This Manual was found in a file cabinet that came from the Wanderlodge Factory Auction

For More Details See Thread:

http://www.wanderlodgeownersgroup.com/forums/showthread.php?t=6059

In Post #23 of that thread Ross MacKillop (2006 450 LXi) Noted that "Unfortunately, the manual is not accurate"

According to Ross the Hadley active in-motion portion was deactivated early in the recall modifications. The front air bags wire plumbed together so the height sensors could not affect individual bag pressures. Increasing one side air pressure to keep the coach level overloaded the wheel/tire and axle in many coaches. This de-activation causes the front side to side loads to remain similar but allows tipping.

Therefore this Manual should be used for reference only

Hadley
2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
www.hadley-products.com

QS-9000 / ISO 9001 Certified

Smart Air Management System
And
Self-Leveling System

Bluebird

Owner & Service Manual

3/04/2005

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2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
www.hadley-products.com

Hadley
2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
www.hadley-products.com

System Scope

The Smart Air Management System is designed for this application to maintain a predetermined vehicle ride height automatically and provides a means to manually lower or raise the ride height and exhaust and fill the tag axle through a customized user interface. The system provides for side to side height control as well as front to back control. The system also contains a feature to determine if the vehicle is on a surface that will enable the chassis to be leveled within vehicle mechanical parameters. A visual indication is also provided to determine mode selection and system malfunction detection.

System Definition

The Smart Air Management System (SAMS) contains four vehicle height sensors, a pneumatic manifold assembly, an electronic control unit (ECU), the necessary wire harnessing, a pushbutton control user interface, and the necessary vehicle interface hardware to provide the defined modes of operation and system functionality. The user interface contains the required pushbuttons to allow the vehicle operator to raise and lower the vehicle manually, exhaust and fill the tag axle manually, enable a self-leveling feature to level the vehicle when parked on an uneven surface, and contains LED's (light emitting diodes) to provide a visual indication to the vehicle operator of the manual mode status, as well as system error detection. The location and mounting of the user interface will be on the left side of the driver seat, on the main operator control counsel. The angle sensors will be mounted on the vehicle frame in a 4-point configuration: rear (2); front (2). The wire harnessing will provide the necessary connections for providing DC electrical control power and ground to the SAMS system (from a suitable vehicle power source), provide the necessary height sensor connectors, provide the pneumatic manifold wiring interface, provide the necessary color coded wires for vehicle hardware integration, and provide the electrical connections for the user interface. Functionally, the system will provide the following modes of operation, i.e. *normal, raised, lowered, tag dump,* and *self-leveling*. This information is further defined in the following sections.

Normal Mode

This mode of operation occurs automatically when the vehicle is operated at speeds of 20MPH and above. It requires no further interaction by the vehicle operator. The ECU monitors the feedback signals from the height sensors during normal vehicle operation. Should any of the four signals dictate that the vehicle is above or below the programmed ride height; the ECU will energize the necessary manifold valve coils to either fill or exhaust the respective air bag(s) to bring the vehicle back to the correct vehicle ride height. The system will stay in this mode of operation unless conditions are satisfied to enter the other modes of operation, as defined in the following sections.

Important: When towing, jacking, or raising the vehicle for service, the white harness plug, located near the manifold assembly must be disconnected. This will prevent the SAMS system from operating and eliminating the potential for unexpected suspension movement that may cause damage to the vehicle or personal injury.

Raised Mode

This mode of operation is used to *increase* the clearance between the underside of the vehicle frame and the ground surface. The vehicle operator must select this mode of operation and choose to raise either the rear only of the vehicle or to raise the entire vehicle. A separate action must be performed by the vehicle operator in order to initiate either function of the *raised mode* of operation. This action is further discussed in the following two paragraphs.

Raising the **rear only** of the vehicle can be chosen by the vehicle operator to increase the clearance between the rear bumper of the vehicle and the ground. It may be necessary for the operator of the vehicle to select this mode when situations arise where the rear of the vehicle may drag due to the length of the vehicle and the departure angle. This mode may be selected by momentarily depressing the “raise” pushbutton located on the user interface, with the vehicle speed at 20MPH or less. Once the mode is selected, the system ECU will temporarily raise the rear of the vehicle and the LED located above the pushbutton on the user interface will blink as a visual indication the mode has been activated.

The ECU will automatically return the rear of the vehicle to the normal ride height when the speed exceeds 20MPH, the mode has been active for more than 40seconds, or the operator momentarily depresses the “lower” pushbutton located on the user interface. Once the mode has been deactivated, the ECU will automatically turn off the LED.

Raising the **entire vehicle** can be chosen by the vehicle operator to increase the clearance between the entire vehicle and the ground. It may be necessary for the operator of the vehicle to select this mode when situations arise where the body of the vehicle must be raised to avoid or to overcome an undercarriage obstacle. This mode may be selected by depressing and holding the “raise” pushbutton for approximately 3 seconds, with the vehicle speed at 10MPH or less. The pushbutton must be held until the LED located above the pushbutton remains on continuously. At that point, the pushbutton can be released and the mode will remain active. Once the mode becomes active, the system ECU will raise the entire vehicle and the LED located above the pushbutton will remain on as a visual indication the mode is active.

The ECU will automatically return the entire vehicle to the normal ride height when the speed exceeds 10MPH or the operator momentarily depresses the “lower” pushbutton located on the user interface. Once the mode has been deactivated, the ECU will automatically turn off the LED.

Lowered Mode

This mode of operation is used to *decrease* the clearance between the underside of the vehicle frame and the ground surface. The vehicle operator must select this mode of operation and choose to ***partially*** lower or ***entirely*** lower the whole vehicle. A separate action must be performed by the vehicle operator in order to initiate either function of the *lowered mode* of operation. This action is further discussed in the following two paragraphs.

Partial lowering of the vehicle ride height can be chosen by the operator of the vehicle to decrease the clearance between the vehicle and the ground, to a predetermined position, in order to clear an overhead obstruction. This mode may be selected by momentarily depressing the "lower" pushbutton located on the user interface, with the vehicle speed at 10MPH or less. Once the mode is selected, the system ECU will lower the entire vehicle to a ***predetermined position*** and the LED located above the pushbutton on the user interface will blink as a visual indication the mode has been activated.

The ECU will automatically return the entire vehicle to the normal ride height when the speed exceeds 10MPH or the operator momentarily depresses the "raise" pushbutton located on the user interface. Once the mode has been deactivated, the ECU will automatically turn off the LED.

Entire lowering of the vehicle ride height can be chosen by the operator of the vehicle to further decrease the clearance between the vehicle and the ground to a mechanical minimum distance in order to allow additional clearance for an overhead obstruction. This mode may be selected by depressing and holding the "lower" pushbutton for approximately 3 seconds, with the vehicle speed at 5MPH or less. The pushbutton must be held until the LED located above the pushbutton remains on continuously. At that point, the pushbutton can be released and the mode will remain active. Once the mode becomes active, the system ECU will lower the entire vehicle to the ***lowest possible mechanical position*** and the LED located above the pushbutton on the user interface will remain on as a visual indication the mode is active.

The ECU will automatically return the entire vehicle to the normal ride height when the speed exceeds 5MPH or the operator momentarily depresses the "raise" pushbutton located on the user interface. Once the mode has been deactivated, the ECU will automatically turn off the LED.

Tag Dump Mode

This mode of operation is used to control the air pressure in the tag axle of the vehicle. This mode allows the vehicle operator to reduce the load on the rear axle to decrease the turning radius and improve maneuverability. This feature can also be used to increase the traction of the drive axle. This mode may be selected by depressing the "tag dump" pushbutton located in the center of the user interface, with the vehicle speed at 12MPH or less. Once the mode is selected, the system ECU will reduce the tag axle pressure from normal to approximately 5psi and the LED located above the pushbutton on the user interface will remain on as a visual indication the mode is active.

The system will remain in this mode as long as the vehicle speed remains at or below 12MPH or the vehicle operator does not momentarily depress the "tag dump" pushbutton. If the "tag dump" pushbutton is depressed the system ECU will deactivate the mode and return the tag axle to the normal pressure. However, if the "tag dump" pushbutton is not depressed, with the mode active, and the vehicle speed increases above 12MPH, but remains below 20MPH, the mode remains active. With the vehicle speed above 12MPH and below 20MPH, the ECU will partially increase the tag axle pressure to 30psi. Should the vehicle speed exceed 20MPH, then the ECU will automatically cancel the mode and the tag axle pressure will be returned to normal. Once the mode becomes deactivated, by depressing the "tag dump" pushbutton or exceeding 20MPH, the ECU will automatically turn off the LED.

Note: The following illustration summarizes the raise, lower, and tag dump operation with relation to the respective user interface pushbuttons and indicators.

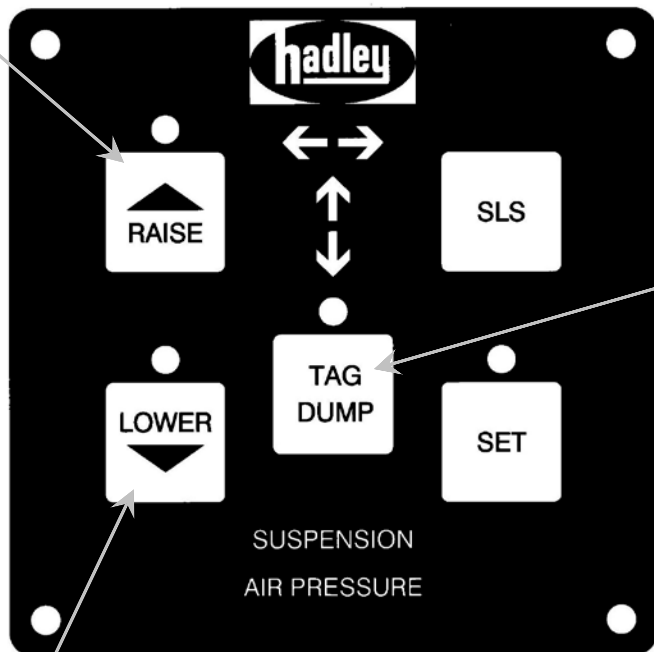
<u>RAISE Button</u>

Press once to raise the rear of the RV for increased bumper clearance. (The Raise light flashes) [Speed < 20 MPH]

or

Press and hold button until raise light remains "on" to raise entire vehicle for increased ground clearance. [Speed < 10 MPH]

Press "LOWER" switch once to return vehicle to normal height. (Raise light off)



<u>TAG DUMP Button</u>

Press once to exhaust the air in the rear tag axle to low pressure. The led indicator is on while this axle is in dump mode. [Speed < 20 MPH]

Press button again to refill tag axle to normal pressure. The led indicator is off while this axle is normal mode.

<u>LOWER Button</u>

Press once to partially lower the vehicle to decrease overall height. [Speed < 10 MPH]
(The Lower light flashes)

or

Press and hold button until the lower light remains "on" to lower the vehicle to lowest overall height. [Speed < 5 MPH]

Press "RAISE" switch once to return to normal height
(Lower light off)

Self-Leveling Mode

This mode of operation is two-fold. First, it can be used to evaluate perspective vehicle parking areas to ensure the vehicle can be adjusted to be within leveling parameters for maximizing occupant comfort (*level find mode*). Second, once a suitable parking area is found, it is used to automatically level the suspension of the vehicle, even though the parking area may be an uneven surface (*self leveling mode*). The following paragraphs further explain this mode of operation.

The "SLS" pushbutton, located on the right hand area of the user interface is used to initiate the ***self leveling mode***. This pushbutton serves as the "ON" switch to begin the entire self leveling process. When the SLS pushbutton is depressed and the vehicle is operating at slow speed (typically 5MPH or less), the ECU will begin the ***level find mode***. This is an evaluation process, whereas the system ECU will look at the signals received from the four height sensors and the signals from the two inclination sensors. The height sensors will provide the ECU with real time information on the location of each corner of the vehicle in reference to the normal ride height. At the same time, the inclination sensors will provide real time information to the ECU on the location of the "X" and "Y" axis of the vehicle in relation to the reference horizontal position. The ECU will perform the necessary comparisons and determine if the vehicle is capable of being leveled at the particular location. The ECU will provide a visual indication of this process to the vehicle operator by turning on the indicator arrows located to the left of the SLS pushbutton.

The two arrows reference the "X" and "Y" axis of the vehicle. The top arrow, (points left to right) represents the "Y" vehicle axis (long axis – front to back) and the bottom arrow (points top to bottom) represents the "X" vehicle axis (short axis – side to side). The arrows will be "flashing" or "ON" solid and be either an amber or green color. The four combinations of light status and color can be interpreted by the following information:

- Solid Green – the vehicle is near level
- Flashing Green – Adjustment is possible and within range
- Flashing Amber – Adjustment is marginal
- Solid Amber – Self Leveling May Not Be Possible (Excessive Slope)

Once activated, the system will remain in the *level find mode* until the "SLS" pushbutton is depressed a second time.

When the ***level find mode*** is complete, the operator can proceed to initiate the ***self leveling*** part of the process. To initiate this process, the SLS pushbutton must first be depressed (this may have already been performed if the vehicle operator used the *level find mode*), the vehicle must be stopped, placed in park, the parking brake applied, and then the "SET" pushbutton is depressed. **(*Note: If the parking brake is not applied, the self leveling process will not be allowed to occur by the system ECU*).** Once the *self leveling mode* is activated, the LED located above the "SET" pushbutton will flash as a visual indication the mode is active. The ECU will first adjust the vehicle "Y" axis and then the "X" axis. Once the leveling process is complete, the LED located above the "SET pushbutton will be "ON" continuously.

