

Electronics in the Mobile Industry

As the mobile industry becomes more sophisticated and automated in its equipment the need for electronic control of the hydraulic systems is growing. More and more OEM's are integrating electronic and electrohydraulic equipment into their machines at a rapidly increasing rate.

The one major drawback to the acceptance of electronics on mobile equipment has been overcome. The reliability and ruggedness of electronic components has improved to the point that they can withstand millions of cycles and the harsh outdoor environments that mobile equipment is exposed to.

It has become increasingly important for the Hydraulic Application Engineer and the Hydraulic Component Salesman to become familiar with the many electronic terms that are used and products that are being integrated into the OEM's machine.

The compatibility of electrohydraulic valves and the many electronic valve drivers and PLC controllers is becoming an important issue for both the OEM and the hydraulic component supplier. It is necessary that one has an understanding of the terminology and principles of operation of the electronic components being used.

Many modern electrohydraulic devices, such as proportional pressure, flow and directional valves require relatively high-power electrical signals for control and/or positioning. Typically, however, the source of the command or control signal is a device capable of delivering only low- power signals. Because of this it is necessary to raise or amplify the electrical level of the signal (in terms of voltage or current, or both) before it is capable of operating the particular proportional valve.

Because of heat handling and physical size limitations, it is not practical to increase the capacity or output of the originating device in order to deliver higher power signals. Fortunately, when a low power signal is applied to the input of an electronic circuit known as an amplifier, it can produce the required command signal for electrohydraulic devices at its output.

Amplifier definition

An amplifier is a relatively simple circuit used to raise the level (or increase the amplitude) of an electronic signal. The amplified output is proportional to the input signal. Various types of amplifiers are used in electrical equipment, but all of them perform the same basic function

Why Pulse Width Modulation

When voltage is applied to a valve coil the current flowing through it creates a magnetic field which provides the force to shift the spool or poppet. The input voltage divided by the resistance of the coil equals the current draw. This is very straight forward when used with on/off valves, but proportional valves are only useful if one can control the spool position by varying the input current.

A simple potentiometer can be used to add resistance in series with the coil to vary the current. This simple technique is very inefficient and not practical when high currents are required. Therefore it is necessary to use a form of amplification of the input signal to obtain the desired current level to drive the proportional valve.

When an infinitely variable DC signal is used to operate a proportional valve solenoid, the output transistor of the amplifier acts like a variable resistor. It has to drop the power supply voltage down to that required by the solenoid coil at any given time. Also the full coil current, which may be several amps, has to pass through this output transistor. The result of high current draw and large voltage drops is high heat created in the transistor which requires a relatively large heat sink to dissipate.

Pulse Width Modulation (PWM) is a technique used in amplifiers to overcome this problem. In this case the output transistor is used as an on/off switch and feeds the solenoid coil with a series of on/off pulses at a constant voltage. The pulses are set at constant frequency (typically 400-5000+ Hz) and the signal level is determined by varying the duration of the "on" pulse relative to each "off" pulse.

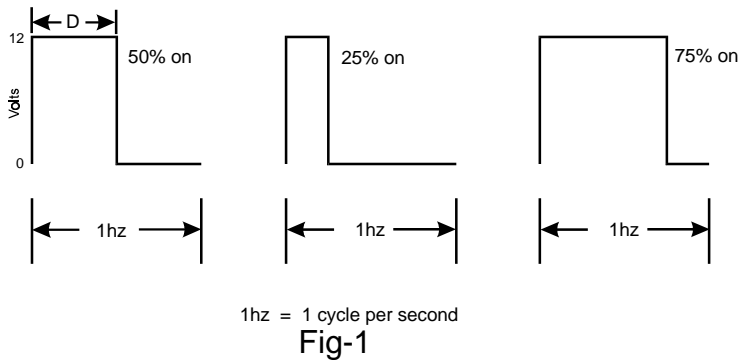
The advantage of this technique is that during each off pulse, the output transistor is not passing any current and during each on pulse, there is virtually no voltage drop across the transistor and therefore very little heat is created. In practice of course, there will be a small voltage drop across the transistor during the “on” pulses, and it takes a finite amount of time to switch on and off, so a small amount of heat will still be created. The amount of heat will be considerably smaller than that produced by a conventional DC output signal.

Pulse Width Modulation has become the standard for all valve amplifiers in order to reduce amplifier size and power waste. No modifications are required to the valve solenoid in order to use this technique.

Pulse width modulation (PWM) is an efficient technique to control current for driving a proportional valve coil that allows the use of electronics for current regulation, dither, ramping, short circuit protection and dead band elimination.

How PWM works

A PWM signal is not constant, it is simply an electronic switch. The signal is on for a period of time and off for the rest (fig-1).



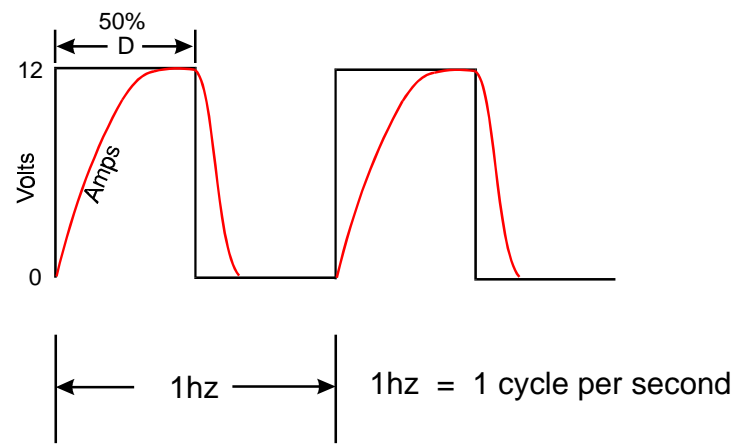
The duty cycle “D” refers to the percentage of the cycle for which the signal is on. The duty cycle can be anywhere from 0, the signal is always off, to 1, the signal is constantly on. A 50% “D” results in a perfect square wave.

The PWM signal frequency can be low frequency (100-400 Hz) or high frequency (above 5000 Hz). High frequency PWM is more desirable in that it produces a more constant ripple free amperage output.

Coil Inductance

A simplified explanation of coil inductance is required to clarify the behavior of the current in a PWM signal.

Because of the configuration of a coil it has in addition to its resistance, a certain inductance. When a voltage is applied across an inductive element (a coil), the current produced does not immediately jump up to its constant value, but gradually rises to its maximum over a period of time. Conversely the current does not disappear instantaneously, even if voltage is removed abruptly (fig-2).



Inductance is the characteristic of a circuit that makes itself evident by opposing the starting, stopping, or changing of current flow.

Electrical inductance is like mechanical inertia, and the growth of current in an inductive circuit can be compared to the acceleration of an automobile on the surface of a road. The car begins to move at the instant a constant force is applied to it. At this instant its rate of change of speed (acceleration) is greatest, and all applied force is used to overcome the inertia (inductance of the coil) of the car. After awhile the speed of the car increases and the acceleration becomes zero. The applied force is now used up in overcoming the friction of the road (resistance of the coil) against the tires and the inertia effect disappears. Conversely when power is removed the car’s inertia tends to keep it going until the friction of the road slows the car to a stop and the inertia effect again disappears.

PWM current characteristics

At 25% signal(fig-3), “D” is shorter than the time it takes the current to reach its maximum value. This will result in a reduced current output to the valve coil and therefore a reduced hydraulic output. Also if the PWM frequency is low enough the current will go back to zero during the off period and the circuit will be said to have discontinuous current.

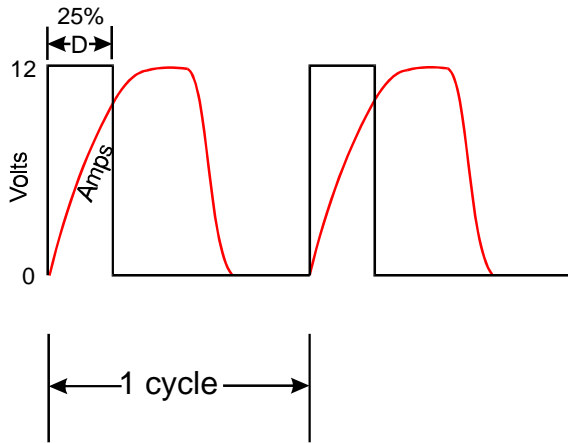


Fig-3

Dither (current ripple)

Stiction and hysteresis can make controlling a hydraulic valve seem erratic and unpredictable.

Stiction can keep the valve spool from moving when input signal changes are small. The spool then tends to over shoot when the signal becomes large enough to free it. The force required to get the spool to move initially is more than the force required to keep it moving to the desired position. Friction of a sliding spool causes a reduction in the distance moved.

Hysteresis can cause the spool shift to be different for the same command signal input, depending on whether the change is increasing or decreasing.

Dither is a rapid, small movement of the spool about the desired position. It is intended to keep the spool moving to avoid stiction and average out hysteresis. Dither amplitude must be large enough and the frequency slow enough to enable the spool to respond and yet small and fast enough not to cause a resulting pulsation in the hydraulic output. These requirements sometimes are in conflict and the goal is to provide just enough dither to overcome the problem without creating other issues.

Dither is caused by coil current “ripples”; current changes at some frequency and amplitude about the command value. The spool will not follow high frequency ripples as well as low frequency ripples due to inertia. The amplitude of the ripples determines how far, and if, the spool will move at a given frequency.

Low Frequency PWM

Low frequency PWM, typically less than 400 Hz, generates dither (current ripple) as a by-product of the PWM process (fig-4). The PWM frequency is low enough that the current has time to decay before the next rise takes place. The amount of dither (ripple) changes as the average coil current changes; the dither is maximum at 50% “D”, decreasing to zero at 0 and 100% “D”. This can result in too much dither at some current levels and not enough at others.

In this instance the dither current amplitude at a given average current is a function of coil inductance and the PWM frequency. The inductance of coils within a manufacturer’s product offering is generally a function of their rated voltage and wattage. A low wattage coil will usually have more inductance (thus less by-product dither for a given PWM frequency) than a high wattage coil.

This is further complicated by different valve designs having a different response to the same dither frequency and amplitude. Changing the PWM frequency will allow adjusting the dither, but the amplitude and frequency of the dither can not be set independently as may be required by various valve designs.

