SERVICE MANUAL SECTION

3200 Integrated Mobility Option Service Manual

Model: 3200 IM

Unit Code: 10WZN

Unit Code: 10WZP

Unit Code: 10WZR

Unit Code: 10WZU

S10018

10/11/2005

Table of Contents

1. FRAME

The Frame is essentially as described in the International Master Service Manual with a few notable exceptions:

1. The frame is dropped 250 mm (9.85 in.) immediately behind the cab with the use of unique “drop brackets ”to permit a lowered floor on whatever body is to be carried.
2. The top side of the right side of the frame has a depressed segment which is parallel to the ground to permit deployment of an ADA access ramp.
3. The rear portion contains “bridge” segments which bring the frame up and above the wheel centers and provide mounting for “geared wheel ends”.
4. The rear portion of the frame contains an “H” section between the “bridge” segments that provide three point mounting for a floating differential.
5. Frame alignment (see the Figure below).

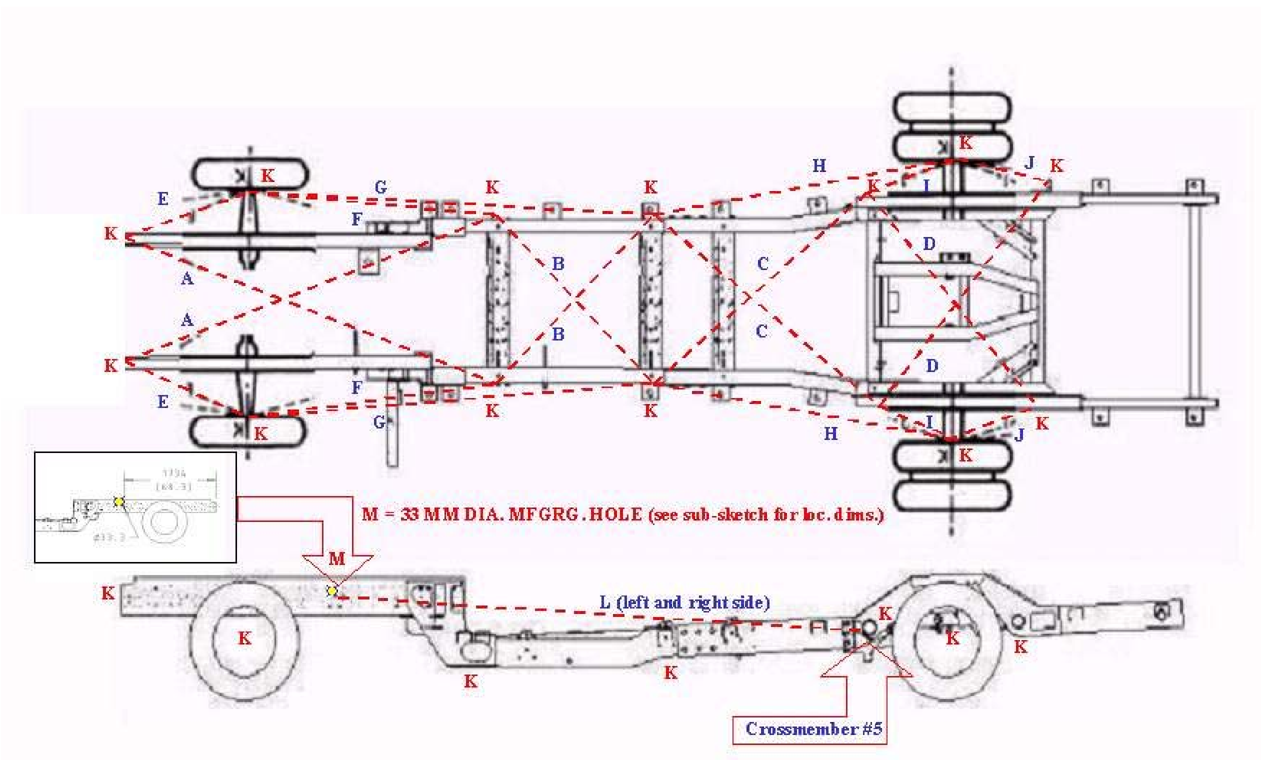


Figure 1 Frame Alignment

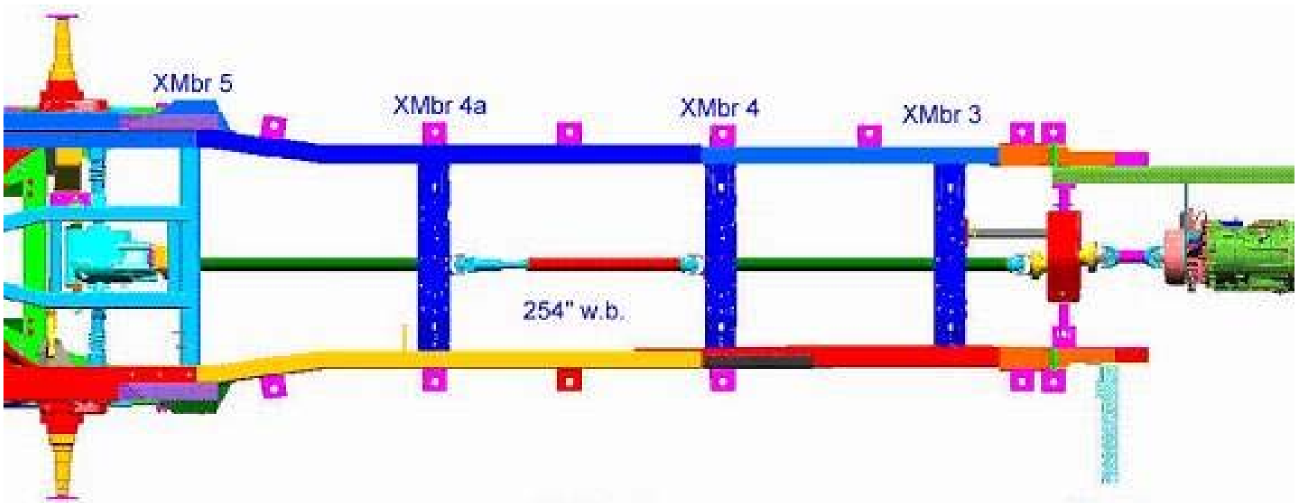


Figure 2 Frame

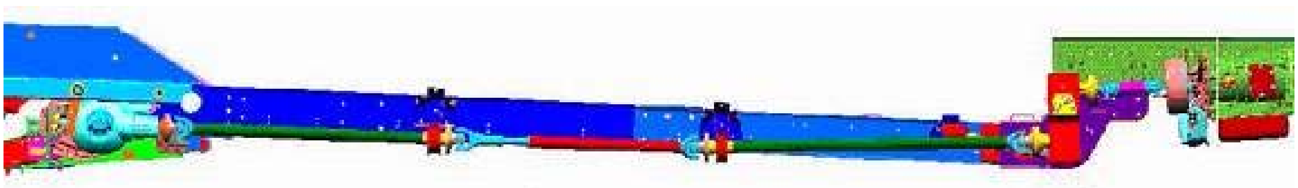


Figure 3 Frame

2. TRANSFER CASE

The Transfer Case is a set of helical gears (driver, idler, driven) with a 1:1 overall ratio in a ribbed, sand cast aluminum gear case running in oil which serves to drop the driveline's centerline 250mm (9.85 in.) behind the transmission. This permits a lowered frame and therefore floor in the body being carried. The Transfer Case has support arms at the left and right sides (note the right side three bolt pad in Figure 5, left side is similar).

Figure 4 Transfer Case, Front

Figure 5 Transfer Case, Right

Lubricant: SAE 75W-90 Synthetic. Fill to overtop at upper plug, Figure 4, approximately 7 pints. Lower plug is Drain.

Figure 6 Transfer Case Support, Left

Figure 7 Transfer Case Support, Lower

Figure 8 Transfer Case Support, Right

The Transfer Case is mounted with two lateral support arms, one at the left side (Figure 6) and one at the right side (Figure 8). Note the right side three bolt pad in Figure 5, left is similar. The outer ends of these support arms are isolator mounted to support brackets welded to the dropped portions (drop brackets) of the side frame rails.

A lower, longitudinal stabilizing / support arm (Figure 9) mounts at the left, rear side of the Transfer Case and runs aft to an isolator / bracket at cross member #3 (Figure 10, Figure 11).