Once activated, the system will remain in the *self leveling mode* until either the “SET” pushbutton is depressed a second time or the vehicle parking brake is released.

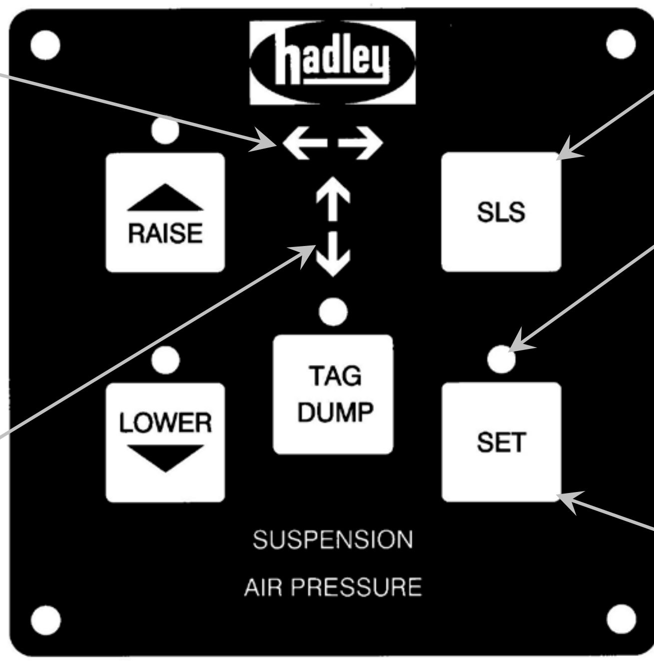
Note: The following illustration summarizes the “level find” and “self leveling” operation with relation to the respective user interface pushbuttons and indicators.

Level Indicator Light
“Y” or Long Axis

Solid Green – RV is near level
Flashing Green – Adjustment is possible and within range.
Flashing Amber – Marginal conditions - possible self-level
Solid Amber – Excessive slope – Self leveling may not be possible

Level Indicator Light
“X” or Short Axis

Solid Green – RV is near level
Flashing Green – Adjustment is possible and within range.
Flashing Amber – Marginal conditions - possible self-level
Solid Amber – Excessive slope – Self leveling may not be possible



Press once to activate the SLS System and initiate the “Level Find Mode”

Press once again to turn the “Self-Leveling” off.

Indicator flashes as system levels the coach. The indicator stays “on” after leveling is done

Press once to activate the “Self-Leveling” process.

Press once again to switch the self leveling “off”.

<u>Note</u>: Parking brake must be applied for “self-leveling” adjustments to occur.

Visual Indicators
As explained in earlier sections of this document, if either the *raised mode (rear only)* or *lowered mode (partial)* is selected, the respective pushbutton LED will flash. Additionally, if the *raised mode (entire vehicle)*, *lowered mode (lowest possible mechanical position)*, or the *tag dump mode* is selected the respective LED will be "ON" continuously. The user interface also contains a *suspension* and an *air pressure* indicator. Should the system ECU detect a problem, the suspension light will blink in such a manner as to identify an error code associated with the fault. Additionally, should the system air pressure fall below 90psi, the system ECU will illuminate the air suspension indicator.

Note: ***The following section provides more information regarding the specific system error codes.***

Error Codes
The ECU has the ability to monitor the SAMS system and detect electrical problems. Should the ECU detect a problem, a visual indication will be given by flashing the *suspension* indicator located on the user interface panel in such a manner as to represent a two or three-digit code. The first number of the code can be identified by counting the first series of flashes. It will be followed by a short pause, and then provide a second series of flashes to represent the second number of a two-digit code (if applicable, the second number will be followed by another short pause, and then provide a third series of flashes to represent a three-digit code). For example one flash, followed by a short pause, and then three additional flashes would illustrate a code 13.

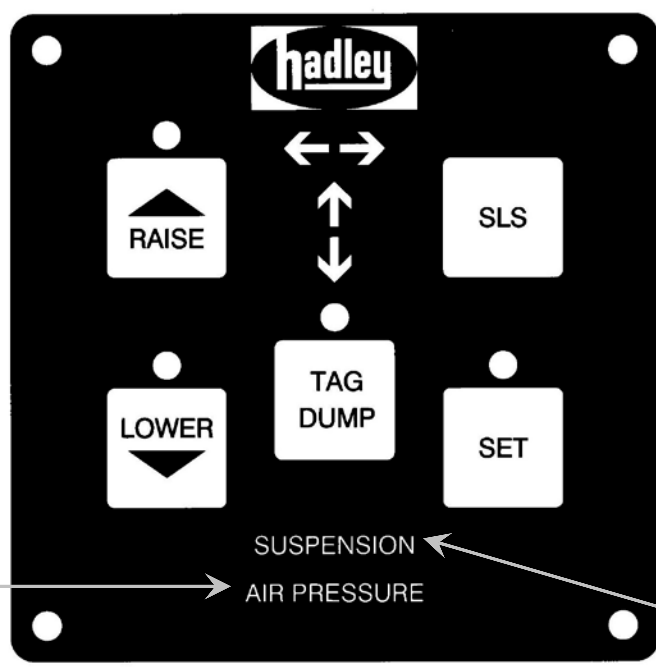
In the event of more than one detected problem, the ECU will cycle through this process and flash an individual error code for each identified problem. The ECU will continue to flash the error code(s) until the problem(s) have been corrected. Once the problem(s) are corrected, the ECU will proceed to turn off the *suspension* indicator. A list of potential error codes and their probable cause are as follows:

- 11 (eleven) – Rear Drive, Driver Height Sensor
- 12 (twelve) – Rear Drive, Curb Height Sensor
- 13 (thirteen) – Rear Drive, Driver Pressure Transducer
- 14 (fourteen) – ECU Sensor Reference Voltage
- 21 (twenty-one) – Rear Drive, Curb Pressure Transducer
- 22 (twenty-two) – Rear Tag, Driver Pressure Transducer
- 23 (twenty-three) – Rear Tag, Curb Pressure Transducer
- 24 (twenty-four) – X Axis Inclination Sensor
- 31 (thirty-one) – Y Axis Inclination Sensor
- 32 (thirty-two) – Front, Driver Height Sensor
- 33 (thirty-three) – Front, Curb Height Sensor
- 34 (thirty-four) – Supply Pressure Transducer
- 41 (forty-one) – Invalid Battery Voltage
- 42 (forty-two) – Not Used
- 43 (forty-three) – Low Battery Voltage (less than 9.7VDC)
- 44 (forty-four) – High Battery Voltage (greater than 14.8VDC)

- 111 (one hundred eleven) – Front, Driver Exhaust Solenoid Valve
- 112 (one hundred twelve) – Front, Driver Fill Solenoid Valve
- 113 (one hundred thirteen) – Front, Curb Exhaust Solenoid Valve
- 114 (one hundred fourteen) – Front, Curb Fill Solenoid Valve
- 121 (one hundred twenty-one) – Rear Drive, Driver Exhaust Solenoid Valve
- 122 (one hundred twenty-two) – Rear Drive, Driver Fill Solenoid Valve
- 123 (one hundred twenty-three) – Rear Drive, Curb Exhaust Solenoid Valve
- 124 (one hundred twenty-four) – Rear Drive, Curb Fill Solenoid Valve
- 131 (one hundred thirty-one) – Rear Tag, Driver Exhaust Solenoid Valve
- 132 (one hundred thirty-two) – Rear Tag, Curb Exhaust Solenoid Valve
- 133 (one hundred thirty-three) – Rear Tag, Curb Fill Solenoid Valve
- 134 (one hundred thirty-four) – Rear Tag, Driver Fill Solenoid Valve
- 144 (one hundred forty-four) – RV Suspension Dump LED
- 213 (two hundred thirteen) – Valve Manifold Connector 1 (Male) Disconnected
- 214 (two hundred fourteen) – Valve Manifold Connector 2 (Female) Disconnected
- 333 (three hundred thirty-three) – CANbus Data Not Read

Note: ***Each time the engine is started, the "suspension" indicator will be illuminated for approximately 5 seconds. During this time interval, the ECU will gather information from the system sensors. After the time interval has elapsed the ECU will turn off the indicator. This is a normal "power-up" function and should not be confused with a system problem.***

Note: The following illustration summarizes the system warning lights with relation to the respective user interface indicators.



Air Pressure Indicator

This indicator will flash when the air pressure is insufficient to properly operate the air suspension control system.

Suspension Indicator

This indicator will be flash when a system fault has occurred.

This indicator will light for five (5) seconds when the engine is started.

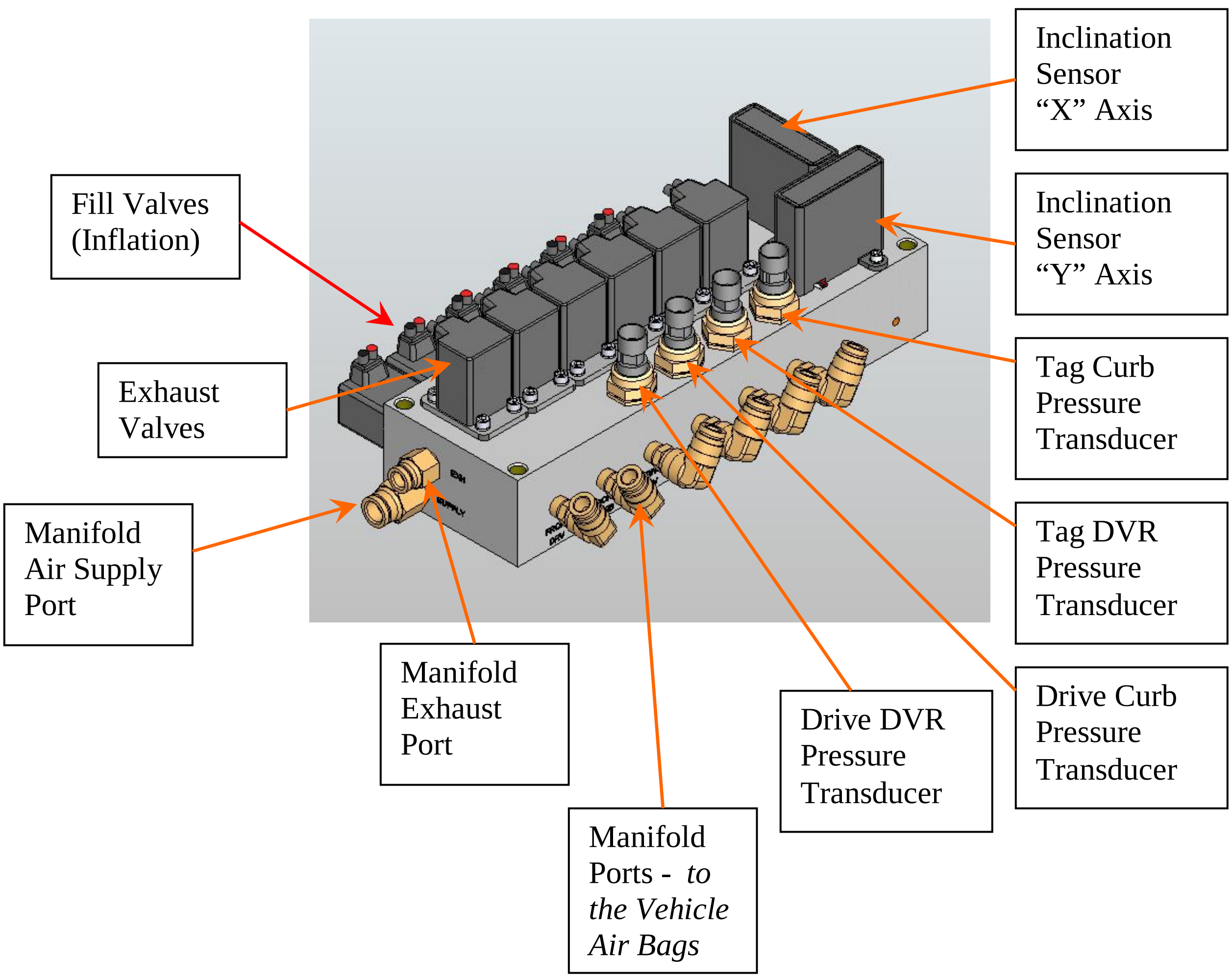
Hadley
2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
www.hadley-products.com

SAMS Manifold & Valves

This document is written to provide an introduction to the manifold and valves used on Blue Bird's Smart Air Management System (SAMS). This discussion will create a basic understanding of the valve functionality. The knowledge gained by understanding the document content will provide service personnel with information to diagnose and repair related system problems.

<u>Theory of Operation</u>

The manifold is an electro-pneumatic device used to control the air flow within the SAMS system. The valves are two-position and of a coil actuated design. This application requires two valves per air bag for ride height control, totaling twelve (12) valves in all. One valve serves as a "fill" valve and allows system air to pass through the manifold "into" the air bag. This causes the air bag to inflate, thereby increasing the vehicle ride height. The second valve serves as an "exhaust" valve and allows air to pass "from" the air bag, through the manifold, into the atmosphere. This causes the air bag to deflate, thereby decreasing the vehicle ride height.



