Toledo Transducers
PLS-601
Programmable Limit Switch System
User's Manual

Rev. 1

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1.0 SCOPE

The purpose of this User's Manual is to describe the operation, installation and programming of the Toledo Transducer's PLS-601 Programmable Limit Switch. It is strongly recommended that this User's Manual be read entirely before placing the PLS-601 into operation. Failure to follow the instructions given in this User's Manual may void your PLS-601 warranty.

Questions regarding any aspect of the PLS-601 should be referred to Toledo Transducers, Inc.:

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2.0 PROGRAMMABLE LIMIT SWITCH FUNCTIONAL DESCRIPTION

A wide variety of industrial applications require that an electrical switch be turned ON and OFF at exactly the same point in each cycle of machine operation. The point in the machine cycle that the switch is turned ON is commonly known as the TIMING, whereas the length of time that the switch is ON is termed the DWELL.

TIMING and DWELL can be provided by mounting a mechanical cam on a rotating shaft, such that it can make contact with a corresponding electrical switch. The portion of the cam that comes into actual contact with the switch is often known as the LOBE. The design of the cam must allow the user to be able to set both the TIMING and DWELL of the LOBE.

Several cam/switch assemblies can be placed on the same shaft, to provide independent TIMING and DWELL for a number of different machine functions. Each cam/switch assembly is commonly known as a CIRCUIT.

Mechanical cam switches can be very time consuming to set when more than a few circuits are required. In addition, mechanical cam switches are not practical in applications where the switch must be turned ON and OFF a number of times during a single machine cycle (MULTIPLE LOBES).

A programmable limit switch is a device which overcomes the shortcomings of mechanical cam switches by performing the cam functions electronically rather than mechanically. Instead of having to physically adjust the TIMING and DWELL of a number of mechanical cams, the programmable limit switch (PLS) allows a user to enter the TIMING and DWELL settings via a keyboard. The TIMING and DWELL settings are then stored in a solid state memory and used to control whether the outputs of the electronic switches are turned ON or OFF.

Because of the relative low cost of today's solid state memories, a PLS can readily accommodate applications requiring a large number of circuits, each with single or multiple LOBES.

3.0 PLS-601 SYSTEM COMPONENTS

The PLS-601 is a state-of-the-art, microprocessor based programmable limit switch that allows a user to easily program single or multiple LOBES for a maximum of 16 independent circuits (CHANNELS). In addition, the PLS-601 provides the user with TACHOMETER and MOTION DETECT functions.

The PLS-601 consists of four standard components. These components are an ANGULAR POSITION TRANSDUCER designed to be mounted on the target machine. The CONTROL UNIT that is normally mounted in a NEMA type enclosure. A PROGRAMMER that provides a keyboard/display for data entry and inspection. And an INTERFACE CABLE that connects the TRANSDUCER to the CONTROL UNIT. An optional INTEGRAL RELAY BOARD is available to handle a variety of external AC or DC loads.

The TRANSDUCER, which utilizes a BRUSHLESS RESOLVER, produces an analog signal proportional to the angular position of the machine shaft. This signal is sent to the CONTROL UNIT, where it is converted to digital format and displayed on the PROGRAMMER. During each machine cycle, the CONTROL UNIT will turn the CHANNEL outputs ON and OFF in accordance with the user programmed LOBE data. The CHANNEL outputs can be used directly, or in conjunction with the INTEGRAL SOLID STATE RELAYS.

3.1 TRANSDUCER

The TRANSDUCER is a single-turn rotary position transducer that is used in conjunction with the Control Unit. The TRANSDUCER utilizes a BRUSHLESS RESOLVER which eliminates the reliability problems associated with optical encoders or brush-type resolvers. The brushless resolver is housed in a rugged extruded aluminum enclosure, which is anodized to provide a durable finish. The enclosure is sealed and gasketed to provide oiltight, dust-tight (NEMA 13) protection for the internal electrical components.

A 3/4 inch stainless steel input shaft is used to provide a heavy-duty, corrosion resistant transducer/machine interface. A flexible coupling provides mechanical isolation between the transducer shaft and the resolver for increased mechanical reliability. Sealed ball bearings are used to maximize transducer life, performance, and reliability by providing a high quality bearing for the transducer. The transducer enclosure contains an integral industrial-duty, MS-type connector for interfacing to the Control Unit.

The TRANSDUCER may be mounted via the standard front face mount, or an optional foot mount adapter for retrofit applications.

3.2 PLS-601 CONTROL UNIT

Each CONTROL UNIT consists of an ENCLOSURE, INTERNAL ELECTRONICS, AC/DC POWER SYSTEM and I/O INTERFACE CONNECTORS.

All CONTROL UNITS require a PROGRAMMER for data entry and inspection. A PROGRAMMER consists of nineteen tactile-feel keys, a sixteen character liquid crystal alphanumeric display and a keyswitch for mode selection.

Each CONTROL UNIT is packaged complete with one AC POWER CORD and two MOUNTING BRACKETS.

PLS-601 SPECIFICATIONS

Input Power ....115Vac +/- 10%, 1 Phase, 60 hertz

Operating Temperature.....................................32° F to 125° F

Storage Temperature... 0° F to 150° F

Maximum Resolution ....1000 counts/turn

Standard Scan Time..200 microseconds
....(300 rpm at 1000 counts per turn)
Consult factory if lower scan times are required.

Maximum Number of Lobes...............................3808
....(238 lobes x 4 channels x 4 groups)

3.2.1 ENCLOSURE

The CONTROL UNIT ENCLOSURE is constructed of 14 gauge anodized aluminum, and is designed for easy access should maintenance or repair be required.

3.2.2 PLS-601 FRONT PANEL USER INTERFACE

The PLS-601 front panel has been designed for ease of use. The front panel utilizes a 16 digit alphanumeric display, an operating mode selection keyswitch, a positive tactile feel keypad, and various LED status indicators. Figure 3.2.2 depicts the PLS-601 front panel user interface.
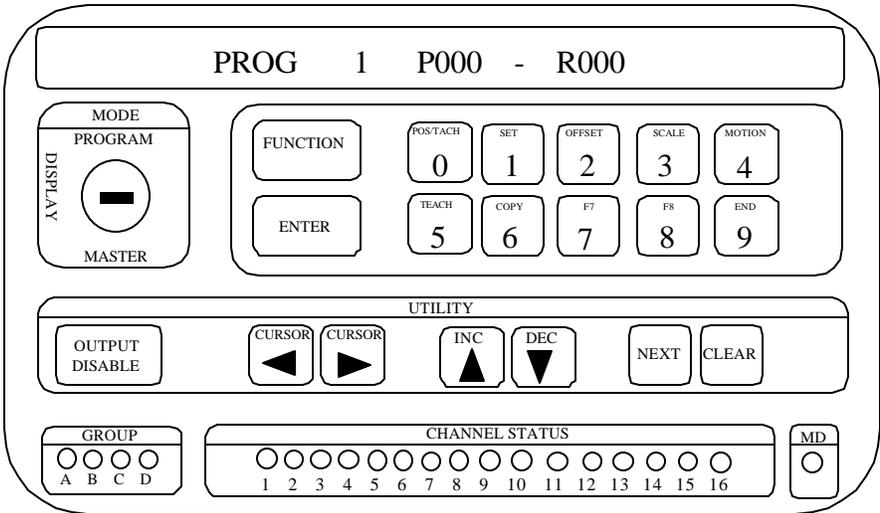

Figure 3.2.2 PLS-601 Front Panel User Interface

3.2.2 PLS-601 FRONT PANEL USER INTERFACE - Continued

Each element of the front panel will be discussed in order to give insight into the operation of the PLS-601 unit. The description of the front panel elements follows.

Display: The PLS-601 front panel user interface is equipped with a 16 digit alphanumeric display that is used to inspect and/or program data fields or operating modes of the unit. The display is of the vacuum fluorescent type which provides bright, easy to see visual feedback even in dimly lighted areas.

Mode Keyswitch: The mode keyswitch protects the user program data from being changed by unauthorized personnel, through the provision of three, key-selectable modes of operation. In Display mode, program data can be displayed and verified, but not changed. In Program mode, all standard PLS-601 functions can are enabled, allowing the user to enter program data into memory even while the unit is operating. In Master mode, access is allowed to a set of optional Master functions that are normally required only during system installation and configuration. The key can only be removed while the switch is in the display mode position.

Function/Data Keys:

FUNCTION ○

The *FUNCTION* key is used to select whether the ten dual-purpose function/data keys are to be used to select one of the PLS-601 functions, or to enter numerical data. By pressing the function key, the associated function LED will either turn on to indicate function entry mode, or turn off to indicate data entry mode. While in data mode, numerical data 0 through 9 can be entered.

ENTER

The *ENTER* key is used to enter data into non-volatile EEPROM memory during execution of the PLS-601 functions. The PLS-601 currently supports the following functions:

POS/TACH 0

The *POS/TACH* function is used to display the selected PROGRAM NUMBER (PROG), the current resolver angle POSITION (P), and the current speed of the resolver shaft in RPM (R) when the function key is active. In data entry mode, this is the number 0 key.

SET 1
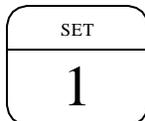
The *SET* function is used to enter LOBE data in to the PLS-601 control unit's memory. Set allows single or multiple lobes to be entered on any or all of the 64 channels. A total of 3808 LOBES (238 LOBES per channel group per program). In data entry mode, this is the number 1 key.

OFFSET 2

The *OFFSET* function is used to display or enter a positive value that is added to the actual resolver angle value. This parameter is used to align the resolver zero angle reference point to the actual machine zero angle reference point. In brief, electrical zero can be adjusted to match that of mechanical zero through the use of the OFFSET value. In data entry mode, this is the number 2 key.
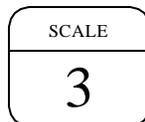
SCALE 3

The *SCALE* function is used to display or enter the scale factor parameter into the PLS-601 Control Unit's memory. The scale factor is the number of intervals that one complete resolver rotation is divided into. In data entry mode, this is the number 3 key.

MOTION 4

The *MOTION* function allows the user to set a window for shaft speed. If the resolver shaft speed falls within the defined window criteria, the MD LED (Motion Detect) and Motion Detect outputs will provide visual and electrical feedback depending on how the Motion Detect parameters are programmed into the control unit's memory. In data entry mode, this is the number 4 key.

