MVP-F

Digital Closed Loop Proportional Valve Controller

The MVP-F is a compact, inline controller for use with proportional solenoid valves. The MVP-F is a closed loop system which provides the necessary current to a valve coil in order to follow a command signal. The controller monitors a feedback signal for outer loop closure. Bright LED indicators on the top of the unit provide an overview of the operating status. Setup is accomplished through a convenient hand held interface or portable computer. There is no cover to remove and no tiny pots to set. Once configured, the settings are stored in permanent memory within the unit. The MVP comes pre-wired with standard or custom lengths of industrial grade cable. The MVP is housed in a rugged, low-profile 18mm DIN connector body.

- Easily configured using WhiteOak Terminal software or our hand held interface
- LED indication of Status and Output Current
- Permanently sealed, standard DIN 43650 Form A connector body
- Selectable dither frequency up to 1000 Hz
- Adjustable current limited output with short circuit protection
- All input and output limits are independently adjustable
- Fully adjustable PID control loop
- User configurable over and under limit handling
- Pre-wired, shielded PVC cable
- Microprocessor controlled for consistent, reliable performance

Operating Specifications:

Supply Voltage	9 to 28VDC
Supply Current	I_{SOL} + 20mA
Output Current	**-06A:** 600mA MAX. **-12A:** 1.2A MAX. **-25A:** 2.5A MAX.
Solenoid Resistance	2Ω MIN.
Dither Settings	50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 350, 400, 500, 1000 Hz
Analog Input Range	**-F1V:** 0 to 10V **-F2A:** 0 to 20mA
Analog Input Impedance	**-F1V:** 12kΩ **-F2A:** 250Ω
Loop Closure Rate	Based on selected dither frequency
Accuracy	+/- 0.25%
Operating Temperature Range	-20º to 70º C
Enclosure	Glass filled Nylon

WARRANTY INFORMATION, PERFORMANCE ASSURANCE, AND APPLICATION LIMITATIONS

Limited Warranty

WhiteOak Controls, Inc. warrants its products free from defects in material, workmanship, and design for a period of one year after installation, provided the installation date is less than one year after manufacture. In no instance is there any warranty of fitness for a particular use and WhiteOak Controls, Inc. cannot and does not accept responsibility of any type for any of its products that have been subjected to improper installation, improper application, negligence, tampering, or abuse, or which have been repaired or altered outside of the WhiteOak Controls factory. WhiteOak Controls' liability under this warranty shall extend only to replacement or correction, f.o.b. our factory, of any defective part or product determined by inspection as not conforming to this warranty. We make no other warranties, expressed or implied, and are not responsible for any consequential damages resulting from use by any buyer or user, our liability being limited to the value of product sold or obligation to replace a defective part.

Performance Assurance

All WhiteOak Controls products are individually tested at the factory to perform as indicated in all applicable sales and technical documentation. However, assurance of suitability of all WhiteOak Controls products in the buyer's application is the responsibility of the buyer. Such assurance would typically include the manufacture of a prototype followed by a test or qualification program on the part of the buyer.

Application Limitations

WhiteOak Controls, Inc. designs and manufactures its products specifically for use in commercial, industrial and mobile control applications and WhiteOak Controls' products are only warranted for this type of use. WhiteOak Controls' distributors are not authorized to approve the use of any WhiteOak Controls product in any of the following applications:

- Any product that comes under the Federal Highway Safety Act, namely steering or braking systems for passenger-carrying vehicles or on-highway trucks.
- Aircraft or space vehicles.
- Ordnance equipment.
- Any end product that, when sold, comes under the U.S. Nuclear Regulatory Commission rules and regulations.

Specific written approval for any application of WhiteOak Controls products in any of the above named applications should be obtained from WhiteOak Controls, Inc. Consultation with WhiteOak Controls distributors or factory engineers is advised in unusual situations where applicability is questionable.

Physical Description

The MVP-F is shown at the right. There are two indicator lamps labeled STATUS and OUTPUT. The STATUS lamp will light green whenever power is applied to the unit and is within the specified voltage range. The STATUS light will flash red when a fault has occurred. The type of fault is indicated by the number of successive flashes. It will continue to flash until the power has been cycled or depending on the configuration, the command signal has been removed to clear the fault. The yellow lamp labeled OUTPUT provides an indication of the current being supplied to the solenoid.

