged.
Digital output A2 indicator is Red, and valve loop indicator W0 is Pink	Valve command and valve feedback is out of phase.	Valve solenoid cables are reversed.
	Valve feedback is missing, incorrect, or erratic.	Check the +24V output to the valve feedback sensor. It must be greater than +19V. Check for correct wiring and secure connections.
Same as above but also erratic and noisy pump operation at start-up or after valve replacement.	Air trapped in valve.	Operate the pump at zero flow and maximum pressure on the pressure limiter control. Bleed aerated fluid from the control valve air bleed screws until the fluid is free of air.
Digital output A2 indicator is Red and pin Z18 is low. Bar graphs are in phase and W0 and W1 loop monitors are yellow.	One or more of the selected 4 – 20 mA signals are missing.	Check wiring continuity of the 4–20 mA circuits.
		Check the 4–20 mA sources of each circuit. If they are OK, the problem is in the EC01 card. Return the EC01 card to Denison.

Fault	Possible Reason	Recommendation
Valve Y feedback bar graph does not return to zero when the pump is operated near maximum displacement and ± command signals are equal.	Pump control is against the mechanical displacement stop.	Reduce input command signal or adjust Limit X.
	Pump displacement sensor may not be properly centered.	Check pump displacement sensor zero adjustment. (See section on pump zero adjustment.)
	Maximum input displacement command and pump feedback signals are not balanced.	Determine maximum pump displacement feedback signal and set Gain X to the same level in millivolts.
	Displacement input command signal may be too large on one side or the other due to pump displacement asymmetry.	Reduce maximum input command if possible or use the Limit X adjustment to compensate for the displacement asymmetry.
Pump X feedback bar graph is at 100% but the actual pump flow is lower than expected.	Gain X parameter setting may be too low.	Determine maximum pump displacement feedback signal and set Gain X to the same level in millivolts.

EC01 DC2 GENERAL ELECTRICAL & MECHANICAL SPECIFICATIONS.

Dimensions ----------------------------- Euro Card 160 x 100 mm

Front panel dimensions--------------- 3U / 8HP (128.5 x 40.4 mm)

Weight ----------------------------------- approximately 250g

Connector------------------------------- DIN 41612, 3 row FORM F, male, 48 pin B-D-Z

Card Holder Code Number-----------701-00066-8

Supply Voltage ------------------------- 24 V DC (nominal), 20-32VDC Limits

Supply Type ----------------------------- Bridge rectified and filtered DC, ripple <5%)

Current Consumption ----------------- Card only 350mA ; with accessories and valve current 1500mA

Reference voltages--------------------- ±15V (±5%) @ 50mA , ±10V (±0,5%) @ 10mA for accessories

Storage Temperature ----------------- -40°C……. +125°C

Operating Temperature--------------- 0°C……….+70°C

Output Stages ------------------------- Two 24V PWM for Valve Solenoids

Output Stage Current ----------------- Maximum Current approximately 3000 mA (Factory Set)

Dither Amplitude------------------------ Software Setting Only (Factory Set)

Dither Frequency----------------------- Software Setting Only (Factory Set)

Ramps Up/Down ----------------------- Software Setting: 1...50V/s (±20%)

Digital Inputs --------------------------- 5mA @ 24V (Functions Defined by Application Software)

Digital Outputs ------------------------- (Defined by Application Software)

Analog Inputs -------------------------- 3 Voltage, 3 Current

DIGITAL INPUTS

The driver card is equipped with digital inputs for control. The inputs are electrically isolated by means of onboard optocouplers, providing isolated control of the digital input functions.

The 0V (return) line of the source must be connected to Pin B20 (Dig.INGND) of the driver card when using an external voltage source for the digital control inputs (i.e. PLC).

If voltage isolation is not necessary, the 24Vout voltage (Pins D6, D32) or +15VDC (Pin B2) can be used for the digital control inputs. When using the driver card 24Vout or +15V, a connection from Pin B20 (Dig.INGND) to one of the GND Pins Z28, Z30 or B6 is required for the card to work correctly.

The digital input voltage level+$V_{digital}$ must be between +4V and +32VDC. The current consumption for each digital input at 24V is approximately 5mA.