3.2.2 PLS-601 FRONT PANEL USER INTERFACE - Continued

TEACH
5

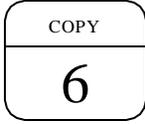The *TEACH* function allows a user to enter the current shaft position into memory as the FROM or TO position of a LOBE, using only the ENTER key. In data entry mode, this is the number 5 key.

COPY
6

The *COPY* function allows the user to copy the stored program data from one channel to another, one program to another, or from one PLS-601 control unit to another. In data entry mode, this is the number 6 key.

F7
7
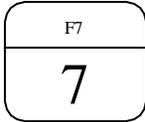
The *F7* function can be used to implement a special function, as required by a specific user's application. In data entry mode, this is the number 7 key.

F8
8
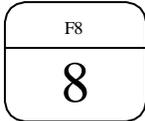
The *F8* function can be used to implement a special function, as required by a specific user's application. In data entry mode, this is the number 8 key.

END
9

The *END* function is used to end data entry for the current program. It also allows for the selection of the other programs available for data entry. Currently, the number of programs available is 1 through 4. In data entry mode, this is the number 9 key.

Each of the above functions will be described in detail, later within this manual.

Utility Keys: The utility keys are used in conjunction with the function/data keys to increase the ease of entering data into the PLS-601 memory. Following is a functional description of each.
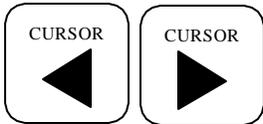
CURSOR ◀   CURSOR ▶

CURSOR KEYS are used to move the cursor within the various PLS-601 data fields, allowing the user to select only those positions at which data entry or data modification is desired.

INC ▲   DEC ▼
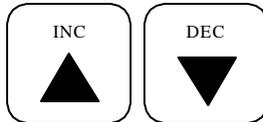
The INC and DEC keys are used to modify existing user data by either INCrementing or DECrementing the selected data field.

NEXT   CLEAR
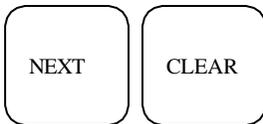
The NEXT key is used to display the sequence of user LOBE data for the SET and TEACH functions. The CLEAR key is used with several of the PLS-601 functions to set a data field to a pre-defined value such as zero.
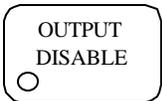
OUTPUT DISABLE ○

The OUTPUT DISABLE key provides the capability of enabling or disabling the relay outputs of the remote relay output board. When the LED is active, the output relays are disabled. Take note that the channel and motion detect output indicators located on the PLS-601 control unit will continue to display output status even though the outputs are turned off.

Group and Channel Status LEDs: The GROUP and CHANNEL LEDs are used in conjunction with each other to give the status of the sixty-four independent channel outputs. The channel outputs are divided into four groups designated as A, B, C, and D. Each group contains sixteen channel outputs. The channel outputs per group are represented as channels A01-A16, B01-B16, C01-C16, and D01-D16. The active group LED designate the active channel outputs.

Motion Detect LED: The MD (motion detect) LED is used to give the status of the MOTION DETECT output. The MD LED is active whenever the resolver shaft speed value (RPM) falls within the programmed MOTION DETECT window. The MOTION DETECT output is brought out to the twenty pin male connector that is located on the bottom of the PLS-601 Control Unit.

3.2.4 AC/DC POWER SYSTEM

The AC POWER PLUG offers a safe, convenient method of providing AC power to the CONTROL UNIT - eliminating the need to connect individual power wires. An RFI LINE FILTER provides built in protection against RFI (Radio Frequency Interference) induced line noise. An AC POWER FUSE provides electrical protection for the CONTROL UNIT's electronics. The internal DC POWER SUPPLY provides DC power for the CONTROL UNIT as well as up to four solid state relay boards or one electromechanical relay board. This eliminates the need for an external power supply.

3.2.5 INTERFACE CONNECTORS

Three interface connectors are supplied on the standard PLS-601 CONTROL UNIT: a TRANSDUCER INTERFACE CONNECTOR, a COMMUNICATIONS OUTPUT CONNECTOR, and a RELAY OUTPUT BOARD connector. These connectors are located on the bottom side of the CONTROL UNIT ENCLOSURE, as shown in FIGURE 3.2.5.

The TRANSDUCER INTERFACE CONNECTOR is an eight-pin male connector, used to interface the CONTROL UNIT to the TRANSDUCER. Refer to SECTION 3.3 for complete details on the TRANSDUCER INTERFACE.

The COMMUNICATIONS OUTPUT CONNECTOR is a four-pin male connector that provides serial data to the remote display. If the CONTROL UNIT is configured for RS232 output, the data can interface to an external computer or PLC.

The RELAY OUTPUT BOARD connector is a twenty pin male connector used to interface to either a solid state relay board or an electromechanical relay board. The pin-out of this connector will not be detailed because of the proprietary interface between the PLS-601 and the relay output boards. The remaining connectors and their pin-out definitions are defined in Figure 3.2.5.

Communications Connector	
Pin 1	Ground
Pin 2	RD
Pin 3	TD
Pin 4	CTL1
Resolver Interface Connector	
Pin 1	No connection
Pin2	No connection
Pin 3	S1 (Stator 1)
Pin 4	S3 (Stator 3)
Pin 5	S4 (Stator 4)
Pin 6	S2 (Stator 2)
Pin 7	R2 (Rotor 2)
Pin 8	R1 (Rotor 1)
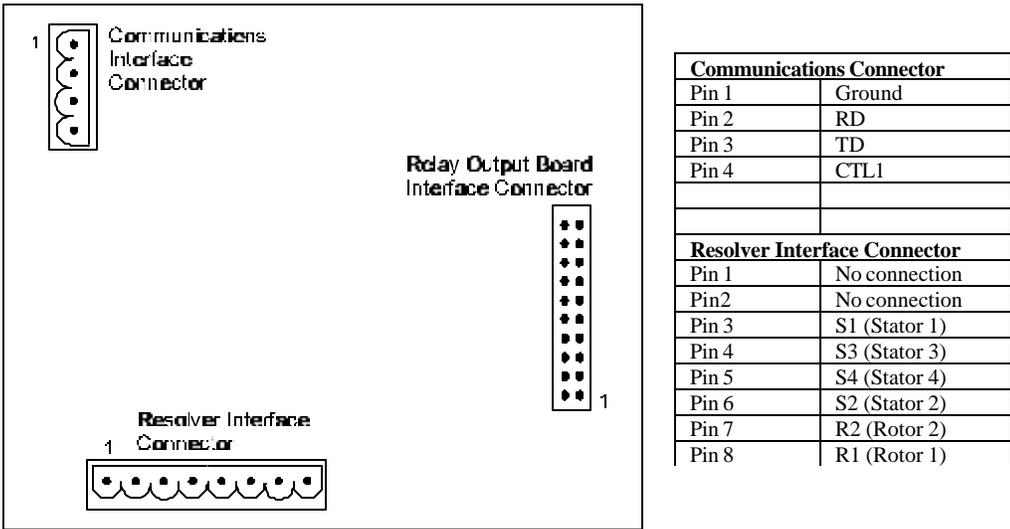
Figure 3.2.5 Bottom view of PLS-601 control unit and connector pin-out definitions.

3.3 TRANSDUCER/CONTROL UNIT INTERFACE CABLE

The CONTROL UNIT is interfaced to the TRANSDUCER via a custom made transducer interface cable. This cable consist of three individually shielded pairs, that has an eight pin female plug-connector on one end, and a seven pin female MS-type connector on the other end.

The standard transducer interface cable is wired at the factory to provide an **INCREASING** angular position reading for **CLOCKWISE** rotation of the TRANSDUCER shaft (when looking into the END of the shaft). The wiring diagram for this cable is shown in Figure 3.3A.
If an **INCREASING** angular position reading for **COUNTER CLOCKWISE** rotation of the TRANSDUCER shaft is desired, refer to Figure 3.3B for that wiring diagram.
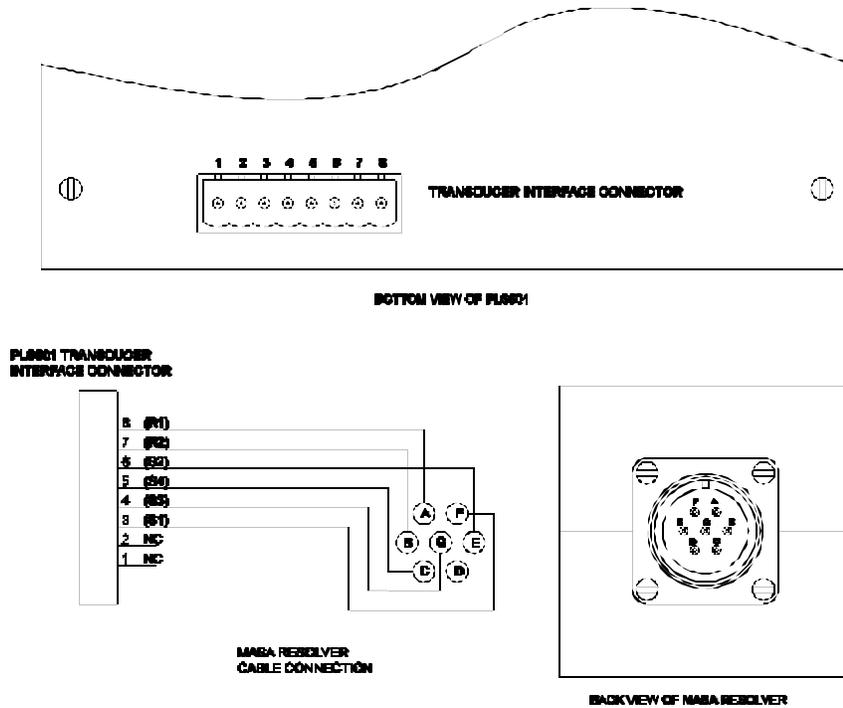
Figure 3.3A
Standard Wiring Diagram (Clockwise transducer shaft rotation)
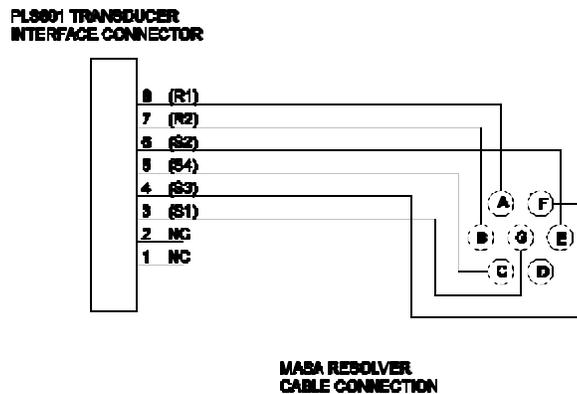
Figure 3.3B
Wiring Diagram (Counter clockwise transducer shaft rotation)

3.4 PLS-601 RELAY OUTPUT BOARDS

The PLS-601 is available with solid state or electromechanical relay boards. Each relay board can contain up to seventeen relays. Sixteen of these relays are dedicated for channel outputs. The remaining relay is dedicated to the MOTION DETECT output. A maximum of four relay boards can be interfaced to the control unit, providing a total of sixty-four relay outputs.