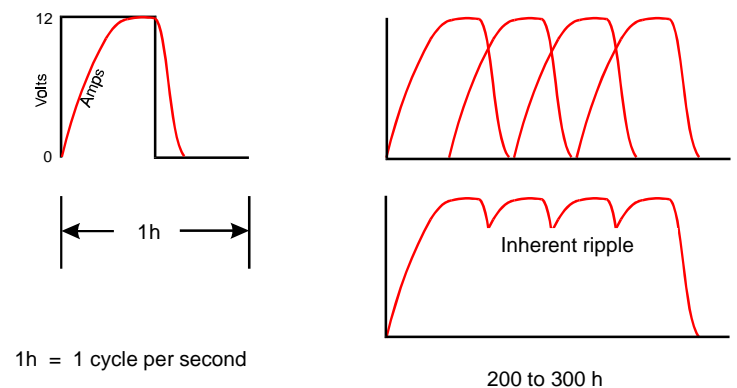


Fig-4

High Frequency PWM

When the PWM frequency is high enough (fig-5), typically above 5000 Hz, the coil current for all practical purposes will be constant. No by-product dither will be produced by high frequency PWM.

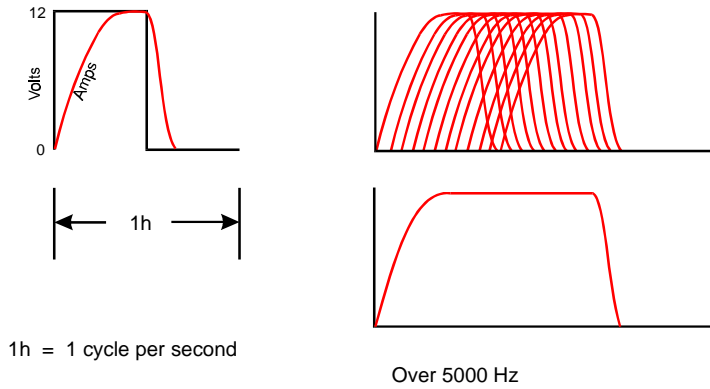


Fig-5

The advantage of using high frequency PWM is that dither can be generated separately and then superimposed on top of the output current (fig-6). This allows the user to independently control the current level, as well as the dither frequency and amplitude. The dither will therefore be constant for any current level and its frequency and amplitude can be set by the user to optimize the function of the particular hydraulic valve.

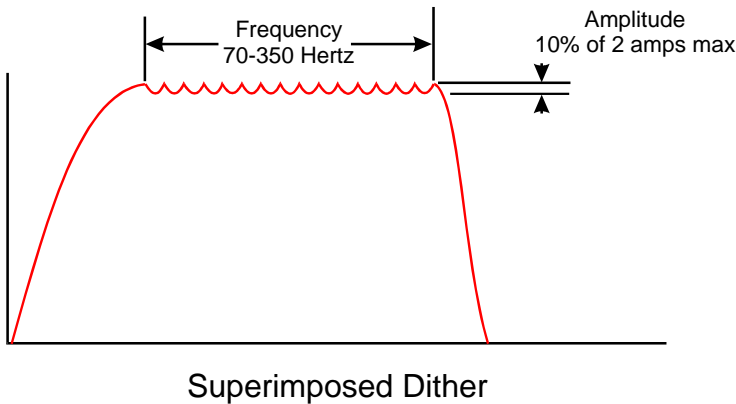


Fig-6

Ramps

Ramps are used to slow down the response of the valve driver to a changing command input. This results in a smooth transition when a fast change of the command input signal occurs. Ramps have no effect if the input signal change is slower than the ramp setting.

Ramps can be fixed or adjustable, symmetrical or independent and single or dual.

Adjustable ramps usually operate in the 0 to 8 second range and are controlled by a potentiometer. Single side ramps are usually used in slow shift controls where only acceleration is a concern.

Symmetrical ramps (fig-7) are controlled by a single potentiometer that adjusts the increasing ramp and the decreasing ramp identically. The slope of the ramp is the same for up and down.

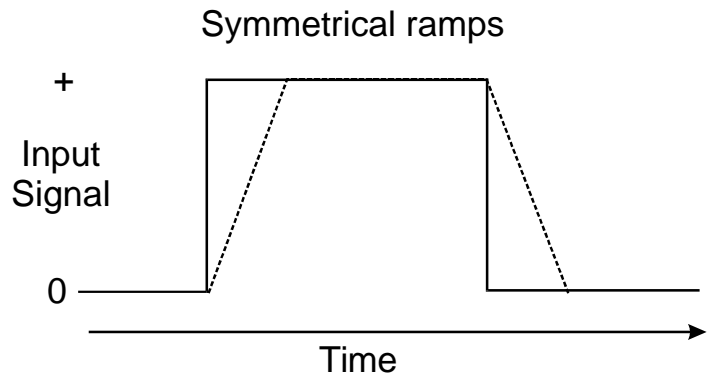


Fig-7

Independent ramps (fig-8) will have separate potentiometers for the increasing side as well as the decreasing side. This allows for independent control of both acceleration and deceleration of the function.

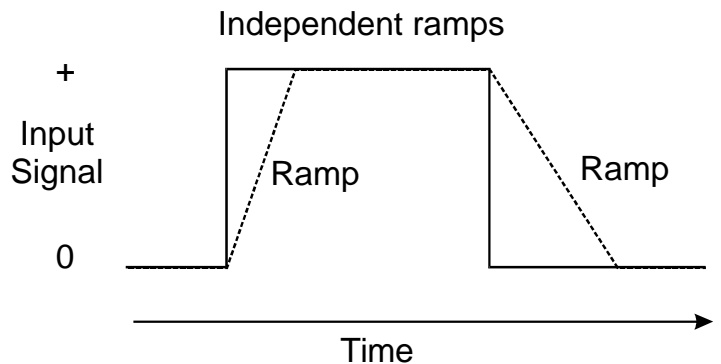


Fig-8

On dual coil bi-directional valve drivers, there are two ramps per coil for a total of four ramps that can be controlled. With four potentiometers independent control of all the ramps can be obtained (fig-9).

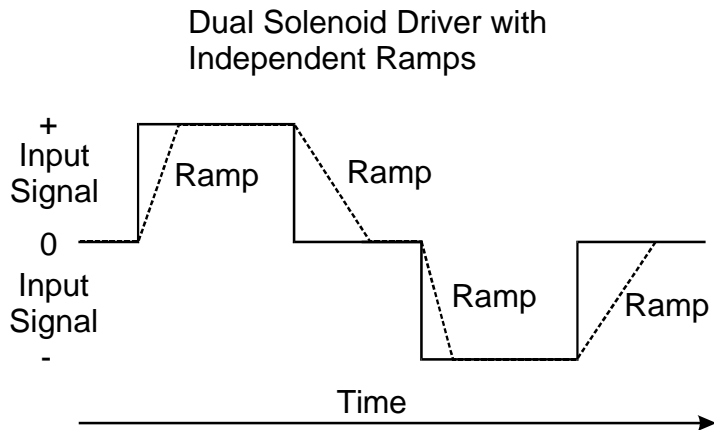


Fig-9

Gain or I-max

Gain of an amplifier is a measure of the ratio of its small input signal to its large output current flow to the valve.

$$\text{Gain} = \frac{\text{Output Signal}}{\text{Input Signal}}$$

The gain is usually adjusted by a potentiometer on the amplifier. This adjustment is frequently called I-max

Adjusting the I-max therefore adjusts the amplifier gain. This can be used, for example, to adjust the maximum output of the amplifier (and hence valve setting) for full input signal.

Enable/Disable

Certain amplifier cards incorporate an enable function where a specific voltage must be present at the enable connection before the output stage of the card will operate.

This is to allow an emergency stop switch or other safety interlock device to be connected to this function so that if the enable signal is lost, the amplifier output will immediately go to zero and the valve will respond accordingly.

Placing an emergency stop switch in the power supply is not recommended since stored charges in capacitors may maintain the valve signal for a period of time after the switch is opened.

Deadband / I-min

Spool type proportional valves will normally have a certain amount of overlap (or deadband) either at the start of spool movement (in the case of pressure or flow controls) or around the center position (for directional valves). This overlap reduces spool leakage in the null position and also provides a greater degree of safety in power failure or emergency stop situations. The effect of spool overlap however means that a certain minimum signal level has to be present at the solenoid coil before any noticeable result occurs in the system.

If this characteristic is undesirable then the deadband, for pressure and flow controls, can be effectively eliminated (or considerably reduced) by setting a minimum current (I-min) on the amplifier. With I-min adjusted above the zero point, the valve spool will jump to this setting when the amplifier is powered, effectively removing the deadband.

The I-min adjustment will affect the I-max setting so it should always be set first.

On multifunction or dual solenoid drivers (directional control valves) a deadband elimination function is normally built in and can be selected by a dip switch. The amount of deadband jump is usually factory set and is application specific.

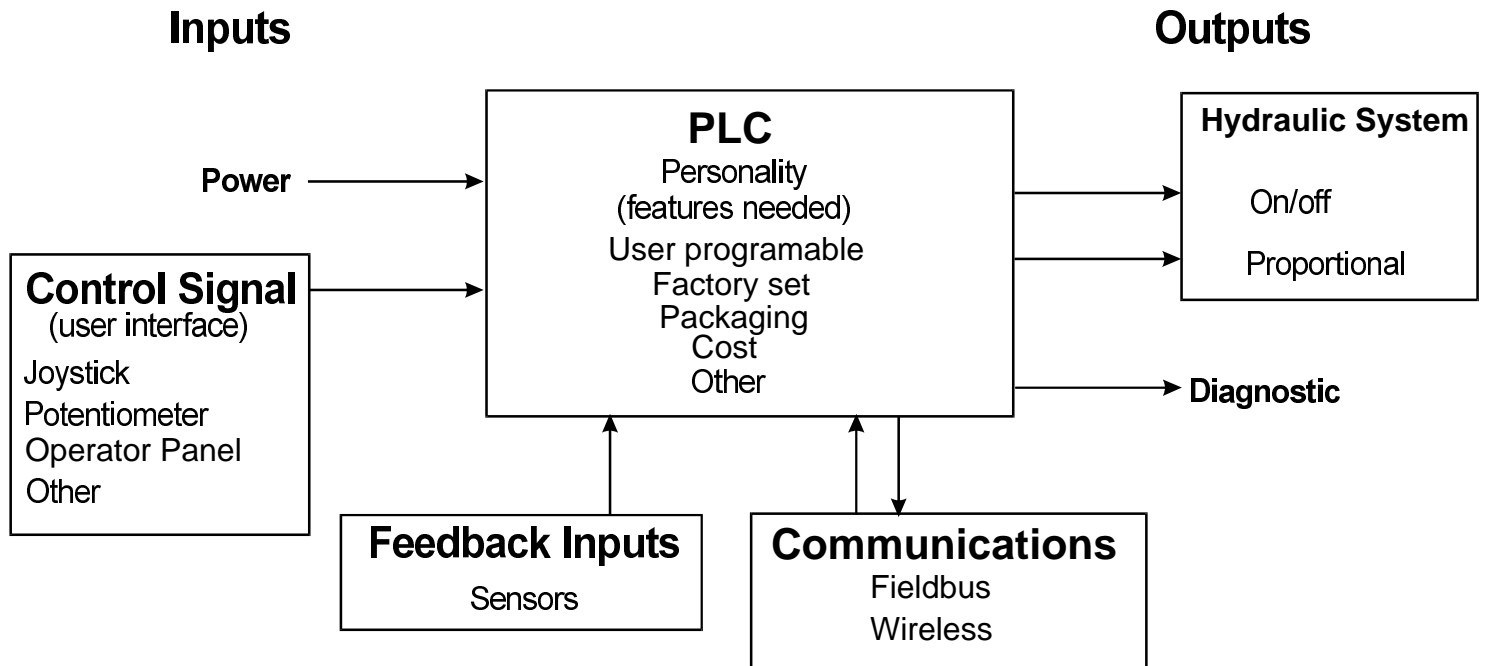
Current Feedback

When passing a current through a solenoid the coil generates heat. This heat increases the resistance of the coil. For example, a coil may have a resistance of 7.2 ohms at a temperature of (20 C) and a resistance of 9.4 ohms at 100 C. This change in resistance will cause a reduction in coil power and valve setting.