ENABLE

The digital input E7 (pin B16) is the driver card **ENABLE** function. Connecting a positive voltage to pin B16 will **ENABLE** the driver card at the X-Cmd logic block. The driver card must be **ENABLED** before the system will respond to the external commands for pump displacement. If 0V or no voltage is connected to the **ENABLE** input, the pump controller X-Cmd logic block output is zero and all external commands to the driver card are ignored.

NOTE:

Even if the 'ENABLE' function is off, the controller still stays powered up and only the external commands are blocked from controlling the pump displacement.

$$B16 \quad = \quad +V_{digital} \ (\text{Logic 1 = ENABLE ON, Logic 0 = ENABLE OFF})$$

$$B20 \quad = \quad GND_{Digital}$$

CHANGE SIGN FEEDB

The digital input E1 at pin D16 changes the sign of the pump displacement feedback signal. Connecting a positive voltage (Logic 1) will invert the sign of the pump displacement feedback signal. This allows the user to easily change the pump displacement feedback polarity for proper closed-loop operation. See Phase Charts to determine the correct D16 setting for pump flow, type of feedback assembly (potentiometer or DC RVDT), and the location of the feedback sensor (A or B port side of the pump).

$$D16 \quad = \quad +Vdigital \ (\text{Logic 1 = Invert Feedback Sign; Logic 0 = Non-invert Sign})$$
$$B20 \quad = \quad GNDDigital$$

CHANGE SIGN COMMAND

The sign of the sum of the input commands at the X-Cmd logic block output is inverted when a positive voltage is applied to the digital input E2 at pin D18. This inversion changes the pump output flow to ports A or B for a given input command polarity. This function can be used to change the polarity of an outer loop or to produce the desired system reaction for a given polarity command signal.

$$D18 \quad = \quad +Vdigital \ (\text{Logic 1 = Invert Command Sign; Logic 0 = Non-invert Sign})$$
$$B20 \quad = \quad GNDDigital$$

CHANGE SIGN B10/D10

The sign of the command input from terminal B10/D10 is inverted when a positive voltage is applied to digital input E3 at pin D20. B10/D10 is a unipolar positive input. To permit negative (or opposite pump response) the E3 Sign B10/D10 inverts the polarity in the software logic. This inversion is in addition to any inversion by the E2 function.

    D20   =   +Vdigital (Logic 1 = Invert Sign B10/D10; Logic 0 = Non-invert Sign)
    B20   =   GNDDigital

RAMP

Applying a positive voltage to digital input E8 at pin B18 turns on the **RAMP** function.

    B18   =   +Vdigital (Logic 1 = RAMP ON; Logic 0 = RAMP OFF)
    B20   =   GNDDigital

DIGITAL OUTPUTS

The driver card has four digital outputs, but only A1 (Pin Z16) and A2 (Pin Z18) are used in the Standard HI-IQ application. Each output is isolated by means of an on-board optocoupler to provide fully isolated output switching. When using an external voltage source for the supply of the optocouplers, the plus voltage line of the source must be connected to Pin B32 (+VEXT) and the 0V line of the source **MUST** be connected to Pin B22 (Dig.OUTGND) of the driver card.

If isolation is not necessary, the 24Vout voltage available on pins D6 & D32 can be used to power the opto-couplers. When using the internal +24Vout, a connection from pins D6 or D32 to pin B32 (+Vext) and a connection from Pin B22 (Dig.OUTGND) to one of the Pins Z28, Z30 or B6 is required for correct operation.

The outputs from the opto-couplers are standard 'high side' output type with internal overload and short-circuit protection with a maximum switching capability of 500mA. However, if the internal +24Vout (pins D6 or D32) is used, the output current is limited to 80mA total and should only be used to drive LED indicators (with appropriate resistor in series) or to interface with the main system buffered inputs. If higher currents are required (i.e. up to 500mA), an external voltage supply with corresponding current ability must be connected to pins B32 as indicated above. The 24V supply voltage for the driver card can also be used as the +Vext source. (See **INSTALLATION AND WIRING OF THE EC01 DRIVER CARD**.)

Ready – A1, Dig.1Out

The digital output A1, Dig.1OUT (pin Z16) is not intended for general customer use in the HI-IQ application.