The valves are controlled by the SAMS electronic control unit (ECU). The ECU provides the *brains* for the Smart Air Management System. The ECU contains the system specific program to control the vehicle ride height, as defined by Blue Bird's engineering specifications for system operation. The ECU receives signals from various system components, i.e. height sensors, pressure transducers, inclination sensors, and the user control panel (mode of operation) to provide system control for obtaining the desired vehicle ride height.

With no power applied to the valve coils, they are in a de-energized condition. This allows an internal spring to expand and pushes a plunger against the associated manifold port, thereby sealing off the internal air passage. The stem of the plunger contains two-neoprene rings to serve as a guide to provide true and even travel within the body of the valve assembly. The face of the plunger also contains a seal that when forced against the seat of the manifold, provides a positive seal to prevent air flow through the manifold when the valves are de-energized. This mechanical action enables the SAMS system to seal the air within the system and maintain the desired ride height.

Note: *The ports of the manifold contain a mesh screen to help prevent air contaminates from entering the manifold. However, it is possible for the screen to become damaged and allow contaminates to enter the manifold. Should this occur, it is possible for debris to collect on the plunger face seal or cause the plunger to stick open, thereby affecting system operation and performance.*

*Should an **inflation valve plunger** become contaminated or the plunger stick "open", it is possible for air to leak past the plunger and continuously **fill** the associated air bag. This would cause a corner of the vehicle to continuously creep "upwards" while the vehicle is in operation, and result in the SAMS system constantly making corrections to lower the affected corner of the vehicle.*

*Should an **exhaust valve plunger** become contaminated or the plunger stick "open", it is possible for air to leak past the plunger and continuously **exhaust** the associated air bag. This would cause a corner of the vehicle to continuously creep "downwards" and result in the SAMS system constantly making corrections to raise the affected corner of the vehicle.* ***It should be noted that this condition would be most noticeable after the vehicle has not been in operation for a period of time because the respective corner of the vehicle would lean.***

Note: An external leak, such as a loose air fitting, defective air bag, or tube leak could also cause the vehicle to lean when not in operation for a period of time. External leaks can be detected by squirting a suitable inspection solution, i.e. soap, water, & glycerin mix onto the external system components. If an air leak is present, air bubbles will be created in the applied solution.

If either of these conditions is noticed, the vehicle should be inspected and the cause of the problem corrected. These conditions could eventually cause premature compressor failure due to overheating from excessive cycling. The compressor would attempt to maintain system pressure that would continuously fluctuate due to the ECU trying to compensate for the system problem.

When it becomes necessary to either raise or lower the vehicle ride height, the ECU will energize the respective manifold valve coil(s) by applying 12VDC. With 12VDC applied to the coil, current flows through the windings and creates an electro-magnetic field. This magnetic field is stronger than the existing spring pressure that holds the valve plunger against the valve seat within the manifold. The strength of the magnetic field will cause the plunger to move inside the body of the valve assembly, compressing the spring, and opens the respective "fill" or "exhaust" passage within the manifold. This will allow system air to either "fill" or "exhaust" the associated airbag. This action will either raise or lower the vehicle, depending upon which valve has been energized. When the desired position has been reached, the ECU will remove power from the valve coil(s), the internal spring will decompress (expand), and the plunger will once again seal off the associated manifold port. This sealing action will sustain the desired ride height until system adjustment once again becomes necessary.

Valve Servicing

The valves are secured to the body of the manifold by using four (4), 10-32NF X ½" socket head cap screws (SHCS) with lock washers and are factory tightened to 30in/lbs. of torque. Care must be taken when removing or replacing the valve assembly so as not to lose the mounting hardware or the O-ring that is installed in the respective manifold surface machined groove. The O-ring and mounting hardware create a positive seal between the valve assembly mounting plate and the valve mounting surface of the manifold.

Note: *If the O-ring is lost or damaged or the valve is not properly attached to the manifold by using all of the previous mentioned hardware, an external leak will occur and a source for contamination to enter the manifold is created.*

The valve body and coil are independent assemblies and can be replaced individually, if necessary. The coil ***only*** can be replaced by the following procedure:

1.) Disconnect the associated valve wiring harness.
2.) Remove the power wire from the harness connector and remove the ground wire SHCS.
3.) Insert an appropriately sized flat head screwdriver into the hook section of the clip groove located on the top of the valve assembly.
4.) Tilt the screwdriver handle down, so the clip slides out (towards the screwdriver).
5.) Remove the clip and slide the coil upward, to clear the housing of the valve body.
6.) To reinstall, slide the coil over the valve body and reinstall the clip.
7.) Install and crimp a new pin/connector on the coil wires.
8.) Reinstall the wire in the harness connector, reattach the ground wire, and reconnect the wire harness connector.

Warning: System operating pressures are typically 90-130psi. Steps should be taken to relieve pressure from the system prior to removing any valve assembly from the manifold.

Hadley
2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
www.hadley-products.com

Error Codes

The ECU monitors its outputs and has the ability to detect either an "open" or "short" in the load circuitry. This diagnostic ability will generate an error code when such an electrical problem is detected with any of the manifold valves or the associated wiring. Once an "open" or "short" is detected, the respective error code will be displayed by the ECU flashing the *suspension* indicator located on the user control panel. The error code will be either a two or three digit number and can be interpreted by counting the number of times the *suspension* indicator flashes. Each digit will be separated by a short delay. Once each digit has been represented, a longer delay will occur and the error code will cycle through each digit again.

Example: *An error code of 22 would be represented by two flashes, a short pause, and two more flashes. A longer pause will occur, and then the error code 22 would be repeated.*

The ECU will continue cycling through the error code until the problem has been corrected. Once the problem is corrected, the ECU will automatically turn off the *suspension* indicator. If multiple problems have been detected, each error code will be displayed individually. The ECU will continuously cycle through all active error codes until the problems are corrected.

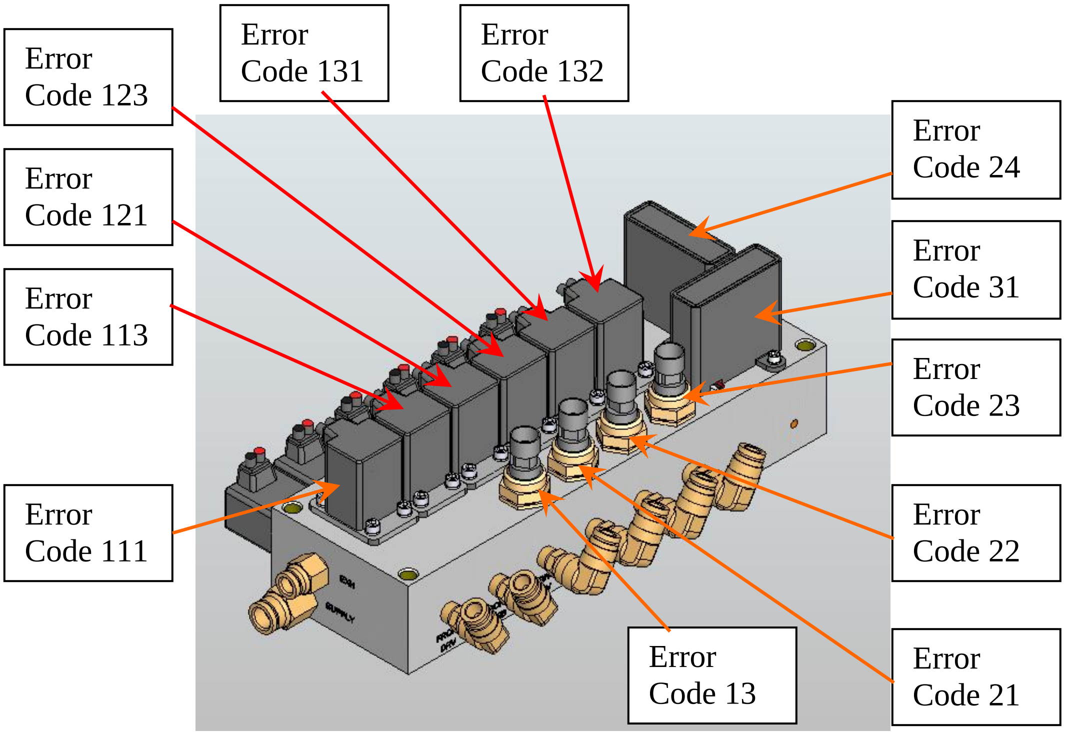
See the below chart for an example of possible error codes. The error code number is identified in the far right column and descriptions are provided in the preceding columns.

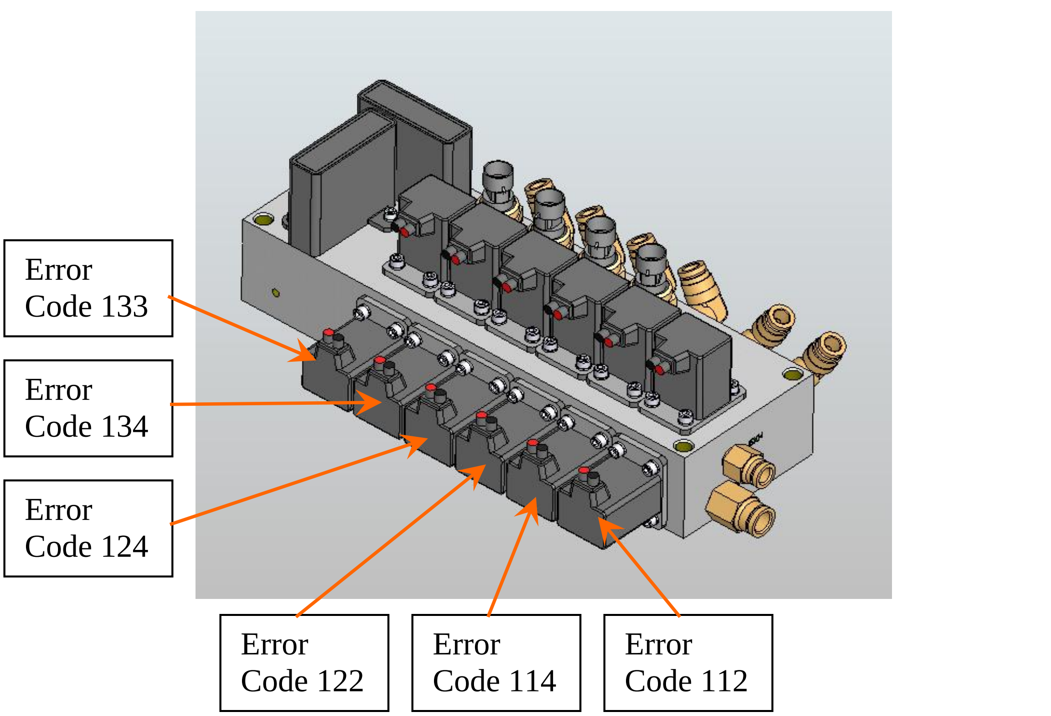
SAMS Error Code Info:

	Description 1	Description 2		Error Code Number Open/Short
ANA				
0	Angle Sensor	Drive DVR Angle Sensor		11
1	Angle Sensor	Drive Curb Angle Sensor		12
2	Pressure Sensor	Drive DVR Pressure Transducer		13
3	V ref +	Internal Circuit Board Reference		14
4	Pressure Sensor	Drive Curb Pressure Transducer		21
5	Pressure Sensor	Tag DVR Pressure Transducer		22
6	Pressure Sensor	Tag Curb Pressure Transducer		23
7	Inclination Sensor	X Axis Inclination Transducer		24
8	Inclination Sensor	Y Axis Inclination Transducer		31
9	Angle Sensor	Front DVR Angle Sensor		32
10	Angle Sensor	Front Curb Angle Sensor		33
11	Pressure Sensor	Supply Pressure Transducer		34
12	Voltage	Battery Voltage Invalid		41
13	User			42
	Power Source	Low Battery Voltage <9.7 VDC		43
	Power Source	High Battery Voltage >14.8 VDC		44
	Can Bus Error	Can Bus Data Not Read		333
Output			Connector #	
RC0	POWER OUTPUT 1	FRONT DVR EXH Solenoid Valve	1	111
RC1	POWER OUTPUT 2	FRONT DVR FILL Solenoid Valve	1	112
RC2	POWER OUTPUT 3	FRONT CURB EXH Solenoid Valve	1	113
RC3	POWER OUTPUT 4	FRONT CURB FILL Solenoid Valve	1	114
RC4	POWER OUTPUT 5	DRIVE DVR EXH Solenoid Valve	1	121
RC5	POWER OUTPUT 6	DRIVE DVR FILL Solenoid Valve	1	122
RB4	POWER OUTPUT 7	DRIVE CURB EXH Solenoid Valve	2	123
RB5	POWER OUTPUT 8	DRIVE CURB FILL Solenoid Valve	2	124
RJ0	POWER OUTPUT 9	TAG DVR EXH Solenoid Valve	2	131
RJ1	POWER OUTPUT 10	TAG CURB EXH Solenoid Valve	2	132
RJ2	POWER OUTPUT 11	TAG CURB FILL Solenoid Valve	2	133
RJ3	POWER OUTPUT 12	TAG DVR FILL Solenoid Valve	2	134
RJ4	POWER OUTPUT 13	unused		141
RJ5	POWER OUTPUT 14	unused		142
RJ6	POWER OUTPUT 15	unused		143
RJ7	POWER OUTPUT 16	TO RV SUSP DUMP LIGHT		144
	Power Conn 1 Unplugged	Valve Manifold Plug Disconnected		213
	Power Conn 2 Unplugged	Valve Manifold Plug Disconnected		214

Manifold Error Code Identification

The below information identifies the manifold component with its associated error code listed in the previous chart.