3.4.1 Solid State Relay Board

The solid state relay board is available with four different types of relays. These relays are as follows:

- 120 VAC at 3 Amps
- 240 VAC at 3 Amps
- 60 VDC at 3 Amps
- 200 VDC at 1 Amp

All solid state relays are optically isolated and individually fused for safe, reliable operation. Each relay also has an associated LED to indicate its ON/OFF status. An additional feature of the PLS-601, is that the internal power supply can drive up to four fully loaded solid state relay boards. This eliminates the need for an external power supply.

Figure 3.4.1 shows the layout of the solid state relay board.
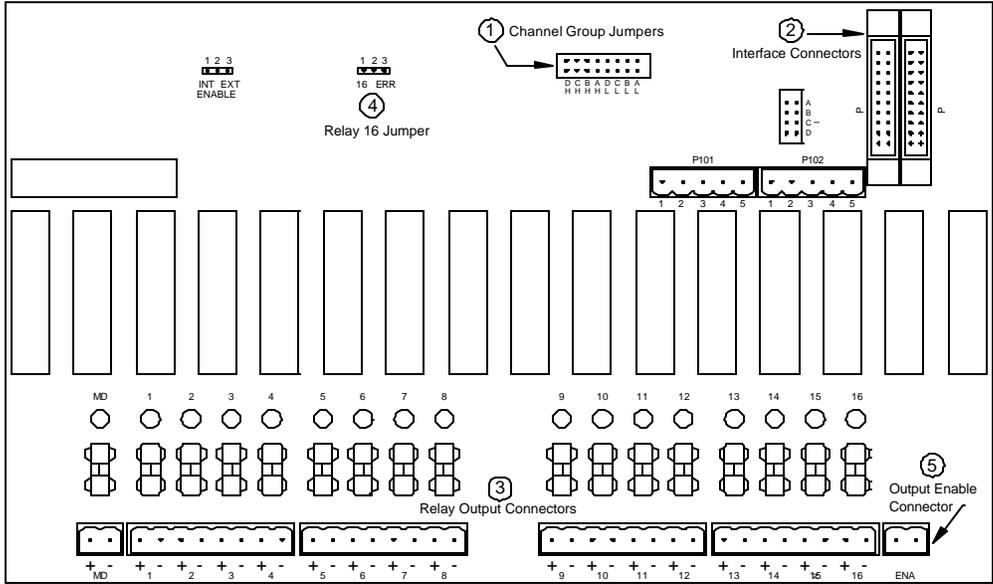
Figure 3.4.1 PLS-601 Solid State Relay Board

(1) Channel Group Jumper Options - Solid State Relay Board

The PLS-601 control unit provides sixty-four channel outputs that are divided into four groups of sixteen channels each. The channels are designated as A01-A16, B01 - B16, C01 - C16, and D01-D16. Up to four solid state relay boards, each with sixteen output relays can be attached to the PLS-601 control unit. Each board must be assigned to one of four output groups designated as A, B, C, or D. This is done by installing the two channel group jumpers in the proper positions on the relay board (see "Channel Group Jumpers" in Figure 3.4.1). The solid state relay board must be configured to match the PLS-601 output group that will drive it. Output Group A will drive relay output board A, Group B will drive relay output board B and so forth.

3.4 PLS-601 RELAY OUTPUT BOARDS - Solid State Relay Board Continued

(2 Interface Connectors) - Solid State Relay Board
Each solid state relay output board contains two 20 pin male interface connectors labeled P101A and P101B (see Interface Connectors in Figure 3.4.1). The PLS-601 Control Unit will connect to P101A through the use of a twenty pin ribbon cable. To add additional solid state relay output boards, simply connect P101B of the first (or previous) relay output board to P101A of the next relay output board. Up to four solid state relay output boards can be connected to the PLS-601 Control Unit by this interface method.

(3) Relay Output Connectors - Solid State Relay Board
Each solid state relay board contains four 8 pin plug connectors that provides two output pins for each of the sixteen channels (see Relay Output Connectors in Figure 3.4.1). These outputs are normally off until activated by the PLS-601 Control Unit. The solid state relay output connectors are labeled (+ 1 -) through (+ 16 -). In addition, a 2 pin connector is available for the MOTION DETECT function. This connector is labeled (+ MD -).

(4) Relay 16 Jumper Options - Solid State Relay Board
Solid state Relay 16 may be used as one of the standard channel output relays, or it may be used as an indication that an error has occurred in the PLS-601 Control Unit. To enable solid state Relay 16 as a standard output, connect pins 1 and 2 together of J1 (see Relay 16 Jumper in Figure 3.4.1). To enable solid state relay 16 as an error indicator, connect pins 2 and 3 together of J1. When solid state relay 16 is used as an error indicator, it will be active in non error conditions (ON) and non-active in an error condition (OFF).

(5) Output Enable - Solid State Relay Board
Each solid state relay board has a 2 pin input connector that implements an OUPTUT ENABLE function (see Output Enable Connector in Figure 3.4.1). This connector is labeled ENA. The ENA pins must be shorted together in order for any of the seventeen solid state relay outputs to be enabled. If this connection is opened, all seventeen solid state relay outputs will be disabled.

3.4 PLS-601 RELAY OUTPUT BOARDS - Continued

3.4.2 Electromechanical Relay Board

The electromechanical relay board contains a maximum of seventeen electromechanical relays, each rated at 240 VAC at 10 Amps, or 30VDC at 10Amps. Each relay is configured as SPST, providing one normally open contact (N.O.) and one normally closed contact (N.C.).
Figure 3.4.2 shows the layout of the electromechanical relay board.
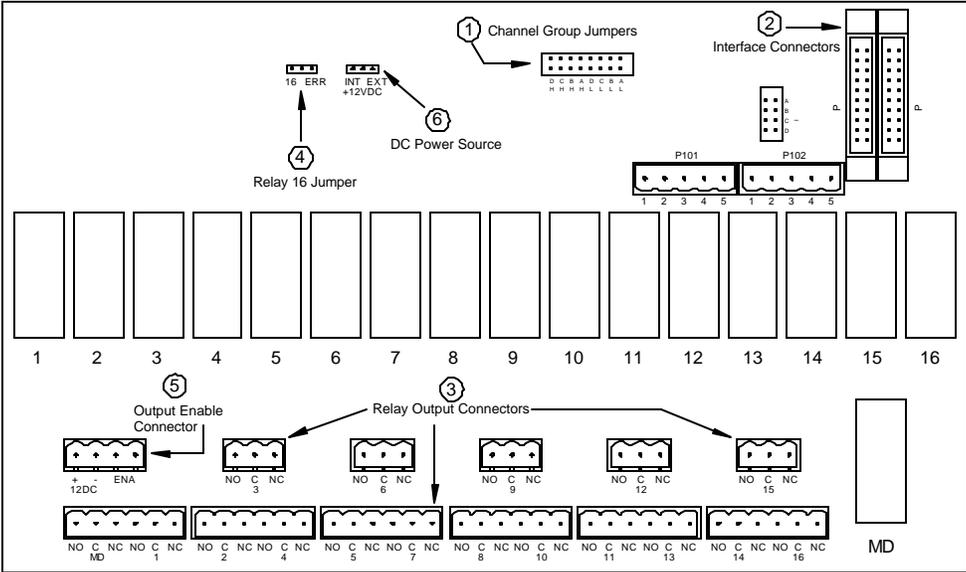
Figure 3.4.2 PLS-601 Electromechanical Relay Board

(1) Channel Group Jumper Options - Electromechanical Relay Board

The PLS-601 Control Unit provides sixty-four channel outputs that are divided into four groups of sixteen channels each. The channels are designated as A01-A16, B01 - B16, C01 - C16, and D01-D16. Up to four electromechanical relay boards, each with sixteen relays, can be attached to the PLS-601 Control Unit. However, only one electromechanical relay board can be directly driven from the PLS-601 Control Unit's power supply. If additional boards are required, an external power supply must be used (see DC Power Source for details). Each board must be assigned to one of four output groups designated as A, B, C, or D. This is done by installing the two channel group jumpers in the proper positions on the relay board (see Channel Group Jumpers in Figure 3.4.2). The relay board must be configured to match the PLS-601 output group that will drive it. Output Group A will drive relay output board A, Group B will drive relay output board B and so forth.

(2) Interface Connectors - Electromechanical Relay Board

Each electromechanical relay output board contains two 20 pin male interface connectors labeled P101A and P101B (see Interface Connectors in Figure 3.4.2). The PLS-601 Control Unit will connect to P101A through the use of a twenty pin ribbon cable. To add additional electromechanical relay output boards, simply connect P101B of the first (or previous) relay output board to P101A of the next relay output board. Up to four electromechanical relay output boards can be connected to the PLS-601 Control Unit by this interface method.

(3) Relay Output Connectors - Electromechanical Relay Board

Each electromechanical relay board contains five 3 pin plug connectors and six 6 pin connectors that provides two output pins and a common for each of the sixteen channels (see Relay Output Connectors in Figure 3.4.2). These outputs are normally closed (NC) until activated by the PLS-601 Control Unit. The electromechanical relay output connectors are labeled (NO C NC) for each of the channels. In addition, 3 pins are available for the MOTION DETECT function. The MD function shares the first three pins of the channel 1 connector.