GREEN NO ERROR, RED ERROR – A2, Dig.2Out

The digital output A2, Dig.2OUT (pin Z18) is configured and used for **ERROR** detection. This digital output is set to logic '1' (green = no error) when no errors are detected in either the pump or valve control loops. If an error is detected, the output is set to logic '0' (red = error) to indicate that an error has occurred. The Z18 output can be connected to the master control system logic to provide a safety interlock. (See the sections on fault analysis and digital input and digital output display for more information.)

ANALOG INPUTS

The driver card has 6 analog inputs. Three are voltage inputs and three are 4-20mA current inputs. The function of these analog inputs is defined by Denison for the HI-IQ application. The following defines the function and electrical specifications of the analog inputs:

Term B8 --±2.6V input range; 10MΩ input impedance, OpAmp buffered. This input is dedicated to the pump displacement feedback signal.

Term B10/D10 —Differential 0..+10V unipolar input; >10MΩ input impedance, OpAmp buffered. This input is dedicated to auxiliary command input. The polarity can be changed by the software logic and digital input E3 at Pin D20.

Term B12/D12 --±10 input range, 200KΩ input impedance. This input is dedicated to the pump command input (either main or auxiliary).

Term D8 — 4-20mA current input into a 250Ω current sensing resistor. Used as main pump command when a current input signal is used. It is a 12 ± 8mA signal when it is used as a pump displacement command signal. A 'loss of signal' detector is activated in the software when the D8 input is selected.

Term D14 — 4-20mA current input into a 250Ω current sensing resistor. This input is dedicated to the valve spool position feedback signal. The 'loss of signal' or 'broken wire' detector is activated in the software when the D14 input is selected.

Term B14 — 4-20mA current input into a 250Ω current sensing resistor. This input is not used in the standard HI-IQ application. It can be used as an alternate pump command input or as the valve spool position feedback input in case either is defective. When the B14 input is selected a 'loss of signal' or 'broken wire' detector is activated in the software.

DENISON DEFAULT PARAMETER SETTINGS FOR P6, P7, AND P8 PUMPS WITH POTENTIOMETER DISPLACEMENT SENSOR:

GLOBAL

2	Ki Y	Ki	75			T -Cmd	1	
		Umin	-2000			T -Cmd	1	
		Umax	2000	4	X Offset	Offset	0	
		dX	2000	4	Overlap Y	U plus	0	
2	Kp Y	Kp	400			U minus	0	
2	Kd1 Y	Kd	1000			U width	0	
		Tf D	1000	4	Gain X	Kp	2100	
2	Dt1 U	Kd	27					
		Tf D	700					
2	Y Offset	Offset	0					
4	Ki X	Ki	5					
		Umin	-512					
		Umax	511					
		dX	2000					
4	Kis X	Ki	25					
		Umin	-200					
		Umax	200					
		dX	40					
4	Kp X	Kp	900					
4	Kd X	Kd	2000					
		Dmax	25					
4	Limit X	Uminus	100					
		Uplus	100					
4	Ramp X	T +Cmd	1					
		T +Cmd	1					

Write to RAM

Read from RAM

Cancel

DENISON DEFAULT PARAMETER SETTINGS FOR P6, P7, AND P8 PUMPS WITH DC RVDT DISPLACEMENT SENSOR:

2	Ki Y	Ki	75			T -Cmd	1
		Umin	-2000			T -Cmd	1
		Umax	2000	4	X Offset	Offset	0
		dX	2000	4	Overlap Y	U plus	0
2	Kp Y	Kp	400			U minus	0
2	Kd1 Y	Kd	1000			U width	0
		Tf D	1000	4	Gain X	Kp	2365
2	Dt1 U	Kd	27				
		Tf D	700				
2	Y Offset	Offset	0				
4	Ki X	Ki	5				
		Umin	-512				
		Umax	511				
		dX	2000				
4	Kis X	Ki	25				
		Umin	-200				
		Umax	200				
		dX	40				
4	Kp X	Kp	900				
4	Kd X	Kd	2000				
		Dmax	25				
4	Limit X	Uminus	100				
		Uplus	100				
4	Ramp X	T +Cmd	1				
		T +Cmd	1				

GLOBAL

Write to RAM

Read from RAM

Cancel

DENISON DEFAULT PARAMETER SETTINGS FOR P11 AND P14 PUMPS WITH POTENTIOMETER DISPLACEMENT SENSOR:

GLOBAL

2	Ki Y	Ki	75			T -Cmd	1	
		Umin	-2000			T -Cmd	1	
		Umax	2000	4	X Offset	Offset	0	
		dX	2000	4	Overlap Y	U plus	0	
2	Kp Y	Kp	400			U minus	0	
2	Kd1 Y	Kd	1000			U width	0	
		Tf D	1000	4	Gain X	Kp	2200	
2	Dt1 U	Kd	27					
		Tf D	700					
2	Y Offset	Offset	0					
4	Ki X	Ki	8					
		Umin	-512					
		Umax	511					
		dX	2000					
4	Kis X	Ki	35					
		Umin	-200					
		Umax	200					
		dX	40					
4	Kp X	Kp	1800					
4	Kd X	Kd	2000					
		Dmax	25					
4	Limit X	Uminus	100					
		Uplus	100					
4	Ramp X	T +Cmd	1					
		T +Cmd	1					

Write to RAM

Read from RAM

Cancel

DENISON DEFAULT PARAMETER SETTINGS FOR P11 AND P14 PUMPS WITH DC RVDT DISPLACEMENT SENSOR:

GLOBAL

2	Ki Y	Ki	75			T -Cmd	1
		Umin	-2000			T -Cmd	1
		Umax	2000	4	X Offset	Offset	0
		dX	2000	4	Overlap Y	U plus	0
2	Kp Y	Kp	400			U minus	0
2	Kd1 Y	Kd	1000			U width	0
		Tf D	1000	4	Gain X	Kp	2475
2	Dt1 U	Kd	27				
		Tf D	700				
2	Y Offset	Offset	0				
4	Ki X	Ki	8				
		Umin	-512				
		Umax	511				
		dX	2000				
4	Kis X	Ki	35				
		Umin	-200				
		Umax	200				
		dX	40				
4	Kp X	Kp	1800				
4	Kd X	Kd	2000				
		Dmax	25				
4	Limit X	Uminus	100				
		Uplus	100				
4	Ramp X	T +Cmd	1				
		T +Cmd	1				

Write to RAM

Read from RAM

Cancel

DENISON DEFAULT PARAMETER SETTINGS FOR P24 AND P30 PUMPS WITH POTENTIOMETER DISPLACEMENT SENSOR:

2	Ki Y	Ki	75				T -Cmd	1	
		Umin	-2000				T -Cmd	1	
		Umax	2000	4	X Offset		Offset	0	
		dX	2000	4	Overlap Y		U plus	0	
2	Kp Y	Kp	400				U minus	0	
2	Kd1 Y	Kd	1000				U width	0	
		Tf D	1000	4	Gain X		Kp	2200	
2	Dt1 U	Kd	27						
		Tf D	700						
2	Y Offset	Offset	0						
4	Ki X	Ki	10						
		Umin	-512						
		Umax	511						
		dX	2000						
4	Kis X	Ki	50						
		Umin	-200						
		Umax	200						
		dX	40						
4	Kp X	Kp	2700						
4	Kd X	Kd	2000						
		Dmax	25						
4	Limit X	Uminus	100						
		Uplus	100						
4	Ramp X	T +Cmd	1						
		T +Cmd	1						

GLOBAL

Write to RAM

Read from RAM

Cancel

DENISON DEFAULT PARAMETER SETTINGS FOR P24 AND P30 PUMPS WITH DC RVDT DISPLACEMENT SENSOR:

GLOBAL

2	Ki Y	Ki	75			T -Cmd	1
		Umin	-2000			T -Cmd	1
		Umax	2000	4	X Offset	Offset	0
		dX	2000	4	Overlap Y	U plus	0
2	Kp Y	Kp	400			U minus	0
2	Kd1 Y	Kd	1000			U width	0
		Tf D	1000	4	Gain X	Kp	2475
2	Dt1 U	Kd	27				
		Tf D	700				
2	Y Offset	Offset	0				
4	Ki X	Ki	10				
		Umin	-512				
		Umax	511				
		dX	2000				
4	Kis X	Ki	50				
		Umin	-200				
		Umax	200				
		dX	40				
4	Kp X	Kp	2700				
4	Kd X	Kd	2000				
		Dmax	25				
4	Limit X	Uminus	100				
		Uplus	100				
4	Ramp X	T +Cmd	1				
		T +Cmd	1				

Write to RAM

Read from RAM

Cancel

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