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Electrical Testing

A digital multimeter is a useful tool for troubleshooting and isolating electrical related problems. Open circuits are identified by no continuity shown on the display (1OL). Open circuits in the SAMS manifold electrical system are typically caused by pins that have pulled loose from the associated harness connector, wires that are broken at the pins in the harness connector, breaks in the coil windings, or broken wires in the wiring harness due to improper harness routing during the installation of the system.

The coil can be tested for an “open” or “short” circuit by checking the resistance value of the windings. The coil must first be isolated by disconnecting its associated wiring harness connector. Obtain a multimeter as previously suggested and rotate the dial to the OHMS (resistance) setting. In most cases, this should turn on the power to the multimeter. If not, turn on the required switch to power the multimeter. Connect the **red** lead of the multimeter to the **red** lead in the wiring harness connector of the coil to be tested. Next, connect the **black** lead of the multimeter to the **black** lead in the wiring harness connector of the coil to be tested. The display on the multimeter should read approximately 8 to 10 ohms of resistance. If the display of the multimeter shows zero ohms of resistance, the coil is “shorted” and requires replacement. If the display shows an “open” circuit, as indicated by displaying “1OL”, the coil requires replacement, as well.

Note: *Prior to disconnecting the manifold wiring harness to perform the continuity check, be sure power has been removed from the SAMS system ECU. This can be accomplished by disconnecting the white wiring harness connector in the vicinity of the manifold assembly. This prevents the SAMS system from operating when the engine is not running, which could result in unanticipated suspension movement.*

The SAMS system requires 12VDC for proper system operation. The ECU uses the 12VDC supplied by a user defined vehicle power source to control the manifold valve coils and also uses the voltage to create an internal 5VDC reference signal. This lower voltage provides feedback to the ECU from the system sensors to detect and maintain the vehicle ride height. Therefore, if the supply voltage is either excessively low (typically less than 9.7VDC) or excessively high (typically 14.8 VDC or above) system performance can be adversely affected.

The multimeter, using the DC voltage scale, is also a useful tool in checking and verifying the correct supply voltage and that a good system and manifold ground is present. The system ground and manifold ground are provided through separate ground wires. Refer to the SAMS wiring diagrams to determine the power and ground wires associated with the system.

Note: *DC voltage is polarity sensitive. Therefore the multimeter red lead should be connected to positive (system power: 12VDC) and the* ***black*** *lead connected to negative (system ground).*

See the following pages for samples of the SAMS system schematics.

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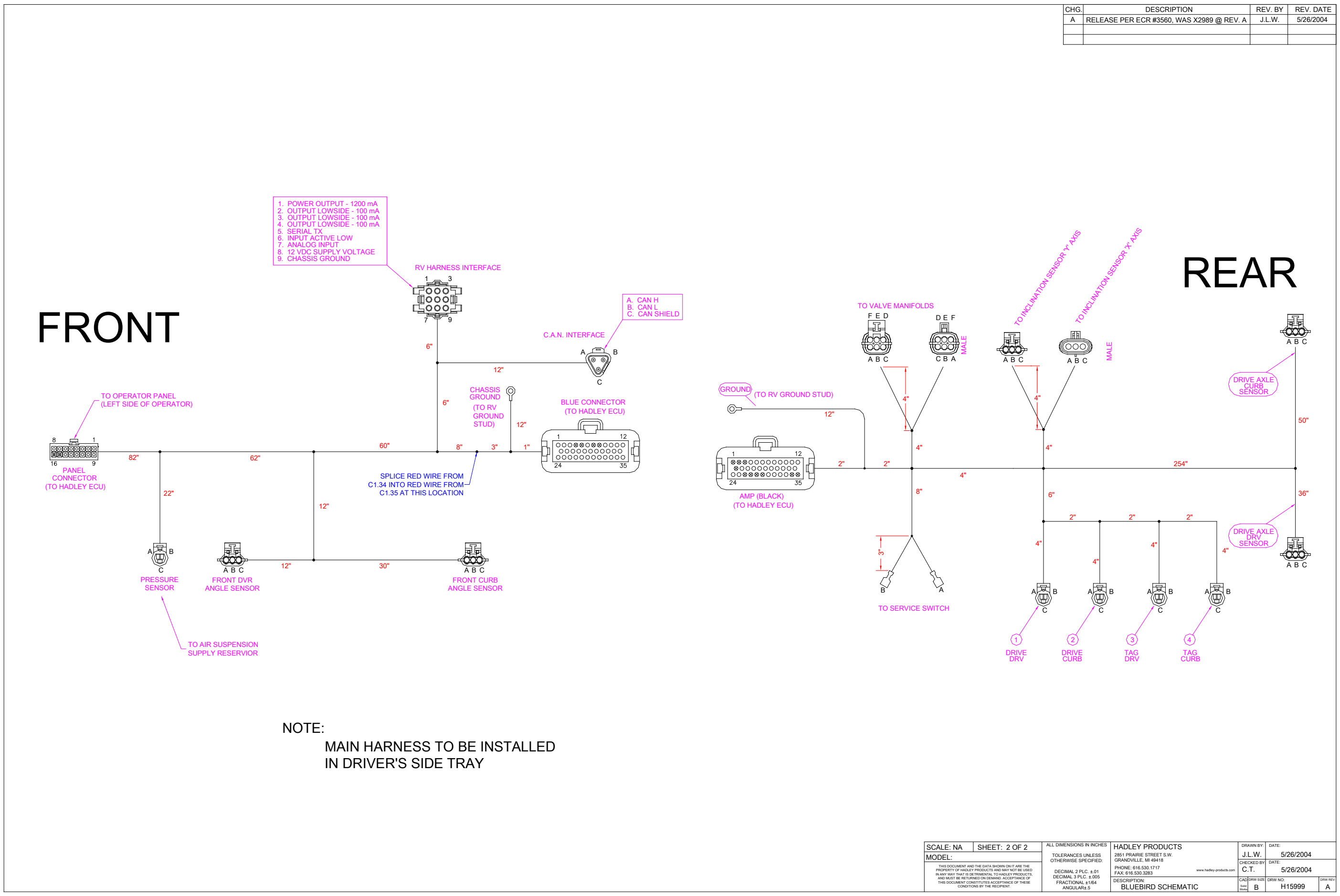
The below illustrates the two system wiring harness schematics.



Comment: *Open and short circuits in the wiring harness are often the direct result of improper installation procedures. Hadley engineering has created separate documentation to serve as a guide for installation of the electrical and pneumatic hardware. However, there is no guarantee these installation procedures and associated document recommendations are adhered to by installation personnel. It is often the service personnel who must address and correct issues that arise from installation errors.*

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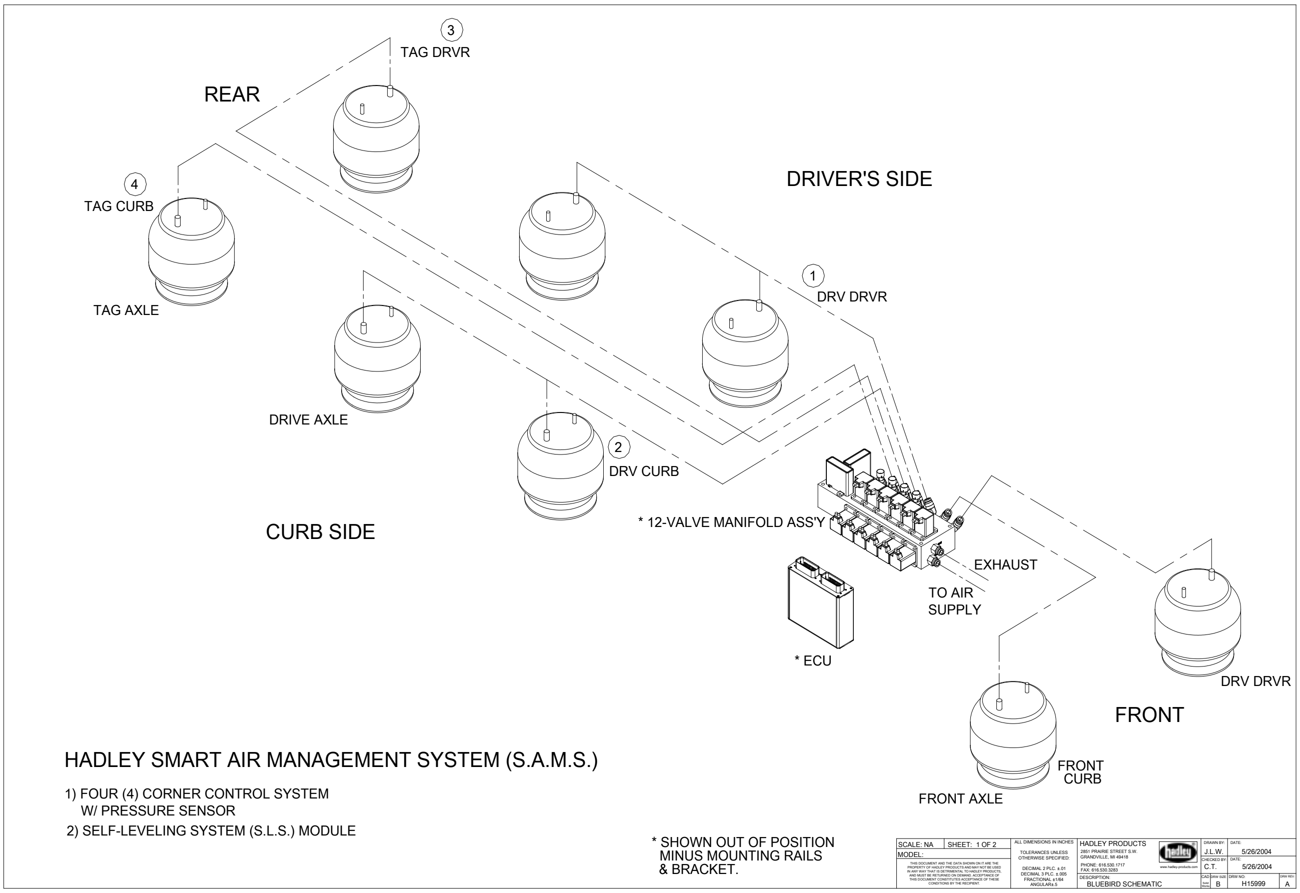
The below illustrates the system pneumatic layout.



Comment: *Leaks associated with the tubing and pneumatic components are often the direct result of improper installation procedures. Hadley engineering has created separate documentation to serve as a guide for installation of the pneumatic hardware. However, there is no guarantee these installation procedures and associated document recommendations are adhered to by installation personnel. It is often the service personnel who must address and correct issues that arise from installation errors.*

Summary

This completes the operation and service information regarding the SAMS manifold and valve assemblies. The information contained in this document is not intended to be all inclusive but to serve as a reference document. Time spent by installation and service personnel to better acquaint themselves with this information will provide a greater understanding of system operation and the associated servicing procedures.

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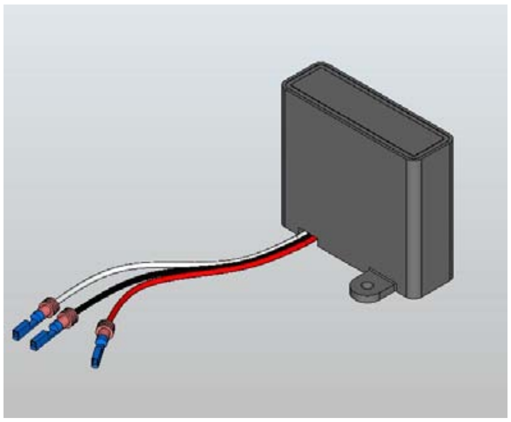
SAMS Inclination Sensor

This document is written to provide a basic understanding of the inclination sensors used on the Smart Air Management System (SAMS). This discussion will create a basic understanding of the sensor functionality. The knowledge gained by understanding this information will provide installation and service personnel with information to diagnose and repair related system problems.



