# Section 25. Valve Positioner Module

## 25-1. Descriptions

### 25-1.1. Description for Single VP Module

The Digital Electro-Hydraulic (DEH) system controls steam turbine valve positions in order to adjust steam flow for turbine speed control, or to change generator load when connected to the grid.

The Ovation Valve Positioner I/O module provides an interface between the DEH Ovation Controller and an electro-hydraulic servo valve actuator. Valve styles controlled by the Ovation Valve Positioner I/O module include throttle valves, governor valves, interceptor valves, extraction valves, and bypass valves. The Ovation Valve Positioner module provides closed-loop valve positioning control.

A valve position set point is maintained by the module. The set point is normally altered by the Ovation Controller via the Ovation I/O bus. If the Ovation Valve Positioner module operates in Local Manual mode, the set point is controlled by a SLIM operator interface station. Inside the electronics module, an 80C196 microcontroller provides real-time closed loop proportional-plus-integral (PI) control.

The Ovation Valve Positioner I/O module generates redundant output control signals which drive the electro-hydraulic servo valve actuator coils. The feedback loop is closed with the valve's position measurement being obtained from a Linear Variable Differential Transformer (LVDT) that is mounted on the valve stem.

The Valve Positioner module can perform the following:

- Calibration
- Diagnostics
- 10 millisecond loop time
- SLIM interface for local control
- Local serial interface for testing and calibration
- Shutdown input
- Seating and backseating logic

The Valve Positioner Module is applicable for CE Mark Certified Systems.


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## 25-1.2. Description and Guidelines for Redundant VP Module

Two Ovation Valve Positioner (VP) cards (Primary and Backup) operate as a Primary backup pair to control a single steam valve (see Figure 25-1). The steam valve is fitted with two LVDTs, one connected to each Valve Positioner. Each VP then drives one coil in a high pressure hydraulic servo valve. The coils are completely isolated.

The Valve Positioners communicate serially to determine which VP should be Primary, and which should be Backup. Critical parameters of the redundant subsystem are exchanged over the serial link. These critical parameters are also exchanged over the Ovation bus, thus providing a redundant data path.

The Backup VP suspends its software PI routine, and replicates the servo output of the Primary. It then takes over control if the Primary fails. There are three types of failures that the subsystem will detect and respond to:

- Hardware Failures - Each VP continuously runs internal diagnostics and will cease operations if a diagnostic fails. A failure is indicated when both the serial communications and Ovation line watchdog timers expire. The VP card continuously executes these diagnostics:
  - — Microcontroller RAM
  - — Ovation RAM
  - — EPROM Checksum
  - — DA Converter Readback
  - — Ovation Watchdog Timer
  - — Redundant Communications Watchdog Timer
- Coil Drive - If the Primary VP detects a shorted or open servo coil, it will transfer control to the Backup VP. There is a customer setup requirement described in the section on servo coil failures.
- LVDT Failures - LVDT failures are detected by measuring the derivative of position feedback. As with the servo coil, there are setup requirements that enable the detection of LVDT problems. The requirements are described in the section on LVDT failures.

The VP pair utilizes the SLIM serial port for VP-to VP communications. The serial link is a VP-to-VP connection, not the “party-line” bus utilized with the SLIM.


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Failover events are NOT bumpless (that is, the valve will dip, or move in the direction indicated by the mechanical bias setting, during the failover period). Catastrophic hardware failures, or removal of the Primary VP, are the worst failures because the Backup must wait for various timers to expire and then engage the PI loop.

If, for example, the failover required one second to complete (determined by the Controller loop time for example), and the valve was programmed to drift shut in 30 seconds under control of the mechanical bias-setting, the valve could drift 3% (=1/30).

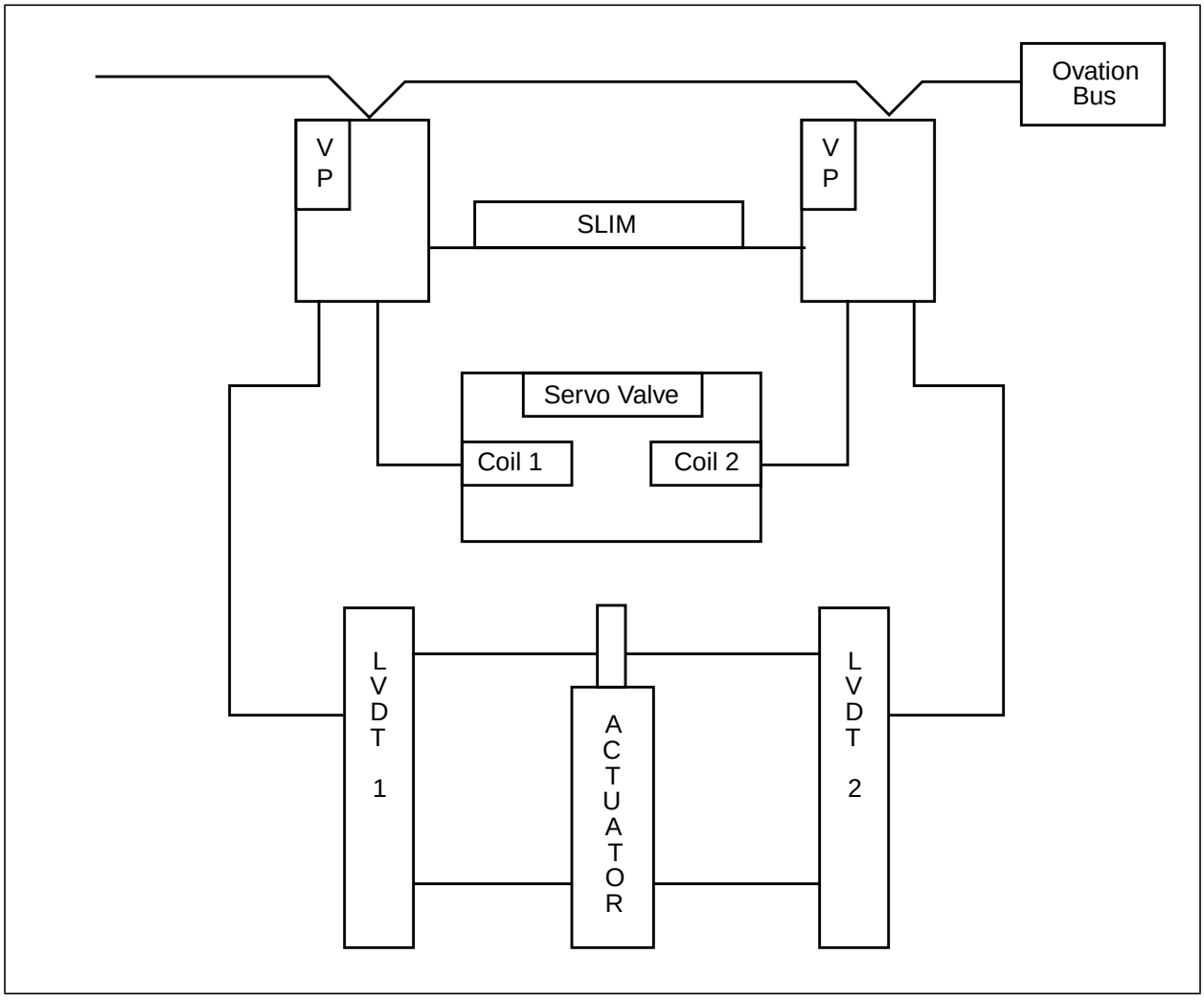



**Figure 25-1. Redundant Ovation Valve Positioner Subsystem**



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## 25-1.3. VP-to VP Serial Connection

Figure 25-2 illustrates the serial connections for redundant VP modules.

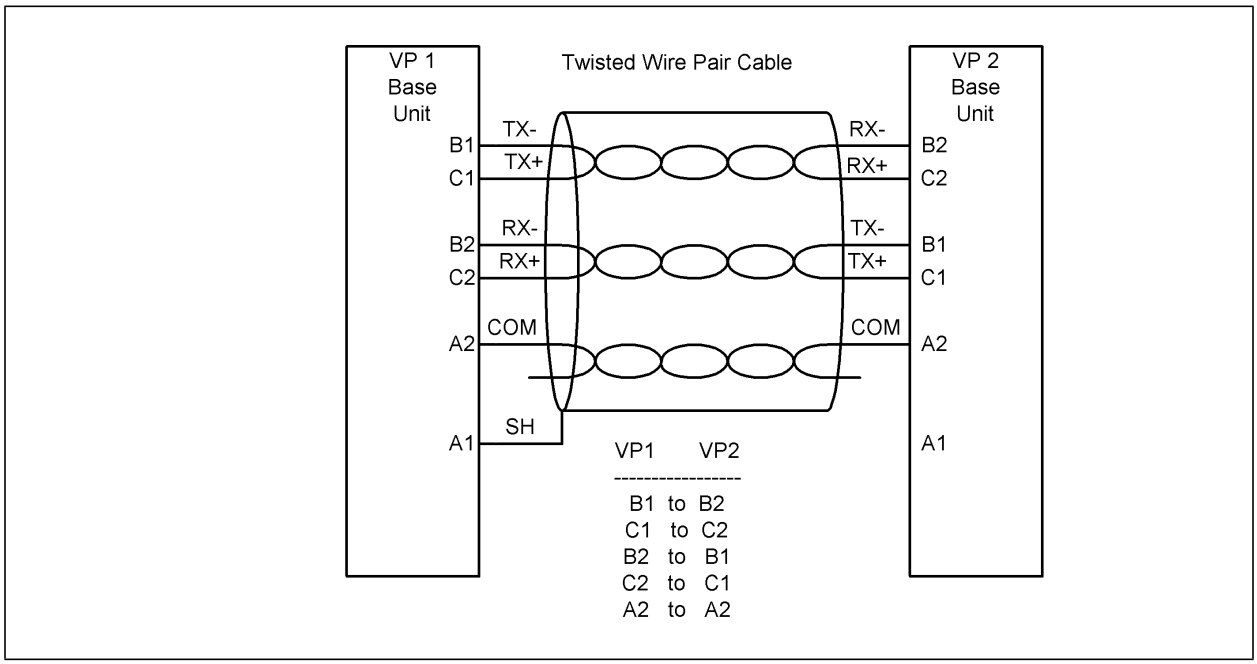



**Figure 25-2. Redundant VP to VP Serial Connections**

## 25-1.4. Primary/Backup Status Transitions

### Primary to Backup

If the VP is in the Primary mode, it will transition to Backup mode if:

- Serial Line Status is OK and Ovation Watchdog bit indicates partner is Alive, and is the primary (start condition).
- Partner is OK according to serial line data.
- Partner is OK according to Ovation data.
- Its own status is not OK.

### Backup to Primary

If the VP is in the Backup mode, it will transition to Primary mode if:

- Its own status is OK and the partner's Ovation Watchdog Bit indicates Not Alive and Serial Line Status is not OK.

- Partner is in Backup mode, according to serial data.
- Partner is in Backup mode, according to Ovation data.

## Setup Requirements

The following items must be set up before operating redundant Ovation Valve Positioner modules:

## LVDT Setup

There are requirements on the LVDT setup for a redundant subsystem.

- First, the linear range of the LVDT must exceed the mechanical range. This means that when the valve is at either endpoint, one of the secondary voltages will be at its minimum. The secondary voltage must be large enough at the endpoint so that if a wire breaks and the secondary voltage goes to zero, the change of voltage will be large enough to be readily detected. A good guideline is to ensure that each secondary always contributes at least 10%, positive or negative, to the demodulated voltage. That is,

  $\min(|A|, |B|) / (|A| + |B|) > 10\%$

  This minimum secondary value is expressed in percentage, is tunable, and is called MIN2NDRY.

- Second, the LVDTs must be calibrated prior to being placed into redundant service, and for all possible positions, the feedback signal of the Primary should be near the feedback signal of the backup. This value is called LVDTTRACKING, and its default value is 1%.

## Coil Setup

Coil diagnostics rely on a steady voltage across the coil. This voltage will be present if you adjust the servo valve per the WPC recommendation.

The servo valve has a mechanical bias set-screw that pushes the spool to one side, allowing fluid to escape the actuator and slowly close the valve in the absence of electrical excitation. In the standard setup approximately 200 mV across both coils opposes the mechanical bias adjustment and holds the spool in the center position, trapping the fluid in the actuator, and holding the valve in a fixed position. Adjusting coil current changes spool position so that current can flow into or escape from the actuator. (Technically, the operation of the servo valve is dependent on current through the coil and the mechanical bias adjustment. However, the VP is set up to measure voltage across the coil and at the amplifier output, so voltage measurements are typically referenced in this description.)



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# 25-2. Module Groups

**Note**

When using the I/O Builder to configure the Valve Positioner (VP) module, note that whatever voltage/ current description is displayed in the Slot position at the top of the window does **NOT** impact the configuration of the VP module.

## 25-2.1. Electronic Modules

There are two Electronics module groups for the Valve Positioner module:

- 1C31194G01 provides 17 Volts AC peak-to-peak 1 KHz LVDT drive.
- 1C31194G02 provides 23.75 Volts AC peak-to-peak 3 KHz LVDT drive.

## 25-2.2. Personality Modules

There are four Personality module groups for the Valve Positioner module:

- 1C31197G01 has 330 Ohm resistors that provide up to ±24.9 mA into 82 ohm servo coils. Use with any Valve Positioner Electronics module.
- 1C31197G02 has 360 Ohm resistors that provide up to 16.8 mA into 250 ohm servo coils. Use with any Valve Positioner Electronics module.
- 1C31197G03 has 240 Ohm resistors that provide up to 8.3 mA into 1000 ohm servo coils. Use with any Valve Positioner Electronics module.
- 1C31197G04 has 160 Ohm resistors that provide up to 36 mA into 125 ohm servo coils. Only two coils may be driven by 1C31197G04. Use with any Valve Positioner Electronics module. The C3+ and C3- coil outputs are not available.

## Table 25-1. Valve Positioner Subsystem [1]

| Range | Channels | Electronic Module | Personality Module |
|---|---|---|---|
| **17 Volts AC peak-to-peak 1 KHz or 23.75 Volts AC peak-to-peak 3 KHz to an LVDT** 24.8 mA into three 82 ohm coils | 8 | 1C31194G01 or 1C31194G02 | 1C31197G01 |
| **23.75 Volts AC peak-to-peak 3 KHz or 17 Volts AC peak-to-peak 1 KHz to an LVDT** 16.8 mA into three 250 ohm coils | 8 | 1C31194G02 or 1C31194G01 | 1C31197G02 |
| **23.75 Volts AC peak-to-peak 3 KHz or 17 Volts AC peak-to-peak 1 KHz to an LVDT** 8.3 mA into three 1000 ohm coils | 8 | 1C31194G02 or 1C31194G01 | 1C31197G03 |
| **23.75 Volts AC peak-to-peak 3 KHz or 17 Volts AC peak-to-peak 1 KHz to an LVDT** 36 mA into two 125 ohm coils | 8 | 1C31194G02 or 1C31194G01 | 1C31197G04 |

When using the Point Builder to define points for a Valve Positioner module, only the following point types are valid for each channel:

| I/O Channel | Name | Type | Input Source or Output Destination | Terminal Block Connection [2] |
|---|---|---|---|---|
| 1 | Shutdown Status | Input | Valve Positioner | DI1 |
| 2 | Auxiliary (wetting) Voltage Sense | Input | Valve Positioner | DI2 |
| 3 | SLIM ON Signal | Input | Valve Positioner | DI3 |
| 4 | Position Feedback | Input | Valve Positioner | |
| 5 | Coil 1 Voltage (Read-back) | Input | Valve Positioner | Coil 1 |
| 6 | Coil 2 Voltage (Read-back) | Input | Valve Positioner | Coil 2 |
| 7 | Coil 3 Voltage (Read-back) | Input | Valve Positioner | Coil 3 |
| 8 | Raw Demodulator Voltage | Input | Valve Positioner | |

[1] This module will provide an interface between an Ovation Controller and **ONE** Electro-Hydraulic (EH) servo-valve actuator in the field. To use this module, the MASTATION algorithm must reside in the Ovation Controller. Refer to "Ovation Algorithm Reference Manual" (R3-1100) for detailed information about the MASTATION algorithm.

[2] The terminal block connection depends upon the application being used. Refer to wiring diagrams.



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## 25-2.3. Firmware Levels

This table lists all VP module firmware releases that added additional functionality to the VP.

| VP Firmware Level (Electronics Module) | VP Revision Level (Electronics Module) | Firmware Features |
|---|---|---|
| **0F** | 9 | Added support for the following:<br>Calibration from the Controller using graphics.<br>Upload/download of calibration constants to and from the Controller.<br>New tuning constants kServo and kServoD**b** to replace hard-coded constants. They add flexibility in dealing with differing coil impedances.<br>Reduction of valve calibration time. |
| **0C** | 6 | Added support for VP Redundancy. |
| **0B** | 5 | First full production firmware release. |



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# 25-3. Specifications

### Electronics Module (1C31194)
### Personality Module (1C31197)

**Table 25-2. Valve Positioner Module Specifications**

| Description | Value |
|---|---|
| Valve positioning field interface channels | One |
| LVDT position feedback Input range | 25 V AC peak to peak (LVDT A and LVDT B) maximum |
| LVDT position feedback input impedance | 20 kΩ (LVDT A and LVDT B) differential input with floating source<br>10 kΩ (LVDT A and LVDT B) one input line referenced to common |
| LVDT excitation output voltage | 17 V AC peak to peak ± 11% @ 1.0 kHz ± 10% (1C31194G01)<br>23.75 V AC peak to peak ± 11% @ 3.0 kHz ± 10% (1C31194G02)<br>500 Ω minimum load impedance (1C31194G01 & G02)<br>Drift 0.5% max/yr |
| Peak servo valve coil output voltages | (1C31197G01) up to three 82 Ω coils, ±2.04 V<br>(1C31197G02) up to three 250 Ω coils, ±4.20 V<br>(1C31197G03) up to three 1000 Ω coils, ±8.26 V<br>(1C31197G04) up to two 125 Ω coils, ±4.5 V |
| Servo valve coil output voltage accuracy | 0.4% of full scale output |
| Field interface dielectric isolation | 1000 V DC<br>The valve positioning field interface has 50 V and 150 V short term isolation from the logic common/Ovation I/O bus |
| SLIM interface serial port | RS-485 |
| SLIM interface serial port baud rate | 9600 |
| SLIM interface dielectric isolation | ±1000 V DC |
| Local serial port | RS-232, non-isolated |
| Local serial port baud rate | 19200 |
| SHUTDOWN digital input<br>Input voltage range<br>Propagation delay of contact change of state<br>Cable length<br>Dielectric isolation | <br>24 V/48 V DC nominal 18 V DC minimum, 60 V DC maximum<br>1.9 mSec minimum; 25.5 mSec maximum<br>1000 feet maximum (cable capacitance ≤ 50 pF/ft)<br>±1000 V DC |



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**Table 25-2. Valve Positioner Module Specifications (Cont'd)**

| Description | Value |
|---|---|
| MANUAL digital output<br>Output voltage<br>Off voltage (maximum)<br>On voltage (maximum)<br>Output current<br>Off current (maximum)<br><br>On current<br>Maximum propagation time<br>Dielectric isolation | <br>60 V DC<br>1.0 V @ 500 mA<br>0.2 V @ 100 mA<br><br>25 µA @ 60 V, TA = 25° C<br>250 µA @ 60 V, TA = 60° C<br>500 mA<br>2.5 mSec for Rload = 500 Ω<br>±1000 V DC |
| Module power | Main: 4.3 2W typical, 6.5 W maximum<br><br>Aux:<br>Digital Input:<br>0.09 W (24V) typical<br>0.18 W (48V) typical<br>Digital Output<br>(100mA load)<br>2.4 W (24V) typical<br>4.8 W (48V) typical |
| Logic board processor | 80C196KB (16-bit microcontroller) |
| Operating temperature range | 0 to 60˚C (32˚F to 140˚F) |
| Storage temperature range | -40˚C to 85˚C (-40˚F to 185˚F) |
| Humidity (non-condensing) | 0 to 95% |

# 25-4. Valve Positioner Modes

Rapid or erratic valve movement can damage the turbine. The Valve Positioner enforces a set of rules to accomplish bumpless transfer between modes. The description of each mode includes mode transfer.

## 25-4.1. Start Mode

When the Valve Positioner is powered-up or restarted, its primary objective is to avoid an indeterminate output that would result in valve movement, and possible damage to the valve or turbine. There are a number of hardware and software features that prevent an indeterminate output.



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