SAUER DANFOSS

PLUS+1™ GUIDE
Software

JS6000 PWM
Service Tool
User Manual

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COMPLIANT
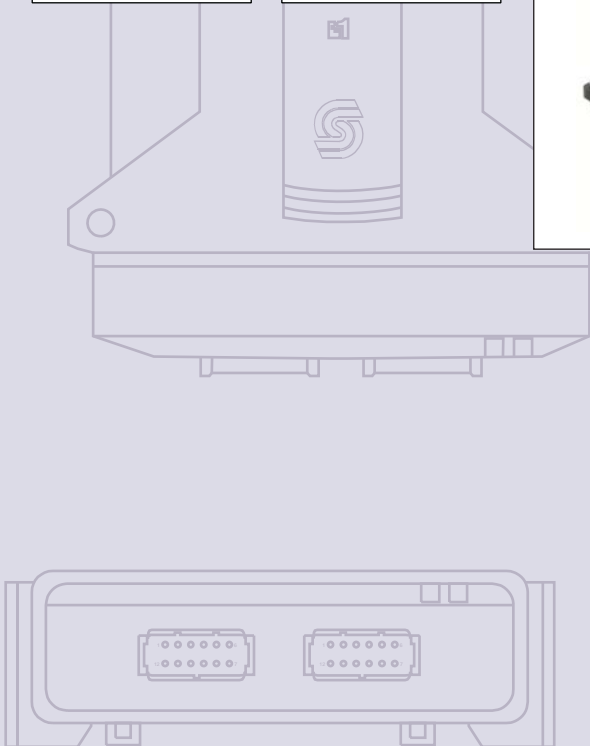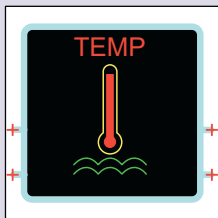
About this Manual

Organization and Headings

To help you quickly find information in this manual, the material is divided into sections, topics, subtopics, and details, with descriptive headings set in red type. Section titles appear at the top of every page in large red type. Topic headings appear in the left-hand column in **bold red type**. Subtopic headings appear above the body text in **bold red type** and detail headings in *italic red type.*

References (example: See *Topic xyz*, page *XX*) are also formatted in *red italic type*. In Portable Document Format (PDF) files, these references are hyperlinks that jump to the corresponding document pages.

Tables, Illustrations, and Complementary Information

Tables, illustrations, and graphics in this manual are identified by titles set in *blue italic type* above each item. Complementary information such as notes, captions, and drawing annotations are also set in blue type.

Special Text Formatting

Controls and indicators are set in **bold black type**.

Black italic type is used in the text to emphasize important information, or to set off words and terms that are used in an unconventional manner or alternative context.

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Revision History

Revision	Date	Comment
Rev BA	August 2009	

Contents

The JS6000 PWM Joystick Base can be used along with a grip to directly drive a hydraulic valve, such as used in a hydrostatic pump. A PLUS+1™ microcontroller is not required. It can provide up to 2.5 amps of current on each of two bi-directional output pairs. It also has six digital outputs and some additional inputs.

This manual will describe some of the unique features of the JS6000 PWM Joystick Base, as well as providing complete details regarding the use of the PLUS+1 GUIDE Service Tool interface for troubleshooting and configuring the device.

All outputs on standard product JS6000 PWM joystick bases are disabled until the joystick has been configured using the PLUS+1 GUIDE Service Tool as described in this manual.

- The base can be configured for use with a specific grip type and configuration

- Valve outputs can be configured to have different output characteristics, such as maximum current, acceleration and deceleration rates, dual profiles, etc.

- Valve outputs can be configured to be controlled by grip buttons, proportional inputs, or combinations thereof

- Digital outputs can be configured to be controlled by grip buttons, proportional inputs, or combinations thereof

- Operator presence switch(es) can be configured in several different ways

- An external analog input and an external digital input can be configured

The JS6000 PWM Joystick Base has the following standard features:

- Either Y axis only or XY axis mechanical joystick operation

- Proportional inputs for the X and Y axis in the base

- Proportional inputs for up to two rockers in the grip

- One analog input for connecting an external variable voltage, such as a potentiometer; can be used as a simulated digital input; has limited usage as a proportional input (Note: this input (C1P09) is not available if the system uses shielded CAN wiring.)

- Inputs for up to 8 grip buttons

- Two inputs for connecting an external operator presence circuit

- One configurable digital input for connecting an external switch

- Two configurable valve outputs capable of driving up to 2.5 amps each

- Six configurable digital outputs capable of driving up to 3 amps each

The total output current at any time is limited to 13 amps maximum.

- Please refer to the *JS6000 Joystick Base Technical Information* document (**520L0760**) for much of the general technical information required for this product.

- Please refer to the *JS1000, JS6000 Joystick Grips Technical Information* document (**520L0872**) for information on grips available for use with this product.

- Some unique features of the PWM version of the JS6000 joystick base are described in more detail in this document.

Outputs

Proportional Outputs

The proportional outputs are bi-directional pulse width modulated (PWM) outputs. The duty cycle of the PWM output signal can be varied from -100% to +100% by moving the controlling input. The controlling input can be independently configured to be one of the following:

- X or Y axis of the joystick base

- One of the grip rockers

Each of the two proportional outputs uses two pins on the connector for bi-directional output current. Each output pair is rated for 2.5 amps maximum output at 100% duty cycle.

Digital Outputs

The six digital outputs are on / off type outputs. They are each rated for 3 amps maximum output. The output is a high-side sourcing type output.

> The total maximum output current of the device is limited to 13 Amps at any time. This includes both the proportional and the digital outputs. The system designer must assure that the system will not need more than the maximum rated output for proper system operation. Failure in this regard may result in dangerous operation of the system.

Inputs

Digital Inputs

There is one general purpose digital input on the device connector. This input can be configured to use a pull-up resistor, a pull-down resistor, or no resistor. Also, the true/false logic can be inverted, if desired. This input can be configured to control one of the digital outputs or the Maximum Speed and Dual Profile functions for the Valve Outputs.

Analog Input / CAN Shield

This input on the device connector (C1P09) can be used as a CAN shield connection in systems using shielded, twisted pair CAN wiring. If not used for a CAN shield, it can be configured as:

- An analog input which can be used to control the dual profile function.

- A simulated digital input which can be used to control one of the digital outputs. When used as a simulated digital input, the turn on and turn off voltages can be configured as desired. This allows hysteresis to be added by the proper selection of voltages. Also, the true/false logic can be inverted, if desired.

Operator Presence

The operator presence utilizes two pins on the connector called OPS+ and OPS-. Proportional and digital outputs can be individually configured so that they are enabled by the operator presence signal. If the operator presence is used, there are several other settings available for controlling the output. Please refer to the individual service tool setup screens for further details.

**Connecting Device to
PLUS+1 GUIDE Service Tool**

In order to successfully communicate, there must be the proper connections to the CAN port. There must be a 120 ohm termination resistor across CAN High (C1P03) to CAN Low (C1P04). This wiring must be properly connected to a **CG150 CAN Gateway**'s 9-pin DIN connector. (See wiring diagram below.) For further details on the CG150, see document **520L0945**.
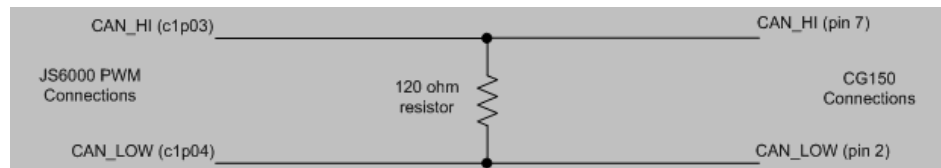
The other connection on the CG150 must be connected to a USB port on a PC running the GUIDE Service Tool.

After the proper connections are made and the device is powered up, start the PLUS+1 GUIDE Service Tool on the PC. Scan the system and then open the proper diagnostic (p1d) file for the JS6000 PWM Joystick Base. Select Normal View from the menu. Expand the **Log Functions** section if it is not already.

Monitoring Device Operation with PLUS+1 GUIDE Service Tool

- Device monitoring is accomplished by using the Log Functions section of the Service Tool.

- Please refer to the *PLUS+1 GUIDE Service Tool User Manual* (**520L0899**) for detailed information on operation of the PLUS+1 GUIDE Service Tool.

Monitoring Grip Buttons

Click on **Grip Buttons** in the Log Functions section of the tree in the Diagnostic Navigator. When monitoring Grip Buttons, the following real-time states will be shown:

Real-time States

Not Available	This will be shown if there is no hardware available in the grip for a particular button selection.
Inactive	This will be shown if there is no hardware available in the grip for a particular button selection.
Active	This will be shown if an available grip switch is currently in the active state.
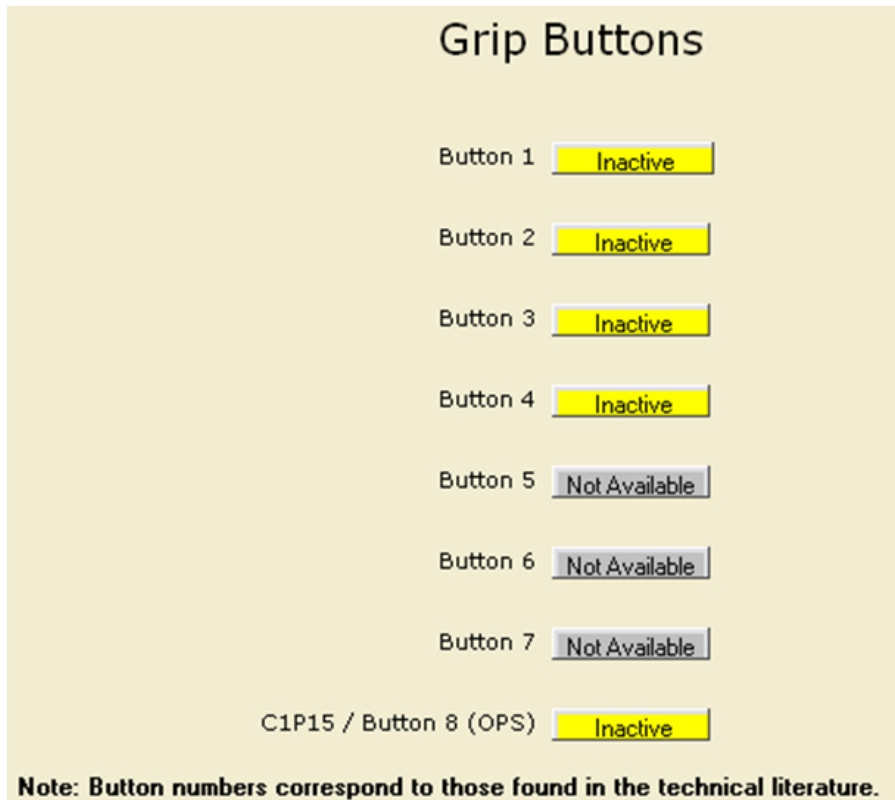
Monitoring Proportional Inputs

Click on **Proportionals** in the Log Functions section of the tree in the Diagnostic Navigator. When monitoring Proportional Inputs, the real-time values of the inputs will be shown. The values are shown in units of Pct*10. For example, a value of **469** is actually **46.9%**. The values can be positive or negative, depending on the position of the actual proportional input device.

Fault Flags are shown to the right of each input. If **OK** is displayed, then there is no fault on that input at this time. If anything else is shown, please refer to the separate section on **Fault Flags** to determine the actual problem. (Note: C1P09 does not have any fault flags associated with it.)

If a proportional input is not available on the actual hardware, then the "Not Available" flag will be shown to the right of the input as shown below.
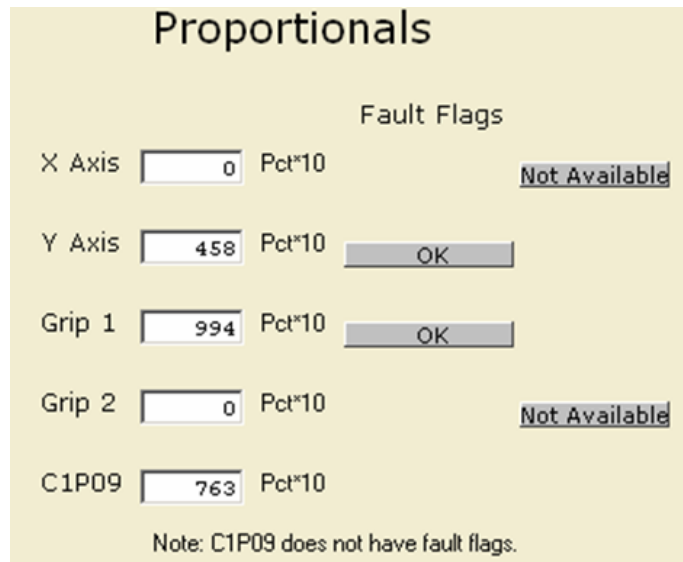
Monitoring Battery Voltage

Click on **Battery Voltage (C1P02)** in the Log Functions section of the tree in the Diagnostic Navigator. The battery input voltage to the joystick is shown in millivolts.

Monitoring Valve Outputs
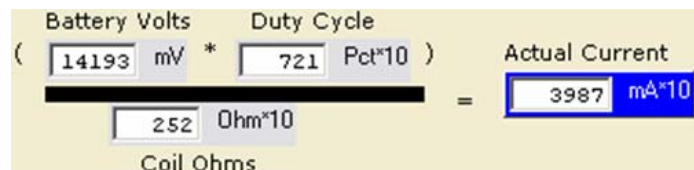
Click on **Valve Out 1 (C1P05_06)** in the Log Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 screen is shown below. **Valve Out 2 (C1P07_08)** is similar.
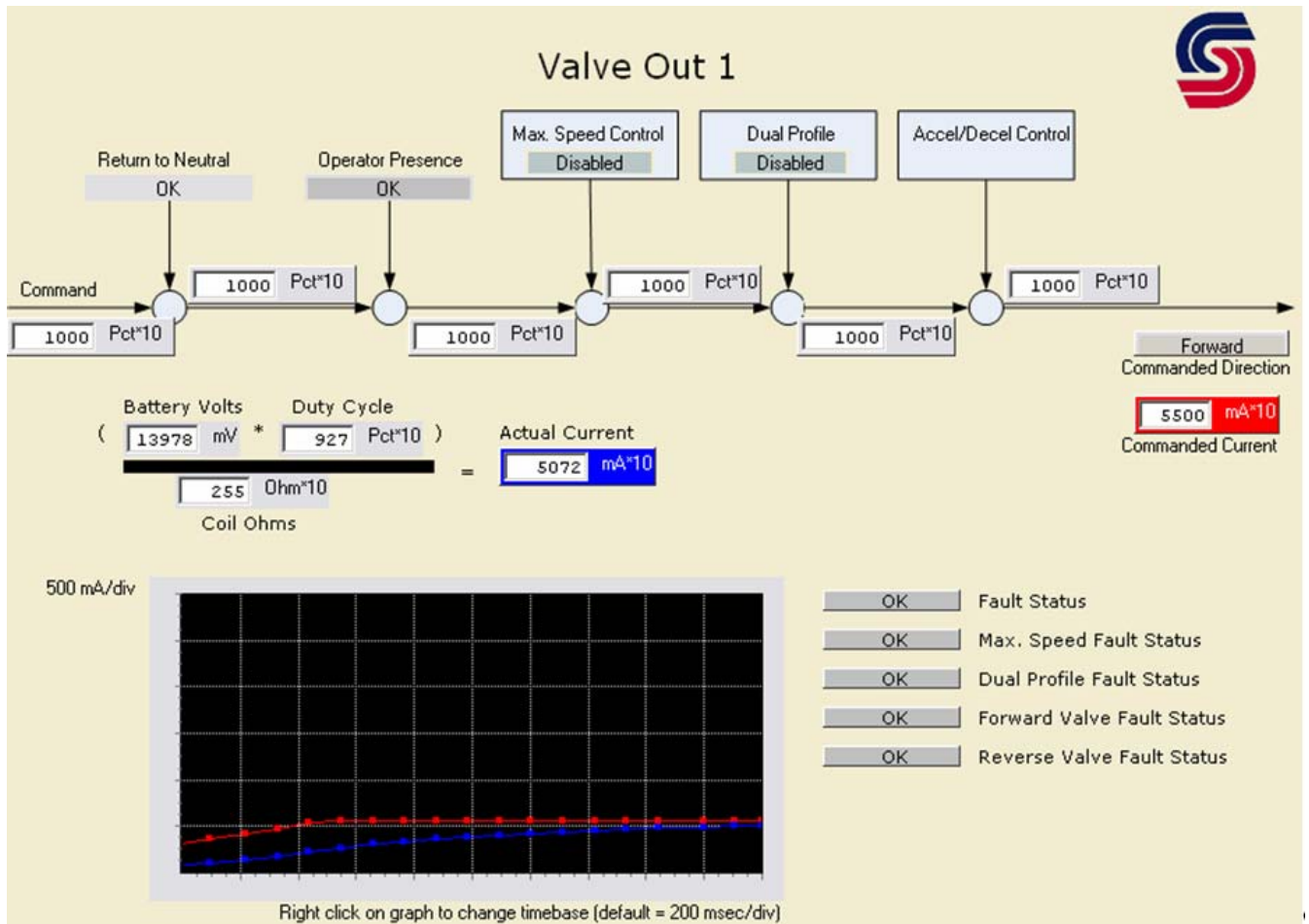
The elements of the screen are:

- **Command** – this value shows the command value (Pct*10) from the proportional input that has been selected to control this output.

- **Return to Neutral** – this value will show either OK or Return To Neutral . If it is **OK** then the Command value will be transferred to the next box in the signal flow. If it is **Return to Neutral**, then the next box will show 0%. The controlling proportional input must be returned to neutral for the proper amount of time (see Valve Ouput Configuration) before the **Return to Neutral** signal will switch to **OK** and allow the signal flow to transfer.

- **Operator Presence**—this value will show Not Used , Activate OPS , or OK . If it is **OK** or **Not Used**, then the Command value will be transferred to the next box in the signal flow. If it is **Activate OPS**, then the next box will show 0%. If Operator Presence is being used, then the controlling proportional input must also be returned to neutral for the proper amount of time after the Operator Presence condition is satisfied.

- **Max. Speed Control** – the Maximum Speed Control function can either be Enabled or Disabled . If it is **Disabled**, then the Command value will be transferred to the next box in the signal flow. If it is Enabled, then the Command value will be dependent on the Maximum Speed Control function. See the section below for details on the **Valve Output Configuration – Maximum Speed Control**.

- **Dual Profile** – the Dual Profile function can either be Enabled or Disabled . If it is **Disabled**, then the Command value will be transferred to the next box in the signal flow. If it is Enabled, then the Command value will be dependent on the Dual Profile function. See the section below for details on the **Valve Output Configuration – Dual Profile Function**.

- **Accel/Decel Control** – the Acceleration/Deceleration Control will affect the speed at which the next box in the signal flow will change. See the section below for details on the **Valve Output Configuration – Accel/Decel Control**. This is the final output command to be sent to the current driver.

- **Commanded Direction** – the final commanded direction will be shown as Forward , Neutral , or Reverse .

- **Commanded Current** – the final Commanded Current = ((Final Command Pct) * (Maximum Current – Threshold Current)) + Threshold Current. Units are in tenths of milliamps, i.e. 4339 is equal to 433.9 milliamps. **Commanded Current** is shown in a red box and corresponds to the red line plotted on the graph. (Note: the red line does not show on the screen capture above, because it is equal to the value plotted by the blue line.)

- **Actual Current** – the Actual Current is a closed-loop value that attempts to match the Command Current. It is calculated based on the actual Battery Voltage (in millivolts), the Duty Cycle of the PWM signal, and the measured Coil Resistance in Ohms. **Actual Current** is shown in a blue box and corresponds to the blue line plotted on the graph.

Note: the numbers in the Actual Current calculation are not perfect, but will give a close approximation of the Actual Current. For example, the numbers above would calculate out to 4060, not 3987 as shown.

- **Real-time Plot of Commanded and Actual Current** – the real-time plot is shown at the bottom of the screen.

  – The y-axis is fixed at 500 milliamps per division.

  – The x-axis default is set at 200 milliseconds per division. However, the x-axis can be changed by right clicking in the graph area and selecting **Settings / Control Panel / Time base…**.
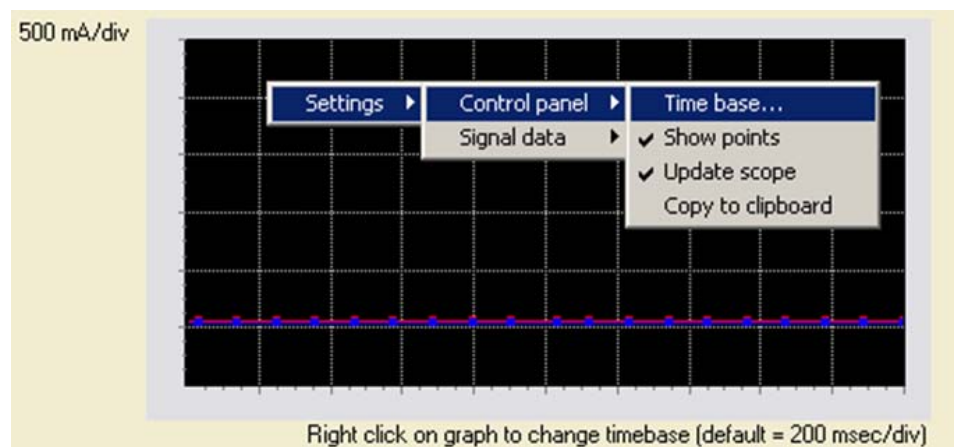
Manually changing the time base will not change the text "…(default = 200 msec/div)" at the bottom of the graph. If you save the p1d file when you close it, the time base will remain whatever you changed it to. Do not save if you want the default to remain at 200 msec/div.

  – The red line on the graph shows **Commanded Current**.

  – The blue line on the graph shows **Actual Current**.

- **Fault Status Indications** – five fault status conditions are shown in the lower right of the screen. If **OK** is displayed, then there is no fault on that function at this time. If anything else is shown, please refer to the separate section below on **Fault Flags** to determine the problem.

Monitoring Analog Input/CAN Shield (ANIN CAN_SHLD—C1P09)

Click on **ANIN_CAN_SHLD (C1P09)** in the Log Functions section of the tree in the Diagnostic Navigator. This screen shows both the way the analog input is configured and the actual values of the input at run time.

Current Configuration

Button On Volts	If the actual millivolt reading is above this value, then the Button State will be Active.
Button Off Volts	If the actual millivolt reading is below this value, then the Button State will be Inactive.
Button Invert	If the Button Invert is enabled, then the Active and Inactive states will be reversed.

> ✍ Note on hysteresis: the above values are the values at which the Button State will change, if necessary. In between the values is the hysteresis range. In the hysteresis range the Button State will remain whatever it was already.

Runtime Value (shows the actual state)

Anin	Shows the actual analog-to-digital converter value. A value of 1023 is the maximum.
Volts	Shows the actual voltage in millivolts. A value of 5753 millivolts is the maximum.
Button State	Shows the Active or Inactive state.
Proportional	Shows the proportional value in tenths of a percent. A value of 1000 is the maximum, equivalent to 100.0%.

Monitoring Digital Input (DIN—C1P10)

Click on **DIN (C1P10)** in the Log Functions section of the tree in the Diagnostic Navigator. This screen shows both the way the digital input is configured and the actual state of the input at run time.

Current Configuration

Invert	If the Invert is enabled, then the Active and Inactive states will be reversed. If disabled then they will act normally.
Pull Up/Down Resistor	The configuration for Pull Up/Down Resistor can be [None], [Pull Down], or [Pull Up]. See the section below on Digital Input (DIN—C1P10) Configuration for a complete description of how the resistor is configured.

Runtime Value (shows the actual state)

Button State	Shows the [Active] or [Inactive] state.

Monitoring Digital Outputs (DOUT)

Click on **DOUT1 (C1P11)** in the Log Functions section of the tree in the Diagnostic Navigator. DOUT2 through DOUT6 are similar. This screen shows both the way the digital output is configured and the actual values of the output at run time. There are six identical digital outputs, each with its own screen.

Current Configuration

Digital Output	Indicates whether this digital output is enabled or disabled.
Button Inputs	The output can be configured to turn on in response to a number of input conditions. This set of bits indicates which inputs will activate this output. If there is a "1" at a particular input, then that input will control this output. If there is more than one input selected, then the output will turn on if one or more of the inputs is active (logical OR condition).
Use Operator Presence	If [Yes] then the Operator Presence condition must be active in order for this output to be turned on. If [No] then the output state is not dependent on Operator Presence.
Startup Time	This is the number of milliseconds that all controlling inputs must be in the inactive state after power up of the joystick. This ensures that all inputs are inactive before starting the actual control of the output signal. If Operator Presence is being used, then the Operator Presence signal needs to be Active for this amount of time before starting control of the output signal.

Current Configuration

Digital Output	Indicates whether this digital output is enabled or disabled.
On Delay	This indicates whether the On Delay function is enabled or disabled. If enabled then the output transition from `Inactive` to `Active` will always be delayed by the delay time in milliseconds. If the controlling Input State(s) goes to `All Inactive` during the delay time, then the delay timer will be reset so that the full delay time will be used the next time the controlling Input State(s) becomes `One (or more) Active`.
Off Delay	This indicates whether the Off Delay function is enabled or disabled. If enabled then the output transition from `Active` to `Inactive` will always be delayed by the delay time in milliseconds. If the controlling Input State(s) goes to `One (or more) Active` during the delay time, then the delay timer will be reset so that the full delay time will be used the next time the controlling Input State(s) becomes `All Inactive`.
Latch Function	If the Latch Function is enabled, then the output will alternately turn On or Off each time the Input State(s) condition goes from `Inactive` to `Active`. If disabled then the output acts in a momentary fashion. If either On Delay or Off Delay are enabled, then they must be included in the time before the output will change states.
Invert Function	If the Invert Function is enabled, then the output state will be inverted for all of the above conditions.

Runtime Value (shows the actual state)

Input State(s)	Shows the `All Inactive` or `One (or more) Active` state.
Initial Input State(s)	Shows OK if all of the controlling Input State(s) have been in the Inactive condition for the proper amount of time after power up of the joystick. This value will show `Return All to Inactive` if either of the following is true:
	— All input states have not met the Return to Inactive Time condition
	— Use Operator Presence is `Yes` and the actual state of the Operator Presence condition is `In Active`. See Operator Presence screen.
Output State	Shows the actual output state as `Active` or `Inactive`.
Fault	If OK is displayed, then there is no fault on this output at this time. If anything else is shown, please refer to the separate section below on Fault Flags to determine the problem.

Monitoring Operator Presence (C1P15)

Click on **Operator Presence (C1P15)** in the Log Functions section of the tree in the Diagnostic Navigator. This screen shows both the way the Operator Presence is configured and the actual state of the Operator Presence at run time.

Current Configuration (read only)

Operator Presence Function Enabled?	This will indicate whether or not the Operator Presence function has been enabled.
Selected Control Button	This will indicate which button input has been configured to act as the Operator Presence.
Invert Function	If the Invert is enabled, then the Active and Inactive states will be reversed. If disabled then they will act normally.
Off Delay	This will indicate the Off Delay time in milliseconds. This is the time between the Input State going inactive and the Output State going inactive. This will allow some bounce in the Input State (i.e,. a seat switch) while holding the Output State in the active condition.

Runtime Value (shows the actual state)

Input State(s)	Shows the Active or Inactive state of the button input that has been configured as the Operator Presence switch.
Output State	Shows the Active or In Active state of the Operator Presence function.
Fault Status	If OK is displayed, then there is no fault on this input at this time. If anything else is shown, please refer to the separate section below on Fault Flags to determine the problem.

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.Configuring Device with PLUS+1 GUIDE Service Tool

- Device configuration is accomplished by using the Parameter Functions section of the Service Tool.

- Please refer to the *PLUS+1 GUIDE Service Tool User Manual* (**520L0899**) for detailed information on operation of the PLUS+1 GUIDE Service Tool.

☝ Whenever any changes are made to the parameter functions, you must do two steps.

1) Before exiting any screen in which you have made changes in the configuration, press the "Download Parameters to ECU (F4)" button on the menu bar.

2) Before all of the changes can become active, cycle power on the joystick. Some parameters are only used at power-up to initialize internal settings.

Valve Output Configuration – General

Click on **Valve Out 1 (C1P05_06)** in the Parameter Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 screen is shown below. Valve Out 2 is similar.
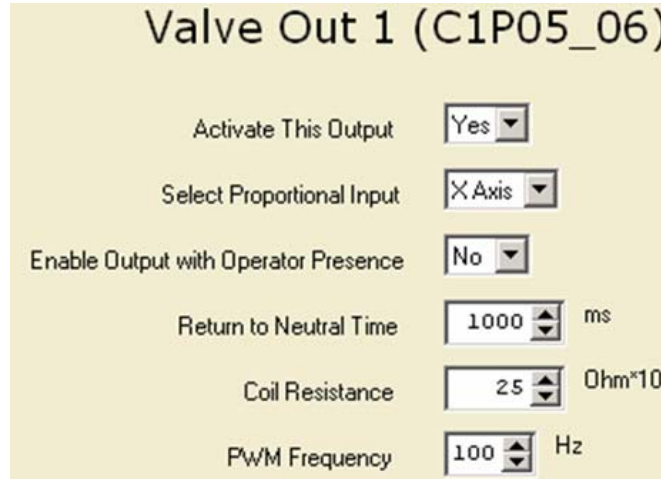
- **Activate This Output** – the drop-down box values are Yes or No. Select Yes if you want this output to be active. Select No if you do not want this output to be active. The default state is No.

- **Select Proportional Input** – this will select which device input will be the control for this valve output. The selections are:

Device Input Selections

X Axis	This is x axis (typically left/right) of the mechanical joystick.
Y Axis	This is y axis (typically forward/backward) of the mechanical joystick.
Grip 1	This is typically the left or bottom proportional rocker on the A grip.
Grip 2	This is typically the right proportional rocker on the A grip.

- **Enable Output with Operator Presence** – the drop-down box values are Yes or No. Select Yes if you want this output to only be active when the Operator Presence condition is also Active.

- **Return to Neutral Time** – this is the time in milliseconds that the selected proportional input must be at neutral (zero command) after the device is powered up. For example, if the y-axis controls propel of the vehicle, then setting this value at 2000 will not allow output on this valve until the joystick y-axis has been moved to neutral and kept there for two seconds after the joystick power has been applied. This can prevent unexpected movement of the vehicle if the joystick is out of neutral when the machine is started.

- **Coil Resistance Adjustment**– initial setting should be the value of the actual nominal resistance of the coil connected across the valve outputs. The setting is in tenths of Ohms. For example, a 10 Ohm coil would be set to a value of 100. Range is 1 – 25 Ohms (10 – 250 value). Increase the coil resistance value for faster response of the current driver, but do not exceed ±50% of measured coil resistance value.

Setting the coil resistance value too low can cause response time of the current driver to be slow and setting the value too high can cause instability in current output.

- **PWM Frequency** – this should be set to the desired PWM frequency for the coil being used. Usually the coil manufacturer will specify a preferred frequency. Range is 100 – 200 Hertz.

Valve Output Configuration – Valve Settings

Click on **Valve Settings** under the desired valve in the Parameter Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 Settings screen is shown below. Valve Out 2 Settings is similar. Forward and Reverse settings are the same so only one is described in the sections below.

- **Threshold Current** – when the controlling proportional input command value goes from zero to a positive (or negative) value, then the valve output current will switch from zero to the Threshold Current setting. Threshold Current is in tenths of milliamps.

- **Max Current** – when the controlling proportional input command value is at 100% (or -100%), then the valve output current will go to the Max Current setting. Max Current is in tenths of milliamps.

The maximum current actually obtainable may be less than this setting due to low battery voltage or high coil resistance. In this case the PWM output signal may be at 100% duty cycle, but the actual current may not be what is expected. Make sure the Max Current is a valid setting based on the actual system configuration.

- **Fault Time** – the valve load is continually monitored for a fault condition. This setting determines how long the fault condition needs to be present before the fault is declared valid. Fault Time is in milliseconds.

- **Min Fault Detect Current** – it is often difficult to reliably check the load for fault conditions when driving low currents. This value will set the minimum current needed before the fault checking will be active. Below this value the valve load will not be monitored. Min Fault Detect Current is in tenths of milliamps.

- **Min Fault Resistance** – this is the low end of the acceptable range of measured load resistance. If the measured value is below this setting for the Fault Time, then a fault will be declared. This is used to detect short circuit conditions. Min Fault Resistance is in tenths of Ohms.

- **Max Fault Resistance** – this is the high end of the acceptable range of measured load resistance. If the measured value is above this setting for the Fault Time, then a fault will be declared. This is used to detect open circuit conditions. Max Fault Resistance is in tenths of Ohms.

Valve Output Configuration – Maximum Speed Control

Click on **Maximum Speed Control** under the desired valve in the Parameter Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 Maximum Speed Control Function screen is shown below. Valve Out 2 Maximum Speed Control Function is similar.
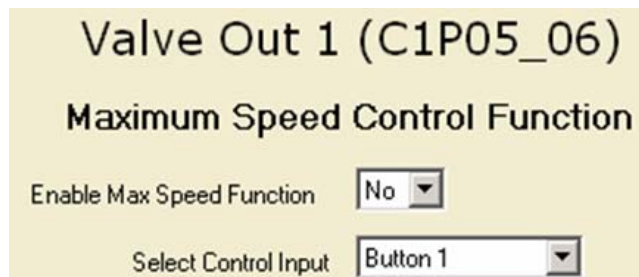
- **Enable Max Speed Function** – the Maximum Speed Control Function can be enabled for either, both, or neither of the valve outputs. The settings are independent.

- **Select Control Input** – a controlling input can be selected for the valve output. Choices are buttons 1 through 8 and C1P09 (analog used as digital) and C1P10 (digital) inputs. The control input is used to turn the function On or Off.

- **Operation of Maximum Speed Control Function:**

  – Maximum speed function must be enabled

  – Select a control input to be used for turning the maximum speed function ON or OFF

- **Turning maximum speed function ON:**

  - Set the valve command so that the valve current is at the desired maximum (normally something less than full valve output)

  - Momentarily activate the control input

  - Return the valve command to zero and the maximum speed setting will be activated

  - Now as the valve command is moved to its maximum position, the valve current will be proportioned to the desired maximum

- **Turning maximum speed function OFF:**

  - Return the valve command to zero

  - Momentarily activate the control input and the maximum speed setting will be deactivated

  - Now when the valve command is set to its maximum position, the valve current will be at its normal full valve output

Valve Output Configuration – Dual Profile Function

Click on **Dual Profile Function** under the desired valve in the Parameter Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 Dual Profile Function screen is shown below. Valve Out 2 Dual Profile Function is similar.

Valve Out 1 (C1P05_06)

Dual Profile Enabled Yes ▼

Selector Input Type Proportional ▼

Selector Input C1P09 ▼

Set Command Output for 50% Command Input

Aggressive Knee 750 ▲▼ Pct*10

Soft Knee 250 ▲▼ Pct*10

Dual Profile Enabled
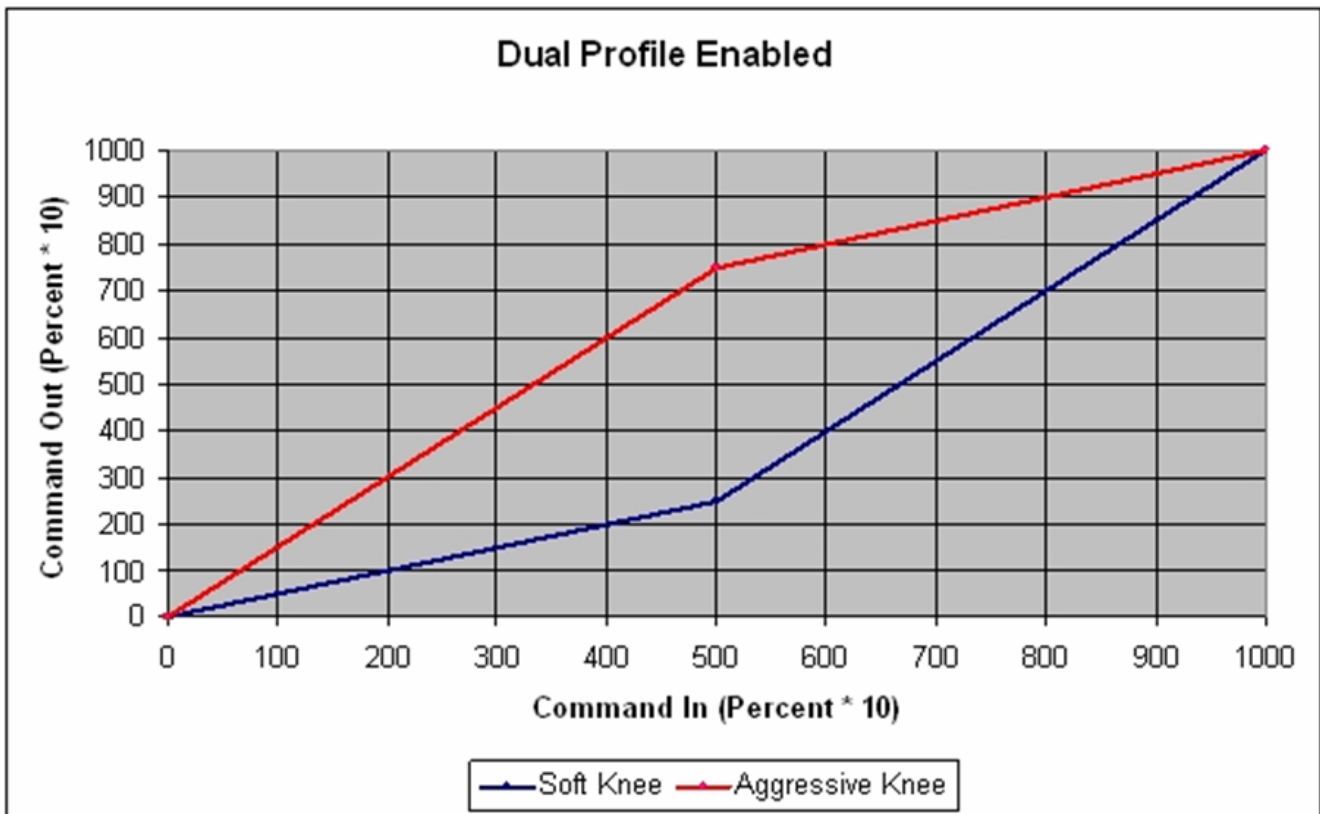
- **Dual Profile Enabled** – the Dual Profile Function can be enabled for either, both, or neither of the valve outputs. The settings are independent. If the setting is changed, then click on the "Download parameters to ECU (F4)" button on the menu bar and the rest of the screen will change to the appropriate selections.

- **Selector Input Type** – a controlling input type can be selected. Choices are Proportional or Button. If the setting is changed, then click on the "Download parameters to ECU (F4)" button on the menu bar and the Selector Input drop-down menu will change to the appropriate selections.

- **Selector Input** – a controlling input can be selected for the dual profile aggressiveness selection.

  - Selector Input Type is **Button**:

    - Selector input choices are buttons 1 through 8 and C1P09 (analog used as digital) and C1P10 (digital) inputs. The control input is used to select the Aggressive or Soft Knee.

    - If the control input is active, then the Aggressive Knee will be used. If the control input is inactive, then the Soft Knee will be used.

  - Selector Input Type is **Proportional**:

    - Selector input choices are X Axis, Y Axis, Grip 1, Grip 2, and C1P09 (analog). The control input is used to select the Aggressive profile, the Soft Profile, or somewhere in between. See the graph below for the following example.

    - If the proportional control input value is at 100%, then the Aggressive Knee profile will be used (red line).

    - If the proportional control input value is at 0%, then the Soft Knee profile will be used (blue line).

    - If the proportional control input value is between 0% and 100%, then a new profile will be used. For example, the green dashed line in the drawing below represents the profile when the Dual Profile control input value is at 30%. This moves the knee point 30% of the difference between the soft knee and the aggressive knee.

Dual Profile Enabled
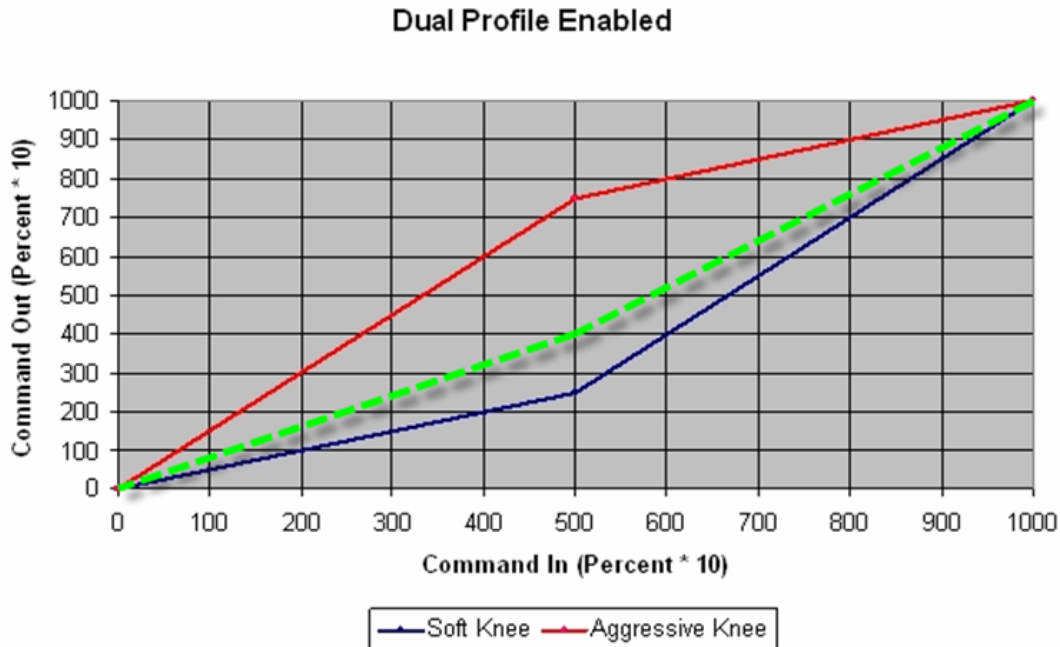
- **Aggressive Knee**—This is the setting for the midpoint of the aggressive profile. When the aggressive profile is being used (control input is active), then the command output of the profile function will be at the set value when the command input is at 50%. For example, in the screen capture above, the command output would be at 75% when the command input is at 50%

- **Soft Knee**—This is the setting for the midpoint of the soft profile. When the soft profile is being used (control input is inactive), then the command output of the profile function will be at the set value when the command input is at 50%. For example, in the screen capture above, the command output would be at 25% when the command input is at 50%.

If the **Dual Profile Function** has been disabled, then the screen will show a linear profile and the knee settings will be hidden as shown below:

Valve Out 1 (C1P05_06)

Dual Profile Enabled [No ▼]

Selector Input Type [Button ▼]

Selector Input [Button 1 ▼]

Dual Profile Disabled
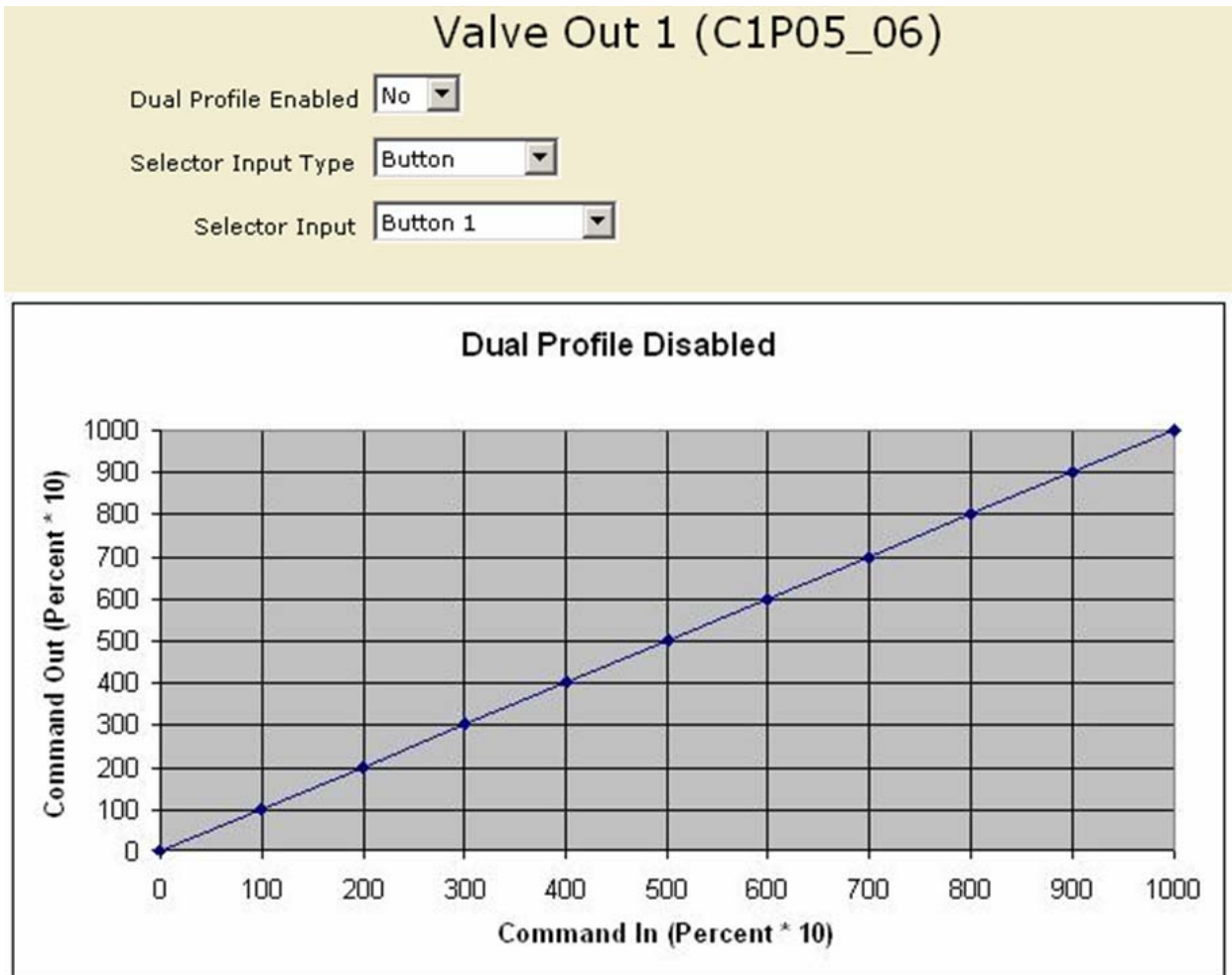
Valve Output Configuration – Accel/Decel Control

Click on **Accel/Decel Control** under the desired valve in the Parameter Functions section of the tree in the Diagnostic Navigator. The Valve Out 1 Accel/Decel Control screen is shown below. Valve Out 2 Accel/Decel Control is similar.

The Accel/Decel Control allows the user to detect four different states of deceleration (coasting, return to neutral, reversal of direction, and braking) and to set individual deceleration rates for each of the states. A single acceleration rate can also be specified.

The Accel/Decel control algorithm implemented in the JS6000 PWM joystick is a linear ramping type control.
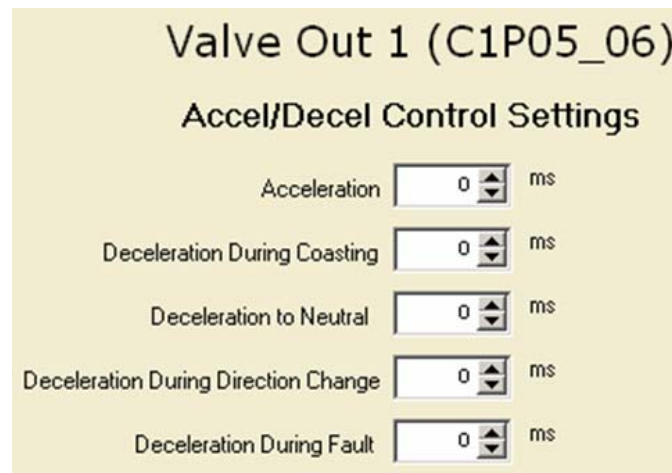
- **Acceleration** – this is the amount of time (in milliseconds) that it would take for the output to change from 0 to 100% of full output. This value is used whenever the magnitude of the valve output command is increasing.

- **Deceleration During Coasting** – this is the amount of time (in milliseconds) that it would take for the output to change from 100 to 0% of full output. This value of deceleration is used whenever the vehicle speed command is decreasing and the vehicle is coasting. Coasting is a condition where the vehicle speed command has decreased, but it has not gone to neutral and has not changed direction. For example, the vehicle is in forward with a speed command of 75%. The speed command changes to 25%, but the vehicle is still in forward. This is considered coasting.

- **Deceleration to Neutral** – this is the amount of time (in milliseconds) that it would take for the output to change from 100 to 0% of full output. This value of deceleration is used whenever the vehicle speed command has gone to neutral.

- **Deceleration During Direction Change** – this is the amount of time (in milliseconds) that it would take for the output to change from 100 to 0% of full output. This value of deceleration is used whenever the valve output command has changed sign. The output command is considered decelerating until it reaches zero output (neutral) and then it will use the Acceleration value (shown above) while increasing in the opposite direction.

- **Deceleration During Fault** – this is the amount of time (in milliseconds) that it would take for the output to change from 100 to 0% of full output.

  - This value of deceleration is used whenever the vehicle speed command has gone to zero speed (neutral) due to the detection of a fault condition that requires stopping the vehicle.

  - This value is also used when the Operator Presence signal (OPS) is lost.

Analog Input/CAN Shield (ANIN CAN_SHLD—C1P09) Configuration

Click on **ANIN CAN_SHLD (C1P09)** in the Parameter Functions section of the tree in the Diagnostic Navigator. The C1P09 configuration screen is shown below. This configuration screen is used for setup of this analog input so it can be used as a switch.

- **Button On Voltage** – set the input in millivolts at which the switch will be considered in the Active state.

- **Button Off Voltage** – set the input in millivolts at which the switch will be considered in the Inactive state.

☞ **Hysteresis**: normally the Button On Voltage will be somewhat higher than the Button Off Voltage. This will provide a hysteresis band between the two values. For example, after the input has gone above the Button On Voltage, it will become Active. It will remain in the Active state until it falls below the Button Off Voltage and only then will it become Inactive.

- **Button Invert** – the Button Invert function can be enabled or disabled. If enabled then the Active and Inactive states will be swapped.

Examples of ANIN Configuration for Digital Operation:

- The system has an external potentiometer connected to C1P09 as shown below. The configuration is set as shown in the C1P09 settings above. When the input voltage on C1P09 goes above 3.000 Vdc, then the input will be considered Active. Due to hysteresis the voltage could then go as low as 2.001 Vdc and still be considered Active. Once the voltage falls to 2.000 Vdc or lower, then the input will be considered Inactive.
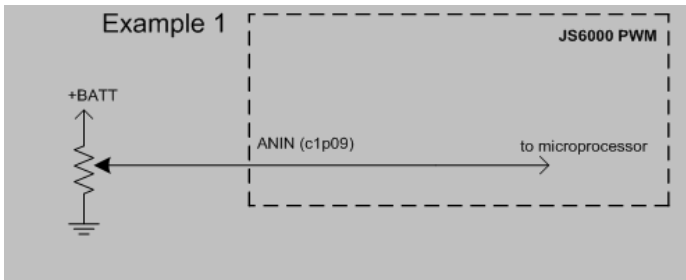
- The system has an external SPDT switch connected to C1P09 as shown below. This configuration is also set as shown in the C1P09 settings above. When the switch is connected to +Batt, the input voltage on C1P09 goes above 3.000 Vdc, and the input will be considered Active. When the switch is connected to ground, the voltage falls to below 2.000 Vdc, and the input will be considered Inactive.
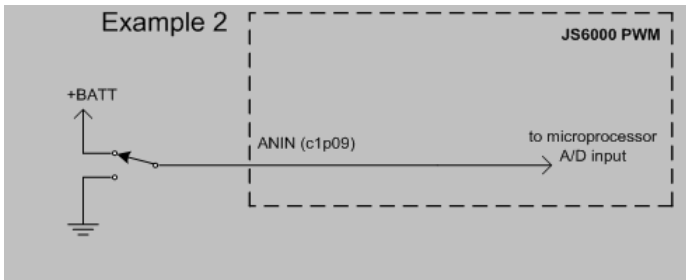
Examples of ANIN Configuration for Analog Operation:

- This ANIN input is mainly designed for CAN Shield capabilities. As such, it has some limitations as an analog input and is best applied as a simulated digital input as shown above. However, it can be used as an analog input for the Dual Profile Function with some restrictions.

- To use the ANIN input as an analog input, the configuration settings are irrelevant. The input hardware itself is not configurable. It is setup to recognize 5.753 Vdc (or higher) as full scale input. This voltage will be interpreted as 100.0% on the analog input scale. It is also equivalent to 1023 counts on the Analog-to-Digital Converter (ADC).

- If a potentiometer is connected as in Example 1 above and the battery voltage is 12 Vdc nominal, then the usable part of the potentiometer would be less than half of its range. Anytime the input voltage is above 5.753 Vdc the proportional value will be 100.0%. If it is a 24 volt battery, then the usable range is only about a quarter.

- To partially overcome this limitation a resistor can be added in series with the potentiometer as shown in Example 3 below. If the resistor and the potentiometer have equal resistance, then the potentiometer will be usable over most of its range. However, the actual value will fluctuate with changes in the battery voltage. Also, with a 24 volt battery the fixed resistor would need to be about three times the resistance of the potentiometer.
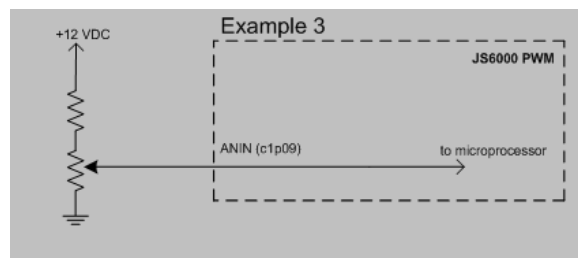
- A more accurate way to handle this situation would be to add an external 5.6 volt zener diode across the potentiometer as shown in Example 4. This will clamp the voltage across the potentiometer at 5.6 Vdc and therefore have almost 100% of the active range across the potentiometer even as the battery voltage fluctuates. The value and wattage of the fixed resistor will need to be calculated so that the zener diode has the proper current. A 24 volt battery can still use the 5.6 volt zener, but will need a different fixed resistor.
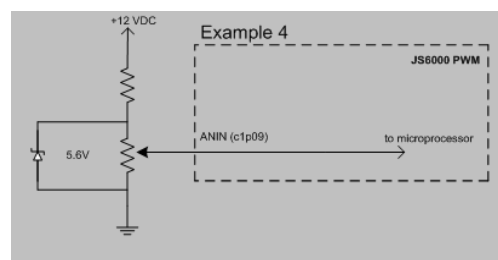
Digital Input (DIN—C1P10) Configuration

Click on **DIN (C1P10)** in the Parameter Functions section of the tree in the Diagnostic Navigator. The C1P10 configuration screen is shown below. This configuration screen is used for setup of this digital input. The user needs to decide what configuration will work best for the type of device that is connected to the digital input.

- **Invert** – the Invert function can be enabled or disabled. If enabled then the Active and Inactive states will be swapped. The normal Active state is when the input is connected to ground (zero volts).

- **Pull Up/Down Resistor** – the joystick has internal resistors which can be electrically connected to the digital input.
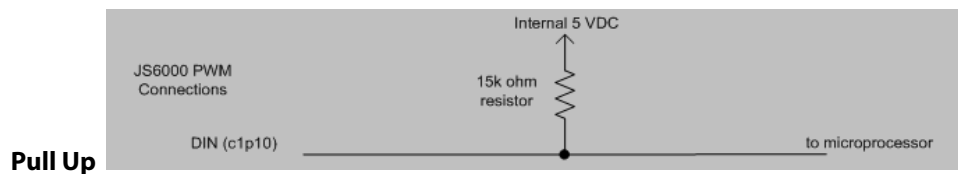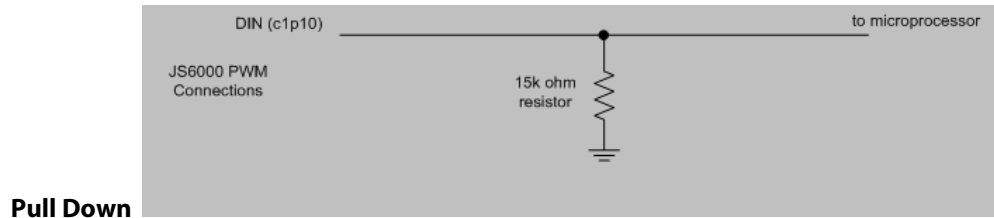
Examples of DIN Configuration:

- If the system has an external normally open switch connected between C1P10 and ground, then the configuration would be set for **Invert Disabled** and **Pull Up Resistor**. When the switch is open, the input state would be considered Inactive (C1P10 will be "pulled up" to the internal 5 Vdc). When the switch is closed, the input state would be considered Active (C1P10 will be connected to ground through the switch).
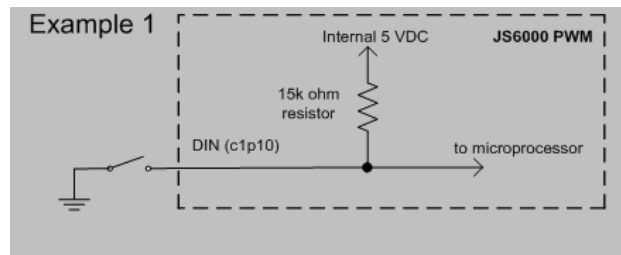
- If the system has an external normally open switch connected between C1P10 and +Battery, then the configuration would be set for **Invert Enabled** and **Pull Down Resistor**. When the switch is open, the input state would be considered Inactive (C1P10 will be "pulled down" to the internal ground). When the switch is closed, the input state would be considered Active (C1P10 will be connected to +Battery through the switch).
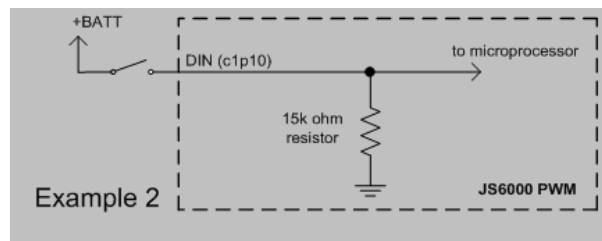
Digital Outputs (DOUT) Configuration

Click on **DOUTx (C1P1x)** in the Parameter Functions section of the tree in the Diagnostic Navigator. The output configuration screen is shown below for DOUT1 (C1P11). DOUT2 through DOUT6 screens are similar. This configuration screen is used for setup of the digital output. This configuration really illustrates the versatility of the JS6000 PWM joystick.

☞ The factory default condition for these outputs is Not Activated for safety reasons. Since this is a general market product, its uses cannot be predicted by the factory. Therefore all outputs are initially set to the OFF condition and all control inputs are deselected. The joystick must be configured initially in order to use these outputs.

DOUT1 (C1P11)

Activate This Output   Yes

Control Output with Which Inputs?   128

0b00000000000000000000000010000000

Button 1 =	1	X Positive	=	4096
Button 2 =	2	X Negative	=	8192
Button 3 =	4	X Neutral	=	16384
Button 4 =	8	Y Positive	=	32768
Button 5 =	16	Y Negative	=	65536
Button 6 =	32	Y Neutral	=	131072
Button 7 =	64	Grip 1 Positive =		262144
Button 8 =	128	Grip 1 Negative =		524288
C1P09	= 256	Grip 1 Neutral	=	1048576
C1P10	= 512	Grip 2 Positive	=	2097152
		Grip 2 Negative	=	4194304
		Grip 2 Neutral	=	8388608

Enable with Operator Presence   Yes

Startup/Inactive Time   500 ms

On Delay   Disabled   0 ms

Off Delay   Enabled   2000 ms

Latch Function   Disabled

Invert Function   Disabled

Add values for all inputs that shall cause this output to be activated. Enter total in control value above.

- **Activate This Output** – the drop-down box values are Yes or No. Select Yes if you want this output to be active. Select No if you do not want this output to be active. The default state is No.

- **Control Output with Which Inputs?** – just about any control input can be used to control the digital outputs, even multiple inputs. If one or more of the selected control inputs is active, then the output will be activated. To set this parameter, first decide which of the inputs will be used to control this output. Add the values shown in the table above for all of the selected inputs. Enter the resultant sum in the value entry position. Download parameters to ECU (F4) and the bit pattern will be updated to show a "1" in the position for the selected input(s). Confirm that the bit pattern shows the correct control inputs for your application.
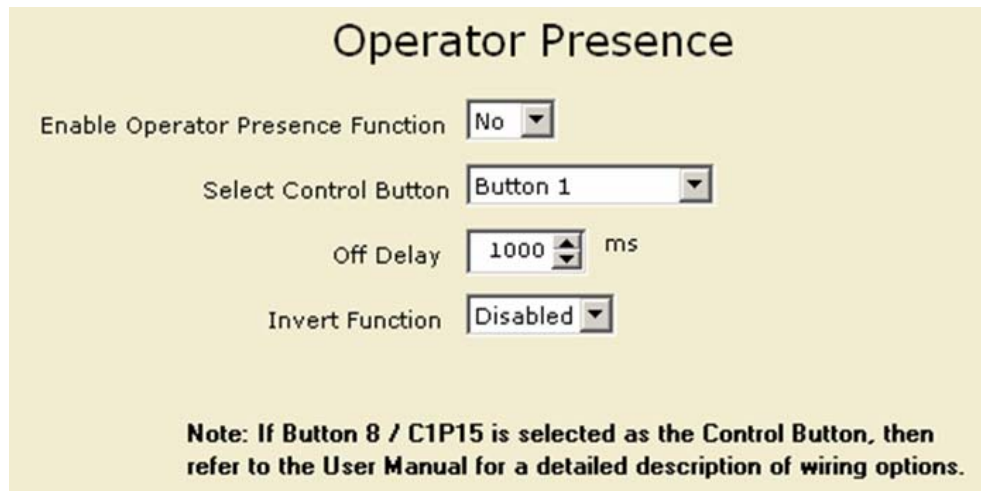
Control Inputs

Button 1 through 8	If the button is pressed, then its condition will be considered Active.
C1P09 (ANIN used as digital input)	The Active or Inactive state depends on the configuration.
C1P10 (DIN)	The Active or Inactive state depends on the configuration.
X (or Y) Axis Positive	If the joystick is moved in the positive X (or Y) direction, then this input will be considered Active.
X (or Y) Axis Negative	If the joystick is moved in the negative X (or Y) direction, then this input will be considered Active.
X (or Y) Axis Neutral	If the joystick is in the neutral X (or Y) position, then this input will be considered Active.
Grip 1 (or 2) Positive	If the proportional rocker on the grip is moved in the positive direction, then this input will be considered Active.
Grip 1 (or 2) Negative	If the proportional rocker on the grip is moved in the negative direction, then this input will be considered Active.
Grip 1 (or 2) Neutral	If the proportional rocker on the grip is in the neutral position, then this input will be considered Active.

- **Enable with Operator Presence** – the drop-down box values are Yes or No. Select Yes if you want this output to only be active when the Operator Presence condition is also Active.

- **Startup Time** – this is an available safety feature. Set the amount of time that all of the controlling inputs must be in the Inactive state after power is applied to the joystick. This can guarantee that the output will not be activated until all of the controlling inputs have been inactivated once at startup. This prevents a stuck switch from immediately turning an output ON. If the switch is stuck, then the output will not turn on because the input never goes to the Inactive state after power up.

- The Startup Time functionality is also used after the Operator Presence goes Active after being Inactive. This is the case if **Enable with Operator Presence** is set to Yes.

- If this feature is not desired, then set the value to 0 milliseconds. That will disable the function. For example, the output is to be turned on when the Grip 1 rocker is in the neutral position. Since the normal position of the rocker *is* in neutral, that will be its position on startup. If the Startup Time is set to a non-zero value, then the rocker would actually have to be moved out of neutral for the Startup Time milliseconds before the output would be activated. This may not be the desired operation.

- **On Delay** – the drop-down box values are Enabled or Disabled. Select Enabled if you want the On Delay function to be enabled. If Enabled then the output transition from Inactive to Active will always be delayed by the delay time in milliseconds. If the controlling Input State(s) goes to All Inactive during the delay time, then the delay timer will be reset so that the full delay time will be used the next time one or more of the controlling Input State(s) becomes Active.

- **Off Delay** – the drop-down box values are Enabled or Disabled. Select Enabled if you want the Off Delay function to be enabled. If Enabled then the output transition from Active to Inactive will always be delayed by the delay time in milliseconds. If one or more of the controlling Input State(s) goes to Active during the delay time, then the delay timer will be reset so that the full delay time will be used the next time the controlling Input State(s) becomes All Inactive.

- **Latch Function** – the drop-down box values are Enabled or Disabled. Select Enabled if you want the Latch function to be enabled. If Enabled then the output will alternately turn On or Off each time the Input State(s) condition goes from Inactive to Active. If Disabled then the output acts in a momentary fashion. If either On Delay or Off Delay are enabled, then they must be included in the time before the output will change states.

- **Invert Function** – the drop-down box values are Enabled or Disabled. Select Enabled if you want the Invert function to be enabled. If Enabled then the output state will be inverted for all of the above conditions.

Operator Presence (C1P15) Configuration

Click on **Operator Presence (C1P15)** in the Parameter Functions section of the tree in the Diagnostic Navigator. The OPS configuration screen is shown below.

- **Enable Operator Presence Function** – the drop-down box values are Yes or No. Select Yes if you want the Operator Presence Function to be enabled for the joystick.

- **Select Control Button** – select which button input is to be configured to act as the Operator Presence.

- **Off Delay** – enter the desired Off Delay time in milliseconds. This is the time delay between the actual control input going inactive and the Output State of the OPS function going inactive. This will allow some bounce in the Input State (i.e,. a seat switch or button) while holding the Output State in the active condition.

- **Invert Function** – the drop-down box values are Enabled or Disabled. Select Enabled if you want the Invert function to be enabled. If Enabled then the Active and Inactive states will be reversed. If disabled then they will act normally.

Setting up the operator presence hardware.

Configuration 1 – The grip has been ordered with the integral Operator Presence Switch (OPS), which is not grounded internally. In this case there are two options for wiring. In both cases OPS+ is not connected.

> **Caution**: connecting battery power to either OPS+ or OPS- may result in damage to the joystick electronics. The joystick may become non-functional.

If external switches are not required , OPS- can be directly connected to ground.
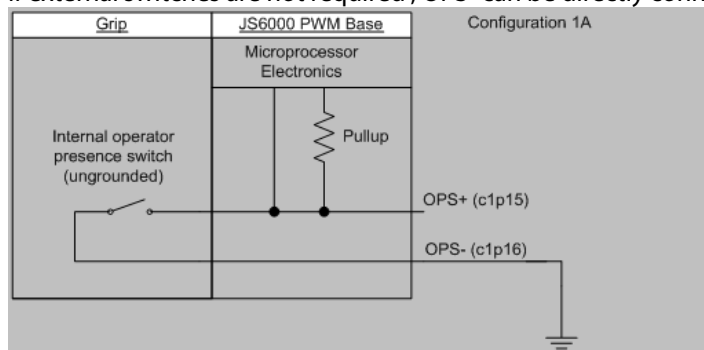
If it is desired to add extra safety OPS switches externally, they can be daisy chained together and connected to **OPS-**.
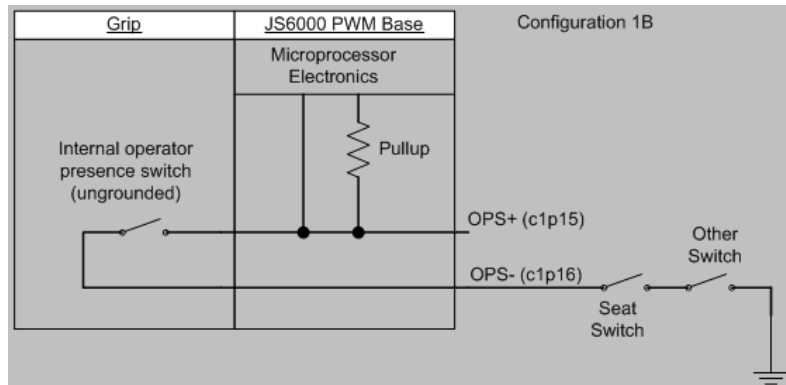
> The internal operator presence switch in the grip is only rated to 200 mA. It should not be used in a circuit to drive any high current loads. Uses other than those shown above are not supported.

Configuration 2 – The grip has been ordered without the integral Operator Presence Switch (OPS), but the customer still wants the OPS functionality by using an external switch. Connect the external switch between OPS+ and ground. OPS- is not connected in this configuration.
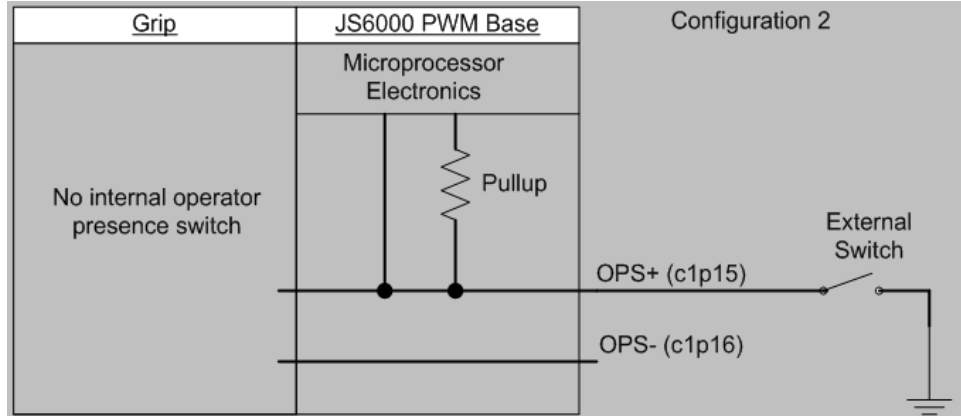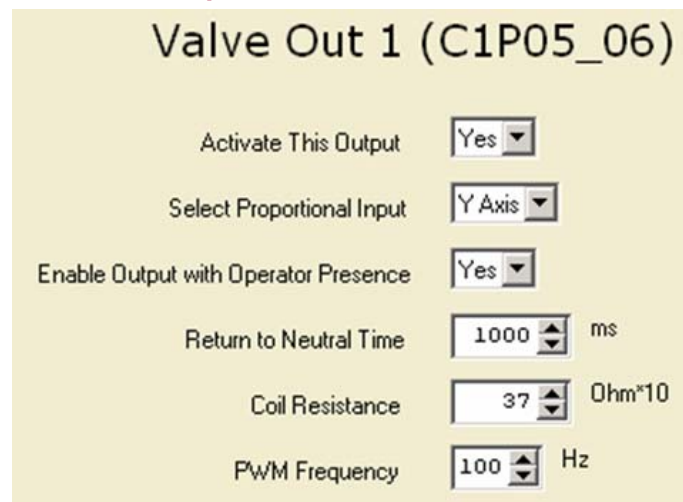
This configuration is shown as a possibility, but is not recommended due to concerns regarding the accidental grounding of the harness between OPS+ and the external switch. This would result in the Operator Presence signal being always true, which could be a safety issue.

Example: Setting Up a Brake Solenoid Control

The vehicle may need to have a brake solenoid which can be controlled by the JS6000 PWM joystick. Here is an example of how this might be done:

- The Y axis of the joystick is used for propel of the vehicle. It will be setup to control Valve Out 1.

- DOUT 1 is connected to the high side of the solenoid and the low side of the solenoid is grounded.

- The brake solenoid must be activated to release the brake.

- The brake must be released whenever the joystick is out of neutral.

Valve Out 1 setup:

- The Valve Out 1 functionality is activated.

- The Y Axis of the joystick is selected for the proportional control of the Valve Output.

- Since this is a propel control, Valve Out 1 is setup to be enabled with the Operator Presence. This means that the valve output will only drive current if the Operator Presence condition is true.

- The joystick Y Axis must be in neutral for 1 second before the output can be activated. This condition would apply after power up of the joystick. It also would apply after the Operator Presence signal has been interrupted. This will prevent unexpected movement on power up if the joystick is out of neutral; also if the Operator Presence signal is Inactive and then becomes Active again while the joystick is out of neutral.

- Coil Resistance and PWM Frequency are dependent on the valve being driven.

DOUT 1 setup:

- The DOUT 1 functionality is activated.

- The control bits are set to a value of 98304, which is the sum of the values for Y Positive and Y Negative. This means that when the joystick Y axis is moved out of neutral, DOUT 1 will be activated.

- Since this is a propel control, DOUT 1 is setup to be enabled with the Operator Presence. This means that the brake can only be released if the Operator Presence condition is true.

- Startup Time is set to 500 msec. Therefore, DOUT1 can only be activated if these conditions are true:

  - both the Y Positive and Y Negative signals are Inactive for 500 msec after the power is applied to the joystick

  - since the Operator Presence is being used, then the Operator Presence signal needs to be Active for 500 msec

- On Delay is disabled so that the brake will be released immediately when the joystick is moved out of neutral. **Caution**: the electrical signal to the solenoid will be changed immediately, but the system designer would need to consider the hydraulics of the system to make sure the brake is fully released on starting movement of the vehicle.

- Off Delay is enabled and set for 2 seconds. When the joystick Y Axis is returned to neutral, DOUT 1 will not be turned on for 2 seconds. This allows the vehicle to come to a complete stop before the brake is activated. If the joystick Y Axis is moved out of neutral before this time expires, then the timer would be reset. This time is, of course, just an example and must be set depending on the system configuration.

- Latch and Invert are disabled, but are dependent on the system configuration.

Example: Calibrating Valve Outputs

- Setup the controls on the main Valve Out (1 or 2) screen. Make sure you have set the valve resistance and PWM frequency properly for your application.

- In the Valve Settings screen set the threshold currents at 1 (mAx10). (Setting it to 0 would disable the output.) Set the maximum current at 10% more than the maximum expected threshold current. This is done so that you will have very good control at low current values.

  – For example: on an H1 pump the nominal threshold current for a 12 Vdc system is 755+/- 90 mA; for the threshold calibration set the maximum current at 930 mA.

  – For example: on an H1 pump the nominal threshold current for a 24 Vdc system is 390+/- 45 mA; for the threshold calibration set the maximum current at 479 mA.

- Set the rest of the settings as needed in your application.

- Single path machine

  – Change to the Valve Output logging screen so you can watch the current.

  – Engine RPM should be at normal operating RPM. Thresholds will vary with engine RPM.

  – Move the control input slowly in the forward direction until the vehicle (or other process) just barely starts to move. Record the current that is required.

  – Move the control input slowly in the reverse direction until the vehicle (or other process) just barely starts to move. Record the current that is required.

  – Return to the proper Valve Settings screen and enter the threshold values that you just recorded.

- Maximum Current:

  - Set the maximum current to the normal expected value.

  - Sometimes it is desired to calibrate the maximum speed settings, not just use the normal expected values. To do this, change the maximum current to a value of 2.5 amps (or a value that is at least 10% more than the expected maximum current). Adjust the control input until the vehicle (or process) is at the desired maximum speed. Record the current that is required. Repeat in the opposite direction. Return to the proper Valve Settings screen and enter the values that you just recorded.

- Dual path machine

  - This joystick could be applied on a dual path vehicle if two joysticks are used, one for each side. Generally speaking, a PLUS+1 controller with non-PWM joysticks will be best for a dual path application. It would provide much more flexibility for maximizing the vehicle control algorithms.

  - However, an open-loop dual path application could be setup using two JS6000 PWM joysticks. This would use an H-pattern joystick control – one joystick for each transmission. Each side of the vehicle would be calibrated as an independent single path. See calibration details above.

Fault Flags

Proportional Inputs

The proportional inputs with faults include the following:

- Base X-axis

- Base Y-axis

- Grip 1 proportional

- Grip 2 proportional

The pin status is encoded into the following bit pattern representing fault states:

Proportional Input Fault Flags

Bit	Fault Description
0	Voltage Too High – the voltage is higher than the calibrated high end voltage.
1	Voltage Too Low – the voltage is lower than the calibrated low end voltage.
2	Redundancy – the redundant sensors on the base do not agree with each other
3	Not Calibrated – the unit needs calibration. Note: this is a factory only calibration.
4	Not Available
5	N/A
6	N/A
7	N/A

Operator Presence Switch (OPS)

The pin status is encoded into the following bit pattern representing fault states:

Operator Presence Switch Fault Flags

Bit	Fault Description
0	Invalid Input or Not Available
1	Input has faults
2	N/A
3	N/A
4	N/A
5	N/A
6	N/A
7	N/A

Digital Outputs (DOUT)

The Digital Output status is encoded into the following bit pattern representing fault states. Each DOUT has its own set of fault flags.

Digital Output Fault Flags

Bit	Fault Description
0	Input Not Available
1	Input Error
2	N/A
3	N/A
4	N/A
5	N/A
6	N/A
7	N/A

Valve Outputs (Valve Out)

The Valve Output status is encoded into the following bit pattern representing fault states. Each Valve Output has its own set of fault flags.

Valve Output Fault Flags

Bit	Fault Description
0	Invalid Input
1	Input Not Available / Input Not Enabled
2	Input Has Faults – refer to the Proportional Input Fault Flags
3	Maximum Speed Function has faults – refer to the Max Speed Function Fault Flags
4	Dual Profile Function has faults – refer to the Dual Profile Function Fault Flags
5	Forward Valve has faults – refer to the Valve Fault Flags
6	Reverse Valve has faults – refer to the Valve Fault Flags
7	PWM Driver has faults – verify the valve settings for Frequency and Coil Ohms, then cycle power

Valve Fault Flags

Bit	Fault Description
0	Not Calibrated
1	Just Calibrated
2	Valve to High – output is open circuited
3	Valve to Low – output is short circuited
4	Invalid Parameters

Valve Fault Flags

Bit	Fault Description
5	N/A
6	N/A
7	N/A

Maximum Speed Function

Maximum Speed Function Faults are encoded into the following bit pattern representing fault states:

Maximum Speed Function Fault Flags

Bit	Fault Description
0	Invalid Input or Not Available
1	Input has faults
2	N/A
3	N/A
4	N/A
5	N/A
6	N/A
7	N/A

Dual Profile Function

Dual Profile Function Faults are encoded into the following bit pattern representing fault states:

Dual Profile Function Fault Flags

Bit	Fault Description
0	Invalid Input or Input Not Available
1	Input has faults
2	Invalid Parameters
3	N/A
4	N/A
5	N/A
6	N/A
7	N/A

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Proportional valves

Sauer-Danfoss Mobile Power and Control Systems – Market Leaders Worldwide

Sauer-Danfoss is a comprehensive supplier providing complete systems to the global mobile market.

Sauer-Danfoss serves markets such as agriculture, construction, road building, material handling, municipal, forestry, turf care, and many others.

We offer our customers optimum solutions for their needs and develop new products and systems in close cooperation and partnership with them.

Sauer-Danfoss specializes in integrating a full range of system components to provide vehicle designers with the most advanced total system design.

Sauer-Danfoss provides comprehensive worldwide service for its products through an extensive network of Global Service Partners strategically located in all parts of the world.

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