To compensate for the negative effect of coil heating, some amplifiers have current feedback, a low value current feedback resistor is added in series with the solenoid coil. This allows the solenoid current to be proportional to the input signal voltage and independent of the solenoid resistance.

This feedback is only effective if the power supply voltage is sufficient to overcome the increased resistance.

Electronic Control Technology



Electronic control

The electronic control of a piece of mobile equipment can consist of the following:

Inputs, which can be defined as the user interface and can consist of joysticks, potentiometers, an operator panel or other input device's.

Controller or PLC, which is the brains of the electronic control and takes the inputs and turns them into a defined output to the hydraulic system. The controller also may have the ability to receive feedback inputs from machine sensors and attenuate its outputs accordingly. The controller can be factory programmed or have the ability to be user programmable to meet the specific requirements of the circuit it is to control.

Outputs, the outputs can be on/off voltage signals or proportional PWM signals to control the hydraulic valving.

Communications, the controller may also have the ability to have two way communications with a bus system.

Feedback Inputs, can consist of pressure transducers, and temperature, flow, velocity

or rpm sensors. When feedbacks are used the system is said to be "closed loop".

PLC Programmable Logic Controller

A PLC is a device that was brought to the market to replace the necessary sequential relay circuits for machine control. The PLC works by looking at its inputs and depending on their state, turns on/off its outputs. The user enters a program, usually via software, that contains instructions necessary to give the desired results

With a programmable controller, the sequence of the logic is converted from the symbology of a circuit diagram to data stored on a memory chip. When a chip has been programmed, all of the logic circuitry has essentially been transferred onto solid state devices. Because these devices can be changed or reprogrammed easily, the PLC has the versatility to quickly modify a process or the parameters that control the machine's function.

The PLC is a digital device that can have the capability to convert analog inputs, process them digitally and provide analog outputs. Some PLC's do not have built in converters, so it is necessary to use analog to digital converters (ADC) on the input

Analog

An analog signal can be defined as an AC or DC voltage or current that varies smoothly or continuously. In an analog system, physical variables are represented by proportional voltages that are analogous to the corresponding physical variables.

A watch with hour and minute sweep hands is an analog device. It continuously indicates the time by the position of the hands on a calibrated dial. To tell the exact time, the hand positions must be estimated. The ability to read the time accurately is limited by the precision of the dial calibration.

Electronic circuits that process analog signals are called linear circuits.

Digital

Digital signals, almost always vary between two distinct and fixed voltage levels. The digital signal is normally in the form of a series of pulses that rapidly change from one voltage level to the other in discrete steps or increments.

A watch on which time is read directly from a decimal number display readout that changes in discrete increments of hours, minutes and seconds is an example of a digital system. The accuracy in this digital system is improved because there is no need to estimate the exact time.

In digital systems, the physical variables are represented by a numerical equivalent using a form of the binary (base 2) number system.

Electronic control platforms

Some of the different forms that mobile electronics can take are illustrated in Fig-1. The chart shows the increasing complexity (and cost) as the vehicle's components go from single function analog controls to complete complex digital control systems.

Digital vehicle controllers offer a high level of sophistication by executing a programmed sequence, enabling constant control of all motion parameters.

Electronic Control Technology Platforms for the Mobile Equipment Market

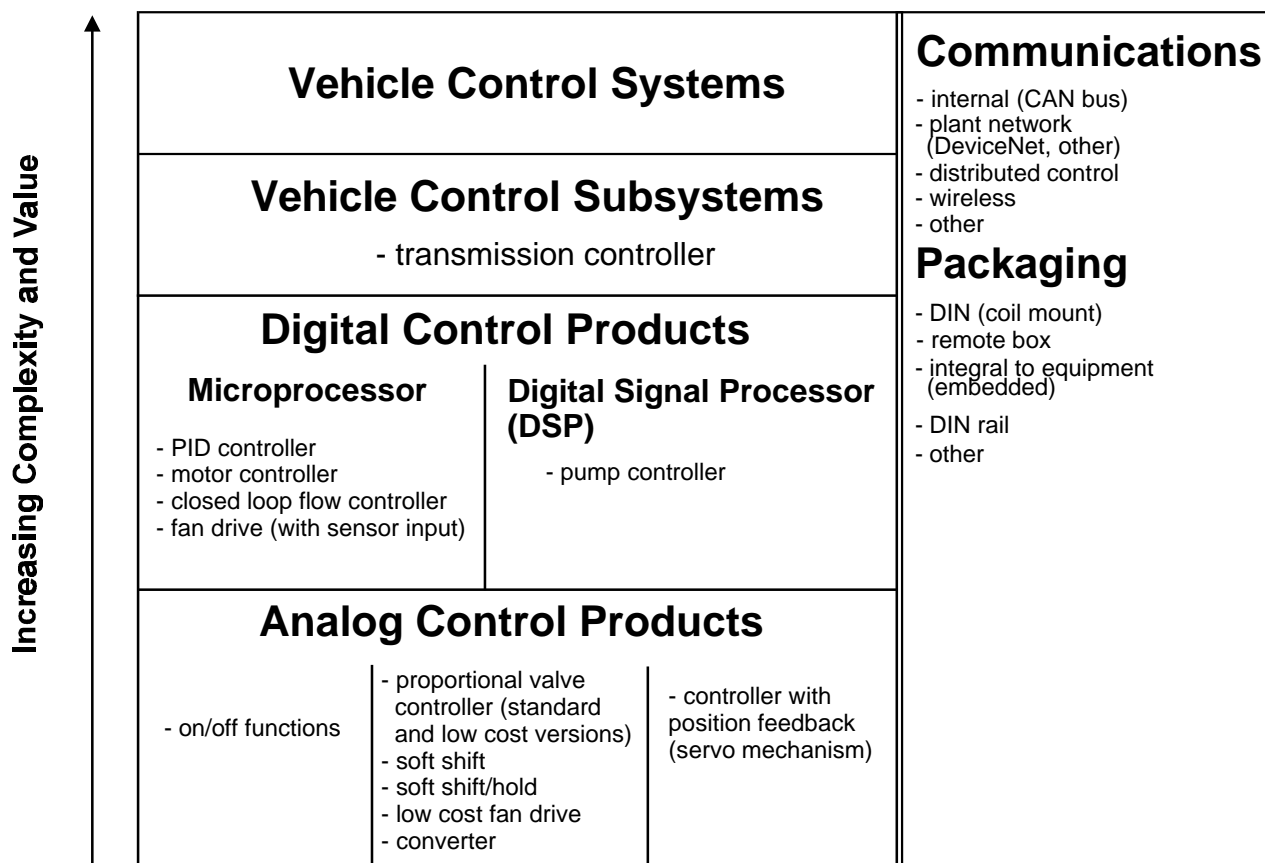


Fig-1

PWM Controller

PLC's and electronic engine control modules will produce PWM outputs that have very low amperage capabilities. This low amperage (less than .5 amps) output is generally not sufficient to drive most hydraulic valves. In these instances it is necessary to use a controller that takes this low amperage PWM signal and converts it into a 0-2 amp PWM output.

The PWM controller provides current that is proportional to the input signal. The controller has I-min, I-max, dither frequency, dither amplitude and independent ramp adjustments.

The PWM controller is available in Din rail mount, IP67 rated metal box or as a PCB board.

Specifications

Input

PWM from 250 to 5000 Hz
 PWM range 5-95%
 Input resistance 200k ohms

Output

current output factory set to 2A
 PWM high frequency
 Short circuit protection provided

General

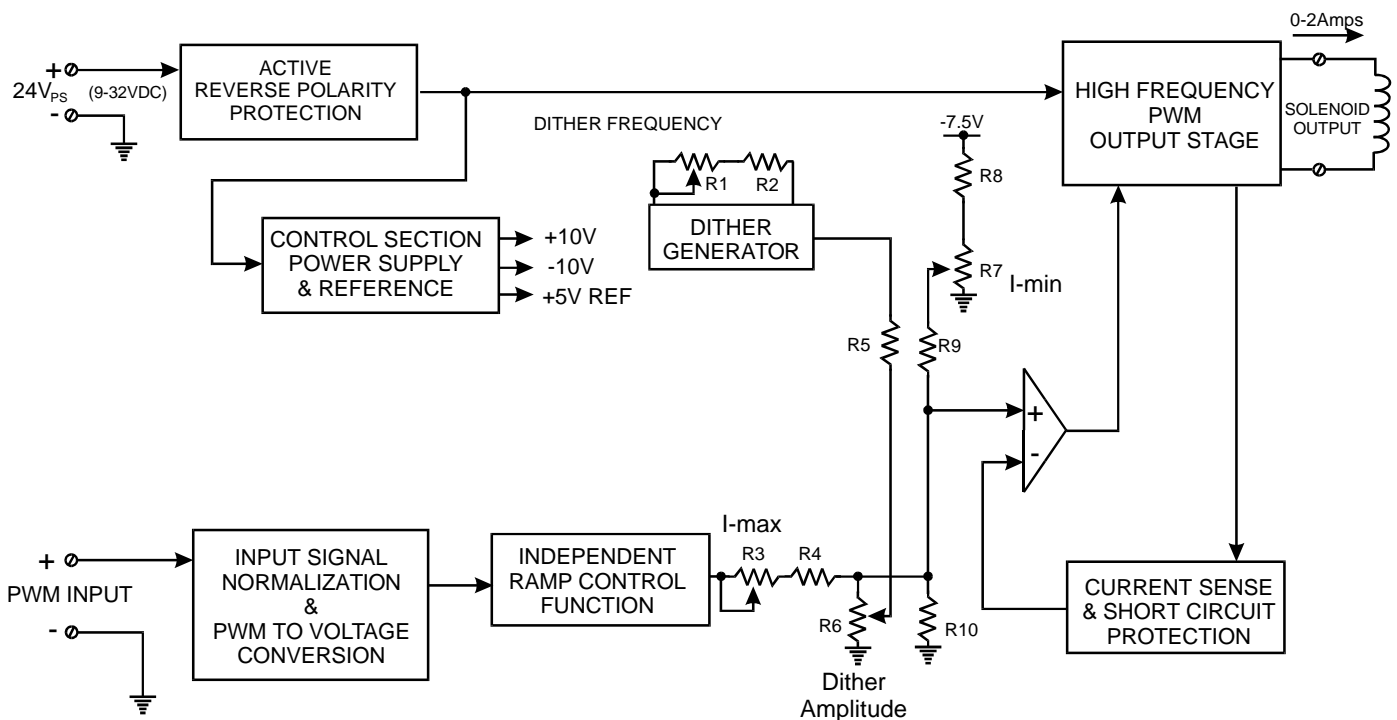
Power supply 9-32 VDC
 Reverse polarity protected
 Enable terminals 7-8 when connected unit is disabled
 Screw terminals

Adjustments

Dither frequency 70-350 Hz single turn pot.
 Dither level 0-10% of max current single turn pot
 I-max .6 to 2A CW = increasing
 I-min CW = increasing
 Ramps 0.01 to 5.0 seconds CW = increasing

Factory settings are all full CCW except for I-max which is full CW.

PWM Controller Block Diagram



SOFT SHIFT CONTROLLER

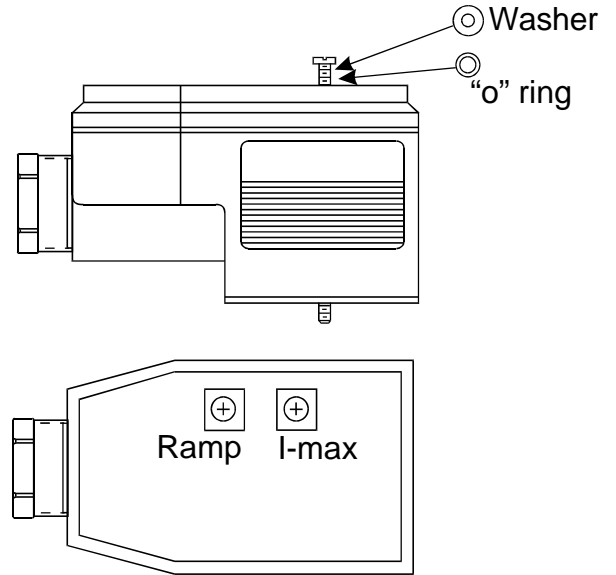
The soft shift controller is designed to enable the soft start of a proportional solenoid valve used for pressure or flow control in hydraulic circuits.

The controller incorporates an adjustable increasing ramp as well as an adjustable I-max setting.

When power is applied to the controller, it ramps to a maximum current, in a time period, that is adjustable within a factory set range. This ramp permits the user to define the time period that the pressure or flow control will reach its maximum output.

When power is removed the out put current immediately falls to zero.

The I-max adjustment limits the maximum current applied to the valve coil. This enables the user to control the maximum flow or pressure to the hydraulic circuit.

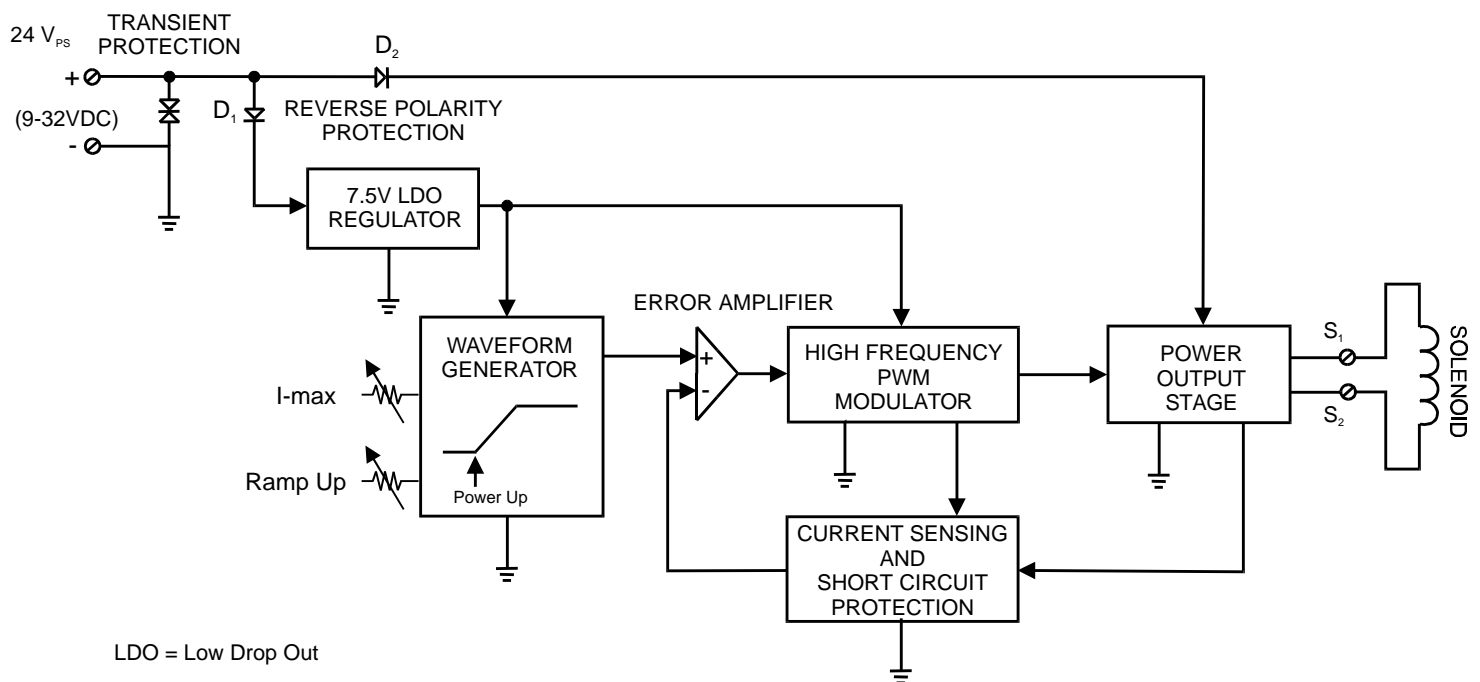


Adjustments

Ramp 0.05 to 5 seconds. CW to maximum delay, single turn potentiometer.

I-max 0.6 to 2 amps. CCW to reduce I-max, single turn potentiometer.

Block Diagram



Soft Shift/Hold Controller

The soft shift/hold controller is designed to ramp up to a high current level and then drop off to a low holding current. The controller is application specific and requires that the correct setting be made at the factory for the coil being used.

The example shown is typical and is for a 10VDC 2.9 ohm coil. Upon start up, the output current jumps to 0.6 Amps and then ramps to full power (3.3 Amps) over 3 seconds. The controller then drops to a holding current of 1.2 Amps.

The controller maintains this energy saving low current level until power is removed. Ramp on time and current levels are factory set.

Applications

Cost effective alternative for soft start

Used for applications that have long on time to reduce heat build up.

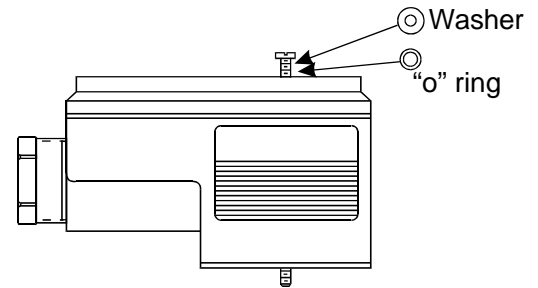
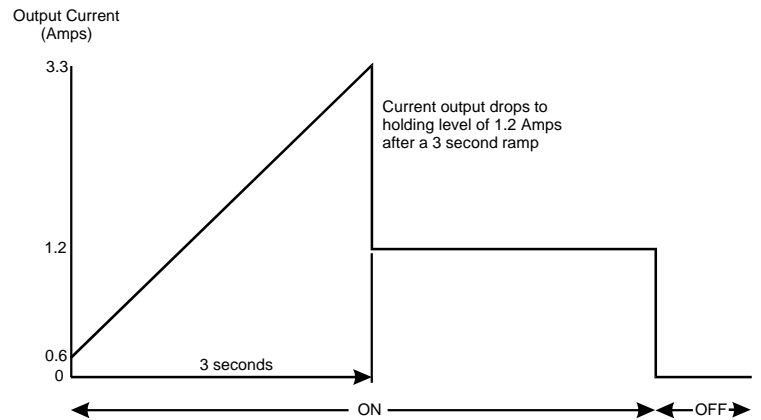
Can be used to "hot start" coils.

Specifications

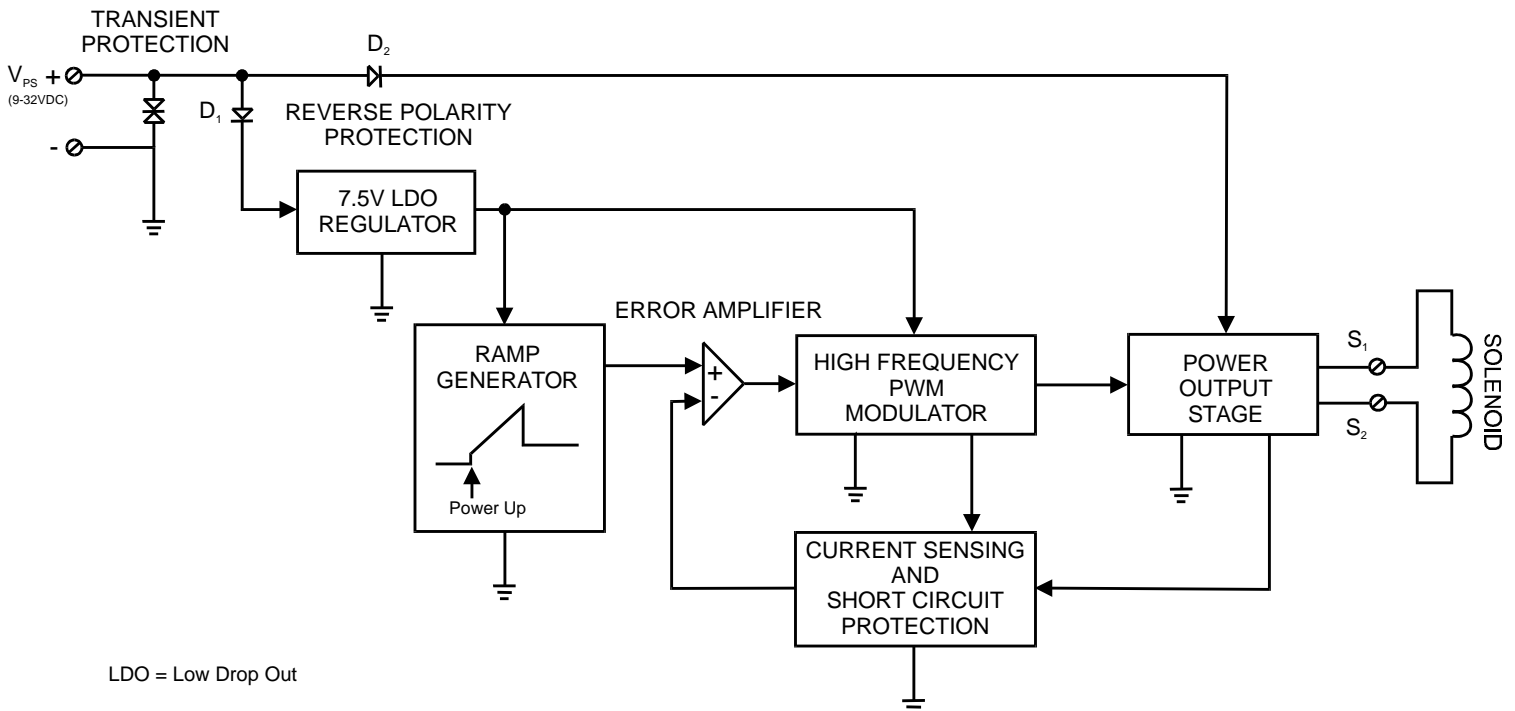
Short circuit protected

Reverse polarities do not damage equipment

Supply voltages of 9-32VDC



Soft Shift/Hold Controller Block Diagram



Proportional Valve Controller/Amplifier

The Proportional Valve Controller/Amplifier simplifies the control of proportional solenoid valves by supplying a output current that varies linearly with various types of input signals. This linear solenoid Controller/Amplifier utilizes a high frequency switching output (PWM) to provide a DC current output of 2 Amps. A current sensing circuit maintains output current, within limits, regardless of a change in coil resistance or input voltage. This current sensing circuit only is operable within the range of the input voltage. If a change in the coil resistance requires a voltage of a higher value than that is the maximum available the current output will drop.

The user can adjust the maximum and minimum current as well as ramp time, dither frequency and dither amplitude.

Dither frequency and amplitude adjustments will vary depending on the type of hydraulic valve used. The proportional valve data sheet will usually specify the desirable settings.

The Controller/Amplifier comes with a DIN 43650 connection to mount directly to the coil on a cartridge or block style proportional valve.

The Controller/Amplifier is available for various input signals and with outputs of 0 to 300, 0 to 600 or 0 to 2000mA.

Input signals

4 to 20 mA
0 to 5V or 0 to 20mA
0 to 10V

The 4 to 20mA control is normally used in conjunction with PLC's while the 0 to 5V and 0 to 10V controls are normally used with potentiometer inputs.

Do not use near high voltage relays or other sources of electrical interference



Electrical Specifications

Input Ω	125K ohms
I-min	0 to 85mA for 0 to 300 model
I-min	0 to 180mA for 0 to 600 model
I-min	0 to 600mA for 0 to 2000 model
I-max	100 to 300mA for 0 to 300 model
I-max	180 to 600mA for 0 to 600 model
I-max	600 to 2000mA for 0 to 2000 model
Ramp time	0.01 to 5 seconds
Dither	Frequency 70 to 350 Hz Amplitude 0 to 10% of rated current

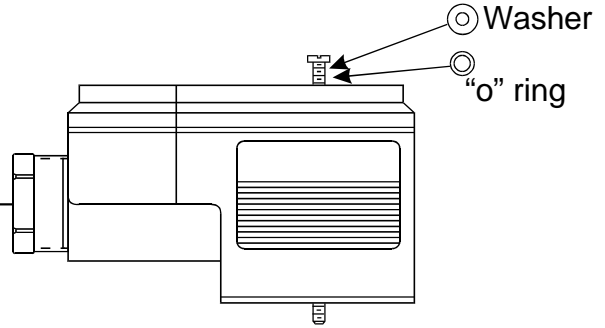
Coils should have no polarity or protection diodes for proper operation of the Controller/Amplifier

Connections

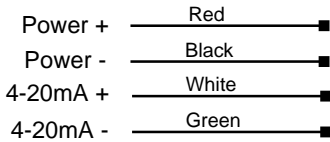
Supply voltage should be between 9 and 32 VDC. Excess voltage will damage the Controller/Amplifier. The power supply should have a voltage rating slightly higher than the valve coil to assure that the current sensing circuit will function. Operating the amplifier with a voltage equal to or lower than the valve coil rated voltage may result in reduced maximum current output.

Connect the power supply and input signals as shown in fig-1.

All but 4-20mA Controller



4 to 20mA control only



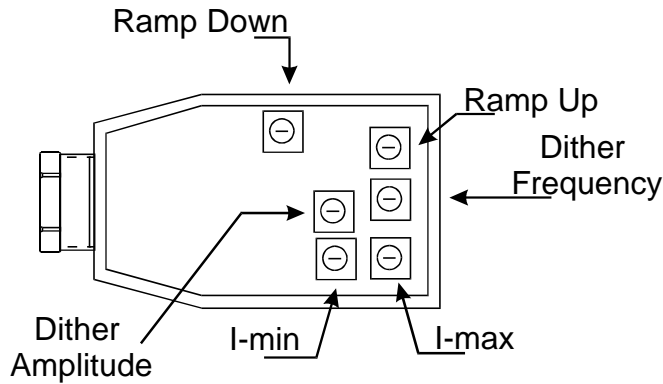
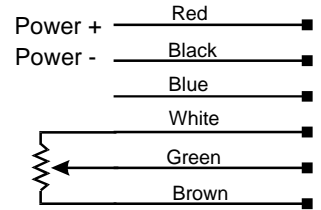
0 to 20mA control



0-5VDC control or 0-10VDC



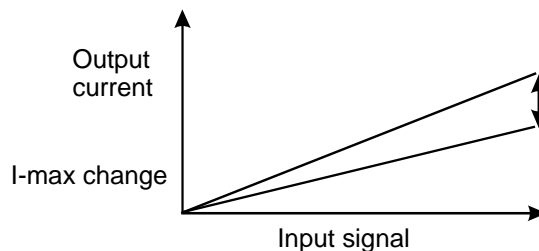
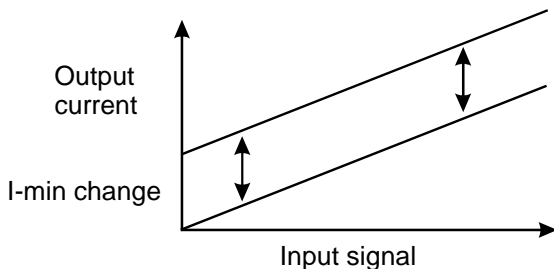
Potentiometer control



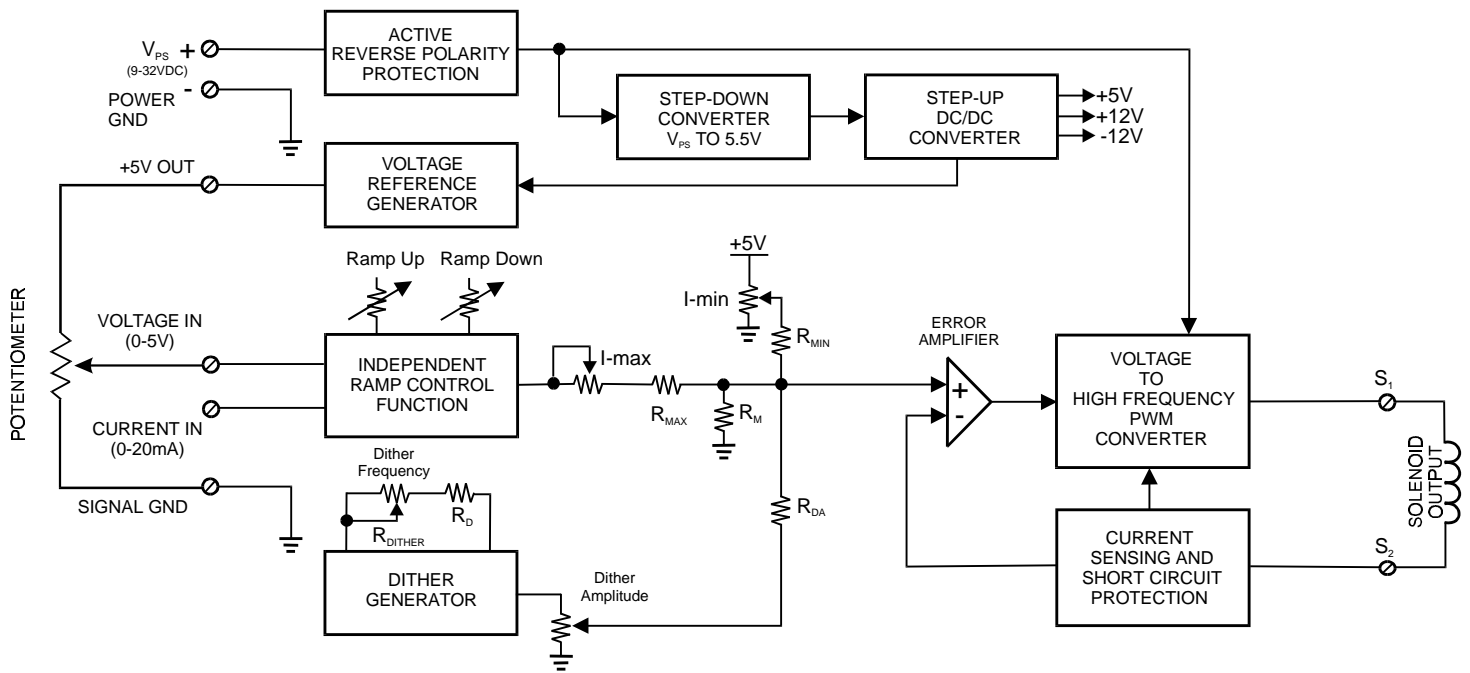
Adjustments (blade type screwdriver 1.5mm)

Ramps	Minimum full CCW	Single turn potentiometer
I-min	Minimum full CCW	Multi turn potentiometer
I-max	Minimum full CCW	Multi turn potentiometer
Dither amplitude	Minimum full CCW	Single turn potentiometer
Dither frequency	Minimum full CCW	Single turn potentiometer

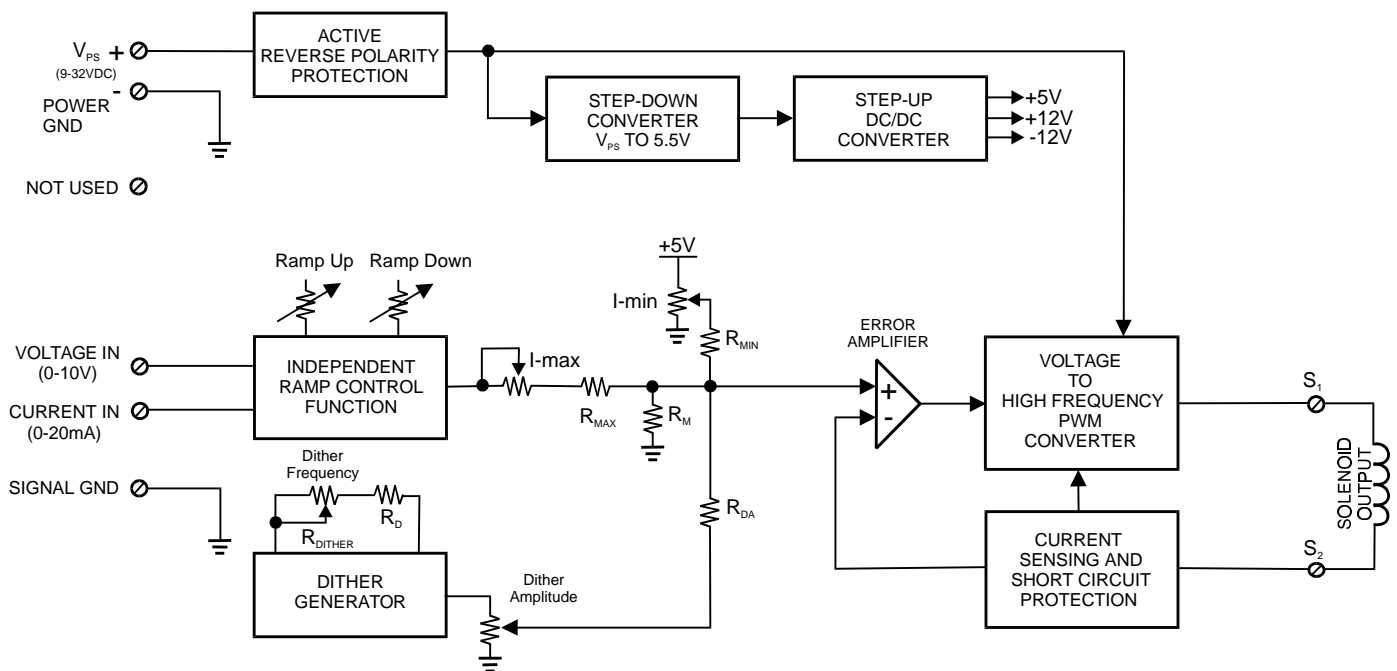
The minimum current (I-min) should be set first as it will affect the maximum setting. When I-min is raised I-max will go up the same amount. Once I-min is set then the maximum current can be set. I-min affects the starting point of the curve while I-max affects the slope.



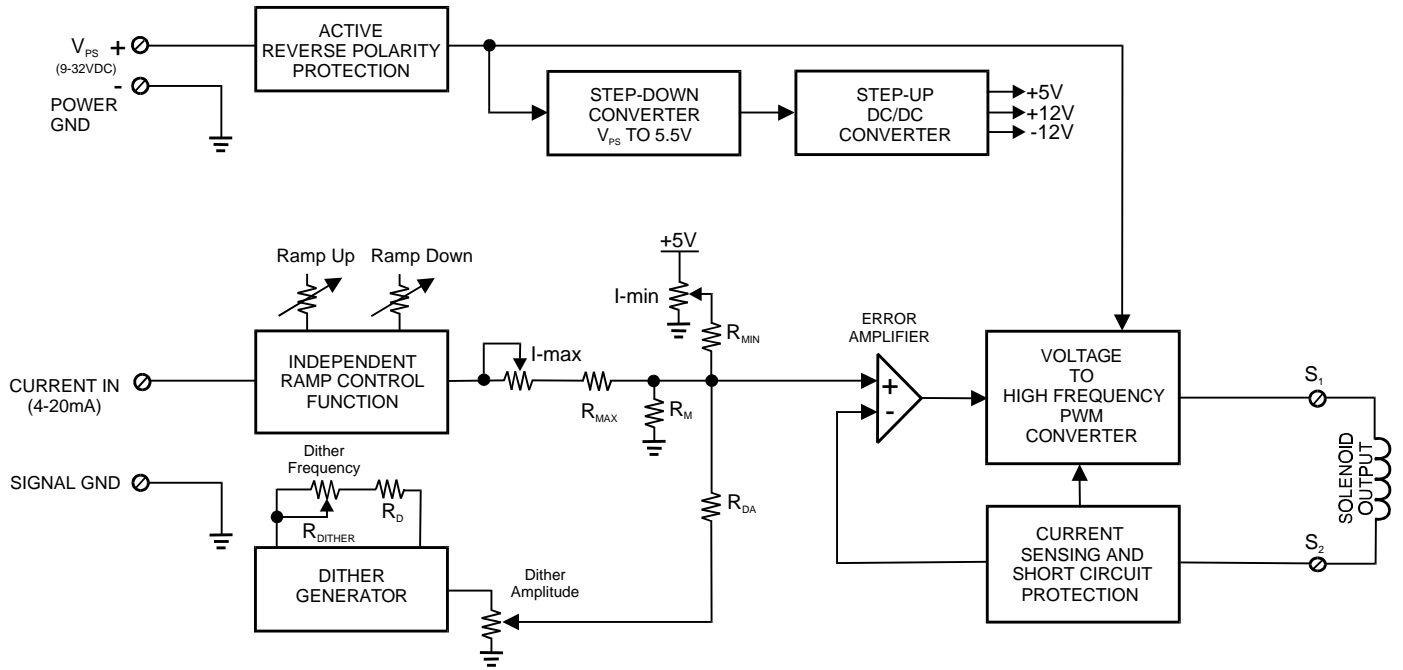
Block Diagram 0-5V or 0 - 20 mA



Block Diagram 0-10V or 0 - 20 mA



Block Diagram 4 - 20 mA



Proportional Valve Controller/Amplifier Remote Mounting

The remote mounted Proportional Valve Driver provides the same control and function as the DIN style coil mounted driver. This linear solenoid driver is available as a PCB board, packaged driver mounted in a housing with screw terminals or mounted in a housing with IP65 or IP67 cable attached.

The user can adjust the maximum and minimum current as well as ramp time dither frequency and dither amplitude.

Dither frequency and amplitude adjustments will vary depending on the type of hydraulic valve used. The proportional valve data sheet will usually specify the desirable settings.

A system of LED's indicates output signal present, input signal present and power on/off.

Figure -1 illustrates the board layout with LED locations, adjustments and terminal designations. The terminals are screw type and accept #18 or #20 wire. The grommet connection for user supplied cable is PG9.

Supply voltage should be between 9 and 32 VDC. Excess voltage will damage the Controller/Amplifier. The power supply should have a voltage rating slightly higher than the valve coil to assure that the current sensing circuit will function. Operating the amplifier with a voltage equal to or lower than the valve coil rated voltage may result in reduced maximum current output.

Table-1 Illustrates the proper connections for the Controller/Amplifier that comes equipped with either the IP65 or IP67 cable.

Electrical Specifications

Input Ω	125K ohms
I-min	0 to 85mA for 0 to 300 model
I-min	0 to 180mA for 0 to 600 model
I-min	0 to 600mA for 0 to 2000 model
I-max	100 to 300mA for 0 to 300 model
I-max	180 to 600mA for 0 to 600 model
I-max	600 to 2000mA for 0 to 2000 model
Ramp time	0.01 to 5 seconds
Dither	Frequency 70 to 350 Hz Amplitude 0 to 10% of rated current

Coils should have no polarity or protection diodes for proper operation of the Controller/Amplifier