Communication with the MVP takes place through an infrared interface port. The port allows for configuration and monitoring of the operating parameters. The infrared adapter clips onto the MVP aligning with the notches in the sides.

User Interface

The MVP-F has a number of internal settings which allow each unit to be configured for the application in which it is used. These settings are accessed with a PC running Windows based WhiteOak Terminal software or with the WhiteOak Hand Held Interface

Both methods require the use of the Infrared Adapter which clips onto the MVP.

WhiteOak Terminal provides a convenient interface to the MVP. The program gives the user the ability to view and make changes to the configuration. It also allows the user to store complete configurations in files on the PC. These files can then be recalled to program new units or update existing ones.

The hand held interface is a stand-alone option. Because it is fully self contained, the programmer, cable and adapter are all that is required. This is a good alternative for field installations where a PC might not be convenient.

Configuration

All interface operations are accomplished with the use of 4 buttons. The buttons are Lock, Unlock, Up, and Down. The hand held interface represents these in graphical form as padlocks and arrows. The same symbols are used on the buttons in WhiteOak Terminal and can be activated with the mouse. The program also recognizes menu commands and short-cut keys. The keys used are '/'(lock), '*'(unlock), '+'(up), and '-'(down).

The data displays for both methods are very similar. The hand held interface has a two-line LCD display. The display is represented graphically in WhiteOak Terminal.
The up and down arrows are used to navigate through the parameter list. When either button is pressed the display will be updated with the next parameter in the list. The parameter name will appear on the first line and the associated setting will appear on the second line. The list is accessed in a circular fashion, stepping down from the last parameter to the first and vice-versa.

There are three types of parameters in the list: fixed; monitor; and variable. Fixed parameters are used to show things such as the module's firmware version number. Fixed parameters do not change. Monitor parameters display things such as output current or system voltage. These parameters are constantly updated when the module is functioning. Variable parameters are those which can be changed by the user in order to configure the module. Examples of this type are operating mode and maximum output current. For convenience, some parameters combine variable and monitor types on one line. This allows the user to set a variable according to the current monitor value.

To change the setting of a variable parameter, the user must press the unlock button to place the system in edit mode. While in edit mode the display will show an asterisk (*) or an Up/Down Arrow symbol at the beginning of the second line. In edit mode the up and down buttons are used to change the value of the parameter. For parameters which contain both variable and monitor data, the monitor data is shown surrounded by square brackets. Pressing the unlock button again while in edit mode will immediately load the current monitor value into the variable. Once the desired setting is displayed, pressing the lock button will save the parameter and end edit mode.

Parameter List

The following table outlines the parameter list for the MVP. Along with the name of the parameter, the table lists the limits and units for each item.

Parameter	**Limits**	**Units**
MVP-Fxx-xxx		Version
MODE	See Mode Description	Mode #
PROPORTIONAL G.	0 to 100	%
INTEGRAL GAIN	0 to 100	%
DERIVATIVE GAIN	0 to 100	%
PID LOOP TIME	1 to 30	# cycles
DITHER FREQ.	OFF to 300	Hz.
MINIMUM COMMAND	0 to 10.0 (0 to 20.0)	V (mA)
MAXIMUM COMMAND	0 to 10.0 (0 to 20.0)	V (mA)
MINIMUM FEEDBACK	0 to 10.0 (0 to 20.0)	V (mA)
MAXIMUM FEEDBACK	0 to 10.0 (0 to 20.0)	V (mA)
MINIMUM OUTPUT	0 to 600*	mA
MAXIMUM OUTPUT	0 to 600*	mA
CMD BELOW MIN	OFF, LIMIT, FAULT	
CMD ABOVE MAX	OFF, LIMIT, FAULT	
FDBK BELOW MIN	OFF, NORMAL, FAULT	
FDBK ABOVE MAX	OFF, NORMAL, FAULT	
COMMAND		V (mA)
FEEDBACK		V (mA)
ERROR		
OUTPUT CURRENT		mA
SUPPLY VOLTAGE		Volts
FAULT STATUS		Fault

*0 to 1.2A for **-12A**, 0 to 2.5 A for **–25A** version

MVP-Fxx-xxx - This is the title parameter. The model number of the unit and the firmware version are displayed. The title parameter is fixed.