3.4 PLS-601 RELAY OUTPUT BOARDS - Electromechanical Relay Board Continued

(4) Relay 16 Jumper Options - Electromechanical Relay Board
Electromechanical Relay 16 may be used as one of the standard channel output relays, or it may be used as an indication that an error has occurred in the PLS-601 Control Unit. To enable solid state relay 16 as a standard output, connect pins 1 and 2 together of J1 (see Relay 16 Jumper in Figure 3.4.2). To enable solid state relay 16 as an error indicator, connect pins 2 and 3 together of J1. When solid state Relay 16 is used as an error indicator, it will be active in non error conditions (ON) and non-active in an error condition (OFF).

(5) Output Enable - Electromechanical Relay Board
Each electromechanical relay board has a 2 pin input connector that implements an OUPTUT ENABLE function (see "Output Enable Connector in Figure 3.4.2). This connector is labeled ENA. The ENA pins must be shorted together in order for any of the seventeen electromechanical relay outputs to be enabled. If this connection is opened, all seventeen electromechanical relay outputs will be disabled.

(6) DC Power Source - Electromechanical Relay Board
The internal power supply of the PLS-601 Control Unit is capable of only driving one fully loaded electromechanical relay board. Additional boards must be driven from an external power supply. To use an external power supply, the jumper labeled INT EXT +12VDC must be placed between 2 and 3 (see DC Power Source in Figure 3.4.2). The external power supply voltage source must enter the board through the connector labeled (+ - 12DC). Make sure that the positive voltage of the external supply is attached to the connector pin labeled (+) and that the negative voltage (or ground) is attached to the connector pin labeled '-'.

4.0 USING THE PLS-601

It is strongly recommended that this portion of the User's Manual be read in its entirety before placing your PLS-601 into operation. Failure to follow the instructions given in the following sections may void your PLS-601 warranty.

4.1 INSTALLATION

ALL PLS-601 ELECTRICAL CONNECTORS MUST CONFORM TO THE NATIONAL ELECTRIC CODE AND ANY LOCAL ELECTRIC CODES IN EFFECT.

IN THE CASE OF ANY DISCREPANCIES BETWEEN THE ELECTRIC CODES AND THESE INSTALLATION INSTRUCTIONS, THE ELECTRIC CODE MUST TAKE PRECEDENT.

4.1.1 MOUNTING THE RESOLVER

The RESOLVER is designed to be mounted on the target machine, and coupled to the target machine shaft. The RESOLVER should be mounted and coupled in a manner such as to minimize shock, vibration, as well as axial and radial shaft loading.

The RESOLVER may be mounted via the standard front face mount or the optional foot-type mounting adapter.

4.1.2 MOUNTING THE CONTROL UNIT

The PLS-601 Control Unit is designed to be mounted in a NEMA type enclosure, which is suitable for the ambient environment. The enclosure must protect the Control Unit from contamination caused by water, oil, dust, or corrosive gases. The Control Unit should not be subjected to excessive amount of mechanical shock or vibration.

The mounting location should be chosen such as to avoid exposure to significant levels of electromagnetic interference (EMI), which can be induced by devices such as motor starters and control relays. The operating temperature must be maintained between 32°F and 125°F.

4.1.3 CONNECTING THE RESOLVER TO THE CONTROL UNIT

The Resolver is connected to the PLS-601 Control Unit via the Resolver/Control Unit Interface Cable. The Cable is a 3-pair, individually shielded cable, containing an eight pin female plug-connector on one end, and a seven pin female MS-type connector on the other.

The standard interface cable is wired at the factory to provide an INCREASING angular position reading for CLOCKWISE rotation of the Resolver shaft (when looking into the END of the shaft). An INCREASING angular position reading during COUNTERCLOCKWISE rotation of the Resolver shaft may be achieved by interchanging two of the wires that are brought into the eight pin female connector. See SECTION 3.3 for complete wiring details.

The interface cable may be a maximum length of 2500 feet, and should always be routed in such a manner as to avoid exposure to electromagnetic interference (EMI).

4.1.3 CONNECTING THE RESOLVER TO THE CONTROL UNIT - Continued

The seven pin female MS-connector is plugged into the mating seven pin male connector located on the rear of the Resolver.

The eight pin female connector is plugged into the mating eight pin male connector located on the bottom of the PLS-601 Control Unit (See SECTION 3.2.5).

4.1.4 MOUNTING THE RELAY BOARDS

The relay boards are designed to be mounted in a NEMA type enclosure that is suitable for the environment that the boards will operate within. The enclosure must be shock mounted and be able to protect the boards from water, oil, dust, and corrosive materials. The boards should not be exposed to excessive amounts of mechanical shock or vibration. The mounting location should not be exposed to extreme levels of electromagnetic interference (EMI) that can be induced by devices such as motor starters and control relays. The operating temperature of the relay boards has been rated at 32°F to 125°F.

4.1.5 INSTALLING THE AC POWER CORD

An AC Power Cord is provided with each PLS-601 Control Unit. The female end of the Power Cord should be inserted into the male AC Power Plug located on the side of the Control Unit enclosure.

4.1.6 POWERING ON THE CONTROL UNIT

The Control Unit requires a clean, stable source of AC Power to operate. See SECTION 3.2 for the complete AC Power requirements and specifications of the various Control Unit input power options.

The male end of the AC Power Cord should be inserted into a standard GROUNDING RECEPTACLE, which has been wired to provide the AC Power requirements specified in SECTION 3.2.

4.2 PLS-601 PROGRAMMING

The PLS-601 Control Unit offers four standard programs, each consisting of OFFSET, SCALE FACTOR, MOTION DETECT, and LOBE data that is entered by the user via the PLS-601 functions. The SCALE FACTOR, OFFSET, SETPOINT and MOTION DETECT functions require the user to enter data via the FRONT PANEL. Parameters can only be entered into the PLS-601 memory when the front panel mode switch is in the PROGRAM position.

The following sections explain how to enter data into the control unit. A typical programming sequence for the PLS-601is as follows:

- Apply power to the PLS-601 control unit.
- Turn mode switch to PROGRAM
- Enter SCALE values
- Enter OFFSET values
- Enter SET mode or "TEACH" mode
- Define MOTION detect window
- Perform COPY command if applicable
- END programming sequence

For each of the PLS-601 functions, a BLINKING digit on the display indicates the position of the cursor at which data may be entered. Once programmed, the user may quickly and easily instruct the unit to operate under the control of any one of the four separate programs. Figure 4.2.1 depicts the front panel of the PLS-601 control unit.
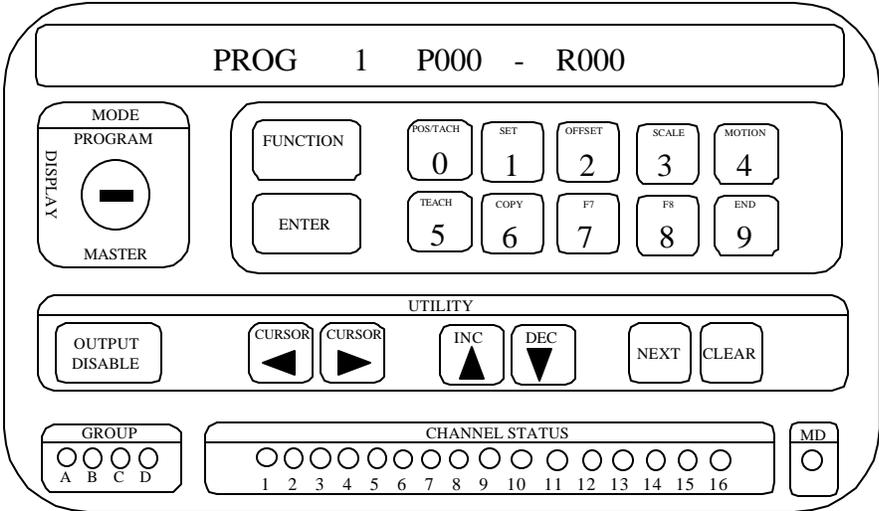
Figure 4.2.1 PLS-601 Front Panel

4.2.1 PLS-601 CHANGE PROGRAM NUMBER

Once the power to the PLS-601 has been applied, one of the four programs must be selected by entering the desired program number (PROG). To accomplish this task, make sure the MODE switch is in the 'PROGRAM' position. The following describes how to change the PROGRAM number of the PLS-601.

CHANGE PROGRAM NUMBER:

CHANGE PROGRAM NUMBER DISPLAY: **PROG 1 P000-R000**
(Highlighted character indicates blinking character that can be changed)

Select: *1 2 3 or 4 (Blinking character will change accordingly)*
or Select: *INC (Blinking character will INCrement to next value)*
or Select   *DEC (Blinking character will DECrement to next value)*
or Select   *CLEAR (Selects PROGRAM NUMBER 1)*

New Display: **PROG 2 P000-R000**

Select: *ENTER*   Selects the new program number into memory for data entry to begin. The FUNCTION LED becomes active and the display prompt for PROGRAM NUMBER stops blinking.

New Display: **PROG 2 P000-R000**

4.2.2 TACHOMETER Function

The TACHOMETER function is used to display the selected PROGRAM NUMBER (PROG), the RESOLVER shaft position (P) in degrees, and the RESOLVER shaft speed (R) in RPM. This function does not allow for data entry.

TACHOMETER DATA Function:

Select: *POS/TACH*

Selects the POS/TACH function in order to display the current RESOLVER shaft position in degrees and RESOLVER shaft speed in RPM.

New Display: **PROG 2 P000-R000**

4.2.3 SET Function

The SET function is used to enter LOBE data into the PLS-601's memory. The SET function will allow single or multiple LOBE data to be entered on any or all of the 64 available channels. A total of 3808 LOBES (238 LOBES per channel group per program) may be entered. The timing and dwell of each LOBE is defined by a FROM position and a TO position. The FROM position defines the timing, whereas the difference between the FROM and TO positions defines the DWELL.

SET Function:

Select: *SET*   Selects the LOBE data entry function.

New Display: **CH A01 F   -T**
(Highlighted character indicates blinking character that can be changed.)

To enter LOBE data, the CHANNEL GROUP must be selected. Once the channel group has been chosen, the desired channel within the group must be selected. The channels are divided into four groups with each group consisting of up to sixteen channels. When all channel groups are active, a total of 64 individual channels become available. The channels are designated as A01 - A16, B01 - B16, C01 - C16, and D01 - D16.

SELECTING THE CHANNEL GROUP:

Display: **CH A01 F   -T**
(Highlighted character indicates blinking character that can be changed)

Select: *INC*   Increments the active group (A, B, C, or D) to the next
                                  available group value.

New Display: **CH B01 F   -T**

Select: *DEC*   Decrements the active group (A, B, C, or D) to the
                                  previous available group value.

New Display: **CH A01 F   -T**

Select: *CURSOR*   Moves the cursor left or right within the three digit
                                  CHANNEL field of the front panel display.

New Display: **CH A01 F   -T   > key used to move CURSOR to the RIGHT.**

                        CH A01 F   -T   < key used to move CURSOR to the LEFT.

Select: *CLEAR*   Sets the displayed CHANNEL GROUP to "A" and the
                                  CHANNEL NUMBER to "1".

New Display :   **CH A01 F   -T**

Select: *ENTER*   Selects the displayed CHANNEL GROUP and
                                  CHANNEL NUMBER for entry of LOBE DATA.

Select: *FUNCTION:*   Terminates the SET function and returns the user to
                                  FUNCTION select mode where any one of the PLS-601
                                  functions can be selected.

4.2.3 SET Function - Continued

SELECTING THE CHANNEL NUMBER:

| Display: | | **CH A0**1** F   -T** |
(Highlighted character indicates blinking character that can be changed)

Select: **2**   The numerical value of the selected DATA KEY is displayed in the present cursor position. In this example, the numerical value of 2 is selected.

New Display: **CH A0**2** F   -T**

Select: **DEC**   Decrements the displayed CHANNEL NUMBER to the previous value.

New Display: **CH A0**1** F   -T**

Select: **INC**   Increments the displayed CHANNEL NUMBER to the next value.

New Display: **CH A0**2** F   -T**

Select: **CURSOR**   Moves the cursor left or right within the three digit CHANNEL field of the front panel display.

Select: **CLEAR**   Sets the displayed CHANNEL GROUP to "A" and the CHANNEL NUMBER to "1".

New Display :   **CH **A**01 F   -T**

Select: **ENTER**   Selects the displayed CHANNEL GROUP and CHANNEL NUMBER for entry of LOBE DATA.

Select: **FUNCTION:**   Terminates the SET function and returns the user to FUNCTION select mode where anyone of the PLS-601 functions can be selected.

ENTERING CHANNEL LOBES

After the channel has been selected, the LOBE data may be entered. If no lobes have previously been programmed for the selected channel, the F and T fields will display blank characters ('_'). If one or more LOBES already exist for the selected channel, the data for the first LOBE will be displayed in the F and T fields.

The PLS-601 allows programming through zero by specifying a FROM field that is larger than the TO field. For example, if the 'FROM' field is specified as 300 and the TO field is set to 060, the channel output will turn on at 300, remain on through zero, and turn off at 060. The PLS-601 will not allow data entry into the FROM or TO fields if the value is greater than the SCALE FACTOR value. If this is attempted, the value will automatically be set to zero.
The following designates the entry of new channel LOBES.

4.2.3 SET Function - Continued

NEW CHANNEL LOBE ENTRY

Display: **CH A01 F█ _ _   -T_ _ _**
(Highlighted character indicates blinking character that can be changed)

Select: *DATA 0 - 9*   The numerical value of the selected DATA KEY is
                                displayed in the present cursor position. As an example,
                                the value of 123 will be entered into the FROM field and
                                the value of 345 will be entered into the TO field.

New Display: **CHA01 F 1 2 3 - T 3 4 █5**

Select: *< CURSOR*   Moves the cursor left within the three digit FROM or TO
                                data fields of the front panel display.

New Display: **CHA01 F 1 2 3 - T 3 █4 5**

Select: *>CURSOR*   Moves the cursor right within the three digit FROM or
                                TO data fields of the front panel display.

New Display: **CHA01 F 1 2 3 - T 3 4 █5**

Select: *ENTER*   The displayed FROM and TO data fields are entered into
                                memory. The cursor is set to the '-' position between the
                                FROM and TO fields and the data is now considered as
                                existing data.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *NEXT*   Selects and displays the next LOBE in sequence.

New Display: **CHA02 F _ _ _ - T_ _ _**
                                *The '_' in the FROM and TO fields indicates that no
                                LOBE data has been stored for this LOBE. If numerical
                                data is present within the FROM and TO fields, than data
                                has been previously entered for the LOBE that is
                                displayed.*

Select: *FUNCTION:*   Terminates the SET function and returns the user to
                                FUNCTION select mode where anyone of the PLS-601
                                functions can be selected.

4.2.3 SET Function - Continued

MODIFYING EXISTING CHANNEL LOBE DATA

Display: **CH A01 F `1` 2 3 - T 3 4 5**
(Highlighted character indicates blinking character that can be changed)

Select:	*DATA 0 - 9*	The numerical value of the selected DATA KEY is displayed in the present cursor position. As an example, the value of 123 will be entered into the FROM fie ld and the value of 345 will be entered into the TO field.

Select:	*< CURSOR*	Moves the cursor left within the three digit FROM or TO data fields of the front panel display.

New Display: **CHA01 F 1 2 3 - T 3 4 `5`**

Select:	*>CURSOR*	Moves the cursor right within the three digit FROM or TO data fields of the front panel display.

New Display: **CHA01 F `1` 2 3 - T 3 4 5**

Select:	*INC*	Increments the numerical value at the current cursor location in the FROM or TO data fields. If the cursor is between the FROM and TO data fields, both FROM and TO data values will be incremented and placed into memory. The INC key does not require the use of the ENTER key.

New Display: **CHA01 F `2` 2 3 - T 3 4 5**

Select:	*DEC*	Decrements the numerical value at the current cursor location in the FROM or TO data fields. If the cursor is between the FROM and TO data fields, both FROM and TO data values will be decremented and placed into memory. The DEC key does not require the use of the ENTER key.

New Display: **CHA01 F `1` 2 3 - T 3 4 5**

Select:	*CLEAR*	The displayed LOBE is erased from memory allowing for new LOBE data to entered.

New Display: **CHA01 F _ _ _ - T _ _ _**

Select:	*ENTER*	The displayed FROM and TO data fields are entered into memory. The cursor is set to the '-' position between the FROM and TO fields and the data is now considered as existing data.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

4.2.3 SET Function - Continued

MODIFYING EXISTING CHANNEL LOBE DATA

Select: *NEXT*   Selects and displays the next LOBE in sequence.

New Display: **CHA02 F _ _ _ - T_ _ _**
The '_' in the FROM and TO fields indicates that no LOBE data has been stored for this LOBE. If numerical data is present within the FROM and TO fields, than data has been previously entered for the LOBE that is displayed.

Select: *FUNCTION:*   Terminates the SET function and returns the user to FUNCTION select mode where anyone of the PLS-601 functions can be selected.

4.2.4 OFFSET

The OFFSET is a constant, positive adjustment that the CONTROL UNIT adds to the actual Resolver position to produce the shaft POSITION which is displayed and used by the Control Unit functions. The OFFSET function allows the user to align the resolver (electrical zero) and machine (mechanical zero) reference points.

The permissible value of the OFFSET parameter is in the range from 0 to the FULL SCALE VALUE.

An AUTO ZERO function is implemented via the CLEAR key that will automatically calculate the offset required to zero the current resolver shaft position. Using this function will electrically set the position of the resolver to 000 within the position field (P) on the PLS-601 front panel display.

NOTE: Changing the OFFSET value causes a corresponding change in the displayed shaft POSITION, but does not affect the values of the stored LOBE data.

The OFFSET function will display the current resolver shaft position within the 'P' data field and the current resolver shaft rotational speed in RPM within the 'R' data field.

RESOLVER OFFSET:

Select: *OFFSET*

OFFSET DISPLAY: **OF 0 0 0   P 0 7 5 - R 0 4 0**
     (Highlighted character indicates blinking character that can be changed)

Select: *DATA 0 - 9*   The numerical value of the selected DATA KEY is displayed in the present cursor position of the OFFSET data field.

Select: *INC*   Increments the OFFSET value on the display.

New Display: **OF 0 0 1 P 0 7 5 - R 0 4 0**

Select: *DEC*   Decrements the OFFSET value on the display.

New Display: **OF 0 0 0 P 0 7 5 - R 0 4 0**

4.2.4 OFFSET - Continued

RESOLVER OFFSET:

Select:	*< CURSOR*	Moves the cursor left within the three digit OFFSET data field of the front panel display.
New Display:		**OF 0 0 0 P 0 7 5 - R 0 4 0**
Select:	*>CURSOR*	Moves the cursor right within the three digit OFFSET data field of the front panel display.
New Display:		**OF 0 0 0 P 0 7 5 - R 0 4 0**
Select:	*CLEAR*	The PLS-601 control unit calculates, displays and stores the offset value required to set the resolver shaft position to electrical '000'. When the CLEAR function is used, the offset value is calculated and placed into memory. This function will terminate the data entry for the OFFSET value.
New Display:		**OF 0 0 0 P 0 7 5 - R 0 4 0**
Select:	*ENTER*	Stores the new OFFSET value into memory on the display. The Control Unit automatically returns to FUNCTION select mode after pressing ENTER.
Select:	*FUNCTION:*	Pressing the FUNCTION key at any time while in OFFSET mode will terminates the OFFSET function and returns the user to FUNCTION select mode where any one of the PLS-601 other functions can be selected.

4.2.5 SCALE

The SCALE FACTOR is the number of increments that the CONTROL UNIT divides one complete Transducer shaft rotation into. The SCALE function allows the user to enter a SCALE FACTOR FROM 0002 TO 1000.

NOTE: Upon changing the SCALE FACTOR, the Control Unit will re-scale all stored LOBE data. Care should be taken when changing the SCALE FACTOR, as the rescaling of the LOBE data may produce undesirable rounding.

SCALE FACTOR:

Select:	*SCALE*	
SCALE DISPLAY:		**SF 1 0 0 0 P 0 7 5 - R 0 4 0**
		(Highlighted character indicates blinking character that can be changed)
Select:	*DATA 0 - 9*	The numerical value of the selected DATA KEY is displayed in the present cursor position of the SCALE FACTOR data field - to a maximum value of 1000.

4.2.5 SCALE - Continued

SCALE FACTOR:

Select:	**CLEAR**	The value of the SCALE FACTOR is set to 1000 and entered into memory. The Control Unit automatically returns to FUNCTION select mode after pressing CLEAR.
New Display:		**SF 1 0 0 0 P 0 7 5 - R 0 4 0**
Select: ‹ *CURSOR*		Moves the cursor left within the four digit SCALE FACTOR data field of the front panel display.
New Display:		**SF 1 0 0 0̶ P 0 7 5 - R 0 4 0**
Select:	› *CURSOR*	Moves the cursor right within the four digit SCALE FACTOR data field of the front panel display.
New Display:		**SF ▯ 0 0 0 P 0 7 5 - R 0 4 0**
Select:	*ENTER*	Stores the new OFFSET value into memory on the display. The Control Unit automatically returns to FUNCTION select mode after pressing ENTER.
Select:	*FUNCTION:*	Pressing the FUNCTION key at any time while in SCALE mode will terminates the SCALE function and returns the user to FUNCTION select mode where any one of the PLS-601 other functions can be selected.

4.2.6 MOTION

MOTION WINDOW

Motion allows the user to set a window for shaft speed, and receive an indication that the shaft speed falls within the window via the MD (Motion Detect) LED and Motion Detect output (See section 3.2.5).

The window is defined by the MOTION FROM (MF) and MOTION TO (MT) values are considered to be WITHIN the window.

Note: If the 'MF' field is less than the 'MT' field, the MD LED and output will be ON when the shaft speed is within the MD window, and OFF when it is outside of the window.

If the 'MF' field is greater than the 'MT' field, the MD LED and output will be OFF when the shaft speed is within the MD window, and ON when it is outside of the window.

4.2.6 MOTION - Continued

Select: *MOTION*   Selects the MOTION data entry function.

    New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**
(Highlighted character indicates blinking character that can be changed.)

Select: *DATA 0 - 9*   The numerical value of the selected DATA KEY is
                                           displayed in the present cursor position of the 'MF'
                                           or 'MT' fields.
New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**

Select: *INC*   Increments the numerical value at the current cursor
                                           location in the MF or MT data fields. The value is
                                           immediately entered into memory, the INC key does not
                                           require the use of the ENTER key.

New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**

Select: *DEC*   Decrements the numerical value at the current cursor
                                           location in the MF or MT data fields. The value is
                                           immediately entered into memory, the DEC key does not
                                           require the use of the ENTER key.

New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**

Select: *CLEAR*   Sets the "MF" and "MT" RPM values to 000

New Display: **MF 0 0 0   MT 0 0 0 - R 0 4 0**

Select: *< CURSOR*   Moves the cursor left within the three digit 'MF'
                                           or 'MT' fields.

New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**

Select: *> CURSOR*   Moves the cursor right within the three digit 'MF'
                                            or MT fields.

New Display: **MF 0 1 0   MT 0 6 0 - R 0 4 0**

Select: *ENTER*   Stores the new MOTION value into memory on the
                                           display. The Control Unit automatically returns to
                                           FUNCTION select mode after pressing ENTER.

Select: *FUNCTION:*   Pressing the FUNCTION key at any time while in
                                           MOTION mode will terminate the MOTION function
                                           and returns the user to FUNCTION select mode where
                                           any one of the PLS-601 other functions can be selected.

4.2.7 TEACH Function

The TEACH function allows a user to enter the CURRENT SHAFT POSITON into memory as the FROM or TO position of a LOBE - using only the ENTER key.

TEACH Function:

Select: *TEACH*   Selects the TEACH data entry function.

New Display*:*   CH **A**01 F   -T
(Highlighted character indicates blinking character that can be changed.)

To enter LOBE data, the CHANNEL GROUP must be selected. Once the channel group has been chosen, the desired channel within the group must be selected. The channels are divided into four groups with each group consisting of up to sixteen channels. When all channel groups are active, a total of 64 individual channels become available. The channels are designated as A01 - A16, B01 - B16, C01 - C16, and D01 - D16.

SELECTING THE CHANNEL GROUP:

Display: CH **A**01 F   -T
(Highlighted character indicates blinking character that can be changed)

Select: *INC*   Increments the active group (A, B, C, or D) to the next available group value.

New Display*:*   CH **B**01 F   -T

Select: *DEC*   Decrements the active group (A, B, C, or D) to the previous available group value.

New Display*:*   CH **A**01 F   -T

Select: <*CURSOR*   Moves the cursor left in the three digit CHANNEL field of the front panel display.

               >*CURSOR*   Moves the cursor right in the three digit CHANNEL field of the front panel display.

Select: *CLEAR*   Sets the displayed CHANNEL GROUP to 'A' and the CHANNEL NUMBER to '1'.

New Display *:*   CH **A**01 F   -T

Select: *ENTER*   Selects the displayed CHANNEL GROUP and CHANNEL NUMBER for entry of LOBE DATA.

Select: *FUNCTION:*   Terminates the TEACH function and returns the user to FUNCTION select mode where any one of the PLS-601 functions can be selected.

4.2.7 TEACH Function - Continued

SELECTING THE CHANNEL NUMBER:

Display: **CH A0**<mark>**1**</mark> **F   -T**
(Highlighted character indicates blinking character that can be changed)

Select:	*2*	The numerical value of the selected DATA KEY is displayed in the present cursor position. In this example, the numerical value of 2 is selected.

New Display*:*   **CH A0**<mark>**2**</mark> **F   -T**

Select:	*DEC*	Decrements the displayed CHANNEL NUMBER to the previous value.

New Display: **CH A0**<mark>**1**</mark> **F   -T**

Select:	*INC*	Increments the displayed CHANNEL NUMBER to the next value.

New Display*:*   **CH A0**<mark>**2**</mark> **F   -T**

Select:	*< CURSOR*	Moves the cursor left in the three digit CHANNEL field of the front panel display.
	>CURSOR	Moves the cursor right in the three digit CHANNEL field of the front panel display.

Select:	*CLEAR*	Sets the displayed CHANNEL GROUP to 'A' and the CHANNEL NUMBER to '1'.

New Display *:*   **CH** <mark>**A**</mark>**01 F   -T**

Select:	*ENTER*	Selects the displayed CHANNEL GROUP and CHANNEL NUMBER for entry of LOBE DATA.

Select:	*FUNCTION:*	Terminates the SET function and returns the user to FUNCTION select mode where anyone of the PLS-601 functions can be selected.

4.2.7 TEACH Function - Continued

ENTERING CHANNEL LOBES

After the channel has been selected, the LOBE data may be entered. If no lobes have previously been programmed for the selected channel, the 'F' and 'T' fields will display blank characters ('_'). If one or more LOBES already exist for the selected channel, the data for the first LOBE will be displayed in the 'F' and 'T' fields.

NEW CHANNEL LOBE ENTRY

Display: **CH A01 F_ _ _   -T_ _ _**
(Highlighted character indicates blinking character that can be changed)

Select: *< CURSOR*   Moves the cursor between F and T fields.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *ENTER*   The displayed FROM and TO data fields are entered into memory. The cursor is set to the '-' position between the FROM and TO fields and the data is now considered as existing data.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *NEXT*   Selects and displays the next LOBE in sequence.

New Display: **CHA02 F _ _ _ - T_ _ _**
                                           The '_' in the FROM and TO fields indicates that no LOBE data has been stored for this LOBE. If numerical data is present within the FROM and TO fields, than data has been previously entered for the LOBE that is displayed.

Select: *FUNCTION:*   Terminates the TEACH function and returns the user to FUNCTION select mode where any one of the PLS-601 functions can be selected.

4.2.7 TEACH Function - Continued

MODIFYING EXISTING CHANNEL LOBE DATA

Display: **CH A01 F 1 2 3 - T 3 4 5**
(Highlighted character indicates blinking character that can be changed)

Select: < *CURSOR*   Moves the cursor between F and T fields.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *INC*   Increments the numerical value at the current cursor
                                      location in the FROM or TO data fields. If the cursor is
                                      between the FROM and TO data fields, both FROM and
                                      TO data values will be incremented and placed into
                                      memory. The INC key does not require the use of the
                                      ENTER key.

New Display: **CHA01 F 1 2 3 - T 3 4 6**

Select: *DEC*   Decrements the numerical value at the current cursor
                                      location in the FROM or TO data fields. If the cursor is
                                      between the FROM and TO data fields, both FROM and
                                      TO data values will be decremented and placed into
                                      memory. The DEC key does not require the use of the
                                      ENTER key.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *CLEAR*   The displayed LOBE is erased from memory and the
                                      next LOBE in sequence is displayed.

New Display: **CHA02 F 0 4 0 - T 0 6 0**

Select: *ENTER*   The displayed FROM and TO data fields are entered into
                                      memory. The cursor is set to the '-' position between the
                                      FROM and TO fields and the data is now considered as
                                      existing data.

New Display: **CHA01 F 1 2 3 - T 3 4 5**

Select: *NEXT*   Selects and displays the next LOBE in sequence.

New Display: **CHA02 F _ _ _ - T _ _ _**
                                      The '_' in the FROM and TO fields indicates that no
                                      LOBE data has been stored for this LOBE. If numerical
                                      data is present within the FROM and TO fields, than data
                                      has been previously entered for the LOBE that is
                                      displayed.

Select: *FUNCTION:*   Terminates the TEACH function and returns the user to
                                      FUNCTION select mode where any one of the PLS-601
                                      functions can be selected.

4.2.8 COPY

The COPY function allows the user to copy the stored program data from one CHANNEL to another, one PROGRAM to another, or from one PLS-601 UNIT to another.

SELECTING THE TYPE OF COPY

Select:	*COPY*	Selects the COPY program function.

New Display*:* **COPY** C P U
(Highlighted character indicates blinking character that can be changed.)