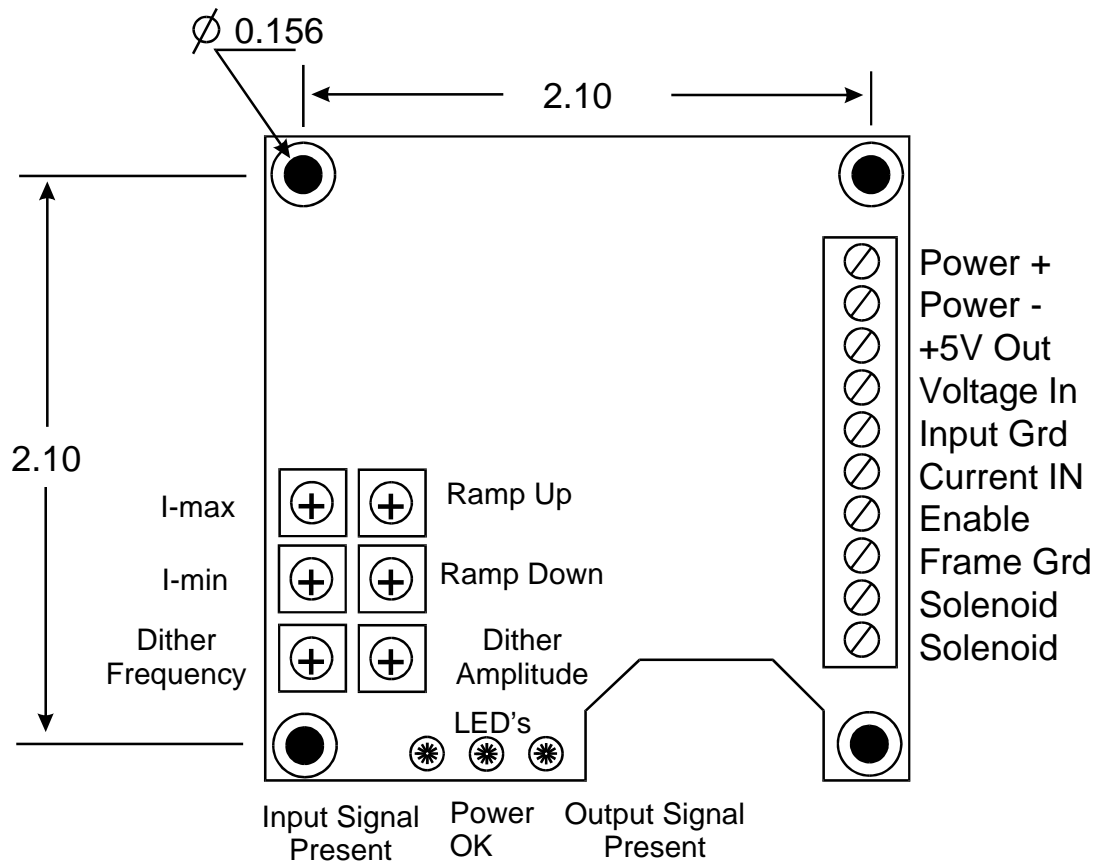


Fig-1

IP 65 Cable

4 to 20mA control	Potentiometer control	0 to 20mA control	0 to 5VDC control
Power + — Red	Power + — Red	Power + — Red	Power + — Red
Power - — Black	Power - — Black	Power - — Black	Power - — Black
— Red/Black stripe	— Red/Black stripe	— Red/Black stripe	— Red/Black stripe
— White/Black stripe	5V ref — White/Black stripe	— White/Black stripe	(+) 0-5V — White/Black stripe
4-20mA - — Green/Black stripe	SGND — Green/Black stripe	0-20mA - — Green/Black stripe	(-) 0-5V — Green/Black stripe
4-20mA + — White	— White	0-20mA + — White	— White
Enable — Blue	Enable — Blue	Enable — Blue	Enable — Blue
Coil — Green	Coil — Green	Coil — Green	Coil — Green
Coil — Orange	Coil — Orange	Coil — Orange	Coil — Orange

IP 67 Cable

4 to 20mA control	Potentiometer control	0 to 20mA control	0 to 5VDC control
Power + — Red	Power + — Red	Power + — Red	Power + — Red
Power - — Black	Power - — Black	Power - — Black	Power - — Black
— Yellow	— Yellow	— Yellow	— Yellow
— Yellow/Red stripe	5V ref — Yellow/Red stripe	— Yellow/Red stripe	(+) 0-5V — Yellow/Red stripe
4-20mA - — Yellow/Black stripe	SGND — Yellow/Black stripe	0-20mA - — Yellow/Black stripe	(-) 0-5V — Yellow/Black stripe
4-20mA + — Yellow/Blue stripe	— Yellow/Blue stripe	0-20mA + — Yellow/Blue stripe	— Yellow/Blue stripe
Enable — Purple	Enable — Purple	Enable — Purple	Enable — Purple
Coil — Orange/Black stripe	Coil — Orange/Black stripe	Coil — Orange/Black stripe	Coil — Orange/Black stripe
Coil — Orange/Red stripe	Coil — Orange/Red stripe	Coil — Orange/Red stripe	Coil — Orange/Red stripe

Table - 1

Dual Solenoid Multifunction Driver

The dual solenoid Multifunction Driver provides accurate control of hydraulic proportional valves used in mobile equipment and industrial machinery. This driver provides a proportional output signal with inputs from a joystick, potentiometer or other control system interfaces.

The multifunction design will support inputs from a joystick potentiometer with or without center tap, a standard potentiometer or commonly available control signals such as 0 to 5 Volts, 0 to +/- 5 Volts, 0 to 10 Volts, 0 to +/- 10 Volts, 0 to 20 mA, and 0 to +/- 20mA.

The power supply connection is protected against polarity and short circuits. The driver is potted and is available in a IP67 enclosure or as a panel mount. Standard connections are 1/4" spades with plug on variations optional

The Dual Solenoid Multifunction Valve Driver has a total of seven outputs that can control a variety of hydraulic valve functions.

- Dual solenoid proportional 4-way valve
- Single solenoid proportional flow and pressure controls.
- Single or double solenoid on/off valves
- Half speed function for proportional outputs

Features

High frequency PWM with adjustable dither amplitude and dither frequency

High speed power up permits the entire electronics package to be powered from a safety interlock or joystick mounted switches.

Independent or symmetrical adjustable ramps user selectable. Adjustment range 0.01 to 5 seconds

I-min and I-max fully adjustable from 0 to 2 Amps.

Half speed input provides for automatic reduced output to proportional function.

Deadband settings can be selectable by the user. When on deadband is created electronically and is a function of the voltage output of the joystick or potentiometer. When off the deadband is disabled and would now be a function of the joystick limit switches.

Center null can be made positive electronically by connecting the half voltage output of the driver to the center tap of the potentiometer.

Master/slave option will permit only one axis of a joy stick to operate at a time.

The I-max/2 terminal of the driver is activated when powered. When activated the driver will reduce the proportional output signal 50%.

Electronic overload, static and surge protection built in.

EMI and RFI resistant.

Input Specifications

9-32VDC Nominal power supply. Reverse polarity protected

10K potentiometer recommended

Electrical Specifications

Input Ω	500K ohms
I-min	0 to 2000mA
I-max	0 to 2000mA
Ramp time	0.01 to 5 seconds
Dither	Frequency 70 to 350 Hz Amplitude 0 to 10% of rated current

Functional Diagram

The functional diagram (fig-1) illustrates the field connections for the Multifunction Valve Driver. There are 22 terminals on the driver so care should be taken to insure the proper connections are made.

Dual Solenoid Driver Functional Diagram

Joystick or Potentiometer Interface

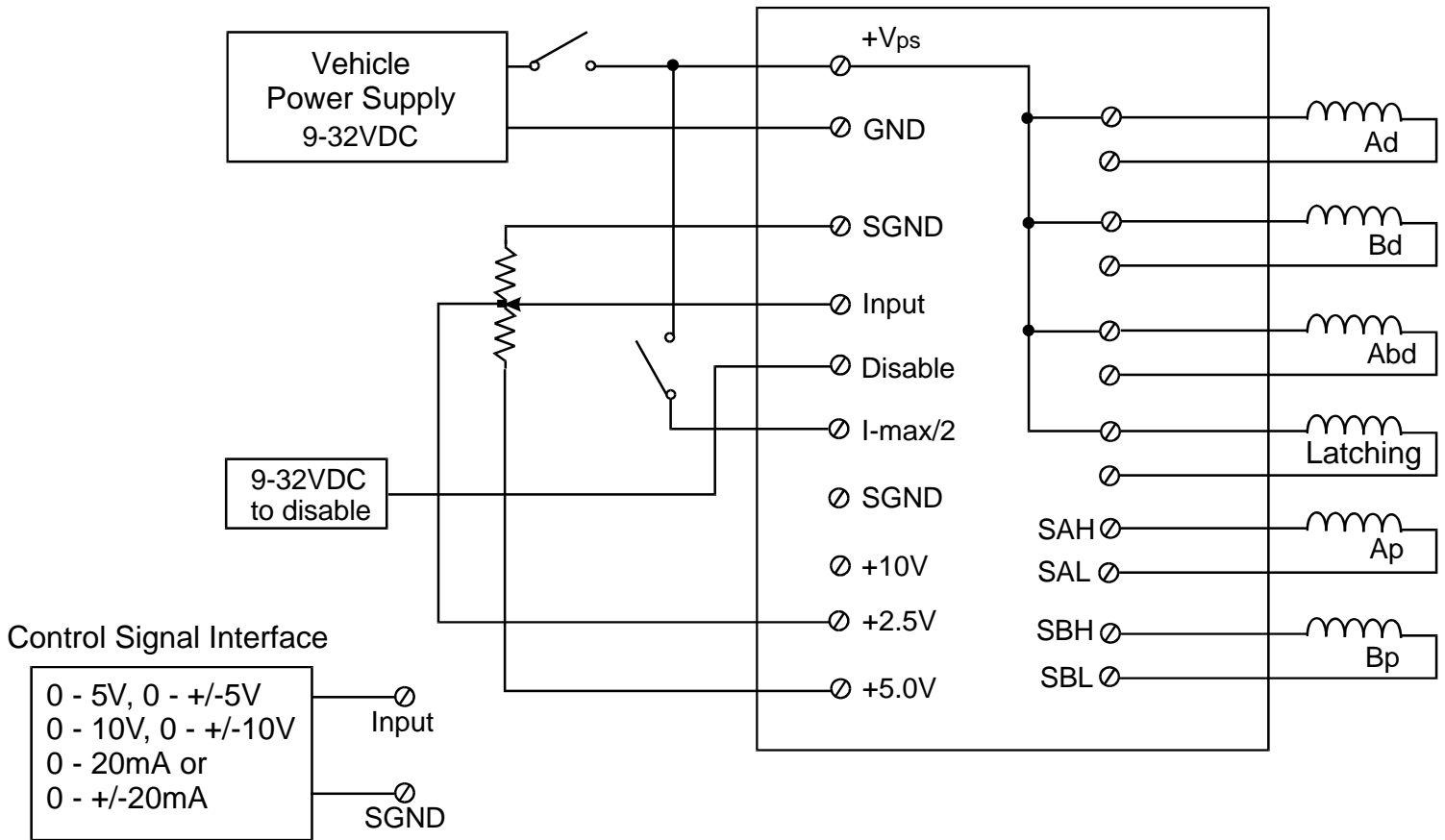


Fig - 1

Single solenoid proportional valve (fig-2)

To use a single solenoid proportional valve the SAL and SBL terminals are connected together and to one side of the proportional valve coil. The other side of the coil is connected to either the SAH or SBH terminal. When using a joystick this connection will power the proportional coil when the joystick is moved either side of center.

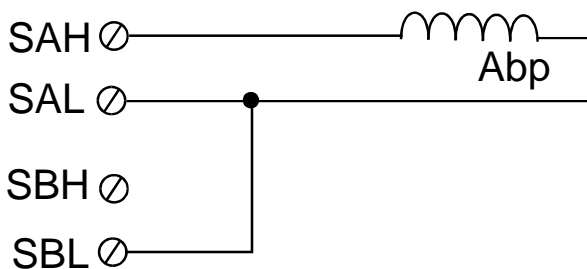


Fig - 2

Positive null connection(fig-3)

To achieve a positive null position electronically, the center tap on the potentiometer can be connected to the half voltage terminal of the driver. This imposes a center position voltage to the wiper when it is in the mechanical center of the potentiometer and will compensate for any differences in resistance between the two halves of the potentiometer.