MODE – There are three modes of operation for the MVP-F controller. The modes are as follows:
1. NORMAL – This is the standard operating mode where increasing output results in increasing feedback.
2. INVERSE – This is an inverted mode where increasing command results in decreasing feedback.

3. OPEN LOOP – In open loop mode the MVP sets the output current relative to the command and does not use the feedback signal. Open loop mode is provided to aid in setup and is not intended to be used in normal operation.

PROPORTIONAL G. - The Proportional parameter sets the proportional gain in the control loop. The proportional gain represents the P term in a PID control loop. The proportional term is simply a multiplication of the error which is added to the output. The Proportional parameter is a variable type.

INTEGRAL GAIN – Integral Gain is used to determine the integral or I term in the PID control loop. The integral term is a cumulation of error over a period of time. The integral term is generally used to overcome an offset in the output or to correct for very small deviations over time at a fixed command. The Integral Gain parameter is a variable type.

DERIVATIVE GAIN - The Derivative Gain parameter sets the derivative gain in the control loop. The derivative gain represents the D term in a PID control loop. The derivative term is the difference between the current error and the error of the previous loop cycle. The derivative term is generally used to increase the responsiveness of a system. The Derivative Gain parameter is a variable type.

PID LOOP TIME – PID Loop Time represents the PID loop closure time in number of dither cycles. Therefore, the lower the number, the more quickly the system will respond to error. The PID Loop Time parameter is a variable type.

DITHER FREQ. - The Dither Frequency parameter has 11 options for dither control. The choices are 50, 75, 100, 125, 150, 175, 200, 225, 250, 275, 300, 350, 400, 500 and 1000 Hz. Dither control provides low frequency modulation which is required in many proportional valve applications. The Dither Frequency parameter is variable.

MINIMUM COMMAND - The Minimum Command parameter is used to establish the minimum command signal for which the control loop is activated. A command signal below this value will be handled according to the Cmd Below Min parameter. The relationship between Command and Feedback settings is show below in Figure 1. The value shown in square brackets is the current command value. The Minimum Command parameter is a combination variable/monitor type.

MAXIMUM COMMAND - The Maximum Command parameter is used to establish the maximum command signal for which the control loop is activated. A command signal above this value will be handled according to the Cmd Above Max parameter. The relationship between Command and Feedback settings is show below in Figure 1. The value shown in square brackets is the current command value. The Maximum Command parameter is a combination variable/monitor type.

MINIMUM FEEDBACK - The Minimum Feedback parameter is used to establish the minimum feedback signal for the desired range of operation. A feedback signal below this value will be handled according to the Fdbk Below Min parameter. The relationship between Command and Feedback settings is show below in Figure 1. The value shown in square brackets is the current feedback value. The Minimum Feedback parameter is a combination variable/monitor type.

MAXIMUM FEEDBACK - The Maximum Feedback parameter is used to establish the maximum feedback signal for the desired range of operation. A feedback signal above this value will be handled according to the Fdbk Above Max parameter. The relationship between Command and Feedback settings is show below in Figure 1. The value shown in square brackets is the current feedback value. The Maximum Feedback parameter is a combination variable/monitor type.

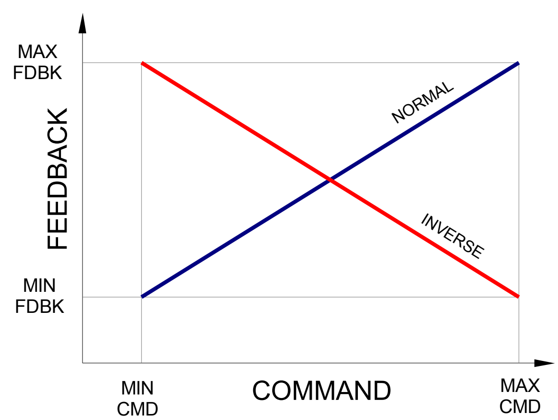

Figure 1: Command/Feedback Settings

MINIMUM OUTPUT - The Minimum Output parameter represents the minimum current of the output. This is often referred to as the deadband. The value displayed represents the current in milliamps (amps for -12A, -25A). The Minimum Output parameter is variable.