Theory of Operation

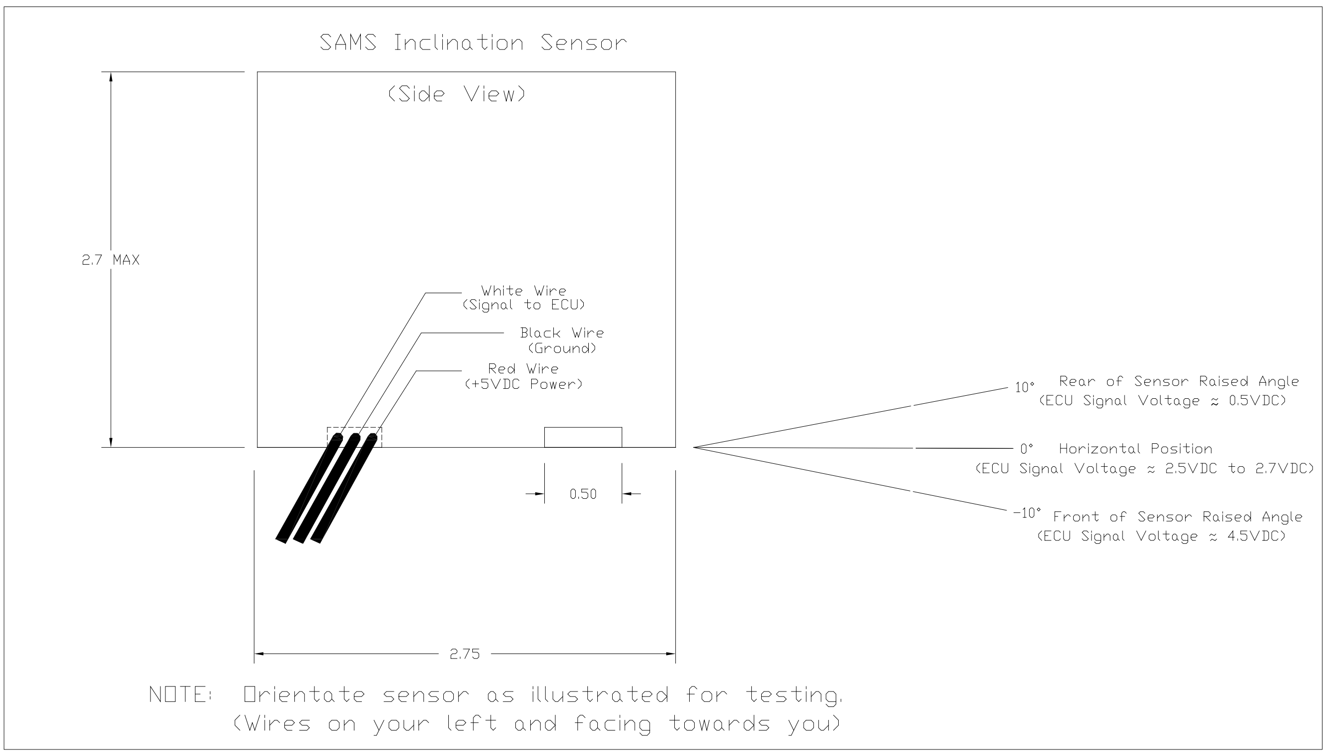
The sensor is used by the system ECU (electronic control unit) to detect the angle change of the vehicle chassis from the true horizontal position, using reliable hall-effect technology. It enables the ECU to monitor the vehicle chassis angle and determine if adjustment to the horizontal position of either axis is necessary during the self-leveling mode of operation.

The two sensors are mounted on the top surface of the SAMS manifold assembly. One sensor monitors the "X" axis (side to side) and the second sensor monitors the "Y" axis (front to back) of the vehicle chassis. The sensor contains three wires (red, **black**, white) that interface with the system ECU through a supplied vehicle wiring harness. The *red wire* provides an ECU generated reference voltage, typically 5VDC (+/- 2%). The ***black wire*** provides the ground and the *white wire* provides the voltage signal back to the ECU. This voltage is proportional to the angle of the sensor from the horizontal position.

With the chassis of the vehicle level, the voltage signal on the *white wire* is one-half of the supplied reference voltage (approximately 2.5VDC to 2.7 VDC). As the ***front*** of the sensor is ***raised***, the voltage on the *white wire* will increase until the sensor reaches approximately a 10degree angle from the horizontal position. With the ***front*** of the sensor raised to this angle, the voltage on the sensor's *white wire* will be approximately 4.5VDC. The sensor angle change in this direction would be typical in an **uphill** slope of the chassis.

As the ***rear*** of the sensor is ***raised***, the voltage on the *white wire* will decrease until the sensor reaches approximately a 10degree angle from the horizontal position. With the ***rear*** of the sensor raised to this angle, the voltage on the sensor's *white wire* will be approximately 0.5VDC. The sensor angle change in this direction would be typical in a **downhill** slope of the chassis.

It is important to clarify the sensor only monitors the angle of change and provides feedback to the ECU through 20degrees of movement. In other words, from the center position, an angle increase of 10degrees or decrease of 10degrees will provide a change in the feedback signal to the ECU. Movement beyond this range will provide no additional change in the feedback signal. Therefore, it is important to mount the manifold assembly as level as possible in both the "X" and "Y" directions to optimize the sensor feedback capability.



Sensor Mounting

The sensors are mounted to the required surface by using two 8/32NF X ½" Long socket head cap screws (SHCS) and flat washers and are factory tightened to 20in./lbs. of torque. The top surface of the sensor is checked and verified to be parallel with the respective "X" and "Y" surface of the manifold. The manifold in turn needs to be level with the vehicle in the respective vehicle "X" and "Y" axis.

After the manifold is properly mounted and secured in the designated vehicle location, connect the sensor wiring harness connectors. The "X" axis connector will typically be of a *female configuration*, while the "Y" axis connector will typically be of a *male configuration*. This interface is an assembly poka-yoke, making it impossible to connect the sensor to the wrong harness connector. Additional poka-yoke measures have been taken to color code the center wire of the vehicle wiring harness connector, as well. The typical vehicle wiring harness center wire color code configuration is as follows:

Wiring Harness Blue Wire = "X" axis inclination sensor
Wiring Harness Violet Wire = "Y" axis inclination sensor

Note: *Prior to connecting the wiring harness to the sensor connectors, be sure to apply a good brand of moisture displacement lubricant to the connectors. This will help prevent moisture from entering the connections and affecting system operation due to the low current and voltage application of the sensor.*

Sensor Test Procedure

The ECU monitors the system and can identify voltages that are below 0.4VDC (short to ground, broken wire, disconnected harness connector, etc.) or voltages equal to the supply reference (short to supply voltage). Voltages associated with these conditions would generate an alarm. The alarm would be displayed by a fault code on the vehicle user panel by flashing the *suspension* indicator. However, voltages that are above 0.4VDC and below the supply reference from the ECU fall within the normal operating parameters of the sensor and are not subject to alarm. If a sensor is suspected to be faulty, a test can be performed to validate its functionality. The following step by step process outlines that test procedure:

1.) Disconnect power from the system prior to performing any repairs or component removal/replacement. This will prevent any possible short circuits that could result in component or supply voltage damage.
2.) Disconnect the respective sensor 3-wire connector from the vehicle wiring harness.
3.) Remove the two mounting screws with washers that secure the sensor to the manifold surface.
4.) Remove the sensor from the vehicle.
5.) Place the sensor on a clean and level surface. Verify the surface to be used is level by using an appropriate level across the "X" and "Y" planes of the surface.
6.) Orientate the sensor in such a manner as to have the wires on your left hand side and facing towards you ***(refer to the earlier illustration)***.
7.) Obtain a DC voltage power supply capable of supplying a regulated 5VDC supply.
8.) Connect the **red** lead from the power supply to the ***red wire*** on the sensor connector.
9.) Connect the **black** lead from the power supply to the ***black wire*** on the sensor connector.
10.) Obtain a voltmeter to monitor the feedback voltage.
11.) Connect the **red** lead of the voltmeter to the sensor *white wire* and the **black** lead of the voltmeter to the sensor ***black wire.***
12.) Turn on the DC power supply and adjust the voltage to 5VDC, if necessary.
13.) With the sensor sitting flat on the horizontal surface for testing, the voltage on the *white wire* should read approximately one-half of the 5VDC supply, i.e. 2.5VDC to 2.7VDC.
14.) Slowly ***raise the front*** of the sensor (sensor end on your left hand side, with the wires), while keeping the **rear** of the sensor (the sensor end on your right hand side) in contact with the horizontal

flat surface. The voltage on the voltmeter should steadily <u>increase</u> until an approximate angle of 10degrees is reached. With the ***front*** of the sensor at this angle, the voltage on the voltmeter should read approximately 4.5VDC. Any further increase in the angle beyond this point will not result in any further <u>increase</u> in the feedback voltage.

<u>Note:</u> *The voltage should increase steadily, with no loss in the voltage signal, no erratic changes should occur, or the voltage should not read +5VDC or 0VDC at any point throughout the angle of movement.*

15.) Return the sensor to the full horizontal position.

16.) Slowly ***raise the rear*** of the sensor (sensor end on your right hand side), while keeping the **front** of the sensor (the sensor end on your left hand side, with the wires) in contact with the horizontal flat surface. The voltage on the voltmeter should steadily <u>decrease</u> until an approximate angle of 10degrees is reached. With the **rear** of the sensor at this angle, the voltage on the voltmeter should read approximately 0.5VDC. Any further increase in the angle beyond this point will not result in any further <u>decrease</u> in the feedback voltage.

<u>Note:</u> *The voltage should decrease steadily, with no loss in the voltage signal, no erratic changes should occur, or the voltage should not read 0VDC or +5VDC at any point throughout the angle of movement.*

17.) If the sensor fails to test as described, then replacement will be necessary.

<u>Note:</u> *When replacing the sensor (or upon re-installation in the event of a satisfactory test), be sure to adhere to the installation instructions mentioned earlier in this document. It is imperative for the sensor to be level to mounting surface, parallel to the respective manifold surface, and be properly secured. This will ensure proper monitoring by the system ECU and system functionality during the self-leveling mode of operation.*

<u>Summary</u>

This completes the basic installation, operation, and troubleshooting information on the inclination sensor. Time spent by installation and service personnel to better understand individual component functions will enhance their understanding of overall system operation. It will also ensure a properly installed and serviced system, thereby optimizing system performance and obtain the intended system functionality.

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SAMS Pressure Transducer

This document is written to provide a basic understanding of the pressure transducer used on the Smart Air Management System (SAMS). This discussion will create a basic understanding of the transducer functionality. The knowledge gained by understanding this information will provide installation and service personnel with information to diagnose and repair related system problems.

Theory of Operation

This device is used by the system ECU (electronic control unit) to monitor a specific pneumatic pressure within the Smart Air Management System. The transducer is of a highly reliable ceramic design, utilizing a variable capacitance sensing element, and state-of-the-art integrated circuitry to provide a linear voltage signal proportional to the applied system pressure.

The Blue Bird system consists of five (5) transducers in total. The pressure transducers are installed at appropriate locations throughout the pneumatic system thereby enabling the respective capacitive sensing element to be directly subjected to the air pressure at the desired point. The integrated circuitry converts the sensed pressure into a useable electrical signal. This electrical signal is detected by the system ECU and is used as one determining factor for achieving the desired system functionality. One transducer is used to determine if sufficient system pressure is available to provide for proper SAMS operation. This pressure must be within the range of 90 – 130psi. If the pressure is below this range, the ECU will illuminate the *air pressure* indicator located on the user interface, to serve as a warning to the vehicle operator of a system air pressure problem. The remaining transducers are threaded into the manifold assembly and are used to monitor the pressures in the drive and tag axle air bags, specifically named, *Drive DRV*, *Drive Curb*, *Tag DRV*, and *Tag Curb* as stamped on the manifold body, near the associated port.

The system wiring harness connector contains three wires (typically orange, black, blue) that interface the system ECU to the sensor. The ***orange wire*** provides an ECU generated reference voltage, typically 5VDC (+/- 2%). The ***black wire*** provides the ground and the ***blue wire*** provides the voltage signal back to the ECU. This voltage is proportional to the respective system air pressure detected by the transducer.

With power applied to the ECU and no pressure applied to the transducer the voltage on the transducer connector *blue wire* will be approximately 0.5VDC. As the pressure on the transducer increases, the voltage will increase at a linear rate. The following chart exemplifies a transducer with a typical 0 – 150 psi sensing range:

Pressure Transducer Comparison Chart
Applied Pressure vs Output Voltage

Applied Pressure (psi)	Voltage Output (VDC)
0	0.5
10	0.7
20	0.9
30	1.25
40	1.5
50	1.75
60	2.0
70	2.25
80	2.5
90	2.75
100	3.1
110	3.4
120	3.75
130	3.9
140	4.25
150	4.5

Note: *The above chart is accurate within +/- 2% at room temperature, according to the manufacturer's specifications.*

Transducer Mounting

The pressure transducers contain ¼ - 18NPT threads and are installed at suitable locations within the system. The threads of the transducers contain a factory installed sealant to prevent air leaks. The ceramic housing is durable and the brass body resists corrosion and helps prevent the threads from seizing within the fitting, thereby assisting with future serviceability.

After the transducers are properly mounted and secured in the designated vehicle location, connect the associated wiring harness connectors. The system wiring harness connectors are of a *male configuration*. The center wire of the wiring harness is color coded for a specific transducer. The following lists the wire colors associated with the five transducer functions:

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Wiring Harness Blue Wire = System Pressure Transducer
Wiring Harness Yellow Wire / Black Stripe = Drive Axle, Driver Side Transducer
Wiring Harness Green Wire / Black Stripe = Drive Axle, Curb Side Transducer
Wiring Harness Yellow Wire = Tag Axle, Driver Side Transducer
Wiring Harness Green Wire = Tag Axle, Curb Side Transducer

Note: *Prior to connecting the system wiring harness connectors to the transducers, be sure to apply a good brand of moisture displacement lubricant to the connectors. This will help prevent moisture from entering the connections and affecting system operation due to the low current and voltage application of the transducers.*

Transducer Test Procedure

The ECU monitors the system and can identify voltages that are below 0.4VDC (short to ground, broken wire, disconnected harness connector, etc.) or voltages equal to the supply reference (short to supply voltage). Voltages associated with these conditions would generate an alarm. The alarm would be displayed by a fault code on the vehicle user control panel by flashing the *suspension* indicator. However, voltages that are above 0.4VDC and below the supply reference from the ECU fall within the normal operating parameters of the transducer and are not subject to alarm. If a transducer is suspected to be faulty, a test can be performed to validate its functionality. The following step by step process outlines that test procedure:

1.) Disconnect power from the system prior to performing any repairs or component removal/replacement. This will prevent any possible short circuits that could result in component or supply voltage damage.
2.) Relieve pressure from the system through an appropriate means.
Warning: ***System operating pressures are typically 90-130psi. To avoid the potential of personal injury, do not remove the transducer without first relieving pressure from the system.***
3.) Disconnect the wiring harness 3-wire connector from the pressure transducer.
4.) Unscrew the transducer from the associated fitting. ***Note:*** ***Use a back-up wrench if necessary to relieve stress on the associated fitting while loosening the transducer.***
5.) Obtain a known good air pressure regulator, with an accurate gauge.
6.) Obtain a DC voltage power supply capable of supplying a regulated 5VDC supply.
7.) Attach a shop air supply line to the inlet of the pressure regulator. **Be sure the regulator adjustment has been backed off completely to prevent any air discharge from the regulator outlet.**
8.) Secure the transducer to the regulator output, utilizing an appropriate reducer fitting. **Be sure to use a suitable thread sealant to prevent an air leak. Also do not use an excessive amount of sealant that could possibly clog the air inlet to the pressure transducer.**
9.) Fabricate and install an electrical test connector onto the pressure transducer, using the same wire colors and pin configurations as the original wiring harness connector.
10.) Connect the **red** lead from the power supply to the ***orange wire*** on the transducer test connector.
11.) Connect the **black** lead from the power supply to the ***black wire*** on the transducer test connector.

12.) Obtain a voltmeter to monitor the feedback voltage.
13.) Connect the **red** lead of the voltmeter to the transducer test connector ***blue wire*** (signal) and the **black** lead of the voltmeter to the transducer test connector ***black wire***.
14.) Turn on the DC power supply and adjust the voltage to 5VDC, if necessary.
15.) With no pressure applied to the transducer, the voltmeter should read approximately 0.5VDC.
16.) Refer to the chart illustrated on the previous page of this document (page 25).
17.) Slowly increase the pressure on the regulator outlet in 10psi increments. Record the voltmeter readings at 10psi, 20psi, 30psi, 40psi, 50psi, 60psi, 70psi, 80psi, 90psi, 100psi, 110psi, 120psi, and if possible, 130psi, 140psi, and 150psi. The voltmeter should read +/- 2% of the voltage listed in the chart at these respective pressures.
Note: *The voltage should increase steadily, with no loss in the voltage signal, no erratic changes should occur, or the voltage should not read 0VDC or +5VDC at any point throughout the test range.*
18.) If the sensor fails to test as described, then replacement will be necessary.

Note: *When replacing the transducer (or upon re-installation in the event of a satisfactory test), be sure to adhere to the installation instructions mentioned earlier in this document. It is important for the transducer threads to be properly sealed with an appropriate sealant in order to be free of air leaks. This will ensure proper monitoring by the system ECU and prevent excessive air compressor cycling from the loss of system pressure.*

Summary

This completes the basic installation, operation, and troubleshooting information on the pressure transducer. Time spent by installation and service personnel to better understand individual component functions will enhance their understanding of overall system operation. It will also ensure a properly installed and serviced system, thereby optimizing system performance and obtain the intended system functionality.

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Phone: 616-530-1717
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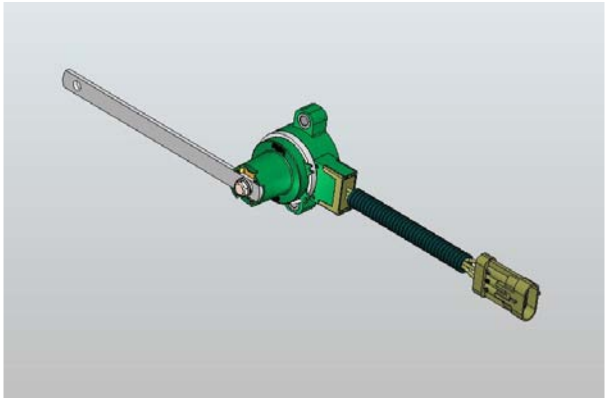
SAMS Height Sensor

This section is written to provide a basic understanding of the SAMS Height Sensor. The content is not intended to be all inclusive, but is to provide basic knowledge for mounting the sensor, the sensor function, and to provide a basic troubleshooting procedure.



Theory of Operation

The height sensor is used by the system ECU (electronic control unit) to monitor and control the vehicle ride height. The sensor arm moves in reaction to the suspension movement and provides a voltage signal that is proportional to the ride height at any given time. Typically, while the vehicle is in operation, the ECU will default to and maintain a programmed ride height. This system design requires a four sensor configuration: two front sensors and two rear sensors, one each mounted at each corner of the vehicle suspension.

The sensor contains three wires (red, black, blue) that interface with the system ECU through the supplied system wiring harnesses. The ***red wire*** provides an ECU generated reference voltage, typically 5VDC (+/- 2%). The ***black wire*** provides the ground and the ***blue wire*** provides the voltage signal back to the ECU. This voltage is proportional to the position of the sensor arm within its range of travel.

The sensor arm is typically installed to be in the center of its travel, when the vehicle is at normal ride height. This would provide a voltage signal on the *blue wire* that is one-half of the supplied reference voltage (approximately 2.4VDC – 2.6VDC). As the sensor arm moves **clockwise**, the voltage on the *blue wire* would continue to increase until the sensor arm reaches approximately +45degrees of rotation from the center position. At the +45degrees of rotation, the voltage on the sensor's *blue wire* would be approximately 4.4VDC to 4.6VDC. The sensor arm travel in the clockwise direction would be typical in a decrease situation from the normal vehicle ride height.

As the sensor arm moves **counter-clockwise**, the voltage on the *blue wire* would continue to decrease until the sensor arm reaches approximately -45degrees of rotation from the center position. At the -45degrees of rotation, the voltage on the sensor's *blue wire* would be approximately 0.4VDC to 0.6VDC.

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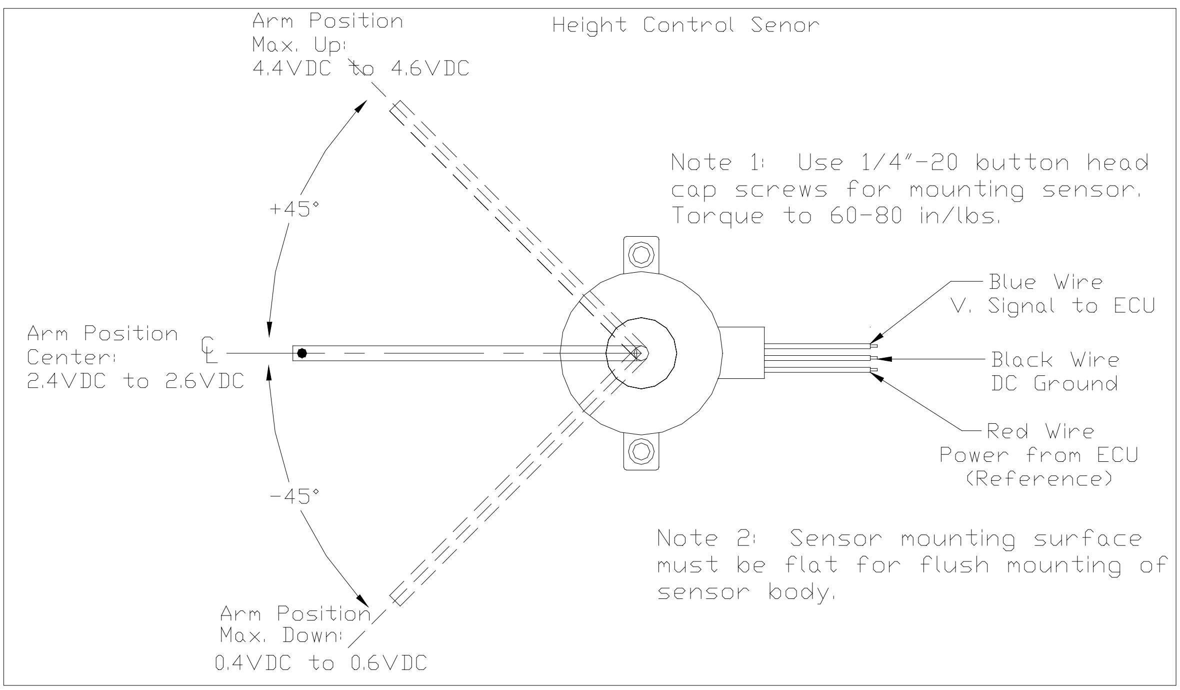
The sensor arm travel in the counter-clockwise direction would be typical in an increase situation from the normal vehicle ride height.

It is important to clarify that the sensor only monitors the ride height and provides feedback to the ECU through only 90degrees of movement. In other words, from the center position, a change in the ride height of +45degrees to -45degrees of sensor arm movement provides a signal to the ECU. Movement either above or below this range provides no additional feedback to the ECU. Therefore it is important to install the sensor correctly to obtain the correct linkage arm inclination (see *SAMS Height Sensor Arm & Linkage Installation* procedure outlined in Appendix C). Improper linkage installation can result in sensor damage and result in improper system control and incorrect vehicle ride height.



Sensor Mounting

Care must be taken when mounting the sensor to the vehicle frame. The mounting surface must be flat so the sensor body is mounted flush to the vehicle surface. It is recommended that two button head cap screws, ¼" – 20 thread, be used to mount the sensor to the vehicle and the screws tightened to 60-80 inch/lbs. of torque. If the frame mounting holes are a through-hole (non-threaded), a nylon style of locknut is also recommended to maintain the tightening torque.

It is important to clarify the above mounting information, otherwise distortion or breakage of the sensor body is possible when tightening the mounting hardware. Not having the sensor flush can distort the sensor body resulting in breakage as well as over-tightening can crack the housing. Damage to the senor will result in improper system control and incorrect vehicle ride height.

After the sensor is mounted to the vehicle, connect the sensor wiring female connector to the respective vehicle wiring harness male connector. The center wire of the vehicle wiring harness connector will be color coded to identify the respective location on the vehicle. The supplied system wiring harness center wire configuration is as follows:

Yellow Wire = Front Drive Height Sensor Connector
Green Wire = Front Curb Height Sensor Connector
Yellow Wire with Black Stripe = Rear Drive Height Sensor Connector
Green Wire with Black Stripe = Rear Curb Height Sensor Connector

Note: *Prior to connecting the wiring harness to the sensor connectors, be sure to apply a good brand of moisture displacement lubricant to the connectors. This will help prevent moisture from entering the connections and affecting system operation due to the low current and voltage application of the sensor.*

Sensor Test Procedure

The ECU monitors the system and can identify voltages that are below 0.4VDC (short to ground, broken wire, disconnected harness connector, etc.) or voltages equal to the supply reference (short to supply voltage). Voltages associated with these conditions would generate a sensor alarm. The alarm would be displayed by flashing a fault code on the user control panel *suspension* indicator. However, voltages that are above 0.4VDC and below the supply reference from the ECU fall within the normal operating parameters of the sensor and are not subject to alarm. If a sensor is identified to be faulty, a test can be performed to validate its functionality. The following step by step process outlines that test procedure:

1.) Disconnect power from the system prior to performing any repairs or component removal/replacement. This will prevent any possible short circuits that could result in component or supply voltage damage.
2.) Disconnect the sensor 3-wire connector from the supplied system wiring harness.
3.) Disconnect the linkage from the sensor arm.
4.) Unbolt the sensor from the vehicle frame and remove the sensor.
5.) Obtain a DC voltage power supply capable of supplying a regulated 5VDC supply.
6.) Connect the **red lead** from the power supply to the **red wire** on the sensor connector.
7.) Connect the **black lead** from the power supply to the **black wire** on the sensor connector.
8.) Obtain a voltmeter to monitor the DC feedback voltage.
9.) Connect the **red lead** of the voltmeter to the sensor **blue wire** and the **black lead** of the voltmeter to the sensor **black wire**.
10.) Orientate the sensor so the lever arm faces up, points to your left, and the sensor wiring is to your right.
11.) Place the sensor in the mid-range of its travel.
12.) Turn on the DC power supply and adjust the voltage to 5VDC, if necessary.
13.) With the sensor arm in the center position, the voltage on the **blue wire** should read approximately one-half of the 5VDC supply, i.e. 2.4VDC to 2.6VDC.

14.) Slowly rotate the senor arm in the clockwise direction and observe the voltage reading on the voltmeter. As the sensor arm is rotated clockwise, the voltage on the **blue wire** should increase until approximately +45degrees of rotation from center is reached. At the +45degrees of rotation, the voltage should read approximately 4.4VDC to 4.6VDC. If rotation continues beyond this point, no additional increase in voltage should be observed. ***Note:*** *The voltage should increase steadily, with no loss in the voltage signal, no erratic changes should occur, or the voltage should not read +5VDC or 0VDC at any point throughout the range of movement.*

15.) After verifying the voltage increase, slowly rotate the sensor arm counter-clockwise. As the sensor arm is rotated counter-clockwise, the voltage on the **blue wire** should decrease until approximately -45degrees of rotation from center is reached. At the -45degrees of rotation, the voltage should read approximately 0.4VDC to 0.6VDC. If rotation continues beyond this point, no additional decrease in voltage should be observed. ***Note:*** *The voltage should decrease steadily, with no loss in the voltage signal, no erratic changes should occur, or the voltage should not read 0VDC or +5VDC at any point throughout the range of movement.*

16.) If the sensor fails to test as described, then replacement is necessary.

Note: *When replacing the sensor (or upon re-installation in the event of a satisfactory test), be sure to adhere to the installation instructions mentioned earlier in this document. Proper installation is necessary to prevent damaging the sensor. Proper sensor operation is necessary to provide accurate feedback to the ECU for correct vehicle height control.*

Summary

This completes the basic installation, operation, and troubleshooting information on the height control sensor. All information contained in this document is of equal importance and should not be ignored. Time spent by installation and service personnel to better understand component operation will ensure a properly installed and serviced system, thereby providing correct system operation.

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2851 Prairie S.W.
Grandville, MI 49418
Phone: 616-530-1717
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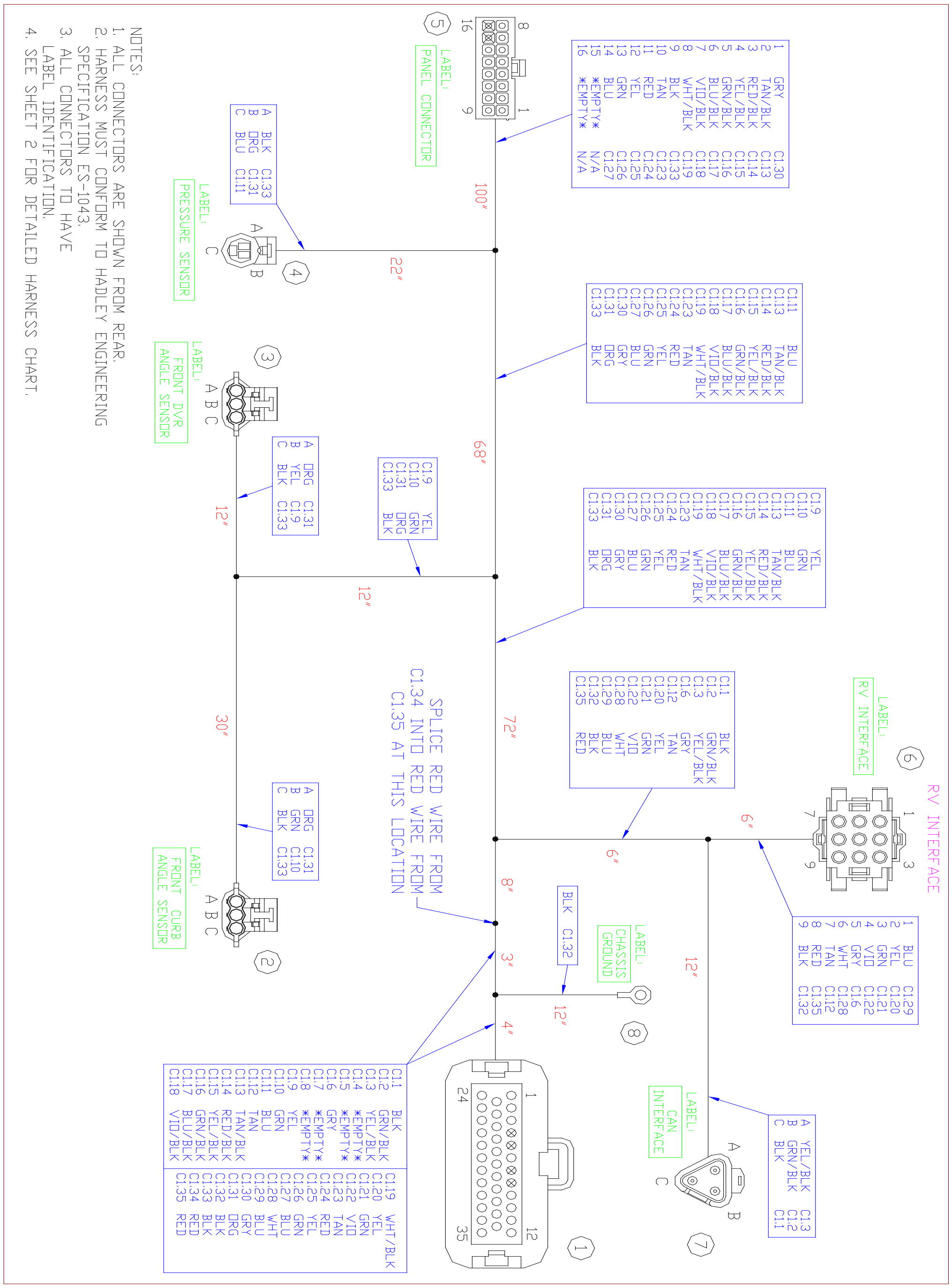
SAMS Front Harness Layout
(Page 1 of 2)



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SAMS Rear Harness Layout
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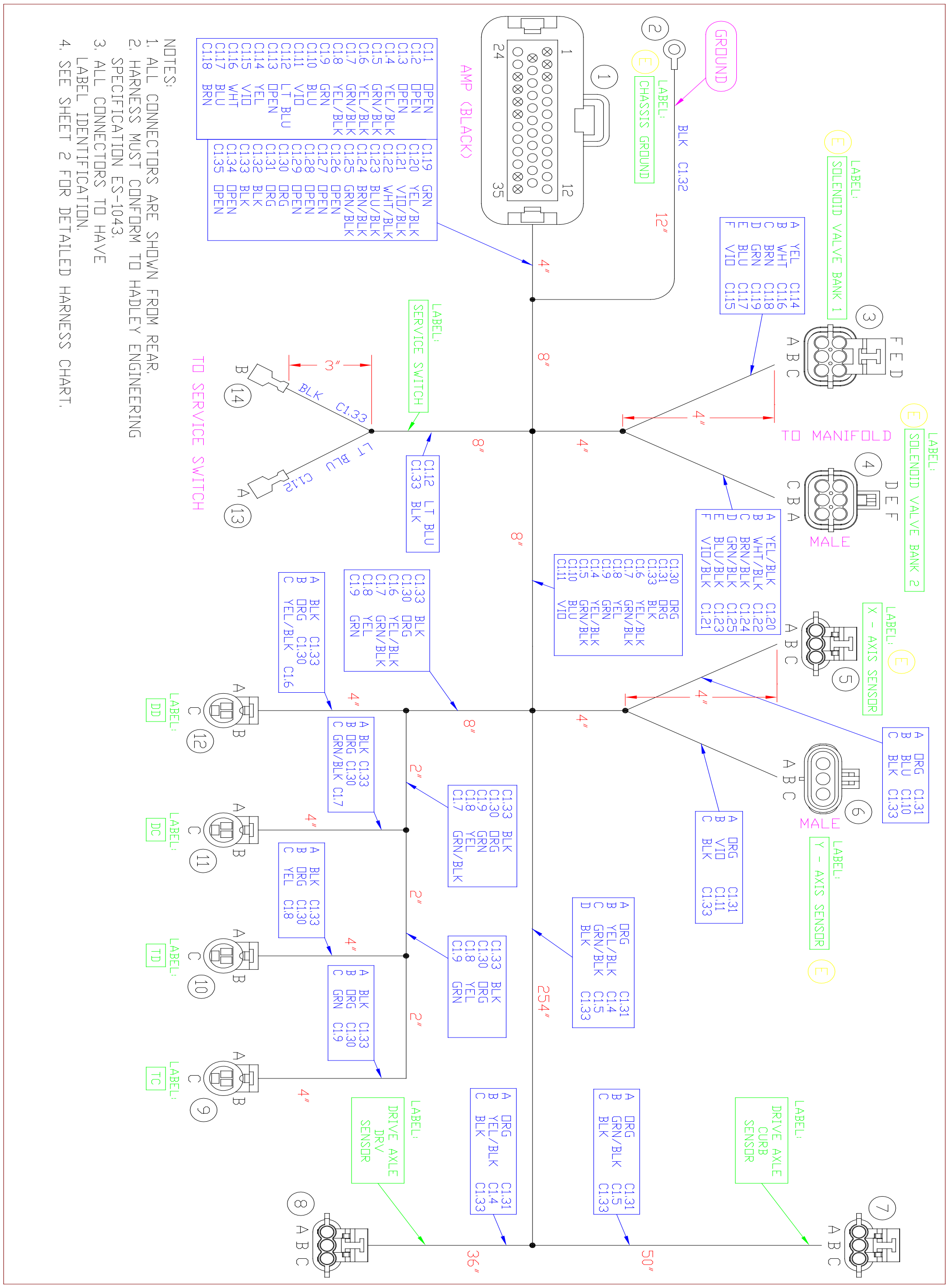

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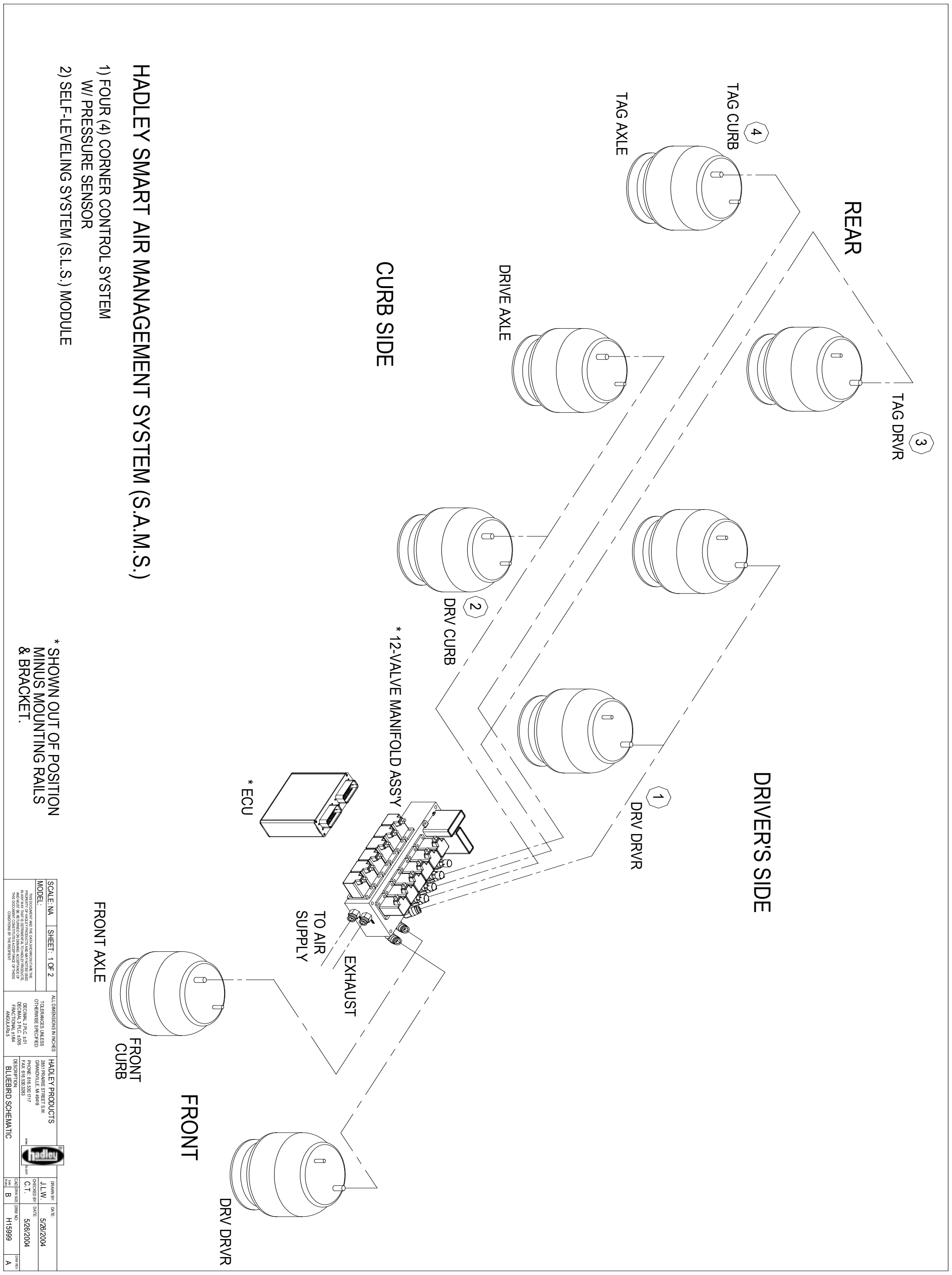
SAMS Pneumatic Layout



