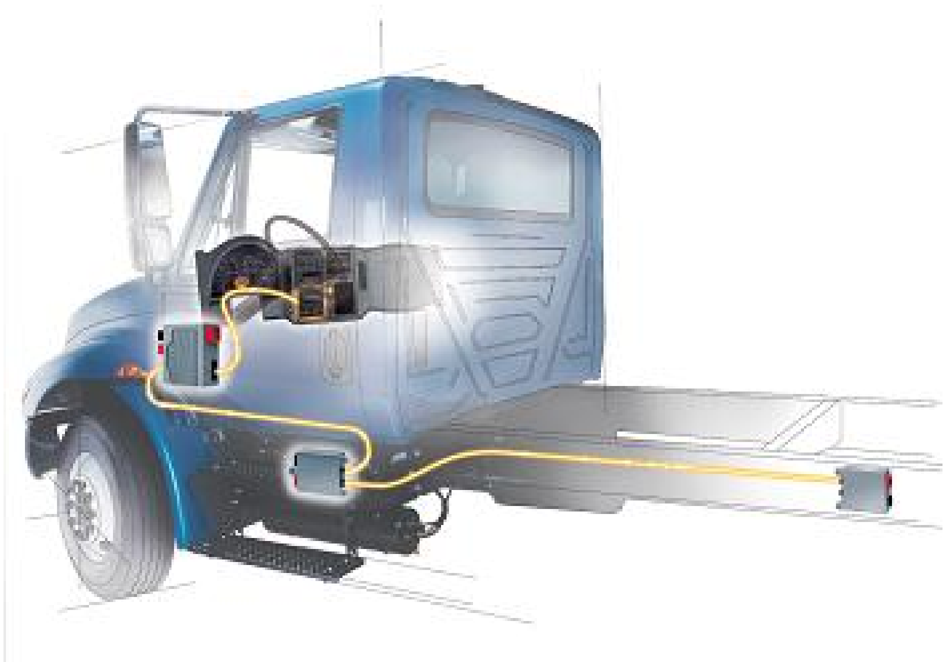

DIAMOND LOGIC® BUILDER SOFTWARE

User's Manual – Advanced Logic Programming (Level 3 Permissions)

S08305 07/12   Formerly TMT-080406 R1

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Section 1 Overview of Advanced Ladder Logic and This Manual

For information about how to use the Diamond Logic® Builder software, for programming and diagnostics, see S08304 DIAMOND LOGIC® BUILDER SOFTWARE User's Manual Dealer (Level 2) No Advanced Logic Programming.

The DIAMOND LOGIC® BUILDER SOFTWARE User's Manual, Advanced Logic Programming (Level 3 Permissions), is designed to describe and illustrate the fundamental elements of writing and applying custom logic for the purpose of performing body equipment integration with The Industry's First High Performance Trucks® chassis.

This manual is presented in a building block approach. The elements of a ladder logic diagram are described, followed by a discussion on the usage of signals to create the desired advanced logic. Once the basics of using ladder logic are understood, examples are provided to help the Diamond Logic® Builder program user adopt the best practices to perform common logic operations. The Diamond Logic® Builder system provides extensive flexibility to build very complex features. All users are encouraged to follow the suggested practices listed in this manual to help ensure that the most efficient and safest solution for your application is created. International Truck and Engine Corporation shall not be liable for any equipment damage or personal injury resulting from the use of Diamond Logic® Builder program. It is imperative that the Diamond Logic® Builder software end-user thoroughly test all advanced logic solutions on a vehicle before releasing the product for public sale or usage.

Section 2 Review of VIN and Template Files

Refer to: S08304 DIAMOND LOGIC® BUILDER SOFTWARE User's Manual Dealer (Level 2) No Advanced Logic Programming for information on how to use Diamond Logic Builder

A template is a separate file that captures and stores vehicle configuration changes that have been performed and applied to a vehicle configuration using the Diamond Logic® Builder software. A template can be saved for future use on additional vehicles.
Configuration changes can be any of the following:

- Adding/Deleting 595XXX Features
- Changing Programmable Parameters
- Adding or Modifying Advanced Logic Blocks

Only VIN files may be programmed into a vehicle. Templates must be applied to a VIN file and then the updated VIN file may be programmed into the vehicle. Each vehicle or VIN may have one or more templates applied; however **extreme caution** must be taken when using multiple templates on the same vehicle. Using the same resources in two different templates and then program the templates on a vehicle will result in a resource conflict. Applying more than one template is not a recommended practice. If multiple templates are use, the user must ensure that resources are used only once per vehicle.

The vehicle program is made up of the following discrete software components: Base Kernel Program, a Configuration Program consisting of Features and Logic Blocks and a Programmable Parameter file. The version of these components is verified at load ensure that the latest version of each is installed in the vehicle. If the kernel program on the vehicle already contains the latest version available from International, then only the configuration file and programmable parameters would be loaded into the vehicle.

A vehicle may be re-programmed after at least one of the following conditions has been met:

- A newer version of the Kernel Program is available from International.
- A newer version of the Configuration Features is available from International.
- One or more features have been added or deleted from the vehicle.
- One or more programmable parameters have been modified.
- Advanced logic changed, added or deleted.

Once a template or VIN is saved it can be exported using the Export option in the File menu. Once exported to a desired directory it can be emailed, copied, etc. like any other data file. When exporting a VIN or template file it is recommended that the file be named the same as the template or the VIN number. Template and VIN files can be imported using Import option in the File menu.

Section 2 Overview of Advanced Ladder Logic and This Manual

The DIAMOND LOGIC® BUILDER SOFTWARE User's Manual, Advanced Logic Programming (Level 3 Permissions), is designed to describe and illustrate the fundamental elements of writing and applying custom logic for the purpose of performing body equipment integration with The Industry's First High Performance Trucks® chassis. For basic information about how to use the Diamond Logic® Builder software, see the Diamond Logic® Builder Software User's Manual, Dealer Level – No Advanced Logic Programming.

This manual is presented in a building block approach. The elements of a ladder logic diagram are described, followed by a discussion on the usage of signals to create the desired advanced logic. Once the basics of using ladder logic are understood, examples are provided to help the Diamond Logic® Builder program user adopt the best practices to perform common logic operations. The Diamond Logic® Builder system provides extensive flexibility to build very complex features. All users are encouraged to follow the suggested practices listed in this manual to help ensure that the most efficient and safest solution for your application is created. International Truck and Engine Corporation shall not be liable for any equipment damage or personal injury resulting from the use of Diamond Logic® Builder program. It is imperative that the Diamond Logic® Builder software end-user thoroughly test all advanced logic solutions on a vehicle before releasing the product for public sale or usage.

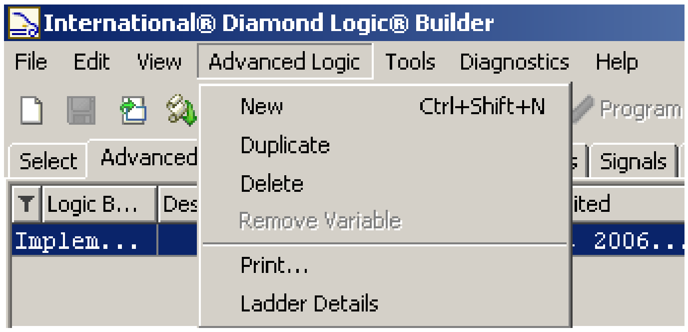
Section 3 Logic Blocks

3.1 Purpose

A logic block is a package of software containing custom logic that is written in order to control the behavior of the vehicle. Logic blocks are created and edited using the Advanced Logic tab.

Advanced Logic Dropdown Menu

Advanced Logic allows the user to view logic blocks. Advanced Logic is active only when a logic block under the Advanced Logic Tab is selected. The Advanced Logic Menu is listed and defined as follows.



Name/Shortcut	Description
New	Creates a new logic block on the template.
Duplicate	Duplicates the selected logic block on the template.
Delete	Deletes the selected logic block from the template or VIN.
Remove Variable	Removes an unused variable from the list under the My Variables tab.
Print	Prints ladder logic and selected logic block.
Ladder Details	Shows mapped signals on ladder.

Note: The items in this menu can also be accessed by right clicking on a logic block or an unused custom variable.

When multiple Logic Blocks are added to a vehicle, the result is a combination of software packages that perform specific tasks in addition to the tasks that are performed by other pre-engineered software features provided by International. Multiple logic blocks provide a way to organize advanced programming, i.e. vehicle lighting in one block, PTO functions in another, emergency lighting in another.

3.2 Using Templates with Advanced Logic Blocks

The Diamond Logic® Builder software allows the user to apply templates in the same manner that is described in Section 10 of the Diamond Logic® Builder Software User's Manual, Dealer Level – No Advanced Logic Programming, with a few additional rules concerning advanced logic. Refer to Section 10 for the mechanics of making and editing templates.

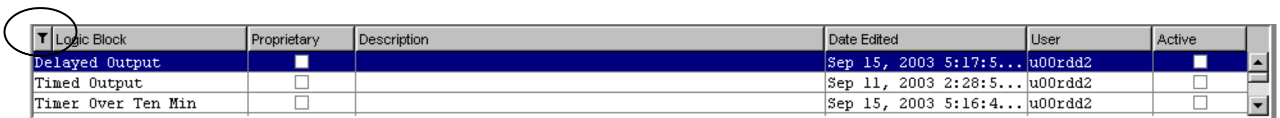
- A user must be trained, tested and certified to have access to write advanced ladder logic.
- Ladder logic may only be edited or modified on a template, not on a VIN.
- Only the original author of a logic block may revise ladder logic in a template.
- Anyone that applies a template to a VIN that contains advanced logic will have their user ID attached to the configuration file and therefore assumes responsibility for the performance of those advanced ladder logic features.

3.3 Usage

When creating blocks of logic, take care to only populate a logic block with enough logic to implement the smallest optional feature that is offered by your company. For example, if you sell a scene light feature that contains a collection of interlocks, then populate a logic block that only contains the advanced logic to perform the scene light feature. Therefore you can add or delete custom features with the checking or un-checking of a selection box instead of re-creating programming files. Refer to section 5.10 Remapping Signals to Physical Input and Output Pins of this document to learn more about the impacts of adding and deleting logic blocks in a vehicle configuration file.

3.4 Column Definition

The headings under the Advanced Logic List Tab are selectable and the column widths are adjustable.



By right-clicking the filter icon  a dropdown menu is displayed showing the column selections available.

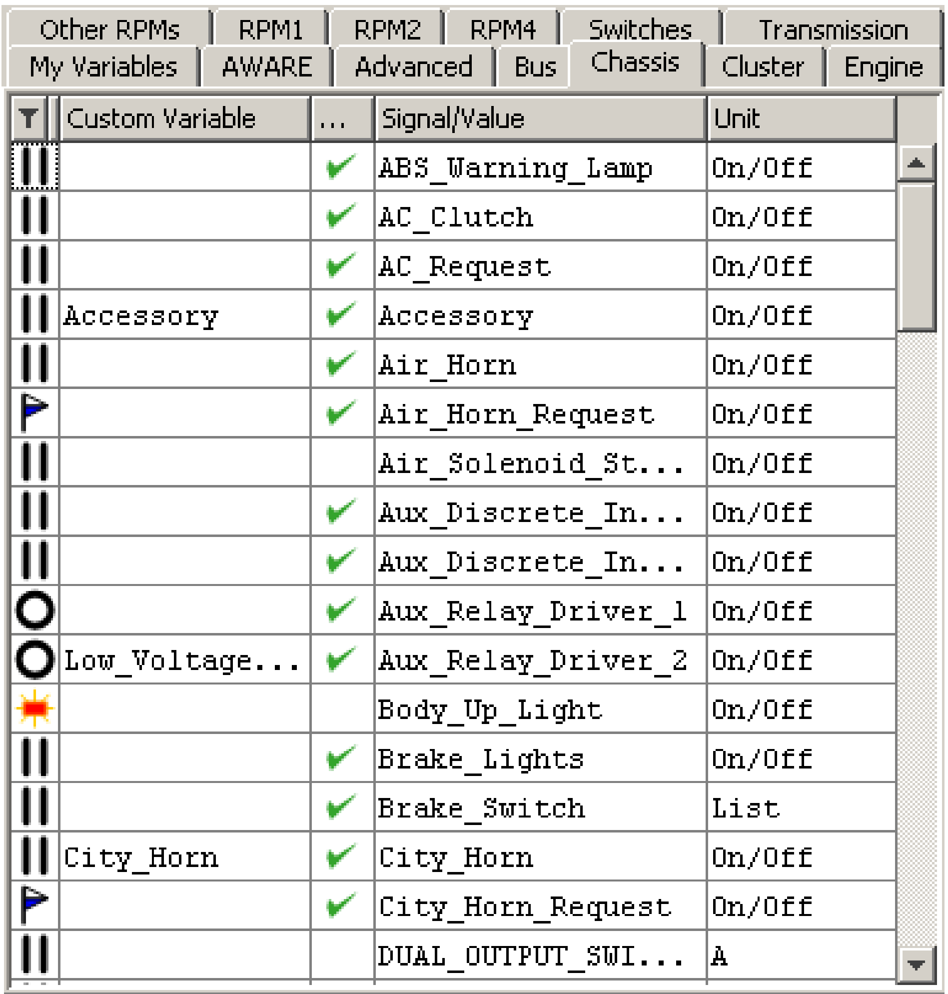
In the left side Dropdown menu in Advanced Logic Tab there are six selectable column headings and two functions. They are listed and defined as follows:

Name	Description
Logic Block	Logic Block file name.
Proprietary	Sets up a check box that allows you to choose proprietary format. Caution: If you make a Logic Block proprietary, then the ladder logic view is restricted to the individual who created it. Therefore, a vehicle with Advanced Logic that is set to proprietary will not be visible or easily diagnosed or serviceable by International® dealers.
Description	Logic Block description.
Date Edited	Date created or edited.
User	User ID that created the Logic Block.
Active	When checked, the Logic Block is included in the vehicle configuration.
Find Matches…	Finds selected words in titles of Logic Blocks. This is the same as left-clicking the Filter icon.
Clear Matches	Clear Matches.

Section 4 Overview of Signals

4.1 Purpose

The right side of the Advanced Logic Screen provides a list of signals. These signals are the building blocks that are used to create ladder logic. The signals are bucketed into a series of categories that may be viewed by selecting the desired tab. For example, signals that are associated with the chassis such as park brake or the door switch are found under the CHASSIS bucket.

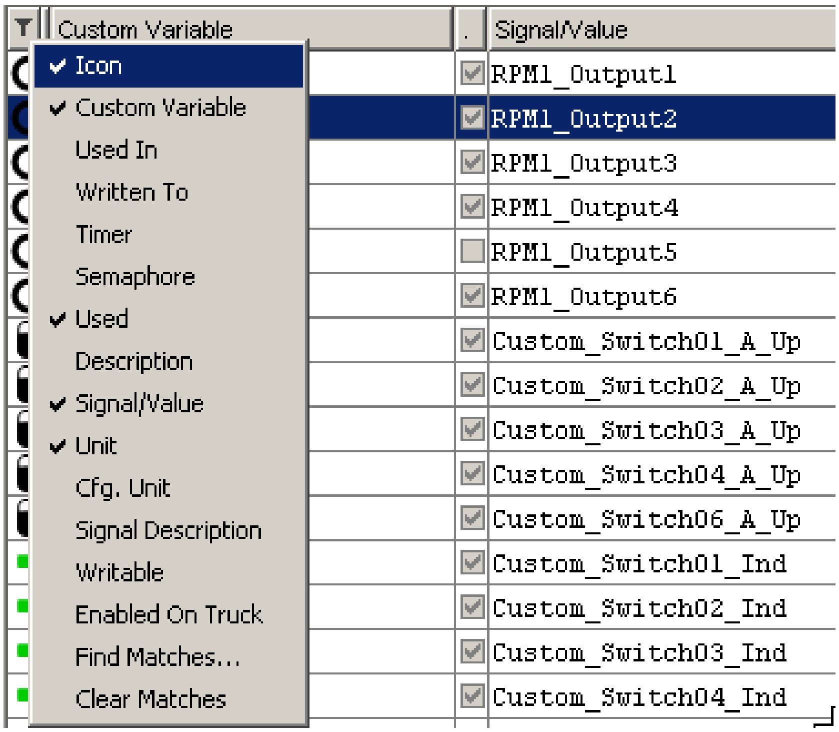


A signal will be available under the My Variables tab after it has been added to a rung of logic.

The signals are provided in two main categories. Some signals are READ ONLY, which means that the value of the signal may be used as an input in ladder logic. Some signals are READ or WRITE accessible which means that the signal may be used as an input or the signal may be WRITTEN TO as an output. Many of the WRITE signals have built in interlocks, which mean that you may not have unconditional access to write a value to the signal. See further discussions in the text concerning Using Signals with limited WRITE access.

4.2 Column Definitions

Shown below are the selectable column headings for the module tabs found in the Advanced Logic right hand screen. These columns are also variable in width.



Column headings are defined as follows:

Name	Description
Icon	Displays the variable name icon that appears in the ladder logic.
Custom Variable	Custom name the user has given to the custom variable. (NOTE no spaces or symbols such as + - & * #, etc may be used.
Used In	The logic block that custom variable is used in.
Written To	Whether it is possible to write to that variable or not.
Timer	Whether the variable is a timer or not.
Semaphore	This variable can be written to, however; other internal variables may take precedence over your set variable.
Used	True when the variable is used in a logic block or the mapped signal is used on the vehicle.
Description	Custom description the user has given to the custom variable.
Signal/Value	The system name for the selected signal.
Unit	Unit of measure the variable displayed as, i.e. seconds, ON/OFF, etc.
CFG Unit	The system unit of measure for the selected variable.
Signal Description	Description for that variable. If no text in this field, the parameter is an internal value.
Writable	Whether you can write to this value or monitor or use it to drive other features.
Enabled On Truck	Checked if the variable is enabled and used on the truck.
Find Matches…	Sort Matching Rows To Top. Find Matching Words in the Selected Screen. This is the same as left-clicking the Filter icon.
Clear Matches	Clear Matches.

4.3 Icons

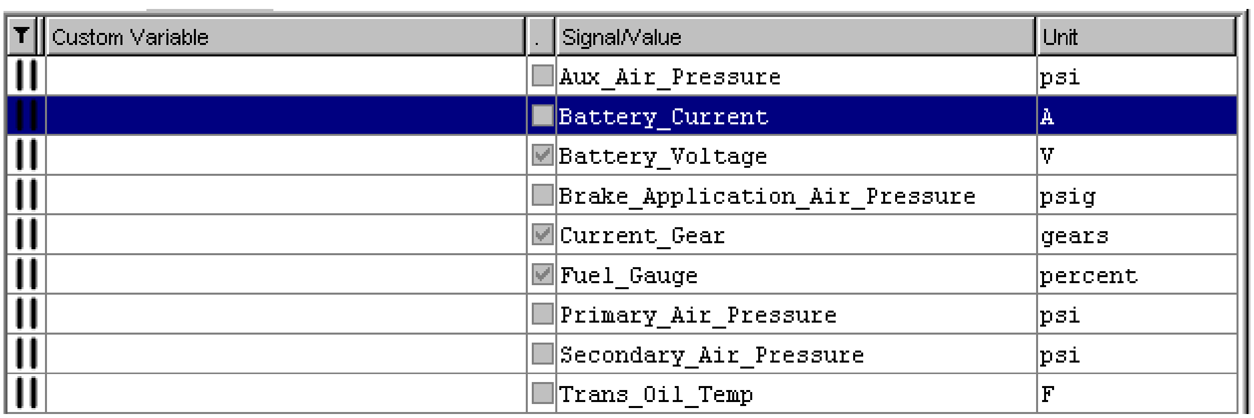
Ladder logic is constructed by dragging signal icons to the display area on the left side of the Advanced Logic screen. These icons represent various signals including inputs, outputs, status and indicators. These icons are described in detail in section 5.2 below.

4.4 Naming

The signals in the advanced logic view have pre-assigned general-purpose system names. These names may be used in ladder logic, but often the user will want to attach a custom name to the system signal to be used. The user can enter a new signal name by selecting the desired signal and typing a new signal name in the "custom variable" column on the right side of the advanced logic view (see example below). Custom signal naming must follow certain rules:

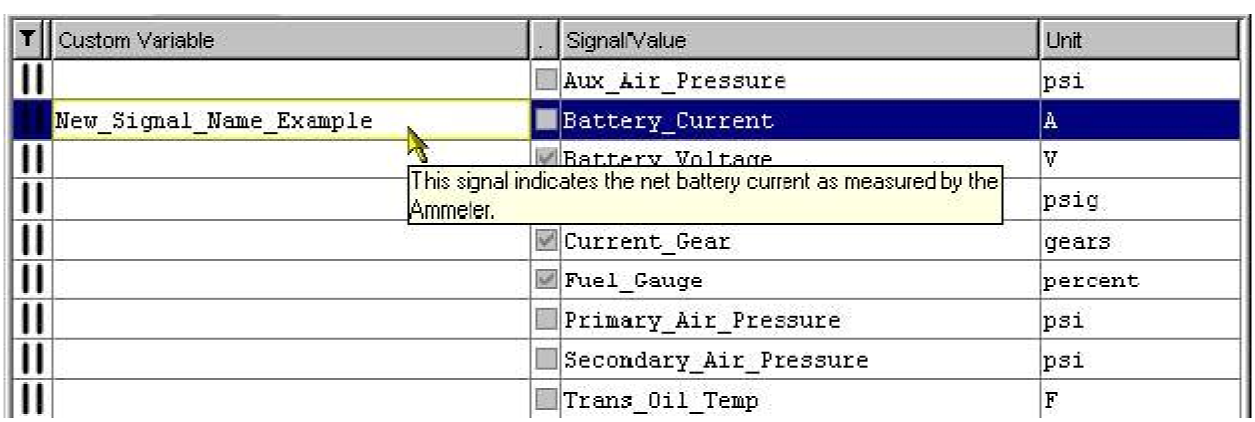
- Signal names must begin with an alphabetical letter. Numbers and letters may be used thereafter.
- Special characters such as commas, spaces, question marks, etc, may not be used.
- Underscore marks are acceptable to break up longer names

Example:
Select signal for naming



Custom Variable	.	Signal/Value	Unit
		Aux_Air_Pressure	psi
		Battery_Current	A
		Battery_Voltage	V
		Brake_Application_Air_Pressure	psig
		Current_Gear	gears
		Fuel_Gauge	percent
		Primary_Air_Pressure	psi
		Secondary_Air_Pressure	psi
		Trans_Oil_Temp	F

Type in new signal name



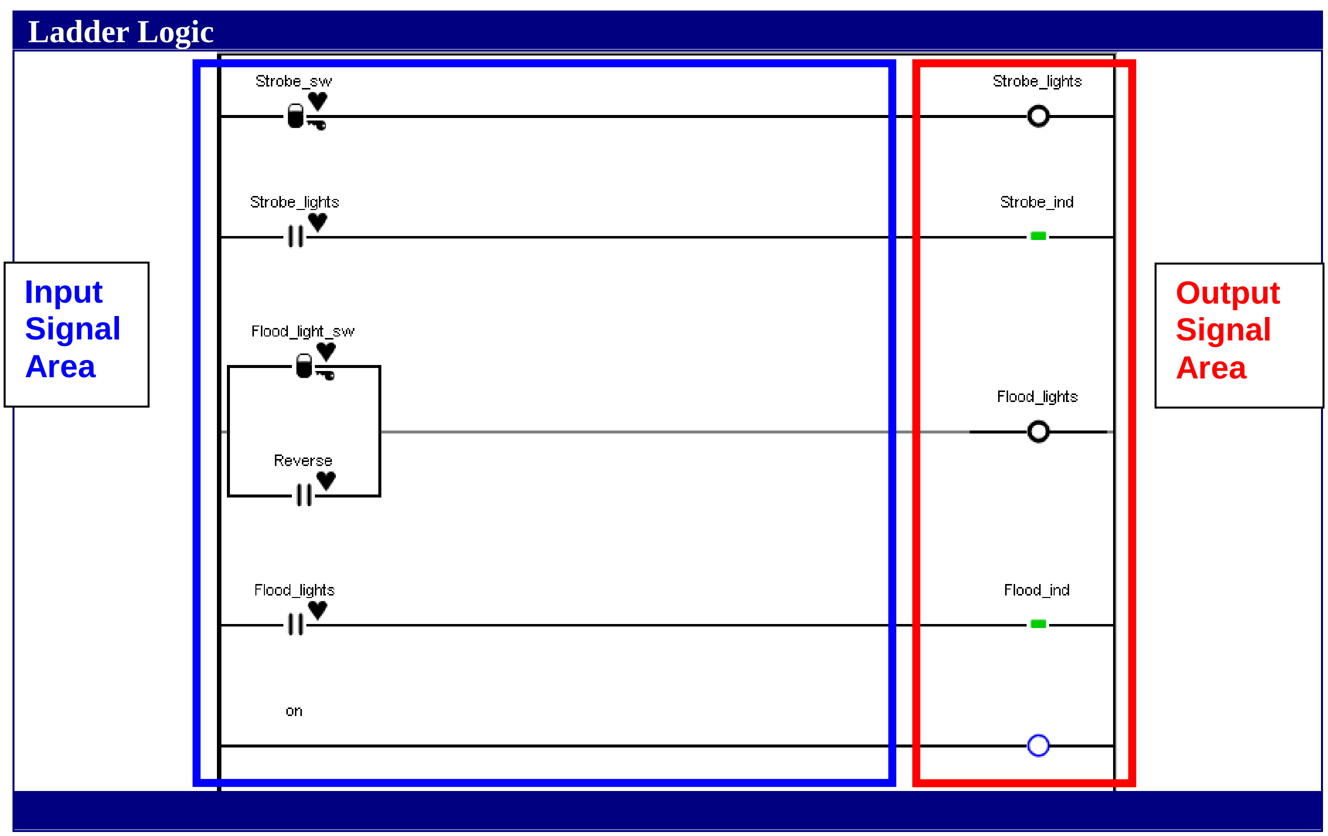
Custom Variable	.	Signal/Value	Unit
		Aux_Air_Pressure	psi
New_Signal_Name_Example		Battery_Current	A
		Battery_Voltage	V
			psig
		Current_Gear	gears
		Fuel_Gauge	percent
		Primary_Air_Pressure	psi
		Secondary_Air_Pressure	psi
		Trans_Oil_Temp	F

Section 5 Overview of Ladder Logic

5.1 Ladder Definition

5.1.1 What is Ladder Logic?

Ladder Logic is a way to simplify programming by using signal icons and a graphical display. In other terms, ladder logic is a graphical method for drawing an electrical circuit. Look at the ladder diagram below. Assume the left side of the ladder is battery voltage connection. The right side of the ladder is a ground connection. Each rung of the ladder represents an electric circuit. In the first rung of the ladder below, we start with battery voltage that is connected to one side of the STROBE Switch. The other side of the strobe switch is connected to one side of an output called STROBE LIGHTS. The other side of the STROBE LIGHTS output is connected to the right side of the ladder, which is ground. Thus, this simple series of picture icons and lines represent a realistic wiring circuit diagram. This and all other rungs of advanced ladder logic are executed or "run" fifty times per second. Ladder logic symbols may be organized in multiple forms of AND & OR relationships. Many arrangements of input icons may be placed on a single rung. However, only one output may be written to on any given rung.



The Diamond Logic® Builder software also contains a Structured Logic tab, which allows for programming using a traditional text method if desired. Only advanced programmers should attempt to use structured logic.

Structured Logic

```
Strobe_lights = not status(Strobe_sw) and Strobe_sw and Accessory
Strobe_ind = not status(Strobe_lights) and Strobe_lights
Flood_lights = not status(Flood_light_sw) and Flood_light_sw and Accessory or not
status(Reverse) and Reverse
Flood_ind = not status(Flood_lights) and Flood_lights
```

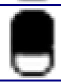
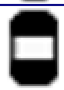
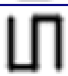
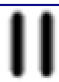
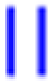
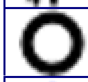
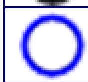
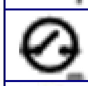
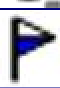
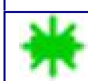
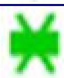
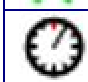
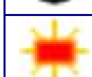
5.1.2 How do you use Ladder Logic?

Using Ladder Logic is as simple as choosing the signals you want to work with and clicking and dragging that signal icon to the right place on the Ladder Logic display area.

5.2 Types of Signal Icons

The following three tables illustrate each of the signal icons available in the Diamond Logic® Builder software: Main Signals, Input Modifiers and Output Modifiers. A short description of each signal is included in each table. When using the icons as listed below on a ladder rung, the signals must be “TRUE” or “ACTIVE” to allow the logic to progress further down the rung toward the output. When any of the icons are TRUE, they are analogous to a closed switch contact. NOTE: Appendix C contains printable versions of these tables with room to make your own notations.

Main Signals are those that are available to the programmer for selection.

Icon	Main Signals Description
	Switch Up
	Switch Down
	Switch Middle
	Flasher Function (NOTE: this signal is created by Diamond Logic® Builder software when you use the flash function)
	Input Signal
	Internal Input Signal
	Special Function Signal
	Output Signal
	Internal Output Signal
	Remote Power Module input that is active with 12 Volts present
	Remote Power Module input that is active with Ground present
	Signal with limited WRITE ACCESS
	Rocker Switch Indicator
	Rocker Indicator Light Flash Fast
	Rocker Indicator Light Flash Slow
	Timer Function (NOTE: this signal is created by Diamond Logic® Builder software when you use the timer function)
	Warning Light in the Gauge Cluster

Input Signal Modifiers are ……

Icon	Input Modifiers Description
	Negate (example:) Inverts ON/OFF type signals. Applies to both INPUT and OUTPUT signals.
	Signal that is turned OFF With Error
	Signal that is turned ON With Error
	Signal will be Maintained With Error (NOTE: there is no icon displayed)
	Positive Edge: Capture one event when the signal turns ON
	Negative Edge: Capture one event when the signal turns OFF
Edg	Edge: Capture one event each time the signal turns ON or OFF
	Good Status: Signal will be ON with a GOOD Status
	Bad Status: Signal will be OFF with a BAD Status
Alt	Altered: Signal goes active each time the value changes for one iteration
	Enabled: Checks if a timer function is enabled
	Running: Checks if a timer is running
	Expired: Checks if a timer is expired
Rec	Receive: Not useable at this time
	Accessory: Signal is interlocked to ACCESSORY so it is always OFF when ACCESSORY is OFF

Output Signal Modifiers are…

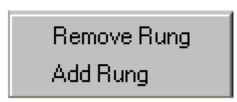
Icon	Output Modifiers Description
	Negate (example:) Inverts ON/OFF type signals. Applies to both INPUT and OUTPUT
Set	Set a signal to a specific value, i.e. ON, OFF, some number, etc.
	Start a timer
	Stop a timer
Snd	Send a request to turn on a signal
	Toggle the output state once
Load	Load Manager: Manager Turns Loads ON
Shed	Load Manager: Manager Sheds Loads OFF
Flash	Flash Feature: Creates a flasher function with a programmable time period
Seq	Load Sequence Feature: Sequences multiple outputs ON and OFF

5.3 Populating a Rung – Adding and Deleting Signals

Custom logic in the Diamond Logic® Builder software is created using signals in the display area and following a few simple steps:
Find the desired signal from the signal categories on the right side of the advanced logic view.
Highlight the signal and holding the left mouse button down, drag the signal to the desired ladder rung on the left side of the screen. Release the left mouse button and a copy of the signal will now be populated on the rung. Where you release the button will determine whether this signal will be an input or output.
See the rules of using signals in section 5.5 below.

5.4 Editing Ladder Rungs – Adding, Moving and Deleting Rung

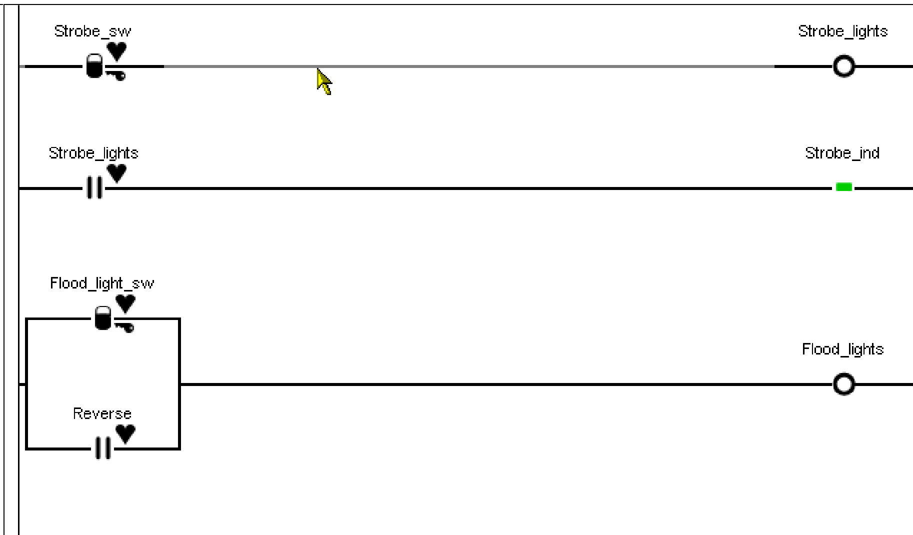
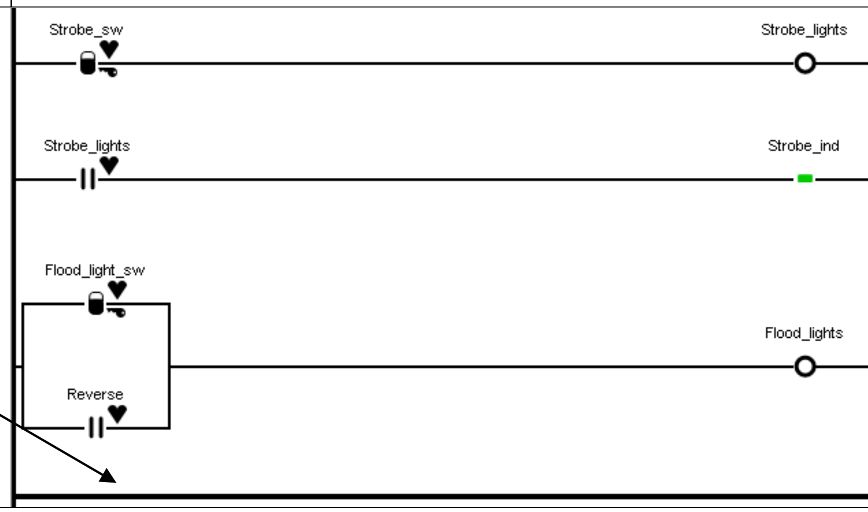
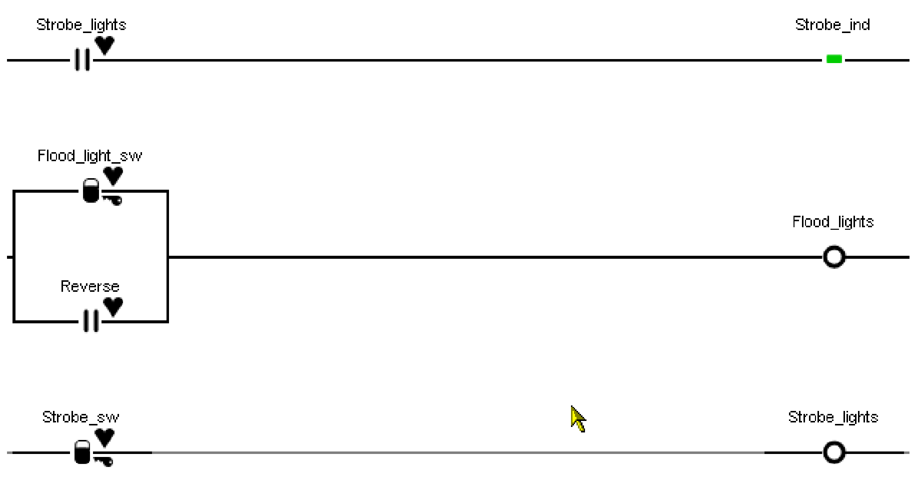
The Diamond Logic® Builder software allows you to add, move and delete rungs of logic. To add or delete a rung, right-click the mouse inside the display area to show this selection box:



To add a ladder rung, click the Add Rung selection:

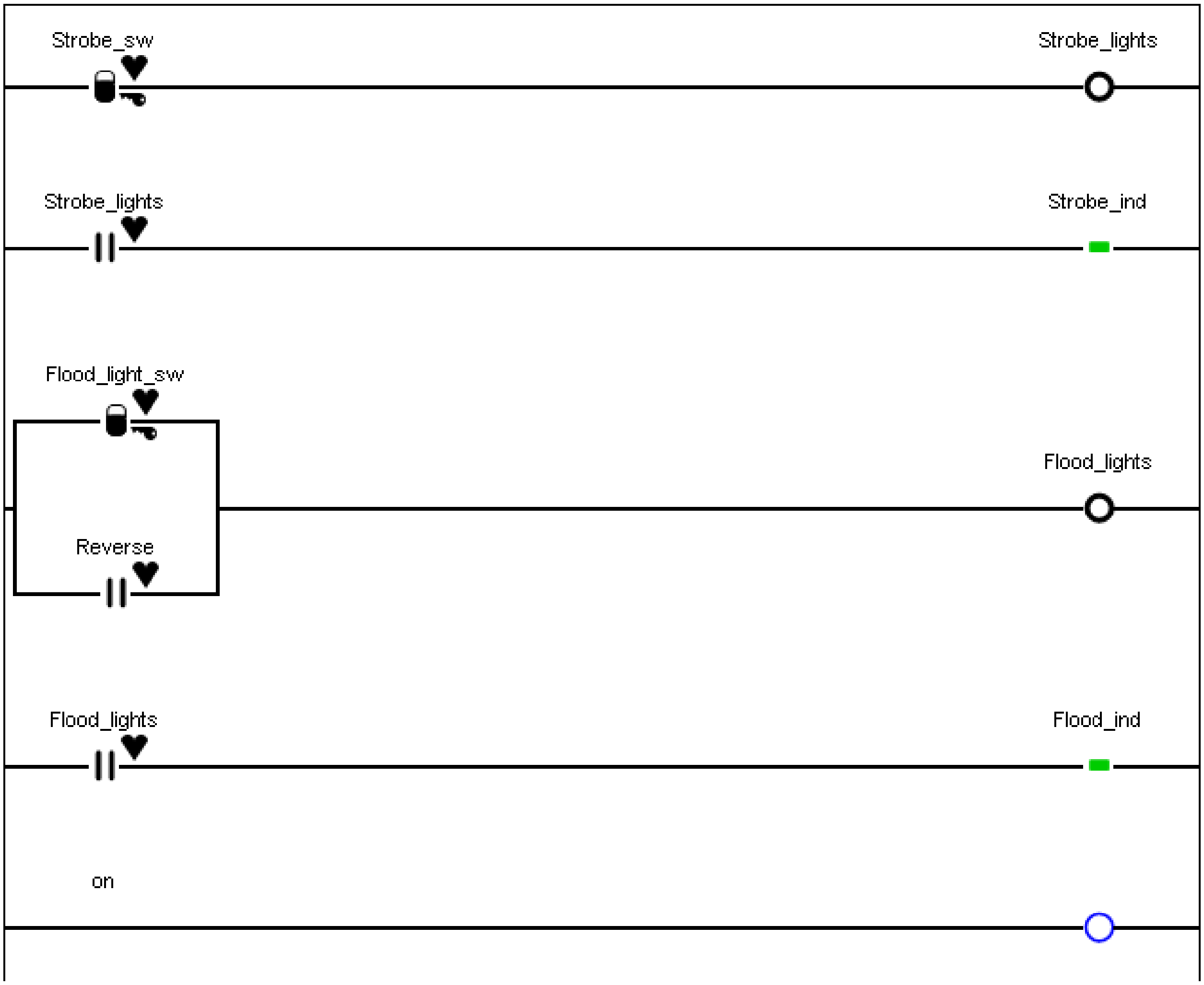
To remove a ladder rung:
Select the rung to be removed by clicking on it
Right click in the display area to show the selection box
Click the Remove Rung selection

To move a ladder rung, click on the rung to be moved and drag it to the new location. The following three graphics illustrate moving the top rung (Strobe_lights output) to below the Flood_lights output.

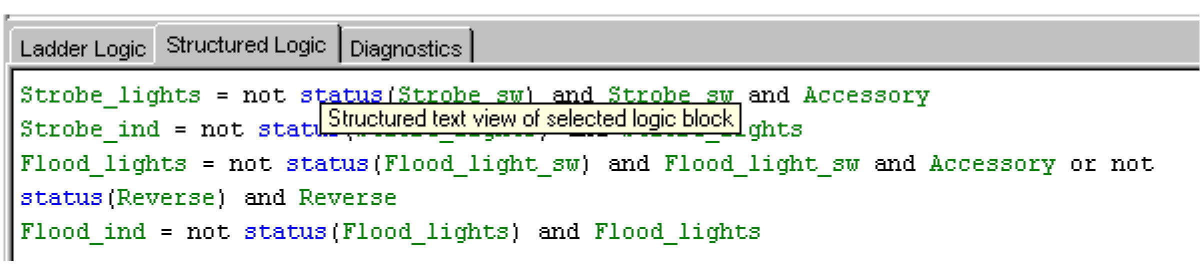
Click on the Strobe_lights rung and drag it below the Flood_lights rung.	
Notice the heavy black line. This shows where the position will be prior to releasing your mouse.	
Now the Strobe_lights output is below the Flood_lights output.	

The Diamond Logic® Builder program also allows you to cut and paste rungs of logic. However, this cannot be done in the Ladder Logic view. To cut and paste rungs of logic, switch to the Structured Logic view and locate the equivalent logic, highlight it and then cut and paste to the desired location. Order of the rungs is important because the logic is executed in order.

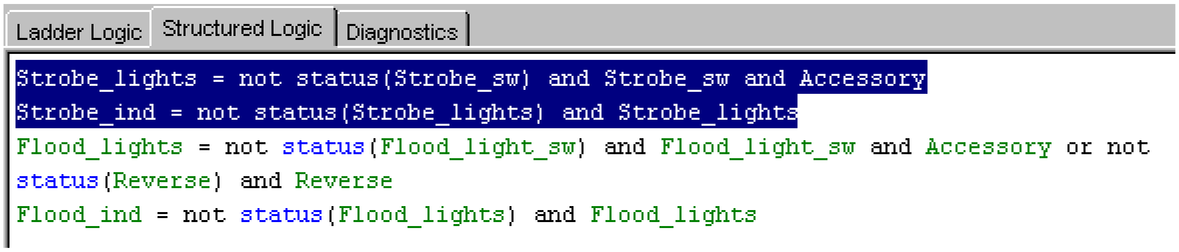
In the example below we will cut the first two rungs of logic and paste them to the last rung.



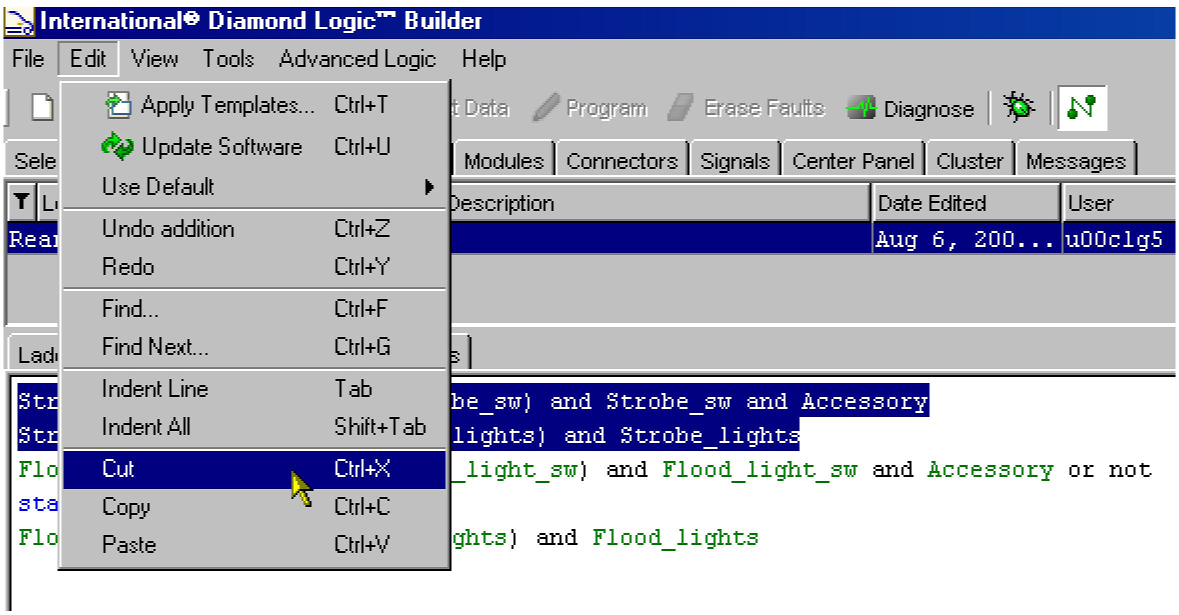
Switch to the Structured Logic view.



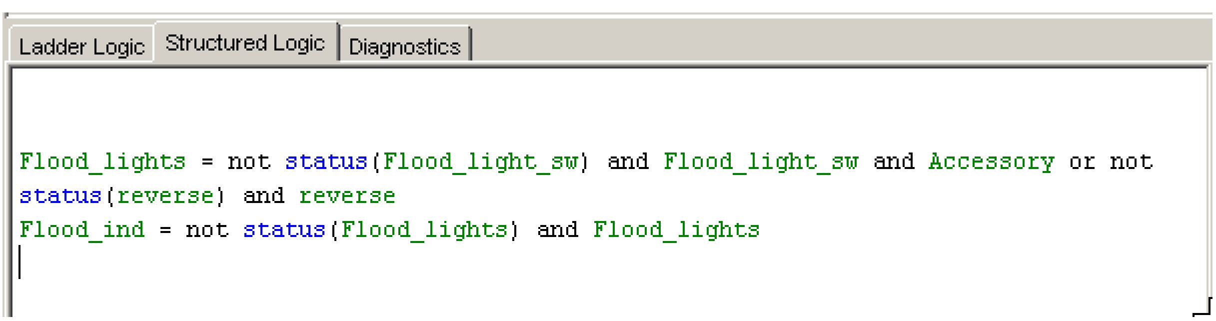
Highlight the first two rows of logic.



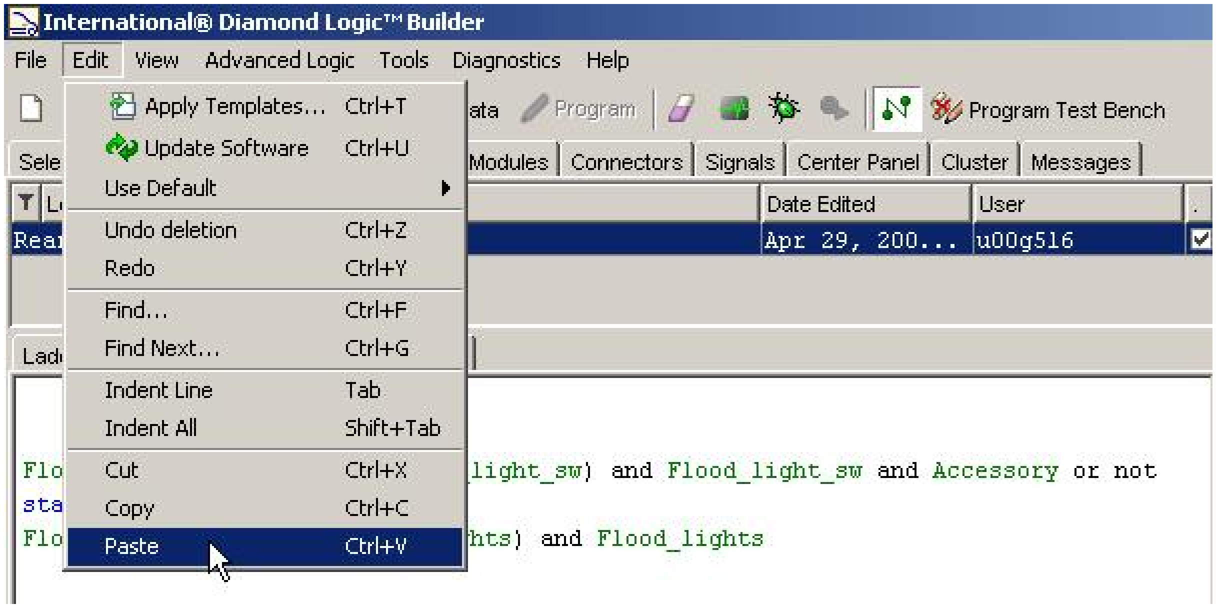
Click on Edit then Cut (or Ctrl+X).



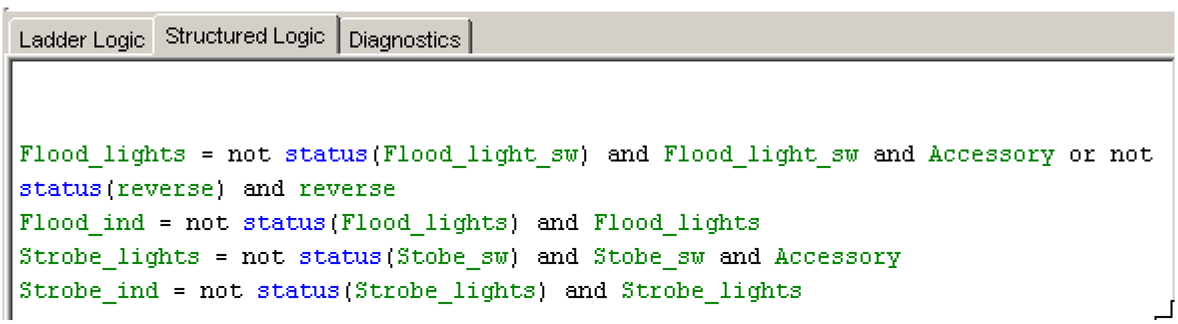
Move the cursor in to the desired paste location.



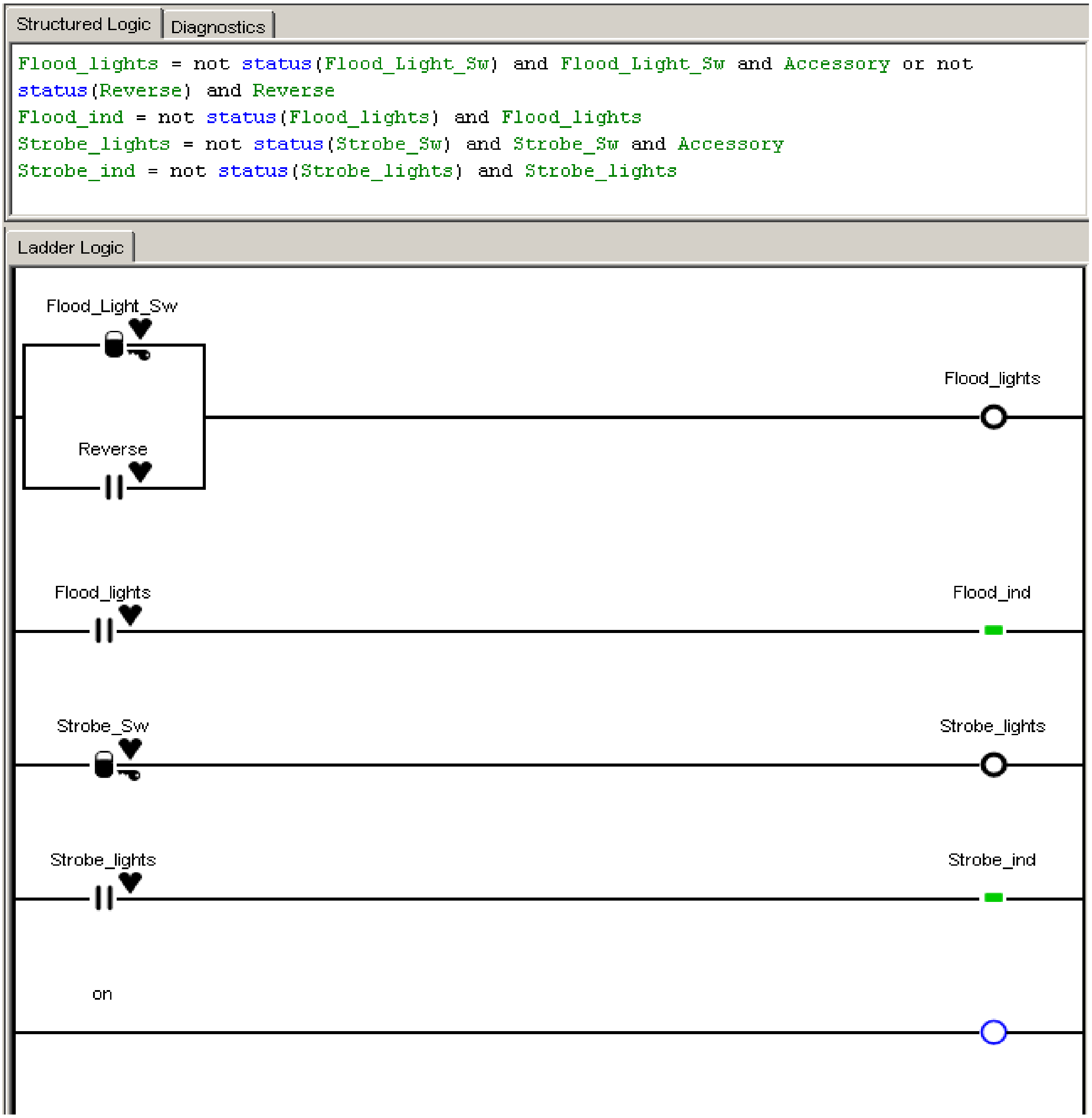
Click on Edit then Paste (or Ctrl+V).



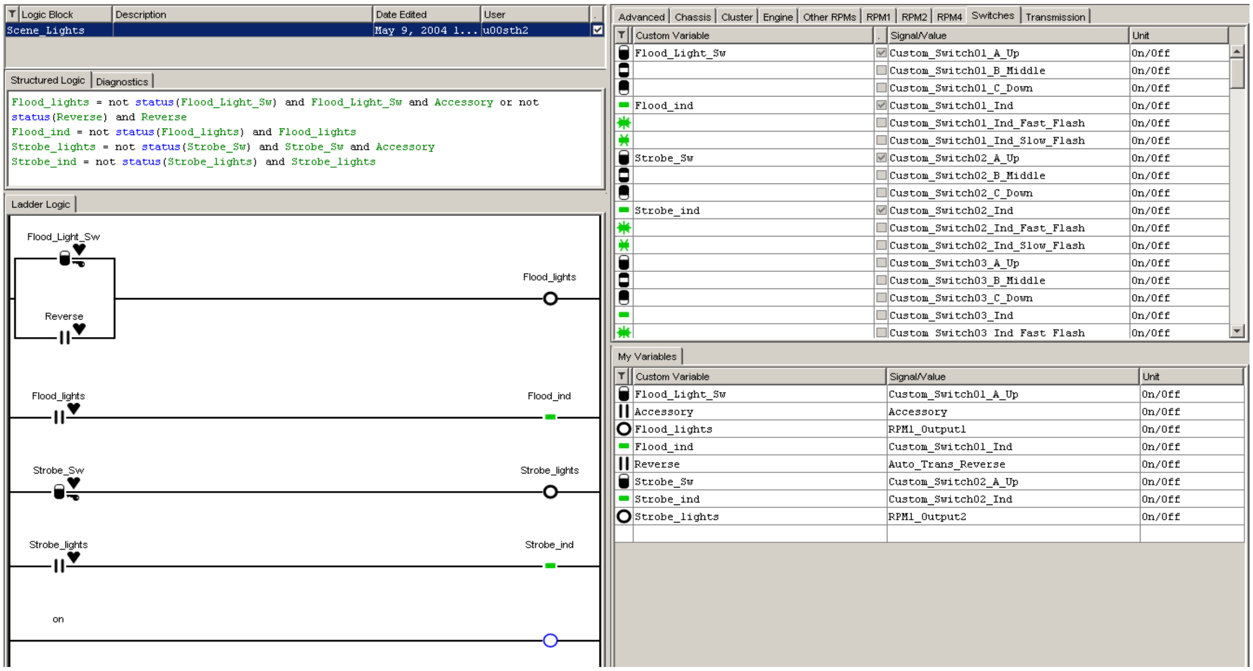
Here is the Structured Logic view after the Paste operation.



Switch back to the Ladder Logic view or double click on one of the tabs. This will split the window and place the selected tab at the bottom of the screen so you can view two tabs at the same time. Either way you can check to ensure the desired results.



Whether in the Ladder Logic view or in the resources tabs, you can double click on any of the tabs and that tab will split off of the main list of tabs to allow viewing of two tabs at once. The following shows an example of each. On the Ladder Logic tab we double clicked on the Ladder Logic tab that will allow viewing the Ladder Logic tab and the Structured Logic or Diagnostic tab. On the resources tab we double clicked on the My Variables tab that will allow viewing the My Variables tab with any other resources tab at the same time.



5.5 Rules for Reading and Writing Signals in Ladder Logic

There are a number of rules concerning the use of ladder logic. Please review the following list:

- Any ladder rung can have only one output on the right side of the ladder.
- Only one rung in an entire vehicle configuration can write to each output that is connected to a physical pin or output.
- Different signals, whether inputs or outputs cannot have the same name.
- Internal variables must be used when it is desired for multiple rungs to control a single signal. The internal variable can then be used as input to control the signal that drives the physical output.
- Signal names cannot contain special characters or spaces.
- If the input logic is too long to fit on a single rung, an internal variable can be used as the output on the first rung and used as in input on the second rung before adding additional input logic.

5.6 Using Signal Status in writing ladder logic

Every signal in the Diamond Logic® Builder program has a "status" associated with it. This is a diagnostic indicator that describes the health or condition of each signal. A zero indicates "GOOD STATUS" and the data provided by this signal can be trusted as valid. A "BAD STATUS" is indicated when the status value is any number other than zero. A variety of numbers have been established to describe various failure modes for the signal. Signal status can be checked to ensure that one of the following conditions has not occurred: Short to ground, Datalink disconnect, power loss, failed module, etc. When a signal has bad status, the signal is generally not valid and should not be used for controlling outputs when in this condition. Examine the following methods for using the signal status indication. It is recommended that users should use OFF WITH ERROR unless the application requires alternative performance during bad status conditions.

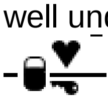
Checking just the status of a signal can be done in the ladder logic view by right clicking the mouse and adding an icon to the ladder rung by select either GOOD STATUS or BAD STATUS. A hollow heart icon will be added to the rung indicating this icon is now checking ***ONLY*** the **STATUS** of the signal and not the **STATE** of the signal.


= If the status is good on this switch, then this icon will be TRUE, but if the status is bad, then this icon is FALSE. Therefore the icon will look like a closed switch when the status is GOOD.


= If the status is bad on this switch, then this icon will be TRUE, but if the status is good, then this icon will be FALSE. Therefore the icon will look like a closed switch when the status is BAD.

Status checking of signals should be done whenever a signal is used as an input. Including chassis signals, engine signals, transmission signals, switches, remote power module outputs/inputs, etc.

Status can also be checked **in addition to** the state or value of a signal. For example, if a switch is driving an output, status can be automatically checked and will turn the signal icon OFF or FALSE if an error occurs. "Off with error" is a default selection for all icons; therefore, a solid heart will be added to all icons used as inputs. If the status of this signal goes bad, then the contact will look like an open (OFF) switch. If this operation is not desired, the icon can be changed to "Maintain with Error" or "ON With Error" by right clicking on the icon. Both ON with Error and MAINTAIN with Error should only be used when the operation of the input is critical and the results of the choice is well understood.

 **Solid Heart on an icon refers to OFF with Error**

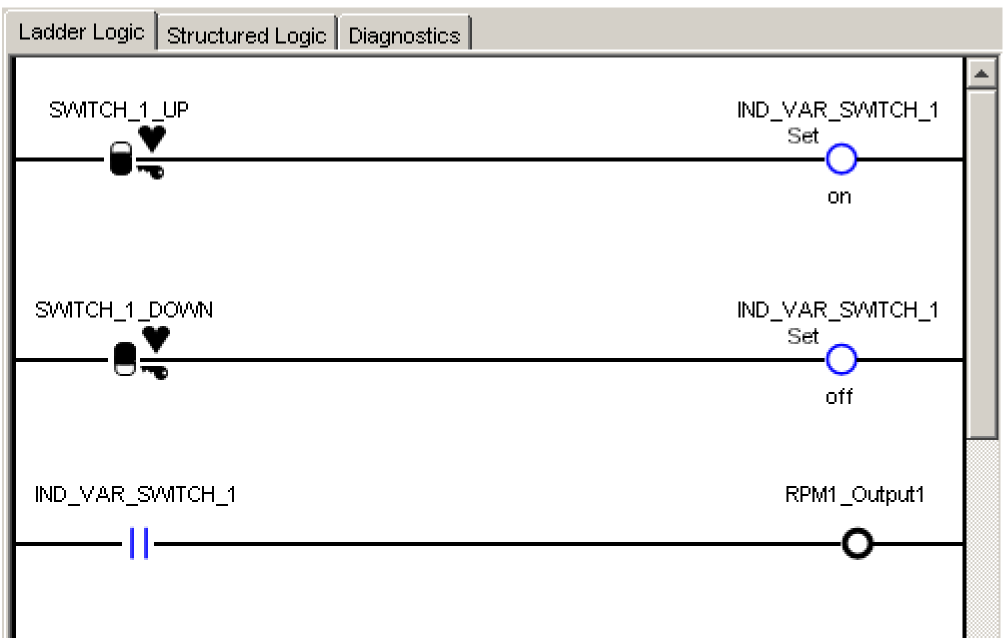
 **Broken Heart to the right of the icon refers to ON with Error**

 **No Heart to the right of the icon refers to MAINTAIN with Error**

Note: Negating an icon does not negate the Hearts; therefore, a solid heart is still OFF with Error if the icon is negated. Therefore the icon will look like an open switch if the status goes bad on this icon.

5.7 Using Independent Variables – Usage, types, naming, limitations

Independent Variables are internal signals that are not tied to any specific physical input or output signals. A blue hollow circle icon or a parallel pair of blue lines identifies these variables as internal signals. These internal signals are used as placeholders for internal processing operations or as a starting point for making a special signal like a timer or a load manager signal.
Common Usage: Independent Variables should be used when more than one rung is required to write to a single output. A physical output cannot be used in more than one rung; therefore, independent variables must be used. For example: a 3-position Momentary Switch will require one rung to set the output ON and another rung to set the output OFF. This will require using an Independent Variable. Below is a ladder logic example demonstrating the use of independent variables.



Independent Variable Sample

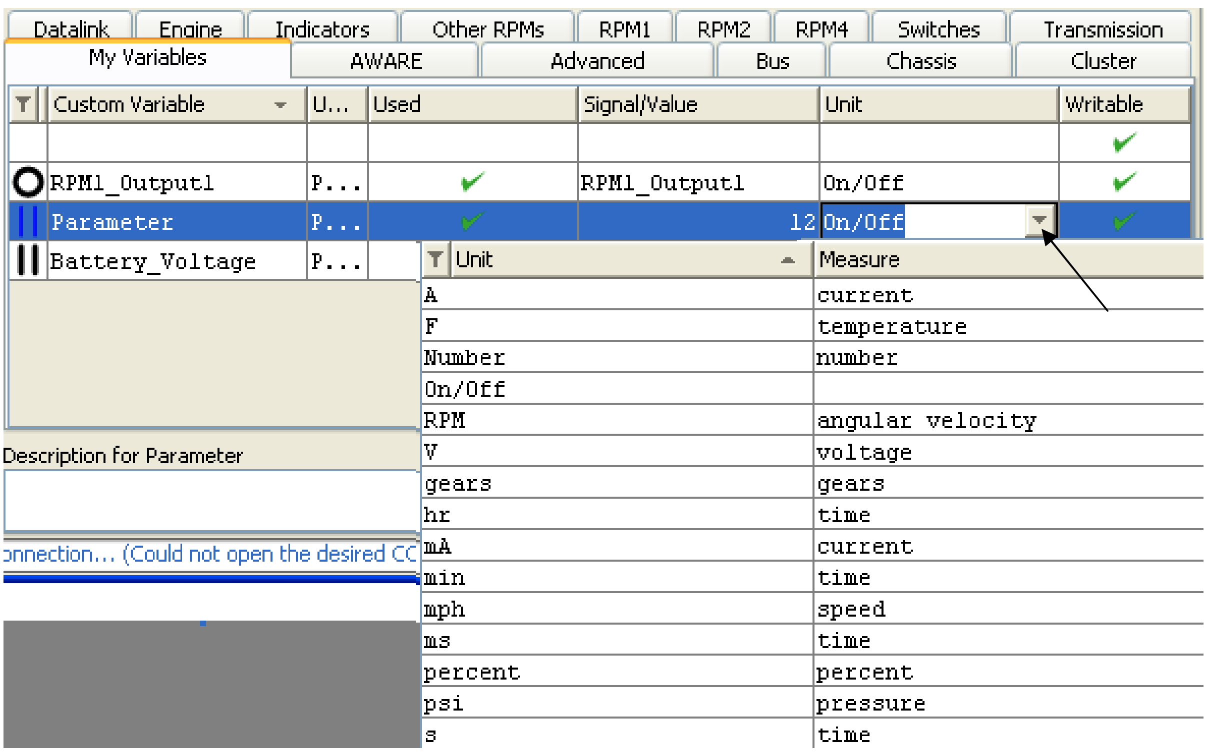
Note: Independent Variables will not keep the Electronic System Controller awake; therefore, these independent variables can be set on and set OFF without causing the Controller to stay awake with the ignition key in the OFF position. This contrasts with physical outputs that will keep the Controller awake and potentially drain the battery.

5.7.1 Using Independent Variables as Custom Programmable Parameters

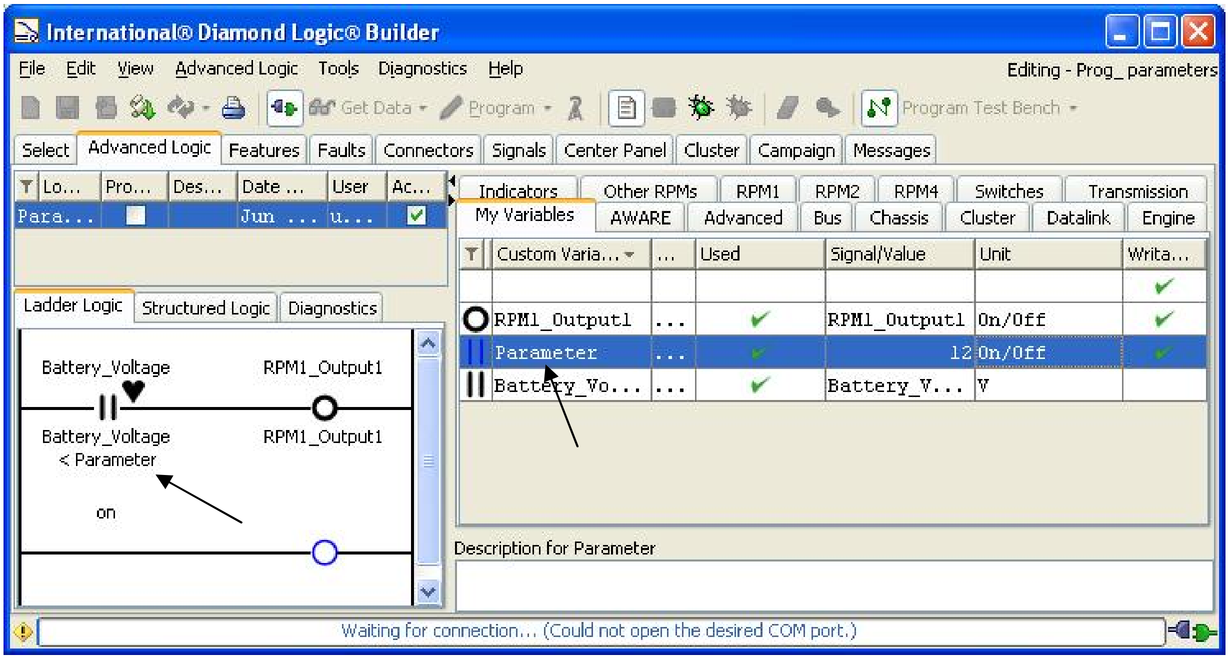
Independent Variables can also be used to configure custom variables that can be changed by Level 2 DLB users.