Select:	*CURSOR*	Moves the cursor between the three COPY types: C (Channels) P (Program) and U (Unit).

New Displa*y:* **COPY C** P **U**

Select	*ENTER*	Selects the COPY type that is currently being indicated by the cursor.
Select:	*FUNCTION:*	Terminates the COPY function and returns the user to FUNCTION select mode where any one of the PLS-601 functions can be selected.

COPYING FROM CHANNEL TO CHANNEL

For a CHANNEL to CHANNEL COPY, the user must specify the 'FROM' CHANNEL and the 'TO' CHANNEL. All LOBE data stored for the 'FROM' CHANNEL will be copied into the 'TO' CHANNEL.

Note: During a CHANNEL to CHANNEL COPY, the current 'TO' CHANNEL LOBE data will be lost.

The channels are divided into four groups with each group consisting of up to sixteen channels. When all channel groups are active, a total of 64 individual channels become available. The channels are designated as A01 - A16, B01 - B16, C01 - C16, and D01 - D16.

Select:	*COPY*	Selects the COPY program function.

New Display*:* **COPY** C **P U**

Select	*ENTER*	Selects the COPY type that is currently being indicated by the cursor.

New Display: **COPY C F** A _ _ **-T A** _ _

Select:	*INC*	Increments the displayed 'FROM' CHANNEL GROUP or 'TO' CHANNEL GROUP, depending on the cursor position.

*New Displa*y: **COPY C F** B _ _ **-T A** _ _

Select:	*DEC*	Decrements the displayed 'FROM' CHANNEL GROUP or 'TO' CHANNEL GROUP, depending on the cursor position.

4.2.8 COPY Function - Continued

Select:	*CURSOR*	Moves the cursor left or right within the three digit 'FROM' CHANNEL field and/or 'TO' CHANNEL fields.

New Display: **COPY C F A ▮ _ -T A _ _**

Select	*CLEAR*	Sets the displayed 'FROM' CHANNEL and 'TO' CHANNEL to A _ _.

New Display: **COPY C F ▓ _ _ -T A _ _**

Select	*ENTER*	Initiates the COPY for the displayed 'FROM' and 'TO' CANNELS
Select:	*FUNCTION:*	Terminates the COPY function and returns the user to FUNCTION select mode where any one of the PLS-601 functions can be selected.

SELECTING the CHANNEL NUMBER

Select:	*>CURSOR*	Move the cursor right within the three digit 'FROM' CHANNEL field until positioned for first blank space on the display.

New Display: **COPY C F A ▮ _ -T A _ _**

Select:	*INC*	Increments the displayed 'FROM' CHANNEL NUMBER or 'TO' CHANNEL NUMBER, depending on the cursor position.

New Display: **COPY C F A ▓ 1 -T A _ _**

Select:	*DEC*	Decrements the displayed 'FROM' CHANNEL NUMBER or 'TO' CHANNEL NUMBER, depending on the cursor position.

New Display: **COPY C F A ▓ 6 -T A _ _**

Select:	*>CURSOR*	Move the cursor right to the three digit 'TO' CHANNEL field until positioned at the first blank space on the display.

New Display: **COPY C F A 0 1 -T A ▮ _**

Select:	*INC*	Increments the displayed 'FROM' CHANNEL NUMBER or 'TO' CHANNEL NUMBER, depending on the cursor position.

New Display: **COPY C F A 0 1 -T A ▓ 1**

4.2.8 COPY Function - Continued

Select: *DEC*   Decrements the displayed 'FROM' CHANNEL
                                             NUMBER or 'TO' CHANNEL NUMBER, depending
                                             on the cursor position.

New Display: **COPY C F A 0 1 -T A 1 6**

Select   *CLEAR*   Sets the displayed 'FROM' CHANNEL and 'TO'
                                         CHANNEL to A _ _.

New Display: **COPY C F A _ _ -T A _ _**

Select   *ENTER*   Initiates the COPY for the displayed 'FROM' and
                                        'TO' CANNELS

Select: *FUNCTION:*   Terminates the COPY function and returns the user to
                                        FUNCTION select mode where any one of the PLS-601
                                        functions can be selected.

CHANNEL TO CHANNEL COPY COMPLETION

During the CHANNEL to CHANNEL COPY, the Control Unit will BLINK the 'COPY' digits
one at a time to indicate that the COPY is in progress.

After the COPY has been successfully completed, the Control Unit will display 'COPY C P U' on
the alphanumeric display and BLINK only the 'C' (Channel) digit. The 'SELECTING THE TYPE
OF COPY' sequence may now be followed (see section 4.2.8)

COPYING FROM PROGRAM TO PROGRAM

For a PROGRAM to PROGRAM COPY, the user must specify only the 'TO' PROGRAM - the
CURRENT PROGRAM is always the 'FROM' PROGRAM. All data stored by the SET,
OFFSET, SCALE, MOTION and TEACH functions are copied from the CURRENT PROGRAM
into the 'TO' PROGRAM.

Note: During a PROGRAM to PROGRAM COPY, the current 'TO' PROGRAM data is lost.

Select: *COPY*   Selects the COPY program function.

Select: *CURSOR*   Moves the cursor between the three COPY
                                      types: C (Channels) P (Program) and U (Unit).
                                      Choose P.

New Display: **COPY C P U**

Select   *ENTER*   Selects the COPY type that is currently being
                                        indicated by the cursor.

New Display: **COPY P F 1 -T**

4.2.8 COPY Function - Continued

Select:	*DATA 2 - 4*	The numerical value of the selected DATA KEY is displayed in the 'TO' field.

    New Display: **COPY P F 1 -T 2**

Select	*INC*	The displayed value of the 'TO' PROGRAM Is incremented.
Select	*DEC*	The displayed value of the 'TO' PROGRAM is decremented.
Select	*CLEAR*	The displayed value of the 'TO' PROGRAM Is set to "_"
Select	*ENTER*	Initiates the COPY for the displayed 'FROM' and 'TO' PROGRAMS
Select:	*FUNCTION:*	Terminates the COPY function and returns the user to FUNCTION select mode where any one of the PLS-601 functions can be selected.

PROGRAM TO PROGRAM COPY COMPLETION

During the PROGRAM to PROGRAM COPY, the Control Unit will BLINK the 'COPY' digits one at a time to indicate that the COPY is in progress.

After the COPY has been successfully completed, the Control Unit will display 'COPY C P U' on the alphanumeric display and BLINK only the 'C' (Channel) digit. The 'SELECTING THE TYPE OF COPY' sequence may now be followed (see section 4.2.8)

COPYING FROM UNIT TO UNIT

In a UNIT to UNIT COPY, all the data stored in the four PLS-601 PROGRAMS is copied from one PLS-601 Control Unit to another.

To perform a UNIT to UNIT COPY, the sequence below MUST be followed in the given order:

    1.   Power on both PLS-601 Control Units (Neither unit need be connected to a transducer).

    2.   Connect the two PLS-601 Control Units by placing a standard. Interface Cable between the Relay interface connectors on each unit (see section 3.2.5).

    3.   Select the COPY function and "U" (Unit) option, on BOTH units (See section 4.2.8). The OUTPUT DISABLE LED is automatically lit when the "U" option is selected, and MUST be left on during the COPY.

    4.   Use the CURSOR key to select one unit as the SENDING UNIT ('SEN') and the other unit as the RECEIVING UNIT ('REC').

    5.   Push the ENTER key on the RECEIVING UNIT, to ready it for receipt of the COPY data.

    6.   Push the ENTER key on the SENDING UNIT, to initiate the COPY.

NOTE: During a UNIT COPY, all program data stored in the RECEIVE UNIT is lost.

4.2.8 COPY Function - Continued

SELECTING THE SEND AND RECEIVE UNITS

Select: *COPY*   Selects the COPY program function.

Select: *CURSOR*   Moves the cursor between the three COPY types: C (Channels) P (Program) and U (Unit). Choose U.

New Display: **COPY C P U**

Select   *ENTER*   Selects the COPY type that is currently being indicated by the cursor.

New Display: **COPY U SEND REC**

Select   *CURSOR*   Moves the cursor between the SEND and REC fields, Designating the SENDING and RECEIVING UNITS

Select   *ENTER*
(RECEIVE)   Readies the RECEIVE UNIT for receipt of COPY data. The "R" field stops blinking (and may become a solid "R" or a blank).

Select   *ENTER*
(SEND)   Initiates the COPY from the SEND UNIT. The "S" field stops blinking (and may become a solid "S" or a blank).

UNIT TO UNIT COPY COMPLETION

During the UNIT to UNIT COPY, the Control Unit will BLINK the "COPY" digits one at a time to indicate that the COPY is in progress.

After the COPY has been completed, the Control Unit will display "FINISHED" on the alphanumeric display of both SEND and RECEIVE units. The "FUNCTION LED" will be lit, allowing the user to select any of the ten PLS-601 functions.

NOTE: The SEND unit may display "FINISHED" even though a successful COPY has not occurred. The true indicator of a successful COPY is when the RECEIVE UNIT displays "FINISHED".

ERROR CONDITIONS

RECEIVE UNIT fails to receive data from SEND UNIT

A. The RECEIVE UNIT will remain in a 'COPY WAIT' state until it receives data from the SEND UNIT. If the COPY is not successful, the RECEIVE UNIT will remain in the 'COPY WAIT' state indefinitely. To remove the RECEIVE UNIT from the 'COPY WAIT' state, press any key on the RECEIVE UNIT front panel. The RECEIVE UNIT will respond by displaying 'RECEIVE LINE ERR', and lighting the FUNCTION LED.

B. The RECEIVE UNIT is placed in 'COPY WAIT' state before the 'COPY U' option is selected in the SEND UNIT.

4.2.8 COPY Function - Continued

The COPY function and 'U' option must be selected on BOTH units before a SEND or RECEIVE selection is made on either. Failure to follow this sequence will result in a 'RECEIVE LINE ERR' being displayed on the RECEIVE UNIT.

4.2.9 SPECIAL FUNCTION - F7

The F7 function key can be used to implement a special function, as required by a specific user application.

4.2.10 SPECIAL FUNCTION - F8

The F8 function key can be used to implement a special function, as required by a specific user application.