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Appendix A

SAMS Wiring Harness Installation Precautions

1.) Be sure the utilized vehicle power source is not overloaded or undersized. Sufficient system power is required to optimize the manifold solenoid-valve operation, i.e.10VDC– 16VDC, 1.2A per solenoid.
2.) Be sure the power and ground connections are clean and tight and the manifold ground wire(s) are connected to a good chassis ground.
3.) Be sure the harness is routed correctly so as the height sensor connectors are installed to the correct sensor on the vehicle. The following describes the **center** wire color of the system harness connectors and their associated sensor connection:
    Yellow Wire *= Front Drive Height Sensor Connector*
    Green Wire = *Front Curb Height Sensor Connector*
    Yellow Wire with Black Stripe *= Rear Drive Height Sensor Connector*
    Green Wire with Black Stripe *= Rear Curb Height Sensor Connector*
4.) **DO NOT** pull on the harness connectors excessively during the installation process. Too much force on these components can pull wires from the connector or break wires from their pin crimp connection.
5.) Keep the harness away from engine exhaust manifolds, mufflers, exhaust pipes, catalytic converters, and other heat generating components.
6.) Keep the harness away from pinch points and sharp objects to prevent crushing, cutting, and damage to the harness assembly which could result in open or short circuits.
7.) Allow sufficient bend radii where applicable to prevent sharp bends, kinks, and unnecessary strain on the wiring that could result in eventual breakage and open circuits. The conduit manufacturer recommends a minimum bend radius of 3-inches.
8.) Allow sufficient slack in the harness to prevent damage at points of vehicle horizontal and/or vertical movement and deflection. This will allow the harness to move with the vehicle and prevent unnecessary stress and fatigue resulting in eventual open and/or short circuits. ***Note: Caution should be taken as not to leave excessive slack which could cause the harness to become snagged while the vehicle is in motion, especially in off road conditions.***
9.) Secure the harness every few inches (typically 6 -12”) with nylon straps.
10.) While securing the harness with the nylon straps, care should be taken as not to crush the polyethylene flexible split conduit.
11.) Be sure the rubber moisture seal is in place on the connectors. This will help to prevent moisture from entering the connection and affecting system operation.
12.) Be sure to apply a good brand of moisture displacement lubricant to the connectors prior to connecting them to their associated sensor/field device. (A good product for this application is Super Lube Silicone Dielectric Grease available through MSC Industrial Supply, P/N 02105658). This will help to prevent moisture from entering the connection and affecting system operation.
13.) When connecting the harness to the vehicle field devices, i.e. sensors, switches, etc. be sure the connector is properly orientated by the connector’s keying mechanism and that the connectors are fully inserted so the latching mechanism is fully engaged. This will help to ensure a positive electrical connection, allowing for correct ECU monitoring and control.

14.)Be sure to seal any holes which may have been created for routing and installation of the ECU harness connectors, if required with an off the shelf expanding foam. A good product for this application is Federal Process Corporation Work Saver Expanding Foam available through MSC Industrial Supply, P/N 36913622.

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Appendix B

SAMS Pneumatic Installation Precautions

1.) Be sure the air supply provides sufficient pressure to allow for proper system operation, typically 90 – 130psi. Pressures excessively above or below this range can affect system performance and can result in incorrect ride height.
2.) If an existing air reservoir is to be used for providing the source air supply, be sure to tap into the source at some point above the bottom of the tank. Moisture settles to the bottom of the tank and the ports in this location are best suited for drain valves.
3.) Be sure the source air supply is as clean and dry as possible. The air supply should be equipped with an industry standard filtration system.
4.) Mount the SAMS system manifold higher than the lowest point in the air system to reduce the possibility of catching air system contamination.
5.) Mount the SAMS air tank (if applicable) so as **not** to interfere with the suspension or frame movement. The tank should be orientated as such in order to place the drain valve(s) facing toward the ground, beneath the vehicle.
6.) Be sure to use either Teflon tape or a heavy duty thread sealing compound on any field installed air fittings prior to installation, (if the fittings are not already provided with sealant on the threads). Either sealant type can be purchased from any local hardware store. ***Note:* If the use of Teflon tape or a heavy duty thread sealing compound is required, care should be taken with its application so as not to obstruct the air passage in the fitting or clog the manifold port screens.**
7.) The tubing should be installed to adhere to the following routing and connections:
    a. Manifold Supply Inlet Port = Supply Line from Vehicle Source
    b. Manifold Drive Outlet Ports = Driver Side Air Bags
    c. Manifold Curb Outlet Ports = Passenger Side Air Bags
    d. Manifold Exhaust Ports = Route and secure tubing to vehicle undercarriage
8.) Route the tubing away from engine exhaust manifolds, mufflers, exhaust pipes, catalytic converters, and other heat generating components.
9.) Keep the tubing away from pinch points and sharp and jagged edges to prevent crushing, pinching, or puncturing of the tubing. Tubing that is damaged in this way can reduce air flow and results in poor system performance.
10.) Air brake tubing is recommended for system installation, Parker Hannifin, P/N PFT-6B. Allow sufficient bend radii, where applicable, to prevent sharp bends and kinks in the tubing. The tubing manufacturer recommends a minimum bend radius of 1-1/2" for tubing with an outside diameter (O.D.) of 3/8" (0.375"). ***Note:* If a kink should occur during the installation process, the tubing must be carefully inspected in the area of the kink for possible permanent damage and/or obstruction. The kink can weaken the tensile strength of the tubing and create a weak spot where a leak could develop. Also the tubing must be free of obstructions which can reduce the amount of airflow and affect system performance.**
11.) Allow sufficient slack in the tubing to prevent damage at points of vehicle horizontal and/or vertical movement and deflection. This will allow the tubing to move with the vehicle and prevent crushing and/or fatiguing of the tubing. ***Note:* Caution should be taken as not to leave excessive slack which could cause the tubing to become snagged while the vehicle is in motion, especially in off road conditions.**

12.)Secure the tubing every few inches (typically 6 -12”) with nylon straps.

13.)The nylon straps should be snug enough to hold the tubing in the desired position, but not over-tightened, which can otherwise distort the tubing and restrict air flow.

14.)To prevent leaks, be sure the tubing end is cut square and the tubing is free from nicks, cuts, abrasions, and any contaminates (such as rust-proofing) at least 3 – 4 inches from the squarely trimmed end, prior to attaching the tubing to the fittings.
Note1*:** *A tubing cutter with a sharp blade is recommended to properly cut the tubing end. (A good tubing cutter can be purchased from either MSC Industrial Supply, P/N 79814323, or from Parker Hannifin Corporation, P/N PTC). It* ***is not *recommended to use any other device for cutting the tubing. If an improper tool is used, uneven cuts, jagged edges, or distortion of the tubing can result, thereby affecting the ability for the tubing to fully engage the fitting. The tubing must fully engage the fitting and be free from damage for air leak prevention.*
Note2: *If circumstances arise which requires disconnecting the tubing from a PTC fitting, careful examination of the tubing end is required. It is possible for the tubing end to become distorted and irregularities may be present in the tubing wall. If any distortion or irregularities are present, it will be necessary to trim off the damaged end (typically ½” is sufficient) by using a good tubing cutter. Removal of the damaged end and using the appropriate tool will ensure a positive seal between the tubing wall and the inside diameter of the PTC fitting. Be sure to check the area with a good leak detection solution after pressurizing the system to ensure that no leak is present. If a bubbling of the inspection solution is present, it may be necessary to replace the PTC fitting, as well.*

15.)Install the tubing into the fitting (compression fittings): (A) Slide the fitting nut over the end of the tubing (threaded end facing the fitting), making sure the insert is in place inside the fitting; (B) Insert the tubing inside the fitting and push down as far as possible. (C) Secure the nut to provide a positive seal between the insert, the tubing, and the nut.

16.)Install the tubing into the fitting (manifold fittings): Simply push the hose completely into the fitting until it locks. This style of fitting is of a push-to-connect (PTC) design. When properly installed, the tubing will not pull from the fitting unless the release mechanism is depressed.

17.)After completing the installation and verifying system operation, the entire air system should be inspected for leaks utilizing a suitable leak detection solution. This may include a soap, water, and glycerin mix, Oatey All-Purpose Leak Detector, or Nu-Calgon Gas Leak Detector (the Oatey and Nu-Calgon products are available through MSC Industrial Supply). ***Note:* It is important to pay particular attention to the vehicle air springs/bags. Leaks in these areas will affect the SAMS system operation and performance and often go undetected, unless the leak is severe enough to cause the vehicle to lean. During the inspection of the air springs/bags, pay particular attention to the interface of the upper bead plate to the air spring/bag lip area. Should a leak be detected in the air spring/bag, it must be replaced as defined by the vehicle manufacturer’s warranty procedure.***

Detecting air leaks and taking corrective action will optimize system performance, eliminate unnecessary troubleshooting, prevent system rework, and prevent unnecessary air compressor wear due to excessive cycling.

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Appendix C

SAMS Height Sensor Arm & Linkage Installation

1.) With the vehicle on a level surface, determine the amount of jounce (compression) travel and the rebound (extending) travel of the suspension. These two dimensions indicate the range of movement for which the suspension can respond to changes in road conditions.
    Example: jounce travel = 3" rebound travel = 4"
2.) Determine which range of travel is the largest distance and make note. The example provided in step #1 would have the "rebound travel" of 4" to be the greater of the two distances.
3.) Using the table below, select the lever length needed based on the largest distance noted in the above example. The prior example defined the largest direction of movement to be 4" (rebound). In the left most column, find 4" of suspension travel. Go across the rows and in the right most column, select the "actual lever length" needed. The example provided would require a 6" length sensor arm with the 4" of maximum suspension travel.

Height Sensor Arm Selection Table		
Jounce or Rebound Maximum Suspension Travel		**Actual Lever Length Needed**
2.0"		3.0"
2.2"		4.0"
2.4"		4.0"
2.6"		4.0"
2.8"		5.0"
3.0"		5.0"
3.2"		5.0"
3.4"		5.0"
3.6"		6.0"
3.8"		6.0"
4.0"		6.0"
4.2"		7.0"
4.4"		7.0"
4.6"		7.0"
4.8"		8.0"
5.0"		8.0"
5.2"		8.0"
5.4"		9.0"
5.6"		9.0"
5.8"		9.0"
6.0"		9.0"

4.) Attach the height sensor to the vehicle frame by adhering to precautions outlined in the appropriate section of this document. The section provides useful information to prevent possible damage to the height sensor during the installation and servicing process.
5.) Unless otherwise specified, the height sensor arm should be oriented in the horizontal position, (center of sensor travel), and facing to the front of the vehicle.
6.) Attach the associated linkage to the sensor arm and the vehicle frame. It is important to note the point where the linkage attaches to the height sensor arm should lead the connection point at the vehicle frame by a distance that is approximately 20% of the sensor arm length. See the illustration below for more details on the proper lever arm inclination dimension (LAI) for the linkage, based on the required sensor arm.

Height Sensor Arm & Linkage Installation

DIAGRAM A

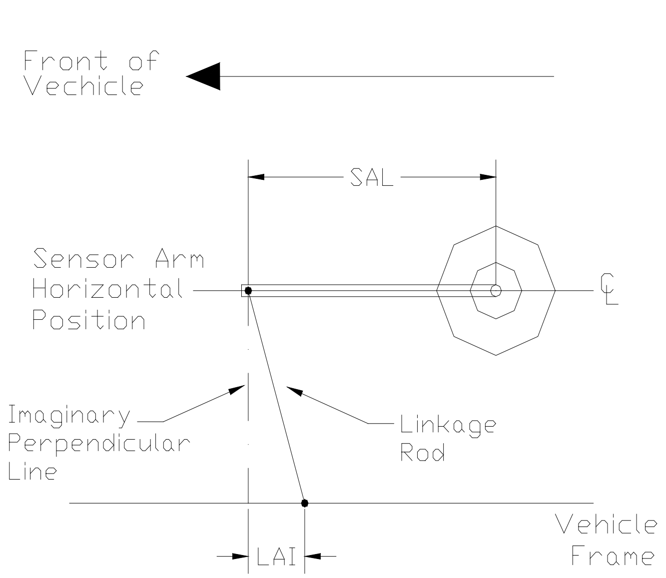

TABLE A

Sensor Arm Length (SAL)	Lever Arm Inclination (LAI)
3″	0.60″
4″	0.80″
5″	1.00″
6″	1.20″
7″	1.40″
8″	1.60″
9″	1.80″

NOTE: LAI is 20% of SAL

Note: *The inclination of the linkage is important to ensure the continuous monitoring of the suspension throughout its travel (jounce and rebound). The sensor monitoring range is typically +/- 45 degrees from the center position (90 degrees of rotation total). Points outside of this range* ***will not*** *provide any further changes in the feedback signal to the system ECU. Also, if the sensor arm is too short and the inclination angle is incorrect, it is possible to over-extend the height sensor. This would result in damage to the sensor and cause faulty system operation.*

7.) Route the SAMS wiring harness as required, adhering to the precautions outlined in Appendix A of this document. This section provides useful information to prevent possible damage to the wiring harness and/or connectors during the installation process and vehicle operation.

8.) Connect the respective wiring harness 3-pin connectors to each height control sensor. Refer to the wiring harness installation precautions outlined is Appendix A for connector identification and moisture prevention procedures.

9.) Route and install the air tubing, adhering to the precautions outlined in Appendix B of this document. This section provides useful information to prevent damage to the nylon tubing and precautions to help in the prevention of air leaks.

10.) After the installation of the required components, the system is ready for power up and test. Start the vehicle to supply power and air to the SAMS system. The system should go through a self-leveling process and automatically adjust to the desired ride height.

11.) Verify the operation of the system by selecting the desired mode of operation, as defined in the respective section of this manual.

12.) At any time, should a problem be detected by the SAMS system ECU, the *suspension* indicator located on the user control panel will flash. The flashing sequence indicates the error code associated with the detected problem. See the respective system error code section of this document for additional information regarding fault identification and associated problem description.