An custom variable can be used as a value under a contact. Once it is configured, this value can be changed under the Features tab and Custom Logic sub tab. This is handy, if a value in a logic block is likely to need changed. It will prevent the need to change the logic block in a template and reapply it. The parameter value can be changed on the VIN, directly.

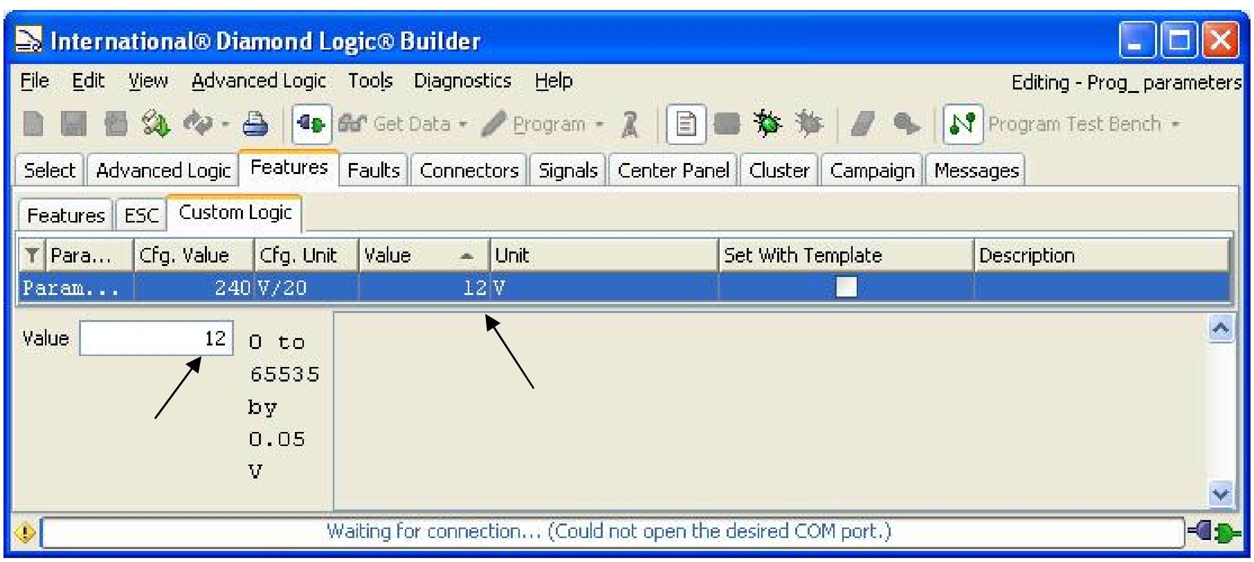
Create the variable parameter, “Parameter” is the name used in this example, in the “Custom Variable” column under the “My Variables tab”. Assign a unit type in the unit column by double clicking “On/Off”, clicking the drop down arrow and selecting a unit of measurement, as illustrated in the figure below:



The custom parameter name can be typed (must exactly match the name created under the My Variables tab, Parameter is the name in this example) to replace a numerical value for a contact value. This is illustrated below:



The value of the custom parameter can be viewed and changed by selecting the Features tab, then the Custom Logic tab. The custom parameter will only be displayed if it is configured correctly and the spelling is correct, when it is used in the logic block.

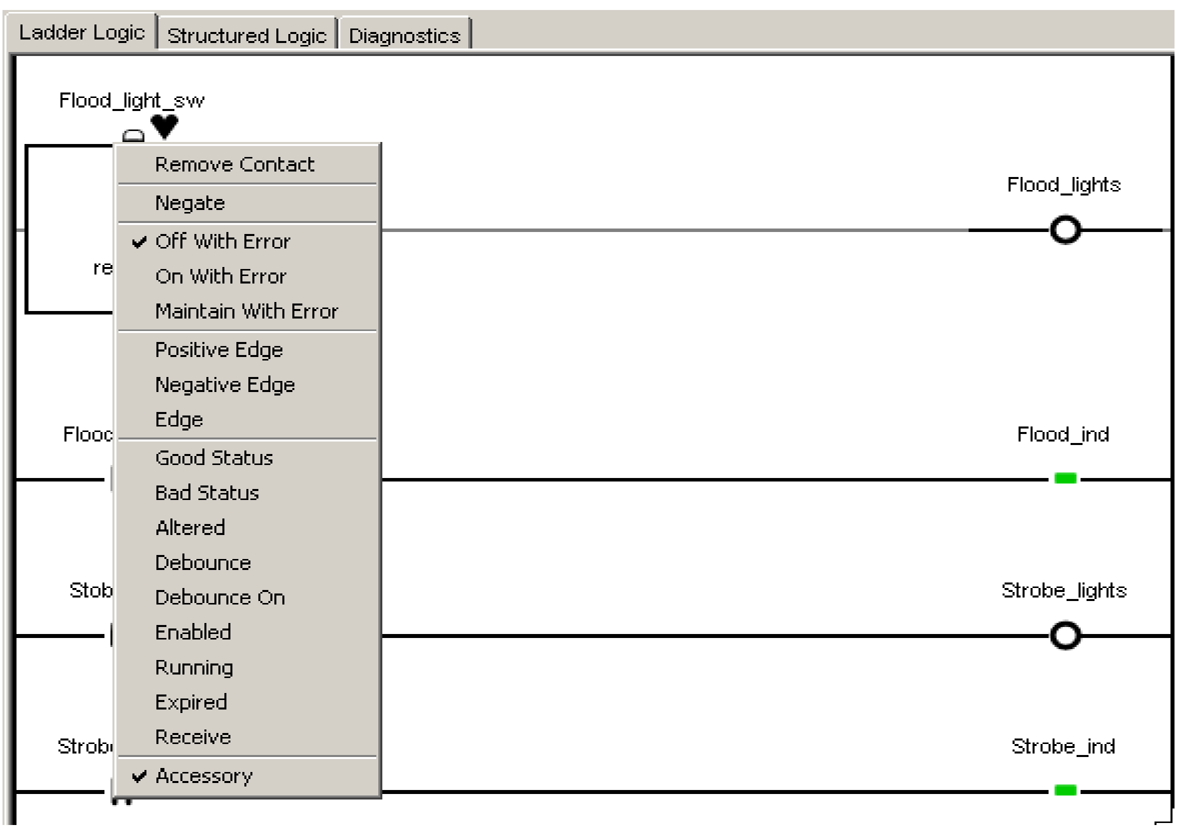


This value can be adjusted to suit the customer's specific need and can be modified by any DLB user, with level II, or greater, permissions.

5.8 Signal Attributes and Special Functions

Signals that are accessible in the Diamond Logic® Builder program may be categorized as input or outputs. Using the input signals as bare switch contacts or driving the outputs, as simple output devices, will not provide the functionality required by most body builders. Therefore, the Diamond Logic® Builder software provides a means to customize input and output signals with special attributes that change the way signals perform when used in ladder logic. The following diagram shows the list of attributes that are available for the Flood_light _sw input signal. By placing the mouse cursor over the input signal and performing a right click of the mouse the list of attributes is revealed. Please note this list is general purpose in nature and provides options for multiple signal types. This means that not all attributes listed will be applicable to all signal types. The Diamond Logic® Builder software will provide an error message if an attribute is applied to an input that is not possible for that signal type. For example, timer attributes may not be applied to the park brake signal since it is a simple switch contact type signal.

5.8.1 Attributes of Input Signals



Input Signal Attributes

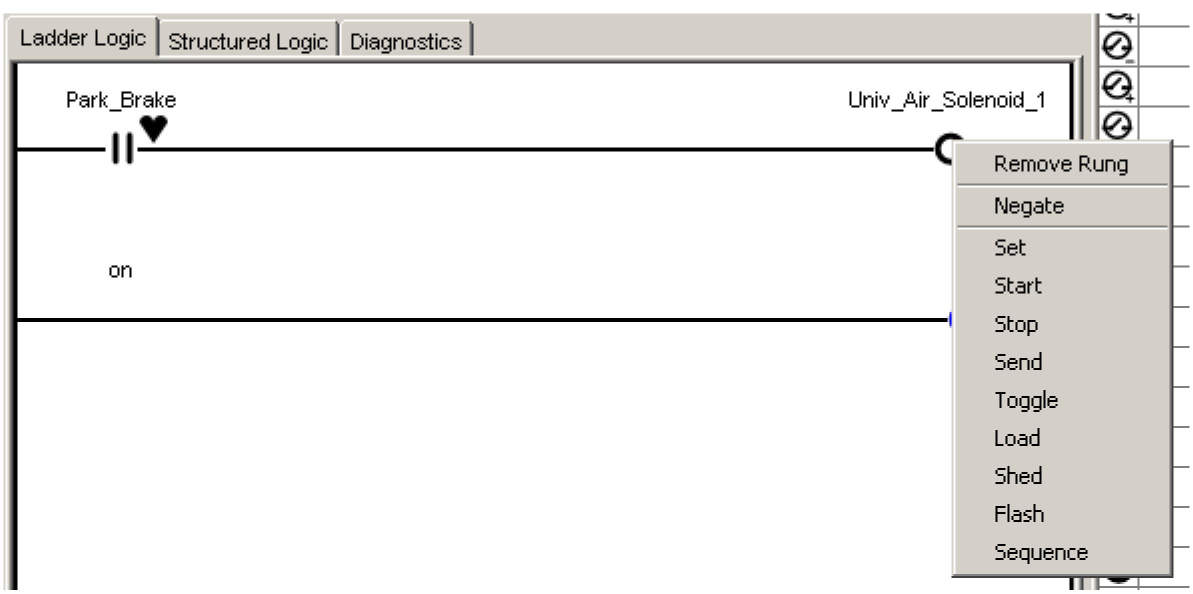
The list of attributes are used for the following purposes:

- **Remove Contact**: Removes the signal from the ladder rung.
- **Negate**: Applies a logical inversion to signals. This attribute may be applied to any signal type.
- **Off With Error**: This attribute provides the ability for the Diamond Logic® Builder software user to check the status of a signal in conjunction with the condition or state of the signal. In this case, if a signal has a BAD STATUS, the signal state is forced to an open contact state. Thus the label OFF With Error indicates that no matter what the signal state may be; the contact will be treated as an open circuit on the ladder rung. Checking OFF with Error from the pick list will place a black heart on the right side of the signal icon.
- **On With Error**: This attribute provides the ability for the Diamond Logic® Builder software user to check the status of a signal in conjunction with the condition or state of the signal. In this case, if a signal has a BAD STATUS, the signal state is forced to a closed contact state. Thus the label ON With Error indicates that no matter what the signal state may be; the contact will be treated as a closed circuit on the ladder rung. Checking ON with Error from the pick list will place a broken heart on the right side of the signal icon.
- **Maintain With Error**: This attribute provides the ability for the Diamond Logic® Builder software user to check the status of a signal in conjunction with the condition or state of the signal. In this case, if a signal has a BAD STATUS, the signal state that was present before the status went bad will be used until the accessory signal is turned OFF. Thus the label Maintain With Error indicates that the last state of the signal will be maintained on the ladder rung. Checking Maintain with Error from the pick list will remove all heart icons on the right side of the signal.
- **Positive Edge**: The positive edge attribute provides a means to capture a single transitional event of the signal going “true” or in other words turning ON. This is valuable when a single event is needed to start a timer or toggle an output. This signal is true or ON for only one processing cycle of .020 seconds when the signal condition transitions from an inactive state to an active state. Therefore, it is not possible to monitor the state of signals with a positive edge attribute in the diagnostic or simulate mode. Note in those modes, the Diamond Logic® Builder software applies a brown background with question marks since the actual state of the signal cannot be accurately displayed. A positive edge attribute is displayed as a positive going edge icon on the left side of the signal.
- **Negative Edge**: The negative edge attribute provides a means to capture a single transitional event of the signal going “false” or in other words turning OFF. This is valuable when a single event is needed to start a timer or toggle an output. This signal is true or ON for only one processing cycle of .020 seconds when the signal condition transitions from an active state to an inactive state. Therefore, it is not possible to monitor the state of signals with a positive edge attribute in the diagnostic or simulate mode. Note in those modes, the Diamond Logic® Builder software applies a brown background with question marks since the actual state of the signal cannot be accurately displayed. A negative edge attribute is displayed as a negative going edge icon on the left side of the signal.

- **Edge**: The edge attribute provides a means to capture a single transitional event of the signal going "false" or "true." This attribute is valuable when a single event is needed to toggle an output from a momentary switch. This signal is true or ON for only one processing cycle of .020 seconds when the signal condition transitions from an active state to an inactive state. Therefore, it is not possible to monitor the state of signals with a positive edge attribute in the diagnostic or simulate mode. Note in those modes, the Diamond Logic® Builder software applies a brown background with question marks since the actual state of the signal cannot be accurately displayed. The letters "edg" are displayed on the left side of the signal.
- **Good Status:** This attribute provides the ability for the Diamond Logic® Builder software user to check for good status on a signal as a stand-alone operation. This means that the logical state of this signal is not evaluated with this attribute. In this case, if a signal has a Good STATUS, the signal is forced to be a closed contact state. Thus the label GOOD STATUS indicates that if the status of the signal is GOOD, the contact will be treated as a closed circuit on the ladder rung. Checking Good Status from the pick list will place a heart outline on the left side of the signal icon.
- **Bad Status:** This attribute provides the ability for the Diamond Logic® Builder software user to check for bad status on a signal as a stand-alone operation. This means that the logical state of this signal is not evaluated with this attribute. In this case, if a signal has a Bad STATUS, the signal is forced to be a closed contact state. Thus the label BAD STATUS indicates that if the status of the signal is bad for any reason, the contact will be treated as a closed circuit on the ladder rung. Checking Bad Status from the pick list will place a broken heart outline on the left side of the signal icon.
- **Altered:** The altered attribute provides a means to capture multiple transitional events of the signal going "false" or "true." This attribute is valuable when it is desired to capture the events of a signal value that has changed. This signal is true or ON for only one processing cycle of .020 seconds when the signal condition transitions from one state to another. Therefore, it is not possible to monitor the state of signals with an altered attribute in the diagnostic or simulate mode. Note in those modes, the Diamond Logic® Builder software applies a brown background with question marks since the actual state of the signal cannot be accurately displayed. The letters "alt" are displayed on the left side of the signal.
- **Debounce:** This attribute provides a user defined delay of response to a signals transitioning from either "Off" to "On" or "On" to "Off". See 'Signal Debounce Functions' section 7.4.7 for more detail.
- **Debounce On:** This attribute allows a user defined delay of response to a signals transition from "Off" to "On" only. See the 'Signal Debounce Functions' section 7.4.7 for more detail.
- **Enabled:** The enabled attribute is used with timers. The enabled attribute is used to check when a timer is in any state other than stopped. The timer with the enabled attribute will be true if the state of the timer is started, running or expired. The timer with the enabled attribute applied will display a clock outline on the left side of the timer signal.

- **Running:** The running attribute is used with timers. The running attribute is used to check when a timer is in the running mode. The timer with the running attribute will be true if the state of the timer has been started and has not yet expired. The timer with the running attribute applied will display a clock outline on the left side of the timer signal with two hands showing a filled time segment between the 12 and 3 o'clock positions.
- **Expired:** The expired attribute is used with timers. The expired attribute is used to check when a timer has timed out and is expired. The timer will stay in the expired state until the timer is stopped or restarted. The timer with the expired attribute applied will display a clock outline on the left side of the timer signal with two hands pointing to the 12 o'clock positions.
- **Receive:** Receive is used with signals with limited access. The receive function should not be used with the current version of the Diamond Logic® Builder program.
- **Accessory:** The Accessory attribute applies the accessory signal to the signal under evaluation. This attribute is defaulted ON for most input signals to ensure that the ladder rungs are OFF when the ignition key is turned OFF. This action will prevent the ESC from running when not required and thus prevent draining of the vehicle batteries. When enabled this attribute will apply a "key" symbol to the lower right side of the signal.

5.8.2 Attributes of Output Signals



Output Signal Attributes

- **Remove Rung:** The remove-rung selection will erase the complete rung from the ladder.
- **Negate**: Applies a logical inversion to output signal. This attribute may be applied to any signal type.

- **Set:** The Set function allows the Diamond Logic® Builder software user to save or latch a logical condition. This is valuable when it is desired to save a transitional event from a momentary switch. The set function may be used in a variety of modes as follows:
    - **Set ON:** Turns ON an output
    - **Set OFF:** Turns OFF an output
    - **Set 1:** Turns ON an output
    - **Set 0:** Turns OFF an output
    - **Set (any numerical value):** Sets an internal variable to a desired value
    - **Set A+1:** Increments the variable "A" by 1 (Other math expressions are valid, i.e. -, *, /)

When the set attribute is applied to an output, the letters "Set" will be located on the left side of the output signal. In addition the word ON will be located below the signal. The user can modify the set function by double clicking on the word ON. The word will be highlighted and a new value may be typed in. Hitting enter saves the entry. The set function may be applied to advanced features like load managers or load sequencers to force the counter variables to specific values.

- **Start:** The start attribute starts a timer. The timer with the start attribute applied will display a green clock on the left side of the timer signal with two hands showing a filled time segment between the 12 and 3 o'clock positions. See the timer section of this document for a full description of how to use timers.
- **Stop:** The stop attribute stops a timer. The timer with the stop attribute applied will display a red stop sign on the left side of the timer signal with two hands pointing to the 1 o'clock position. See the timer section of this document for a full description of how to use timers.
- **Send:** The send attribute is used with signals that have limited access. These signals are identified with a small flag icon. See the Signals with Limited Access section of this document for a full description of this signal type.
- **Load:** The load attribute is used with load managers. See the Load Manager section of this document for a full description of how to use load managers.
- **Shed:** The shed attribute is used with load managers. See the Load Manager section of this document for a full description of how to use load managers.
- **Flash:** The flash attribute is used with flashers. See the Flasher section of this document for a full description of how to create flashers.
- **Sequence:** The sequence attribute is used with load sequencers. See the Load Sequencing section of this document for a full description of how to use load sequencers.

5.9 Keeping track of switch and pin usage

The Diamond Logic® Builder program allows the advanced logic user to create custom logic. However, the Diamond Logic® electrical system also contains pre-engineered features that utilize many of the same components and signal pins that are accessible using advanced logic. When creating advance logic using Diamond Logic® Builder **it is essential** to keep track of inputs and outputs used by pre-engineered features and not map signals to those same pins.

5.9.1 Preventing Pin Usage Conflicts with Pre-engineered Features.

The Diamond Logic® Builder program makes every attempt to warn the advanced logic user when a signal or pin has a conflict in usage. The Diamond Logic® Builder software user should perform the following steps to prevent undesired system performance or compile errors.

- The Diamond Logic® Builder software user should first choose and install all desired pre-engineered features to speed up the body to chassis integration process. The pre-engineered features have been thoroughly developed and tested to provide error free operation.
- Select the connector view of the template and print it out.
- Make note of the ESC, air solenoid and remote power module inputs and outputs that have been used by pre-engineered features.
- Select the center panel view and print it out.
- Note which switches and gauge cluster warning lights have been used by pre-engineered features.
- Refer to these printouts before you begin using signals in the advanced logic view. Do not try to map the Diamond Logic® Builder software signal to pins that have already been used by pre-engineered features.

5.9.2 Default Pin Mapping

The Diamond Logic® Builder program provides a means to allow the user to reset pin assignments using the priority rules that are used by the data processing systems at International. This capability is valuable when the user has added air solenoids and the total have exceeded the space available on the four-pack solenoid base. Since the seven-pack base is meant to be located in the same general spot on the frame rail, it **MAY** be desirable to remove the four-pack and install a seven-pack. In order to force all the air solenoids onto the seven-pack, the user should select the EDIT menu, followed by the USE DEFAULT menu item and then finally choose the PIN MAPPING selection. Now all the solenoids will be located on the seven-pack and the signals will be removed from the direct drive relay driver pins of the ESC configuration. Caution: this may undo previous customization.

This capability may be used to independently restore factory default selections for pin mapping, programmable parameters or switch and gauge locations. Realize that the Diamond Logic® Builder program assigns pin and switch locations in the next available spot as you install additional pre-engineered features. If you need all vehicles to have the same pin assignments without regard to the order that the features were added, it is important that you use the Default pin mapping feature on all of them. Conversely, if you have already wired your vehicles in a particular manner based upon a specific order for adding features, then be sure that you do not select the DEFAULT pin mapping feature. In this case, it would be best to make a template from the vehicle that matches the desired pin mapping and then apply it to all subsequent vehicles to ensure consistent pin assignments.

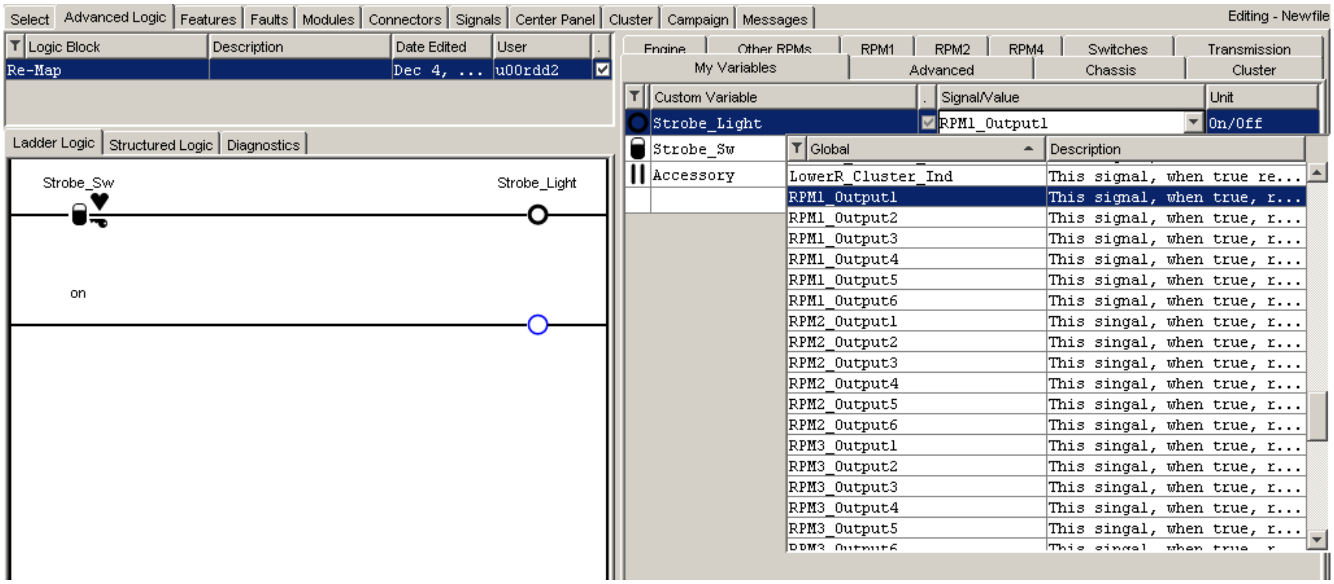
5.10 Remapping Signals to Physical Input and Output Pins

Most signals in the Diamond Logic® Builder program are mapped to specific physical output pins. Some exceptions to this rule are internal variables and special functions such as timers, flashers, load managers and load sequencers. For those signals that are mapped to physical output pins, it may be necessary to relocate a signal to another pin based upon your available module resources and option content on a specific vehicle. A physical output pin may only have one signal mapped to it.

5.10.1 Process for Remapping a Physical Pin

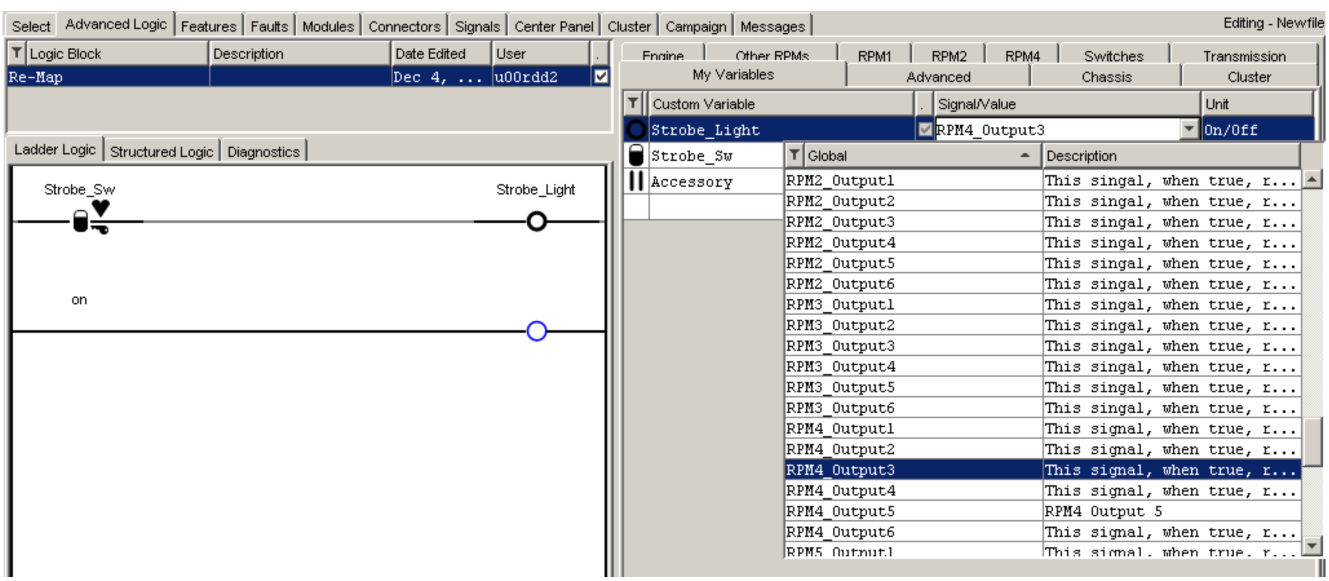
Select the Advanced Logic Tab and select a logic block that contains ladder logic. See that signals on the right half of the screen have a number of available columns that may be displayed. The physical pin that is associated with a signal is listed in the "Signal/Value" column. Not all signals will show a pin destination such as RPM1_Output1. Many signals are provided from other International designed pre-engineered features such as Park_Brake or Door_Switch. You should not try to re-map these signals. Doing so will cause unexpected logic operation. Let's review the process to re-map a signal. See the example below in which we will relocate a strobe light output from RPM1_Output1 to RPM4_Output3.

Locate the Strobe_Light signal in the signal list of the My Variables Tab.
Double click the left mouse switch while the cursor is placed over the Strobe Light signal in the Signal/Value column.

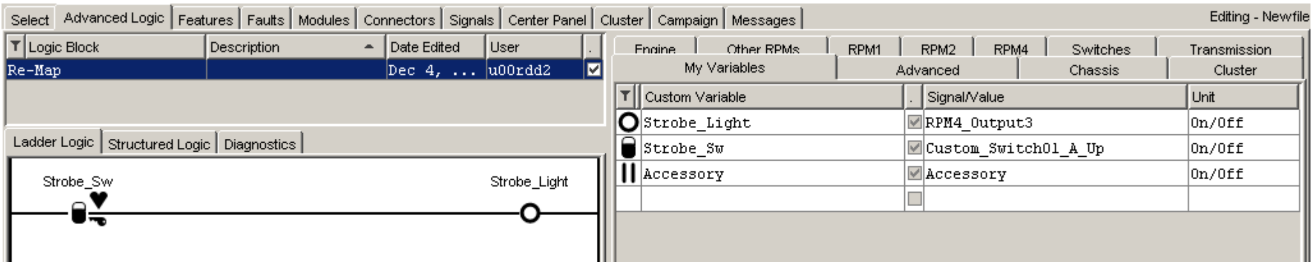


Note that a complete signal list will open and shows that the Strobe Light signal is currently mapped to RPM1_Output1.

Using the scrolling tab, locate the new desired output of RPM4_Output3.
Once the new destination pin is located, hit enter.

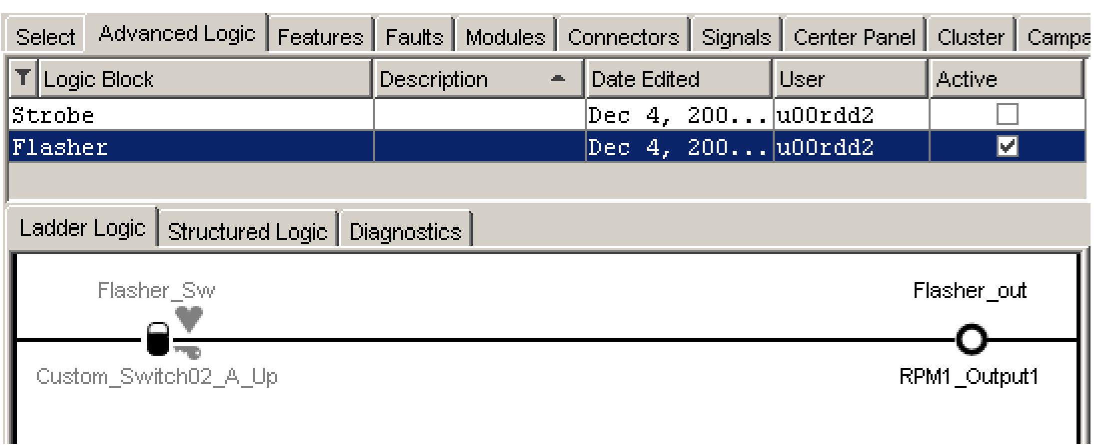


Now the signal shows that the Strobe Light has been re-mapped to RPM4_Output3.



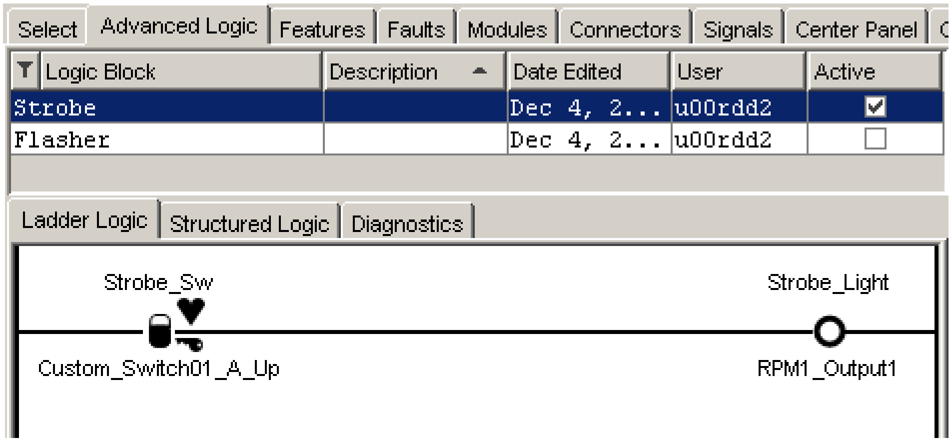
5.10.2 Remapping Outputs When Multiple Logic Blocks are enabled in a Configuration

Remote Power Modules, switch packs and air solenoids all have a finite number of physical input and output signals. It may be necessary to re-arrange signal inputs and outputs based upon pin availability for a vehicle configuration. As advanced logic blocks are designed, you may find that you have mapped signals from different features to the same physical pin on a remote power module or other device. The Diamond Logic® Builder program will not allow the configuration to compile with two features trying to use the same physical output pin. The net result is that if both logic blocks are enabled onto the vehicle, then either an error message will appear on the Message Tab or one of the logic blocks outputs will automatically be re-mapped as internal variables. This means these outputs will not be connected to any output pin or device. Therefore, it is essential that these outputs be re-mapped to available outputs. This condition may happen when you duplicate a logic block or copy advanced logic in the structured logic mode.
Let’s examine what happens when we try to enable two logic blocks that are mapped to RPM1_Output1. First we have two logic blocks loaded into a vehicle configuration but only the Flasher block is enabled. We can view the mapping of signals on the ladder by turning on the “ladder details” under the Advanced Logic pull down tool bar along the top of the screen.



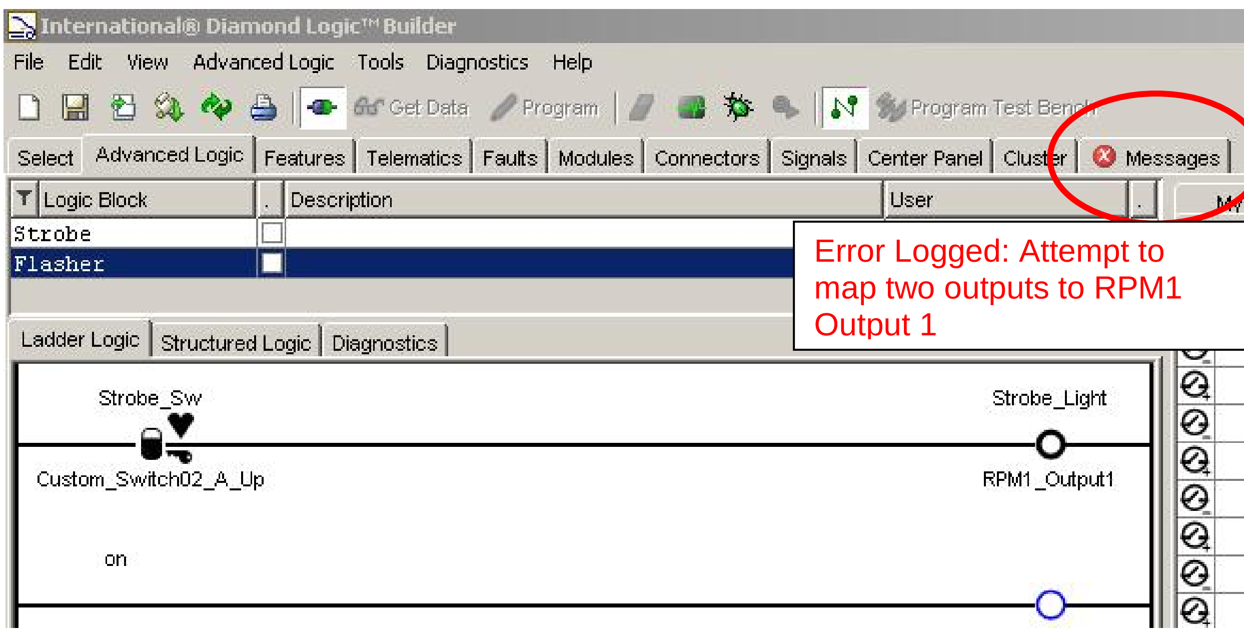
Flasher Feature

Next we see the strobe light is also mapped to RPM1_Output1.

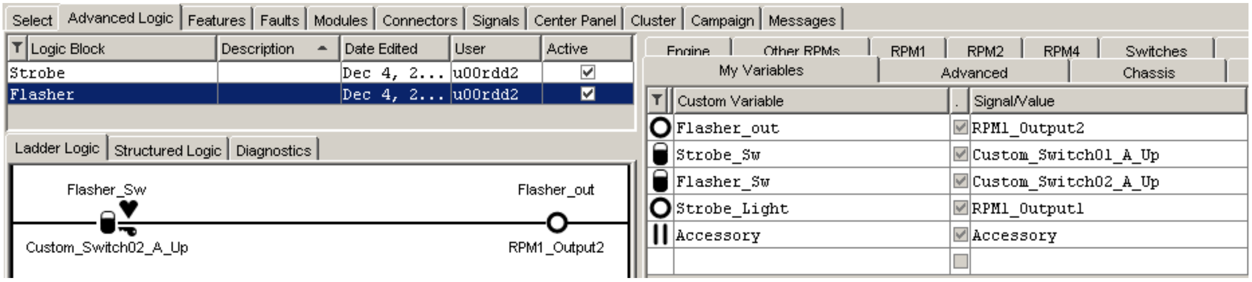


Strobe Light Feature

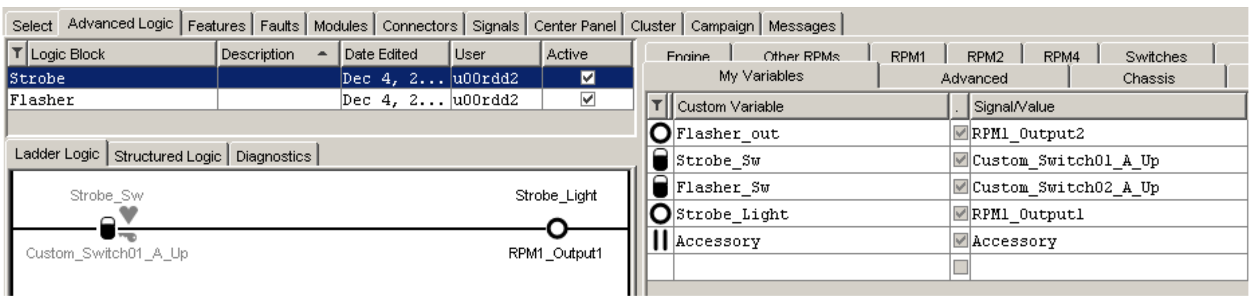
When both logic blocks are turned on we see that the last one to be enabled will lose its' mapping and cause a conflict message. Here the Flasher_Out appears to be the Strobe_Light output.



If we re-map one of Flasher to ***RPM1_Output2***, then both features will function on the same vehicle.

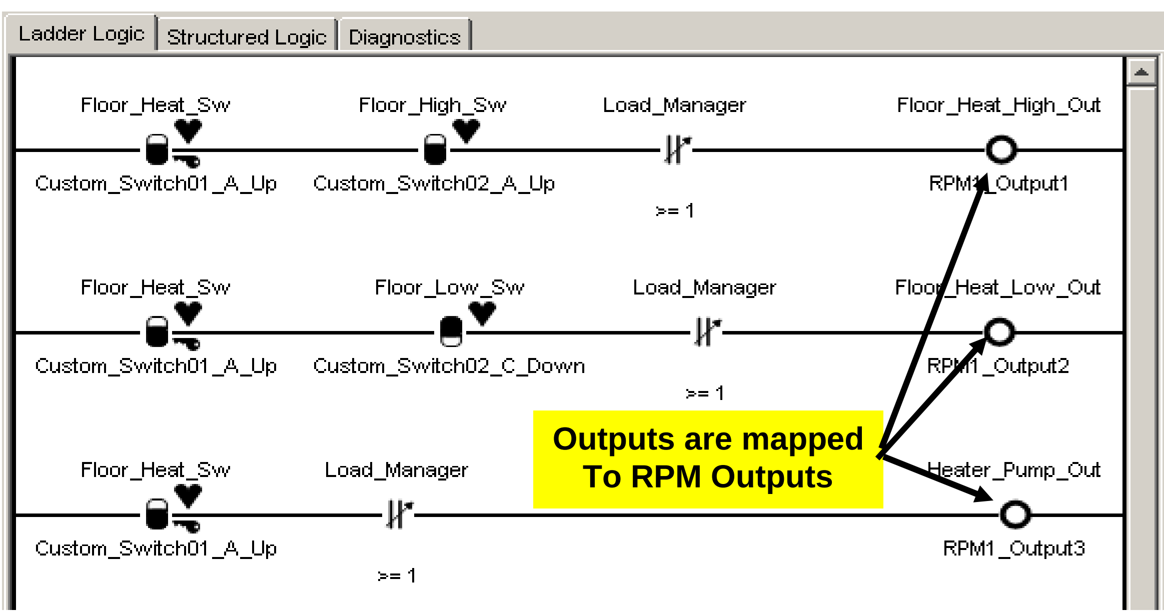


Flasher Feature Enabled

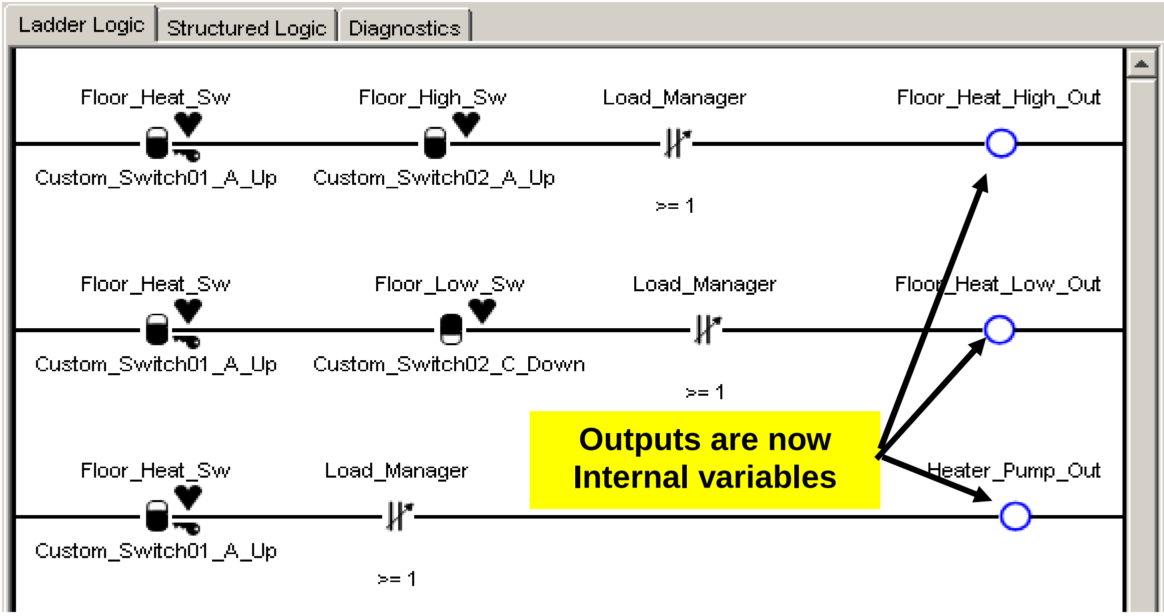


Strobe Light Feature Enabled

The following diagram shows a logic block BEFORE and AFTER it has been copied into a vehicle configuration that conflicts with another set of features.



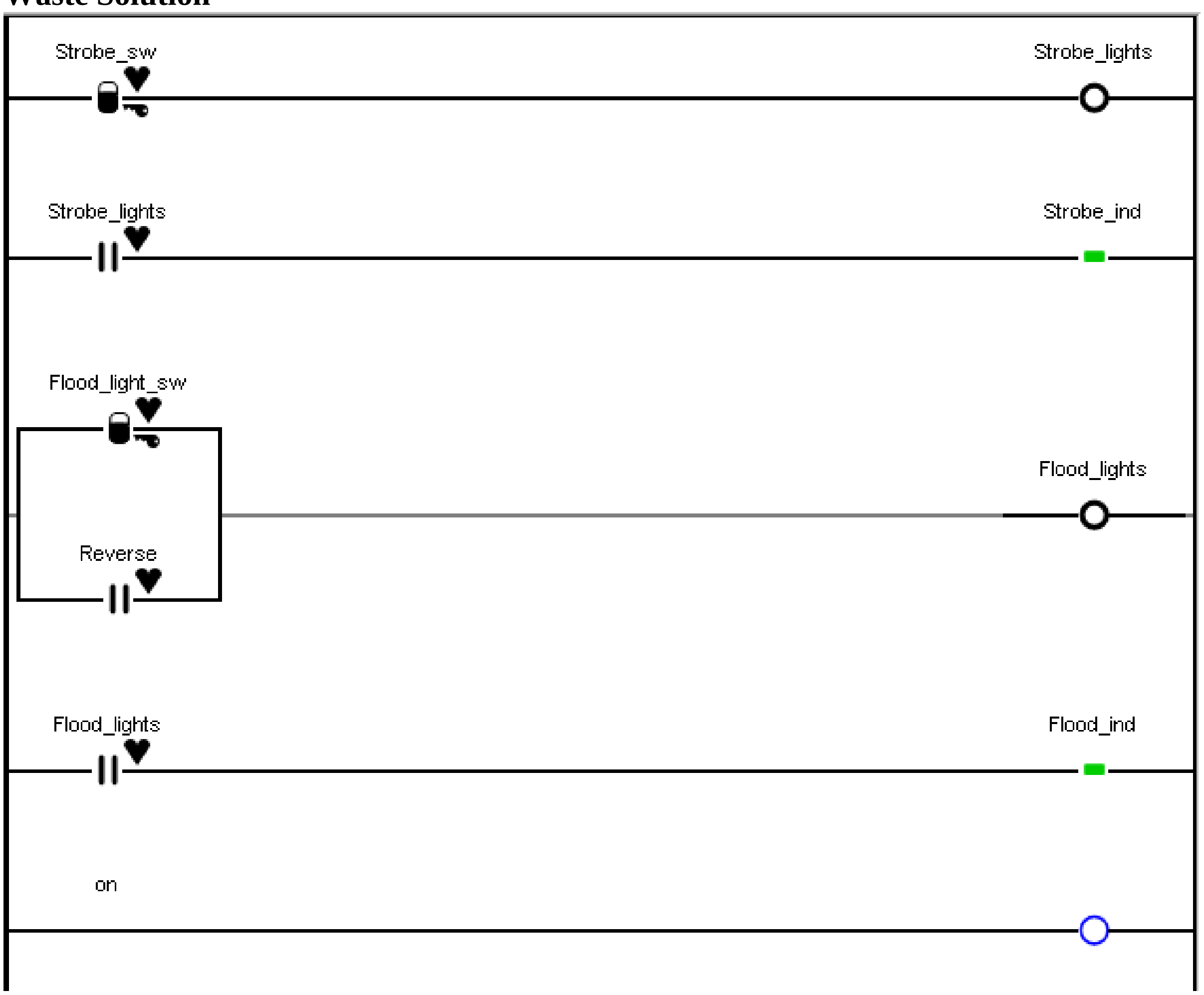
Floor Heater Feature <u>*Before*</u> Conflict With Other Features



Floor Heater Output signals *After* Conflict With Other Features

5.11 Simple Example of Ladder Logic

Waste Solution

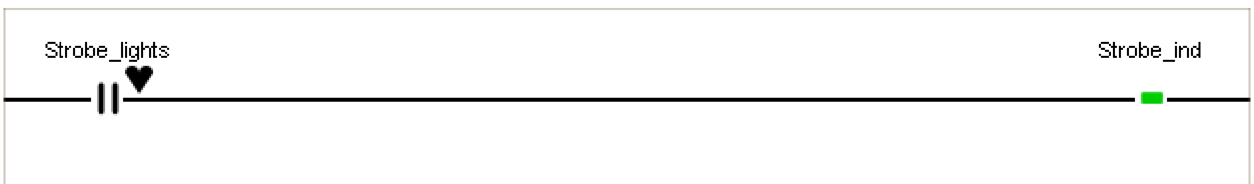


Sample Collection of ladder logic rungs for a Waste Collection Vehicle

Let's look at each of these rungs individually in the Waste Solution example.

The icon Strobe_sw signal input switch pushed up will be true as long as the key is in the accessory or ignition position and the status on the switch signal is good (off with error). If any of these elements are false the signal contact is like an open switch.

The icon Strobe_lights signal output is an RPM output. The output is ON only when the strobe light signal contact is ON.

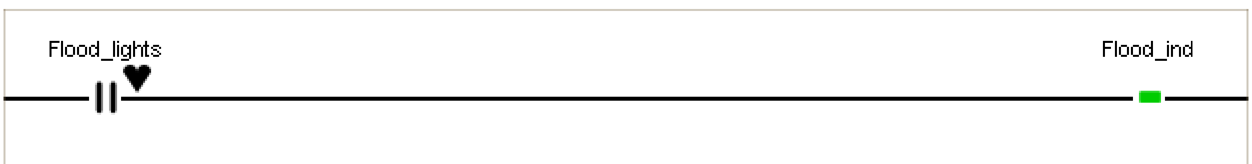


Here, the Strobe-lights output shown above has been used as an input. If Stobe_lights is ON……….

……..then the green indication of ON lamp in the strobe light switch will be illuminated.

The input side shows an "OR" condition. In this case when the Flood light switch is ON OR the transmission is in REVERSE, …………..

…….. then the Flood Lights will be ON.



When the Flood Light output is ON…………

……..then the green indication of ON lamp in the Flood light switch will be illuminated.

Section 6 Commonly Used Functionality (Information, Programming)

6.1 Programming with various Rocker Switch types, momentary, latched, etc.)

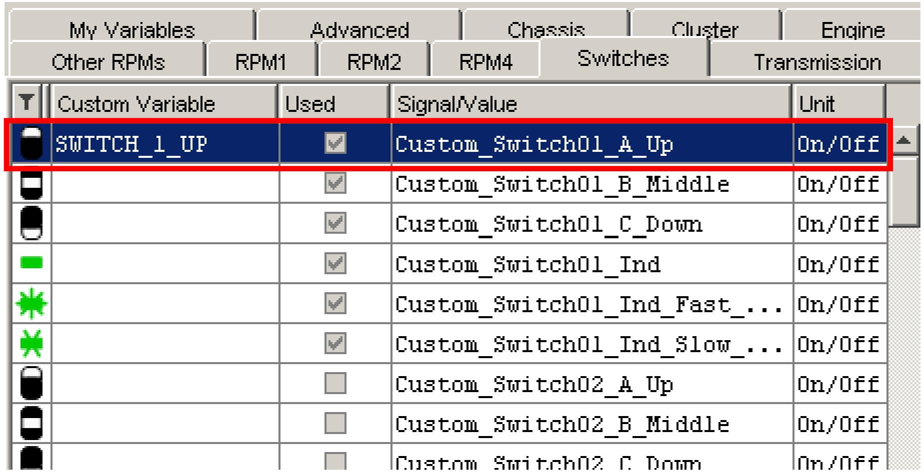
The Diamond Logic® electrical system has two types of in-cab switch configurations, 2-position latched switches and 3-position momentary switches. Both of these switches can be used to control body equipment.

6.1.1 Two-position Latched Switches

This switch is the most commonly used version. A latched switch is latched on or latched off. This functionality is required when it is critical for the system to maintain the last state of the switch in the event of a power loss. For example, when using Remote Start/Stop, a latched switch for the PTO is critical to use so that the last position of the switch is remembered after cranking of the engine. The ESC may go through a system reset during engine cranking and all signals are initialized to OFF during this event. In addition, the ON/OFF state of these switches is visible to the vehicle operator. A 2-position latched switch is recommended for the majority of switching requirements. See the 3-position switch section below for exceptions to this rule.

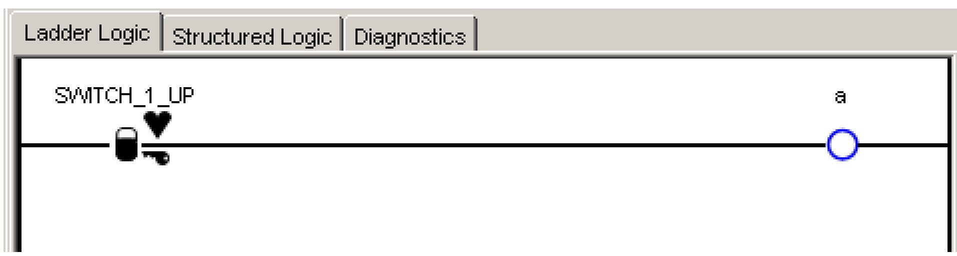
6.1.1.1 Using a 2-Position Latched Switch in Advanced Logic

Select the up position of next available switch icon. Note: For a 2-position latched switch, only the up and down switch icons are applicable, since the switch will never be in the middle position.
The Switch signal can be renamed in the Custom Variable field. It is recommended that the custom variable contain “SW,” “SWITCH,” or some other indication that this is a Switch at the end or beginning of the custom variable. For Example: Double click in the Custom Variable field. Type the name and hit enter. This switch was renamed “SWITCH_1_UP.” Note: No spaces can be used in the custom variable; however, an underscore (“_”) or a dash (“-“) may be used. If no custom name is added, then the Signal name will be copied to the Custom Variable field. It is desirable to keep the names short so the switch labeling in the CENTER PANEL VIEW is more readable.



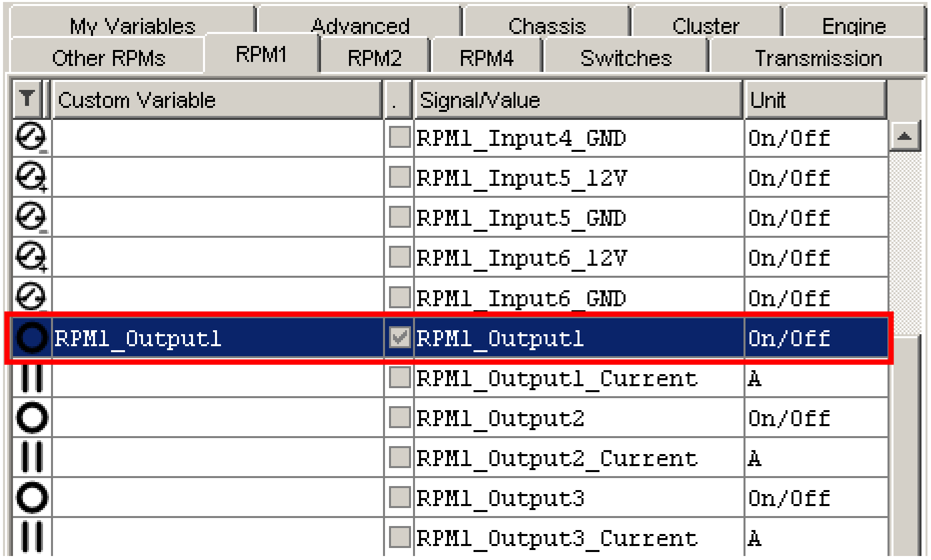
Selecting and Renaming a Switch Icon

Drag the switch up icon (SWITCH_1_UP) to the next available rung in the ladder logic field, as the input.



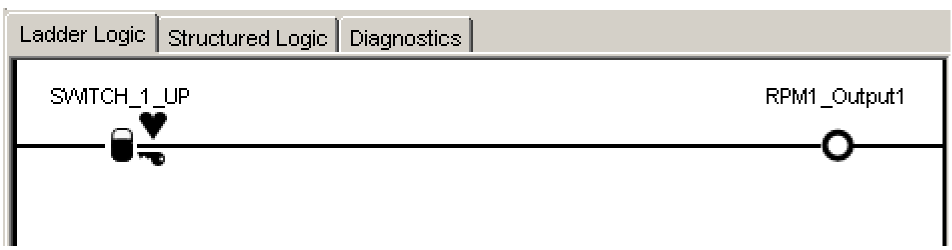
Adding a Switch to a New Rung in the Ladder Logic View

The switch will automatically include a heart that will open the circuit (signal) if the switch status goes bad (See Status section.) In addition, the switch also will automatically include a key indicating that the switch is interlocked to ACCESSORY key position (see ACCESSORY interlock section.)
Next select an output in the signals tabs. The next available Remote Power Module output is the most common selection. Note: If the vehicle is equipped with any other Remote Power Module features that will not be removed, first select the connector tab to determine the next available Remote Power Module Output (See the Keeping Track of Pin and Switch Usage section in this document.)



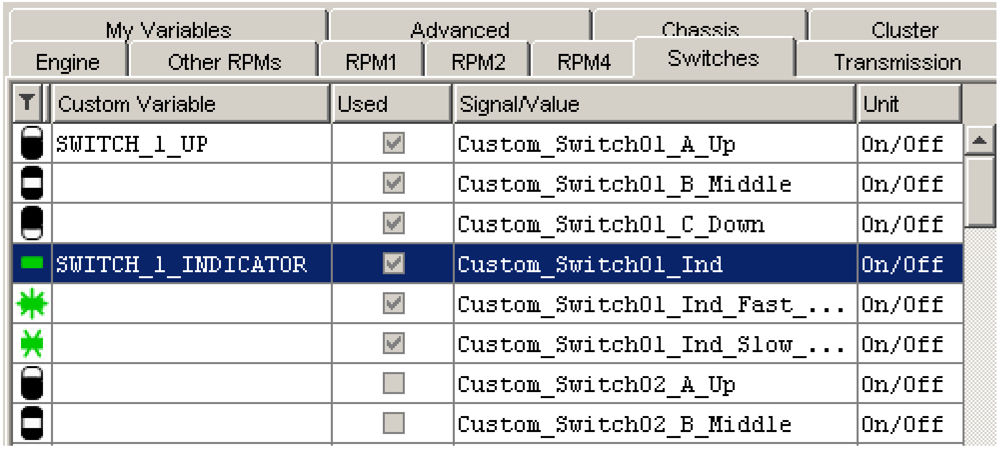
Selecting an Output

Next add the load (RPM1_Output1) to the output of the rung. In this example, when the switch is in the up position (True), Remote Power Module 1, Output 1 will be TRUE and turn on. When the switch is in the down position, the up switch icon will be FALSE and therefore, the Remote Power Module 1 output will turn off.



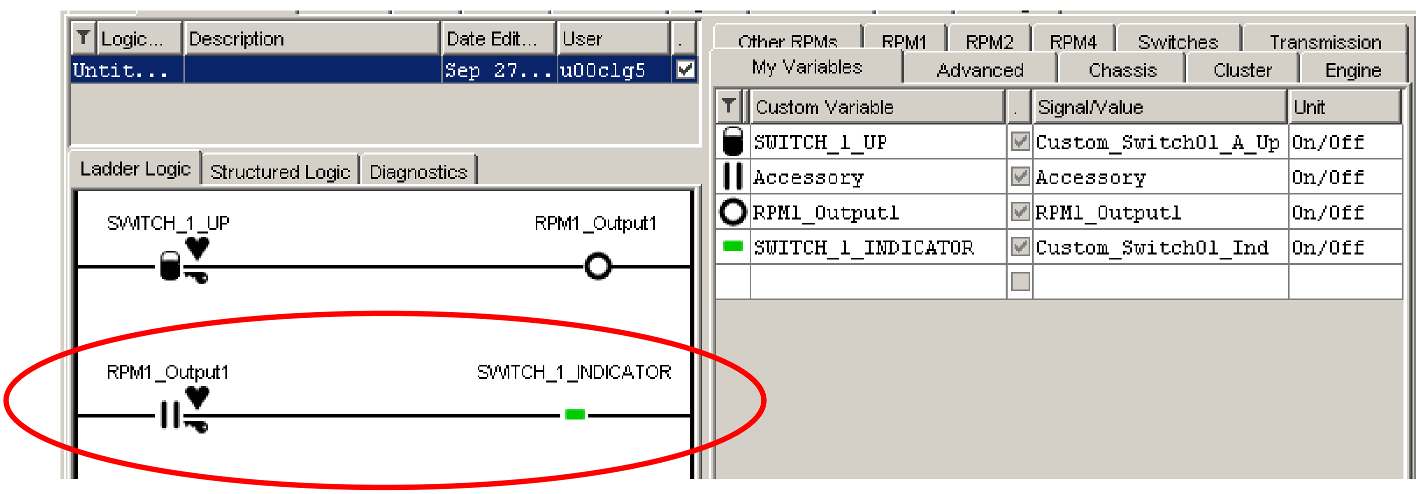
Adding an Output to the Ladder Logic View

An additional rung that turns the switch indicator on when the output is on should be added to demonstrate to the operator that this output is engaged. The Switch indicator light that is solid should be used to indicate that the output is ON. This signal can be renamed as a Custom Variable. It is recommended to include "IND" or some other identifier to the end of the Customer Variable.



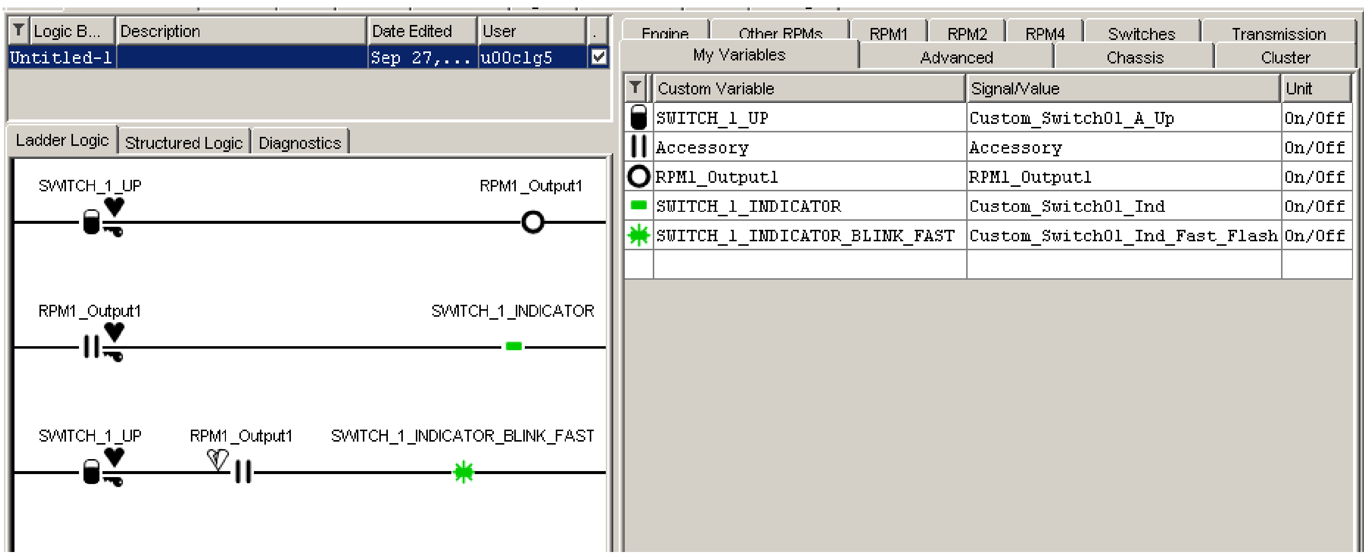
Selecting and Renaming the Switch Indicator Light

Drag the Switch Indicator to the output side of the next available rung. Since the light should be on when the output is on, RPM1_Output1 is used as the input. Select the table My Variables tab and drag RPM1_Output1 to the input of this rung. Note: When using an Output as an input, it is recommended that the accessory interlock be added to this output; therefore, right click on the RPM1_Output1 icon and select ACCESSORY (see Right click functions section). When the RPM1_Output1 is ON, then the SWITCH_1_INDICATOR will illuminate; however, if the ignition key is turned OFF or the status of either the switch or the RPM output goes bad, the output will not be ON and therefore the Indicator light will not illuminate.



Illuminating the Indicator Light in the Switch

Diagnostics: The indicator lights in the switches should be used for diagnostic purposes as well to alert the vehicle operator that a failure has occurred in a particular vehicle feature. If a signal that drives the output goes BAD, then the switch indicator light should blink fast (see Switch indicator light section for more information). Select and rename the Custom_Switch01_Ind_Blink_fast icon in the Switches tab. This icon was renamed “SWITCH_1_INDICATOR_BLINK_FAST”. Drag the Blink fast icon to the output of the next available rung. The indicator light should blink fast when the output should be ON (therefore the switch is rocked up), but the status of the Output has gone bad. Therefore the switch up icon should be ON AND the RPM1_Output1 should be used as an input that is checking for BAD status. To change the icon for RPM1_Output1 to checking the status of this signal, right click on this icon and select BAD STATUS. A broken heart will be added before the icon. This icon will now be TRUE only when the Status of RPM1_Output1 goes BAD (see the section on Status and right click options). It will not check whether RPM1_Output1 is ON/OFF, only whether this signal has BAD STATUS (TRUE) or GOOD STATUS (FALSE). The indicator light will blink fast if the switch is rocked up AND the status of RPM1_Output1 is BAD.

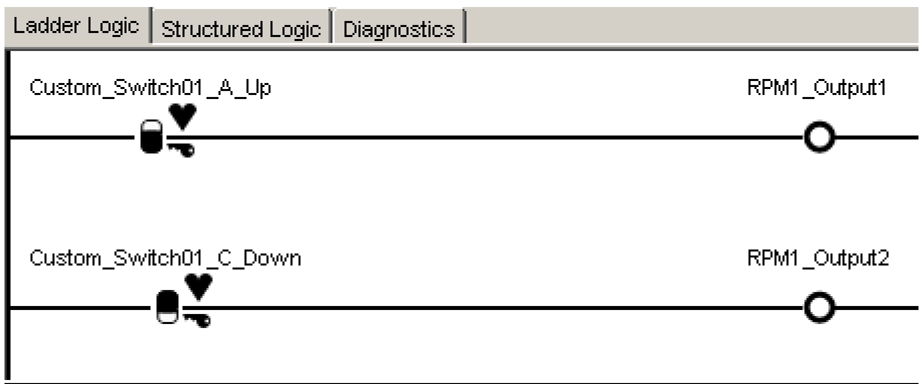


Diagnostics: Blinking the Indicator Light in the Switch Fast with Bad Status

Note: Add diagnostic text in the Diagnostics tab to describe this functionality.

6.1.2 Three-Position Momentary Switch (Using Both Up and Down)

With a 3-position momentary switch, the down switch icon can also be used to control two loads. For example: pushing the switch up could control RPM1_Output1, pushing the switch down could control RPM1_Output2. This action may be useful for a winch or other device that requires one switch to perform two actions (see ladder logic). When the switch is depressed to up position, Remote Power Module 1, Output 1 is TRUE. When the switch is depressed to the down position, Remote Power Module 1, Output 2 is TRUE. When the switch is not depressed, the switch will return to the center stable position and both outputs will be OFF. In this case, the switch indicator light in the top of the switch should not be used, since more than one output is controlled. A yellow backlit LED should be used to illuminate the switch identifier decal.



Single Momentary Switch Controlling Two Outputs

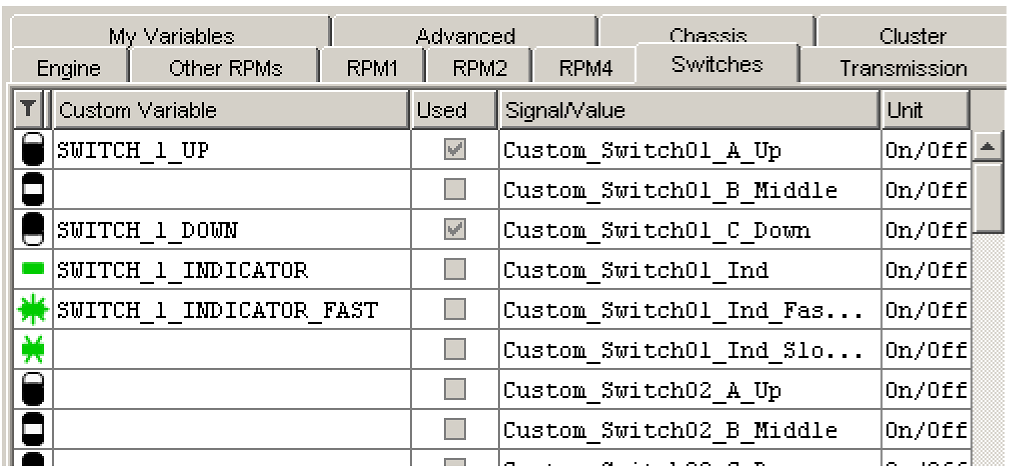
Diagnostics: Text should be added to the Diagnostic Tab to indicate what is turning these outputs on (see Diagnostic section for more information).

6.1.3 Three Position Latched Switches:

These switches are only available from International Service Parts. They should only be used when it is required to provide latched control of two or three different outputs from a single switch. A different custom signal may be assigned to the up, middle and down positions of the switch. The current switch state will be active once the ACCESSORY power has been turned ON and the ESC has completed a reset cycle.

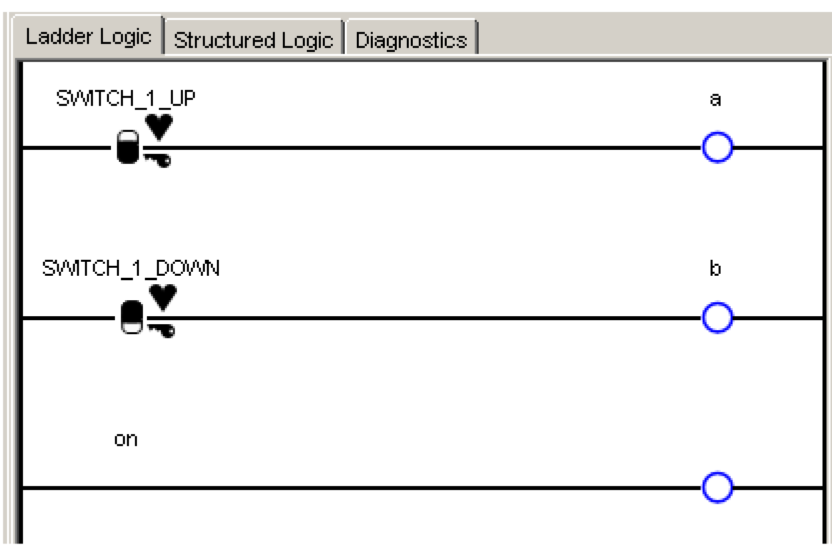
6.1.4 Three Position Momentary Switch Controlling a Single Output:

A three position momentary switch may be actuated up or down but returns to a center stable position. A three position momentary switch may be used to control a single output in a latching fashion, even though the physical switch does not remain latched up or down. In this case, the output is latched ON or OFF by the software (see the example below). The up switch icon will SET the output on. The down switch icon should SET the output off. The float or middle position of the switch does nothing. Select the next available switch and rename the Current Variable for both the UP icon and the DOWN icon. In addition, select and rename the indicator light icons for this switch.