4.2.11 END

The END function is used to end data entry for the current PROGRAM, and allows selection of any one of the four PLS-601 PROGRAMS for data entry.

The Transducer shaft POSITION ('P') and the shaft SPEED in RPM ('R') are displayed.

After entering the PROGRAM NUMBER, the FUNCTION LED is lit indicating that one of the ten PLS-601 functions may be selected.

Select	***END***	Selects the END function
New Display	**PROG 1 P140 - R030**	
Select:	***DATA 1 - 4***	The numerical value of the selected DATA KEY is displayed in the 'PROG' field.
Select	***INC***	Increments the displayed PROGRAM NUMBER
Select	***DEC***	Decrements the displayed PROGRAM NUMBER
Select	***CLEAR***	Sets the displayed PROGRAM NUMBER to 1.
Select	***ENTER***	Selects the displayed PROGRAM NUMBER for data entry, Turns on the FUNCTION LED.

4.3 OUTPUT DISABLE

The OUTPUT DISABLE key provides the capability of enabling or disabling the RELAY outputs (see section 3.4) without affecting the Channel outputs (see section 3.2.5). When lit, the associated OUTPUT DISABLE LED indicates that the Relay outputs have been disabled.

NOTE: OUTPUT DISABLE does not disable the Relay 16 output when RELAY 16 JUMPER OPTION "S" has been selected (See section3.4.1.4 for details of the RELAY 16 JUMPER OPTION).

4.4 CHANNEL STATUS GROUP SELECTION

The Channel outputs are divided into four groups of sixteen outputs each - designated A01-A16, B01-B16, C01-C16 and D01-D16.

The sixteen CHANNEL STATUS LED's display the status of the sixteen Channel outputs in the CHANNEL STATUS GROUP indicated by the GROUP LED's.

Anytime that the FUNCTION LED is lit, the current CHANNEL STATUS GROUP may be changed by using the CURSOR utility keys.

The right CURSOR key will rotate the CHANNEL STATUS GROUP to the (i.e. A to B to C to D to A), while the left CURSOR key will rotate the CHANNEL GROUP to the left (i.e. D to C to B to A to D).

During execution of the SET and TEACH functions, the CHANNEL STATUS GROUP is automatically set to the CHANNEL GROUP currently being shown on the alphanumeric display.

4.5 ERROR CONDITIONS

By selecting RELAY 16 JUMPER OPTION 'S' (see Section 3.4.1), Relay 16 can be used to provide a hardware indication that one of the following Control Unit error conditions has occurred:

> TRANSDUCER SIGNAL ERROR
> CONTROL UNIT MICROPROSSER FAULT
> LOSS OF AC POWER

With the 'S' option selected, Relay 16 is held normally closed (N.C.) by the Control Unit hardware. Should any of the Control Unit errors occur, Relay 16 is OPENED to indicate the error condition.

4.5.1 TRANSDUCER SIGNAL ERROR

If any of the PLS601-IT Interface Cable wires become disconnected or broken, the following error indications will be given by the Control Unit:

In DISPLAY MODE
1. The message 'TRANSDUCER ERROR' will be placed on the display
2. The OUTPUT DISABLE LED will be lit
3. All PLS601-RE Relay outputs will be dis abled
   NOTE: Relay 16 is disabled, regardless of the selected jumper option.

In PROGRAM MODE

1. POSITION and RPM values will read '000' on the display
2. The OUTPUT DISABLE LED will be lit
3. All PLS601-RE Relay outputs will be disabled
   NOTE: Relay 16 is disabled, regardless of the selected jumper option.
4. Normal Control Unit programming will be allowed

4.5 ERROR CONDITIONS - Continued

4.5.2 CONTROL UNIT MICROPROCESSOR FAULT

In the event of a microprocessor fault, the alphanumeric display and Channel outputs are frozen in the State that existed at the time of the failure.

Because it is implemented in hardware, Relay 16 (with the RELAY 16 JUMPER OPTION selected) can be used to give an indication that the control unit has experienced a microprocessor fault.

4.5.3 LOSS OF AC POWER

In the event of a loss of AC power, the Control Unit will cease all operations. The alphanumeric display will become blank, and no signals will be output on the Relay and Transducer interface connectors (see section 3.2.5). Relay 16 is disabled, regardless of the jumper option.

Because the program data is stored in non-volatile EEPROM memory it will not be lost as a result of a loss of AC power.

5.0 PLS-601 MODEL 11

The PLS-601 Model 11 features an "Electric Gearbox" function that provides multi-turn capability for the PLS-601 Model 10, using the standard PLS-TR-1 single turn resolver.

5.1 ELECTRONIC GEARBOX

The 'ELECTRONIC GEARBOX' function allows the user to select the total NUMBER OF TURNS required for the application, which can be any number from 1 to 100. As with the standard system, the selected SCALE FACTOR determines the resolution of each turn, to a maximum of 1000. The total SYSTEM RESOLUTION IS 1000 counts/turn for 100 turns or 100,000 turns. Because the number of turns is stored in non-volatile EEPROM memory, the current POSITION is retained during a loss of power to the Control Unit.

NOTE: Following the loss of power, the system will resume normal operation - providing that the transducer shaft has not rotated more than 1/2 turn (180 degrees) in either direction. If a 180 degree shaft rotation has occurred during the loss of power, the POSITION will be in error and have to be reset.

The following sections out line the differences between the operation and programming of the Model 10 and Model 11 Control Units.

5.2 "MEMORY FULL" CONDITION

The Model 11 Control Unit provides a maximum of 476 LOBES for each of the 4 PROGRAMS. When making a modification to an existing LOBE in memory or in applications which require a large number of LOBES, a MEMORY FULL condition may be reached. 'MEMORY FULL' will be displayed during the SET or TEACH functions to indicate the MEMORY FULL condition. The system will continue with its normal operation, but will not allow further entry or modification of LOBES.

The MEMORY FULL condition may be cleared by pressing the CLEAR key while 'MEMORY FULL' is being displayed. The Control Unit will free up room in memory by eliminating any unused LOBES.

WARNING: The process of compressing the memory is very rapid and is not perceptible to the user. However, during this time, the outputs will be frozen at their current states. To AVOID MACHINE MALFUNCTION, IT IS STRONGLY RECOMMENDED THAT THE OUTPUTS BE DISABLED DURING THIS PROCESS.

5.3 SELECTING THE NUMBER OF TURNS (MASTER MODE)

The NUMBER of TURNS is selected in MASTER MODE (see 3.2.2), through the use of the SCALE function key. The selected TURNS value is used by all four PROGRAMS.

Control Unit in Master Mode

Select: *SCALE*

Display: **TURNS 1 0 0**
     (Highlighted character indicates blinking character that can be changed)

Select: *DATA 0 - 9*   The numerical value of the DATA KEY (i.e. 0-9) is
                                    Displayed in the cursor position of the TURNS field
                                    to a maximum value of 100.

5.3 SELECTING THE NUMBER OF TURNS (MASTER MODE) - continued

Select: *CURSOR*   Moves the cursor left or right within the three digit TURNS field.

New Display: **TURNS   1 0 0**

Select: *CLEAR*   The value of the number of TURNS is set to 100 and entered into memory.

New Display: **TURNS   1 0 0**

Select: *ENTER*   The displayed number of TURNS is entered into memory.

Select: *FUNCTION:*   Pressing the FUNCTION key at any time while in NUMBER of TURNS function will terminate the TURNS function and return the user to FUNCTION select mode where any one of the PLS-601 other functions can be selected.

5.4 USING THE STANDARD FUNCTIONS (PROGRAM/DISPLAY MODES)

Once the NUMBER of TURNS has been selected in MASTER MODE, the ten standard PLS-601 functions can be used in the PROGRAM or DISPLAY MODES. The following sections describe the differences between the Model 10 functions as described in Section 4.2, and the Model 11 functions.

5.4.1 POWER ON

See Section 4.2.1 for a complete description of POWER ON

Display: **P10140   PROG1   R030**

5.4.2 POS/TACH

See Section 4.2.2 for a complete description of POS/TACH

Display: **P10140   PROG1   R030**

5.4.3 SET

With the SET function, the INC/DEC keys DO NOT enter data immediately into memory. The displayed data must always be entered via the ENTER key.

The dash symbol (-) between the FROM and TO fields will be changed to an asterisk (*) to indicate that the displayed data must be entered into memory.

See Section 4.2.3 for a complete description of SET FUNCTION

A. SELECTING THE CHANNEL

Display: **A01F_ _ _ _ _-T_ _ _ _ _**

B. ENTERING LOBES

Display: **A01F10140-T10230**

5.4.4 OFFSET

An asterisk (*) before the 'OF' field indicates that the displayed data must be entered into memory via the ENTER key.

The INC/DEC keys enter data immediately into memory, as in the standard unit.

See Section 4.2.4 for a complete description of OFFSET function

    Display: **P10140 OF-00024**

5.4.5 SCALE

An asterisk (*) between the "TN" and "SF" fields indicates that the displayed data must be entered into memory via the ENTER key.

See Section 4.2.5 for a complete description of the SCALE function

    Display: **TN 100 SF 1000**

Upon entry of a new SCALE FACTOR, the SYSTEM RESOLUTION (Total TURNS times the SCALE FACTOR) is calculated and displayed.

    New Display: **P10140 RES10000**

5.4.6 MOTION

An asterisk (*) between the "MT" and "MF" fields indicates that the displayed data must be entered into memory via the ENTER key.

See Section 4.2.6 for a complete description of the MOTION function

5.4.7 TEACH

With the TEACH function, the INC/DEC keys DO NOT enter immediately into memory. The displayed data must always be entered via the ENTER key.

The dash symbol (-) between the FROM and TO fields will be changed to an asterisk (*) to indicate that the displayed data must be entered into memory.

See Section 4.2.7 for a complete description of the TEACH function

SELECTING THE CHANNEL

    Display: **A01F_-T**

ENTERING LOBES

    Display: **A01F10140-T102330**

5.4.8 COPY

See Section 4.2.8

5.4.9 SPECIAL FUNCTION - F7

See Section 4.2.9

5.4.9 SPECIAL FUNCTION - F8

See Section 4.2.10

5.4.11 END

See Section 4.2.11

     Display: **P10140 PRG1 R030**