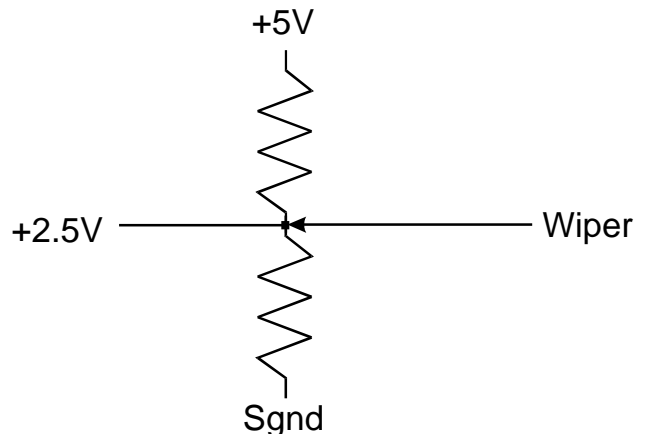
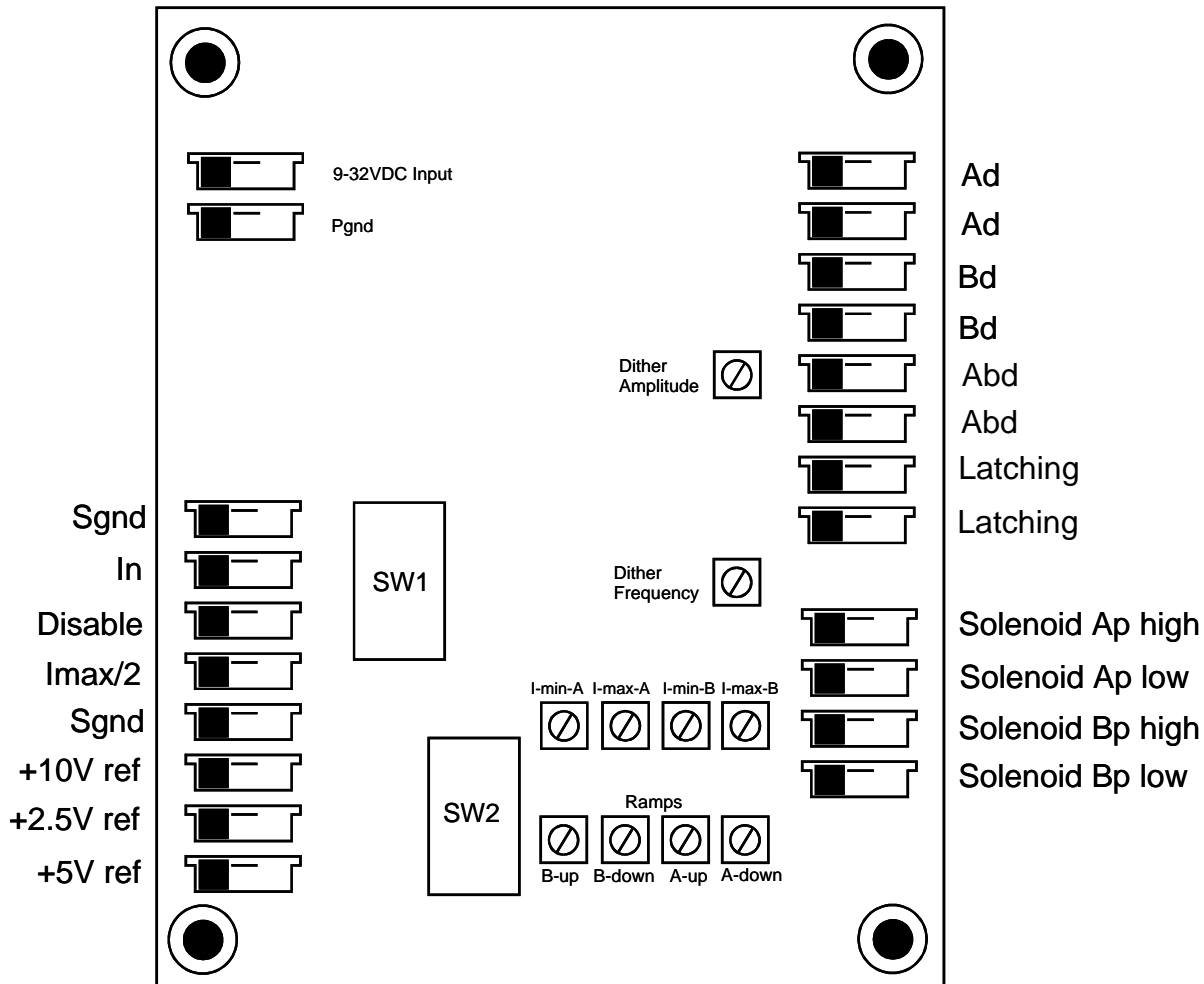
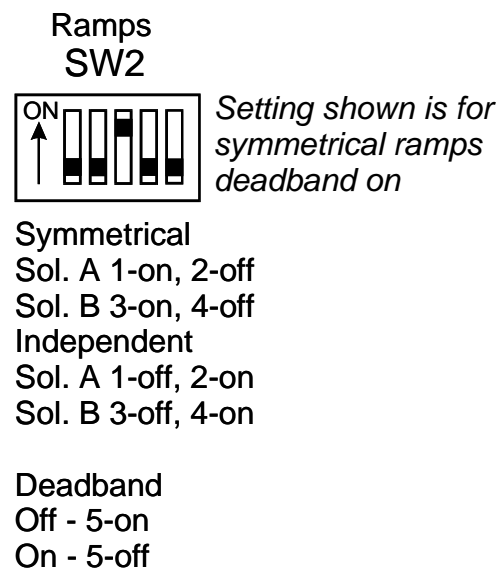
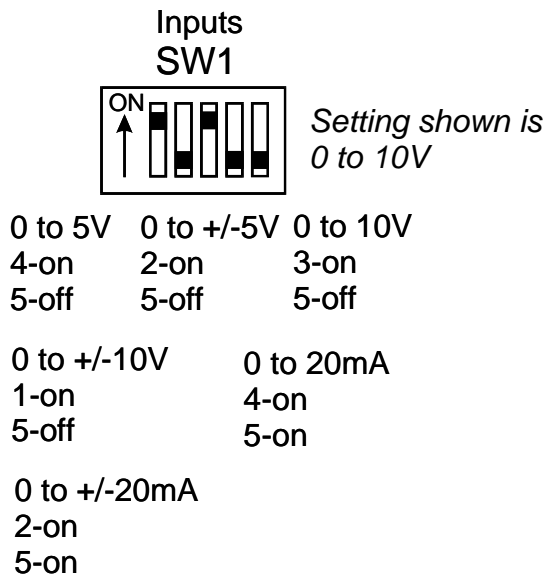


Fig - 3

Board Layout

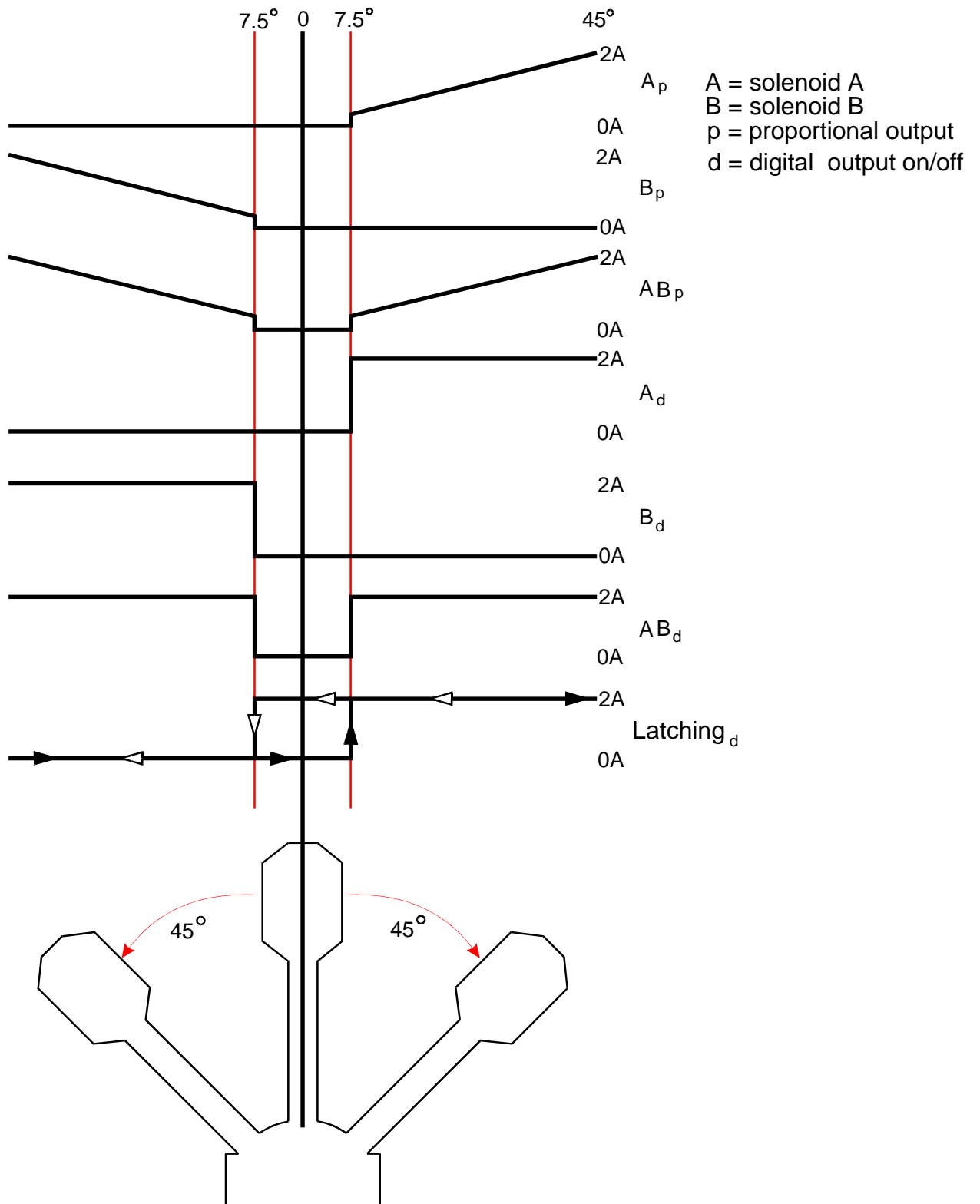


Symmetrical ramps are controlled by “up” adjustment
 Ramp adjustment is CCW to increase, CW to decrease
 I-min and I-max adjustments are CCW to increase
 Dither frequency and amplitude adjustments are CW to increase, CCW to decrease



Typical Joystick Motion as Related to Outputs

Output signals shown as joystick movement



Dual Solenoid Driver Block Diagram