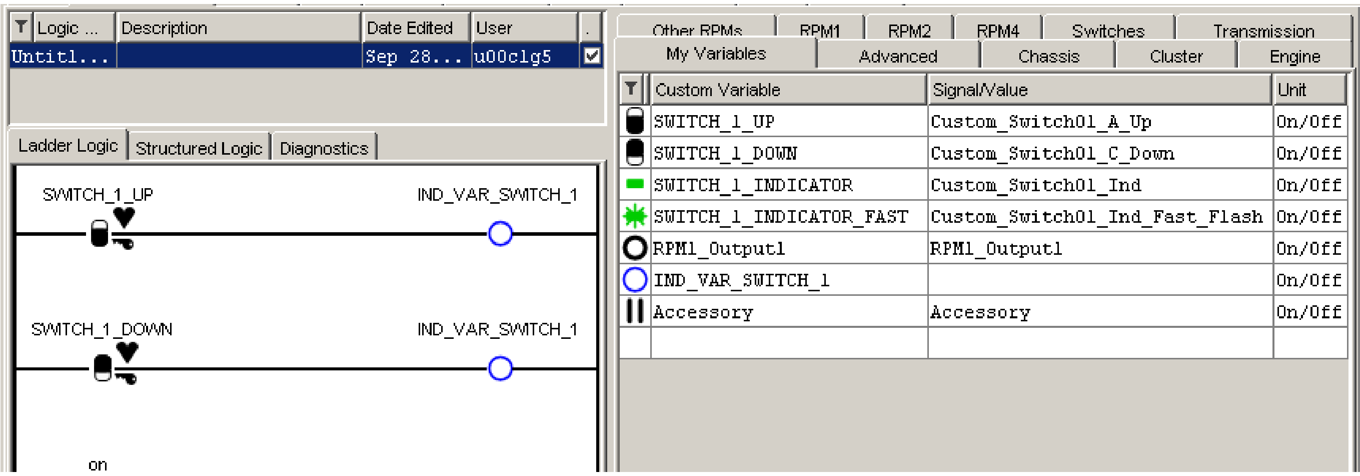
Selecting and Renaming a 3-Position Momentary Switch

Next drag the switch up icon to the next available rung in the ladder logic. Then drag the switch down icon to the next available rung. The output will automatically be generated as a blue INDEPENDENT VARIABLE.



Adding a 3-Position Momentary Switch to the Ladder Logic Rungs

Since more than one rung will be needed to control the load (one rung for turning it ON and one for turning it OFF), an Independent Variable is required. This is because only one rung can control a physical signal. For example: RPM1_Output1 can be the output of one and only one rung. When using a momentary switch with latching software (not a true momentary) more than one rung is required to control the output and therefore an independent variable is required (see Independent Variable Section for more information). The first rung should have the up switch icon on the left and the independent variable as the output on the right side of the ladder. The second rung should also have this Independent variable as the output. The automatically generated independent variable "a" should be renamed in the My Variables tab to the right to a more descriptive name. In this example, "a" was renamed as IND_VAR_SWITCH_1. After changing the name, the first rung should automatically update in the ladder logic.



Selecting and Renaming an Independent Variable

To latch the output ON or OFF with software (in lieu of a latched switch), the SET function is used. To set the Independent variable on, Right click the INDEPENDENT VARIABLE in the first rung that has the Up switch icon as the input and select the SET function. The default state is to SET ON. This is the appropriate state for this rung. The next rung, with the switch down icon as the input, should set the Independent variable OFF. Right click the variable in this rung and select SET again. For this rung, the set function should be changed to OFF. Double click on the word ON and type OFF. These two rungs will set the independent variable ON and OFF.

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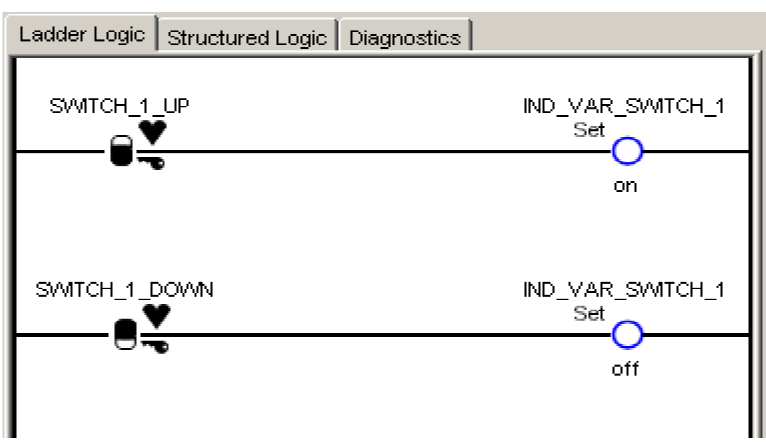
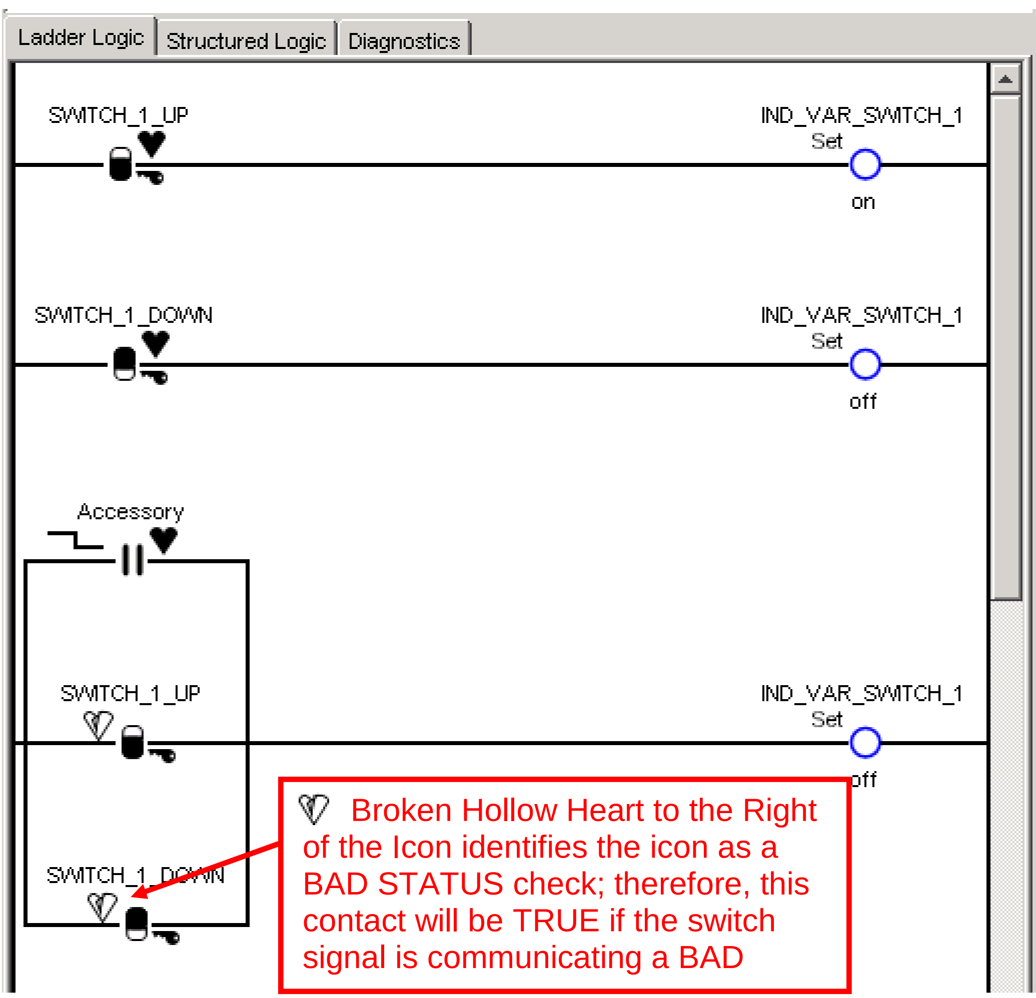


Setting the Independent Variable On and Off for a 3-position Momentary Switch

IMPORTANT: Always include a rung that Sets the Independent Variable OFF if the key is removed (ACCESSORY check) or one of the input signal's status goes bad. Since the independent variable is SET on (and latched on), the conditions need to be re-checked to ensure that they have not changed since the variable was SET ON. Drag the ACCESSORY icon to the next available rung. Then Right click the ACCESSORY icon and select NEGATIVE EDGE. This icon will now be TRUE when ACCESSORY is removed, i.e. turned OFF. When the key is removed or switched OFF, the Independent Variable will be set off. In addition, drag the switch up and down icons to this rung as OR conditions with ACCESSORY. To change these icons to check for BAD STATUS in lieu of the state of the switch, Right click each icon and select "BAD STATUS." This will add a Broken Hollow Heart to the left side of the icon. Now these switch icons will be checking for BAD STATUS; therefore if the status goes bad on either one of these switch signals, the contact will be TRUE and the Independent Variable will be SET OFF. Final step is to add the Independent Variable to the output. Right click this icon and select SET. Double-click the word "ON" and change to OFF. This rung will now check to see if ACCESSORY was removed or one of the inputs is communicating BAD STATUS; and set the independent variable OFF.

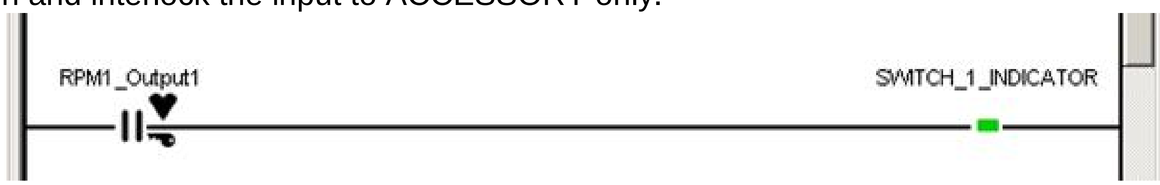


Setting the Independent Variable OFF if Accessory is removed or Switch Status is Bad

The final rung should control the actual output or load that this switch will control. The final rung should therefore turn the output ON if the Independent variable is ON, and OFF if the Independent variable is OFF. The input should be the Independent variable and the output should be RPM1_Output1.

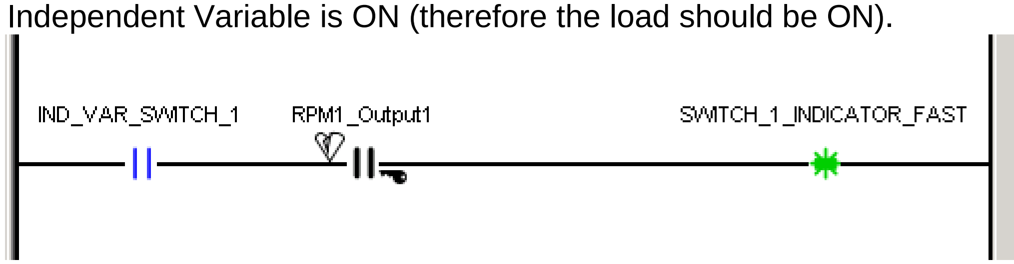
Turning ON the RPM1_Output1 when the Independent Variable is ON

Since the temporary movement of the switch sets the output ON, the output will reset OFF during power loss or engine re-start.
The switch indicator light should be ON when the RPM1_Output1 is ON. Add a rung with RPM1_Output1 as the Input and the Switch Indicator light as the output. Right click on the RPM1_Output1 icon and select ACCESSORY. This will add a key to this icon and interlock the input to ACCESSORY only.



Controlling the Indicator Light for a 3-Position Momentary Switch

Diagnostics should be added for the indicator light in the switch. Blink fast if a Bad status occurs on one or more of the signals. To create the Blink fast rung, add the Independent Variable as the input to the next available rung; therefore, the switch will only blink fast when the output should be ON. All icons that could cause the output to be OFF if the status goes bad, should be additional inputs that are an AND condition to the Independent Variable, but an OR condition to each other. In this example, the icons that could communicate a BAD STATUS is SWITCH_1_UP, SWITCH_1_DOWN or RPM1_Output1; however, if the switches are communicating a BAD STATUS, then the indicator light will also be communicating a bad status. Therefore the only icon included in this line is the RPM1_Output1 status check. To change the icon to check for bad status in lieu of the state of the switch or output, right click on these icons and select BAD STATUS (a broken heart will be added in front of the icons). Finally add the Blink fast switch icon as the output. For example: when the Independent Variable is ON, but the status of the output is BAD, then blink the indicator light fast. This rung will blink the switch indicator light fast if the RPM1_Output1 signal is communicating a bad status and the Independent Variable is ON (therefore the load should be ON).



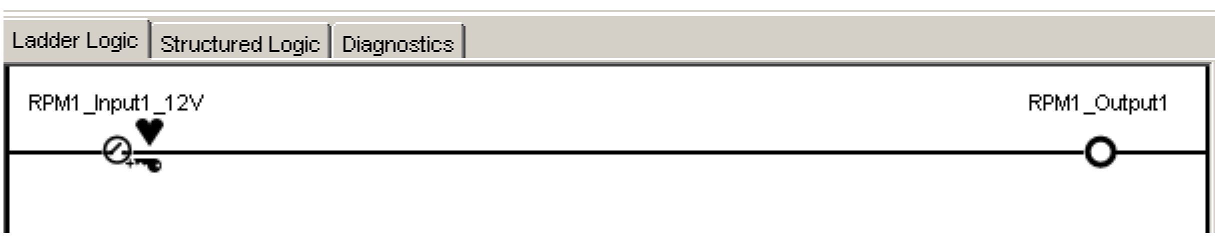
Diagnostics for the Switch Indicator Light with a 3-Position Momentary Switch

Note: Add text in the diagnostic tab regarding this functionality.

6.2 Using Remote Power Module Switch Inputs

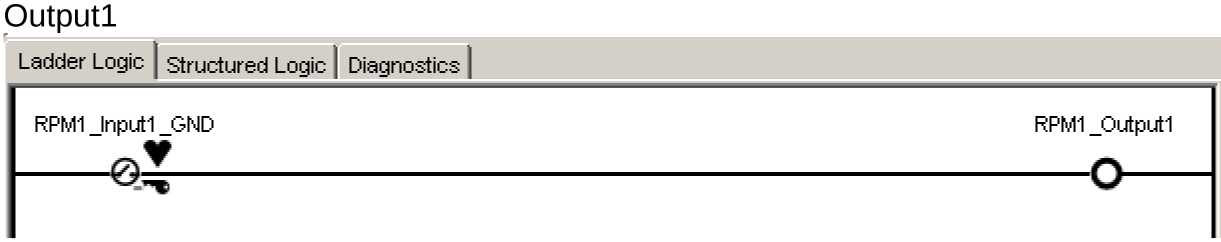
Remote Power Module inputs are the gateway into the Diamond Logic® electrical system. These inputs can be used for proximity switches, pressure switches, remote switches, etc. To use a Remote Power Module input to drive a load, the icon for Remote Power Module input 12V or Ground must be selected and added to a rung. Next the load that this input will drive should be added to the output of this rung, for example Remote Power Module1 output1. The Remote Power Module input 12V icon and the Remote Power Module input Ground icons default to accessory interlocked (key) and OFF with error (heart); therefore the input will be OFF with error and will only look for a signal when the key is in the accessory or ignition position. Note: When renaming a Remote Power Module Input in the Custom Variable column, the new name should include whether the switch is 12V or Ground. For example: Switch1_12V or Switch1_Gnd.

To drive an output using a Remote Power Module Input, drag the next available Remote Power Module input to left side of the next available rung as the Input. Add a Remote Power Module output to the output side of the rung. In this example: RPM1_Input1_12V is the input and RPM1_Output1 is the output. When the body switch is hooked up to RPM1_Input1 is 12V, then RPM1_Output1 will be ON. If the input is Ground or Floating, then the RPM1_Output1 will be OFF.



Remote Power Module Input (12V) Driving a Remote Power Module Output

Modified Example: Ground Remote Power Module input1 drives Remote power Module Output1



Remote Power Module Input (Ground) Driving a Remote Power Module Output

6.2.1 3-way Switching with In-cab Switches and Remote Mounted Switches

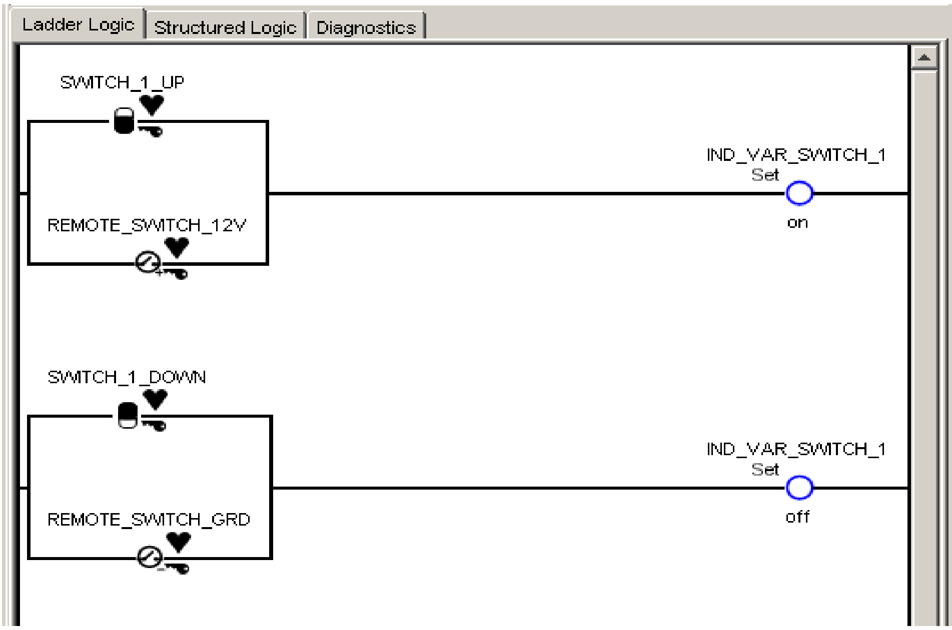
3-way Switching refers to a remote mounted switch on the body and an In-cab Switch to control a load. In addition, the type and operation of the remote mounted switch needs to be considered when selecting a solution for 3-way switching.
Options covered in this section:

- Momentary Switch in cab and Momentary Switch on Body (no Priority)
- Switch in cab has priority over switch on body
- Body or Chassis Signal switch is <u>latched</u> and In-Cab Switch is <u>momentary</u>

The additional switch could be a body mounted switch or a chassis signal (like vehicle in Reverse or PTO engaged). This type of switch control is slightly more difficult to program in Advanced Logic.

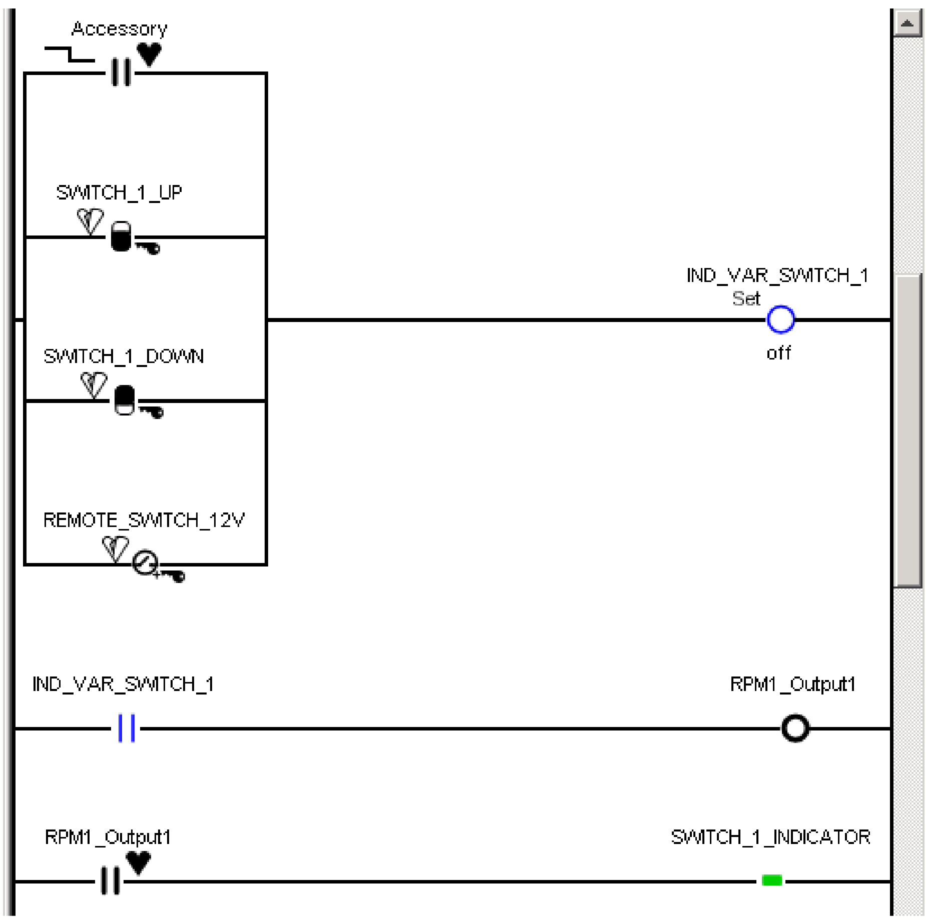
6.2.2 Momentary Switch in cab and Momentary Switch on Body (no Priority)

This configuration is a true OR configuration; therefore, both switches can turn the output ON, and both switches can turn the output OFF. Since both switches are momentary center stable, neither will have a memory and therefore, no priority over the other switch.
The Independent Variable can be set ON by either the momentary 3-position switch being pushed up or the Remote Power Module Input1 receiving an input of 12V (this could also be a 3-position momentary switch where up=12V, Center-Float, down-Ground). The Independent Variable can be set to OFF by either the in-cab switch being pushed down or the Remote power Module Input1 receiving a Ground signal. An additional rung checking the NEGATIVE EDGE of Accessory will also set the Independent Variable OFF. This ensures that Accessory was not removed after the variable was set ON and should be included in all ladder logic that uses the SET function.
The Independent Variable then drives the Remote Power Module Output (RPM1_Output1) ON. In addition, RPM1_Output1 turns on the Indicator light in the switch.



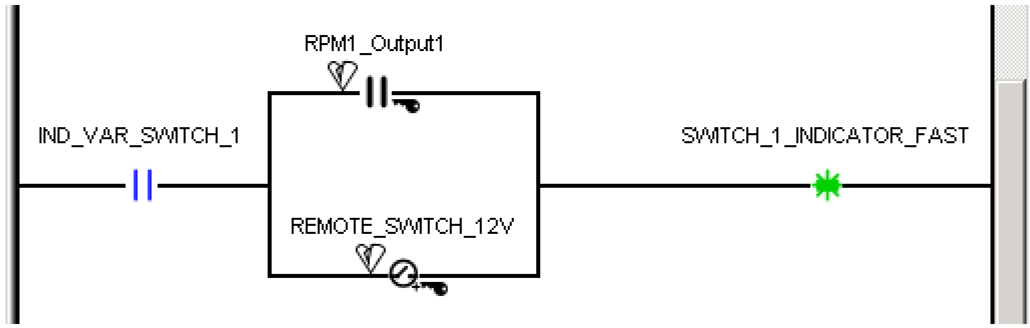
3-Way Switching W/ Momentary In-Cab & Momentary Remote Mounted Switch

Notice the convention of doing the ON setting before the OFF setting. It will turn OFF when one is held ON and the other is held OFF.



3-Way Switching W/ Momentary In-Cab & Momentary Remote Mounted Switch

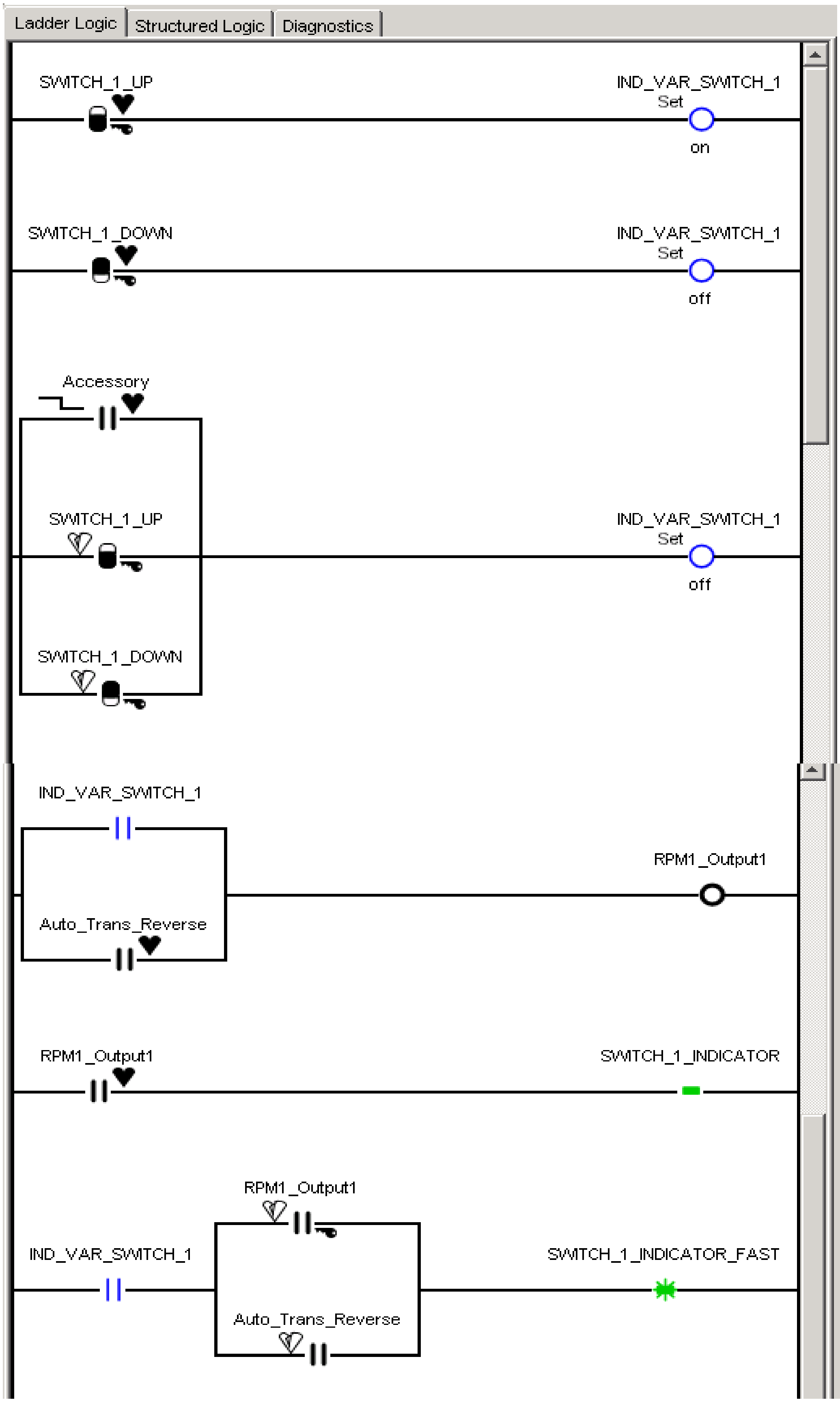
The indicator light in the switch should blink fast if the Independent Variable is SET ON, but one or more of the statuses on any of the inputs/outputs have gone BAD. To change an icon from signal state, to status state of signal, right click the icon and select BAD STATUS. This will add a broken heart to the icon. Now this icon will be TRUE if the status of the signal is BAD and FALSE if the status of the icon is TRUE.



3-Way Switching W/ Momentary In-Cab & Remote Mounted Switches - Status Check

6.2.3 Momentary Switch in cab and a Chassis Signal (Latched)

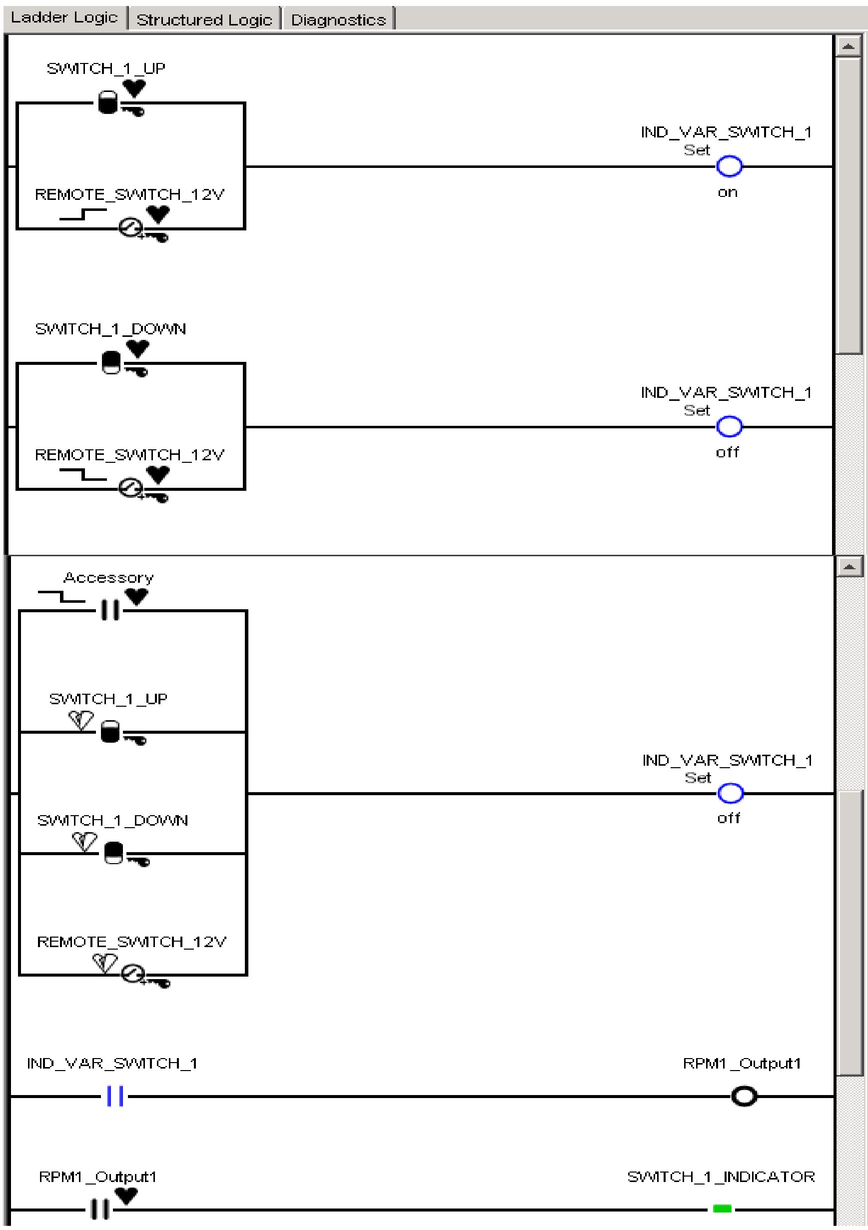
Another version of 3-way Switching is using a Chassis Signal as the alternate switching device. In this example, the chassis signal is a latched ON or latched OFF; therefore, it needs to be in the final rung that drives the Output ON. Therefore, the first three rungs set the Independent Variable ON or OFF using the in-cab switch. The fourth rung will turn ON the Remote Power Module Output (RPM1_Output1) if either the Switch was rocked up with the key in the Accessory or Ignition position OR if the Chassis signal is TRUE. In this case the Output will be ON if the Transmission is in REVERSE OR if the Switch is rocked up. The indicator light in the switch should indicate that the output is ON. Note: The switch will not be able to turn the output OFF if the chassis signal is still TRUE.



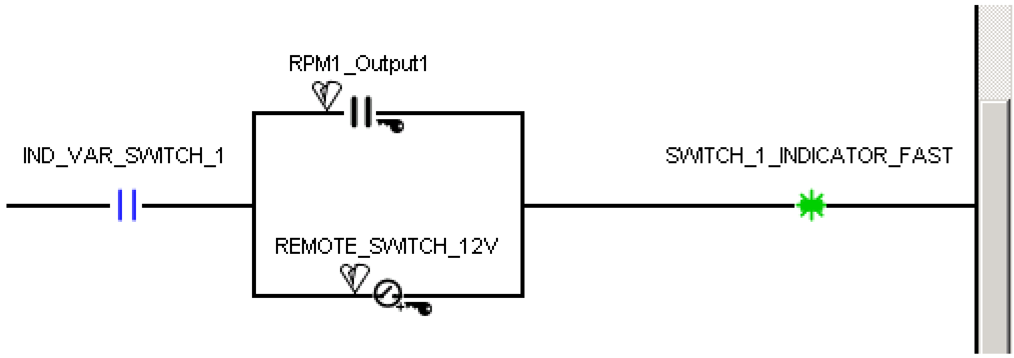
3-Way Switching Using an In-Cab Switch and a Chassis Signal

6.2.4 Momentary Switch in cab and a Latched Switch on the Body (In-cab Switch has Priority)

Another type of 3-Way switching is one where the In-Cab Switch has priority over the remote mounted switch. This functionality is useful if the driver desires the cab switch to provide an override function to a latched remote mounted switch. Therefore, if the remote mounted switch is left ON, the In-Cab Switch will override the remote switch to control the output. To turn the output ON again with the remote mounted switch, the switch must be cycled OFF and then back ON again.



3-Way Switching w/ Momentary In-cab Switch & Remote Mounted Latched Switch *(In-Cab Switch has Priority over the Remote Mounted Switch)*



3-Way Switching w/ Momentary In-cab Switch & Remote Mounted Latched Switch -Status Check

6.3 Illuminating the Indicator light in Rocker Switches

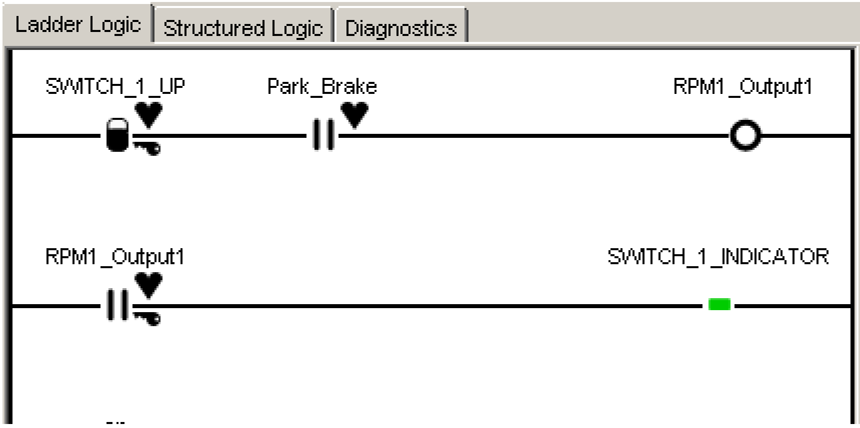
The Indicator lights in the Switches should be used to provide a visual indication that a specific action has occurred. The indicator light should be solid ON when the output is actually engaged. In addition, the indicator light should blink slowly if the output should be engaged, but an interlock is not TRUE. The indicator light should blink fast if the output should be engaged, but a BAD STATUS has occurred on one or more of the inputs or the output.
Diagnostic text should be added to the Diagnostic tab to indicate what the switch indicator lights are displaying.

6.4 Interlocked switches

A switch can also have an interlock. An interlock is an additional requirement for the output to engage. For example, PTO engaged, Door open, Park Brake set, Vehicle Speed<3mph, etc are all interlocks.
Note that the fast flashing will override the constant ON regardless of which order the rungs are placed.

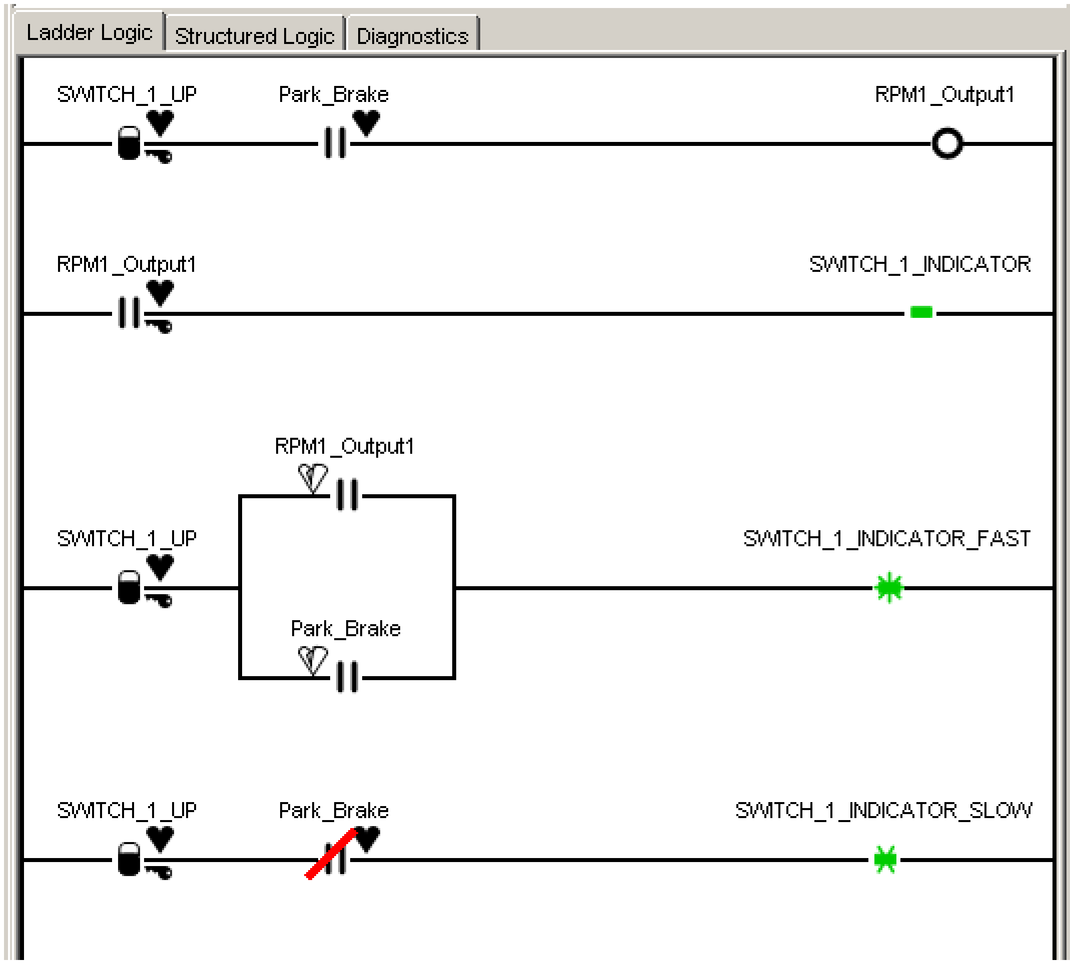
6.4.1 2-position latched switch with one interlock

To use an interlock with a latched switch, simply drag the signal icon for the required interlock to the middle of the rung that turns on the Output as an “AND” condition. The output will only engage (turn ON) when the switch is in the up position and the required signal interlock is TRUE. In the example below, the park brake must be set for the Remote Power Module 1 Output 1 to be ON even if the switch is rocked up. Add a Switch indicator light when the RPM1_Output1 is engaged and the key is in the ACCESSORY position (drag RPM1_Output1 to the next available rung, Right click this icon and select ACCESSORY, add the Switch indicator light to the output).



Interlocked 2-position Latched Switch

Diagnostics should be added for the indicator light in the switch. Blink fast if a Bad status occurs on one or more of the signals, and blink slowly if the interlock is not ON. To create the Blink fast rung, add the Switch up icon as the input. Add the other outputs and inputs to this rung as an AND condition to the switch, but an OR condition to each other. Change these icons to check for BAD STATUS, by right clicking the icons and selecting BAD STATUS (Note: This will add a <u>hollow broken heart</u> before the icon. Now these icons will check for status in lieu of the state of the signal). If the Switch is pushed up, but one or more of the other signals is communicating BAD STATUS, then the indicator light will blink fast. To create the blink slowly rung, the switch should be rocked up (TRUE), but the interlock is NOT TRUE (in this case the Park Brake is NOT set), the indicator in the switch should blink slow, indicating the output is not ON, even though the switch is rocked up. Drag the UP Switch Icon to the rung and add the interlock (Park Brake). Right click on the interlock (Park brake), and select NEGATE. Then add the Blink slow icon for the switch indicator.

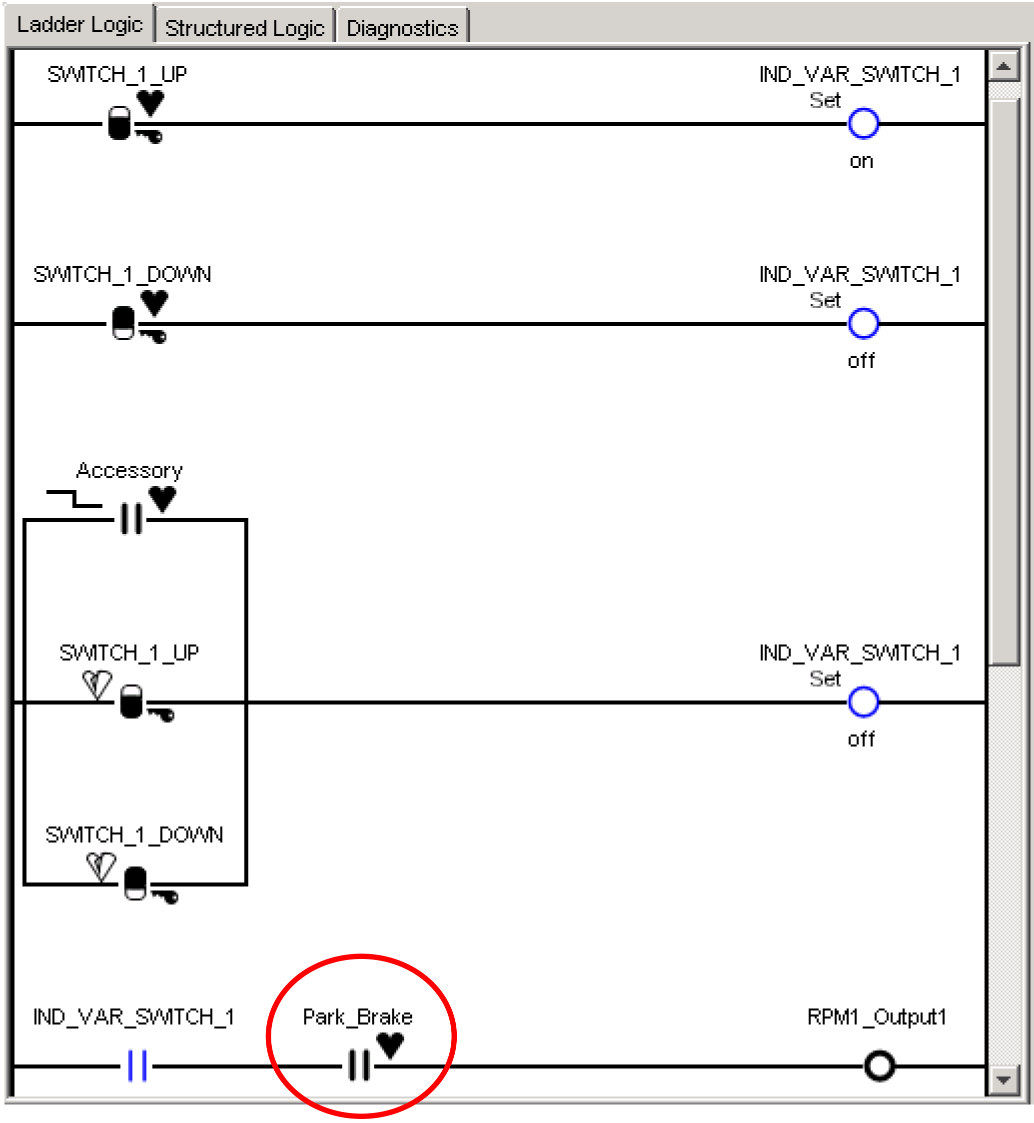


Interlocked 2-position Latched Switch with Diagnostics

Note: Diagnostic text should be added to the Diagnostic tab and include the interlock for the output. Example*:* *RPM1_Output1* - This output is ON when the Switch labeled (SWITCH_1_UP) is rocked up AND the Park Brake is set. If the park brake is not set, the output will be OFF and the indicator light in the switch will blink slowly. If this output signal is reporting BAD STATUS or if the Switch is reporting BAD STATUS, then the output will be OFF and the indicator light in the switch will blink fast.

6.4.2 Interlock Switch with a 3-position Momentary Switch (Re-Engaging Type)

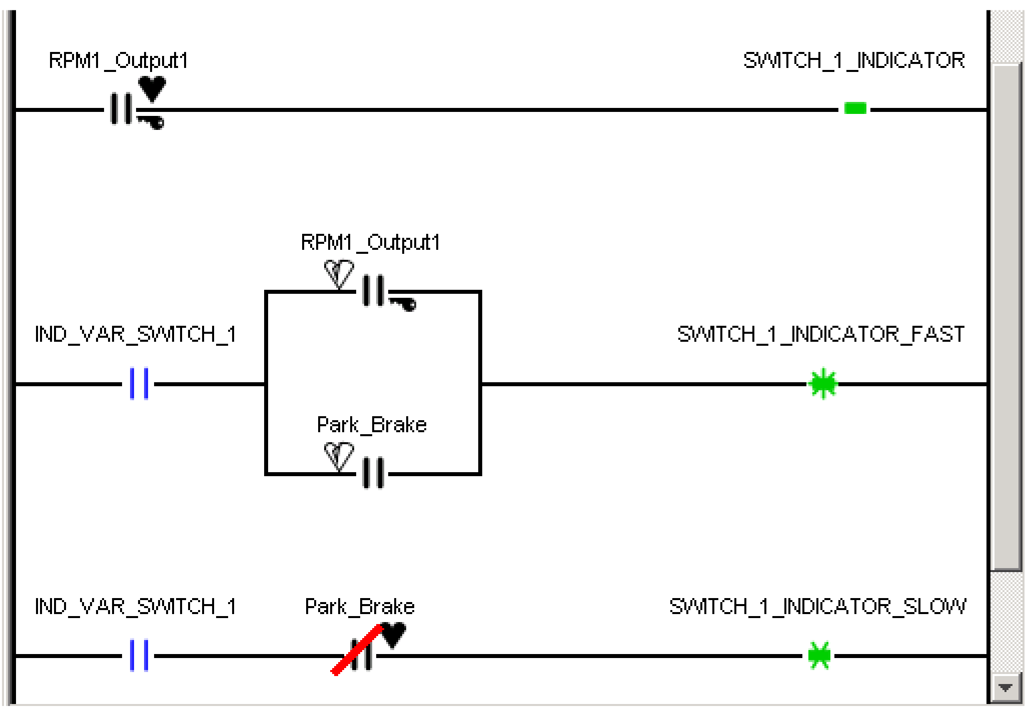
A 3-position Momentary switch can be interlocked to various chassis signals as well. If the output requires the interlock to engage and the user desires the output to re-engage when the interlock is TRUE even after it is removed, then the interlock should be added to the rung that controls the actual output. To add an interlock, drag the icon to the middle of the rung that has the RPM1_Output1 as the output. Even if the Independent Variable is SET ON, the output will still require the interlock to be TRUE before the output will be ON. If the interlock is FALSE (OFF), the output will not be ON. However, the output will re-engage or turn on again when the interlock is re-introduced; therefore the output will re-engage if the interlock is ON after being OFF.



Interlocked 3-Position Momentary Switch (Re-engaging Type)

The Switch Indicator light should be ON when the RPM1_Output1 is ON. Add RPM1_Output1 to the next available rung as an input. Add the solid Switch indicator light as the output. The indicator light in the switch will illuminate when the output is actually ON.

Diagnostics should be added for the indicator light in the switch. Blink fast if a Bad status occurs on one or more of the signals, and blink slowly if the interlock is not ON. To create the Blink fast rung, add the Independent Variable as the input to the next available rung. The icons that could cause the output to be OFF if the status goes bad, should be additional inputs that are an AND condition to the Independent Variable, but an OR condition to each other. In this example, the icons that could communicate a BAD STATUS are the switch icons Park Brake and RPM1_Output1 (however, if the switches communicate a BAD STATUS, so will the indicator lamp; therefore, this input is not checked). To change these icons to check for bad status in lieu of the state of the switch or output, right click on these icons and select BAD STATUS (a broken heart will be added in front of the icons). Finally add the Blink fast switch icon as the output. For example: When the Independent Variable is ON, but the status of the output is BAD, then blink the indicator light fast. This rung will blink the switch indicator light fast if the interlock, or RPM1_Output1 signal is communicating a bad status and the Independent Variable is ON (therefore the load should be ON). To create the blink slowly rung, the Independent Variable should be ON), but the interlock is NOT TRUE (in this case the Park Brake is NOT set), the indicator in the switch should blink slowly, indicating the output is not ON, even though the switch was rocked up setting the Independent Variable to ON. Drag the Independent variable to the rung. Add the interlock (Park Brake). Right click on the interlock (Park brake), and select NEGATE. Then add the Blink slowly icon for the switch indicator.

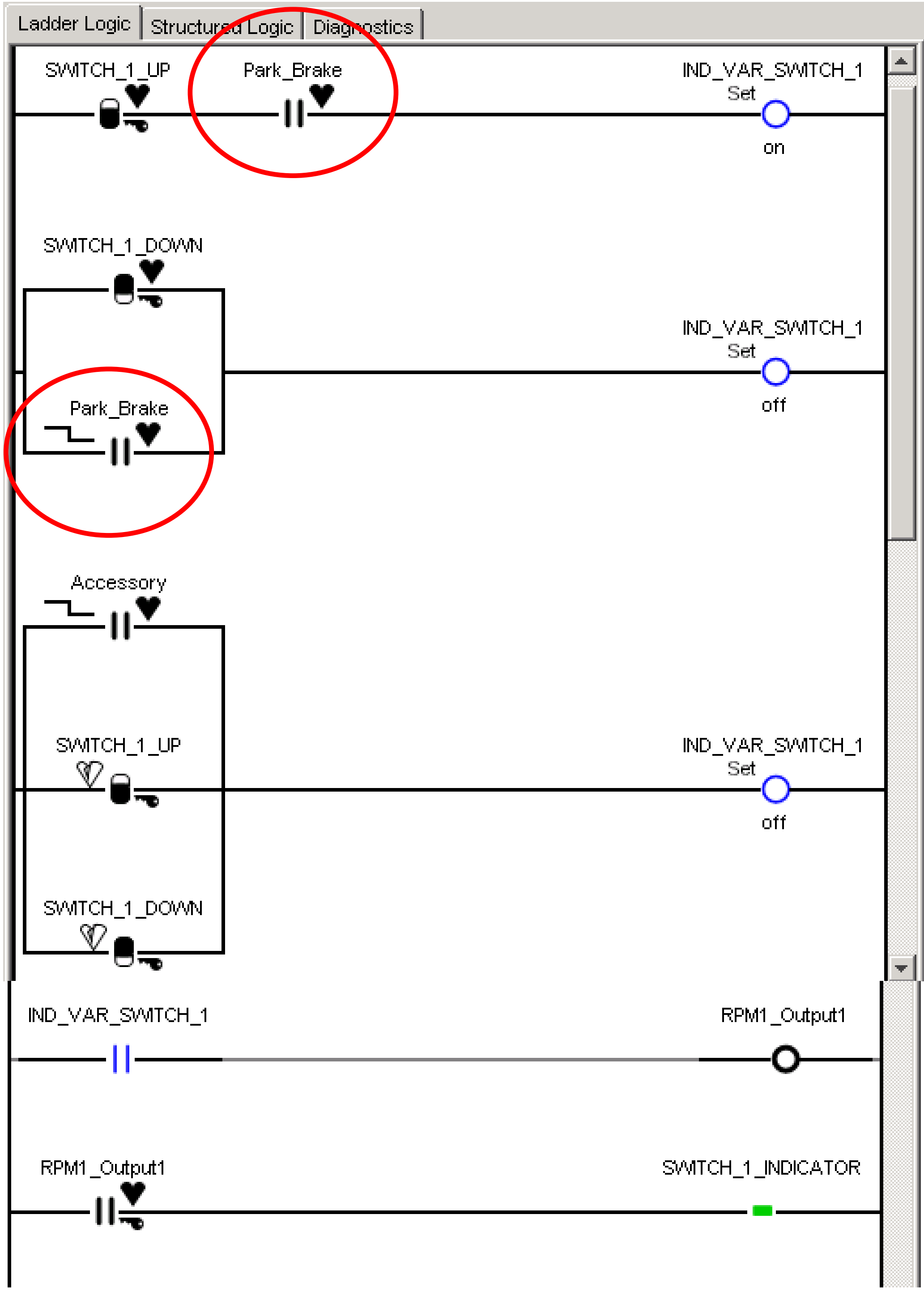


Interlocked 3-Position Momentary Switch Diagnostics

Note: Diagnostic text should be added to the Diagnostic tab and include the interlock for the output. Example: RPM1_Output1: This output is ON when the Switch labeled (SWITCH_1_Up) is rocked up AND the Park Brake is set. If the park brake is not set, the output will be OFF and the indicator light in the switch will blink slowly. If the park brake is re-set, then the output will re-engage. If this output signal is reporting BAD STATUS or if the Switch is reporting BAD STATUS, then the output will be OFF and the indicator light in the switch will blink fast.

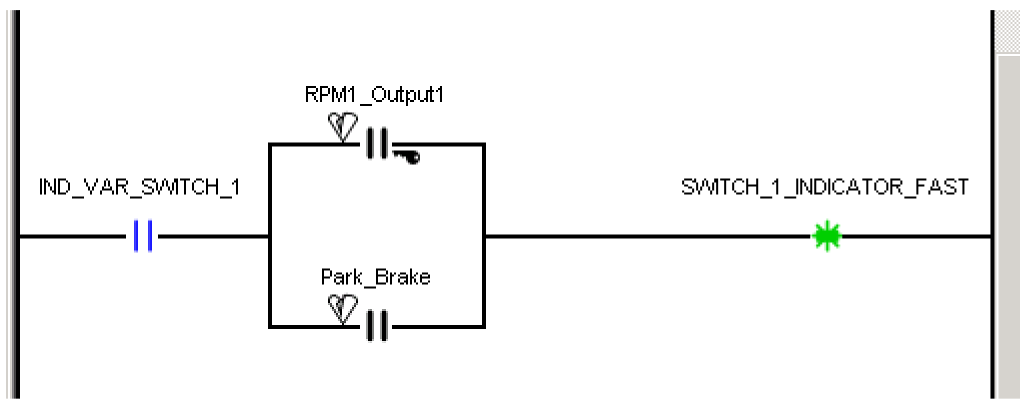
6.4.3 Interlock Switch with a 3-position Momentary Switch (NON Re-Engaging Type)

A 3-position Momentary switch can be interlocked to various chassis signals as well. If the output requires the interlock to engage and the user desires the output to NOT re-engage when the interlock is TRUE even after it is removed, without pushing the switch up again, then the interlock should be added to the rung that Sets the Independent Variable ON. To add an interlock, drag the icon to the middle of the rung that sets the Independent Variable ON. Even if the Switch is pushed up, the Independent Variable will not be SET on unless the interlock is true when the switch is pushed. In addition, NOT with the Interlock must be added to the rung that sets the independent variable OFF as an OR condition. Drag the interlock to this rung as an OR condition to the SWITCH_1_DOWN icon. Right click the Interlock icon and select NEGATIVE EDGE. If the Interlock is removed at any point, the Independent Variable will be set OFF; therefore, the switch must be re-pressed up to turn the Independent Variable ON and therefore turn ON the Output.
The Switch Indicator light should be ON when the RPM1_Output1 is ON. Add RPM1_Output1 to the next available rung as an input. Add the solid Switch indicator light as the output. The indicator light in the switch will illuminate when the output is actually ON.



Interlocked 3-Position Momentary Switch (NONE Re-engaging Type)

Diagnostics should be added for the indicator light in the switch. Blink fast if a Bad status occurs on one or more of the signals. The Blink Slow functionality is not applicable for a 3-Position Momentary Interlocked Switch that will not re-engage if the interlock is reintroduced, because the Independent Variable requires the interlock to be Set On. To create the Blink fast rung, add the Independent Variable as the input to the next available rung. All icons that could cause the output to be OFF if the status goes bad, should be additional inputs that are an AND condition to the Independent Variable, but an OR condition to each other. In this example, the icons that could communicate a BAD STATUS are the switch icons, the Park Brake, or RPM1_Output1 (although switch icons are not included, because the indicator light would also communicate a bad status and therefore not be illuminated). To change these icons to check for bad status in lieu of the state of the switch or output, Right click on these icons and select BAD STATUS (a broken heart will be added in front of the icons). Finally add the Blink fast switch icon as the output. For example: When the Independent Variable is ON, but the status of the RPM output is BAD, then blink the indicator light fast. This rung will blink the switch indicator light fast if the interlock, or RPM1_Output1 signal is communicating a bad status and the Independent Variable is ON (therefore the load should be ON).



Interlocked 3-Position Momentary Switch (NONE Re-engaging Type) - Status Check

Note: Diagnostic text should be added to the Diagnostic tab and include the interlock for the output. Example: RPM1_Output1: This output is ON when the Switch labeled (SWITCH_1_Up) is rocked up AND the Park Brake is set. If the park brake is not set, the output will be OFF. If the Park Brake is released and re-set, then the switch must be pushed up again to turn on the output. If this output signal is reporting BAD STATUS or if the Switch is reporting BAD STATUS, then the output will be OFF and the indicator light in the switch will blink fast.

6.5 Special Gauge Cluster Indicators and Alarms

6.5.1 Illuminating gauge cluster indicator lights

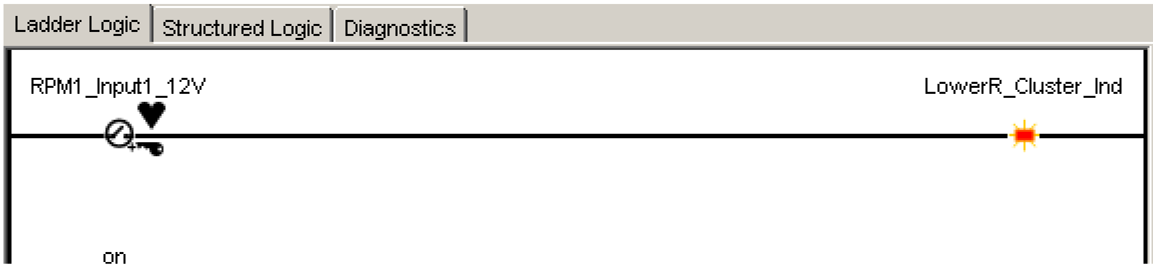
Note: This feature is only applicable (with the exception of the PTO indicator) to vehicles built prior to January 2007. Indicators (with the exception of the PTO indicator) on vehicles, built after January 2007, will have to be incorporated into the switch pack. Refer to section 6.6 Illuminating the Service Parts Indicator Lights

This feature provides a body manufacturer with the ability to customize the instrument cluster for certain specialized alerts. Three indicator lights are allocated for use with Body Equipment. On some vehicles, one may be used for Transmission Retarder and should not be used for Body Equipment. The three signals are found in the gauge cluster bucket and are labeled as follows: LowerL_Cluster_Ind, LowerR_Cluster_Ind, and UpperR_Cluster_Ind.
If the vehicle is equipped with 60AJD or 60AJC (Waste or Utility Indicator light package) then the following signals may be available: Boom_Not_Stowed_Warning_light, Outriggers_Deployed_Warning_Light, Rear_Alert_Cluster_Indicator, and Gate_Open_Light as a Read signal; however, these are Not available for use as an output.
If the vehicle is equipped with one or more of the following 595XXX codes, the LowerL_Cluster_Ind, LowerR_Cluster_Ind, and or UpperR_Cluster_Ind signals are not accessible. Refer to the following chart for indication of which features to remove to use these signals.

	Waste & Refuse	**Utility**	**Dump & Plow**
Feature Code	60AJC	60AJD	60AJK
Equipment Options	▪ Gate Open ▪ Rear Alert	▪ Outriggers Out ▪ Boom not Stowed	▪ Body Up ▪ Gate Open
Software Codes	595197/595AMD or 595255/595AMC 595198/595AKP	595201/595AKR 595202/595AKS	595301/595AKU 595299/595AKT or 595255/595AMC or 595197/595AMD

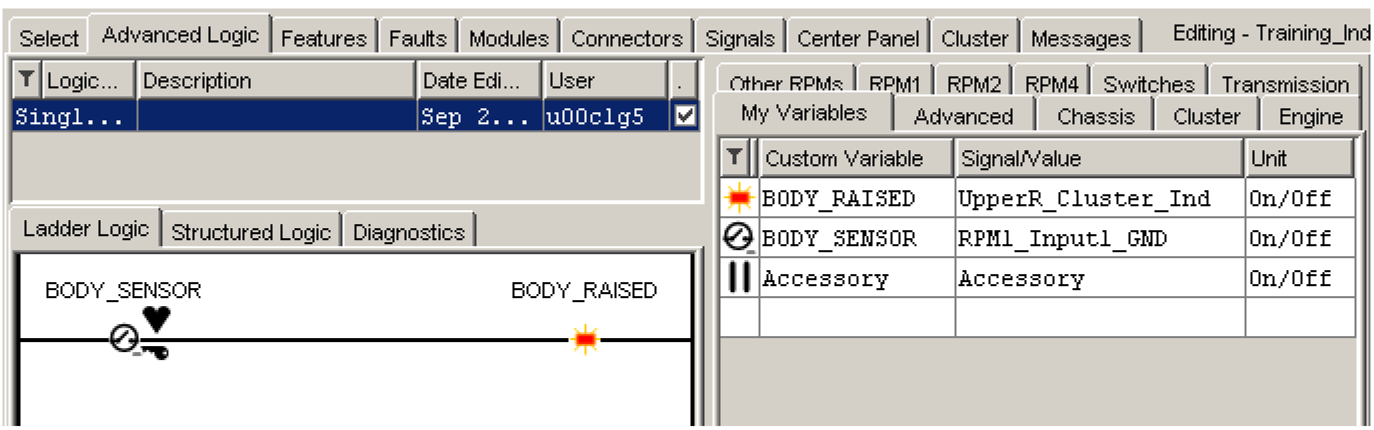
Refer to S08300 or S08323 for additional information programming these features

The LowerR_Cluster_Ind is typically labeled PTO on the High Performance Vehicles. This indicator light when illuminated and the engine is running, will accumulate PTO hours in the digital display
To turn on the LowerR_Cluster_Ind and drive the PTO Hour meter in the LCD display, drag this icon to the output of the next available rung in the Ladder Logic tab. Typically a Remote Power Module input will drive this light; however, many other inputs can illuminate this light (including chassis signals and/or Remote Power Module outputs).



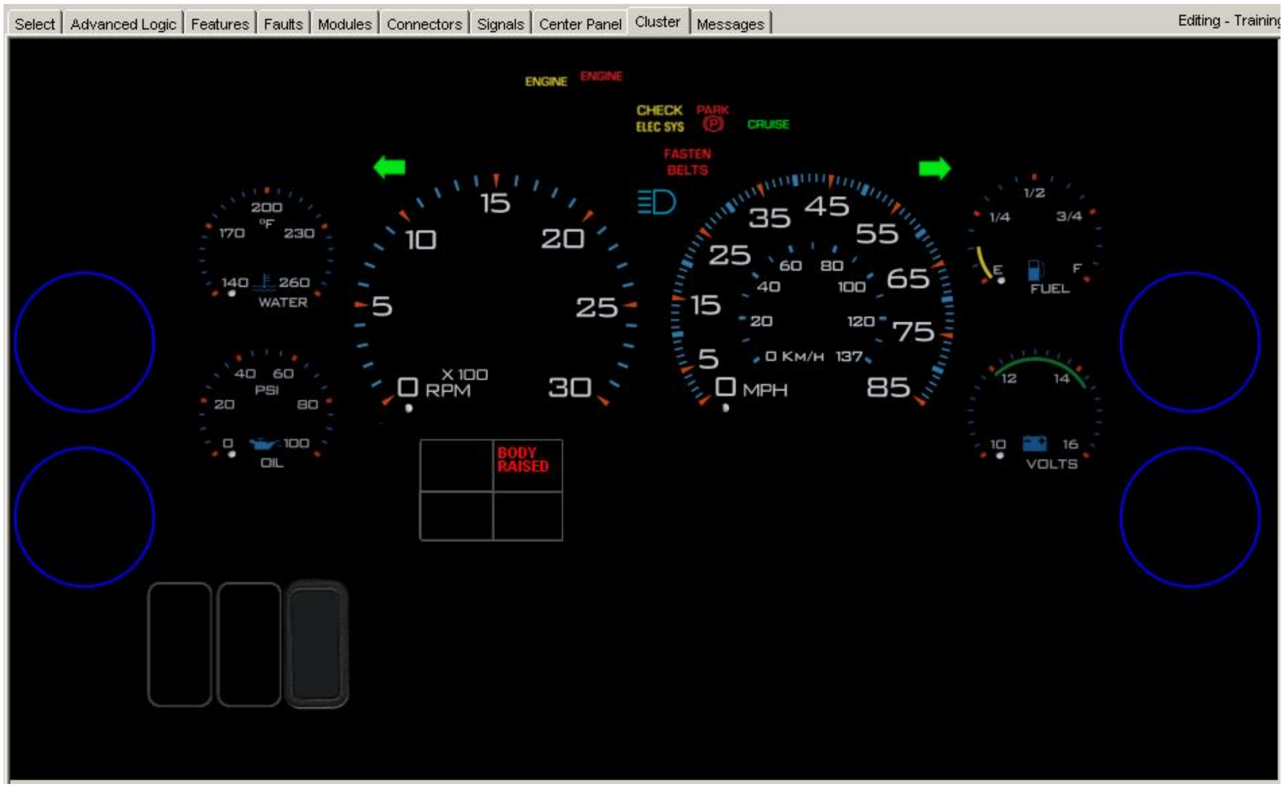
Illuminating the Indicator Lights in the Gauge Cluster

The other two indicator lights can also be illuminated by a Remote Power Module input. Example: Body mounted switch for Body Raised will provide a Ground signal when the Body is raised. This Ground signal can be used to drive the LowerR_Cluster_Ind. Rename this indicator as a more appropriate name by clicking in the Custom Variable field and typing, "BODY UP," and rename the input more appropriately as well to "BODY_SWITCH." In this example the light will illuminate every time the Body is raised.



Ladder Logic for Illuminating the Gauge Cluster Indicator Lights

Note: The appropriate name will also be added to the Gauge Cluster view to indicate where this light is located.



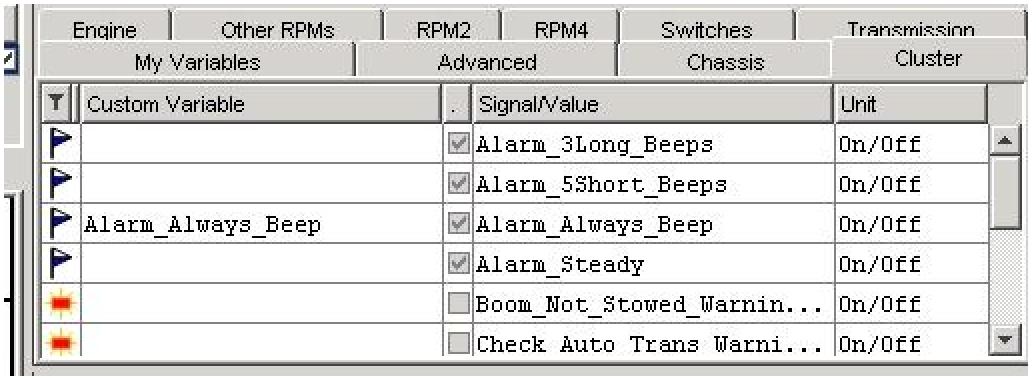
Gauge Cluster View of Custom Indicator Light (built prior to January 2007)

Diagnostics should be added to the Diagnostic tab in the Ladder Logic View.

Note: Refer to the applicable vehicle service manual for instructions on changing the special indicator overlay.

6.5.2 Gauge Cluster Alarm

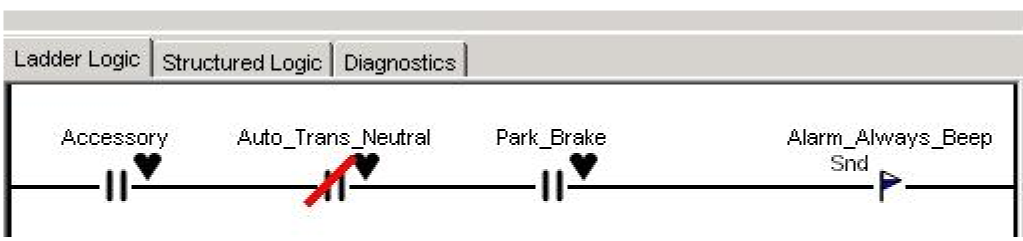
DLB gives the user the ability to create advance logic to control the beeper located within the instrument cluster to a certain degree. The beeper signal is a semaphore signal, which means if the ESC needs control of the beeper; any advance logic created to control the beeper will be ignored until the ESC no longer needs that signal. If the ESC does not require the signal then the beeper will function the way it was designed within the advance logic that was created to control it.
The Alarm Beeper signals can be found under the Cluster Tab in Advanced Logic.



Cluster Tab

They are four signals available and they consist of:
Alarm_3Long_Beeps – The alarm will activate and sound 3 long beeps.
Alarm_5Short_Beeps – The alarm will activate and sound 5 short beeps.
Alarm_Always_Beep – This will activate a consistent short beeping alarm.
Alarm_Steady – This will activate a consistent monotone alarm.

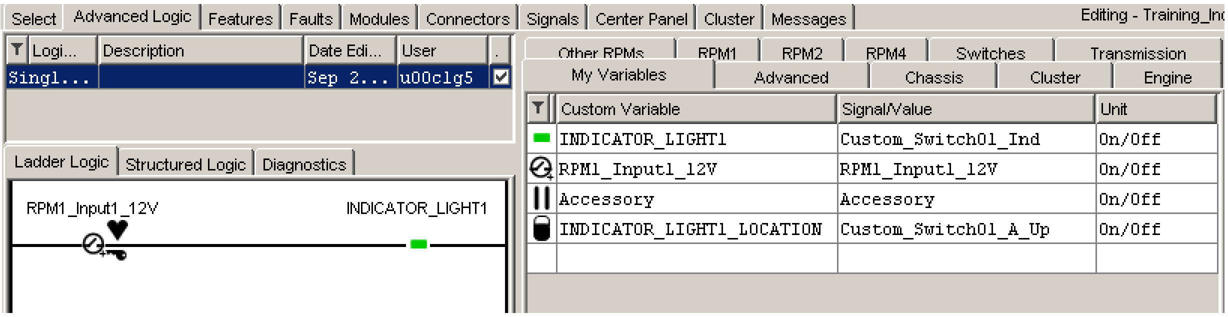
Below is an example of using the three long beeps for an alarm every five seconds once certain conditions are met. The conditions that must be met in order to activate the alarm are
With the key in the ignition or accessory position, the transmission is in gear and park brake is set then these conditions will activate the Alarm Always Beep signal and the cluster will beep until one of these conditions are no longer true.



Example of controlling Cluster Alarms with Advance Logic

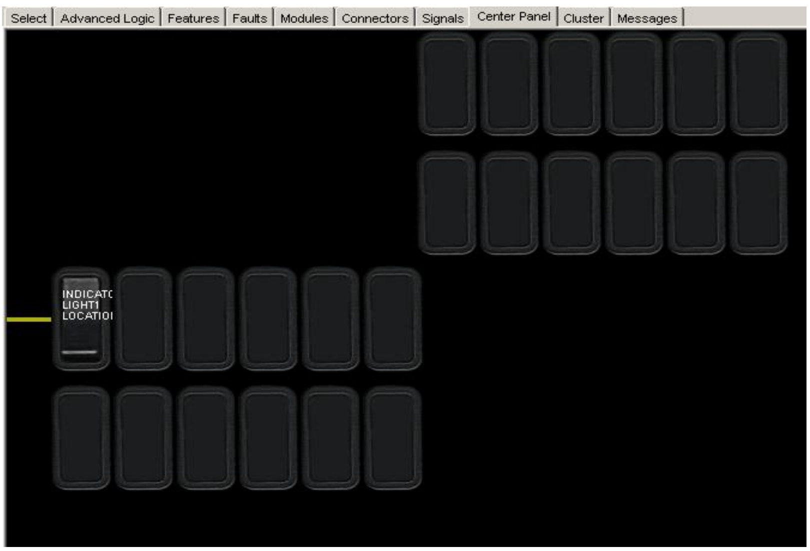
6.6 Illuminating the Service Parts Indicator Lights

Illuminating the Service Parts Indicator light kits, that fit in the switch packs, is similar to illuminating the indicator lights in the switches. Simply use the switch indicator lights as the output. For example: If a Remote Power Module input should illuminate one of these aftermarket lights, rename Custom Variable of the next available solid switch indicator light. In addition, to indicate the location of the indicator light (and to ensure this switch is not used anywhere else), rename the Custom Variable for the corresponding Switch UP signal as an identifiable name (example: "INDICATOR LIGHT1 LOCATION"), although this switch will not be used, this name will indicate in the center panel view where the indicator light should be mounted. You must also drag this switch icon to an unused rung that is not connected to any physical output so that this custom name will show up in the CENTER PANEL VIEW on the VIN. Drag the solid indicator light to the next available ladder logic rung as the output. Add a Remote Power Module Input (either 12V or Ground) as the input.



Ladder Logic for the Service Parts Indicator Lights

Finally check the Center Panel view for the location of the Indicator Light (labeled as the unused switch).



Indicator Light Assemblies are available in RED, YELLOW and GREEN from the Parts Department at your local International dealer. Affix switch name labels as required from switch packs.

Location of Unused Switch – Used to Label Location of Service Parts Indicator Light

Diagnostic text should be added to the Diagnostic tab in the ladder logic view.

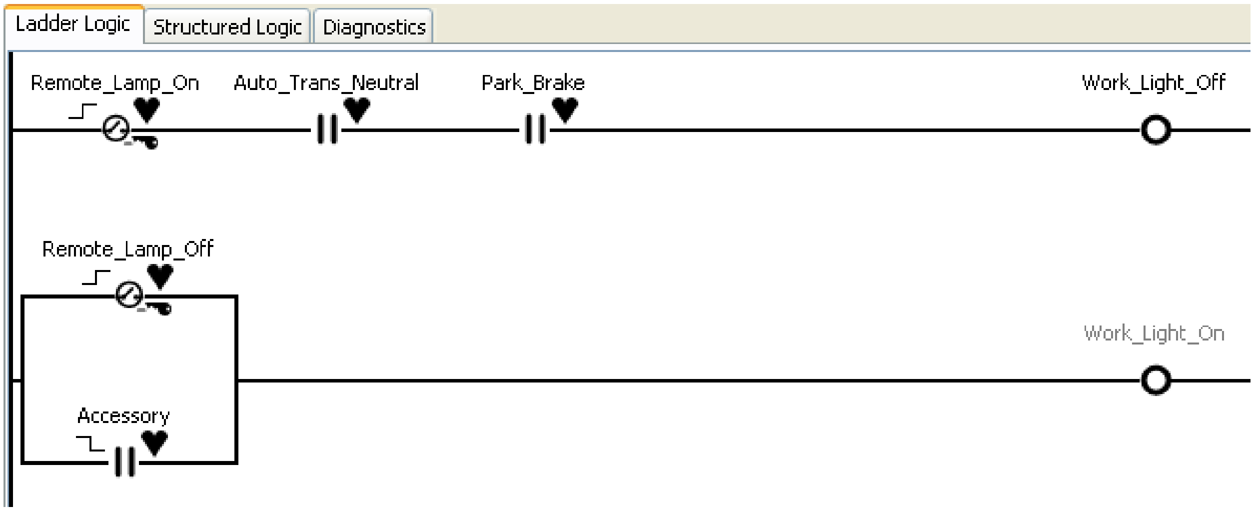
6.7 Controlling the Work Light

The work light power output is a special purpose output on the Electrical system Controller or Body Controller module. This output is the only power channel of the ESC or BC that is functional with the ignition key in the OFF position.

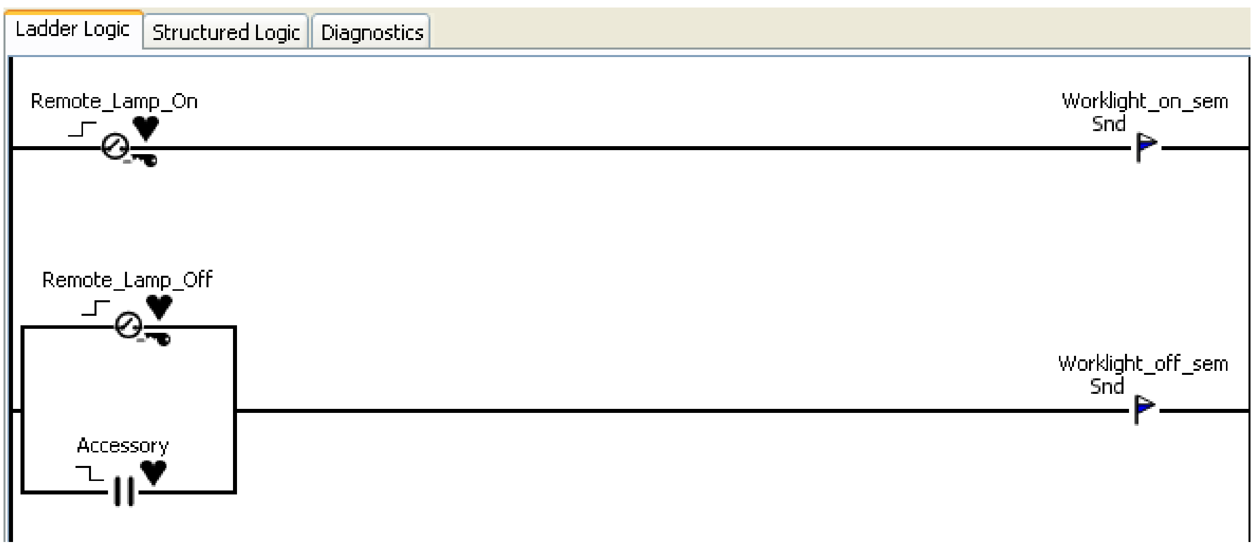
On pre 2007 vehicles, the work light is an optional pre-engineered feature that provides a momentary rocker switch in the lower left three pack of switches on the left side of the gauge cluster that drives a ten amp power feed on the ESC.

On post 2007 vehicles the work light is also an optional pre-engineered feature. It has two possible configurations. The first provides a momentary rocker switch in the first position of the lower right (two pack) of switches, on the right side of the gauge cluster that drives a ten amp power feed on the ESC. The second option provides a push button control on the left side of the gauge cluster that drives a ten amp power feed on the ESC.

This feature, when ordered from the factory, is delivered with a wire harness that contains a two-pin weather sealed connector for the body builder to attach a body lamp or other load to this output. It has a programmable parameter to shut this output OFF with key OFF after a prescribed amount of time; the default is two hours.
The Diamond Logic® Builder program provides the ability for the advanced logic user to write to the work light channel using a unique methodology that is different from writing to other outputs in the system. The Diamond Logic® Builder software user may write to the work light channel using an "OR" relationship with the rocker switch in the cluster. This means that the driver can turn the work light output channel OFF or ON by actuation of the rocker switch in the gauge cluster or else by writing to two individual signals in the Diamond Logic® Builder software. In order to turn the work light channel ON in the Diamond Logic® Builder software, the user may use any single transitional event of logic to activate the output signal called Work_Light_On or Worklight_on_sem SND. In order to turn the work light channel OFF, the Diamond Logic® Builder user may use a single transitional event of logic to activate the signal called Work_Light_Off or Worklight_off_sem SND. Latched or in other words, steady state logic events, may also be used in the Diamond Logic® Builder software to activate the work light ON or OFF signals, however, in doing so, the ON /OFF requests from the rocker switch will be ignored. In addition, any latched events that may be driving the work light signals, should be interlocked with the Accessory signal or there is a risk that the ladder logic will keep the ESC functioning with the ignition key in the OFF position and thus drain the vehicle batteries over time.
See the example below of advanced logic being used to control the work light channel. In this example, we have chosen to use one set of logic to turn the work light channel ON and a different set of logic to shut the channel OFF. The first rung shows that the first transitional event activation of the remote power module switch input will start the chain of logic to activate the Work_Light_On or Worklight_on_sem SND signal. Note that the transmission must be in Neutral and the Park Brake must be set in order for this rung of logic to activate the channel. The work light will be latched ON in a steady state fashion by the software, even though the logic of the rung is only true for one processing cycle. The second rung is used for shutting off the work light. In this case, we used the transitional event activation of another remote power module switch input or de-activation of the ACCESSORY signal to activate the Work_Light_Off or Worklight_off_sem SND signal and thus, shut OFF the work light. In summary, two individual rungs using transitional logic events are required to control the Work Light Channel.



Example of Controlling the Work Light Channel Pre 2007 Vehicles



Example of Controlling the Work Light Channel Post 2007 Vehicles

The advanced logic user has the opportunity to use the Diamond Logic® Builder software signals to control the work light channel without the interaction of the work light rocker switch by merely removing the work light switch and installing a switch blank.
If the third switch position of the gauge cluster is required for use by another feature and yet the controlling of the work light channel is still desired, the advanced logic user may move the work light switch from the gauge cluster to another location in a switch pack in the center panel using the following process:

- Place the cursor over the work light switch in the gauge cluster and then click and hold the left mouse switch.
- Drag the work light switch to the “center panel” tab with the mouse switch still depressed.
- The switch panel view will now be displayed.
- Drag the work light switch to the desired location in the switch packs.
- If the switch will not be used, drag the switch to an unused location in a switch pack that is already in the vehicle and then install a switch blank.

- In order to locate another switch function from the switch packs to the third position of the gauge cluster, reverse the above procedure. Remember the rocker switch should be a momentary type and all supporting logic should shut OFF the channel with key OFF.

Note: **The programmable parameter for shutting OFF the work light channel will be active with the key OFF, even when the channel is controlled by advanced ladder logic. The default is two hours and is adjustable by modifying the programmable parameter Work_Light_Timeout_Enable located in the work light feature 595250 or 595AMU.**

Key points to remember when working with the work light channel:

If you choose to insert a blank switch in your advanced logic and move the pre-engineered work light switch to an unused location and that location is in a switchpack that is not installed on the vehicle, you will get an active error message for a switchpack that is not installed on the vehicle.

Most outputs such as RPM or air solenoid modules can be used to drive items such as switch indicators in advanced logic. The work light outputs are special due to the software that controls the pre-engineered feature and the timer software. The output cannot be used as an input to control items like the work light indicator in the switch. The output that is displayed on the ladder logic is actually a temporary variable that is only active for one processing cycle. You must use items such as a positive edge of the work light switch or an edge of the output to control other rungs of logic.

6.8 Using the Key FOB buttons in Advanced Ladder Logic

The key fob provides a wireless interface to lock or unlock the doors, a button to activate a panic button and an AUX button to normally control the work light channel or a lift gate.

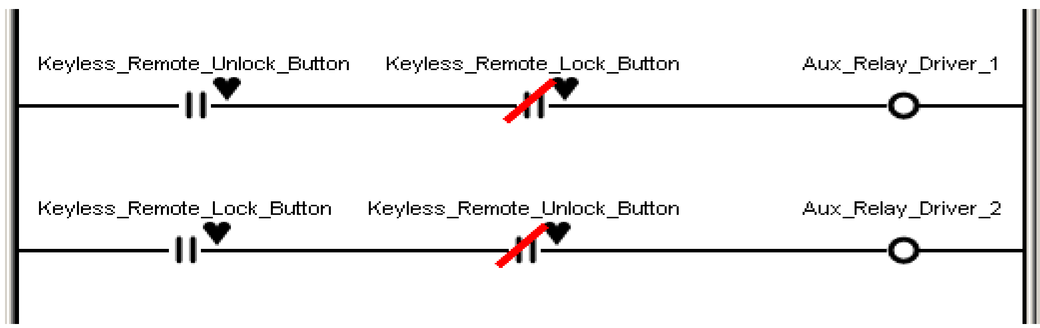
The Diamond Logic® Builder program provides a means to use the key FOB for a number of purposes. The key FOB provides four read only signals in the CHASSIS tab of signals. The four signals are labeled:

- Keyless_Remote_Aux_Button
- Keyless_Remote_Lock_Button
- Keyless_Remote_Panic_Button
- Keyless_Remote_Unlock_Button

These signals may be used as read only signals to construct any form of logic for the control of body locks or other equipment. It must be understood that though these signals may be used for various functions, the door locks will be activated any time the key FOB lock buttons are activated.

6.8.1 Using the Key FOB Lock and Unlock Buttons to Control Reversing Polarity Relays

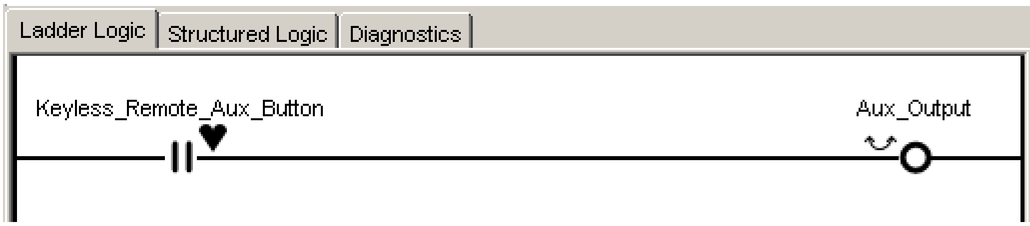
In the following example the Key FOB Lock and Unlock buttons are used to control ESC relay drivers for the purpose of creating a reversing polarity output to control body lock mechanisms. The first rung indicates that the Lock button must be active and the Unlock button must be OFF in order for the output to be active. This prevents the driver from causing any switch action by pushing two key FOB buttons at once. The second rung is used to unlock the doors using the inverse logic of the first rung. Note that for this example the vehicle must be ordered with the Diamond Logic® Builder Expansion Pack Feature (595283/595AKH) to gain access to the spare relay drivers on the ESC. The Expansion Pack feature may not be added later, by the body Builder, using the Diamond Logic® Builder software. The body lock mechanisms should be connected to two customer-supplied relays in a standard H bridge configuration to provide the reversing polarity drive for the body locks.



Using the Key FOB to Generate a Reversing Polarity Output for Driving Two Relays

6.8.2 Using the AUX button

The AUX button on the key FOB is the only button that may be used for two independent purposes. As stated before, if the vehicle is equipped with a work light feature, then the AUX button will control the work light channel in an OR relationship with the rocker switch in the cluster OR with any Diamond Logic® Builder program advanced logic that is controlling the work light ON / OFF signals. If the vehicle is not equipped with the work light feature the AUX button may be used as an input to control any output that is available in the Diamond Logic® Builder software. See the following example that uses the AUX button to control a remote power module output. In this example we can provide control of a remote power module output with the ignition key OFF. Momentarily depressing the AUX button on the key FOB will toggle the remote power module output OFF and ON. The Aux Button signal is active for only as long at the button is depressed. The advanced logic user should use the SET function or TOGGLE function if a latched output is desired due to the activation of this switch.



Aux Key FOB Button Toggles a Remote Power Module Output

6.9 Using Signals With Limited Write Access

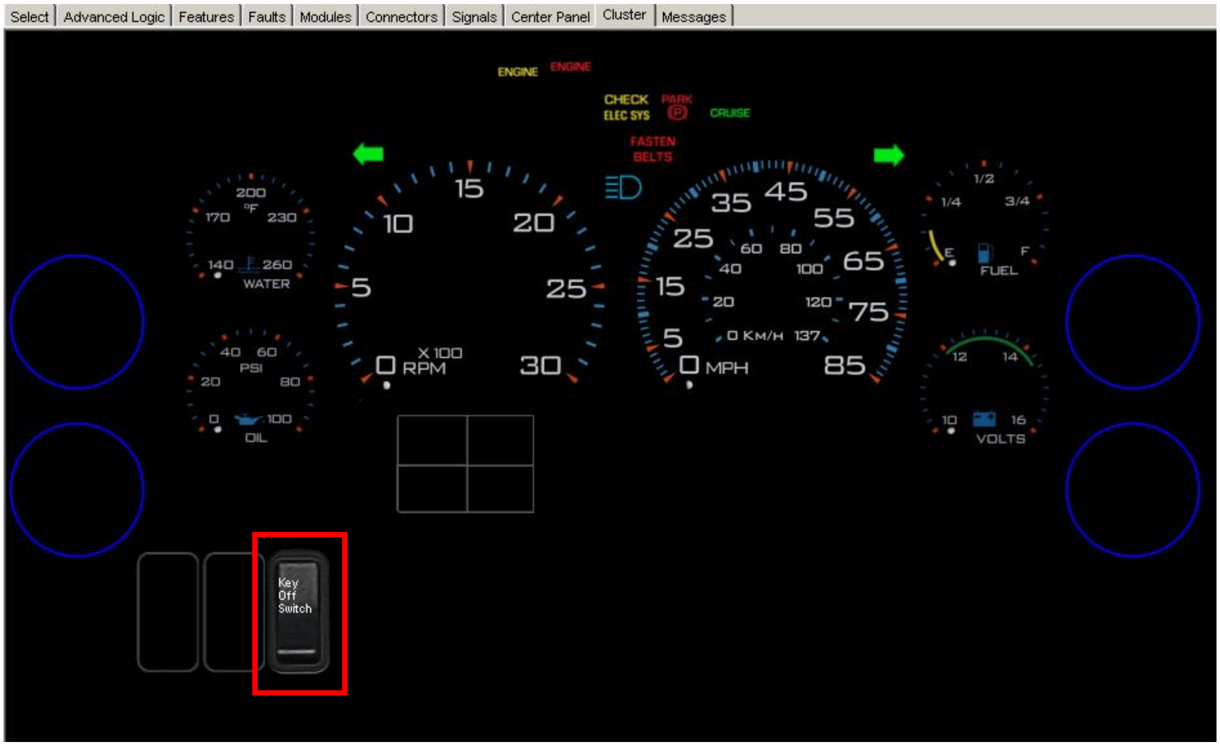
The Diamond Logic® Builder program is designed to make a broad variety of electrical system signals accessible to the advanced logic user. Some of the signals are READ Only, which means that these signals may only be used as inputs on the left side of the ladder rungs. Others are provided with WRITE access. This means that these signals are mapped to outputs in the electrical system. The signals that have unconditional write access with the Diamond Logic® Builder ladder logic are tagged with an icon that looks like an **O** in the signal tabs. Other signals have limited WRITE access using The Diamond Logic® Builder ladder logic and are identified with an icon that looks like a small flag. Signals in this category include the city horn, air horn, the beeper cadences in the gauge cluster and other electrical signals that may be introduced in the future. A signal with limited access provides the Diamond Logic® Builder advanced logic user a secondary control of the output. This means that if a primary vehicle feature has activated an output such as City Horn, ladder logic is not permitted to shut it OFF. In simple terms, the relationship between the Diamond Logic® Builder signals with limited access is a true OR condition with the logical control by the related vehicle feature. Either the Diamond Logic® Builder signal or the vehicle feature can turn an output ON, but both signals must be off in order to disable the related output. The advanced logic inputs that are used to drive the output signals with limited access must employ latching techniques such as signals driven by latched switches or the use of the SET function. These limited access signals do not have any features to stay ON with a momentary type of logical activation.

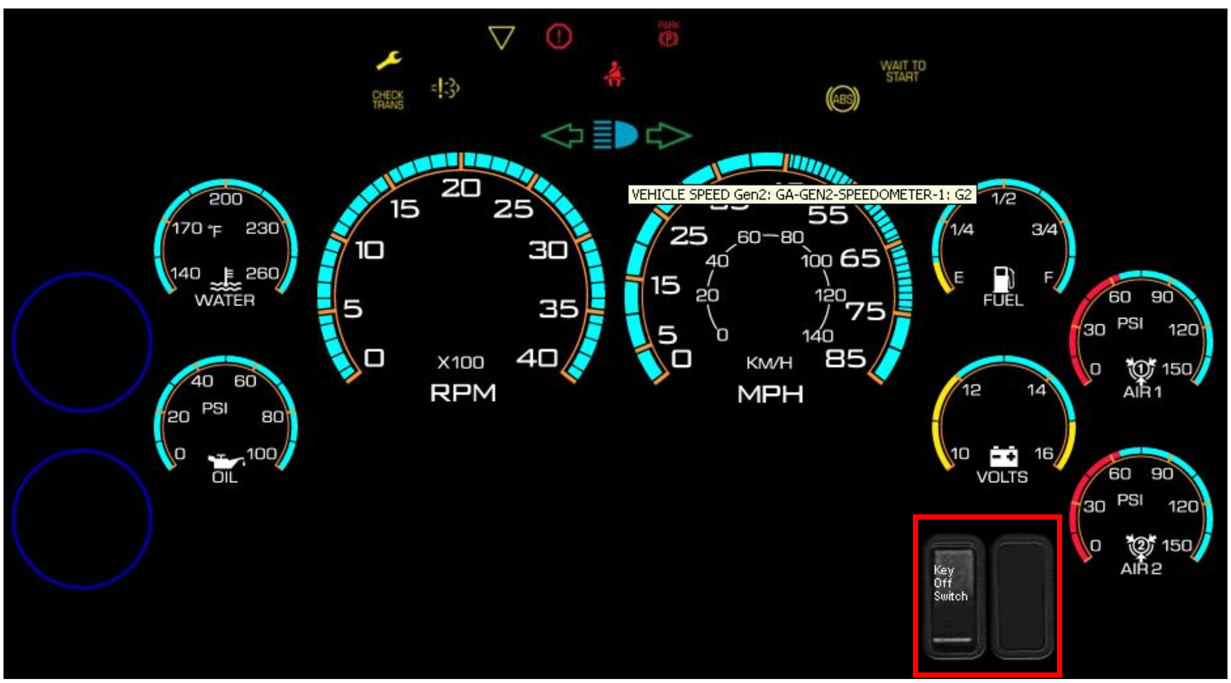
6.10 Providing Key OFF Functionality

6.10.1 Providing Key OFF Functionality in the Gauge Cluster

If a load needs to operate when the key is in the OFF position or removed, there is one instrument panel switch location available for pre 2007 vehicles and two for post 2007 vehicles. This switch location is in the lower left of the gauge cluster in pre 2007 vehicles while there are two switch locations in the post 2007 vehicles.

Note: The lower right switch locations may be occupied by Diesel Particulate Filter Regeneration switches. These switches can be relocated to a switch pack in the center panel if necessary to free up these locations.



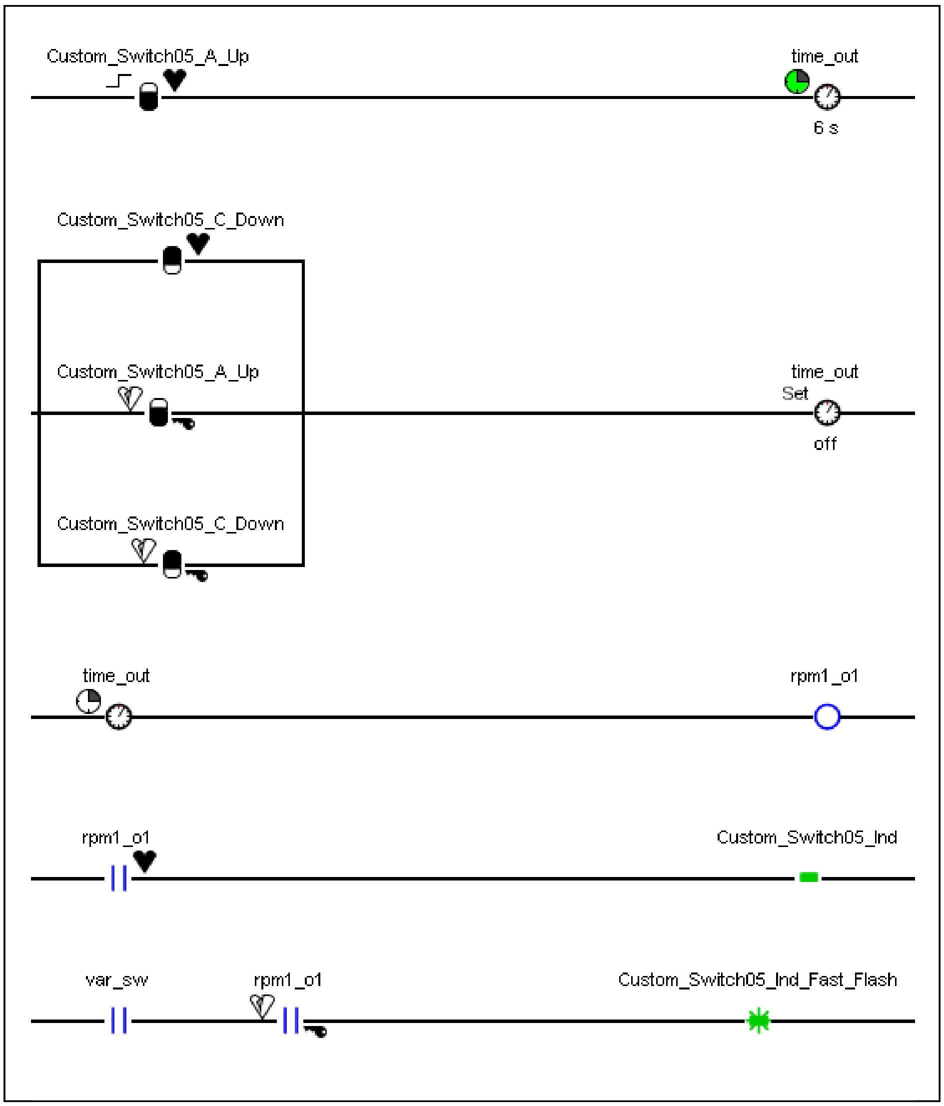


Key OFF Functionality in the Gauge Cluster

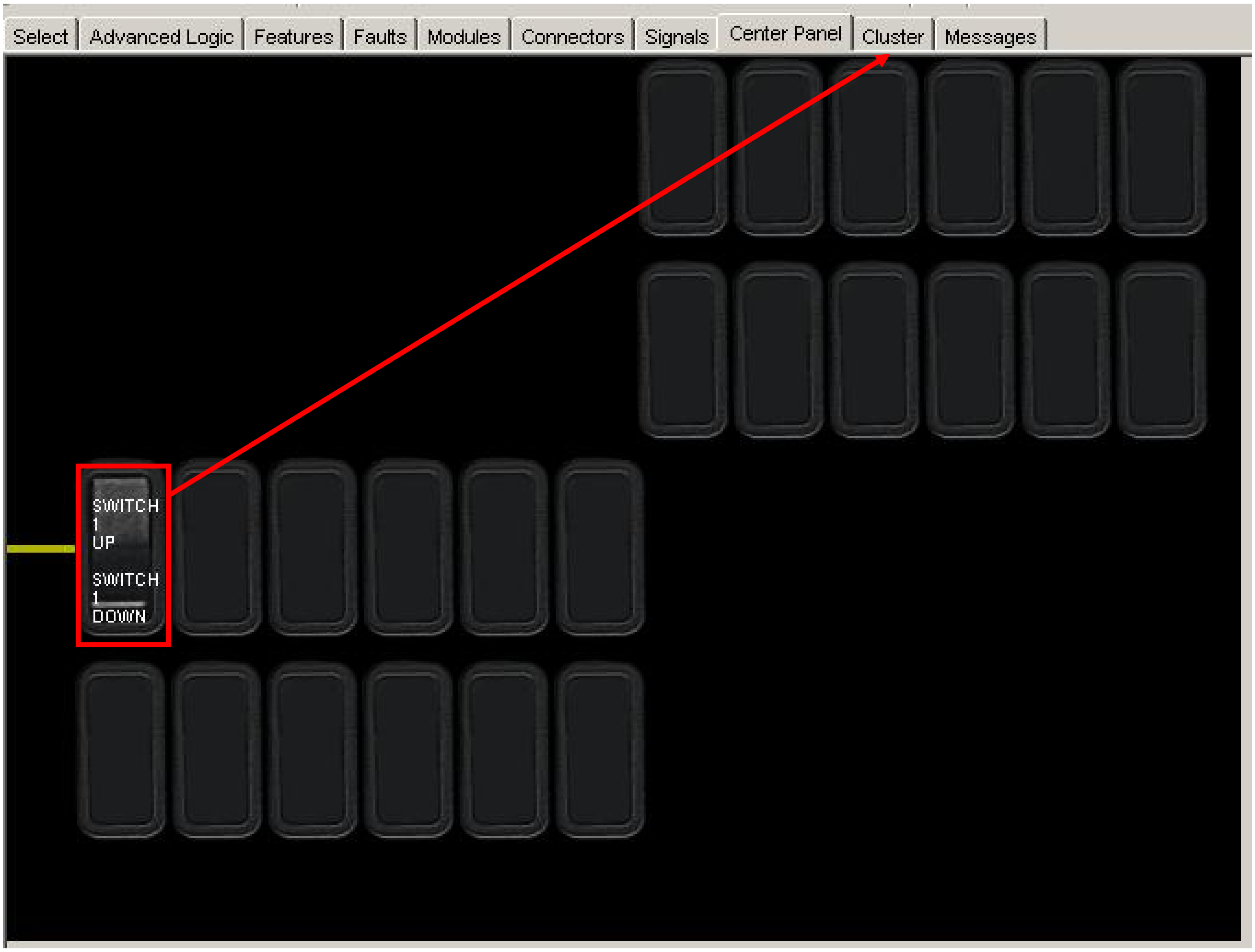
Only 3-position momentary switches should be placed in this location. Typical use of this functionality is for a Strobe Light, Work Light or Spot Light. To add key OFF functionality to a rung, simply create a 3-position Momentary Switch functionality, and remove the accessory interlocks. To remove the ACCESSORY interlock from the switch icons, right click on the switch icon and select ACCESSORY. This will allow the switch to operate without being interlocked to accessory.

6.10.2 Using a "Key OFF" Switch in Ladder Logic

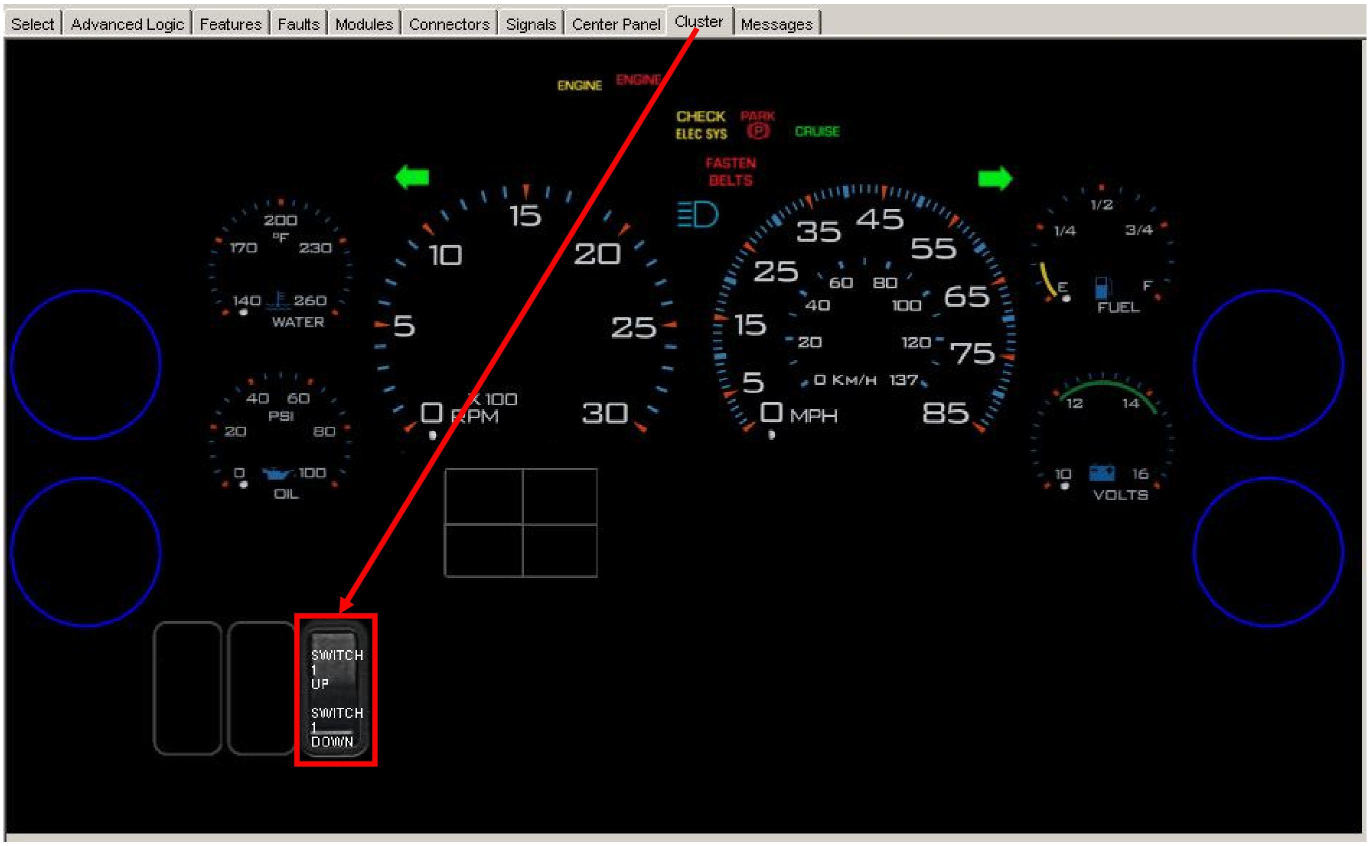
The indicator light should also be illuminated when the output is ON, but the accessory interlock needs to be removed from the rpm1_o1 icon as well. Note: It is recommended that the rungs that slow flash or fast flash the indicator light in the switch still contain an ACCESSORY interlock when checking status or interlock conditions, because these indicator lights could drain the battery.
In addition, a timer should be added before the output to ensure the battery is not drained. See the Timers Section for more information.
The switch will not operate in the key OFF position in the center panel (since the center panel requires the key in the ACCESSORY or IGNITION position). Therefore, the switch must be relocated to the only available key OFF switch location in the gauge cluster. To relocate the new switch, select the switch in the center panel and drag to the Gauge cluster tab. Drop the switch in the Key OFF switch position (3rd switch from the left). See attached pictures…



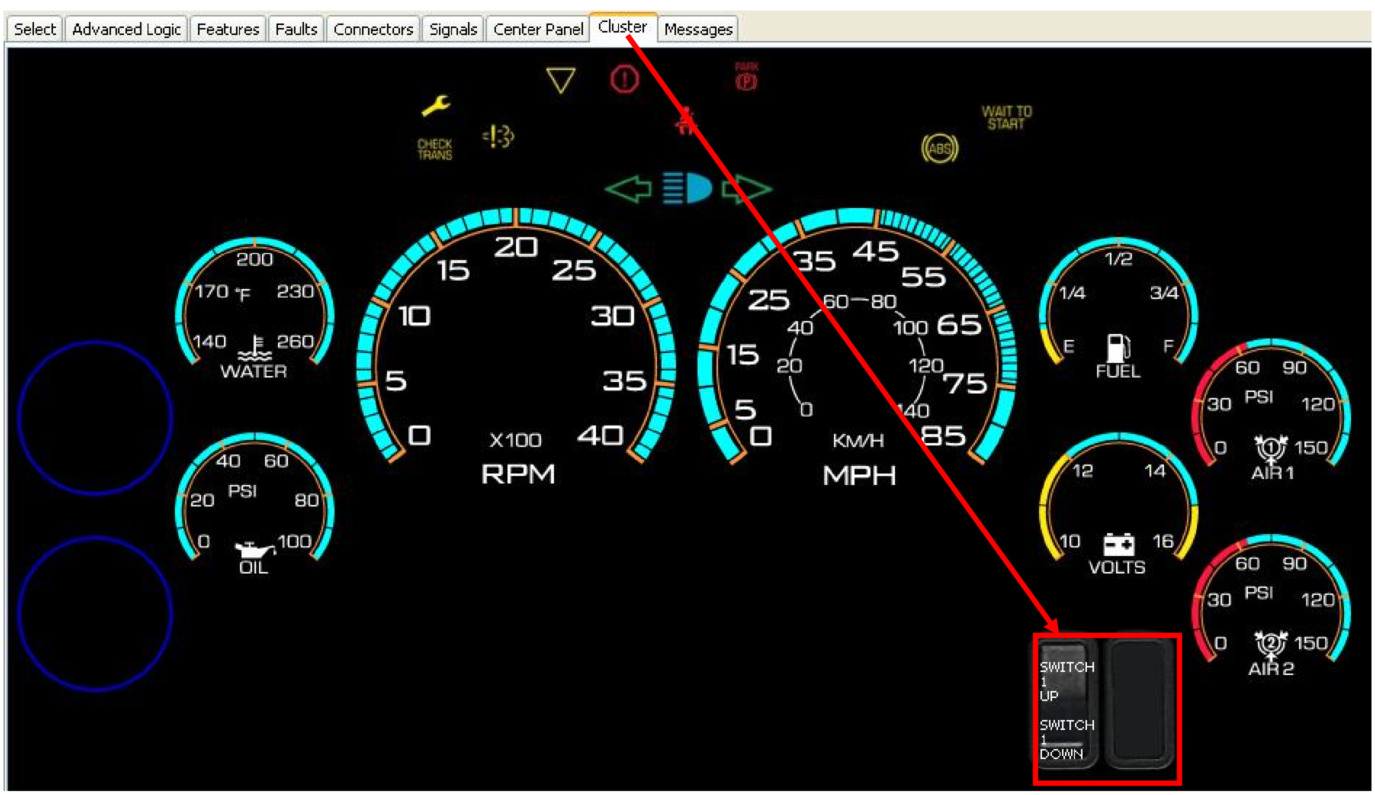
Key OFF Momentary Switch with Timer



Moving a Switch to the Key-OFF Switch Location in the Cluster



Moving a Switch to the Key-OFF Switch Location in the Pre 2007Cluster

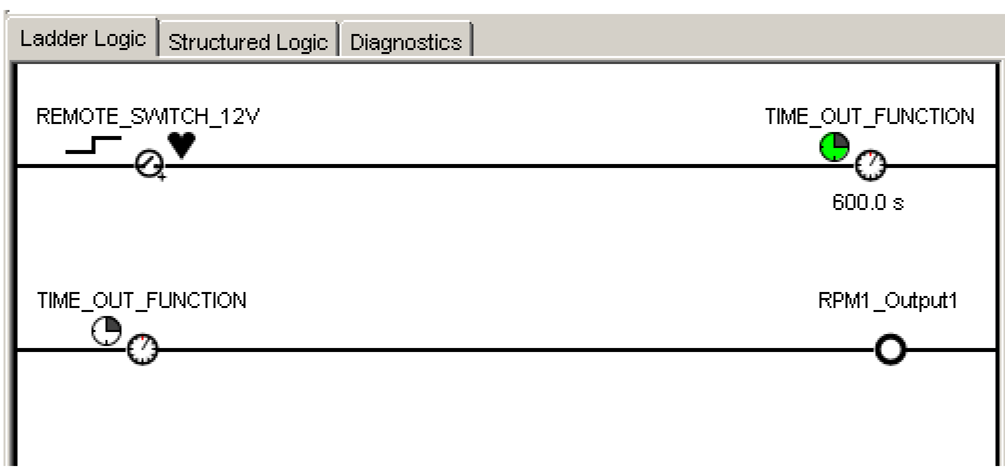


Moving a Switch to the Key-OFF Switch Location in the Post 2007Cluster

This switch will now operate in the key OFF position. Note: It is a good practice to add a time out to this functionality, to eliminate the potential for draining the battery (see timers).

6.10.3 Providing Key OFF Functionality Using Remote Power Module Inputs

Another option for key-OFF functionality is using the Remote Power Modules. These modules will wake-up the Electronic System Controller; therefore, these can be used in a key OFF type functionality. No in cab switches can be used for this type of operation; however, Remote power Module inputs can be used. To change a Remote Switching solution to one that will work with key OFF, remove the interlock to accessory from the remote power module input icons and remote power module output icons (when used as inputs). Example: For a remote body mounted switch to operate a remote power module output in key OFF position, add the next available remote power module input icon as the input. Right click the icon and select Accessory (this will remove the key from the icon). Add the next available remote power module output to the right side of the rung as the output.
A time-out should always be added to any key-OFF functionality to ensure that this switch does not drain the battery. See the section on timers for more information. Below is a key-OFF function with a 10-minute timeout. For a longer timer, see the Using Timers section.



Key-OFF Functionality Using a Timer to Control the Remote Power Module Output

6.11 Programming with the Input / Output Signal Expansion Feature

The Diamond Logic® Builder program provides the user a means to access additional general-purpose inputs and outputs on the ESC. A feature may be purchased when the vehicle is built that provides two active low digital inputs and two active low relay driver outputs that will sink up to 0.5 amps each. The software to access these signals may not be added later, by the body builder, using the Diamond Logic® Builder program. The sales feature to order this feature (595283/505AKH) is 60ACW. In addition, a zero volt reference wire is provided in the bundle as a ground to be used with switches connected to the digital inputs. The wire bundle is provided with blunt cut wires and is packaged under the instrument panel on the left side of the steering column.

The general purpose digital inputs are **READ ONLY** and the associated signals are:

Aux_Discrete_Input_1	**ESC Connector 1600, Pin 26 or**
TEG_Discrete_Input_1	**BC Connector 1602, Pin F14**
Aux_Discrete_Input_2	**ESC Connector 1600, Pin 31 or**
TEG_Discrete_Input_2	**BC Connector 1602, Pin F12**

The general-purpose relay drivers are both **Readable and Writable**. The signals associated with the relay drivers are:

Aux_Relay_Driver_1	**ESC Connector 1601, Pin A or**
	BC Connector 1601, Pin E2
Aux_Relay_Driver_2	**ESC Connector 1601, Pin E or**
	BC Connector 1601, Pin E1

All of these signals are only useable when the ignition key is in the Accessory or Run positions. Each of these signals is located in the CHASSIS Tab of Advanced Logic.

6.12 Programming Control of the Two Speed Axle

The Diamond Logic® Builder program provides a means to control the two-speed axle of the vehicle using advanced logic. Control may be achieved whether the vehicle is equipped with a manual or automatic transmission.
The control of the two-speed axle is performed through a combination of two signals. The first signal is found in advanced logic and is labeled Two_Speed_Axle_High_Request. This signal will be true whenever the logic on the ladder rung is true. The second signal for controlling the two-speed axle contains several interlocks and is named Two_Spd_Axle_Solenoid. This signal will be true only when the transmission is in neutral, vehicle speed is less than 3 MPH and the brake pedal is depressed. Thus both signals must be true before the two-speed axle will be shifted to the high gear position. If either signal is OFF or false, the axle will be shifted to the low gear position. The programmer must be aware of possible gear bind in the vehicle differential and may need to employ specific ladder logic to ensure that the axle is shifted to the correct position when requested to overcome gear bind.
Note: The Two_Speed_Axle High_Request signal cannot be used with vehicles that require the ability to shift the two-speed axle with the vehicle in motion.

6.12.1 Programming the Two Speed Axle with Manual Transmissions

Vehicles with a two-speed axle and a manual transmission come from International equipped with a two speed axle switch on the gearshift lever; an air solenoid mounted on the frame rail and either software features 595039, 595166, 595ANL or 595ALN loaded into the ESC. Programming the control of the two-speed axle may be accomplished using advanced logic, however the pre-engineered software feature 595039, 595166, 595ANL or 595ALN must first be removed from the vehicle by selecting the two-speed axle features in the FEATURE screen and unchecking the installation boxes. Now you can use the Two_Spd_Axle_High_Request signal as the control of the two-speed axle. You may use combinations of advanced ladder logic to decide when you want the axle to shift. Be sure to refer to the CONNECTOR view to ensure that the advanced logic solenoid is mapped to the solenoid that was removed. If you still wish to use the gearshift lever switch as the main input control of the two-speed axle, then the wire from pin 18 of the ESC connector 4004 or pin f8 of BC connector 1601 will need to be rewired to an available input on a remote power module.
In summary, you can control the two speed axle air solenoid with your choice of inputs through advanced logic, however, the vehicle must be stopped with the brake pedal depressed before the shift will occur.

6.12.2 Programming the Two Speed Axle with Automatic Transmissions

Vehicles with a two-speed axle and an automatic transmission come from International equipped with a two speed axle switch in the switch pack; an air solenoid mounted on the frame rail and either software features 595039, 595ANL, 595ALN or 595166 and 514011 loaded into the ESC. Programming the control of the two-speed axle may be accomplished using advanced logic; however the pre-engineered software feature 595039, 595ANL, 595ALN or 595166 and 514011 must first be removed from the vehicle by selecting the two-speed axle features in the FEATURE screen and unchecking the installation boxes. Now you can use the Two_Spd_Axle_High_Request signal as the control of the two-speed axle. You may use combinations of advanced ladder logic to decide when you want the axle to shift. Be sure to refer to the CONNECTOR view to ensure that the advanced logic solenoid is mapped to the solenoid that was removed. If you still wish to use the factory supplied two speed axle switch as the main input control of the two-speed axle, then re-map an available custom switch to the position occupied by the actual two speed switch that is in the switch pack. In summary, you can control the two speed axle air solenoid with your choice of inputs through advanced logic, however, the vehicle must be stopped, the transmission must be in neutral with the brake pedal depressed before the shift will occur.

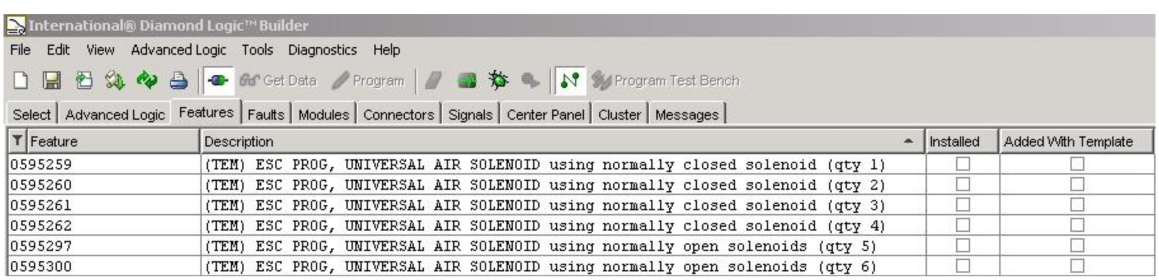
6.13 Using Air Solenoids

Within DLB there are two choices for use with air solenoids; solenoids that have common functionality or solenoids that are added with Advanced Logic.

6.13.1 Solenoid Features

Solenoids that have common functionality; meaning a switch opens and closes the solenoid can be provided by adding one of the following codes under the Features Tab. These should be based on the customer's requirements:

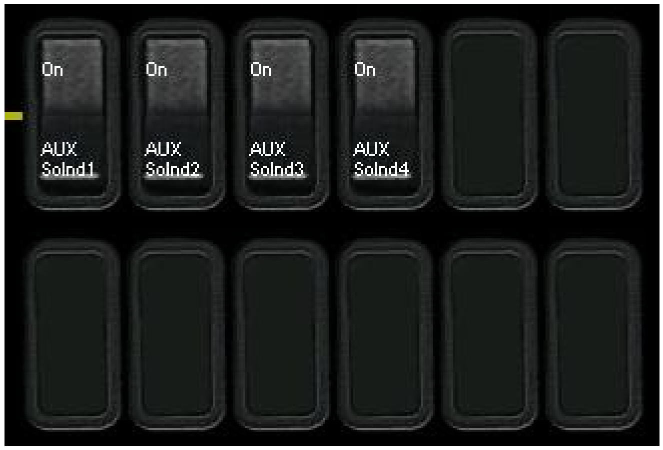
595259/595AHX – 1 Normally Closed Solenoids (08WGA)
595260/595AHY – 2 Normally Closed Solenoids (08WGB)
595261/595AHZ – 3 Normally Closed Solenoids (08WGC)
595262/595AJA – 4 Normally Closed Solenoids (08WGD)
595297/595AKZ – 5 Normally Open Solenoids (08WGP)
595262/595AJC – 6 Normally Closed Solenoids (08WGR)



Feature	Description	Installed	Added With Template
0595259	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally closed solenoid (qty 1)	☐	☐
0595260	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally closed solenoid (qty 2)	☐	☐
0595261	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally closed solenoid (qty 3)	☐	☐
0595262	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally closed solenoid (qty 4)	☐	☐
0595297	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally open solenoids (qty 5)	☐	☐
0595300	(TEM) ESC PROG, UNIVERSAL AIR SOLENOID using normally open solenoids (qty 6)	☐	☐

Universal Air Solenoid Features as displayed for pre 2007 Vehicles.

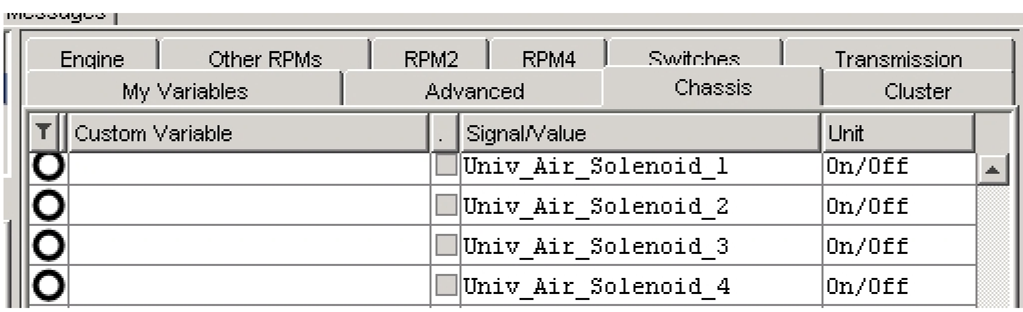
Note: Using the 595XXX features will not allow you to write to or use the solenoids within advance logic. Again, functionality is switch activation to open and close the solenoids.



Center Panel View of 595262/595AJA

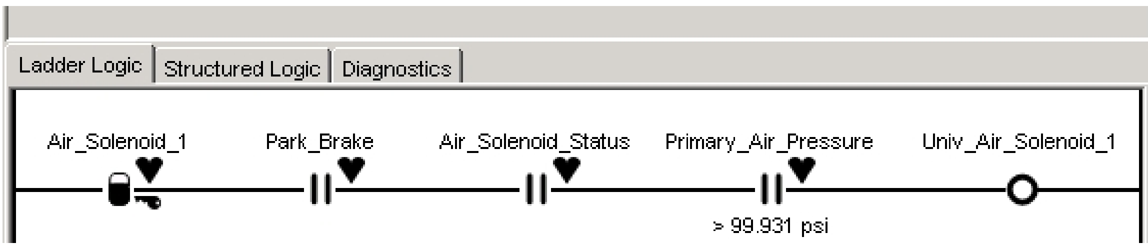
6.13.2 Universal Air Solenoids and Advanced Logic

The other choice, when it comes to the use of air solenoids, is to use them within Advanced Logic. By using Advanced Logic to control the universal air solenoids, the user has many more options for control and functionality as opposed to the basic open and closed functionality that is provided with the 595XXX codes.
As with any other features that are used in Advanced Logic, the user can tie whatever interlocks and or conditions to these solenoids that he/she wants. The user can write to the air solenoids just as if he/she were writing to a remote power module output. The limitations to using air solenoids in advance logic is that the user can currently only write to four solenoids maximum. The user will find the Air Solenoid signals under the Chassis Tab once in Advance Logic.



Chassis Tab

In the example below with the key in the ignition or accessory position, the switch (custom named Air Solenoid 1) is in the up position, the park brake is applied, Air Solenoid Status is good (meaning the solenoids have power and air) and the pressure in the primary air tank is above 100 psi then the air solenoid will activate.



Example of Air Solenoid Logic

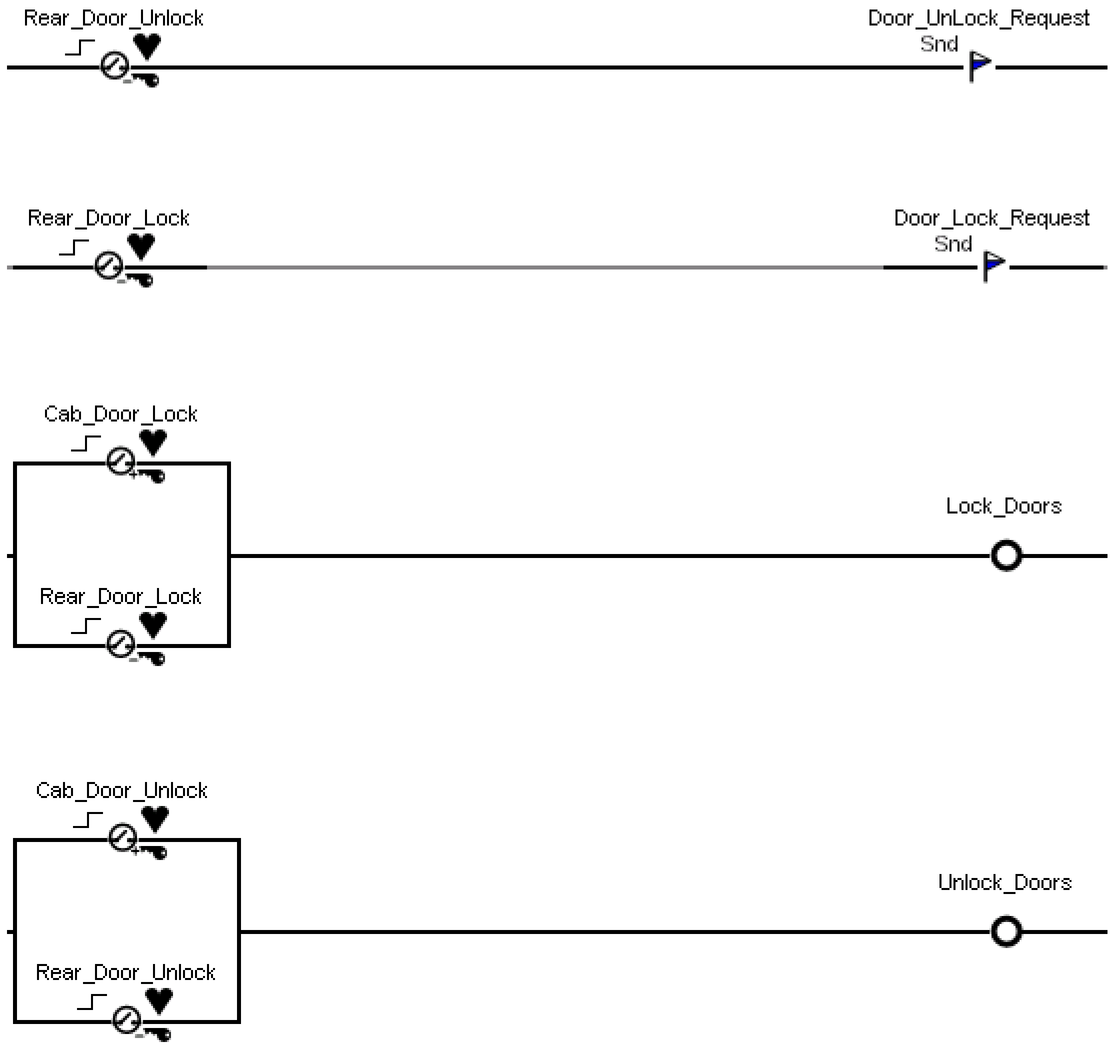
Center Panel View for Above Example

6.14 Using the Door Lock/Unlock Signals

Many vehicle applications have compartments and doors equipped with electrically actuated locks. In most cases, a remote mounted three-position momentary switch is utilized to lock and unlock these compartments. Often this control switch is also used to control locking and unlocking the cab doors and vice versa. In a completely hardwired system, this requires the TEM to splice into the wiring of both cab doors and the addition of numerous relays. The Diamond Logic® Builder advanced logic software provides the user access to signals for locking and unlocking the cab doors. The system can be further extended to utilize remote power module inputs and outputs to control locking and unlocking body compartment and doors.

The advanced logic required to lock and unlock the cab doors from a remote mounted switch is very simple. The lock and unlock switch inputs are fed into remote power module inputs and can be either active ground or 12V. The Door_Lock_Request and Door_Unlock_Request signals are found on the chassis tab of the advanced logic screen. When a lock or unlock input is received on the remote power module inputs, the electrical system controller will send a message to the cab doorpods to lock or unlock the cab doors. Remote power module inputs and outputs can also be utilized to control body compartment and door locks from the cab doorpods and a remote mounted switch.

To control body compartment locks and door locks from the cab doorpods, a lock and unlock input must be fed into remote power module inputs from either the driver-side or passenger-side door lock control circuits. The controls for unlocking and locking of the cab doors are reversing polarity. The inputs to the remote power module are spliced into the door lock motor circuits. To achieve dual control of lock/unlock requests for body compartment and door locks, the remote mounted switch input for lock request OR the input for lock request from the cab door will turn on an RPM output. The RPM output controls the state of a relay to provide a lock request to the body electric locks. The same is true for the unlock request. Refer to the figure below for an example of door lock/unlock advanced logic.



Door Lock/Unlock Request Advanced Logic

The following schematic illustrates the required electrical wiring to complete the advanced logic circuitry. The relay controlled by RPM output 1 provides proper polarity to lock the doors. The relay controlled by RPM output 2 provides proper polarity to unlock the doors. The function of each input into the remote power module is as follows:

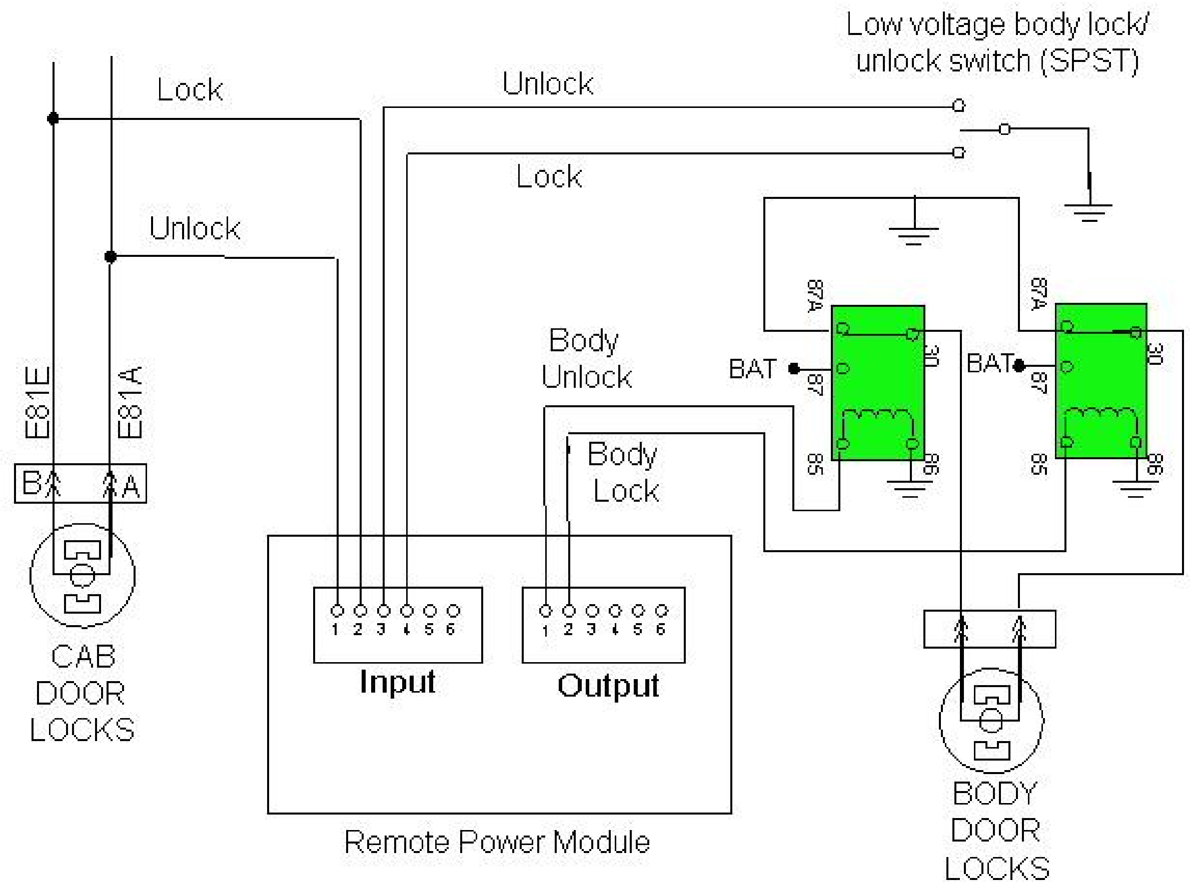
Input 1 - Activated by an unlock request from the cab doorpods which will unlock the cab doors and also activate output 1 to unlock the body locks.

Input 2 - Activated by a lock request from the cab doorpods, which will lock the cab doors and activate output 2 to lock the body locks.

Input 3 - Activated by an unlock request from the body unlock switch and sends an unlock request thru the datalink to the cab doorpod to unlock the cab doors.

Input 4 - Activated by a lock request from the body lock switch and sends a lock request thru the datalink to the cab doorpod to lock the cab doors.

Note: Remember to fuse the battery leads to the relays

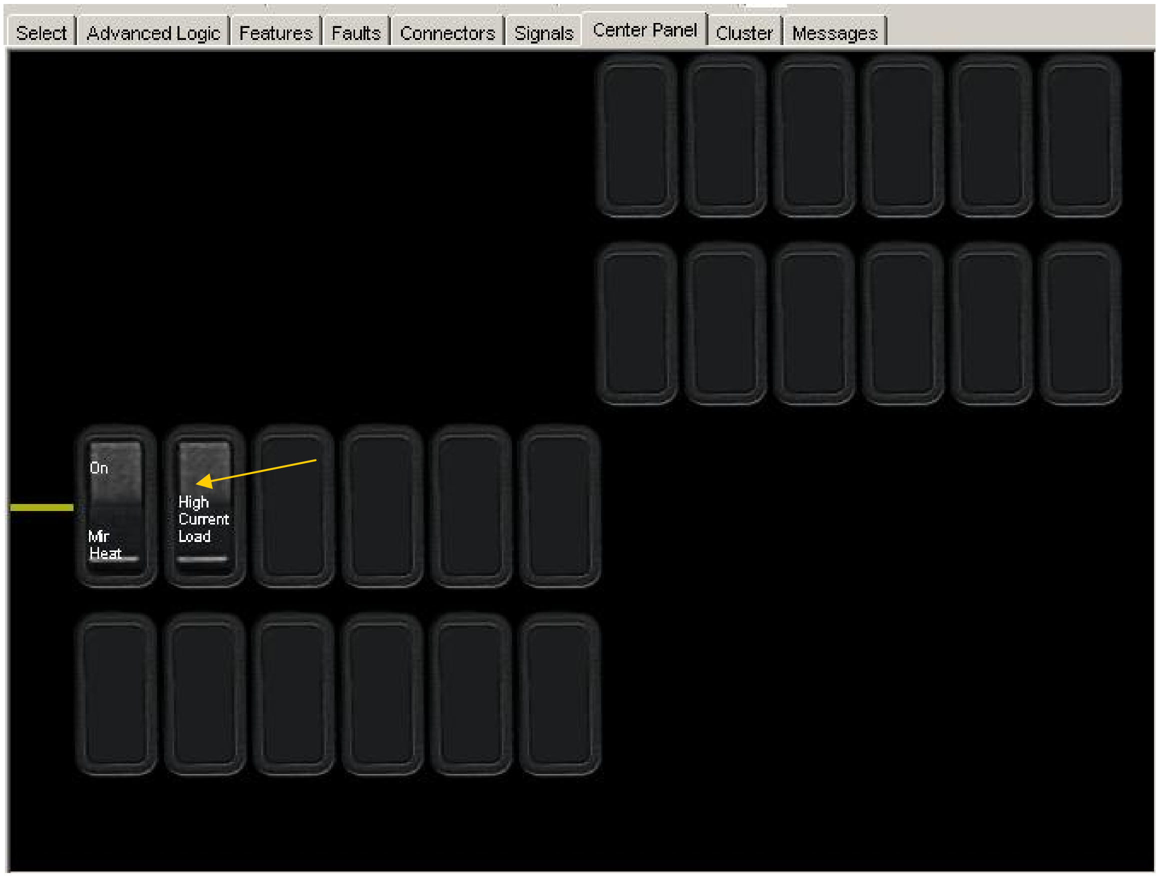


Door lock/unlock circuit to allow cab doorpod switches or body switch to lock and unlock both cab and body doors.

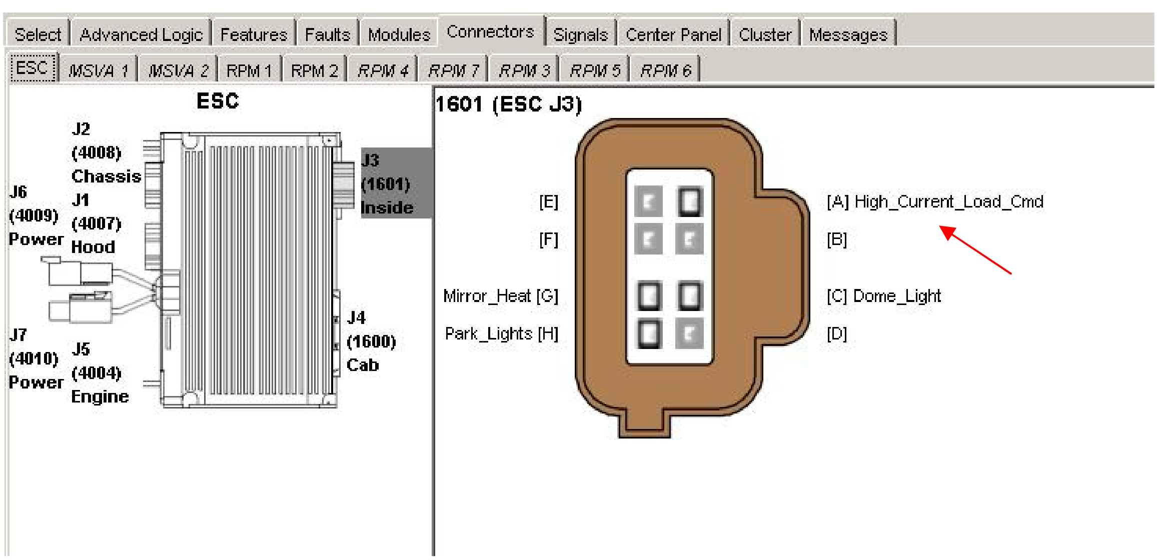
6.15 Controlling the Auxiliary 40 AMP Circuit

Diamond Logic® Builder provides the ability to control the **AUXILIARY 40 AMP CIRCUIT** using advanced ladder logic programming. If the vehicle was ordered with the AUXILIARY 40 AMP CIRCUIT, feature code **08XBK**, then all wiring and components will already be in place. For vehicles not ordered with this feature go to the 08XBK information in the **CT-471** Body Builder Data book and refer to **<u>HOW TO ADD THIS FEATURE</u>**.

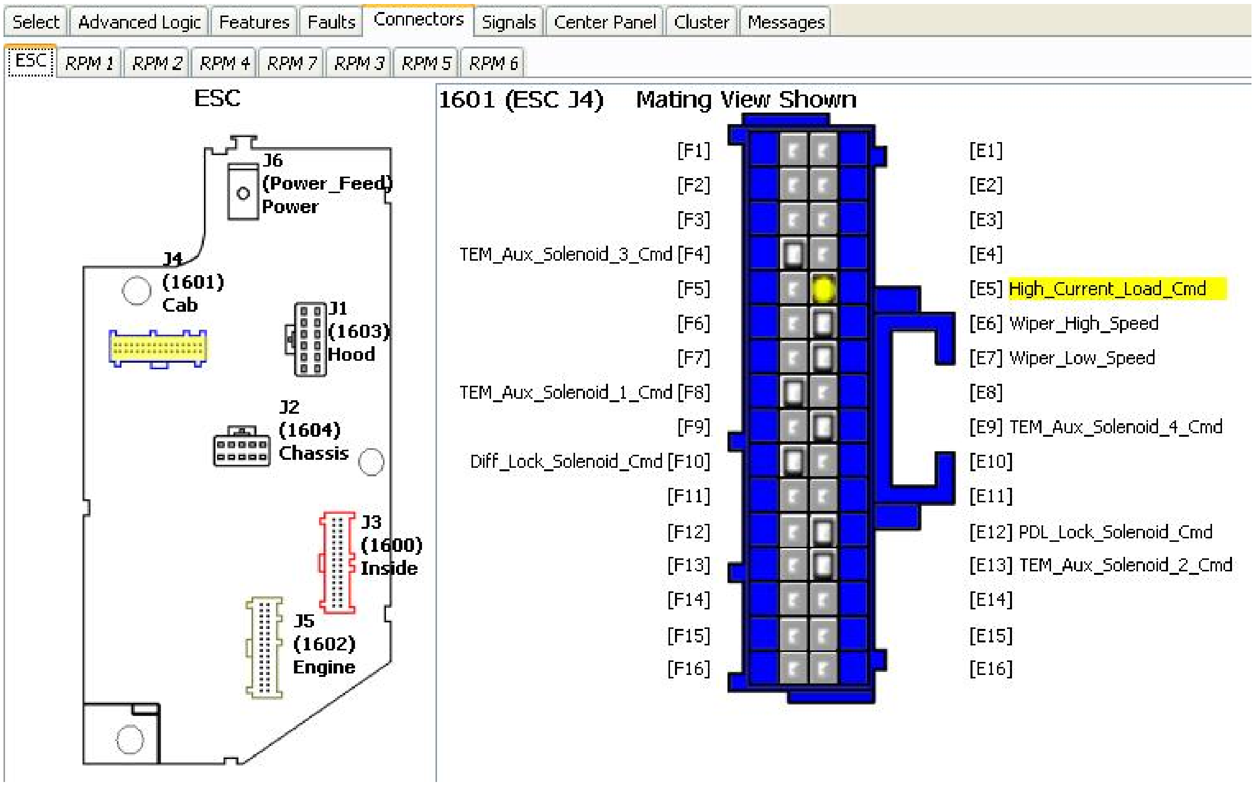
Vehicles ordered with feature 08XBK will also have feature code **595265 (TEM) ESC Prog, High Current Relay Load Output** or **595AJH BC PROG, SWITCH AUXILIARY In Center Panel, With 40 amp Fuse Circuit, Accessory Controlled** installed. This can be verified by looking in the Center Panel tab, Connectors tab and the Features tab as shown below.



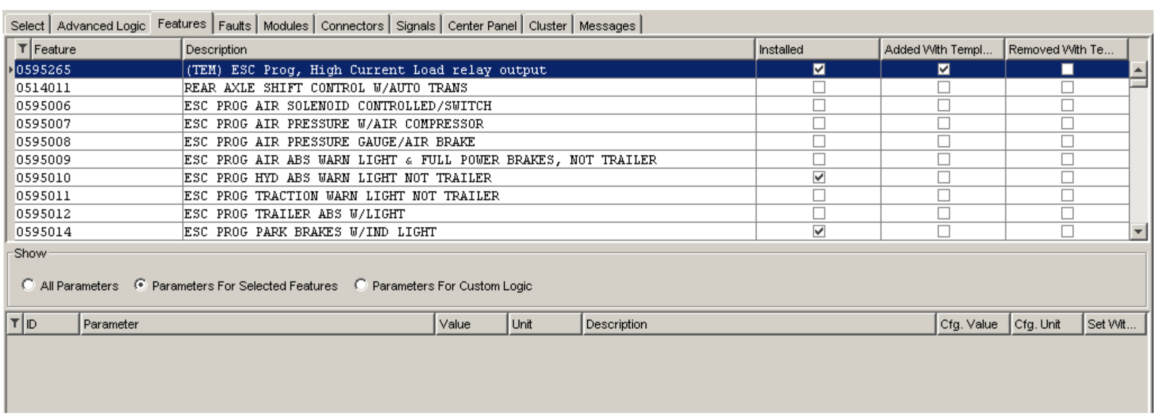
Center Panel tab



Connector Tab Pre 2007 Vehicles

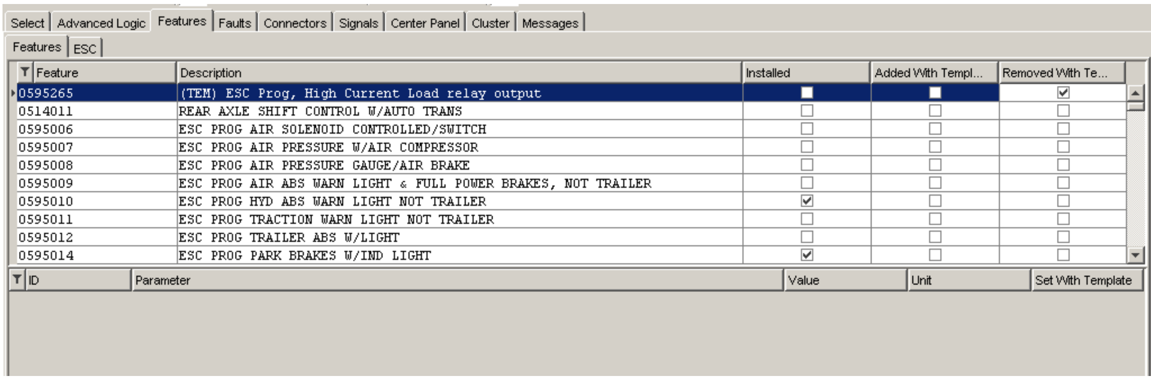


Connector Tab Post 2007 Vehicles



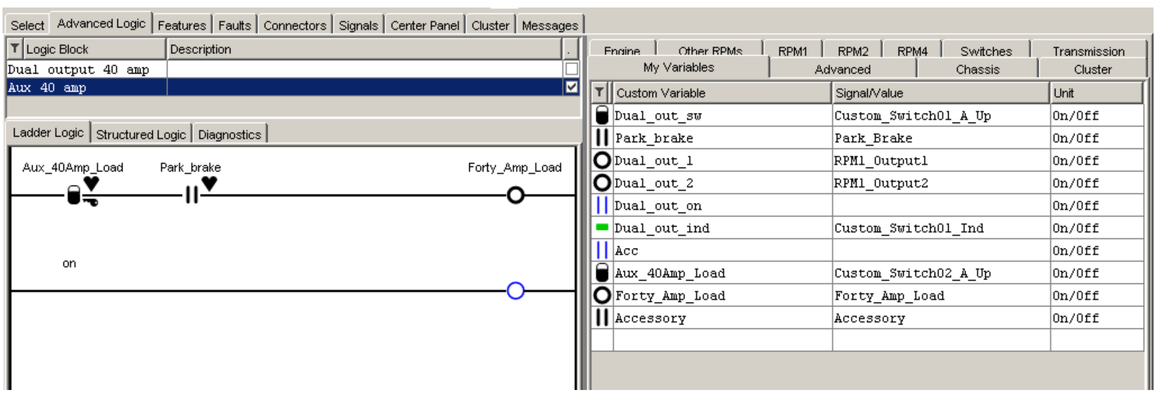
Features tab

In vehicles that were ordered with the pre-engineered feature it is necessary to **un-install feature code 595265 or 595AJH** to avoid conflicts with the ladder logic.
To un-install this feature in the template under development check the box in the "Removed With Template " column of the feature of interest.

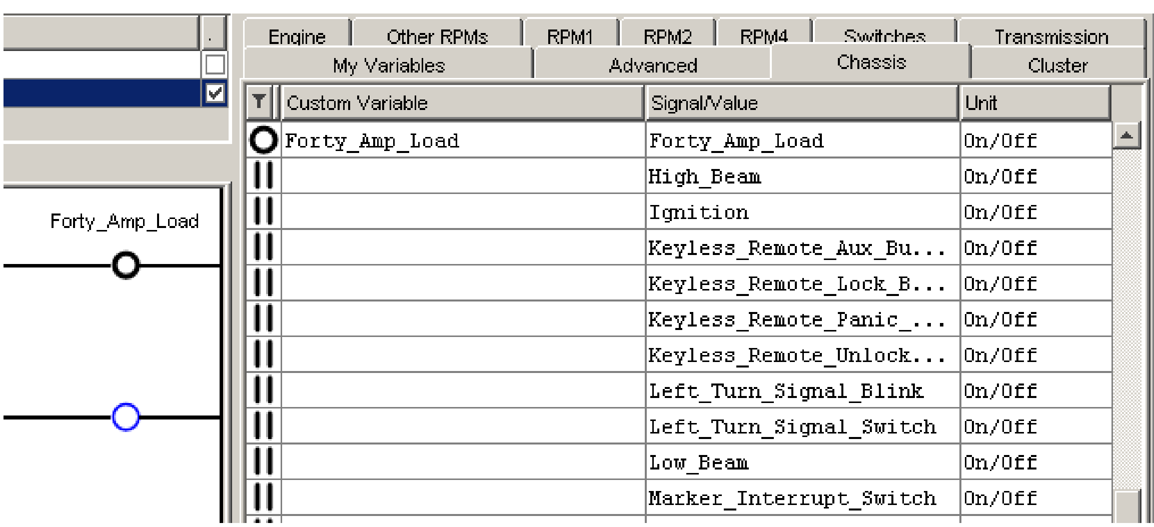


The un-install can then be verified by again looking at the Center Panel and Connector tabs. Once this un-install is completed the Advanced Logic development process is straight forward and the same for both types of circuit installations.

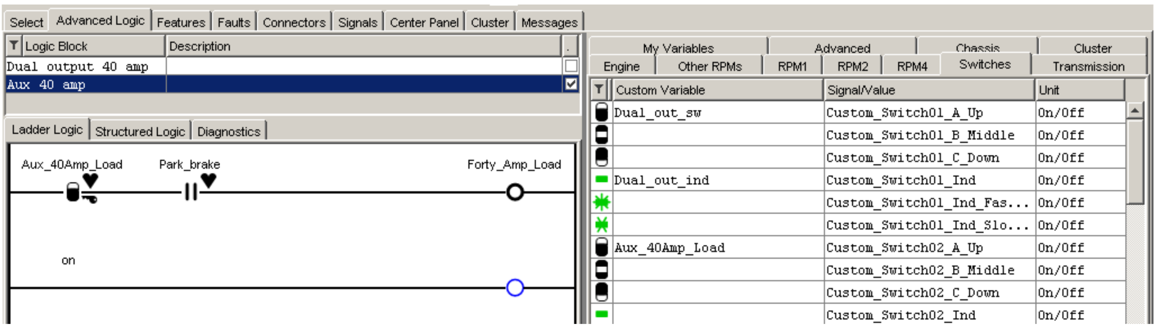
Below is an example of creating a 40-amp control rung with a Park_brake interlock.



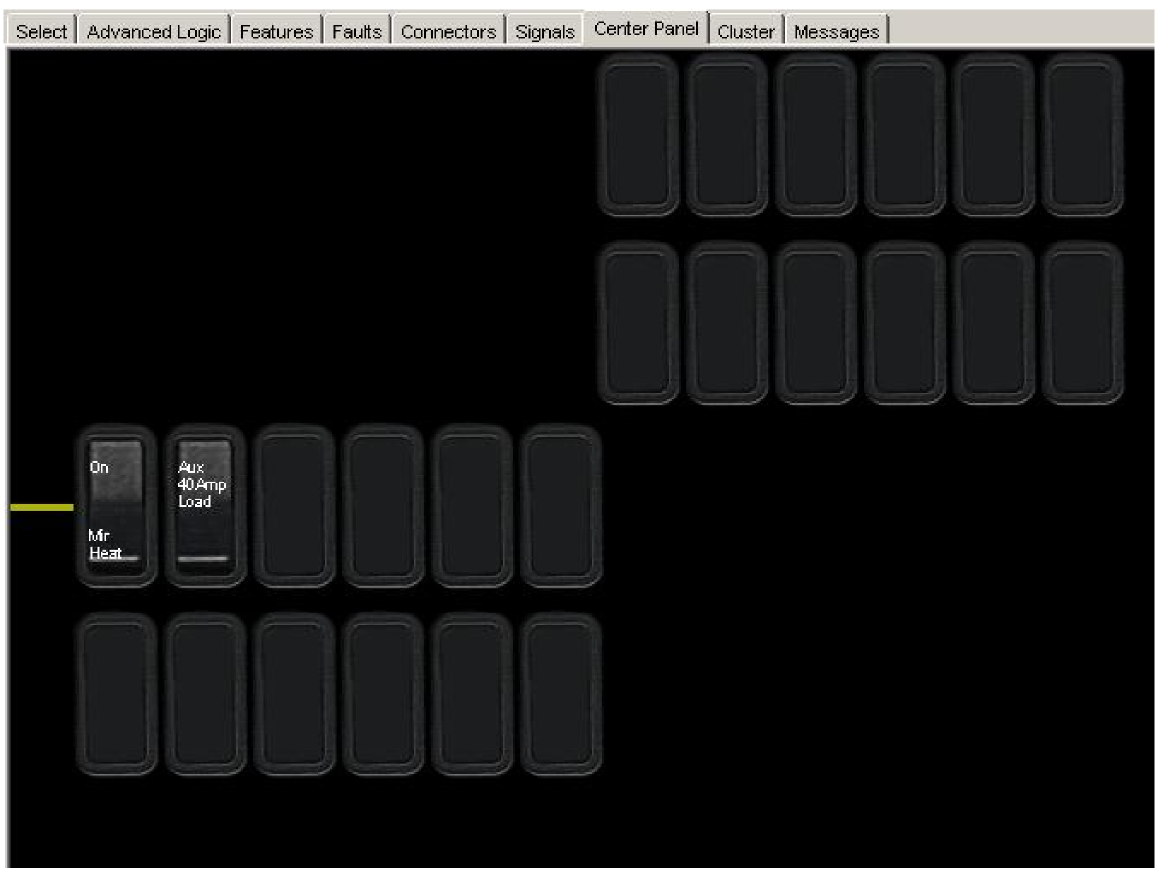
The Forty_Amp_Load, output side of rung, is found in the Chassis tab. In this case the automatic default of the Custom Variable name to the signal name was accepted by doing a drag-and–drop without assigning a custom name.



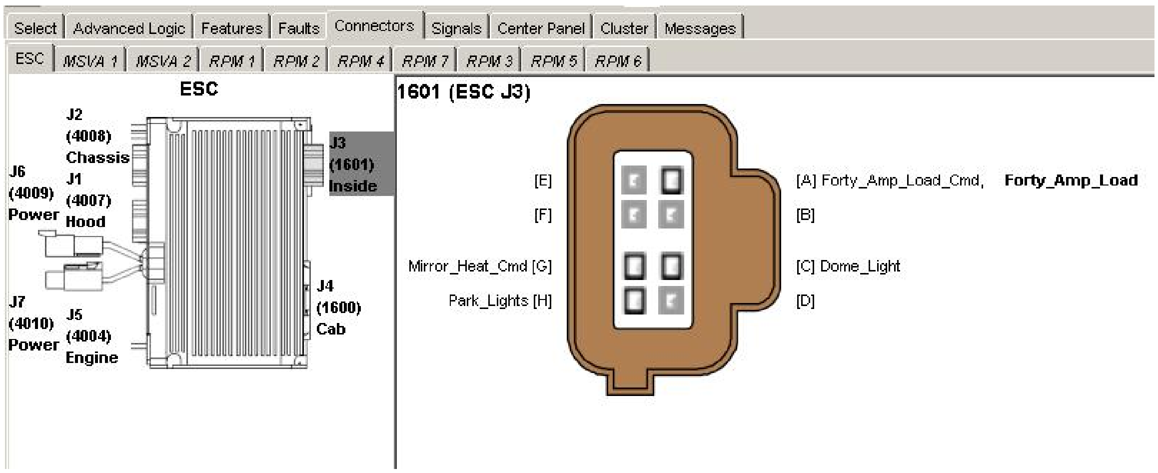
Custom_Switch02_A_Up was chosen as the control or input side of the rung and has been assigned the custom variable name Aux_40Amp_Load. Placement of the Park_Brake completed the rung.



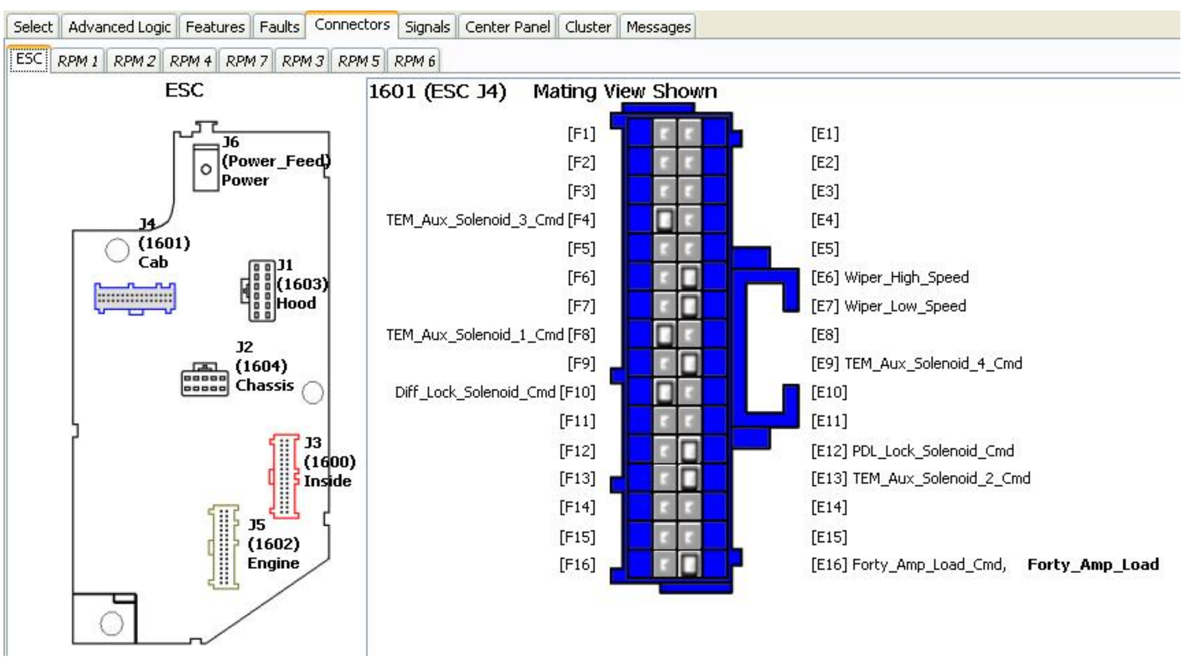
By looking at the Center Panel view it can be seen that the custom switch has been place in the assigned location.



In the Connector tab view, for pre 2007 vehicles, pin A still has the signal name used by the pre-engineered feature with the addition of the bold face signal name from Advanced Logic; indicating this output is controlled by custom ladder logic.



In the Connector tab view, for post 2007 vehicles, pin E16 still has the signal name used by the pre-engineered feature with the addition of the bold face signal name from Advanced Logic; indicating this output is controlled by custom ladder logic.



What was provided here was a very simple example of controlling the 40-amp circuit. With Advanced Logic there are many ways to provide interlocks, alarms and control engagement, disengagement and reengagement parameters. The complexity of the control logic depends on the requirements.

When using Advanced Logic to control the 40 amp circuit in a vehicle that was ordered with feature code 08XBK it is recommended that the original switch location be used if possible. For TEM installed 40 amp circuits a windowed switch actuator is needed for custom labeling or to change the labeling of the factor installed switch.

6.16 Remote Engine Speed Control

Diamond Logic® Builder provides a means to control engine speed using advanced ladder logic. The DLB engine speed control signals operate in conjunction with the cruise control switches in the steering wheel. This means that the DLB user is activating the same signals that are used by the steering wheel switches to control engine speed. Just like the cruise control switches in the steering wheel, the DLB engine speed control signals can only control the engine in either the PRESET or VARIABLE modes. This choice is set in the engine control module programmable parameters. Therefore the following ***Engine ECM*** parameters must be programmed as a minimum:

A. CAB Controls: Enabled
B. Preset or Variable Engine Speed Selection
C. Engine Ramping RPM per second
D. Preset 1 and Preset 2 Engine Speeds (when PRESET Mode is selected)

Diamond Logic® Builder uses four signals for controlling engine speed.

1. Engine_Speed_Enable_Disable

The Engine_Speed_Enable_Disable signal is used to request control of the engine speed. This signal correlates to the CRUISE ON and OFF switches in the steering wheel. When active, the cruise enable signal is active and other forms of vehicle engine speed controls will not be allowed to control the engine speed. When inactive, the cruise enable signal will be turned OFF. This signal is a READ/WRITE type. This signal must be held active as long as engine speed control from DLB advanced ladder logic is desired. Once the Engine_Speed_Control_Inhibited signal becomes active, this enable signal must be driven inactive and then active again in order to regain control of the engine speed.

2. Engine_Speed_Control_Inhibited

The Engine_Speed_Control_Inhibited signal is used to indicate when other engine speed control interfaces have active control of the engine. When other vehicle interfaces have control of engine speed, no requests from ladder logic will be acknowledged. This signal will be true for a variety of reasons:

- 060 Body Integration Remote Engine Speed Control features are active
- Remote Engine Speed Control Module (12VXY) interfaces are true
- Hard-wired interfaces connected directly into the engine control module such as 12VYC or12VVW are true.
- Park Brake is released
- Transmission is not in neutral (when vehicle is equipped with an automatic Transmission)
- Road Speed is greater than 3MPH.
- Brake pedal has been depressed
- A bad STATUS exists on any of the above listed signals.

Once the inhibit signal has become active, the ladder logic cannot take control of the engine speed again until the Engine_Speed_Enable_Disable signal has been placed into an inactive state.

3. Engine_Speed_Function_1

The Engine_Speed_Function_1 signal is used to request control of engine speed. This signal correlates to the Cruise SET switch on the steering wheel. A custom name should be assigned to this signal to make reading the ladder logic more understandable.

When the engine is programmed in the PRESET speed mode, this signal requests that the engine should ramp to the preprogrammed PRESET 1 engine speed. A single active transition of this signal is all that is needed to enable the PRESET 1 engine speed.

When the engine is programmed in the VARIABLE speed control mode, this signal requests that the engine should ramp down toward an idle RPM. The rate at which the engine slows down is determined by the value of the RPM step decrement in the engine programmable parameters. Since ladder logic is executed 50 times per second, the DLB user should use a small step in the engine programmable parameter for RPM steps to ensure that engine speed can be adequately controlled using this signal. If an RPM limit is not used, engine speed will be driven to idle very quickly. See the Variable Engine Speed control logic as an example of one method to control engine speed assuming the engine is programmed in the VARIABLE mode.

4. Engine_Speed_Function_2

The Engine_Speed_Function_2 signal is used to request control of engine speed. This signal correlates to the Cruise RESUME switch on the steering wheel. A custom name should be assigned to this signal to make reading the ladder logic more understandable.

When the engine is programmed in the PRESET mode, this signal requests that the engine should ramp to the preprogrammed PRESET 2 engine speed. A single active transition of this signal is all that is needed to enable the PRESET 2 engine speed.

When the engine is programmed in the VARIABLE mode, this signal requests that the engine should ramp up toward an RPM. The rate at which the engine speeds up is determined by the value of the RPM step increment in the engine programmable parameters. Since ladder logic is executed 50 times per second, the DLB user should use an RPM limit with this signal along with a small engine incrementing value to ensure that engine speed can be adequately controlled using this signal. If an RPM limit is not used, engine speed will be driven to the maximum governed speed very quickly. See the Variable Engine Speed control logic as an example of one method to control engine speed assuming the engine is programmed in the VARIABLE mode.

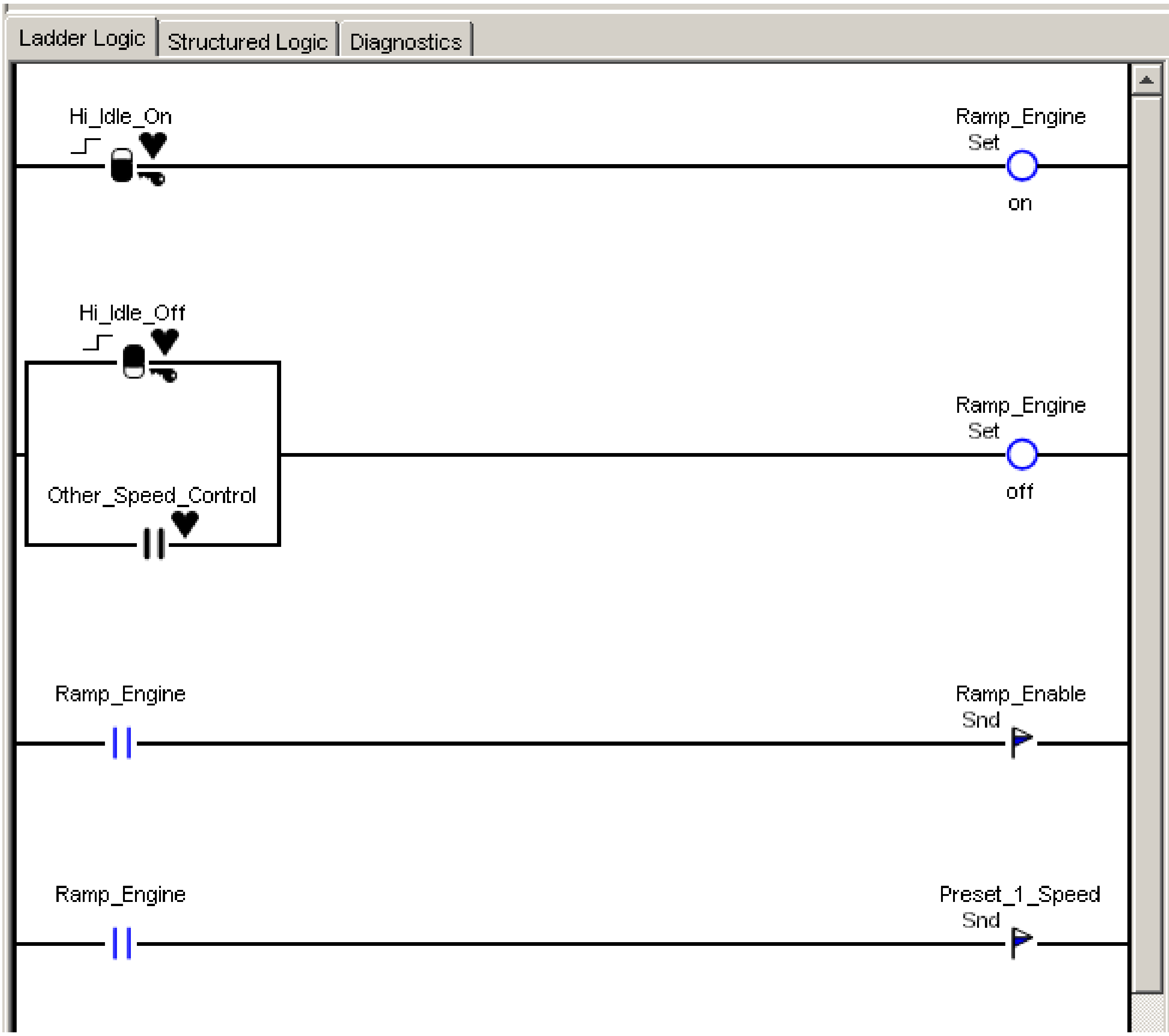
6.16.1 Preset Engine Speed Control

The simplest form of engine speed control involves engaging the PRESET 1 RPM for engine speed control. See the example below. This sample uses a momentary rocker switch to cause the engine to ramp to the first Preset engine speed. Pushing the switch to the up position causes an internal variable, Ramp_Engine, to be set ON. Pushing the switch down or the activation of the Other_Speed_Control signal by the ESC will cause the internal variable, Ramp_Engine, to be set OFF. The state of the internal variable, Ramp_Engine, then drives both the ENABLE and PRESET 1 control signals. The engine will then ramp to the PRESET 1 as long as no other vehicle interfaces have control of engine speed. Other inputs or logical interlocks may be used to control each of these engine speed control signals.

NOTE: Any time a ladder logic engine speed request is activated and another engine speed control interface has control of the engine or an engine speed control signal interlock has been violated, then the Other_Speed_Control signal will be set active. Once this signal is active, the Ramp_Engine signal must be set inactive and then active again to regain control of the engine speed.

This example uses the following naming convention for engine speed control signals.

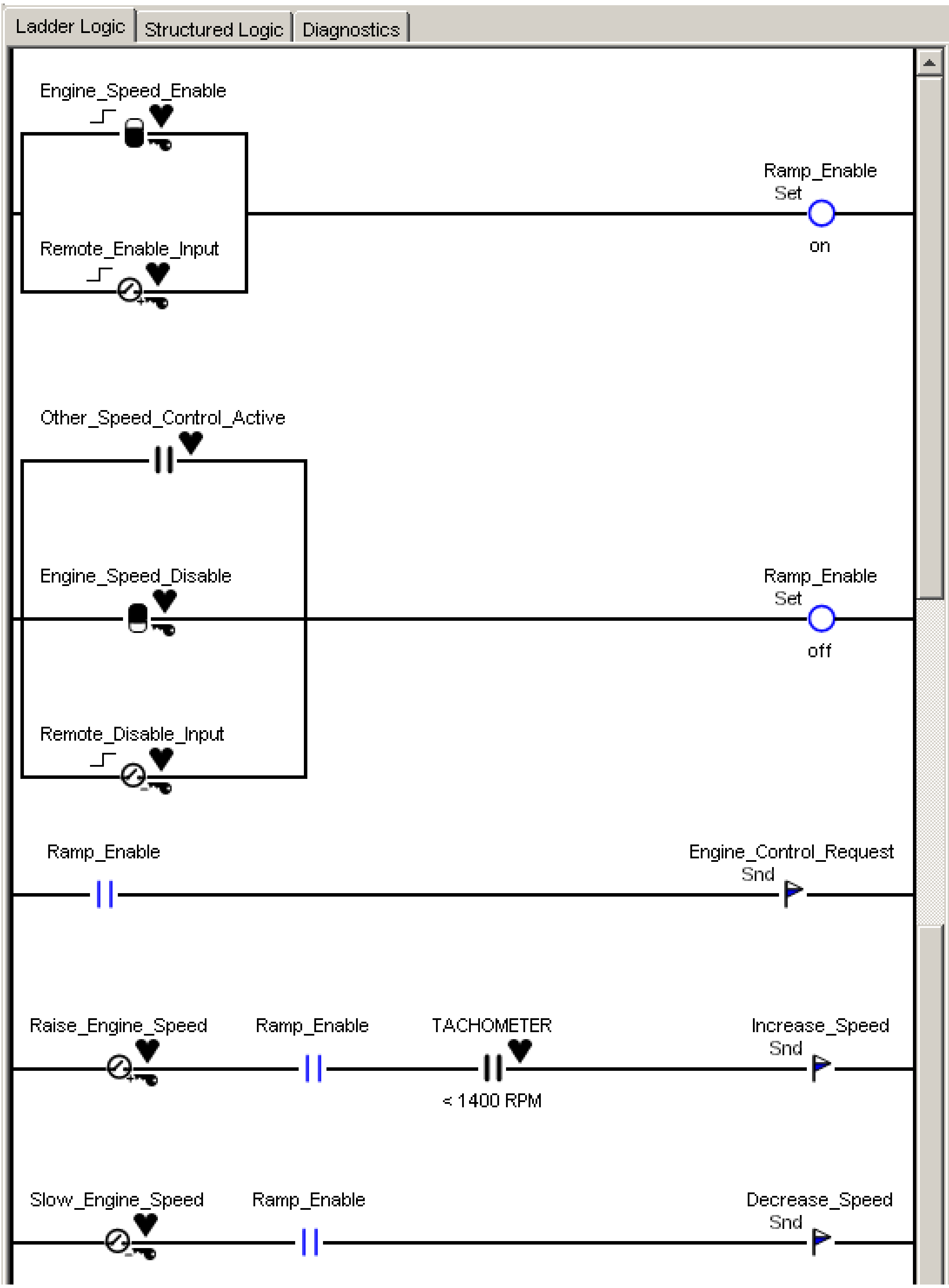
System Signal Name	Custom Name for the Signal
Engine_Speed_Control_Inhibited	Other_Speed_Control
Engine_Speed_Enable-Disable	Ramp_Enable
Engine_Speed_Function_1	Preset_1_Speed



Preset 1 Engine Speed Control Example

6.16.2 Variable Engine Speed Control

Another form of engine speed control involves ramping the engine speed up or down upon activation of a few input signals. See the example below for a method to provide a Variable Engine Speed Control logic block.



Variable Engine Speed Control Example

This sample uses a momentary rocker switch in the cab or a remote switch input to a remote power module to enable controlling of the engine speed. Pushing the switch to the up position or connecting 12 volts to an RPM input causes an internal variable to be set ON. Pushing the cab switch down or placing a ground on the RPM input or the activation of the Other_Speed_Control_Active signal by the ESC will cause the internal variable, Ramp_Enable, to be set OFF. The state of the internal variable Ramp_Enable, determines whether the main speed control inputs will be allowed to control engine speed. Once Ramp_Enable is true, then Engine_Control_Request is turned ON. The last two rungs show that the engine speed may now be increased or decreased based upon which input signal is active and as long as the Ramp_Enable signal is true. The tachometer interlock speed set to 1400 ensures that the engine is not ramped higher than this limit. Since advanced ladder logic is executed 50 times per second, an RPM limit is a good practice to incorporate to prevent a run away engine speed to the maximum governed engine speed. Other inputs or logical interlocks may be used to control each of these engine speed control signals.

NOTE: Any time a ladder logic engine speed request is activated and another engine speed control interface has control of the engine or an engine speed control signal interlock has been violated, then the Other_Speed_Control_Active signal will be set ON. Once this signal is active, the Ramp_Engine signal must be set inactive and then active again to regain control of the engine speed.

This example uses the following naming convention for engine speed control signals.

System Signal Name	Custom Name for the Signal
Engine_Speed_Control_Inhibited	Other_Speed_Control_Active
Engine_Speed_Enable-Disable	Engine_Control_Request
Engine_Speed_Function_1	Decrease_Speed
Engine_Speed_Function_2	Increase_Speed

6.17 Suspension Dump Feature

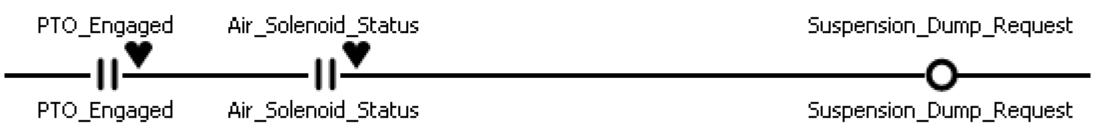
Certain applications, such as ambulance, require the ability to activate suspension dump from a remote input. The current factory suspension dump feature does not readily offer the TEM the ability to integrate remote activation of the suspension dump and requires the use of additional air solenoids or relays. Diamond Logic® Builder Advanced Logic can be utilized to customize the suspension dump feature to accept a remote input from a Remote Power Module requiring no additional relays or air solenoids. Advanced logic can also be written to request the suspension to dump after other parameters are met (Ex: PTO is engaged).

There are currently two versions of the factory suspension dump feature. Chassis built prior to September 2003 utilize a single air solenoid. Chassis built September 2003 or after utilize two air solenoids plumbed through a shuttle valve.

6.17.1 Simple Suspension Dump

The Suspension_Dump_Request Signal can be used for simple Suspension Dump requirements on vehicles with the single or dual solenoid Suspension Dump. This signal can be used with switch inputs, remote inputs on RPM's or in conjunction with other parameters.

The logic below is an example of suspension dump control activated when the PTO is requested.



The Air_Solenoid_Status signal is used to identify that the air solenoid pack has power and air pressure is applied.

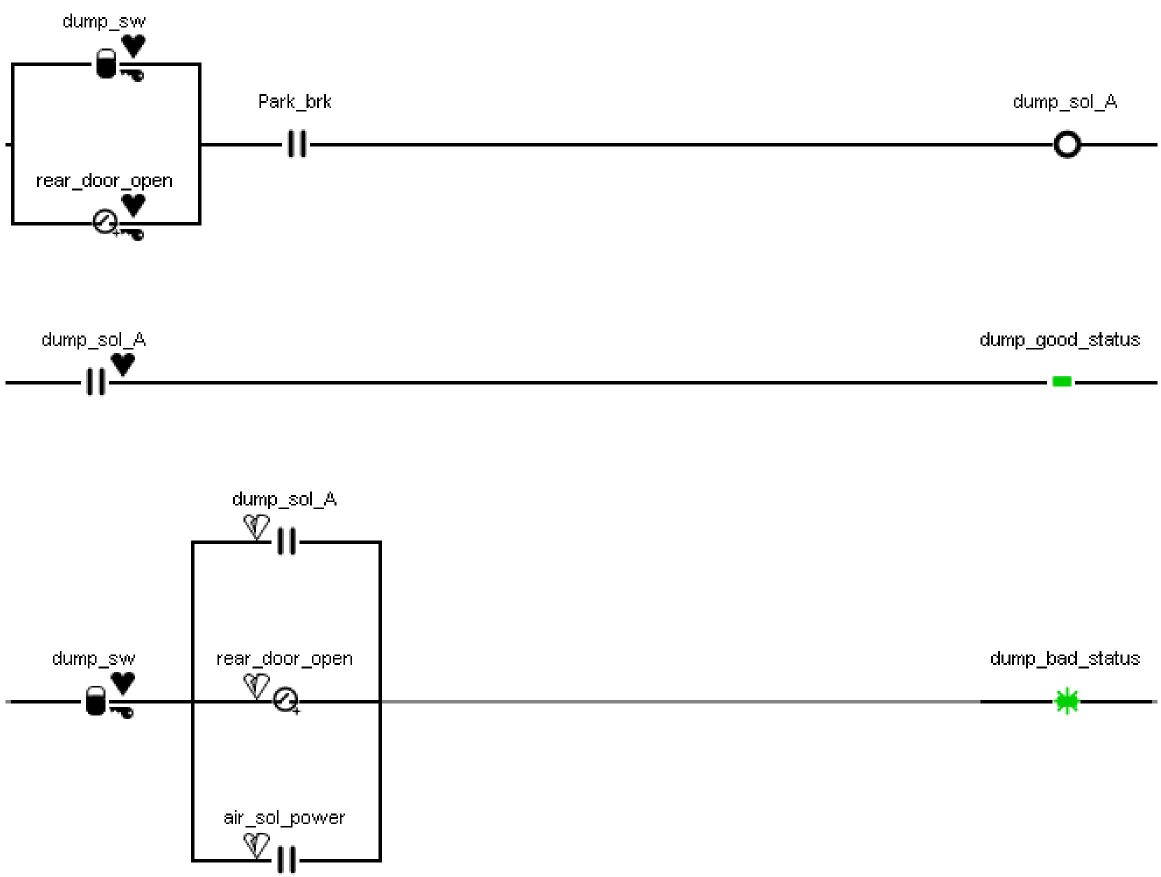
6.17.2 Complex Suspension Dump controlled via single air solenoid

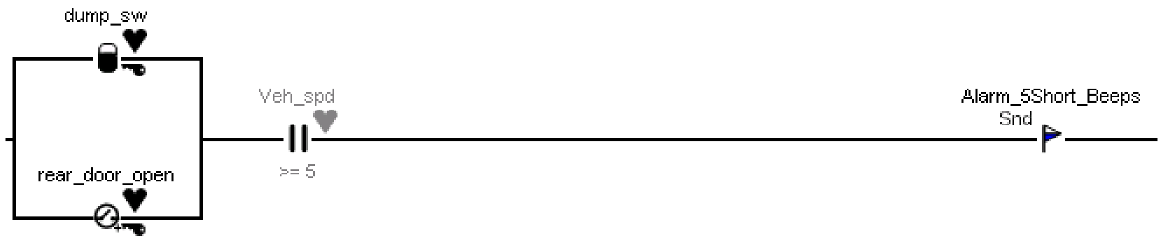
> **Note: this method of controlling the suspension dump is more complex and may not be necessary, if the Simple Suspension Dump meets your requirements.**

Chassis built prior to September 2003 utilize a single air solenoid for suspension dump control. The location of the air solenoid control wiring that controls suspension dump can be verified with the Diamond Logic® Builder software. If the chassis is equipped with a hard-wired four-pack air solenoid module, the solenoid control wire pin location can be viewed from the Connectors tab by selecting the ESC tab and the 4004 connector. If the chassis is equipped with a multiplexed seven-pack remote air solenoid module, the suspension dump air solenoid can be viewed from the Connectors tab by selecting the MSVA 1 tab.

Verifying the location of the solenoid is important prior to applying the advanced logic template to the VIN. The factory suspension dump software feature must be removed as part of the advanced logic template. The hardware and solenoid plumbing will remain in place. After applying the template re-verify the location of the solenoid wiring to ensure the proper solenoid is controlling the suspension dump operation. To replace the factory suspension dump feature, a new template must be created from the specific VIN that it will be replaced on. This is to ensure the appropriate combination of features requiring air solenoids is accounted for.

Remove with template must be selected for feature **595042** as part of the template. A solenoid control is created using Univ_Air_Solenoid_1 located on the chassis tab in the advanced logic screen. The switch in the dash is re-created using a custom switch from the switches tab. An available RPM input is used to provide a remote input to enable a suspension dump. The logic can be customized to any appropriate interlocks but **MUST** be minimally interlocked to either park brake or vehicle speed less than five miles per hour. The logic below is an example of suspension dump control with a single air solenoid.





Suspension Dump Control via Single Air Solenoid

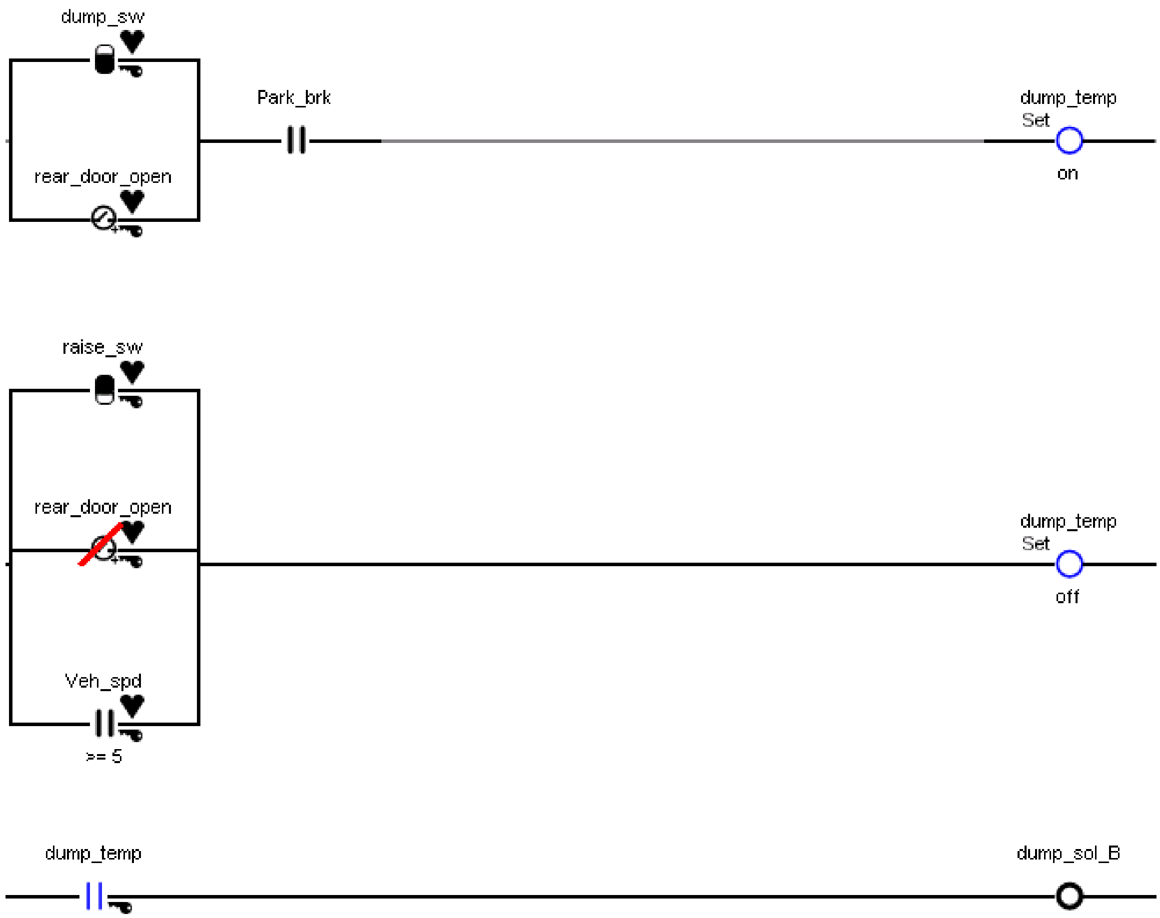
6.17.3 Complex Suspension Dump control via dual solenoids

> **Note: this method of controlling the suspension dump is more complex and may not be necessary, if the Simple Suspension Dump meets your requirements.**

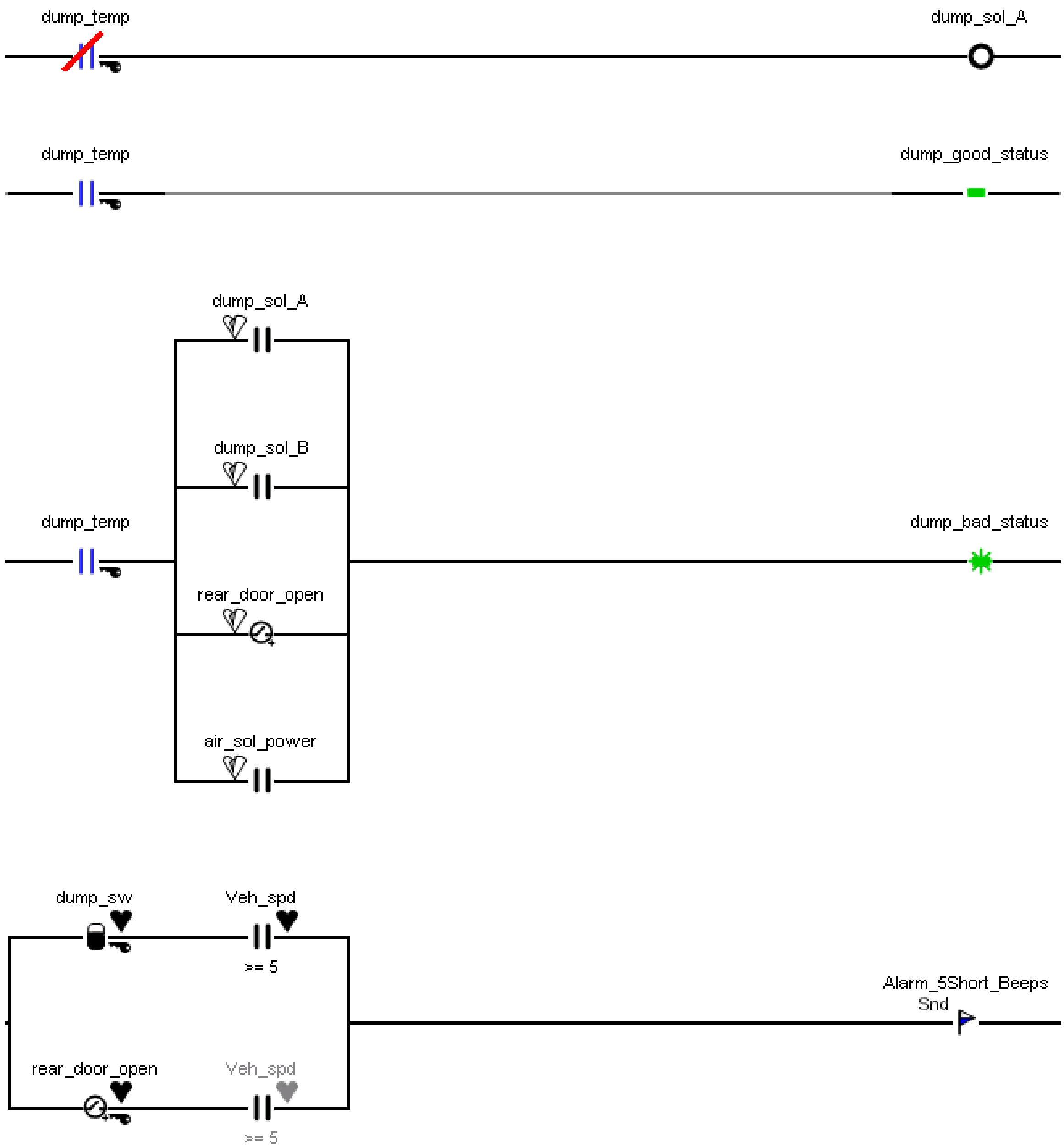
Chassis built September 2003 or after utilize dual air solenoids through a shuttle valve for suspension dump control. One solenoid is normally open and the other is normally closed. The solenoids control the position of the shuttle valve and the dump operation. The location of the air solenoid control wiring that controls suspension dump can be verified with the Diamond Logic® Builder software. If the chassis is equipped with a hard-wired four-pack air solenoid module, the solenoid control wire pin locations can be viewed from the Connectors tab by selecting the ESC tab and the 4004 connector. If the chassis is equipped with a multiplexed seven-pack remote air solenoid module, the suspension dump air solenoids can be viewed from the Connectors tab by selecting the MSVA 1 tab.

Verifying the location of the solenoids is important prior to applying the advanced logic template to the VIN. The factory suspension dump software feature must be removed as part of the advanced logic template. The hardware and solenoid plumbing will remain in place. After applying the template re-verify the location of the solenoid wiring to ensure the proper solenoids are controlling the suspension dump operation. To replace the factory suspension dump feature, a new template must be created from the specific VIN that it will be replaced on. This is to ensure the appropriate combination of features requiring air solenoids is accounted for.

Remove with template must be selected for feature **595273/595ACA** as part of the template. Two solenoid controls are created using Univ_Air_Solenoid_1 and Univ_Air_Solenoid_2 located on the chassis tab in the advanced logic screen. The solenoids work in opposition of each other and are never energized at the same time. The switch in the dash is re-created using a custom switch from the switches tab. An available RPM input is used to provide a remote input to enable a suspension dump. The logic can be customized to any appropriate interlocks but **MUST** be minimally interlocked to park brake and vehicle speed less than five miles per hour. The logic below is an example of suspension dump control with dual air solenoids.



Continued on the next page.



Suspension Dump via Dual Solenoids

Section 7 Advanced Programming Features

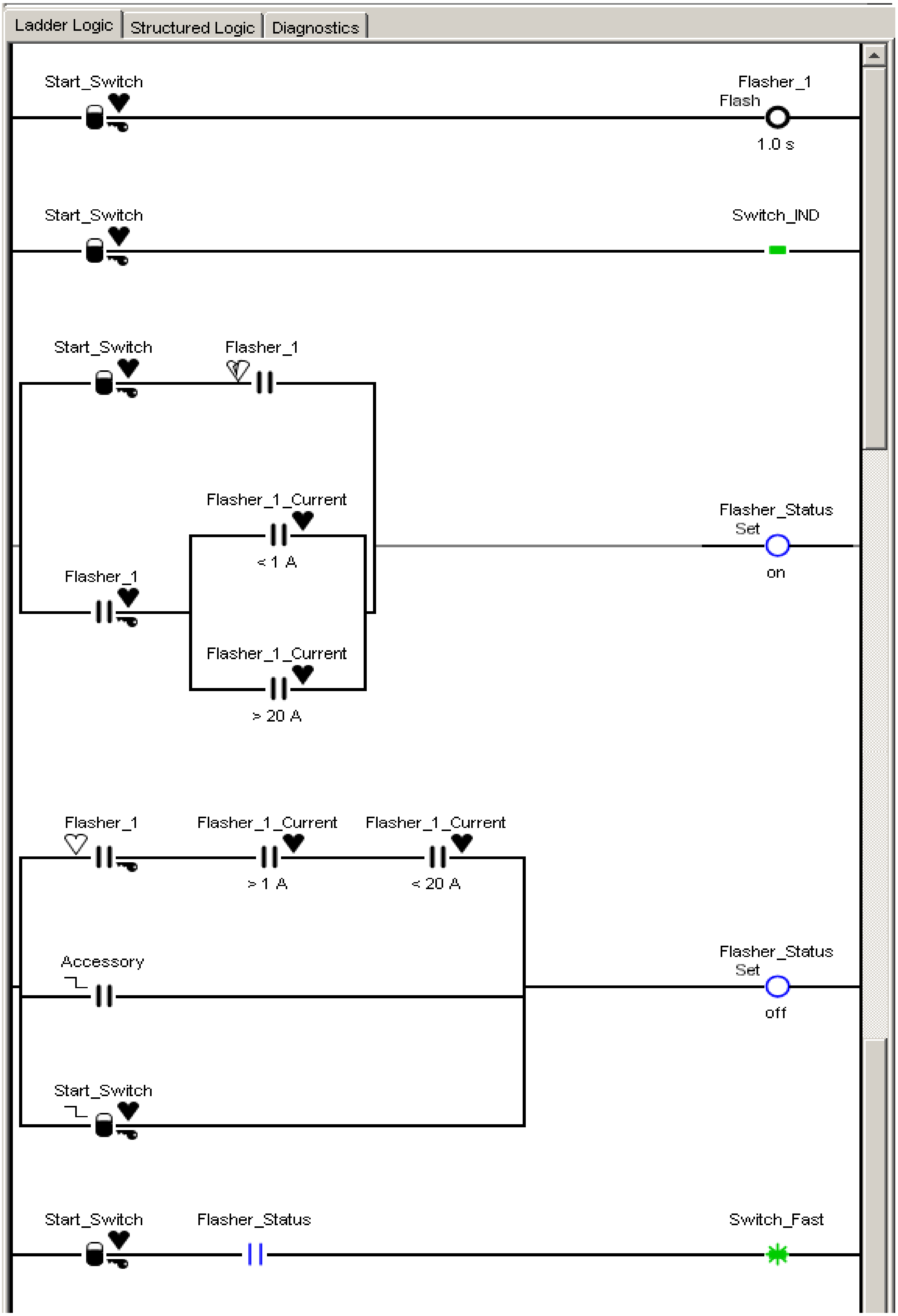
7.1 Flashers

The Diamond Logic® Builder program offers a number of advanced functions that make ladder logic programming quick and easy for performing specific body equipment control features. The Diamond Logic® Builder software user can configure these “canned” features to function as required by the vehicle application. Using these features eliminates the need to add third party control modules and / or components.

The Diamond Logic® Builder program provides a flexible flasher function that is useful for multiple applications. The flasher function may be used to control a single output or by using additional logic, a synchronized alternating flasher may be constructed to drive two or more outputs. The flasher may be used for body lamps, audible alarms or even to make the city horn beep in a repetitive manner. The flasher function provides a duty cycle of 50% ON and 50% OFF. Therefore, if the flasher is set to 1.0 second, the output will be ON for 0.5 seconds and OFF for 0.5 seconds. The time period of the flasher is adjustable by entering a value between .1 seconds and 600 seconds. Flashers may be constructed with a multitude of combinations of ladder logic signals before the flasher function is enabled. However for the purpose of training we shall examine two simple examples of turning on a flasher from a single rocker switch in the instrument panel. See the following examples.

7.1.1 Single Output Flasher

The first example shows a single output flasher. This flasher has a one second time period and directly controls one Remote Power Module output. The first rung will start the flasher as long as the rocker switch named Start_Switch is latched ON and the key is in the IGNITION or ACCESSORY position. The second rung provides an indication to the driver that the flasher is ON when the rocker switch is ON. Note that the flasher output could not be used directly to drive the green indicator in the Start_Switch since it will be blinking OFF and ON as a flasher. The third rung provides an indication to the driver when the Flasher_1 output is not functioning due to a bad status condition on the Remote Power Module output OR if the flasher output has a burned out bulb or is overloaded. A bad status will occur if the Remote Power Module has failed internally, the Remote Power Module Flasher_1 output is overloaded or shorted to ground, the communication link to the RPM has been broken or the Remote Power Module has lost it’s heavy current battery feed. A diagnostic fault code will accompany many of these failure modes. Other failure modes could occur in the electrical system that would render the Flasher_1 output signal inoperative. Failures within the switch pack or cabling to the switch pack would also cause the Flasher_1 output to be OFF, even though the Start_Switch is latched ON. However, if a fault exists in the switch pack, it is not likely that communication between the ESC and the switch pack can be established to flash the green indicator in the switch about the problem. Therefore, the third, fourth and fifth rung merely check for bad status on the Flasher_1 signal.

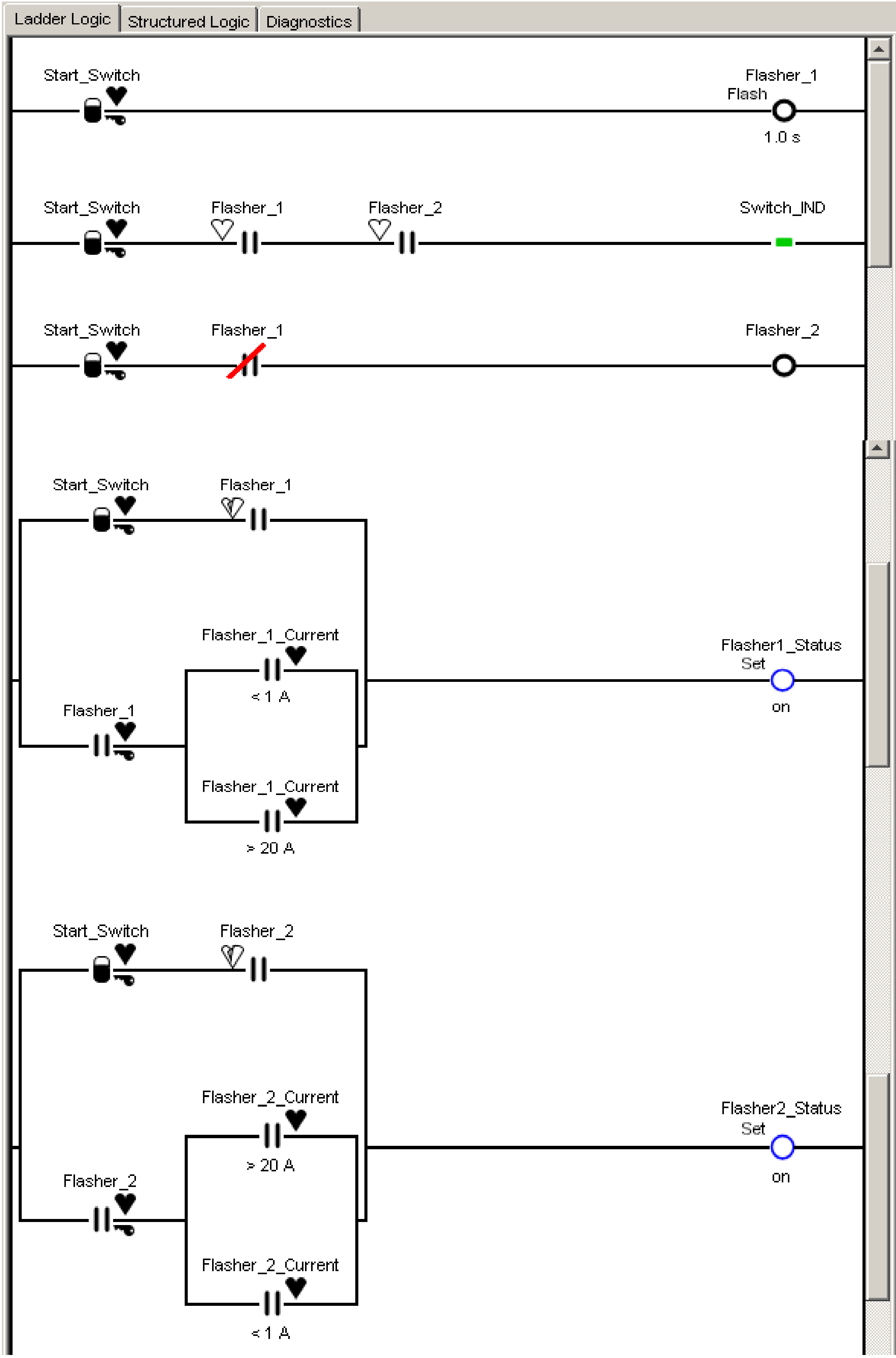


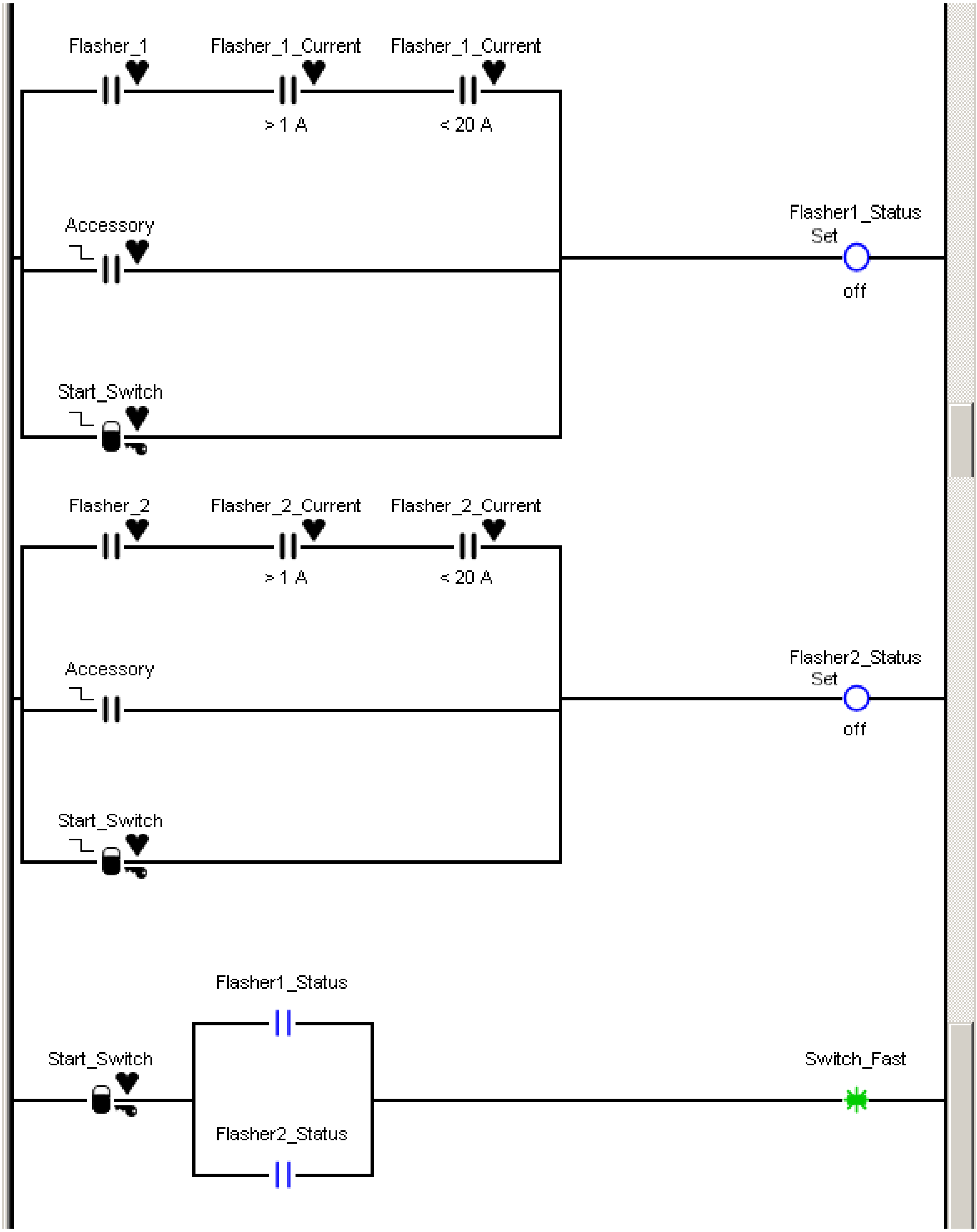
Single Output Flasher Example

7.1.2 Dual Output Alternating Flasher

The second example shows a synchronized alternating flasher. This flasher has a one second time period and directly controls two Remote Power Module outputs. The first rung will start the flasher as long as the rocker switch is ON. The second rung provides an indication to the driver that the flasher is ON when the rocker switch is ON. The third rung will turn on a second Remote Power Module output if the rocker switch is ON and the key is in the ACCESSORY or the IGNITION position. The second output is driven by the inverted state of Flasher_1. Note the use of the “Negate” attribute has been applied to the Flasher_1 output on this rung. Therefore, when Flasher_1 is ON, Flasher_2 is forced OFF. When Flasher_1 is OFF, Flasher_2 is forced ON. Including the rocker switch with the ACCESSORY check is required on this rung because Flasher_2 would always be ON with the ignition key and / or the rocker switch turned OFF. Placing the rocker switch on both rungs ensures that both flasher outputs will be OFF when the flashers are meant to be OFF. The state of these outputs will change every 0.5 seconds if the flasher period is set to 1.0 second. This method provides a well-controlled alternating flasher for two or more outputs.

The fourth rung provides an indication to the driver when the Remote Power Module is not functioning due to a BAD STATUS condition on either the Flasher_1 signal or the Flasher_2 signal or if either flasher output has a burned out bulb or is overloaded. A bad status will occur if the Remote Power Module has failed internally, the Remote Power Module Flasher_1 or Flasher_2 outputs are overloaded or shorted to ground, the communication link to the RPM has been broken or the Remote Power Module has lost its’ heavy current battery feed. A diagnostic fault code will accompany many of these failure modes. Other failure modes could occur in the electrical system that would render the Flasher_1 or Flasher_2 output signals inoperative. Failures within the switch pack or cabling to switch pack would also cause the outputs to be OFF, even though the Start_Switch is latched ON. However, if a fault exists in the switch pack, it is not likely that communication between the ESC and the switch pack can be established to flash the green indicator in the switch about the problem. Therefore, the third, fourth and fifth rungs check for bad status on the Flasher_1 and Flasher_2 signals as well as open or short circuit. Note that the check for bad status on the fourth rung uses an OR condition, meaning that a bad status on either of the two flasher outputs will cause the green indicator in the Start_Switch to display a fast flashing pattern to indicate that a problem exists in the flasher circuits.


Ladder Logic
Structured Logic
Diagnostics
Start_Switch
Flasher_1
Flash
1.0 s
Start_Switch
Flasher_1
Flasher_2
Switch_IND
Start_Switch
Flasher_1
Flasher_2
Start_Switch
Flasher_1
Flasher_1_Current
< 1 A
Flasher1_Status
Set
on
Flasher_1
Flasher_1_Current
> 20 A
Start_Switch
Flasher_2
Flasher_2_Current
> 20 A
Flasher2_Status
Set
on
Flasher_2
Flasher_2_Current
< 1 A



Alternating Dual Output Flasher Example

7.1.3 Diagnostic Descriptions for Flashers

The diagnostic description for flashers should be entered in the “Diagnostics” Tab of the ladder logic view. This description should contain an overall summary of all the signal elements or interlocks that must be true before the flasher will operate. In our example, the description is very simple and would indicate that a rocker switch shall control a Remote Power Module output in a one second flasher sequence as long as the ignition key is in the ACCESSORY or IGNITION position. List in detail all inputs and outputs including switch position in a specific switch pack, plus signal assignments to an output of a specific Remote Power Module address. This text description should contain all AND & OR logical terms in conjunction with specific signal names. Finally a diagnostic summary should be included to identify what indications the driver or technician might witness during various failure modes. In our example, only a fast flashing sequence would be visible to the vehicle user while there are fault conditions present that are associated with the Remote Power Module that is powering the flasher output(s).

7.1.4 Diagnosing Flasher Circuits

Diagnosing flasher circuits may be accomplished with a few simple checks:

1. Check that the Remote Power Module has battery voltage at the red power feed input.
Note: the module is protected with a fusible link at the battery box or starter stud.

2. Check for a fast flashing green indicator in the rocker switch that controls the flasher. Check for burned out bulbs in the flasher system. No electrical system fault codes will be generated for burned out bulbs or open wiring between the RPM and the bulbs. If yes, perform step 3. If there are no fast flash indications and the flasher does not operate, go to step 4.

3. Check for fault codes associated with the Remote Power Module used with the flasher. Resolve using the Diagnostic Troubleshooting Guide.

4. Check for fault codes associated with the switch pack module used with the flasher. Resolve using the Diagnostic Troubleshooting Guide.

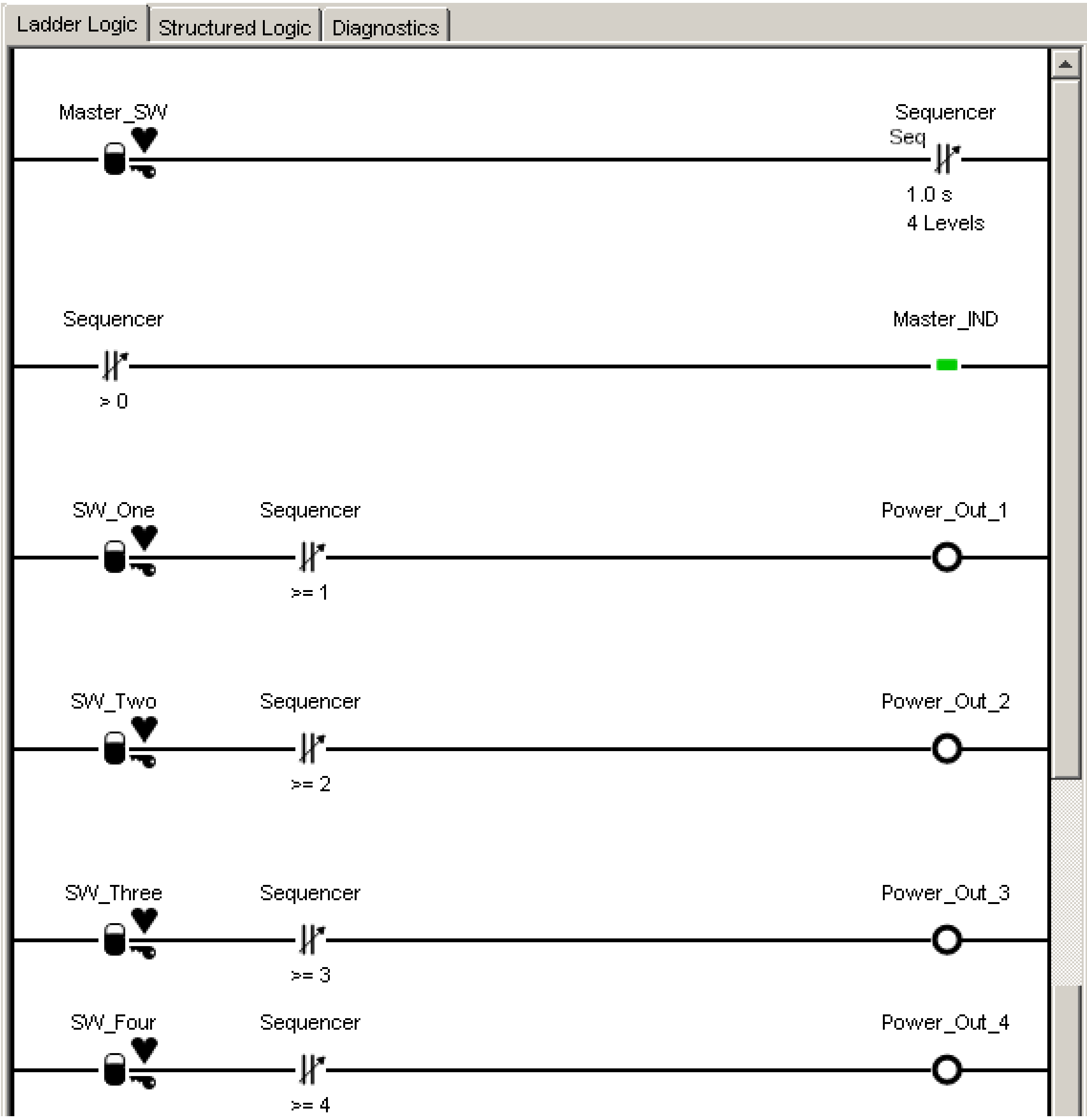
5. If the Diamond Logic® Builder program is available to the technician, select the Advanced Logic View and place the program in Diagnostic mode while connected to the vehicle under test. Examine the signals on each ladder and verify that the indication of OFF or ON is displayed based upon physical state of each input. Note whether the flasher outputs are blinking ON and OFF as desired. Note that the ON / OFF indications will respond at a slower pace than real time for flashers faster than two seconds.

7.2 Master Switch with Load Sequencing

The Diamond Logic® Builder program provides a load sequencing function that may be coupled with a Master Switch control. Certain vehicle applications require the convenience of using a single master switch to enable a number of other switch controlled outputs for enabling body lamps or other loads. Load sequencing is valuable when a master switch will enable multiple high current outputs. Load sequencing is necessary to prevent large voltage dips, due to in-rush currents, that would occur if all outputs were enabled at the same instant. The voltage dips could be great enough to set off low voltage alarms or cause some vehicle circuit modules to go into a reset mode. Sequentially turning power outputs OFF or ON will keep the vehicle battery levels more constant during these modes and prevent electrical malfunctions. The Diamond Logic® Builder software makes incorporating this feature very easy by providing the user a “canned” special function icon to perform this load-sequencing task. A common rocker switch is used as the master switch element.

7.2.1 Master Switch & Load Sequencing Example

The following illustration is an example of a four-stage load sequencer with a master switch. This means that a single master switch will turn ON or OFF four additional outputs based upon the state of that switch. Each output can also be independently controlled using its respective rocker switch as long as the master switch is ON. The sequencer allows the user to enter a time in seconds between sequence steps. The same time shall be used for turning outputs OFF as well as ON. The sequence number entered with the icon is used as the starting point for a count up or count down control algorithm, i.e. a four means that there will be four levels of sequencing; see the illustration below.



Four Level Load Sequencing Controlled by a Master Switch

The master sequence example listed above shows the basic method of creating sequenced outputs. This diagram does not show all possible uses of the switch indicators to develop a fully operational solution. Refer to the diagnostic portion of this section for a complete example of a switch channel that is fully outfitted with diagnostic monitoring.

As with other examples, load sequencing does not need to be controlled by a single rocker switch. Any number of logical signals may be arranged as input interlocks to enable this function. However, for this example, a master switch will be used to control the sequencing. The sequencer works in the following fashion:

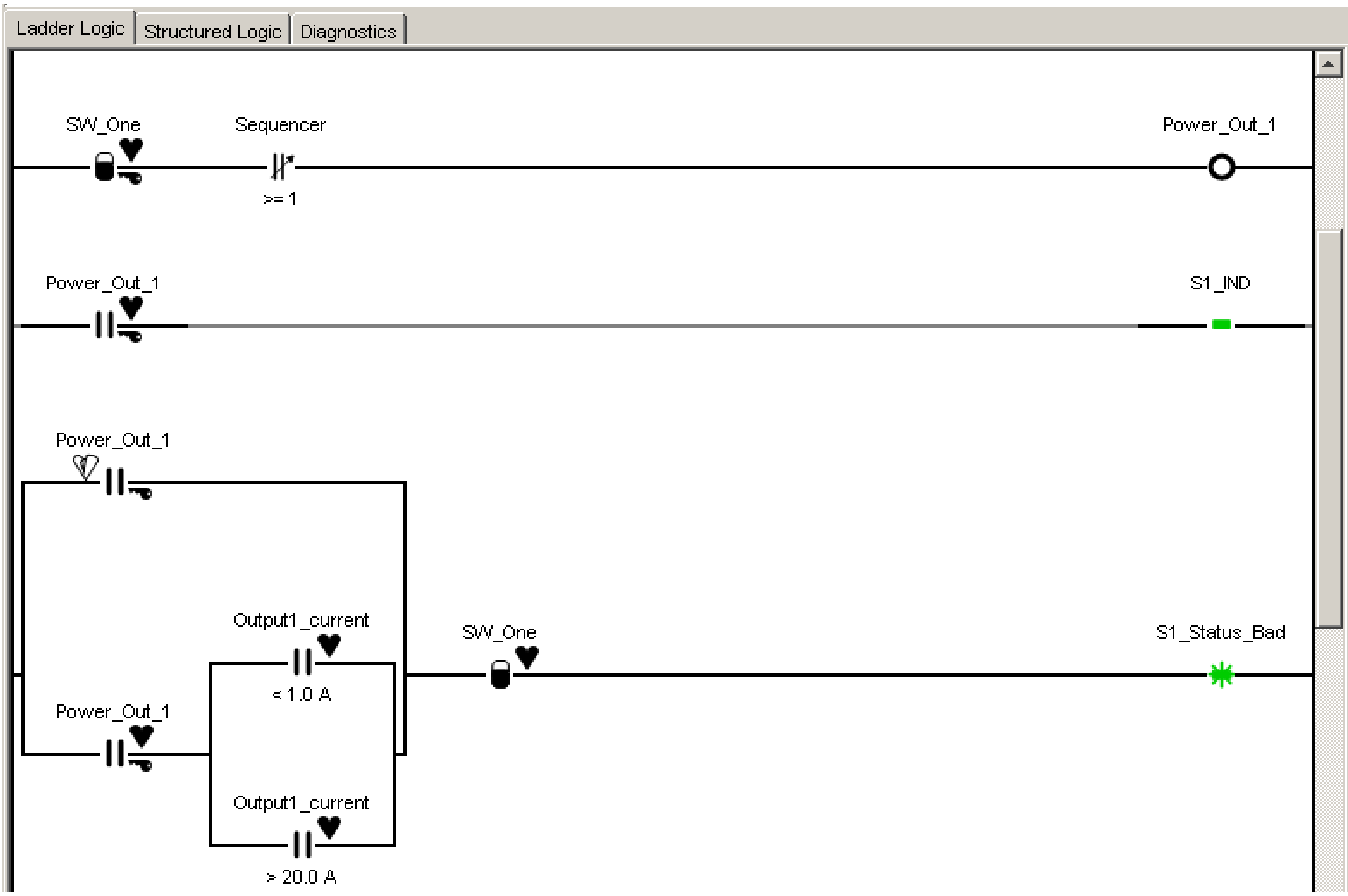
1. The Master Rocker switch is a two position latched switch that must be turned ON.
2. The first rung shows that a master switch enables a special icon signal that is labeled "sequencer." To create a sequencer signal select the My Variables tab and moving the cursor to the bottom of the Custom Variables list. Type in your sequencer name in the open space of the Custom Variable column. Using the left mouse switch, drag your sequencer signal to an open rung on the **OUTPUT SIDE** of your ladder logic view. You must drag your signal to the output side of a rung to make it into a sequencer function. Keeping the cursor over this signal, right click your mouse to expose a number of signal options. Check the entry labeled as sequence. Now your newly created signal is a load sequencing function. Note that the signal icon changed from a circle on the ladder rung to two vertical lines with an arrow through it.
3. Once you have created a load sequencer signal, you must now enter the number of outputs that you wish to be controlled by the sequencer function. The default number is two but you can change this value by placing your cursor over the numeral two and performing a left switch double click with your mouse. The number will now be highlighted. Enter your new number as a whole number or integer, no fractional tenths. Hit enter to lock in your new selection.
4. Next you need to review the time between steps of the load sequencer. The default time is 1.0 second per step. If this is acceptable leave the entry as is. If you wish to change the value, place your cursor over the 1 sec numeral and left double click with your mouse. The time will now be highlighted. Type in your new time with a value between 0.1 s and 600.0 s. Note that longer times will prevent outputs from being powered up until the time intervals have elapsed. This may be a nuisance when a vehicle is powered up and needed for service in a short time period. It is suggested that the 1.0-second time period is adequate for a load sequencer.
5. The next step is to place the same sequencer signal on **THE INPUT SIDE** of the ladder rungs that are to be managed with the load sequencer function. Using your mouse, drag and drop the sequencer to the first rung that is to be controlled. Note that the icon only has a number 2 located below it. This is the number that will decide when this rung is turned OFF or ON. Low numbers will be turned ON first and turned OFF last. Conversely, high numbers will be turned ON last and will be turned OFF first. Placing your cursor over the sequence number and performing left switches double click will change the sequence number. The sequence number will now be highlighted. Type in your new number with a value between 1 and some reasonable maximum number like 24. Note in the example above, you must use the >= in front of the sequencer number in order to ensure that output remains ON or OFF as the sequence number counts up or down.

6. Now that the sequencer signal has been configured and a sequencer signal icon has been placed on all ladder rungs that are to be controlled, let's review the theory of operation. Once the master switch has been latched ON and the key is in the ACCESSORY or IGNITION position, the sequencer function will begin counting up from zero to the maximum number located in the first sequencer icon. The time between steps is also found in the first sequencer icon. See the first rung in the example above. As the sequencer number is equal to or greater than the number attached in each ladder rung, the respective output will be enabled. Once the sequencer reaches the maximum count, the sequencer count will stay at that number. Note that the green indicator in the Master switch will be ON any time the sequencer count is any number greater than zero, i.e. any time a sequenced output is still ON.
7. Once the Master rocker switch has been turned OFF or the ignition key has been placed in the OFF position, the sequencer function will begin to count down toward zero using the same time period between steps that is listed in the first rung. As the sequencer number falls to a value that is less than the number on each rung that is controlled, the respective output will be disabled and turned OFF. Once the count has reached zero, all outputs will be turned OFF.

7.2.2 Diagnostic Description for Master Switch & Load Sequencing

The diagnostic description for Master Switch and Load Sequencer should be entered in the "Diagnostics" Tab of the ladder logic view. This description should contain an overall summary of all the signal elements or interlocks that must be true before the sequencer will operate. In our example, the description is very simple and would indicate that a Master rocker switch will control a four-step load sequencing function. A detailed listing of all inputs and outputs should be listed, including switch position in a specific switch pack, plus signal assignments to an output of a specific Remote Power Module address. This text description should contain all AND & OR logical terms in conjunction with specific signal names. Finally a diagnostic summary should be included to identify what indications the driver or technician might witness during various failure modes.

See the example below for a single channel load sequencer that has diagnostic monitoring built in using the full capabilities of the green indicator in the rocker switch. The third rung in the diagram below checks for BAD STATUS of the Remote Power Module output. A bad status will occur if the Remote Power Module has failed internally, the Remote Power Module output is overloaded or shorted to ground, the communication link to the RPM has been broken or the Remote Power Module has lost its' heavy current battery feed. A diagnostic fault code will accompany many of these failure modes. Other failure modes could occur in the electrical system that would render the sequencer output signal inoperative. Failures within the switch pack or cabling to the switch pack would also cause the outputs to be OFF, even though the Master Switch and SW_One is latched ON. Other diagnostic methods must be used if this is the case. However, if a fault exists in the switch pack, it is not likely that communication between the ESC and the switch pack can be established to flash the green indicator in the switch about the problem. In addition, the fast flashing sequence would also be displayed while an output is turned ON, but the load has a burned out bulb or otherwise open circuit OR the output is overloaded and drawing more than 20 amps. In our example, the load must draw at least one amp when the output is ON or it is assumed that the output has an open circuit.



Diagnostic Design for a Load Sequencer

7.2.3 Diagnosing a Master Switch & Load Sequencing Feature

Diagnosing a Master Switch and Load Sequencer Circuit requires knowledge of all interlocks that are implemented with the design. In addition, the driver or technician must be trained on the diagnostic indications that are being displayed by the system. In this example, diagnostic indications are provided with a fast or slow flash indication on each rocker switch that controls an output. Diagnosing load sequencer circuits may be accomplished with a few simple checks:

1. Verify that the Remote Power Module has battery voltage at the red power feed input. Note the module is protected with a fusible link at the battery box or starter stud.
2. Check for a fast flashing green indicator in any of the rocker switches. This indicates a possible burned out bulb or open circuit wiring in the outputs that are controlled by the sequencer. No electrical system fault codes will be generated for burned out bulbs or open wiring between the RPM and the bulbs. The open circuit and overloaded diagnostic check will only operate when the respective Remote Power Module output is driven ON.
3. If a fast flashing green indicator in the rocker switch is present, perform step 4. If there are no fast flash indications and the output still does not operate, go to step 5.
4. Check for fault codes associated with the Remote Power Module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.

5. Check for fault codes associated with the switch pack module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.
6. If the Diamond Logic® Builder software is available to the technician, select the Advanced Logic View and place the program in Diagnostic mode while connected to the vehicle under test. Examine the signals on each ladder and verify that the indication of OFF or ON is displayed based upon physical state of each input.

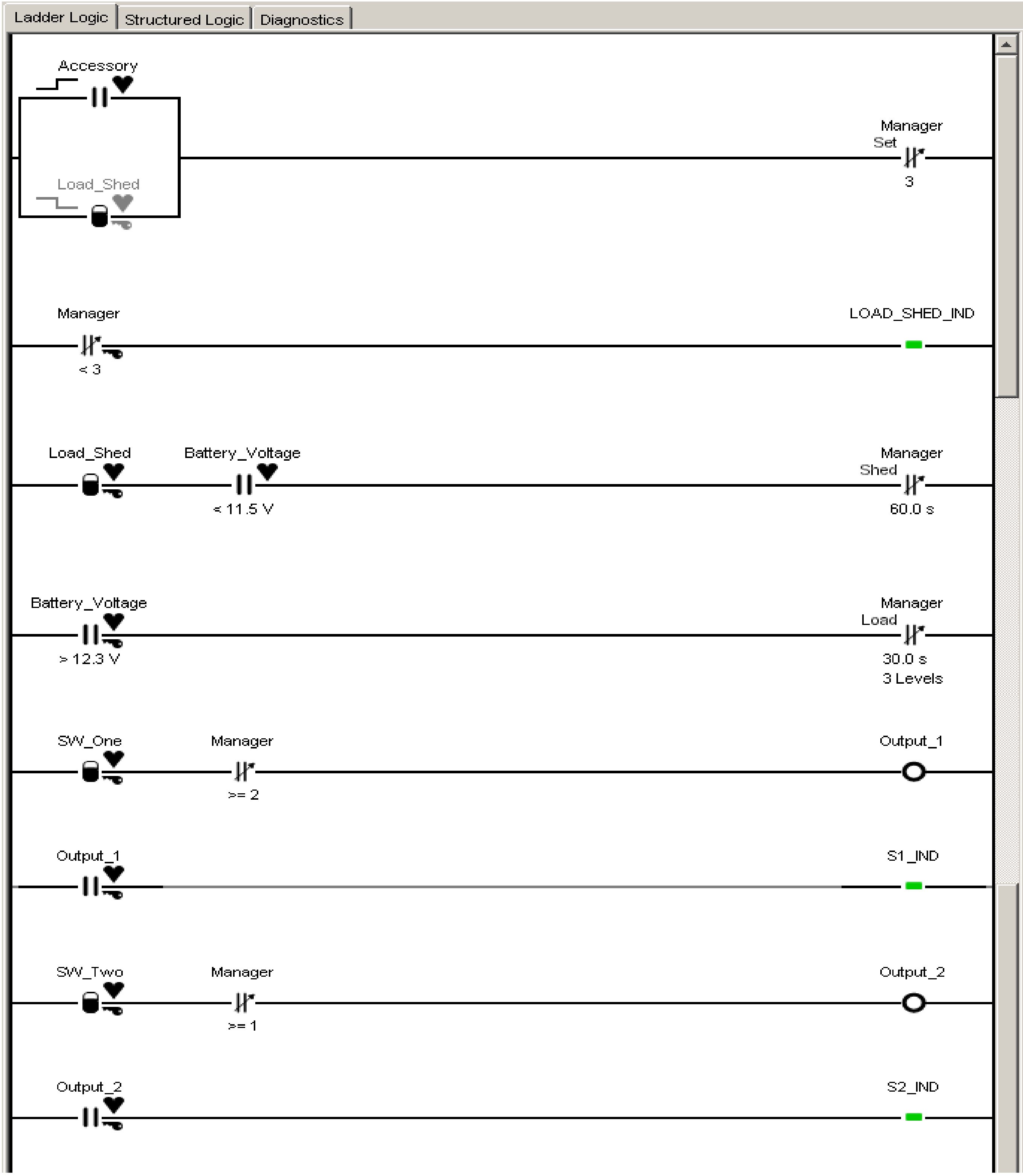
7.3 Load Management

The Load Management feature of the Diamond Logic® Builder program provides a valuable means to shut OFF Remote Power Module loads based upon low battery voltage or other logic driven events. The Diamond Logic® Builder software makes incorporating this feature very easy by providing the user a pair of "canned" special function icons to perform the load-managing task. This software-driven function eliminates the costs of third party after market modules, all associated relays and the wiring that must be added by the body builder. The load manager is completely flexible in that you may configure the shedding of loads based upon a single logical event such as low voltage or you can use multiple copies of the load manager feature to load or shed multiple outputs based upon multiple voltage events or various logic driven conditions.

Important: Please note that load managing can only be accomplished at this time while the ignition key is in the ACCESSORY or IGNITION position. With key off, the battery voltage signal will be measured as zero volts.

7.3.1 Single Point Load Manager

The Single Point Load Manager provides a means of turning OFF Remote Power Module loads based upon a single low voltage trip point. The feature also provides the ability to turn outputs back ON based upon a higher voltage trip point. It is recommended that a dead band range of at least 0.5 volts be entered to ensure that the load manager does not continually shed and re-enable the outputs as the battery voltage hovers near the trip point. Below is an example of a single point load manager that will shed two outputs when the battery voltage falls below 11.5 volts and will re-enable the outputs ON when the battery voltage is greater than 12.3 volts. The body builder should choose the actual trip points based upon past practice, the current draw of the vehicle loads and the charging ability of the alternator. In addition, the load manager feature provides the ability to enter a time between each step of load shedding or load enabling. These times may be independent of each other.



Single Point Load Manager

The load manager operates by incrementing or decrementing a “manager” variable. The process of shedding loads is done by decrementing a variable by a count of one each time the specified time interval has elapsed. Enabling the outputs is achieved by incrementing the same variable. When the count reaches zero, all outputs will be OFF. When the count reaches three, the incrementing will stop and all outputs will be ON.

The first rung shows that either the action of turning the ignition key to the Accessory or Run position OR turning OFF the load manager switch in the instrument panel will set the load manager to the maximum load number or in other words, turn ON all the outputs being controlled by the load manager. This action is necessary to force the outputs ON every time the ignition key is cycled through the OFF position so all outputs will be operational when the vehicle is initially started. Likewise, if it is desired to stop the load manager function with the LOAD SHED rocker switch, the act of turning that switch OFF will also force all the outputs ON immediately. It must be noted that the load manger count variable should always be set to one count greater than the number of outputs that are to be controlled. The load manager does not apply the time interval to the first count reduction once the logical conditions are met to begin shedding.

The second rung shows the conditions for setting up the load shedding function. The logical requirements on the left side of the ladder rung indicate that the LOAD SHED switch in the instrument panel must be ON and the battery voltage must be less than 11.5 volts. The load-shed variable on the right side of the rung is created in the following manner. Select the My Variables TAB and move your cursor to the end of the list to the blank space. Enter the desired name of your load shedder variable in the Custom Variable Column. Using the left switch of the mouse to drag and drop the new load shedder signal to the output side of a blank rung. Now place the cursor over the variable and perform a right switch mouse click to reveal a number of options. Select the Shed option to make this rung a load shedder. Next you will see that the variable is now a load shedder with a default time between sheds of 1 second. You can change this time by double clicking on the 1-second number until it is highlighted. Now enter your desired time interval in seconds, being careful to include the s for a unit of measure. The range for the time interval is from .1 second to 600 seconds. The time interval between shedding outputs is chosen to be 60 seconds for this example. Repeat the process on another rung, except select the “LOAD” option to make the variable enable outputs based upon new logic conditions that may be entered on the left side of the rung. See the third rung for an example of setting up the loading function. Note that the time between the loads turning ON is 30 seconds and that the battery voltage must be greater than 12.3 volts.

The fourth rung shows the usage of the load managing variable with switches and Remote Power Module outputs. See that the variable called Manager has been placed between the input switch and the Remote Power Module output. Used on the input side, the Manager variable has a sequence number attached to it. This number is incremented in order to turn outputs ON and decremented in order to turn outputs OFF. As we stated before, in order for the first output to be turned OFF with the correct timing, the sequence number below the variable must be one less than the number entered above in the setup rungs for the load manager. Therefore, our first output to be shed has a number 2 attached to it. The second output on rung 6 has a 1 attached to the same load manager variable. Therefore the sequence of events for load shedding will be:

- If the load manager switch is ON, the ignition key is in the RUN or in the ACCESSORY position and the battery voltage falls below 11.5 volts, the load manager variable will be decremented to 2 immediately.
- If the battery voltage stays below 11.5 volts for 60 seconds, the load manager variable will be decremented to 1. Now the 4^{th} rung will not be enabled and the Output1 will be turned OFF.
- If the battery voltage stays below 11.5 volts for 60 more seconds, the load manager variable will be decremented to 0. Now the 6^{th} rung will not be enabled and the Output2 will be turned OFF.
- The variable called Manager will stay at 0 for as long as battery voltage is less than 11.5 volts.

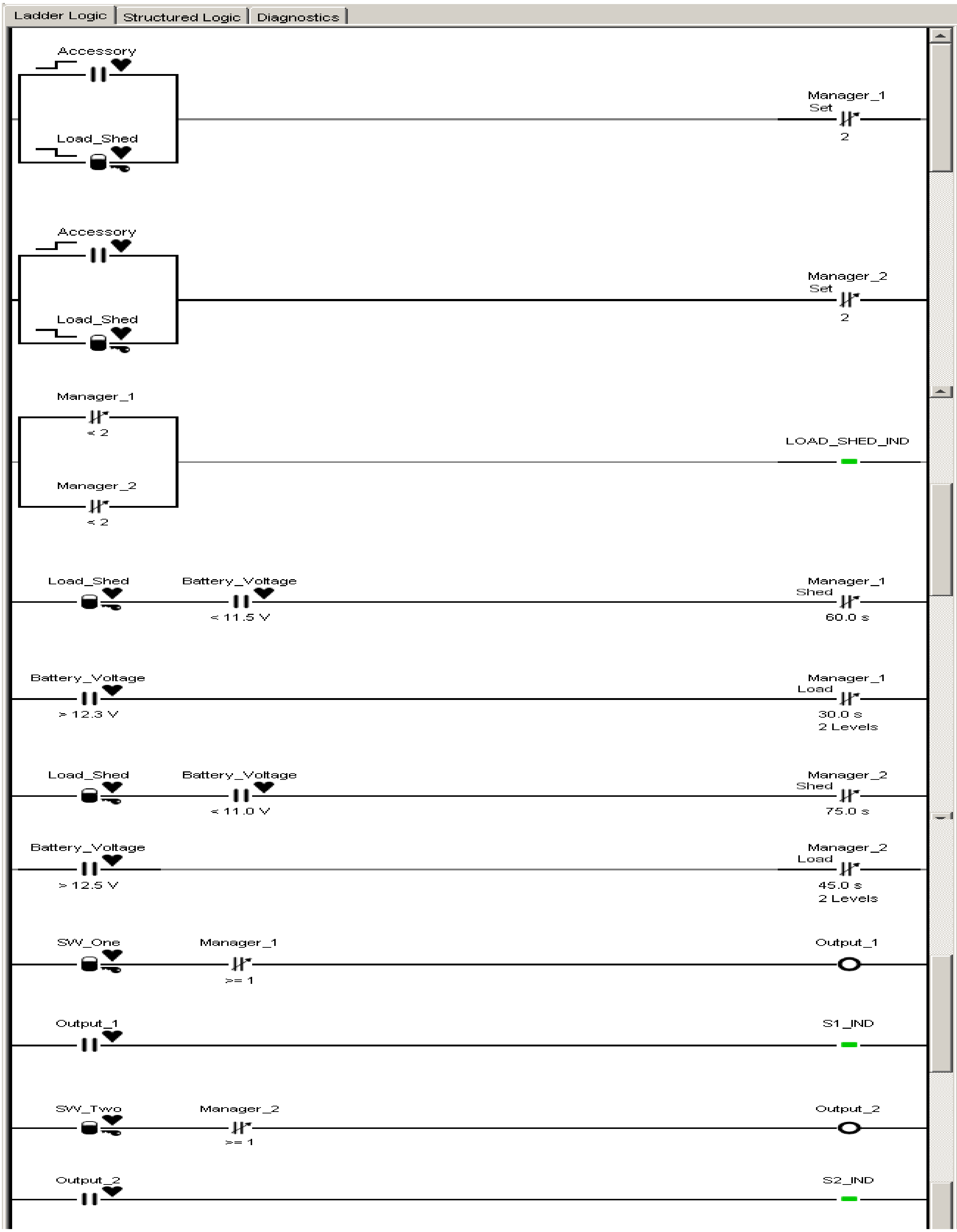
Once the battery voltage is higher than 12.3 volts, the events for enabling outputs are:

- If the load manager switch is ON, the ignition key is in the RUN or in the ACCESSORY position and the battery voltage rises above 12.3 volts, the load manager variable will be incremented to 1 after 30 seconds. Now the 6^{th} rung will be enabled and the Output2 will be turned ON.
- If the battery voltage stays above 12.3 volts for 30 more seconds, the load manager variable will be incremented to 2. Now the 4^{th} rung will be enabled and the Output1 will be turned ON.
- After another 30 seconds of battery voltage above 12.3 volts the variable called Manager will incremented to 3 and stay at that value.

Note in the diagram above that the green indicators for SW_One and SW_Two will be ON only when the Remote Power Module outputs are ON. See the diagnostic description listed below for additional ways to use these indicators to alert the driver that an output has been turned OFF due to an active load manager function.

7.3.2 Multi-Point Load Manager

The Multi-Point Load Manager example provides a means to turn OFF Remote Power Module outputs based upon multiple low voltage trip points. Conversely, the example provides the ability to turn outputs back ON based upon multiple higher voltage trip points. It is recommended that a dead band range of at least .5 volts be entered to ensure that the load manager does not continually shed and re-enable the outputs as the battery voltage hovers near the trip point. See the following example of a multi-point load manager that will shed one output when the battery voltage falls below 11.5 volts and will shed the second output when the battery voltage falls below 11.0 volts. The outputs will be turned back ON when the battery voltage is greater than 12.3 volts for the first output and 12.5 volts for the second output. The body builder should chose the actual trip points based upon past practice, the current draw of the vehicle loads and the charging ability of the alternator. In addition, the load manager feature provides the ability to enter a time between each step of load shedding or load enabling. The times may be independent of each other.



Multi-Point Load Manager

The multi-point load manager operates by incrementing or decrementing two different “manager” variables independently. The process of shedding loads is done by decrementing a variable by a count of one each time the specified time interval has elapsed. When the count reaches zero, all outputs will be OFF. Enabling an output is achieved by incrementing the same manager variable. When the count reaches two, the incrementing will stop and the outputs will be ON.

The first and second rungs show that either the action of turning the ignition key to the Accessory or Run position OR turning OFF the load manager switch in the instrument panel will set the load managers to the maximum load number or in other words, turn ON all the outputs being controlled by the load managers. This action is necessary to force the outputs ON every time the ignition key is cycled through the OFF position so all outputs will be operational when the vehicle is initially started. Likewise, if it is desired to stop the load manager function with the LOAD SHED rocker switch, the act of turning that switch OFF will also force all the outputs ON immediately. It must be noted that the load manger count variable should always be set to one count greater than the number of outputs that are to be controlled. The load manager does not apply the time interval to the first count reduction once the logical conditions are met to begin shedding.

The third, fourth, fifth and sixth rungs show the conditions for setting up the two independent load-managing functions. The logical requirements on the left side of the third and fifth ladder rung indicate that the LOAD SHED switch in the instrument panel must be ON and the battery voltage must be less than 11.5 volts for load manager 1 and less than 11.0 volts for load manager 2. The load-shed variables on the right side of the rung are created in the following manner. Select the My Variables TAB and move your cursor to the end of the list to the blank space. Enter the desired name of your load-shed variable in the Custom Variable Column. Use the left switch of the mouse to drag and drop the new load shed signal to the output side of a blank rung. Now place the cursor over the variable and perform a right switch mouse click to reveal a number of options. Select the Shed option to make this rung a load shedder. Next you will see that the variable is now a load shedder with a default time between sheds of 1 second. You can change this time by double clicking on the 1-second number until it is highlighted. Now enter your desired time interval in seconds, being careful to include the s for a unit of measure. The range for the time interval is from .1 second to 600 seconds. The chosen time interval between shedding outputs is chosen to be 60 seconds for load manager 1 and 75 seconds for load manager 2. Repeat the process on another rung, except select the “LOAD” option to make variable enable outputs based upon new logic conditions that may be entered on the left side of the rung. See the fourth and sixth rung for an example of setting up the loading function. Note that the time between the loads turning ON is 30 seconds and that the battery voltage must be greater than 12.3 volts for manager 1 and 45 seconds with battery voltage greater than 12.5 volts for manager 2.

The seventh and ninth rungs show the usage of the load managing variables with switches and Remote Power Module outputs. See that the variables called Manager_1 and Manager_2 have been placed between the input rocker switches and the Remote Power Module outputs respectively. Used on the input side, the Manager variable has a sequence number attached to it. This number is incremented in order to turn outputs ON and decremented in order to turn outputs OFF. As we stated before, in order for the first output to be turned OFF with the correct timing, the sequence number below the variable must be one less than the number entered above in the setup rungs for the load manager. Therefore, we have attached a number of 1 to each manager variable that is to be shed. The sequence of events for load shedding will be:

- If the load manager switch is ON, the ignition key is in the RUN or in the ACCESSORY position and the battery voltage falls below 11.5 volts, the load manager variable will be decremented to 1 immediately.
- If the battery voltage stays below 11.5 volts for 60 seconds, the load manager 1 variable will be decremented to 0. Now the 7th rung will not be enabled and the Output1 will be turned OFF.
- If the battery voltage drops below 11.0 volts for 75 seconds, the load manager 2 variable will be decremented to 0. Now the 9th rung will not be enabled and the Output2 will be turned OFF.
- The load Manager variables will stay at 0 for as long as battery voltage is less than 12.3 volts for manager 1 and 12.5 volts for manager 2.

Once the battery voltage is higher than 12.3 volts, the events for re-enabling outputs will be:

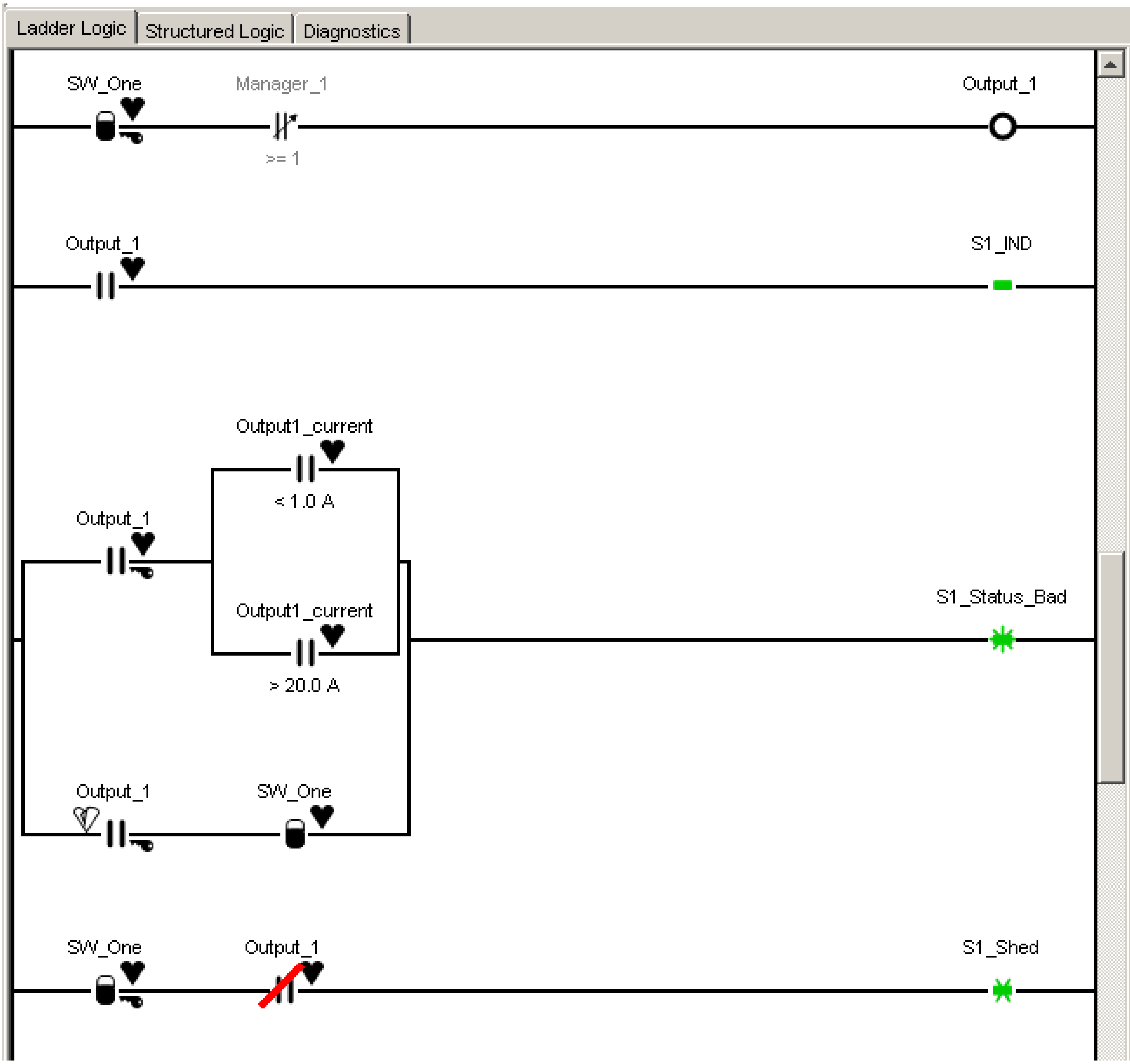
- If the load manager switch is ON, the ignition key is in the RUN or in the ACCESSORY position and the battery voltage rises above 12.3 volts, the load manager 1 variable will incremented to 1 after 30 seconds. Now the 7th rung will be enabled and Output1 will turn ON.
- If the battery voltage rises above 12.5 volts for 45 seconds, the load manager 2 variable will incremented to 1. Now the 9th rung will be enabled and Output2 will turn ON.
- After 30 more seconds of battery voltage above 12.3 volts the Manager 1 variable will incremented to 2 and stay at that value.
- After 30 more seconds with battery volts above 12.5 volts the Manager 2 variable will be incremented to 2 and stay at that value.

Note in the diagram above that the green indicator in SW_One and SW_Two will be ON only when the Remote Power Module outputs are ON. See the diagnostic description listed below for additional ways to use these indicators to alert the driver that an output has been turned OFF due to an active load manager event.

7.3.3 Diagnostic Descriptions for Load Managers

The diagnostic description for Load Managers should be entered in the “Diagnostics” Tab of the ladder logic view. This description should contain an overall summary of all the signal elements or interlocks that must be true before the load manager will operate. In our example, the description would indicate that a Load Shed rocker switch and vehicle battery voltage controls a two-level load manager function. A detailed listing of all inputs and outputs should be listed, including switch position in a specific switch pack, plus signal assignments to outputs of a specific Remote Power Module address. This text description should contain all AND & OR logical terms in conjunction with specific signal names. Finally a diagnostic summary should be included to identify what indications the driver or technician might witness during various failure modes.

See the example below for a single point load manager with diagnostic monitoring built in using the full capabilities of the green indicator in the rocker switch. The third rung in the diagram below checks for BAD STATUS of the Remote Power Module output. A bad status will occur if the Remote Power Module has failed internally, the Remote Power Module output is overloaded or shorted to ground, the communication link to the RPM has been broken or the Remote Power Module has lost its’ heavy current battery feed. A diagnostic fault code will accompany many of these failure modes. Other failure modes could occur in the electrical system that would render the load manager output signals inoperative. Failures within the switch pack or cabling to switch pack would also cause the outputs to be OFF, even though a rocker switch is latched ON. However, if a fault exists in the switch pack, it is not likely that communication between the ESC and the switch pack can be established to flash the green indicator in the switch about the problem. Other diagnostic methods must be used if this is the case. In addition, the fast flashing sequence would be displayed while an output is turned ON, but the load has a burned out bulb or otherwise open circuit OR if the output is overloaded and is drawing more than 20 amps. In our example, the load must draw at least one amp when the output is ON or it is assumed that the output has an open circuit. The indicator will display a slow flashing pattern if the switch is ON but the load manager has the output turned OFF.



Diagnostic Design for Load Managers

7.3.4 Diagnosing Load Managers

Diagnosing a Master Switch and Load Sequencer Circuit requires knowledge of all interlocks that are implemented with the design. In addition, the driver or technician must be trained on the diagnostic indications that are being displayed by the system. In this example, diagnostic indications are provided with a fast or slow flash indication on each rocker switch that controls an output. Diagnosing load manager circuits may be accomplished with a few simple checks:

1. Verify that the Remote Power Module has battery volts at the red power feed input. Note the module is protected with a fusible link at the battery box or starter stud.
2. Check for a fast flashing green indicator in any of the rocker switches. This indicates a possible burned out bulb, open circuit wiring in the outputs or overloaded outputs that are controlled by the sequencer. No electrical system fault codes will be generated for burned out bulbs or open wiring between the RPM and the bulbs. The open circuit diagnostic will only operate when the respective Remote Power Module output is driven ON. If a fast flashing green indicator in the rocker switch is present, then perform step 3. If there are no fast flash indications and the output still does not operate, go to step 4.
3. Check for fault codes associated with the Remote Power Module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.
4. Check for fault codes associated with the switch pack module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.
5. If any of the green switch indicators in the rocker switches display a slow flashing pattern, the load manager function has disabled the outputs. Restore battery voltage to normal operational levels to allow the load manager to re-enable the outputs.
6. If the Diamond Logic® Builder software is available to the technician, select the Advanced Logic View and place the program in Diagnostic mode while connected to the vehicle under test. Examine the signals on each ladder and verify that the indication of OFF or ON is displayed based upon physical state of each input.

7.4 Timers

7.4.1 Timer Basics

The Diamond Logic® Builder program allows the user to measure time intervals in a variety of ways. The two main purposes for a timer are to enable an output **FOR** a prescribed amount of time or to enable an output **AFTER** a specific amount of time has elapsed.

Timers in the Diamond Logic® Builder program are designed as count down timers, much like an egg timer in your kitchen. A timer can be placed into the following states:

- Start the Timer
- The Timer is Running
- The Timer is Expired
- The Timer is Stopped

Each of these modes may be enabled or monitored by enabling key attributes to a signal that has been created to be a timer function. A timer is created in the following manner:

- Select the Advanced Logic Tab.
- Select the My Variables on the right side of the screen.
- Move your cursor to the end of the list where a blank space is found.
- Type in the name of your timer in the Custom Signal column.
- Using your mouse, drag the icon of this timer signal to the right side of an open ladder rung.
- Place the cursor over this new signal and right click the mouse to reveal possible options.
- Select the START attribute if you wish this signal to start the timer.
- Note that the signal icon now appears to be a clock with a green circle beside it and that 1.0 s is visible below the icon.
- You may change this default time of one second to any value between 0 and 600 seconds.
- The time may be entered with a resolution of 0.020-second intervals.
- Timer values must be entered with a complete notation, i.e. 5s or 12s. The unit of measure must be included with the numerical value. Letter case must be maintained with your entry.
- The timer icon will have a green circle beside the clock to denote the timer is started.

A timer may be checked to see if it is running in the following manner:

- Using your mouse, drag the icon of this timer signal to the left side of an open ladder rung.
- Place the cursor over this new signal and right click the mouse to reveal possible options.
- Select the RUNNING attribute if you wish to check that the timer is running.
- Select the NEGATE attribute in addition to the RUNNING attribute if you want to check that the timer is not running.
- The timer icon will have a smaller clock with the hands showing elapsed time to denote the timer is running.

A timer may be checked for expiration in the following manner:

- Using your mouse, drag the icon of this timer signal to the left side of an open ladder rung.
- Place the cursor over this new signal and right click the mouse to reveal possible options.
- Select the Expired attribute if you wish to check that the signal is expired.
- The timer icon will have a smaller clock with the hands at 12 to denote the timer has expired.
- A timer will stay in the expired mode until the timer is stopped or re-started.

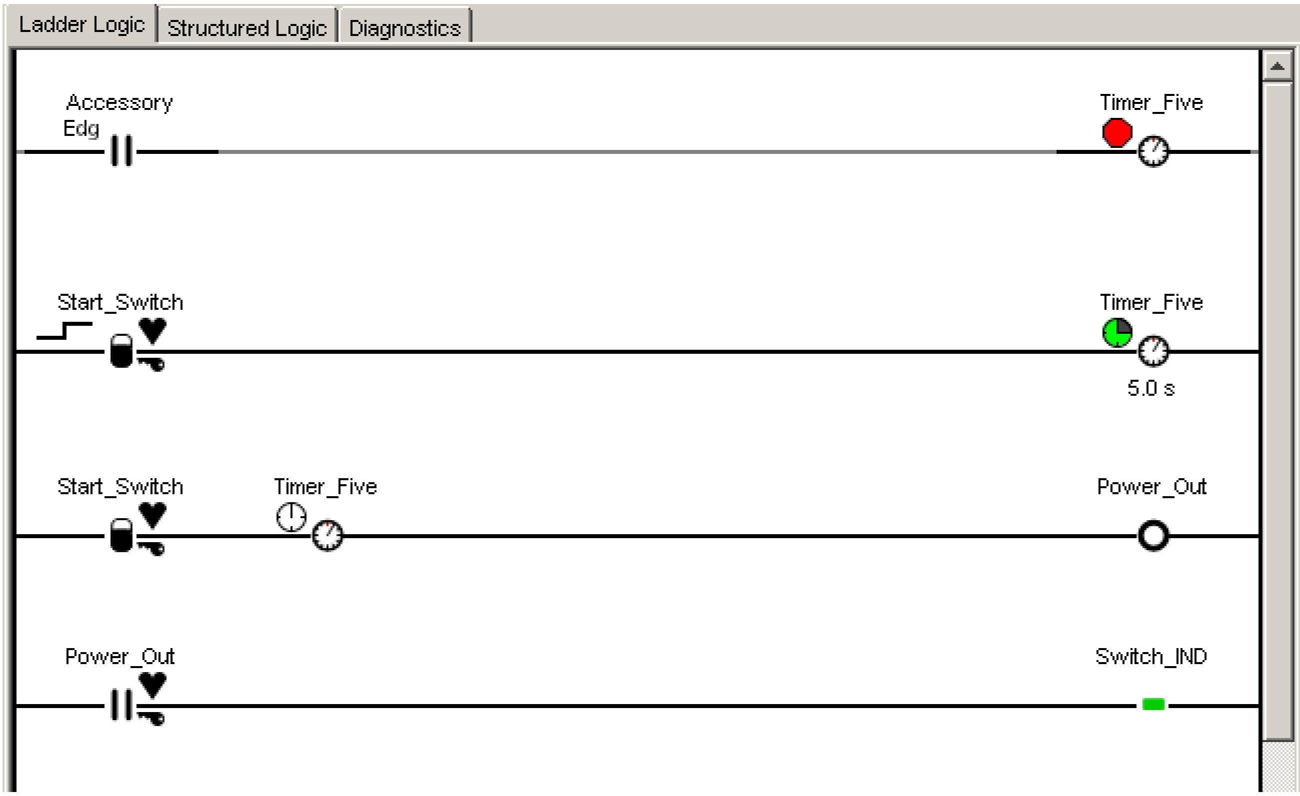
A timer may be stopped in the following manner:

- Using your mouse, drag the icon of this timer signal to the right side of an open ladder rung.
- Place the cursor over this new signal and right click the mouse to reveal possible options.
- Select the STOP attribute if you wish the timer to be stopped by the logic on the left side of the rung.
- The timer icon will have a red stop sign beside the clock.
- The timer will stay in the stopped mode until the timer is re-started.

Implementing the usage of timers in advanced logic writing requires that the user must understand some basic operational principles. Remember that advanced logic rungs are executed every .020 seconds. Therefore, steps must be taken to ensure that timers are not continuously re-started with every processing cycle. Likewise, logical signal icons must be arranged in a manner to prevent the stopping of a timer before the cycle is complete. If desired, signal icons may be fashioned in manner to allow a timer to manipulate an output in a variety of ways; either delay the engagement of an output or force an output on for a prescribed length of time. The following paragraphs provide detailed descriptions of how to use timers in various modes of operations.

7.4.2 Delayed Engagement of an Output Using a Timer

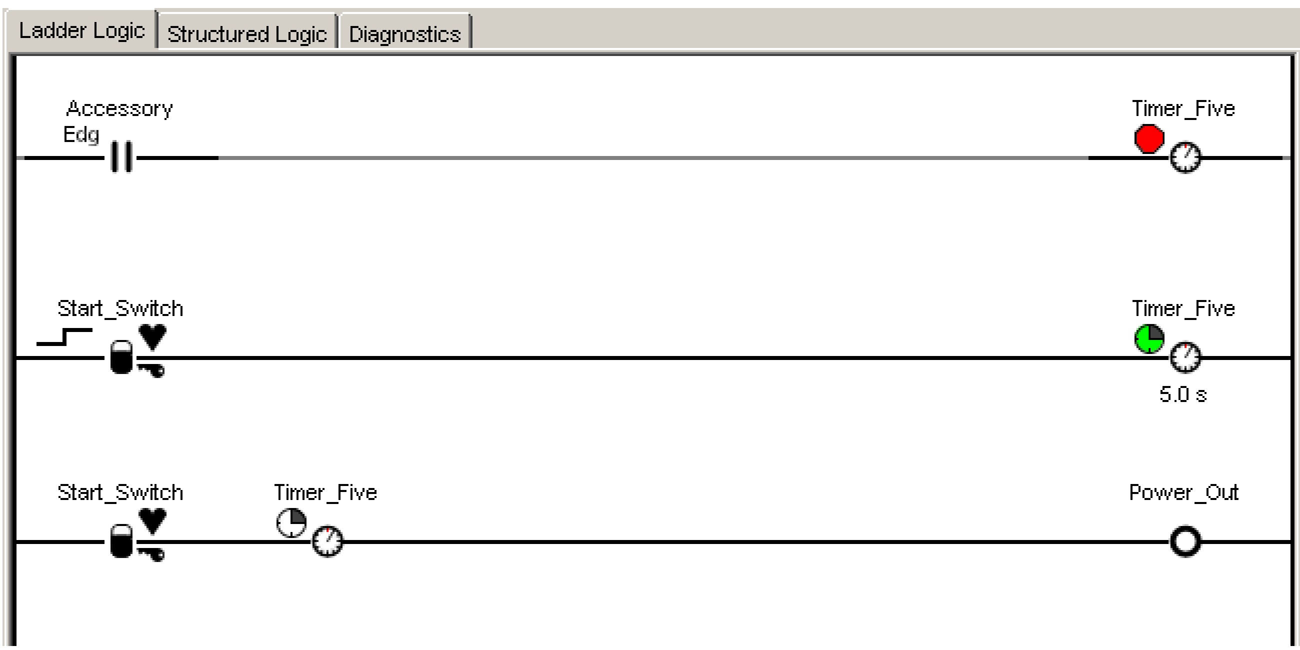
Timers may be used to turn on an output **AFTER** a prescribed length of time. See the following example. This exercise will turn on a Remote Power Module output exactly five seconds after a latched rocker switch is activated ON. It only requires three advanced logic ladder rungs to perform this operation. The example assumes that a rocker switch or other input is available in a latched ON or OFF condition. The first rung is used to initialize the timer as OFF or stopped. The second rung detects the rocker switch has been turned ON using the positive edge detection attribute. This single active edge detection method is used so that we start the five-second timer only once. When the logic is executed in subsequent processing cycles after starting the timer, this second rung will not be true and thus the timer will not be re-started. Note that the switch input shall be turned OFF when the ignition key is in the OFF position or if the switch pack experiences a status error condition. The third rung enables the Remote Power Module output to be turned ON as long as the rocker switch is ON and the timer has expired. The timer stays in the expired mode until it is re-started. Thus the output is turned on after five seconds and stays on as long as the rocker switch is ON and the key is in the RUN or ACCESSORY position.



Delayed Output Using a Timer

7.4.3 Enabling of an Output for a Specified Time

Timers may be used to turn ON an output **<u>FOR</u>** a prescribed length of time. See the following example. This exercise will turn on a Remote Power Module output for exactly five seconds when a latched rocker switch is activated ON. It only requires three advanced logic ladder rungs to perform this operation. The example assumes that a rocker switch or other input is available in a latched ON or OFF condition. The first rung is used to initialize the timer as OFF or stopped. The second rung detects the rocker switch has been turned ON using the positive edge detection attribute. This single active edge detection method is used so that we start the five-second timer only once. When the logic is executed in subsequent processing cycles after starting the timer, this second rung will not be true and thus the timer will not be re-started. Note that the switch input shall be turned OFF when the ignition key is in the OFF position or if the switch pack experiences a status error condition. The third rung enables the Remote Power Module output to be turned ON as long as the rocker switch is ON and the timer is running. The timer stays in the expired mode until it is re-started. Thus the output is turned on for only five seconds as long as the rocker switch is ON and the key is in the RUN or ACCESSORY position.

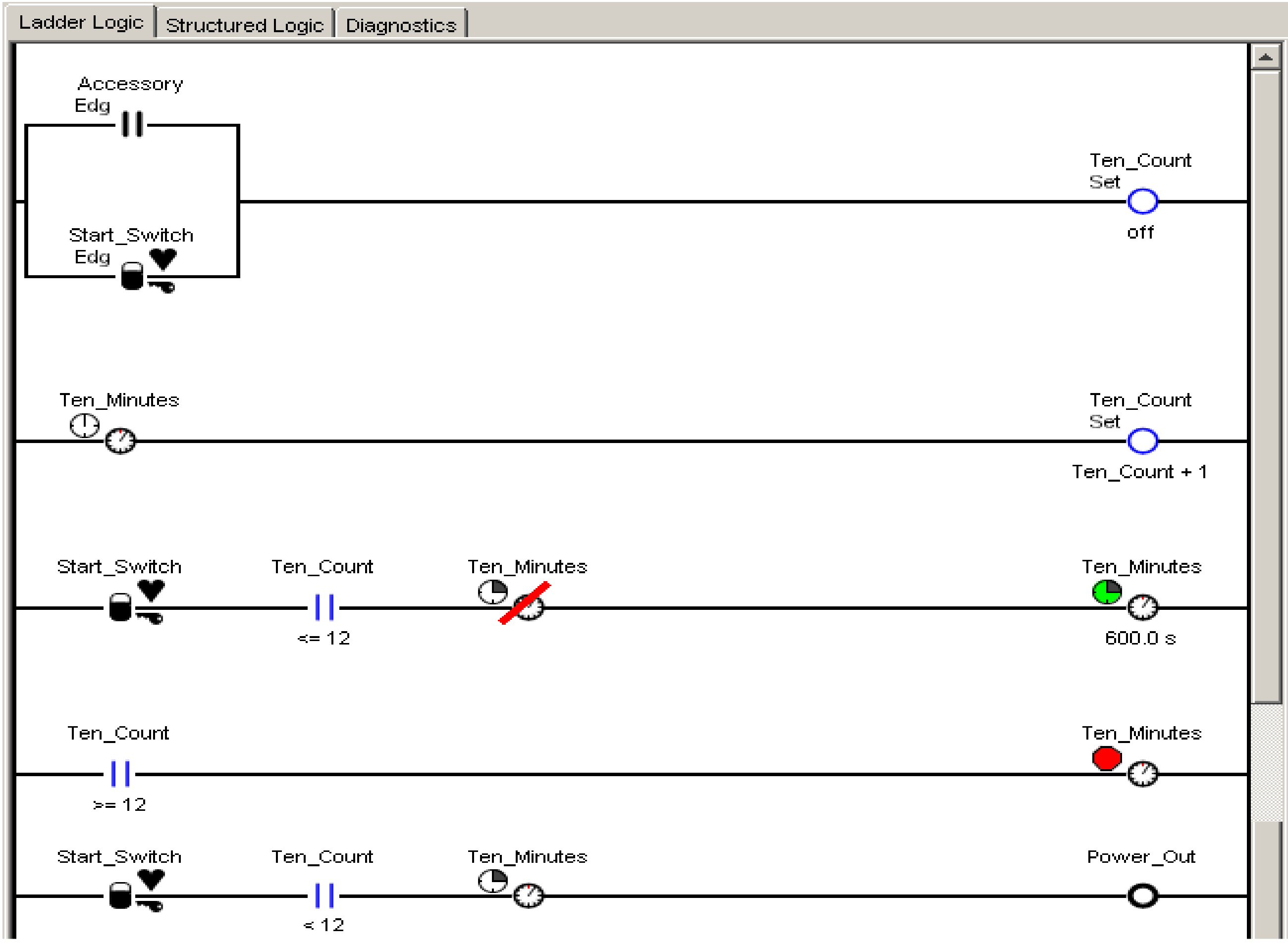


Output Enabled for a Specified Time

7.4.4 Creating Timers Longer Than Ten Minutes

The Diamond Logic® electrical system has extensive capabilities to construct custom logic to meet your body equipment control needs. However, the system can currently only measure time periods of up to ten minutes with a simple timer signal function. If your application requires a timer longer than ten minutes, it is possible to construct ladder logic that will count for very large periods of time. See the following example. This exercise will turn on a Remote Power Module output for exactly two hours when a latched rocker switch is activated ON. The two-hour timer is accomplished by allowing a ten-minute timer to elapse twelve times, which equals 120 minutes (2 hours). It only requires five advanced logic ladder rungs to perform this operation. The example assumes that a rocker switch or other input is available in a latched ON or OFF condition. The first rung is used to initialize a counter variable, Ten_count, as OFF or stopped whenever the key is cycled OFF or the rocker switch has been placed in the ON or OFF position. Ten_count is used to count a ten minute time period. The second rung checks for when the ten-minute timer has expired or in other words, has a ten-minute time period elapsed. If yes, then Ten_count is incremented by one using the Set function. The third rung enables the basic ten-minute timer. The ten minute timer called Ten_Minutes will be started only if the rocker switch is ON, Ten_count is less than or equal to12 and the ten minute timer is not running. The fourth rung checks if the final timer period has elapsed as defined by Ten_count. In this case, once Ten_count is greater than or equal to 12, the timer Ten_Minutes is stopped. The fifth rung controls the final Remote Power Module output. The output will be ON as long as the rocker switch is ON, Ten_Count is less than twelve and Ten_Minutes is still running.

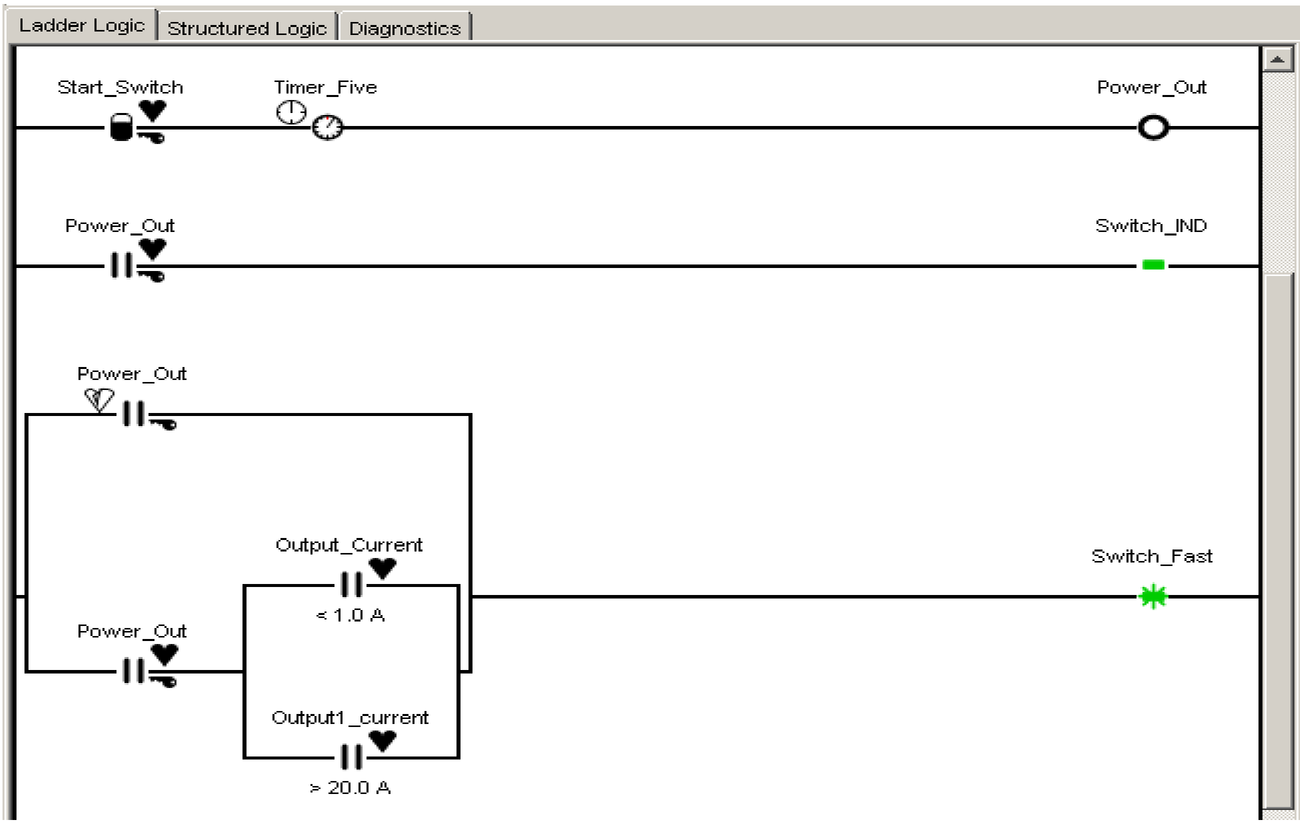
Note that the rocker switch input shall be turned OFF when the ignition key is in the OFF position or if the switch pack experiences a status error condition. Thus the output is turned on for two hours as long as the rocker switch is ON and the key is in the RUN or ACCESSORY position. Changing all entries of Ten_count shall change the length of the timer in ten-minute increments.



Two-Hour Timer Example

7.4.5 Diagnostic Descriptions for Timers

Writing detailed and effective diagnostic descriptions for timers is very important since the performance of the outputs may appear rather confusing to the technician who is troubleshooting the vehicle. In the advanced logic view, select the “diagnostics” tab above the ladder logic. This is where you should enter your diagnostic descriptions. The text should include an overall summary of how the timed output is expected to perform. The description of our first example would state that a Remote Power Module output would be turned on five seconds after the Start_Switch is turned ON. The description of our second example would state that a Remote Power Module output would be turned ON for only five seconds after the Start_Switch is turned ON. The description of the third example would state that a Remote Power Module output would be ON for two hours after the Start_Switch is turned ON. Each of these descriptions should contain an overall summary of all the signal elements or interlocks that must be true before the timer will operate. A detailed listing of all inputs and outputs should be listed, including switch position in a specific switch pack, plus signal assignments to an output of a specific Remote Power Module address. This text description should contain all AND & OR logical terms in conjunction with specific signal names. It is up to the user to decide how the green indicator in the rocker switch might be used in conjunction with a timer. A diagnostic summary should be included to identify what indications the driver or technician might witness during various failure modes if flashing modes of the green indicator of the rocker switch are used. See the example below for the diagnostic design for a five second delayed output timer that drives a Remote Power Module output.



Diagnostic Design for a Delayed Output Timer

In this example, the green indicator for Start_Switch is used to show that the Remote Power Module output has come ON after the elapsed of a five-second-delay period. If the status of the power module output is good, then the indicator will be ON steady. If the Remote Power Module output has a bad status or the output has a burned out bulb or open circuit OR the output is overloaded and drawing more than twenty amps, then the green indicator in the Start_Switch will be displaying a fast flashing pattern. A bad status will occur if the Remote Power Module has failed internally, the Remote Power Module output is overloaded or shorted to ground, the communication link to the RPM has been broken or the Remote Power Module has lost its' heavy current battery feed. A diagnostic fault code will accompany many of these failure modes. Other failure modes could occur in the electrical system that would render the timer output signals inoperative. Failures within the switch pack or cabling to the switch pack would also cause the outputs to be OFF, even though the Start_Switch is latched ON. However, if a fault exists in the switch pack, it is not likely that communication between the ESC and the switch pack can be established to flash the green indicator in the switch about the problem.

7.4.6 Diagnosing Timers

Diagnosing a timer requires knowledge of all interlocks that are implemented with the design. In addition, the driver or technician must be trained on the diagnostic indications that are being displayed by the system. In this example, diagnostic indications are provided with a fast or slow flash indication on each rocker switch that controls an output. Diagnosing load sequencer circuits may be accomplished with a few simple checks:

1. Verify that the Remote Power Module has battery volts at the red power feed input. Note the module is protected with a fusible link at the battery box or starter stud.
2. Check for a fast flashing green indicator in any of the rocker switches. This indicates a possible burned out bulb, open circuit wiring in the outputs or overloaded outputs that are controlled by the sequencer. No electrical system fault codes will be generated for burned out bulbs or open wiring between the RPM and the bulbs. The open circuit diagnostic will only operate when the respective Remote Power Module output is driven ON. If a fast flashing green indicator in the rocker switch is present, then perform step 3. If there are no fast flash indications and the output still does not operate, go to step 4.
3. Check for fault codes associated with the Remote Power Module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.
4. Check for fault codes associated with the switch pack module used with the sequencer. Resolve using the Diagnostic Troubleshooting Guide.
5. If Diamond Logic® Builder software is available to the technician, select the Advanced Logic View and place the program in Diagnostic mode while connected to the vehicle under test. Examine the signals on each ladder and verify that the indication of OFF or ON is displayed based upon physical state of each input.

7.4.7 Signal Debounce Functions

"**Debounce**" refers to the delaying of two transitional scenarios of the same signal. Those transitions are "On" to "Off" which could also be referred to as the signal going from "True" to "False", and "Off" to "On" which could also be referred to as the signal going from "False" to "True". There are two types of Debounce functions: "Debounce" and "Debounce "On".

The Debounce functions are simply delay timers that can be attached to Diamond Logic® Builder ladder logic ("read" not "write") signals. It is the purpose of the Debounce functions to dampen or filter out unwanted momentary switch state changes and logic activations that occur before they are desired.

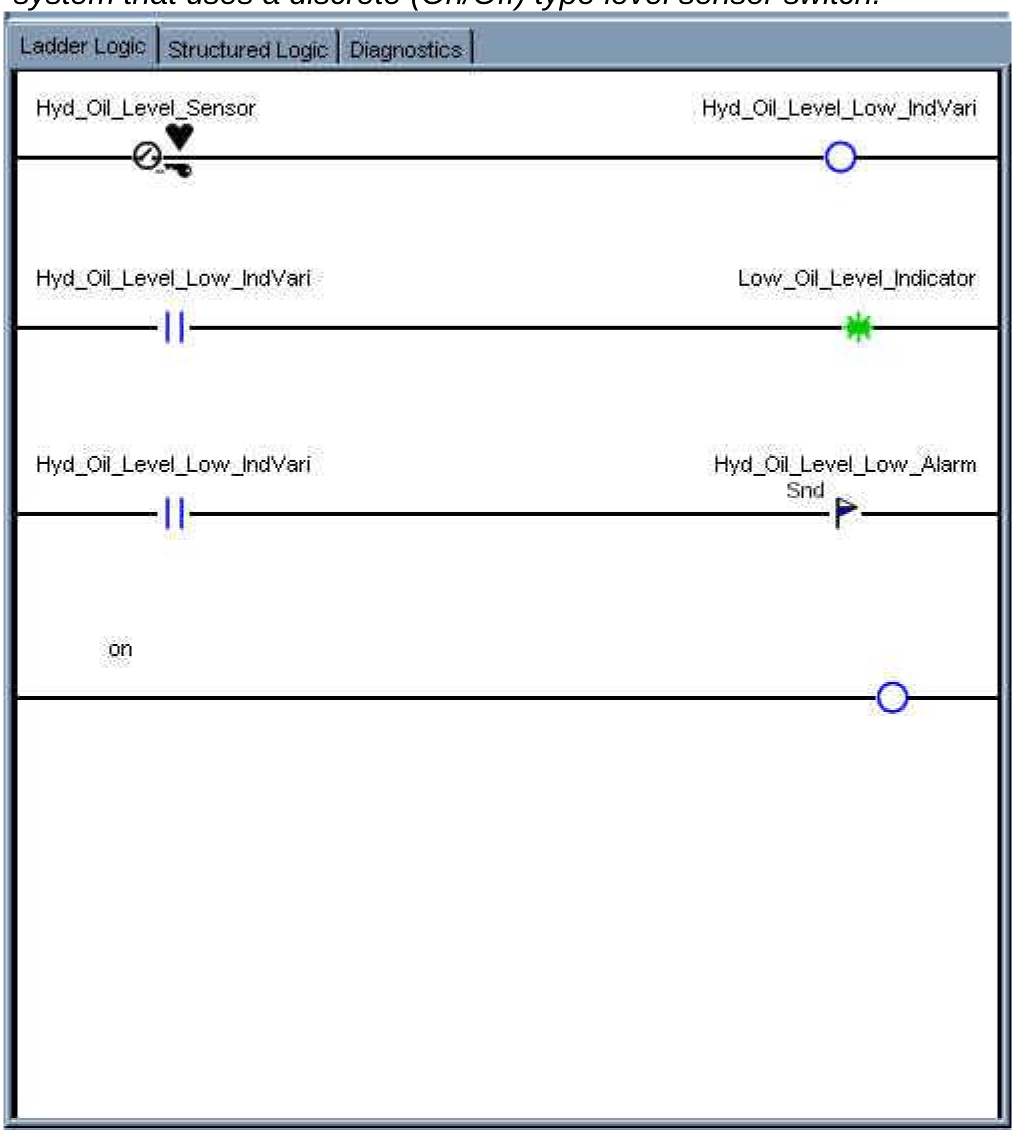
The Debounce functions allow a Diamond Logic® Builder user to reduce the amount of ladder logic that would ordinarily be required to create such a "filtering" system through the implementation of timers.

An example of the "Debounce" function in practice would be that of a remote power model input signal being used to report to the multiplex electrical architecture the status of a body builder installed discrete hydraulic oil reservoir oil level indicator. Because of the strong propensity for hydraulic oil to "slosh" in its' reservoir, it is very likely that periodic oil movement will cause the level indicator switch to make switch transitions momentarily indicating the hydraulic oil level is low. Conversely, the opposite scenario can exist where the oil level is low and because of the unstable nature of the oil, the oil level indicator would sense that the oil level is satisfactory. In practicum, because of the normal movement of oil, it would be very difficult to use such an erratic signal beneficially without some form of "dampening" or "Debounce" function.

How do I create the example above?

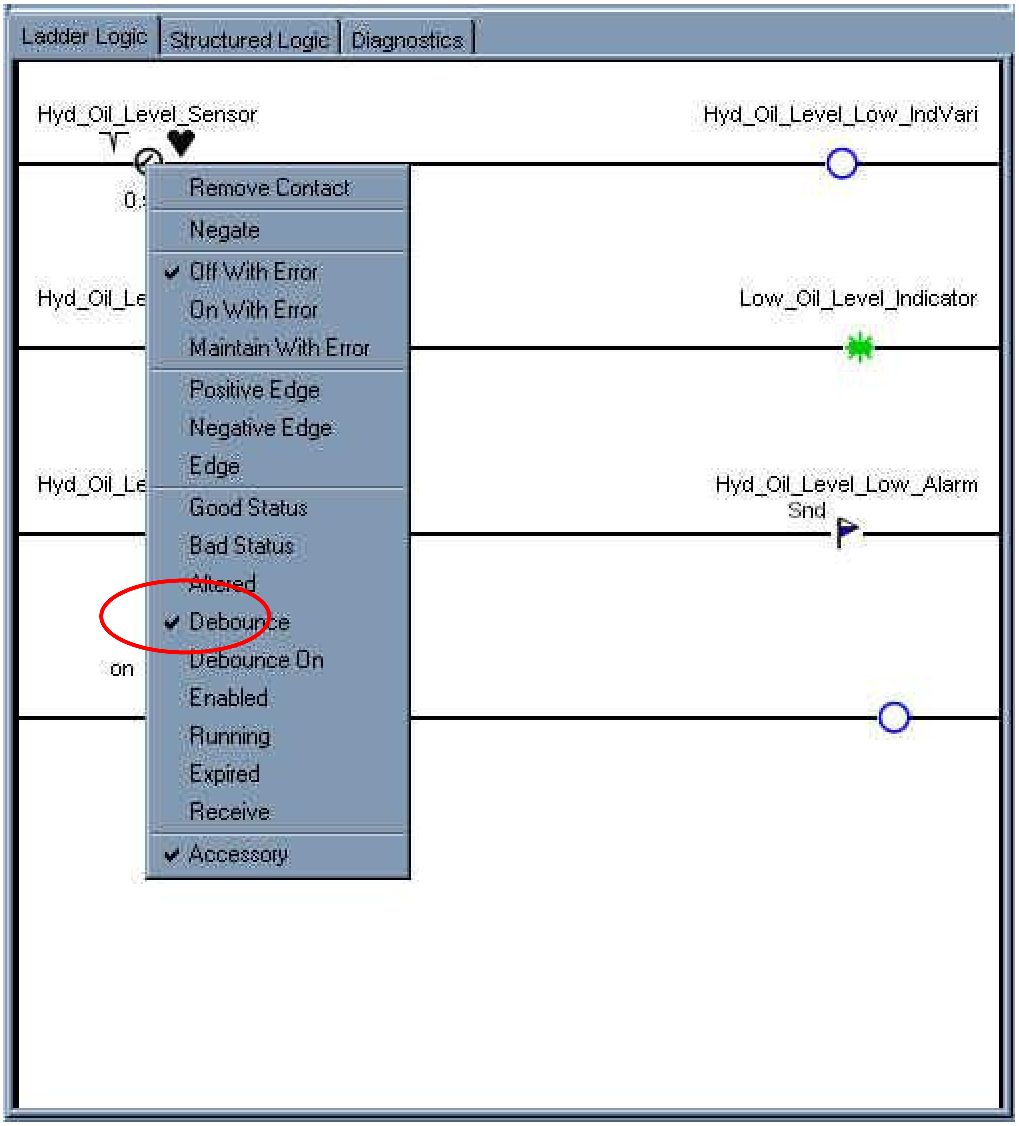
Step #1
Create the necessary ladder logic needed to support the requirement's base functionality as illustrated below.

In this example we will be working with an advanced logic version of a hydraulic oil level indicator system that uses a discrete (On/Off) type level sensor switch.



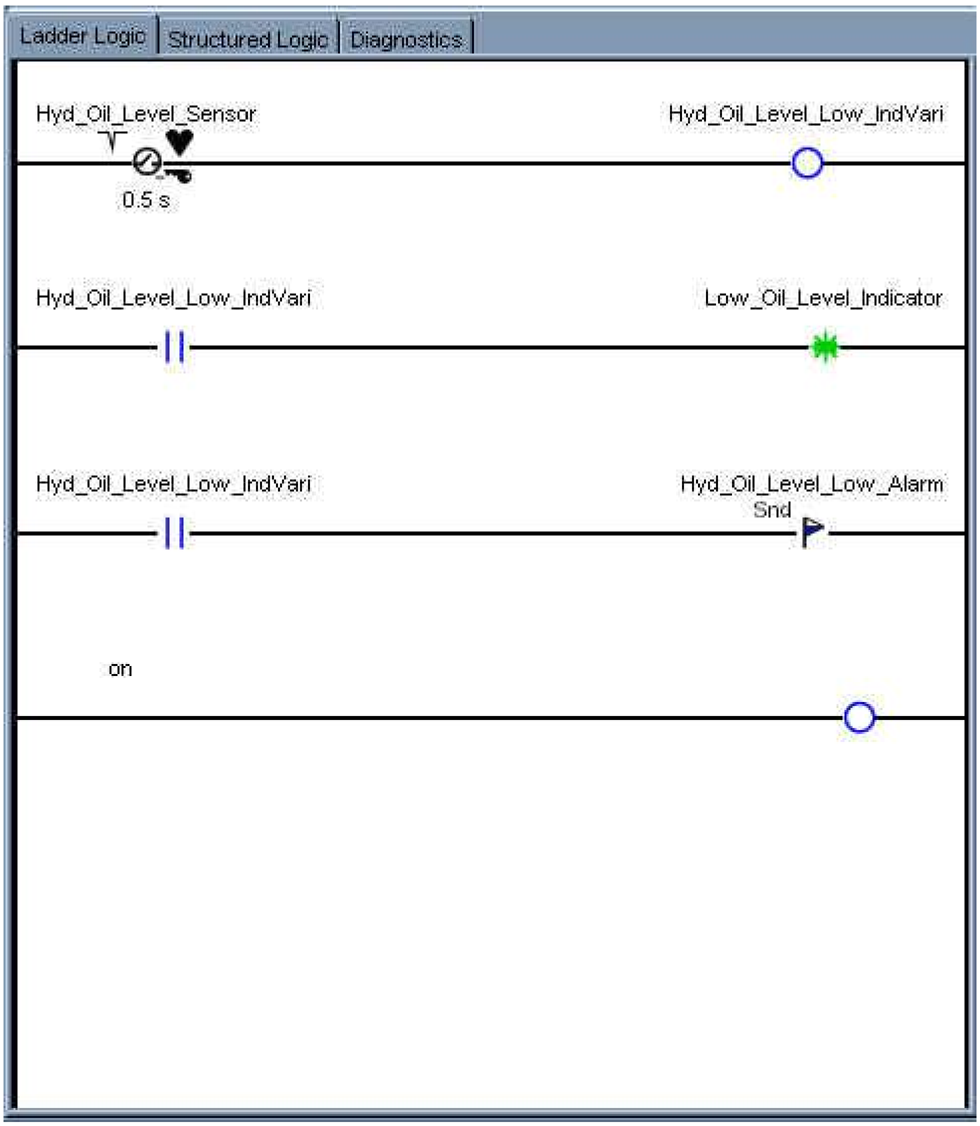
Step #2

Right mouse click ("B" button) on the signal to be "Debounced". This action will generate a pop-up menu that will provide a host of signal modification functions, one of which will be the "Debounce" function.



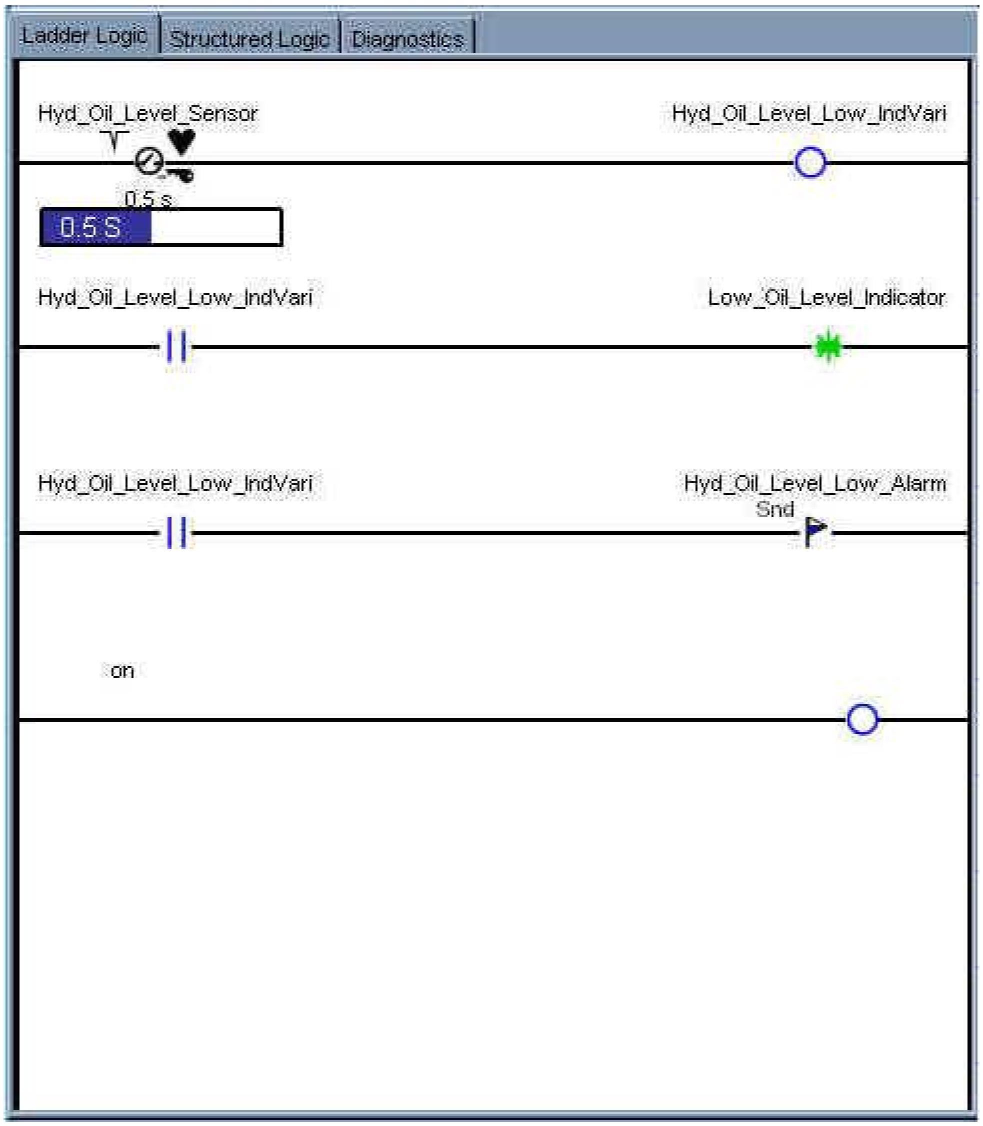
Step#3

Once the “Debounce” menu function is checked, the pop-up menu will disappear leaving the signal icon with two new icons near it. The first is the “Debounce” icon, located at approximately the10 o’clock position and the second is the “Debounce” time interval, defaulted to 0.5 seconds, which is located beneath the signal icon.

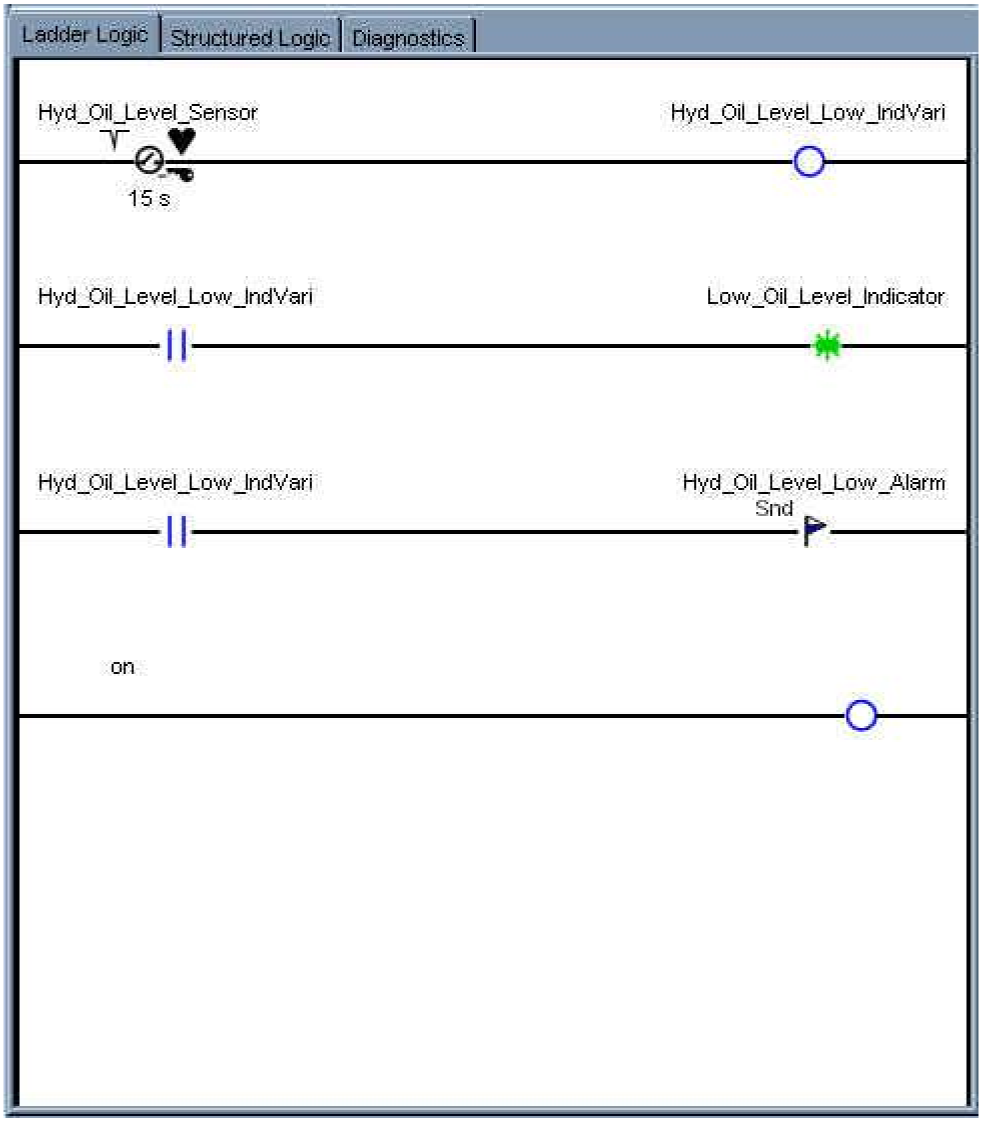


Step #4
In order to change the interval time value from its default value of 0.5 seconds, first double click on the time interval value, this will reveal a rectangular text box where a new interval value may be entered.

In this example the "Debounce" function will be added only to the Hyd_Oil_Level_Sensor signal icon in order for this feature to function correctly.



Once the desired “Debounce” interval value has been enter into the text box and the Enter key depressed, or the mouse “A” button is clicked while not on the signal icon, the value will be set in the “Debounce” function and the rectangular text box will disappear leaving only the interval value visible. Once the “Debounce” interval value has been set in the signal icon, it can be changed again if desired by double clicking on the interval value. This action will once again reveal the rectangular text box at which time a new value may be entered.



Step #5
Save the changes to the configuration.

“Debounce On”” refers to the delaying of a single signal state transition. This transition is from “Off” to “On” which could also be referred to as the signal going from “False” to “True” only. This function only delays the “Off” to ”On” signal status and not the “On” to “Off” ”…. Hence, “<u>Debounce “On”</u>”.

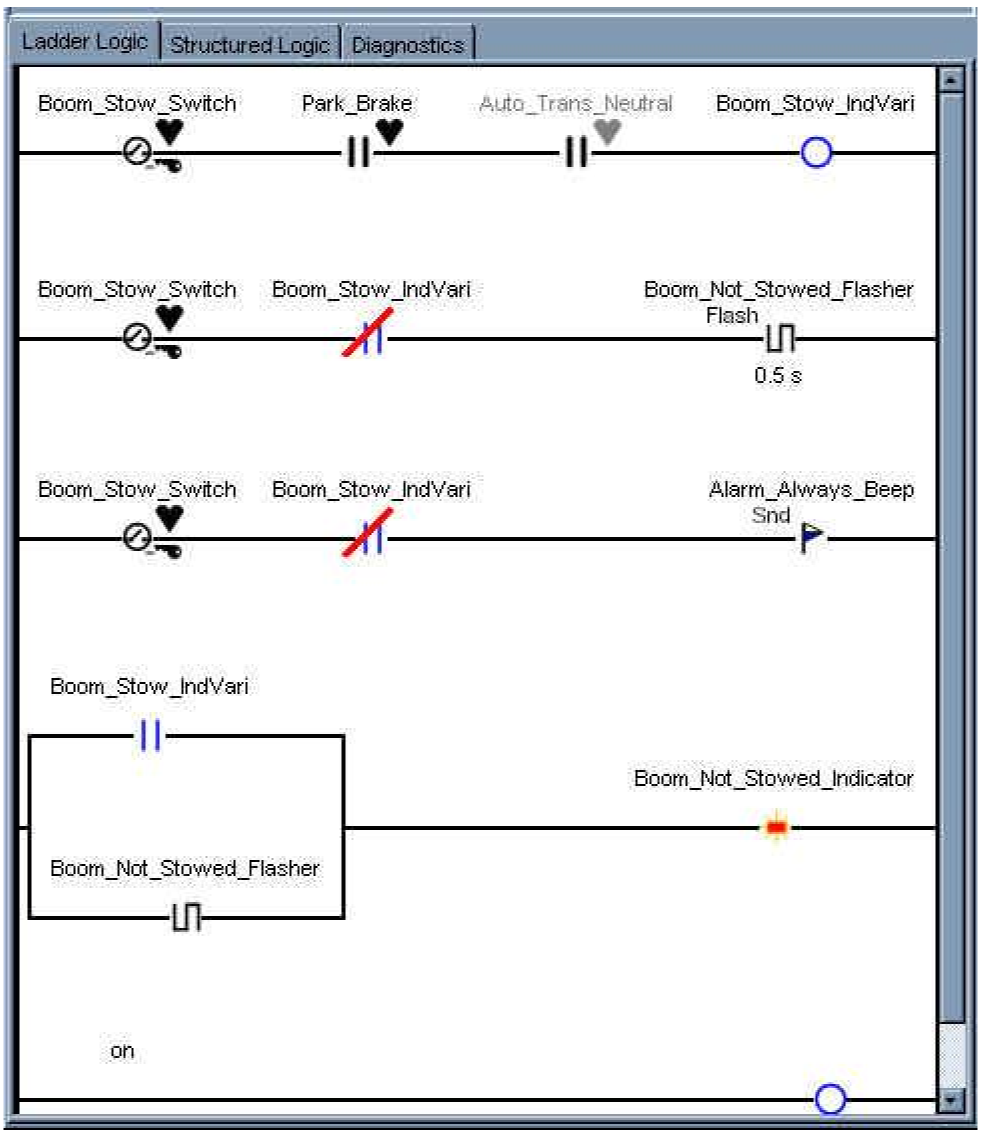
An example of the "Debounce On"" function would be a boom out of stow sensing system. Because of the forces normally imposed during travel and the normal flexing of a truck chassis and its' integrated body equipment the boom may on occasion become momentarily un-stowed. The "Debounce On"" function allows for the filtering out of these occasional "bounces" as the boom position switch senses the boom's movement. However, once the boom is back in its stowed position there is no delay in the software's signal status, it immediately transitions "Off" and waits for the next occurrence when the boom comes out of stow

How do I create the example above?

Step #1

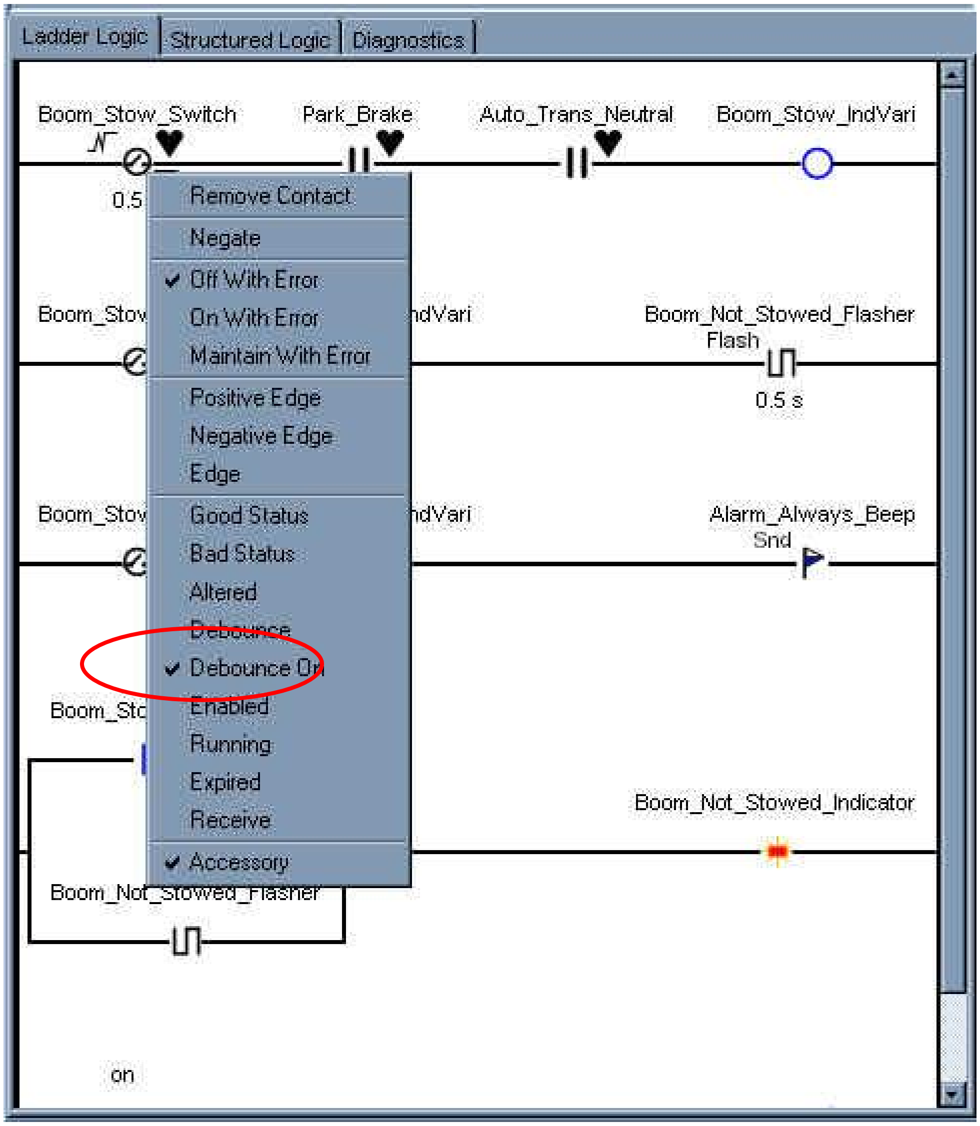
Create the necessary ladder logic needed to support the requirement's base functionality.

In this example we will be working with an advance logic version of the released boom- out-of-stow feature code 60AXX.



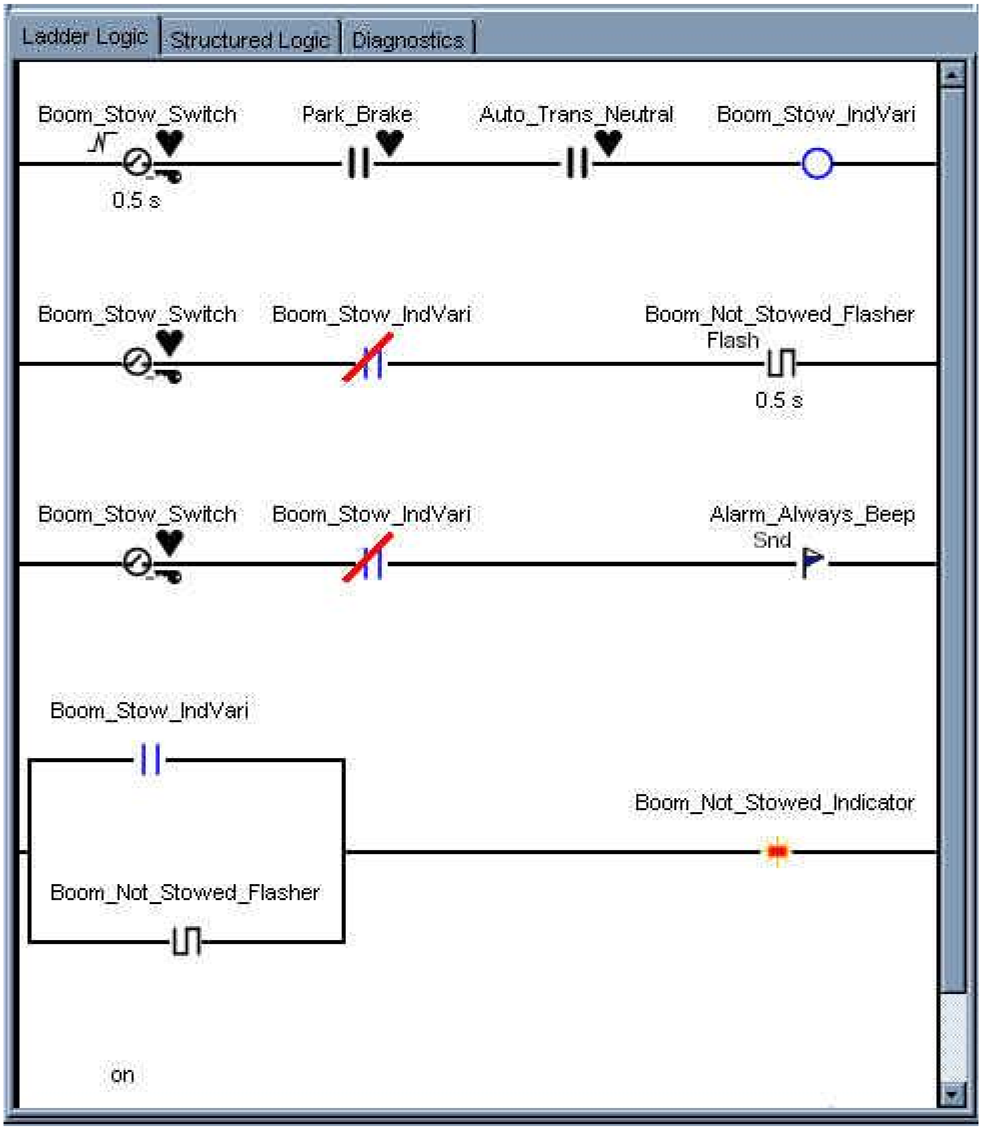
Step #2

Right mouse click ("B" button) on the signal to be "Debounced On". This action will generate a pop-up menu that will provide a host of signal modification functions, one of which will be the "Debounce On" function.



Step#3

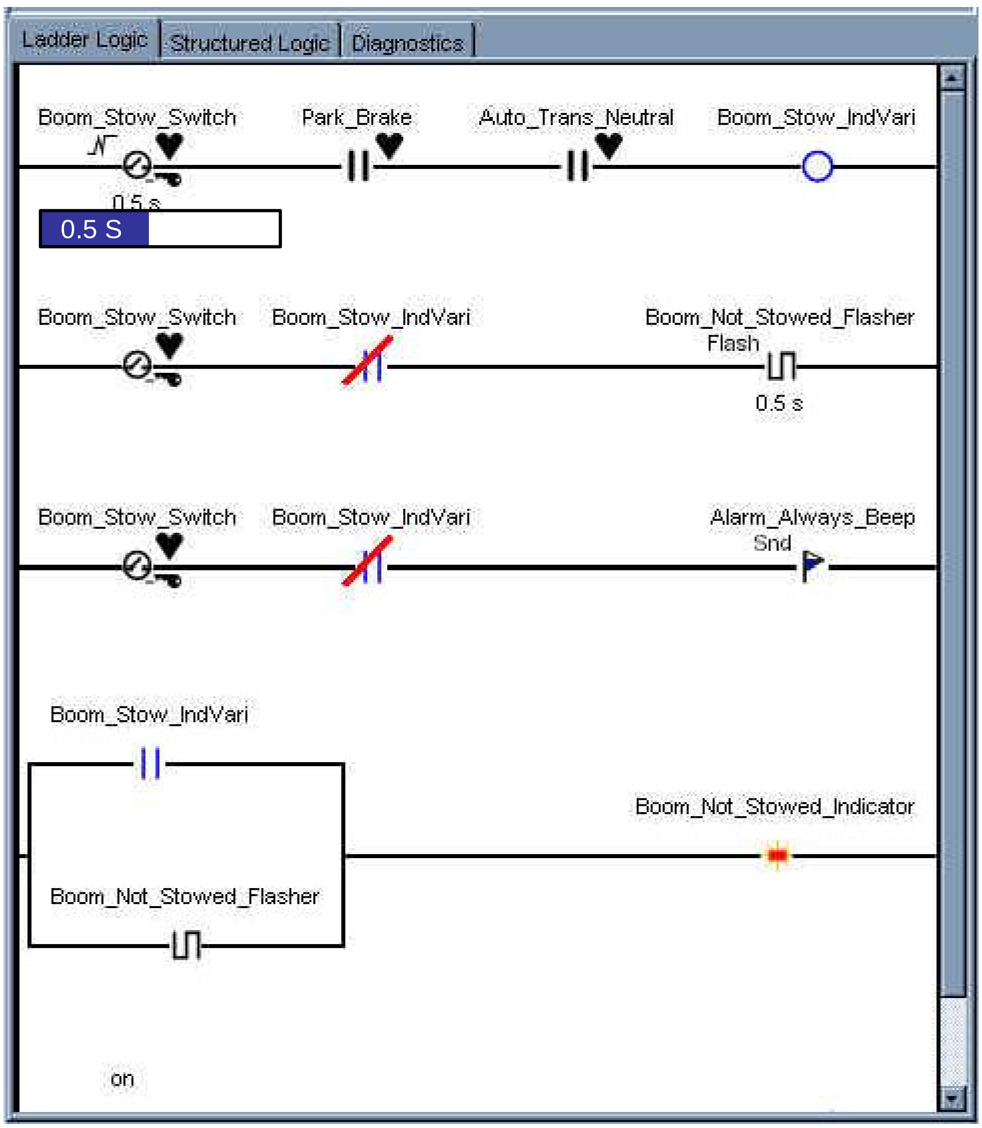
Once the "Debounce On" menu function has been checked, the pop-up menu will disappear leaving the signal icon with two new icons near it. The first being the "Debounce On" icon, located at approximately 10 o'clock relative to the signal icon; the second is a "Debounce On" time interval, defaulted to 0.5 seconds, located directly beneath the signal icon.



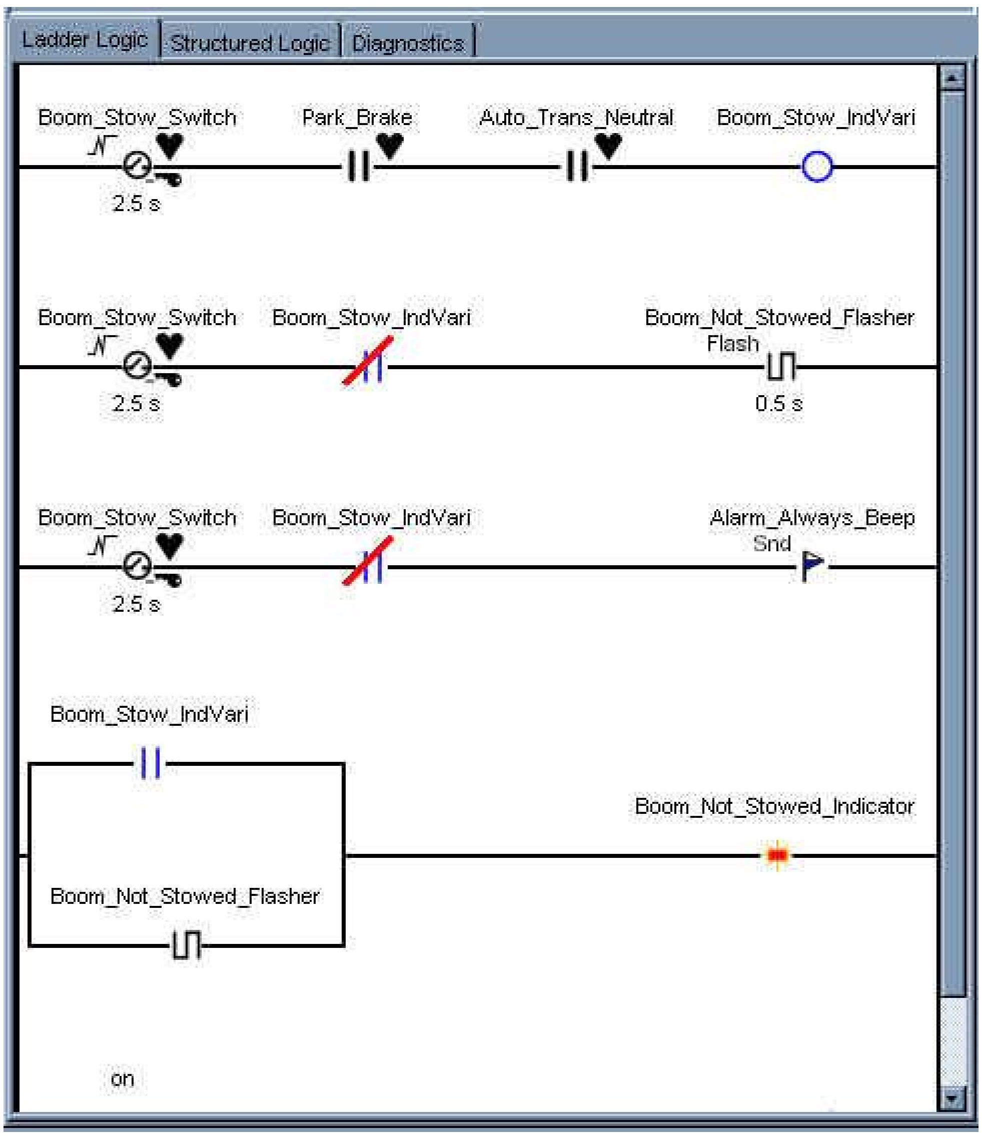
Step #4

In order to change the interval time value from its default value of 0.5 seconds, first double click on the time interval value, this will reveal a rectangular text box where a new interval value may be entered. Once the desired “Debounce On” interval value has been enter into the text box and the Enter key depressed, or the mouse “A” button is clicked while not on the signal icon, the value will be set in the “Debounce On” function and the rectangular text box will disappear leaving only the interval value visible. Once the “Debounce On” interval value has been set in the signal icon, it can be changed again if desired by double clicking on the interval value. This action will once again reveal the rectangular text box at which time a new value may be entered.

In this example the “Debounce On” function will have to be added to all three of the Boom_Stow_Switch signal icons in order for this feature to function correctly.



Once the desired “Debounce On” interval value has been enter into the text box and the Enter key depressed, or the mouse “A” button is clicked while not on the signal icon, the value will be set in the “Debounce On” function and the rectangular text box will disappear leaving only the interval value visible. Once the “Debounce On” interval value has been set in the signal icon, it can be changed again if desired by double clicking on the interval value. This action will once again reveal the rectangular text box at which time a new value may be entered.



Step #5
Save the changes to the configuration.

7.5 PTO Control Feature

International has developed a variety of pre-engineered PTO features that control many kinds of PTO engagement mechanisms. These pre-engineered features have 42 different engagement, disengagement, re-engagement and alarm parameters available for use as interlocks. However, interlocks such as “Hydraulic Oil Level, Hydraulic Oil Temperature, and Fire Pump Controls are some examples of what are not available with the pre-engineered International PTO features. In order to implement these interlocks, it may be necessary create a PTO feature using Advanced Ladder Logic.

Before we begin to discuss creating the Advanced Ladder Logic for PTO control, lets examine what International Truck and Engine Corporation included in the pre-engineered features. All of the available programmable parameters for PTO controls are the same for all features whether an electric, air or hydraulic engaged PTO is used. Parameters may be “turned ON or OFF” to achieve the level of PTO control desired. For example, feature code 60 ABE is an electric over clutched hydraulically engaged PTO control. If it is desired to disengage the PTO when the park brake is released and allow re-engagement when the Park Brake is set, then programmable parameters ID 2108, TEM_Pk_Brake_Disengages, 2149 TEM_Pk_Brake_Allow_ReEng and 2108 TEM_Pk_Brake_Engmnt_Inhibit must be turned ON. Refer to the following graphic. Be sure to use “Set With Template” when using this template on multiple vehicles. See the PTO section of the Electrical Body Builder Book CT-471 for a full description of PTOs and the application of pre-engineered International PTO control features. The pre-engineered PTOs should always be used whenever possible since the interlock parameters have been thorough extensive validation testing.

Feature	Description	Installed	Added With Templ...	Removed With Te...
0595193	(TEM) ESC PROG, PTO SHIFT for Hydraulic Clutch engagement mechanism	☑	☑	☐
0595295	ESC PROG, WATER IN FUEL LIGHT With J1939, for 2004 International I6 ...	☐	☐	☐
0595179	(TEM) ESC PROG, PTO LOGIC With dash switch and engagement and disenga...	☑	☑	☐
0595170	(TEM) ESC PROG, PTO MONITOR With indicator and alarm	☑	☑	☐
0514011	REAR AXLE SHIFT CONTROL W/AUTO TRANS	☐	☐	☐
0595006	ESC PROG AIR SOLENOID CONTROLLED/SWITCH	☐	☐	☐
0595007	ESC PROG AIR PRESSURE W/AIR COMPRESSOR	☐	☐	☐
0595008	ESC PROG AIR PRESSURE GAUGE/AIR BRAKE	☐	☐	☐
0595009	ESC PROG AIR ABS WARN LIGHT & FULL POWER BRAKES, NOT TRAILER	☐	☐	☐
0595010	ESC PROG HYD ABS WARN LIGHT NOT TRAILER	☐	☐	☐

Show

○ All Parameters ◉ Parameters For Selected Features ○ Parameters For Custom Logic

ID	Parameter	Value	Unit	Set With Temp...
2123	TEM_PTO_Mast_Swtch_Allow_ReEng	☐	On/Off	☐
2118	TEM_PTO_Mast_Swtch_Disengages	☐	On/Off	☐
2099	TEM_PTO_Mast_Swtch_Engmnt_Inhib	☐	On/Off	☐
2089	TEM_PTO_Neut_Engmnt_Inhib	☐	On/Off	☐
2132	TEM_PTO_Non_Neut_Alarms	☐	On/Off	☐
2148	TEM_PTO_Non_Neut_Allow_ReEng	☐	On/Off	☐
2109	TEM_PTO_Non_Neut_Disengages	☐	On/Off	☐
2088	TEM_PTO_Non_Neut_Engmnt_Inhib	☐	On/Off	☐
2149	TEM_PTO_Pk_Brake_Allow_ReEng	☑	On/Off	☑
2108	TEM_PTO_Pk_Brake_Disengages	☑	On/Off	☑
2087	TEM_PTO_Pk_Brake_Engmnt_Inhib	☑	On/Off	☑
2133	TEM_PTO_Veh_Spd_Alarms	☐	On/Off	☐
2119	TEM_PTO_Veh_Spd_Allow_ReEng	☐	On/Off	☐
2111	TEM_PTO_Veh_Spd_DisEng_Limit	0	mph	☐
2110	TEM_PTO_Veh_Spd_Disengages	☐	On/Off	☐
2090	TEM_PTO_Veh_Spd_Engmnt_Inhib	☑	On/Off	☐
2091	TEM_PTO_Veh_Spd_Engmnt_Limit	3	mph	☐
2147	TEM_RPM_PTO_Engaged_Param	1	List	☐

7.5.1 Gathering PTO Requirements

The first step in creating an advanced logic block for controlling PTOs is to gather the performance and interlock requirements. It is essential that the rules for PTO engagement, disengagement and re-engagement be specifically identified for the vehicle under development. Next the type of PTO engagement mechanism that is to be used for the vehicle must be identified. There are many types of PTO mechanisms and the logic to control them is very different.

WARNING: DO NOT USE ANY LADDER LOGIC EXAMPLES IN THIS DOCUMENT FOR CONTROLLING PTOs UNTIL YOU ARE CONFIDENT OF THE LOGIC REQUIRED TO CONTROL THE PTO MECHANISM IN THE VEHICLE UNDER DEVELOPMENT.

1. The main types of PTOs are:
2. Electric over Hydraulic with a clutch type engagement
3. Electrically actuated gear engagement with a pull-in coil and a holding coil (Lectra-Shift)
4. Air shifted with a clutch type engagement.
5. Air shifted with a gear to gear engagement
6. Cable Shifted with gear to gear engagement

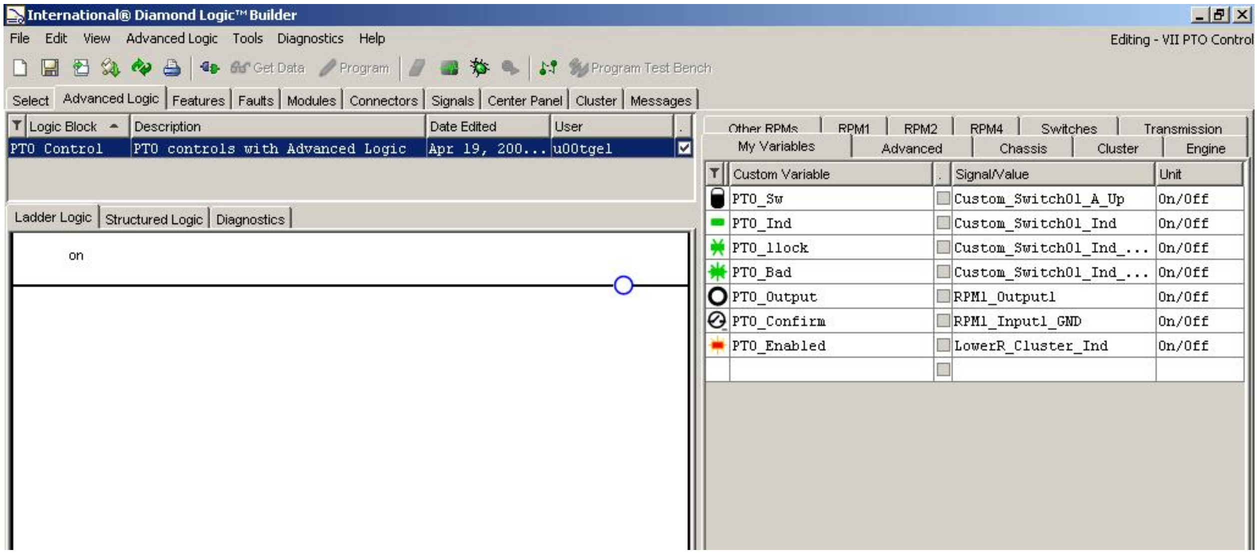
The type of transmission that is used in the vehicle limits the type PTO mechanism that may be used. Some transmissions such as the Allison WTEC cannot use a non-clutched PTO since the PTO gear is constantly turning while the engine is running. Non-clutched PTOs can be used with an Allison LCT transmission as long as the transmission is in gear and the vehicle is parked while the PTO is engaged, then the transmission must be placed in neutral. Non-Clutched PTOs may also be used with manual transmissions as long as the clutch is depressed when the PTO is engaged. It becomes obvious that the control logic is very different from one PTO type to another.

Warning: Consult with the manufacturer of the PTO mechanism for application notes on using the device before creating ladder logic to control it. International Truck and Engine shall not be liable for any equipment damage or personal injury due to events arising from the control of a PTO.

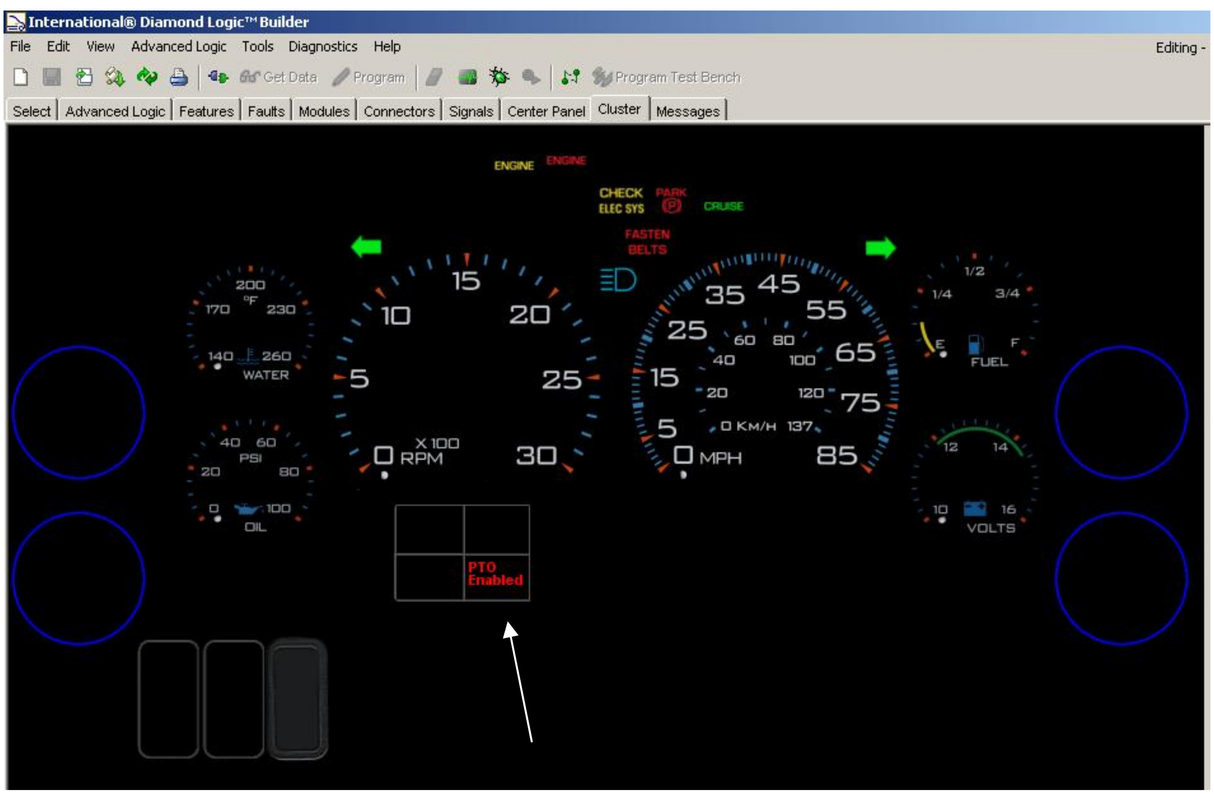
7.5.2 Basic PTO Fundamentals

The first example is designed to control an electric over hydraulic PTO with a clutch type engagement. The feature provides control of the PTO mechanism from either a rocker switch in the cab or else a ground active switch on the body. First create a Logic Block named PTO Control. The required component inputs and outputs include a two position latched PTO rocker switch located in the Center Panel of the instrument panel, a latched two position switch located in the body that is connected to an RPM Input to actuate the PTO from the body, an RPM output named PTO Output connected to the PTO hydraulic engagement solenoid, an RPM Input to verify that the PTO is engaged and an indicator light in the gauge cluster that is labeled PTO. Additionally we will need to add indicator lights to indicate the PTO status to the PTO rocker switch in the cab.

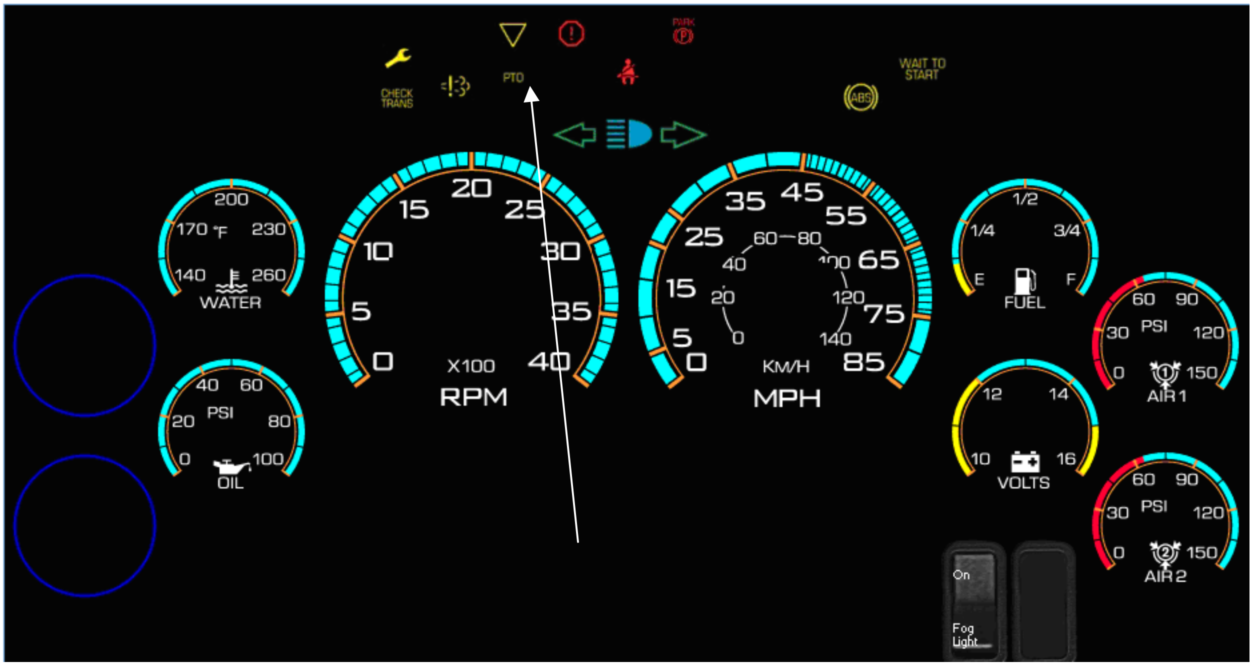
This includes the LED located behind the PTO switch located in the Center Panel. Refer to the following graphic.



The PTO indicator light located in the Instrument Cluster is always located in the Lower, Right section of the warning indicator light section of the Instrument Cluster. When mapping to the PTO indicator in the Instrument Cluster you will need to always write to the “LowerR_Cluster_Ind” located in the “Cluster” Tab within the variable tab named “Advanced Logic”.



Gauge Cluster View with PTO Light (built prior to January 01, 2007)



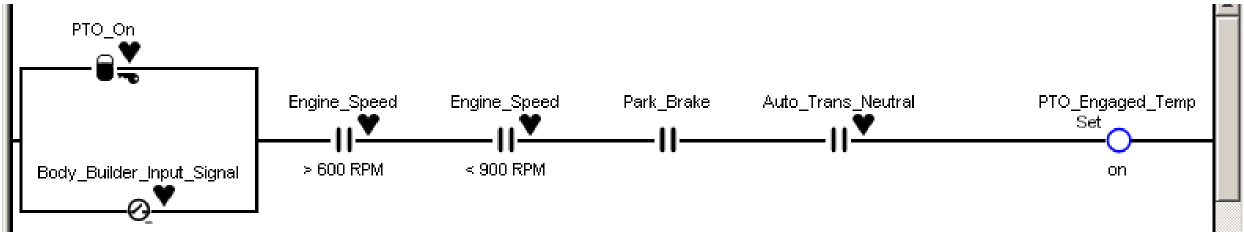
Gauge Cluster View with PTO Light (built after January 01, 2007)

7.5.3 Building the Logic for a Clutch Type PTO

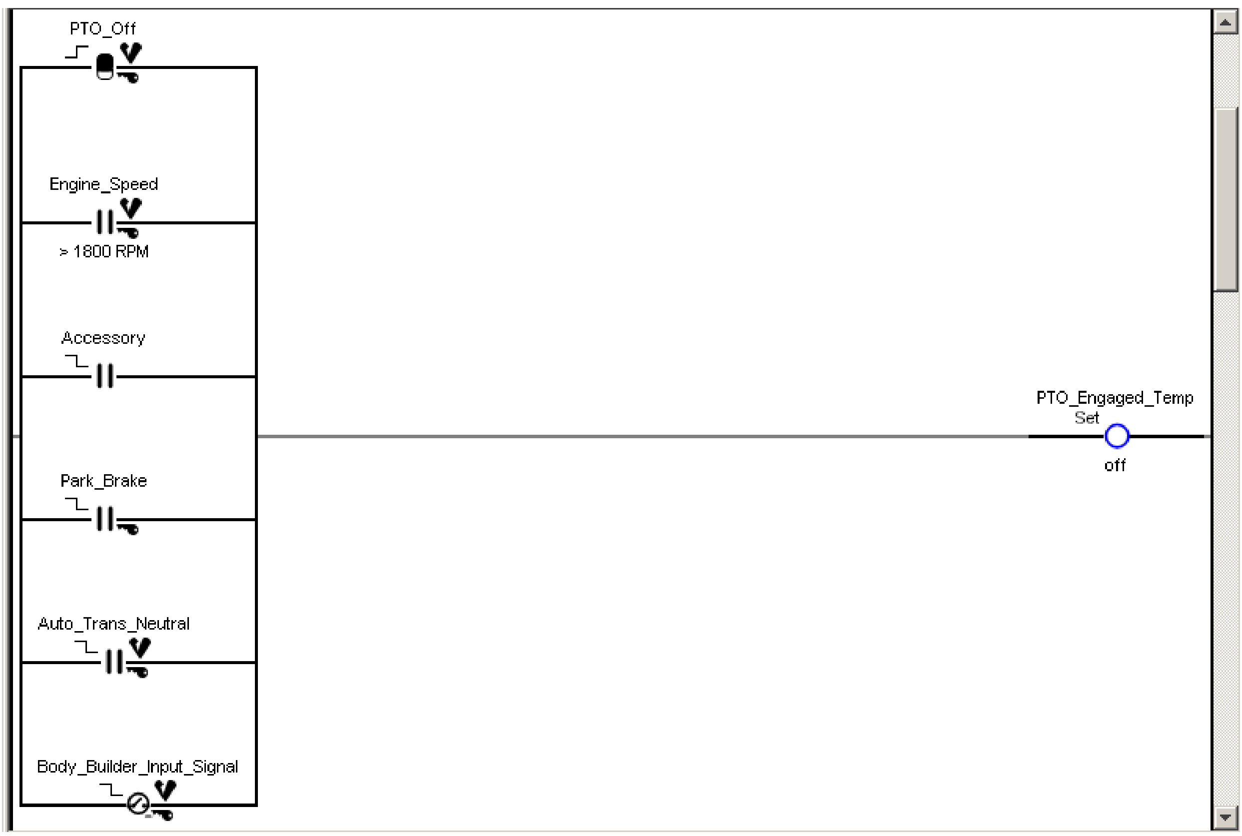
As stated before, this first example is designed to control an electric over hydraulic PTO with a clutch type engagement. This example employs a variety of interlocks to ensure that the PTO may only be operated when the vehicle is in a stationary position. Additional interlocks could be added to this logic but for the sake of keeping the example simple, a limited number of interlocks have been included. The total list of requirements for the this Clutch Type PTO example include:

1. Transmission must be in Neutral to engage the PTO
2. Park Brake must be Set to engage the PTO
3. Engine must be running (Engine RPM > 600 RPM) to engage the PTO
4. PTO will not engage unless Engine RPM is less than 900 RPM
5. PTO will disengage with Engine RPM greater than 1800 RPM
6. Either the Cab Rocker Switch OR the body mounted switch will engage the PTO
7. Both PTO switch controls must be OFF to turn off the PTO
8. Bad status on any of the Interlocking signals shall turn off the PTO
9. The PTO will re-engage if all interlocks are met.
10. PTO light in the gauge cluster shall illuminate when the PTO is engaged
11. PTO light shall flash and a beeper shall alarm when the park brake is released, the engine speed is greater than 1800 RPM, or the transmission is placed in gear while the PTO is engaged.
12. The Green indicator in the cab PTO switch shall flash fast when a signal fault has occurred.
13. The Green indicator in the cab PTO switch shall flash slowly when an interlock is violated.

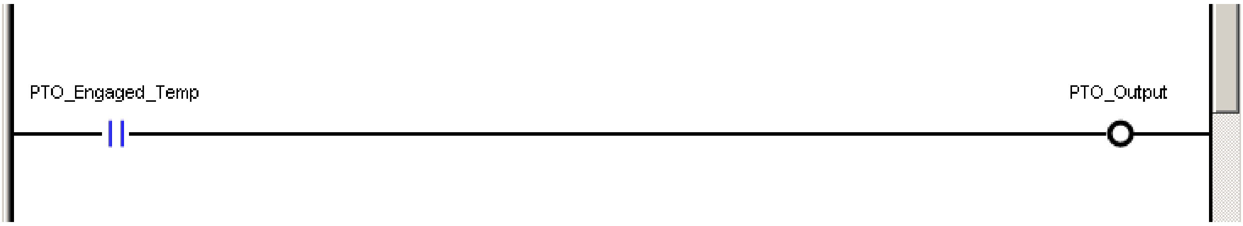
See the first rung below that allows the control of an independent variable when all the interlocks are met.



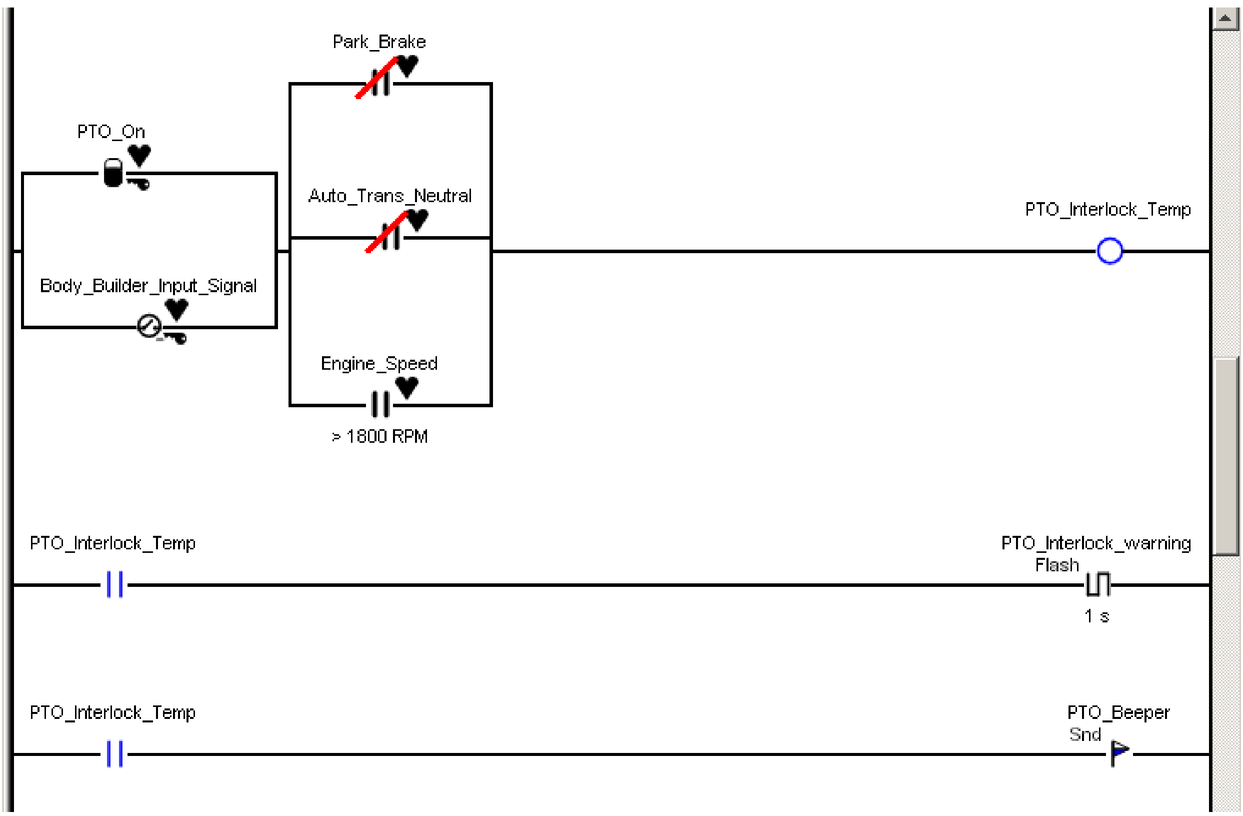
Logic must be included to disable the PTO when an interlock is not met. Note that the rung below, uses the “ON with Error” Icon on each signal so that either the signal condition or a bad signal status will shut off the PTO. Also see that the shutting off the ignition key will also force the PTO OFF so that it is in a known safe state when the vehicle is restarted. If auto re-engagement after a remote start stop sequence is required, then the Accessory signal would not be used.



The internal variable PTO_engaged_temp is then used to control the RPM output which drives the PTO mechanism.



The next rungs are used to detect when various signal interlocks have not been met. When either the cab switch or the body switch is activated and one of the three listed interlocks are not true, an internal variable PTO_Interlock_Temp is turned ON. This variable is then used to start a flasher function and to drive the beeper in the gauge cluster with a repetitive beeper cadence. See the ladder logic below.

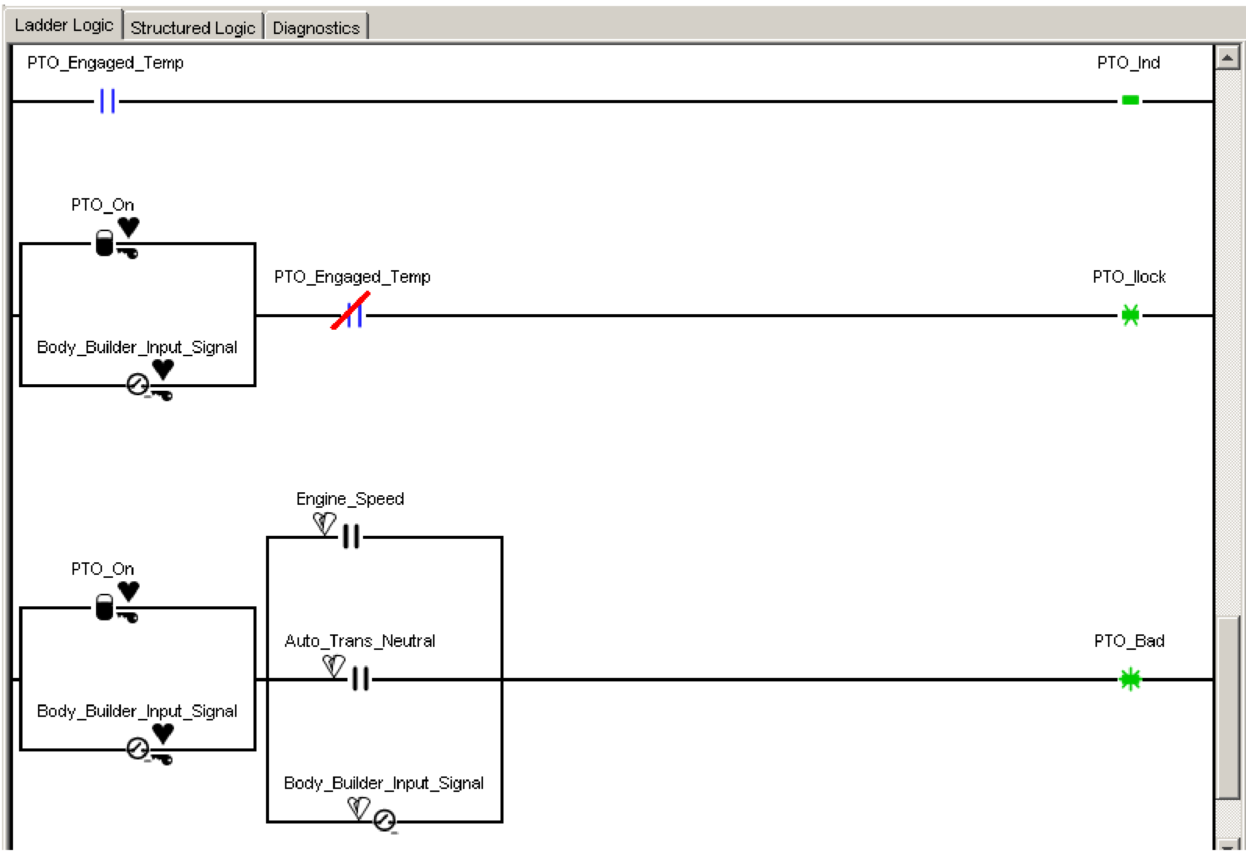


7.5.4 Visual Indicators

A visual indicator should be provided to alert the operator that the PTO is engaged. Most PTO's have a "feedback" switch. For this example, the switch should have one side of the switch hooked to chassis ground. In the following graphic you can see the remote input turns on the indicator in the instrument cluster (orange ladder logic Icon indicator). The new input named "PTO_Confirm" is used to drive the PTO lamp in the gauge cluster. Note that the Gauge cluster lamp will flash when the interlock internal variable is flashing.


PTO_Confirm
PTO_Interlock_warning
PTO_Engaged

The visual indicator in the rocker switch may be used to alert the operator if the PTO mechanism is or is not engaged. To accomplish this task we will need to name three more icons. We will need to create a “Steady On”, “Fast Flash” and a “Slow Flash” signal for the PTO switch. The “Steady On” indicator indicates that the PTO is requested ON and all interlocks are true. The “fast flash” indicator will be used to alert the driver the PTO was requested ON with the switch in the center panel or the body switch, but the Remoter Power Module output has been turned OFF due to a component failure with one or more of the devices used in the PTO system. The “slow flash” indicator will be used to alert the driver the PTO is not engaged due to an interlock that is not true.



The fast and slow flash LED’s are located in the tab called “Switches”. You must associate the fast and slow flash PTO indicators with the custom switch used with PTO rocker switch. See the PTO switch assignment list below.

	PTO_On	Custom_Switch01_A_Up	On/Off
		Custom_Switch01_B_Middle	On/Off
	PTO_Off	Custom_Switch01_C_Down	On/Off
	PTO_Ind	Custom_Switch01_Ind	On/Off
	PTO_Bad	Custom_Switch01_Ind_Fast_Flash	On/Off
	PTO_Ilock	Custom_Switch01_Ind_Slow_Flash	On/Off

7.5.5 Entering the Feature and Diagnostic Description

There is one last crucial piece of information that needs to be installed to the logic. And that information would be the synopsis, diagnostics, pin out, and switch locations that you will manually type in the "Diagnostics" tab on the ladder logic screen. Remember, failure to complete this step will result in the logic designer's user id being disabled by International Truck and Engine Corporation. If the user id is disabled the user will no longer be able to create Advanced Logic™ solutions. The diagnostics tab is used by truck technicians as a troubleshooting manual, should the truck be in need of repair. If the logic description is not provided with the ladder logic, the technician may not be able to troubleshoot the vehicle problem. This will result in excessive truck downtime, repair time as well as elevated repair costs. You hold the key to managing the success of the Diamond Logic® solutions you create. It is desirable that the name and company phone number of the advanced ladder logic should be included in the diagnostic description. See the chapter on diagnostics for a full description of the information that should be included in the diagnostic description.

7.5.6 Building the Logic for a Non-Clutched Type PTO

Creating an advanced ladder logic block for a non-clutched type PTO is more difficult. The logic rules for controlling a gear-to-gear type PTO are much more restrictive in order to prevent gear grind while engaging the PTO. Some transmissions such as the Allison WTEC cannot use a non-clutched PTO since the PTO gear is constantly turning while the engine is running. Non-clutched PTOs can be used with an Allison LCT transmission as long as the transmission is in gear and the vehicle is parked while the PTO is engaged, then the transmission must be placed in neutral. Non-Clutched PTOs may also be used with manual transmissions as long as the clutch is depressed when the PTO is engaged. A non-clutched PTO should never employ logic rules that would allow automatic re-engagement after being dis-engaged by an interlock that was not true such as the park brake being released. Since engaging a non-clutched PTO requires stopping the transmission PTO gear, using driver involvement, this type of PTO cannot be engaged from body mounted controls. A momentary switch should be used in the cab to prevent accidental re-engagement.

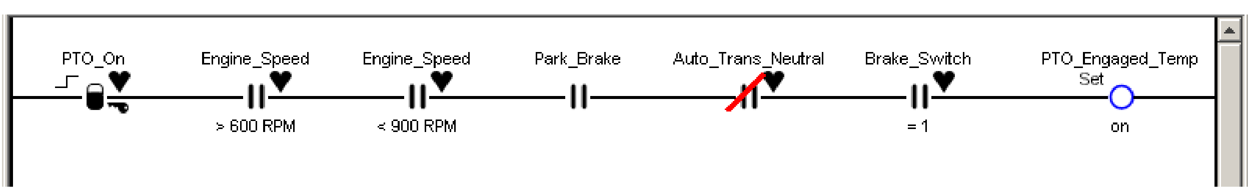
7.5.7 Non-Clutched PTO Requirements

The second example is designed to control an electric over air PTO with a non-clutch or gear-to-gear type engagement on an Allison LCT transmission. This example employs a variety of interlocks to ensure that the PTO may only be operated when the vehicle is in a stationary position. Additional interlocks could be added to this logic but for the sake of keeping the example simple, a limited number of interlocks have been included. Once the PTO is engaged, the driver must place the transmission in Neutral. The total list of requirements for the this Non-Clutch Type PTO example include:

Park Brake must be Set to engage the PTO
Engine must be running (Engine RPM > 600 RPM) to engage the PTO
PTO will not engage unless Engine RPM is less than 900 RPM
Transmission must be in a forward or reverse gear to engage the PTO
Driver must have brake pedal depressed to engage the PTO.
PTO will disengage with Engine RPM greater than 1800 RPM
Pushing the upper portion of the Cab Rocker Switch will engage the PTO
Pushing the lower portion of the Cab Rocker Switch will dis-engage the PTO.
Bad status on any of the Interlocking signals shall turn off the PTO
The PTO will not re-engage after a dis-engagement unless the PTO switch is depressed again while all interlocks are true.
PTO light in the gauge cluster shall illuminate when the PTO is engaged
The Green indicator in the cab PTO switch shall flash fast when a signal fault has occurred.

The required component inputs and outputs include a three position, center stable, momentary PTO rocker switch located in the Center Panel of the instrument panel, an RPM output named PTO Output connected to the electrically activated air solenoid, an RPM Input to verify that the PTO is engaged and an indicator light in the gauge cluster that is labeled PTO. Additionally we will need to add indicator lights to indicate the PTO status to the PTO rocker switch in the cab.

See the first rung below that allows the control of an independent variable when all the interlocks are met. Remember the PTO switch must be a momentary type.

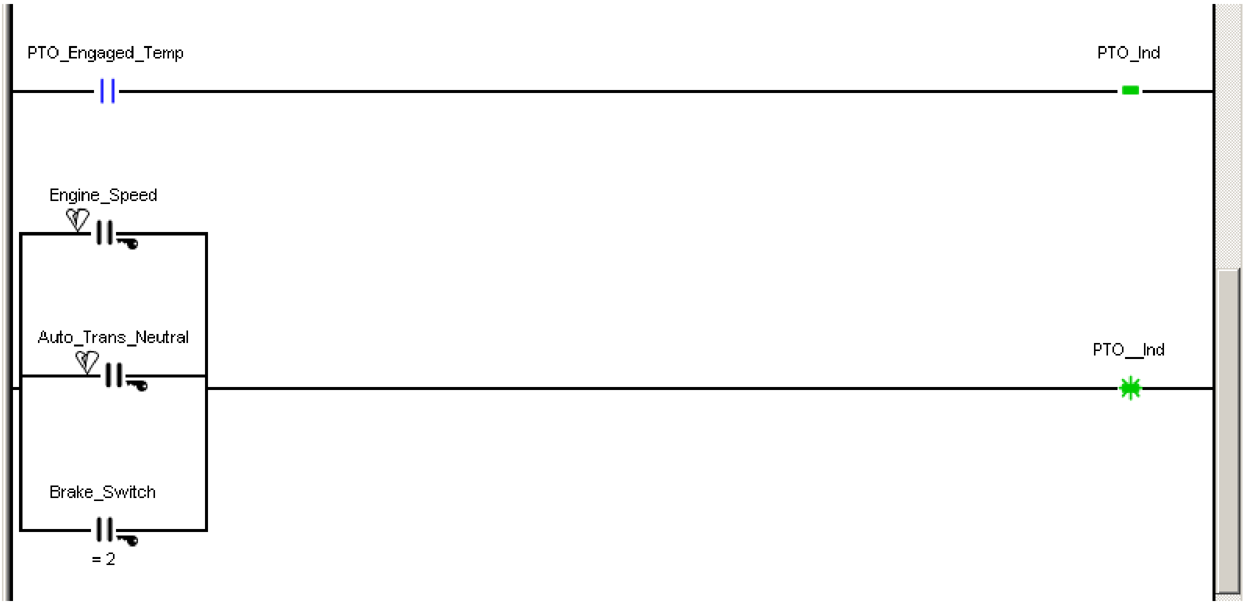


Logic must be included to disable the PTO when an interlock is not met. Note that the rung below, uses the “ON with Error” Icon on each signal so that either the signal condition or a bad signal status will shut off the PTO. Also see that the shutting off the ignition key will also force the PTO OFF so that it is in a known safe state when the vehicle is restarted. If auto re-engagement after a remote start stop sequence is required, then a non-clutched PTO cannot be used. Note that a value of 2 indicates a bad status on the Brake Switch.

7.5.8 Visual Indicators

A visual indicator should be provided to alert the operator that the PTO is engaged. Most PTO's have a "feedback" switch. For this example, the switch should have one side of the switch hooked to chassis ground. In the following graphic you can see the remote input turns on the indicator in the instrument cluster (orange ladder logic Icon indicator). The new input named "PTO_Confirm" is used to drive the PTO lamp in the gauge cluster.

The visual indicator in the rocker switch may be used to alert the operator if the PTO mechanism is or is not engaged. To accomplish this task we will need to name two more icons. We will need to create a "Fast Flash", and a "Steady ON" signal for the PTO switch. The "fast flash" indicator will be used to alert the driver the PTO was requested ON by the switch in the center panel, but the Remoter Power Module output has been turned OFF due to a component failure with one or more of the devices used in the PTO system. The "Steady ON" indicator will be used to alert the driver the PTO is requested ON and all interlocks are true.



The steady and fast flash LED's are located in the tab called "Switches". You must associate the fast and slow flash PTO indicators with the custom switch used with PTO rocker switch. See the PTO switch assignment list below.

	PTO_On	Custom_Switch01_A_Up	On/Off
		Custom_Switch01_B_Middle	On/Off
	PTO_Off	Custom_Switch01_C_Down	On/Off
	PTO_Ind	Custom_Switch01_Ind	On/Off
	PTO_Bad	Custom_Switch01_Ind_Fast_Flash	On/Off
	PTO_Ilock	Custom_Switch01_Ind_Slow_Flash	On/Off

7.5.9 Entering the Feature and Diagnostic Description

There is one last crucial piece of information that needs to be installed to the logic. And that information would be the synopsis, diagnostics, pin out, and switch locations that you will manually type in the "Diagnostics" tab on the ladder logic screen. Remember, failure to complete this step will result in the logic designer's user id being disabled by International Truck and Engine Corporation. If the user id is disabled the user will no longer be able to create Advanced Logic™ solutions. The diagnostics tab is used by truck technicians as a troubleshooting manual, should the truck be in need of repair. If the logic description is not provided with the ladder logic, the technician may not be able to troubleshoot the vehicle problem. This will result in excessive truck downtime, repair time as well as elevated repair costs. You hold the key to managing the success of the Diamond Logic® solutions you create. It is desirable that the name and company phone number of the advanced ladder logic should be included in the diagnostic description. See the chapter on diagnostics for a full description of the information that should be included in the diagnostic description.

7.5.10 PTO Conclusions

As you can see in this chapter, there is a lot of thought that needs to be placed in designing ladder logic. What we have reviewed in this section is just the beginning! We covered just five interlocked parameters. International Truck and Engine Corporation did this with forty-two different parameters! It would be very beneficial to use the parameters that were designed by International Truck and Engine Corporation whenever possible.

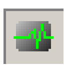
Section 8 Diagnostics, Simulation and Validating Solutions

A significant feature of the Diamond Logic® Builder software is its' ability to diagnose and validate both hardware and software elements of the Diamond Logic® electrical system. By leveraging the factory-installed modules on the vehicle along with the bodybuilder installed components it becomes much easier to diagnose and validate software and hardware programmed on the vehicle. The following section will explain proper techniques for diagnosing and validating complete electrical solutions.
A very effective tool found in both the diagnostic and simulate mode is the ability to print any portion of the vehicle programming file. You can print the entire vehicle architecture or just a piece of the logic. If you print the entire vehicle, be advised that it can be up to 60 pages long. Individual items that can be printed include the advanced logic blocks, which include the actual ladder logic (graphical view of the logic), the structured logic (text version of the ladder logic) or the diagnostics text descriptions for the ladder logic. The diagnostics portion is a critical piece that should be printed after a vehicle file or template is created. The diagnostic portion of ladder logic will be discussed later in this section. Other portions that can be printed are features, faults, modules, connectors, signals, center panel, cluster and messages. It is highly suggested that after creating advanced logic, to print the advanced logic, connectors and center panel and add these items to the vehicle packet that you ship with the vehicle. This is the minimum suggested; if there is more complexity to your particular vehicle, you may find it useful to print additional sections to send with the vehicle. These printouts will assist your service locations or International dealers in diagnosing issues after the vehicle leaves the bodybuilder.

8.1 Simulate Mode: Purpose, Definition and usage

Simulate mode allows a Diamond Logic® Builder program user to test pre-engineered features as well as advanced logic solutions. Vehicle files can be retrieved from history and then a template can be created using the Diamond Logic® Builder software and simulated to ensure that all the features and interlocks are set to your particular preference. Certain features contain interlocks such as the PTO feature. The PTO feature has 42 programmable parameters that are selectable to a Diamond Logic® Builder software user. Engagement, disengagement and reengagement parameters are a few examples of PTO interlocks that the simulate mode can test out to ensure that they are set to your specifications before you program a vehicle. Simulate mode can be a useful tool to ensure that the right codes are ordered on your vehicle so you know all the items you will be adding will work when the vehicle gets to your location. Simulate works independently of a vehicle so you can test solutions even before a vehicle is ordered. Being able to work through a vehicle file or template before applying it to a vehicle is a huge time saver. It allows you to actually troubleshoot any inconsistencies in your programming and not interfere with the production of the vehicle. The controls and procedures in simulate and diagnostic are very similar and will be explained in the rest of section 8.

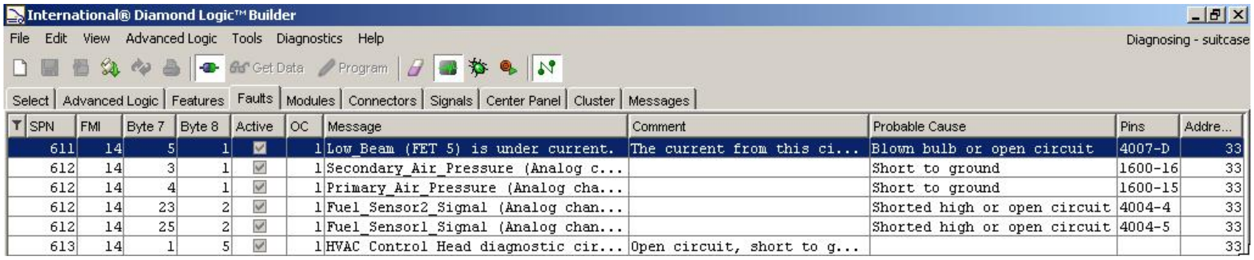
8.2 Diagnostic Mode: Purpose, Definition and Usage



Diagnostic mode gives the technician the ability to diagnose vehicle faults and verify driver complaints quickly and easily. The first step in diagnostics is to connect to the vehicle. Do this by using an interface device such as the IC3 Com, IC4 Com or IC4 USB cable. The interface cable should be one that is approved by International. When diagnosing or programming, always start with the key in the accessory position. A key in the ON position or a vehicle started should only be used when you must test a feature that requires this. The primary reason for this is that with the vehicle started or the key in the on position, all vehicle modules including the engine, transmission, ABS and all multiplex modules are communicating on the data link. With all this data traffic, it can take up to 4 times as long to do diagnostics or programming.

Diagnostic mode can show short and open circuits, amperage loads that are too high or too low, or custom logic that has not been properly written. The diagnostic mode allows you to view switches, contacts, outputs and many other signals that are on the vehicle. It allows you to view and override signals to test and diagnose problems with multiplex features on the vehicle. Later in this section we will discuss diagnosing different components such as switches, gauges and connector outputs.

One of the first things we can do with the Diamond Logic® Builder software in the diagnostic mode is to read a list of faults that are on the vehicle by clicking on the fault tab. The fault tab can show diagnostic trouble codes, whether a fault is active or inactive, pin locations, probable causes and comments etc.



Fault Detection Tab

The following information can be displayed on the fault tab:

Name	Description
SPN	Suspect Parameter Number: Number that indicates the Major System that is experiencing a failure mode.
Byte 7	Number that indicates the sub-system that is experiencing a failure mode.
Byte 8	Number to describe the detailed fault mode such as open circuit, shorted to ground, etc.
OC	Occurrence Count: Number of times a fault has gone active and then inactive.
Active	Indicator to show whether a fault is currently active or inactive.
Message	Text description of the numerical fault code.
Comment	Explanation of Message Description.
Probable Cause	Probable cause of the fault.
Pins	Module pin and connector associated with the fault code, if applicable.
Address	Address of the module logging the fault. Currently, this number is always 33 for the ESC. This column should be turned OFF until later enhancements make it more usable.
FMI	FMI is a number for “Fault Mode Indicator.” Currently this value is always 14 for “Indeterminate” as per the SAE J1939

	specification. The FMI for the Diamond Logic® electrical system is currently displayed under the Byte 8 column listed above. This column should be turned OFF until later enhancements make it more usable.
Find Matches…	Use to find matches anywhere on the table and bring them to the top of the screen.
Clear Matches	Clears the find matches function and puts the screen back to the currently sorted column format.

8.3 Diagnostic feature descriptions-Writing useful text

It is extremely important to write detailed descriptions of any advanced logic you create. All the items written in Advanced Logic should be documented in the description tab. If the diagnostic description is detailed and explains the advanced logic well, it will go a long way to assist technicians in troubleshooting your advanced logic. If he advanced logic is hidden, this document is the only way that a technician can diagnose and troubleshoot the advanced logic.

Items that should be documented are:

Synopsis

A general overview of the each advanced logic block. The synopsis should give the technician an idea of the overall vehicle configuration.
Fault Detection Management

The fault detection management portion of the document should explain the use of the switch indicators and how they will respond in a fault situation.

Any exceptions to the standard fault indicators

The virtual fusing set for RPM outputs.

Feature Extended Descriptions

Each Logic Block should be explained in detail.

Features should be described so that anyone reading the description could tell you what input, switches and outputs are used and what each item does in the feature Items such as load management and master switching should be explained in full to include voltages and all rungs that are incorporated in the management or switching.

Contact Information

Contact information should be provided so technician or customer questions about the operation or settings within the advanced logic can be answered.

Recommended contact information should include: Name of the person who created the advanced logic, address and phone number of the bodybuilder and or the call center number so the technician or customer can obtain answers.

Below is an example of proper and detailed diagnostic descriptions written for an advanced logic block.

Ladder Logic | Structured Logic | Diagnostics

Synopsis:

The following electrical loads are to be connected to one Remote Power Module, RPM mounted under the cab, with five (2 POS) latched rocker switches and one switch pack din warning indicator light assembly. Each body builder electrical circuit attached to the RPM will provide on-board self-diagnostics consisting of each circuit signal input status utilized for each circuit, which will cause the circuit to default to one of the two following conditions:

Fault Detection Management:

1. Slow flashing switch indicator will represent that the driver desired requests is out of specific parameters or circuit function interlocks.

2. Fast flashing switch indicator will represent an electrical circuit fault is present.

3. Exceptions to switch circuit self-diagnostics will be the door open warning light circuit. On-board diagnostics can be exercised via the vehicles system Diagnostics Trouble Codes cluster LCD display.

Virtual fusing parameters for RPM outputs as follows:

Output 1: 20A	virtual accessory
Output 2: 10A	Siren horn
Output 3: 10A	Beacon light
Output 4: 5A	upper flashers
Output 5: 10A	step lights
Output 6: 15A	park lights

Detailed Feature Descriptions:

Fan & Interior Lighting
RPM 1 Output 1 (Brown 8-way Pin A) is controlled by the key switch in Ignition or Accessory position, with continuous power to two aftermarket interior fans with individual H/M/L fan speed switches on each fan housings and two aftermarket interior fluorescent dome light fixtures located in the roof of the body, with individual on/OFF switch. No interlocks are tied to this circuit other than key state.

Beacon
RPM 1 Output 2 (Brown 8-way Pin B) will control an exterior body builder installed

beacon light. This circuit will be connected to a single RPM output, and utilize the second in-dash advanced logic latched rocker switch. The key switch in Ignition or Accessory position will control this RPM output; no interlocks will be tied to this circuit other than key state.

Siren
RPM 1 Output 3 (Brown 8-way Pin C) will control an exterior body builder installed siren. This circuit will be connected to a single RPM output, and utilize the third in-dash advanced logic latched rocker switch. The key switch in Ignition or Accessory position will control this RPM output; no interlocks will be tied to this circuit other than key state.

Panic Circuit
RPM 1 Output 4 (Brown 8-way Pin D) will control an emergency driver switch activated “Panic Circuit” to flash the clearance light circuits at a rate cycle of 3 tenths of a second, that is it will be on for .15 of second and OFF for .15 of second. This circuit is interlocked logic to vehicle speed below 10 mph, and the park brakes set. This circuit will be connected to a single RPM output, and utilize the first in-dash advanced logic latched rocker switch.

Door Open Warning System/Step Light
RPM 1 Output 5 (Brown 8-way Pin E) will control the exterior body builder installed rear step light and utilize the fourth in-dash advanced logic switch location with a service parts switch blank tooled with a red domed lens and illuminated with a single 3 candle power LED. The body builder installed remote switches located at each door assembly all tied to the same RPM input circuit (Black 23-way Pin 18) to control circuit functionality.   This RPM output will be controlled by the key switch in Ignition or Accessory position and the following circuit function interlocks are as follows:

1. Any time a door connected to this system is open the rear step light will illuminate, also activating the in-dash flashing red warning lamp indicator.

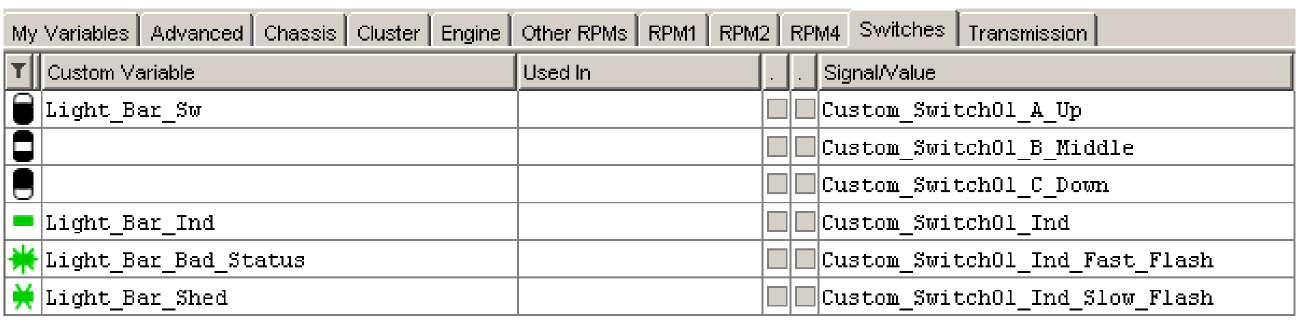
2. The door open warning light system is programmed with an ESC internal software clock in conjunction with the cluster audible alarm; activated when any door connected to this system is opened for more than 30 seconds. The ESC internal software clock will reset when the open door is closed or if power is cycled.

Marker/Park Lights
RPM 1 Output 6 (Brown 8-way Pin H) will control the vehicles marker/park light circuit. This function does not utilize an advanced logic switch to control the circuit function, other than the vehicles headlight switch. The “Panic Circuit” switch function is interlocked to this circuit. The RPM output is spliced into the center chassis harness clearance marker light circuit at the ESC connector 4007, pin H, circuit wire J58. The marker/park light circuit function will be controlled via the RPM output circuit instead of the ESC. Based on the state of marker/park light request and based on the state of the “Panic Circuit” switch, will determine if the RPM output channel will activate or not. If the marker/park light switch is on and the park lights request are not flashing the output should be on steady. If the marker/park light is OFF and the Panic Switch is active the output will flash the mid-body upper marker light.

Contact Information:
John Doe
International Truck And Engine
2911 Meyer Rd.
Fort Wayne, In. 46801
260-461-0000
Call center: 1-800-123-4567

8.4 Diagnostics- Suggestion for using switch indicators (slow/fast blink)

An excellent way to write fault indicators for switch outputs in advanced logic is to use the switch indicator lights. Normally the steady on indicator (green light in the upper portion of the switch) indicates that the switch output is on. There are also two additional light states that can be used. The light can blink slow or fast. The slow and fast blink can be programmed in the Diamond Logic® Builder program to represent an error state such as a bad output status on an RPM output or when the switch is in the on position but the output is not on due to an interlock requirement that has not been met for the output, i.e. you have selected the switch ON but because of load shedding, the output is not ON.



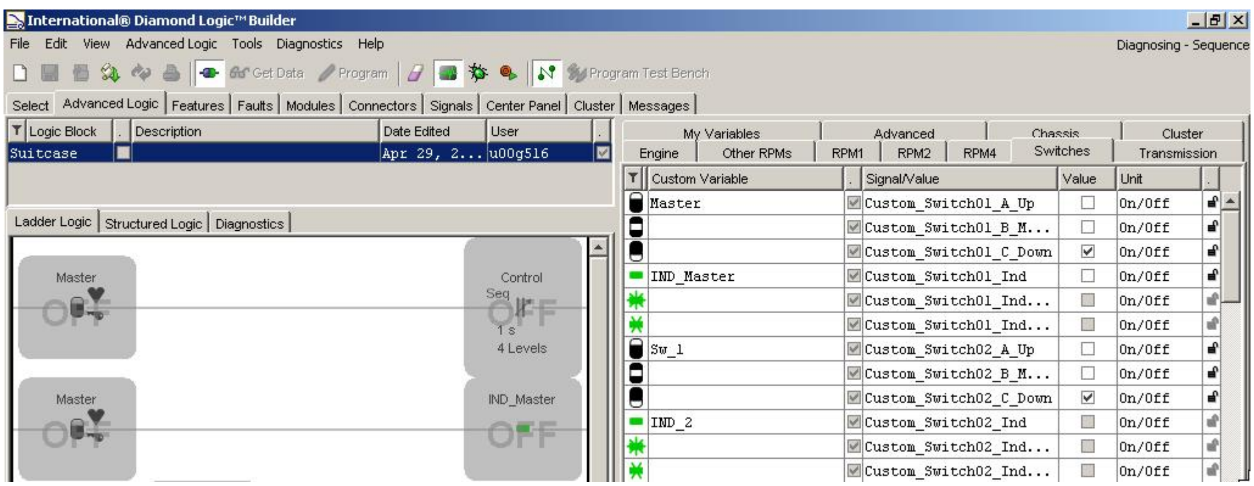
	Custom Variable	Used In	.	.	Signal/Value
	Light_Bar_Sw				Custom_Switch01_A_Up
					Custom_Switch01_B_Middle
					Custom_Switch01_C_Down
	Light_Bar_Ind				Custom_Switch01_Ind
	Light_Bar_Bad_Status				Custom_Switch01_Ind_Fast_Flash
	Light_Bar_Shed				Custom_Switch01_Ind_Slow_Flash

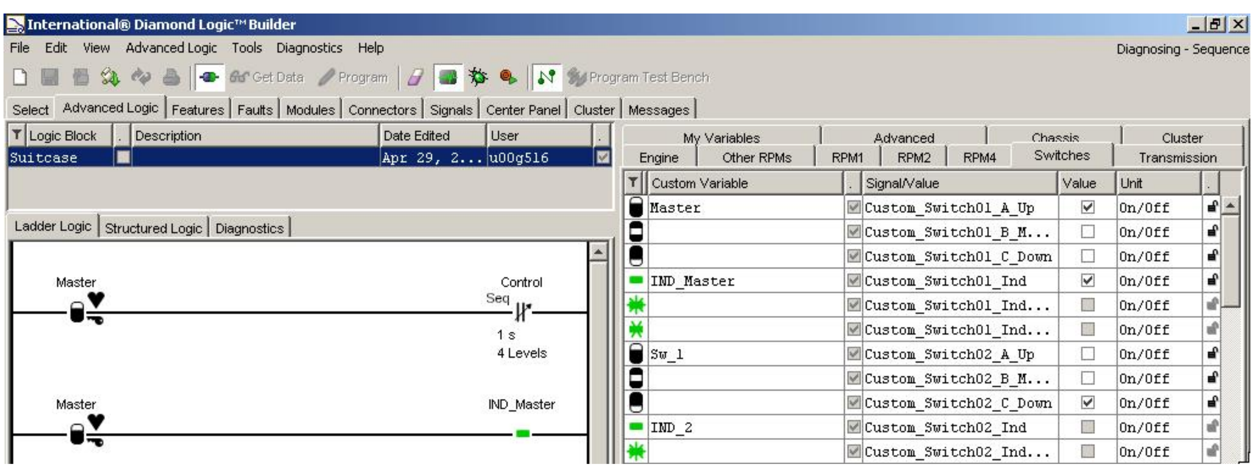
Switch Tab Example

8.5 Diagnostic Descriptions

8.5.1 Diagnostics in the ladder view

Diagnostics in the ladder view are very easy. Hook up to the truck as stated in section 8.2. Enter diagnostics mode and select the advanced logic tab. You will see the ladder logic with gray OFF blocks and brown question mark blocks around some items. On the right of the screen you will see the tabs that contain all the signals that can be used in advanced logic. At this point, you can observe actual signals received from the truck. An example is, while hooked up to the vehicle, in diagnostic mode and on the advanced tab, you can observe the actions on the vehicle. The first figure shows an advanced block with a master switch in the first and second rung of the ladder logic. There are two ways of testing to ensure the vehicle is working properly. The first is to actually activate the switch in the vehicle and watch for the outcome on the screen. The second is to override the switch and click the checkbox in the value column on the right of the screen. Clicking the checkbox is the way to test out the advanced logic in the simulate mode. This tells the ESC to ignore the switch state and activate the circuit regardless of switch location. The second figure shows the same screen with the switch in the up position. Notice on the left side of the screen, the graphic display shows that the switch and corresponding outputs are now in the on position. The right side of the screen now has checkmarks in the items that are now set to ON. Returning the switch to the OFF position will once again turn OFF the switch and the switch outputs.



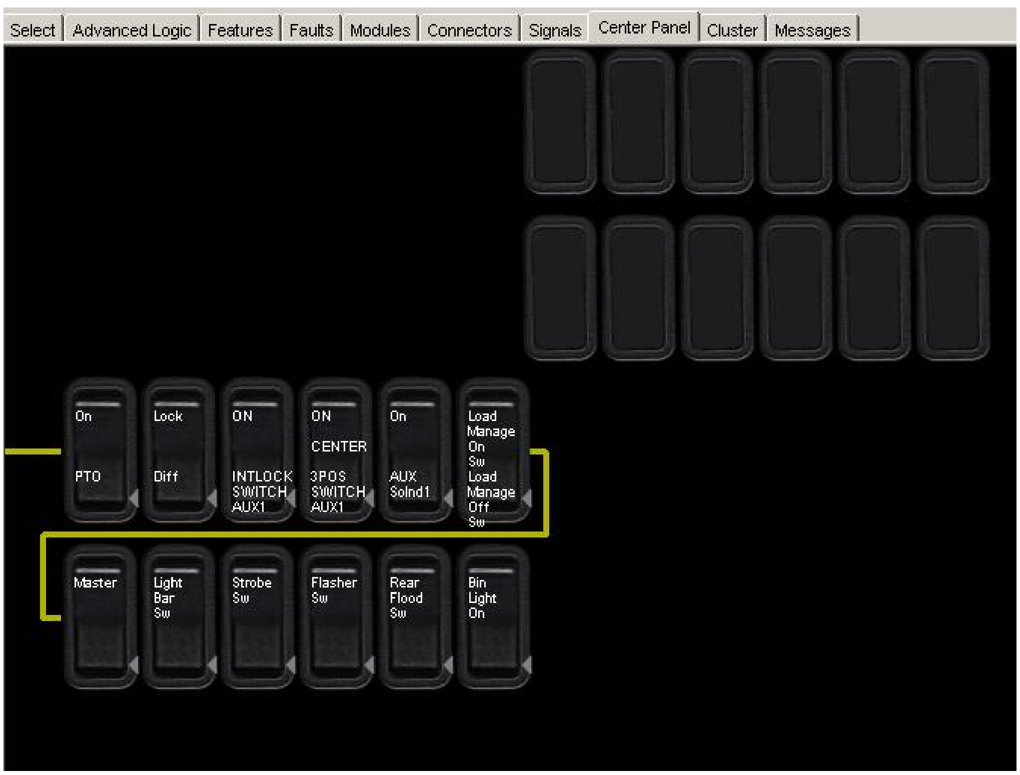


Ladder View Example

Each of these techniques has value. For items such as switches and the park brake, it is very easy to either turn them on or OFF. However for items such as intermediate variables created in the ladder logic and RPM input signals, the value column is an excellent option. This again overrides the vehicle signal and by observing the reaction of the logic rung you can diagnose the vehicle. If all the items on the left side of the logic block are properly set, the value on the right should be either on or OFF. If the contact, light, or output indicator is on, on the diagnostic screen, the output should also be on. If the output isn't, check for a fault code on the fault tab.

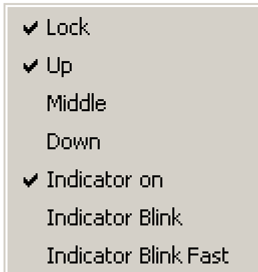
8.5.2 Diagnostics in the center panel view

When you select the center panel view in the diagnostic mode you will see the switches, a yellow line representing the multiplex datalink tying the switch packs together and arrows representing the current switch setting. When you cycle the switch, you can see the switch arrow and the image of the switch change from one state to another. You can also see the switch indicator react to the state of the output that is controlled by this switch.



Switch Tab Screen

You can also override the switch by clicking on the switch, or by right mouse clicking on the switch and selecting from the following list. By clicking on the top of the switch it will activate that switch output and the arrow will move to the up position. This overrides the switch and allows you to determine if there is a switch problem. One last item in the center panel view is the padlock. This allows you to lock that signal in any of the switches valid positions.



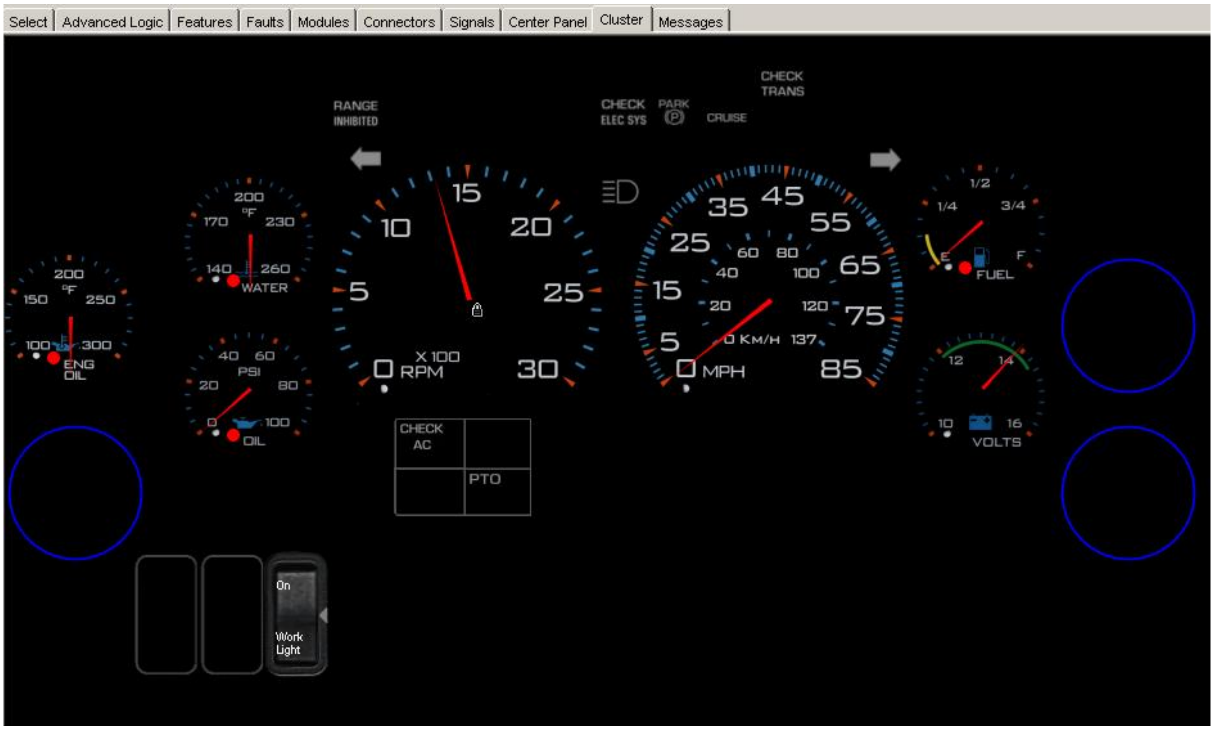
Switch right-click screen

Switch shown in the on position with lock

When diagnosing switches, it is important to remember a few facts about the switches. The switch rocker is nothing more than a plunger, when a switch is pushed; it pushes one of two plungers in and contacts a micro switch in the switch pack. Each switch location has two micro switches. There are 3 states that the switch can be in, micro switch 1 is depressed, micro switch 2 is depressed or neither micro switch is depressed. The other thing to remember with switches is that when diagnosing a switch by checking the box in the signals, features, or advanced logic tabs while in either diagnostic or simulate mode; you must select the switch position you want, i.e. switch up position. You must also make sure that the switch middle and switch down check boxes are not selected. If you have more than one switch state selected in the advanced logic or signal view, your switch will show yellow in the center panel view. This tells you that you have put the switch in an illegal state. Turn OFF or unlock the individual switch signals in the advanced logic view of signals view before you continue with the diagnostics or simulation with the Center Panel View.

8.5.3 Diagnostics in the gauge cluster view

When you select the gauge cluster view while in diagnostic mode, you can observe the movement of the gauges that will mirror the actual gauge movement. For example, if the fuel gauge does not appear to be working you can check the gauge cluster view and see if the signal is driving the diagnostic mode gauge. If the gauge in the diagnostic view is working but the actual gauge isn't, follow the International troubleshooting guide. You can also override the gauge signal by placing the cursor on the outer ring of a gauge and clicking the left mouse button. This forces the gauge to the reading indicated by the cursor location. In the illustration below the Tachometer has been clicked at the 1300RPM mark.



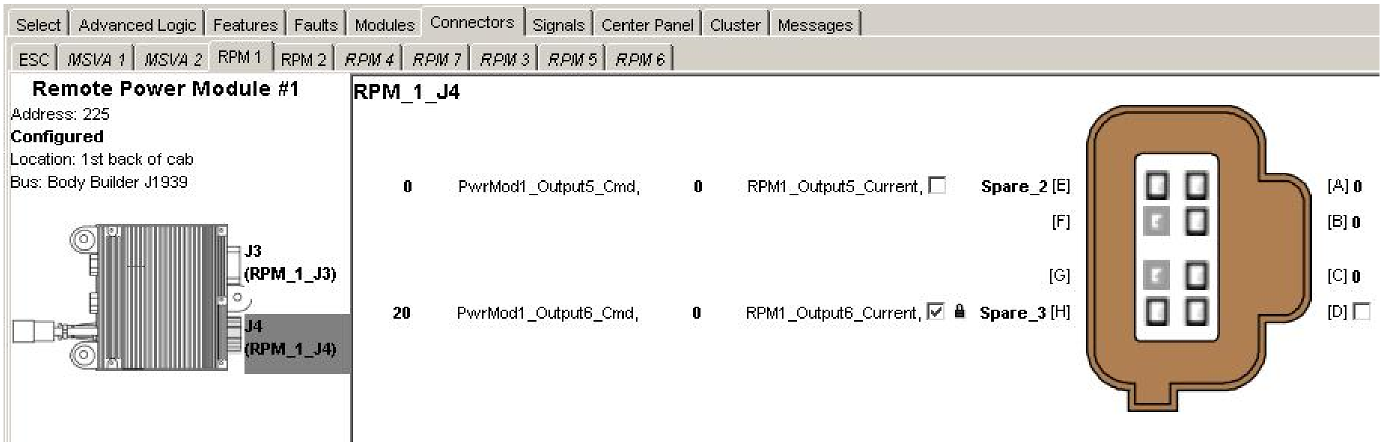
Gauge Cluster View

You can also double click in an area around the center of a gauge and a text box will appear in which to type a specific set value for the gauge. The gauge should follow the diagnostic gauge setting. If the gauge does not follow the diagnostic gauge, then the gauge should be replaced.

Gauge cluster after double clicking on the temperature gauge

8.5.4 Diagnostics in the connector view

In the connector view you can observe the state of each input and output from the ESC, RPM and MSVA. You can also override the output of each input and output. You select the specific module by clicking on the module tab. In this case we have selected RPM 1. This brings up a picture of the RPM and displays the connectors to that module on the graphical view on the left. After selecting the module, we then select a connector of that module. We have selected the Output connector of RPM 1 by clicking on the connector definition (in gray).



RPM Output Connector View

Below are the output and input connectors of RPM 1. We will discuss the output connector first.

On the output connector you will notice that each contact has several things associated with it. The following explains what each item means:

[B] – Indicates the pin number for that cavity

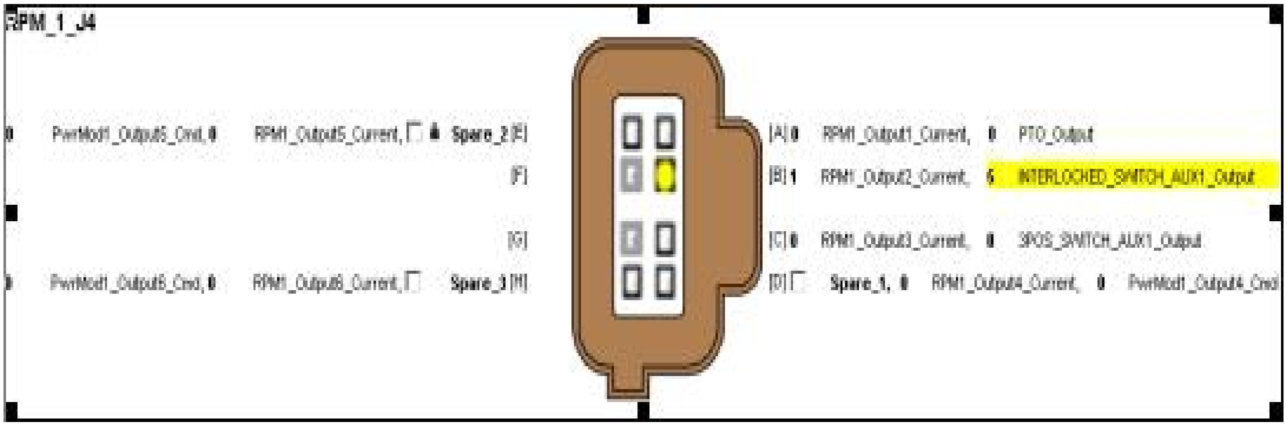
INTERLOCKED_SWITCH_AUX1_Output – This is the name assigned by the feature that output is tied to. The 5 before Pin E shows that this output is virtually fused to 5 Amps. The default amperage is set to 20 Amps.

RPM1_Output2_Current – This depicts the current draw on the RPM output. The 1 before the name represents the current drawn by the load on output 2.

The Bold "Spare_1" next to pin D is the custom name we gave that signal.

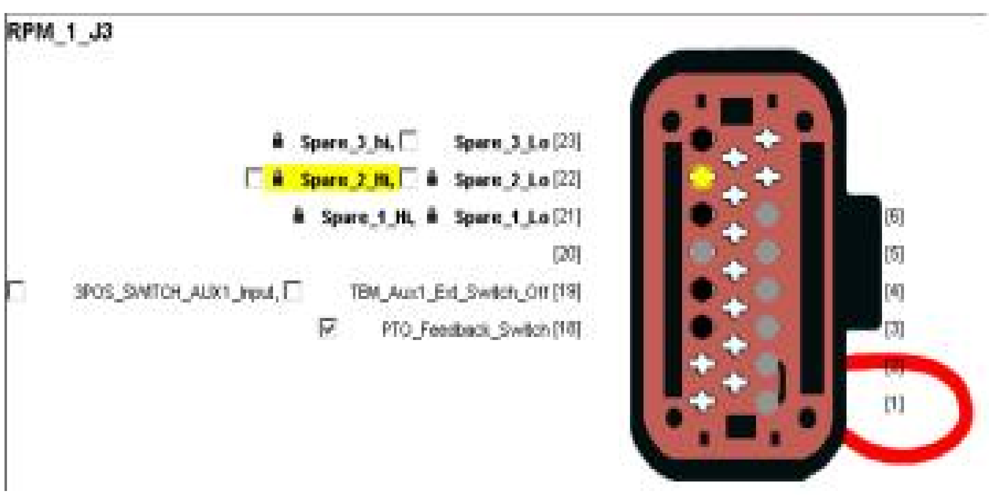
The check box and lock on pin E allow you to click in the box and turn the output ON and OFF. Clicking on the lock allows you to lock the output either ON or OFF no matter what other signal may be trying to drive it.

NOTE: If you are having trouble with outputs not coming on when you think they should, be sure that you don't have outputs locked OFF and vice versa.
Notice how the "INTERLOCKED_SWITCH_AUX1_Output" is highlighted in yellow in the figure below. If you select an output by clicking on the name, the pin in the connector will also highlight. Selecting an output in this way will also automatically select this output in the signals tab. This is a very helpful feature if you are not sure of the feature code that controls that particular RPM output. To turn off the yellow highlight hold down the Ctrl key while selecting an output.



RPM Output Connector View

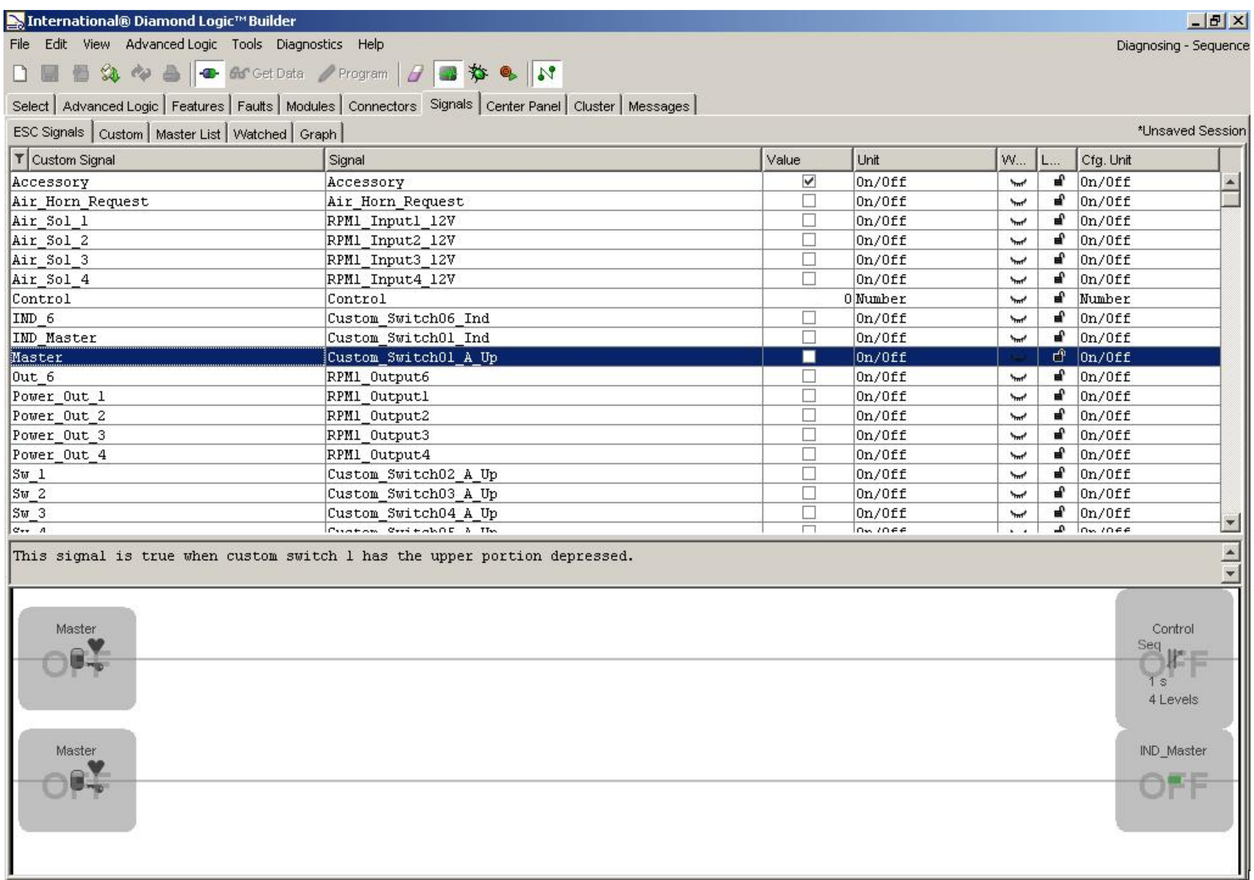
The input connector is similar to the output connector in the selection and checkbox; however the names are represented a little differently. An example is pin 23 on the RPM output connector below. Each pin in the input connector can receive either a 12v signal or a ground signal. The input can be programmed in the ESC to respond to either signal on the same input pin. The ground signal is always listed closest to the connector image, in this case “Spare_3_Lo” is the ground signal and “Spare_3_hi” is the 12v signal. The lock on this connector works the same as it did on the output connector. The input connector also shows a quick representation of the addressing of the RPMs. Note the red jumper wire between pin 1 and 2. Jumper wires on the RPM input connector is the way we address the RPMs. It is extremely important to address the RPMs properly and not move the input connectors around. Doing so will also move all inputs and outputs programmed to that particular RPM. Or if you have the jumper wire for RPM 2 on but you have everything addressed to RPM 1, all you will get are error messages, and none of your input and outputs will work.



RPM Input Connector View

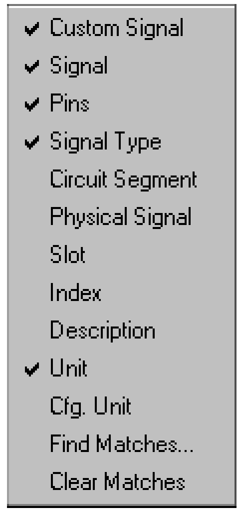
8.5.5 Using the Signals tab to diagnose ladder logic

The signals tab is a very useful screen when diagnosing a vehicle. There are 2 parts to the screen, the signal list on top and the ladder logic view on the bottom. On the signal tab, you can observe specific signals in 2 different ways. You can observe the status of a signal by watching the value column, or by observing the ladder logic at the bottom of the screen. To view the signal responses, you must click on the closed eye in the watch column. When you click on the closed eyelid, an eyeball will appear.  If you don't select the watch feature, you will not be able to see the status change. The second and most important thing is to be aware of the lock feature. If a signal is locked on or OFF, you will not be able to change that signal state no matter what you do to the switch or the input/output. Use caution when locking signals. If you are activating a signal or switch and think that you have checked all the locks on all the pages and the feature still does not work, try clicking OFF of diagnostics, disconnecting from the vehicle for 10 seconds, reconnecting and then running diagnostics again. This will reset all the locks and test values that you have entered. From there you can start with a clean slate and ensure that only the values and locks you want set, are in fact set.



Signal Tab View

There are also numerous columns you can display in the signal list.



Name	Description
Custom Signal	Displays the custom signal name assigned by the Diamond Logic® Builder software user.
Signal	Displays internal system name for each signal.
Pins	Displays connector and pin location in words.
Signal Type	Displays, if applicable, generated signal type, analog, digital, J1939, 1708 etc.
Circuit Segment	Circuit number.
Physical Signal	Name of the signal used by the system controller. This column would normally not be displayed since it is of no use to the Diamond Logic® Builder software user.
Slot	Displays physical source of signal.
Index	Entry in the electrical system data table. This column would normally not be displayed since it is of no use to the Diamond Logic® Builder program user.
Description	Displays the logic description.
Unit	Unit that the variable is displayed as, i.e. Seconds, on/OFF, etc.
Cfg Unit	The unit of the raw data value used by the system. This column would normally not be displayed since it is of no use to the Diamond Logic® Builder program user.
Find Matches…	Use to find matches anywhere on the table and bring them to the top of the screen.
Clear Matches	Clears the find matches function and puts the screen back to the currently sorted column format.

Appendix A—Do's, Don'ts AND IMPORTANT NOTES FOR USING THE DIAMOND LOGIC® BUILDER PROGRAM ADVANCED LOGIC

Do's

- Test all designs thoroughly before selling equipment controlled by Diamond Logic® Builder programming. Exercise inputs and outputs under ALL possible combinations and conditions. Someone in addition to the advanced logic writer should test the design on the vehicle with the equipment that is to be controlled with the Diamond Logic® Builder software.
- Use timers when key OFF functionality is required to ensure that the system will shut down before the batteries are drained.
- Use the Accessory signal once on each rung that does not require key OFF operation to ensure that the system will shut down with the ignition key OFF.
- Attach warning labels on the vehicle if logic is employed that could cause unexpected equipment action as a result of time delayed events, use of interlocks, control of engine speed, etc.
- Before the vehicle is built, order the Diamond Logic® Expansion Pack Feature, 060ACW, to gain access to two general-purpose inputs and two general-purpose relay driver outputs. The Diamond Logic® Builder program cannot add it later.
- To gain access to the work light channel with the Diamond Logic® Builder software order the Work Light Accommodation Feature, 08WMA, before the vehicle is built. The Diamond Logic® Builder program cannot add it later.
- Initialize load manager functions to their full ON condition using the SET function to ensure all outputs are functional at each ignition cycle. It is recommended that a load manager disable switch be employed in your design to provide a means to turn outputs ON during emergency conditions.
- Keep switch and advanced logic names short so the switches in the CENTER PANEL VIEW will be more readable and so that more logic signals may be placed on a single advanced logic rung.
- Expand the ladder logic panel so both sides of the ladder are always visible. This will ensure that the outputs are plainly visible and there is no confusion about whether a signal has been used as an input or as an output.
- Pre-order pre-engineered 060 codes as much as possible before writing advanced logic to provide the necessary hardware and software on the vehicle to minimize the need to write advanced logic.

Don’ts

- Don’t use a latching switch in the switch positions, on the gauge cluster. This position is functional, with ignition key OFF. If these switches are left up or down, with key OFF, the batteries will be drained, since this switch will keep the system awake and consume power continuously.

- Don’t leave outputs ON with the ignition key OFF, to prevent draining the batteries. Any output left ON will keep the system awake. Some examples of using the Diamond Logic® Builder software that will keep the system running are:
  - Switch indicators driven ON while the ignition key is OFF.
  - Outputs that have been set ON by inputs but have not been set OFF when the key is OFF.
  - Rocker switch inputs that have “maintain with error” assigned for the switch signal.
  - Latched Remote Switch inputs that do not have ACCESSORY enabled on the signal.
  - Using a latched switch in the third position of the gauge cluster switch pack.
  - Not setting the Work_Light_OFF signal with the ignition key OFF.

Important Notes

- The Electrical system Controller (ESC/BC) is not guaranteed to operate through engine crank cycles. Advanced Logic must be written such that equipment control is not adversely affected if the ESC should perform a reset cycle during the starting of the vehicle.
- Do not try to program a vehicle with the ignition key in the RUN position. Data traffic from power train system may prevent successful programming of the ESC. Always program the ESC with the ignition key in the OFF or ACCESSORY position.
- Air solenoids used with the Diamond Logic® Builder program will turn OFF and air will be exhausted when the ignition key is turned to the OFF position. Provide operator warning labels and instructions when personnel may be exposed to unexpected equipment movement or operation.
- Air solenoid outputs deliver pilot air of about 4 CFM. Ensure that air solenoids are not used for primary air sources that could quickly empty the air brake tank supply. Universal air solenoids should only be used with closed cavity applications such as air shifted PTO mechanisms, air controlled sprayer heads, etc.
- The signal BATTERY_VOLTAGE cannot be used while the ignition key is OFF. The value drops to two or three volts and should not be used for advanced logic with the ignition key OFF. This signal should always have the ACCESSORY signal enabled when used.
- Disable load manager that use the BATTERY_VOLTS signal during key OFF operation with the ACCESSORY signal. Since battery voltage will be very low with the ignition key OFF, an active load manager will shut OFF outputs if the load shedder function is used during key OFF operation.
- A variety of signals are invalid with the ignition key OFF since either the inputs are biased to ACCESSORY or else the internal programming of the software disables the signal during key OFF operation. These signals include:
    - Park_Brake
    - Aux_discrete_input1
    - Aux_discrete_input2
    - AC_Clutch
    - AC_Request
    - Air_horn_switch
    - All wiper signals
    - Plow_Lights
    - Marker_Interrupter
    - Suspension_Dumped
    - Vehicle_Speed
    - All engine signals
    - All transmission signals
    - All custom rocker switch signals, unless one is place in the gauge cluster three-pack of switches

- It is not apparently obvious when Remote Power Module inputs and outputs are used by International electrical features, while working in the Advanced Logic view in the Diamond Logic® Builder software. Print out the Connector view of the VIN before you begin writing advanced logic to ensure that you map inputs and outputs that are not used by International engineered features.
- Ensure that existing International software is removed from the ESC feature configuration file when implementing similar but different body control features using the Diamond Logic® Builder software and you wish to use the same hardware resources. Refer to the Electrical Body Builder Book for a listing of all 595XXX features that are associated with body control features. Be sure to use “remove with template” when replacing International body control features with advanced logic on a repetitive basis.
- When creating internal variables, ensure that the correct unit of measure has been assigned to your new variable in the UNIT column of advanced logic, i.e. “number” should be assigned for numerical variables; “ON/OFF” should be assigned for binary variables.
- Certain signals cannot be forced off by advanced logic. Signals such as the audible alarm in the gauge cluster, the city horn, air horn, etc. may engage the outputs while custom logic is not requesting the output. See Signals With Limited Access above in this document.
- When using the SET function to turn ON a variable, ensure that a status check and the ACCESSORY signal are used to set the output OFF.

Information

- The order in which rungs are placed on a ladder can sometimes affect the logical performance of the ladder. See the Timer section above in this document for a detailed explanation of this effect.
- The ACCESSORY signal is automatically attached to all rocker switch signals and Remote Power Module switch inputs.
- For switch indicators, flash fast overrides flash slow, which overrides the normal ON.
- All ladder logic and International developed electrical features are executed 50 times per second.
- Advanced logic cannot be edited when applied to a VIN.
- Only the original advanced logic writer may edit advanced logic on a template.
- International features and programmable parameters may be added or deleted directly on a VIN.
- Changing programmable parameters in advanced logic may be accomplished by editing the list of parameters under code 595231/595ACX. This list is primarily used for setting output fuse levels for Remote Power Modules.
- Standard timer functions can only be set to run for a maximum of 655 seconds. Timers of longer duration may be constructed by referring to the Timer section above in this document.

- Some signals have a special encoding built into the signal definition. Using these signals requires knowledge of the data content. Some examples are:

Brake Switch

Data Value	Definition
0	Brake switch OFF, Good Status
1	Brake switch ON, Good Status
2	Brake switch OFF, Bad Status
3	Brake switch ON, Bad Status

Clutch Switch

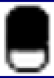
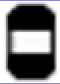
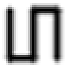
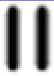
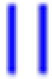
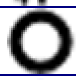
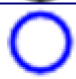
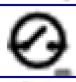
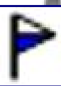
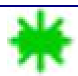
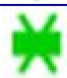
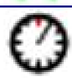
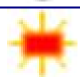
Data Value	Definition
0	Clutch switch OFF, Good Status
1	Clutch switch ON, Good Status
2	Clutch switch OFF, Bad Status
3	Clutch switch ON, Bad Status

APPENDIX B – ACRONYMS

ABS – Anti-lock brake system
AMP—Ampere
ATC – Automatic Traction Control
BC—Body Controller
BOC—Back of Cab
EGC – Electronic Gauge Cluster
ESC – Electronic System Controller
FET—Field Effect Transistor
FR—Front
GA—Gauge
GND—Ground
HVAC – Heating, Ventilation and Air Conditioning
HYD—Hydraulic
I/O – Input/Output
IGN—Ignition
MSVA – Modular Solenoid Valve Assembly (also know as RASM in other areas)
PDC—Power Distribution Center
RAM – Random Access Memory
RASM – Remote Air Solenoid Module
ROF—Rear of Frame
RPM – Remote Power Module
RR—Rear
SW—Switch
VIN – Vehicle Identification Number
VSS—Vehicle Speed Sensor

APPENDIX C – SIGNAL ICONS

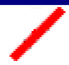
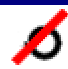
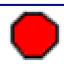
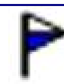
Main Signals

Icon	Description
	Switch Up
	Switch Down
	Switch Middle
	Flasher Function
	Input Signal
	Internal Input Signal
	Special Function Signal
	Output Signal
	Internal Output Signal
	RPM input that is active with 12v present
	RPM input that is active with ground present
	Signal with limited write access
	Rocker Switch Indicator
	Rocker Indicator Light Flash Fast
	Rocker Indicator Light Flash Slow
	Timer Function (NOTE: created by the software when you program a timer function)
	Warning Light in the Gauge Cluster

Input Signal Modifiers

Icon	Description
	Negate (example:) Applies to both INPUT and OUTPUT
	Signal that is turned OFF With Error
	Signal that is turned ON With Error
	Signal that will be Maintain(ed) With Error
	Positive Edge
	Negative Edge
Edg	Edge
	Good Status
	Bad Status
Alt	Altered
	Timer Enabled
	Timer Running
	Timer Expired
Rec	Not Used at this time
	Accessory

Output Signal Modifiers

Icon	Description
	Negate (example: ) Applies to both INPUT and OUTPUT
Set	Set signal to a specific value
	Start a timer
	Stop a timer
Snd	Sends a request to turn on a signal that has limited write access. 
	Toggle
Load	Turns Loads ON
Shed	Sheds Loads OFF
Flash	Flash Feature
Seq	Load Sequence Feature

APPENDIX D – MINIMUM REQUIREMENTS

Minimum system requirements to load and run the Diamond Logic® Builder program:

Pentium® II class processor or greater
500 MHz processor or faster
Windows 98® operating system or greater (XP recommended)
128M of RAM for Windows 98® operating system
256M of RAM for Windows® 2000 operating system or greater
An Internet connection
An RP1210A device. Nexiq™ USB-Link™, NavCom or NavLink preferred. IC3 Com, IC4 Com, IC4 USB, Dearborn Group or International J1939 cable may still work.

NOTE: The Diamond Logic® Builder software will operate very slowly with a Pentium® II processor. International suggests the use of a Pentium IV processor with a minimum speed of 1GHhz for best performance. Improved system performance will occur with the installation of increased RAM.

It is strongly recommended that all Terminate and Stay Resident (TSR) programs like Quicktime®, CD player programs and Pocket PC programs be removed prior to starting the Diamond Logic® Builder software. These programs interfere with the efficient operation of the Diamond Logic® Builder program and can cause errors reading and programming the ESC.

The Diamond Logic® Builder program may be distributed on custom CDs. The installation will autorun from the CD after insertion. It loads the program and supporting libraries. A menu will be displayed allowing the user to choose what parts need to be installed. These include the Java™ runtime environment, Java™ Web Start and the Diamond Logic® Builder program.

The Diamond Logic® Builder program may also be from the website at http://evalue.internationaldelivers.com/servicetools/dlb/.

APPENDIX E – CONTACT INFORMATION

International Truck and Engine maintains a customer service technical support line for assistance with advanced logic and programming issues. Please use the following number for technical support:

1-800-336-4500 option 3, then option 6

APPENDIX F – ADDITIONAL RESOURCES

Advanced Electrical Theory – Self-Study (available on Body Builder Resource Center in PDF format)

Body Builder Book, CT-471, Series (available in print or on the Body Builder Resource Center), See especially Component Information, PBB-71000A and the Electrical Component Book, S08300, S08323

Body Builder Resource Center (online information)

Diamond Logic® Builder Software Sales DVD

Diamond Logic® Builder Software Service Computer Based Training (CBT)

Diamond Logic® Builder Software User's Manual Volume I – Overview

Electrical Circuit Diagrams, Series (available in print or Body Builder Resource Center by model)

Electrical system Troubleshooting Guide, Series (available in print, by model)

International® Diamond Logic® Electrical system, PDB-71000

Sales Data Book, CT-400, Series (available in print or on the Body Builder Resource Center), See especially General Information Book, PDB-15000B and the Component Book, PDB-70000BA

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