MAXIMUM OUTPUT - The Maximum Output parameter represents the maximum current of the output. This is often referred to as the gain. The value displayed represents the current in milliamps (amps for -12A, -25A). The Maximum Output parameter is variable.

CMD BELOW MIN
CMD ABOVE MAX – These parameters select which function to use when the Command Input falls below the Minimum Command or above the Maximum Command. OFF will place the output in the off state, LIMIT will hold the Command to the respective setting, and FAULT will trigger the corresponding fault causing the controller to shut down. The parameters are variable type.

FDBK BELOW MIN
FDBK ABOVE MAX – These parameters select which function to use when the Feedback Input falls below the Minimum Feedback or above the Maximum Feedback. OFF will place the output in the off state, NORMAL will use the normal Feedback signal, and FAULT will trigger the corresponding fault causing the controller to shut down. The parameters are variable type.

COMMAND - Command displays the nominal voltage (or current) present at the Command Input. The Command parameter is a monitor type.

FEEDBACK - Feedback displays the nominal voltage (or current) present at the Feedback Input. The Feedback parameter is a monitor type.

ERROR – The Error parameter displays the magnitude of error presently calculated. The Error parameter is a monitor type.

OUTPUT CURRENT - Output Current displays the nominal current being supplied to the output. The Output Current parameter is a monitor type.

SUPPLY VOLTAGE - The Supply Voltage parameter displays the module's power supply voltage. This value is included as an aid to troubleshooting. The Supply Voltage parameter is a monitor type.

FAULT STATUS - The Fault Status parameter displays the current fault code when a fault exists. The possible faults are:

1 – Over Current
2 – Open Output
3 – Output Shorted
4 – Command Below Minimum
5 – Command Above Maximum
6 – Feedback Below Minimum
7 – Feedback Above Maximum

The Fault Status parameter is a monitor type. In addition to the on-screen fault status, the STATUS light will flash red indicating a problem. The light will flash a number of times periodically corresponding to the above fault codes.

PID Algorithm

The PID algorithm used in the controller is a digital, velocity style PID as shown:

$$O(t)=O(t-1)+P*(e(t)-e(t-1))+I*T*e(t)+D/T*(e(t)+e(t-2)-2*e(t-1))$$

Where:

O = output
P = proportional gain term
I = integral gain term
D = derivative gain term
e(t) = error at time t
T = PID loop time

Setup Procedure

The following steps are recommended when commissioning an MVP-F controller:

1. Set the Minimum and Maximum Outputs according to the valve data sheet.
2. Set the Minimum and Maximum Command as desired for the controlling system.
3. Set the Dither Frequency as recommended by the valve manufacturer. Closed loop systems often require a higher dither frequency for best performance.
4. Place the controller in Mode 3 – Open Loop.
5. Apply a command signal equal to the Minimum Command setting.
6. Set the Minimum Feedback to the value it reads at Minimum Command. If a higher minimum result (pressure, etc.) is desired it can be increased.
7. Apply a command signal equal to the Maximum Command setting.
8. Set the Maximum Feedback to the value it reads at Maximum Command. If a lower maximum result (pressure, etc.) is desired it can be decreased.
9. Place controller in Mode 1 – Normal.
10. Cycle command through full range to verify desired operation.

Wiring

Wire functions are listed in the table below. Following the table are wiring examples for various modes of operation.

Terminal	Function
BROWN	+V Supply
BLUE	Supply Common
BLACK	Command Input
WHITE	Feedback Input
RED	+5V Reference
GRN/YEL	Connector ground

Schematic

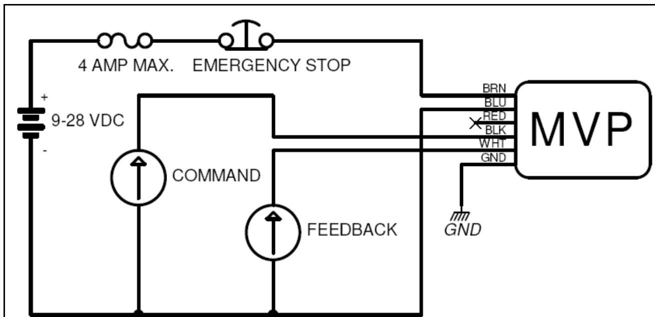

Figure 2: Wiring Diagram

Ordering Information

The following is a break down of the MVP-F part numbering system: