*LIGO Laboratory / LIGO Scientific Collaboration*

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# Pump Servo Users Guide

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Distribution of this document:
LIGO seismic isolation team

This is an internal working note
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**Overview**:

The pump servo (D020436) regulates the hydraulic pressure in the LIGO seismic pre-isolation system by controlling the speed of a hydraulic pump. The system also provides pressure, temperature and level monitoring functionality.

A composite alarm output provides warning for low liquid level in the hydraulic reservoir as well as hydraulic pump over-temperature alarm.

The control loop pressure setpoint, proportional gain and integral gain terms are adjustable, and come with "best guess" values already loaded.

Readout of all measured parameters is by a front panel LCD display. The system has much built-in flexibility due to its microprocessor-based design. Any combination of LCD readings could easily be combined to sense an alarm condition beyond the default pressure and temperature alarms intrinsic to the initial design.

**Detailed Description:**

1. Front panel features

**Front Panel of Pump Servo**


1.1. LCD – Displays text for measured sensor parameters. Default units used for measurement are: Degrees Celsius and PSI.
1.2. AC Power switch – This should be obvious…
1.3. PID Alarm – Acknowledgement of an alarm condition as sensed by the PID microprocessor.
1.4. PID Heartbeat – For normal operation, the LED will flash at approximately the sample rate of the PID loop.
1.5. Regulation OK – Not currently implemented, but will eventually indicate that the hydraulic pressure is within a designated band.
1.6. Filter δP OK – The silkscreen on this is messed up. It was printed as "OP" instead of "DP". It is not currently implemented, but could eventually indicate the differential pressure across the particulate filter in the hydraulic system.
1.7. Mon Heartbeat – Flashes fairly rapidly at the update rate of the LCD during normal operation of the monitoring microprocessor.

1.8. Mon Alarm - Acknowledgement of an alarm condition as sensed by the Monitoring microprocessor.
1.9. PID Port – Permits code updates of the internal PID processor via a custom cable using a PC.
1.10. MON Port – Permits code updates of the internal Monitoring processor via a custom cable using a PC. An internal jumper can be configured to prohibit inadvertent changes via this port.
1.10 RS-232 Port – Permits expansion via a full RS-232 interface. This feature is not yet used, but would allow the Pump Servo to control – or, be controlled by – another RS-232 compatible device. Setpoints and other data could be loaded into the pump servo by this port without needing a change in the downloaded program.

2. Rear Panel features

**Rear Panel of Pump Servo**


2.10 All of the DB-9 connectors have the same pin-out given as shown in the table

| DB-9 pin | Function |
|---|---|
| 1 | +10 Volt Reference |
| 2 | Not Used |
| 3 | Not Used |
| 4 | Differential Amplifier Plus Input |
| 5 | Not Used |
| 6 | Differential Amplifier Minus Input |
| 7 | Not Used |
| 8 | Ground |
| 9 | Not Used |

2.11 Three general-purpose pressure inputs labeled "**Press 1**", "**Press 2**" and "**Press 3**" are supplied for use with Invensys Inc. pressure sensors via a custom cable interface. The default gain of these sensors is 0.1 volt per 300 PSI. An internal gain of 10 is applied before these signals appear on the composite monitoring connector. The details of the interface are included in the schematics to the unit.

2.12 One input labeled "**Level Sense**" interfaces with a liquid level sensor to monitor the level of the hydraulic fluid reservoir. If a low liquid level is detected, or if the sensor is unplugged, the system responds with a change of state of the alarm relay contacts (NO and NC contacts are available), and the "Drive To Motor Controller" output is commanded to zero.

2.13 Two temperature sensors labeled "**Temp 1**" and "**Temp 2**" are monitored and will cause a similar alarm as with the level sensor if the sensed temperature exceeds the set point of 54 degrees C. Removal of either temperature sensor triggers the alarm. Temperature is displayed on the front panel LCD in units of degrees Celsius. The sensors are based on Analog Devices AD-590 solid-state temperature sensor chips and interface to the unit by a custom cable.

2.14 Two load sensors labeled "**Lo Side Press**" and "**Hi Side Press**" are provided. These inputs are compatible with Invensys Inc. pressure sensors using the same interface cable assembly as the other three pressure sensor inputs. The gain of these transducers is 0.1 volt per 500 PSI and, like all sensor inputs, can be read on the front panel display in converted units. A jumper exists (J7 on the schematics) on the main circuit board to allow differential pressure control between these two pressure inputs. The default configuration is for "single ended" pressure control and a shorting jumper should be installed on J7 between pins 1 and 2 (these pins are at the end of the header next to the silkscreen "J7" lettering. Differential control is implemented by putting a standard shorting header on the two pins of J7 closest to R6. In either configuration, the pressure for both channels is still correctly displayed on the front panel LCD.

2.15 An output labeled "**Combined Monitor**" is provided to give access to each rear panel analog input. The monitor outputs are amplified by a gain of 10 from the raw transducer inputs as detailed in the table below. The source impedance of these monitoring channels is 100 ohms.

| Function of pin | Pin number on DB9 | Gain |
|---|---|---|
| Pressure sensor 1 | 1 | 300 PSI / Volt |
| Pressure sensor 2 | 6 | 300 PSI / Volt |
| Pressure sensor 3 | 2 | 300 PSI / Volt |
| Temperature sensor 1 | 7 | 100 Deg. C / Volt |
| Temperature sensor 2 | 3 | 100 Deg. C / Volt |
| Level sensor | 8 | 0/5 Volts for Normal/Low Level |
| High side load sensor | 4 | 500 PSI / Volt |
| Low side load sensor | 9 | 500 PSI / Volt |
| Ground | 5 | |

2.16 A BNC output is provided to supply a voltage to the motor speed control unit. The default sense is increasing voltage should increase motor speed. The range of voltages is 0-10 volts. The initial prototype revealed a problem with direct connection to the motor speed control unit. Extreme noise in the motor controller circuitry necessitates the use of an external isolation amplifier which has been built and will be available. Future revisions of the pump servo will incorporate this feature internally.

2.17 AC power input is a standard instrument AC power feed. The internal DC power supply has an integral fuse internally.

3. Programming the microprocessors

3.1 Two "phone" type RJ-11-6 jacks are available on the front panel for programming the unit. Using the custom programming cable, a PC can be connected to the unit via a PC serial port (9pin D-sub) and code can be downloaded from the code editor. A copy of the editor software is available on my website (www.ligo.caltech.edu/~abbott) under the Seismic section. The program can also be downloaded from the manufacturer (www.parallax.com). The code written for this application is also available on my website.

3.2 Once the programming software has been installed, the target code should be opened within the programming software. Two jumpers (J12 and J13) are present on the main circuit board of the pump servo. These jumpers can be positioned to prohibit inadvertent programming of the microprocessors. If an attempt is made to download to the unit without these jumpers in place, a warning will be displayed within the programming software and no download of code will occur.

4. Miscellaneous idiosyncrasies

4.1 Great care is needed not to inadvertently ground any of the sensors or a significant increase in sensor noise will occur. By design, the sensor cables will not allow the sensors to be grounded. The body of each pressure sensor is isolated from pump sensor ground internally. The type of action that will result in trouble would be to ground pin 5 of the external monitoring D connector to the pump stand piping or motor controller ground.