Figure 9 Stabilizing/Support Arm

Figure 10 C’mbr #3/Brkt, Front

Figure 11 C’mbr #3/Brkt, Rear

Reference sketches of Transfer Case mounting and Dropped Frame

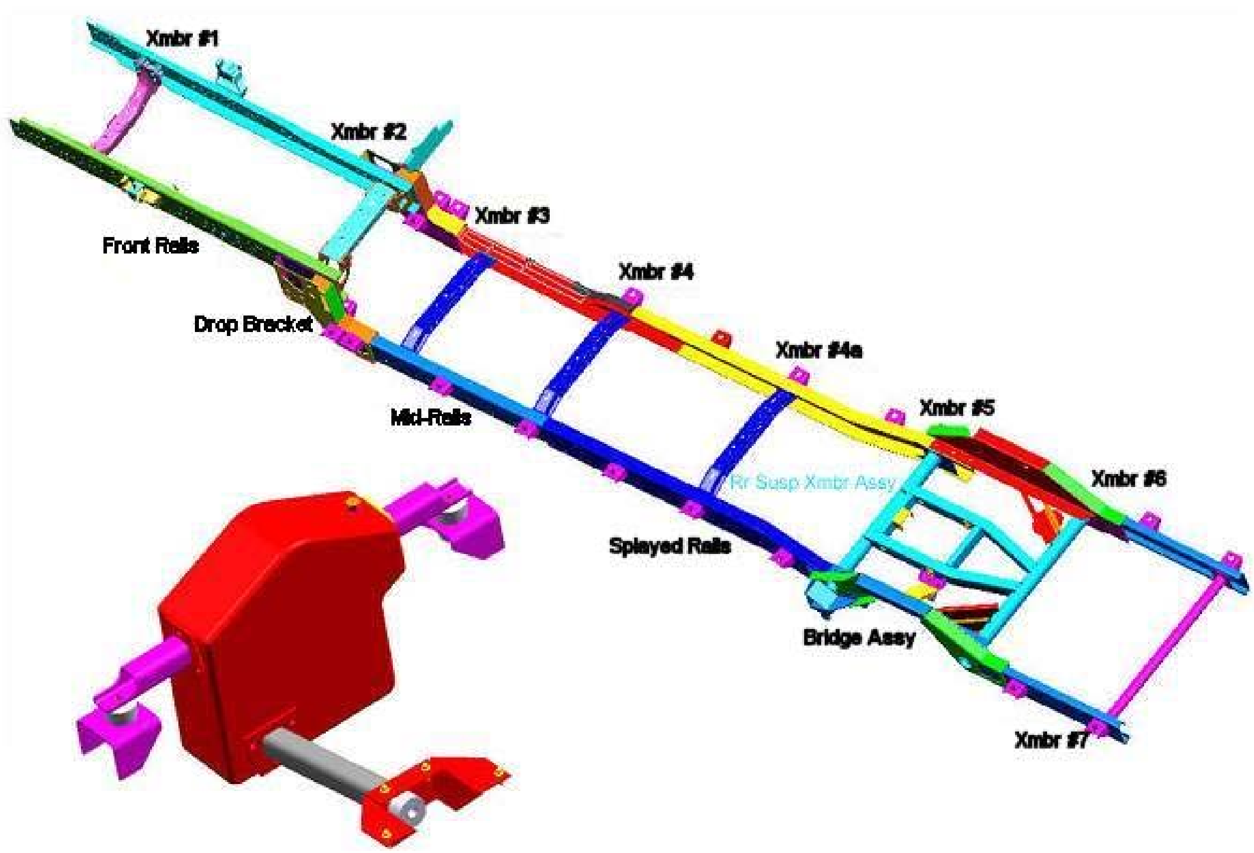


Figure 12 C’mbr #3/Brkt, Rear

NOTE – The following parts are to be serviced by International dealers [torques shown]:

Table 1

(1)	2589512C1	Plug, Drain #8 (Magnetic)	48 Lb-Ft
(1)	2589513C1	Drain Plug #8 ‘O’ Ring	48 Lb-Ft
(2)	2589841C1	Washer, Yoke	
(2)	2589842C1	Nut, Lock, Yokes	400 Lb-Ft
(1)	152127H1	Breather	
(1)	N/A	Coupling, Pipe	
(1)	144603	Nipple, Pipe 3/8-18 NPT x 3.0	
(1)	2644029R1	Gear Lube, SAE 75W-90 Synthetic (112 Ounces)	
(2)	CR23782	Seal, Oil	
(2)	200990R1	Yoke, End w/ splined hole	

3. DIFFERENTIAL

The Differential (2.167 overall ratio) has its forward facing input companion flange (mating with driveshaft rear companion flange) low in its case and two output companion flanges which mate with the inner ends of the halfshafts’ companion flanges. The differential case is cast iron with the bearings, seals, shafting and gearing running in oil. The configuration of the differential serves to bring the working level of the drivetrain up from the low driveshaft level to the level of the wheel centers. The differential is mounted at the center of the rear “H” frame (Differential Carrier and Mount) assembly, Figure 13, on three rubber isolated mounts (one at the forward facing end and one at each side).

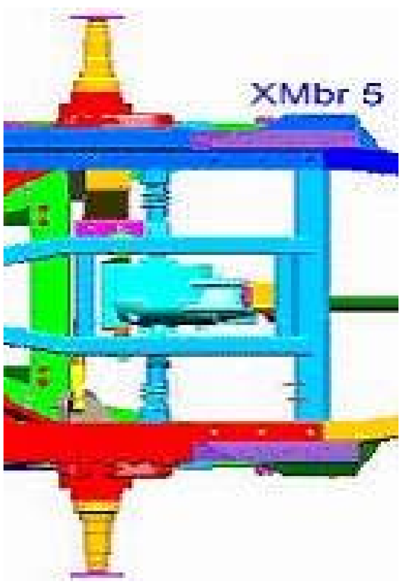


Figure 13

Figure 14

Lubricant: SAE 75W-90 Synthetic. Fill to overtop at upper plug, approximately 5 pints. Lower plug is Drain.

NOTE – The following parts are to be serviced by International dealers [torques shown]:

Table 2

(1)	2589512C1	Plug, Drain #8, Magnetic	48 Lb-Ft
(1)	2589511C1	Breather	
(1)	2589513C1	O-Ring, Drain #8	48 Lb-Ft
(2)	2589841C1	Washer, Yoke	
(2)	25898412C1	Nut, Lock, Yokes	400 Lb-Ft
(1)	2589510C1	Seal-Input	
(3)	2589843C1	Companion Flange – Input, Output	
(1)	2644029R1	Gear Lube, SAE 75W-90 Synthetic (80 Ounces)	

4. GEARED WHEEL ENDS

The left and right Geared Wheel Ends (2.348 overall ratio) input companion flanges mate with the outer ends of the halfshaft companion flanges. The Geared Wheel End cases are cast iron with the bearings, seals, shafting and gearing running in oil. The Geared Wheel Ends are mounted onto the left and right trailing arm assemblies with 13 bolts (4 forward flange, 3 rearward flange, 2 bottom, 5 to bracket across top).

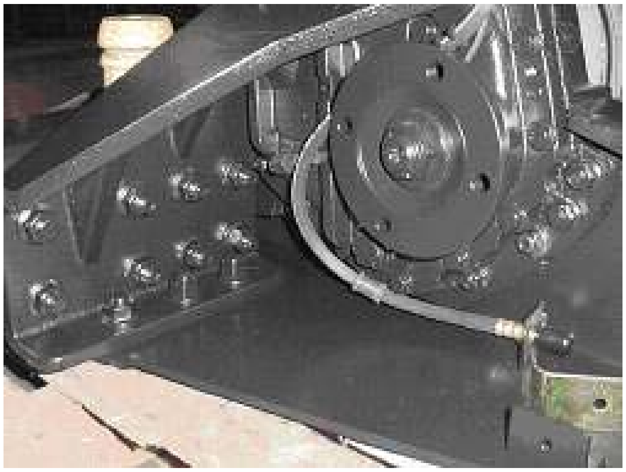


Figure 15

Figure 16

Lubricant: SSAE 75W-90 Synthetic. Fill to overtop at upper plug, approximately 3 pints each side. Lower plug is Drain.

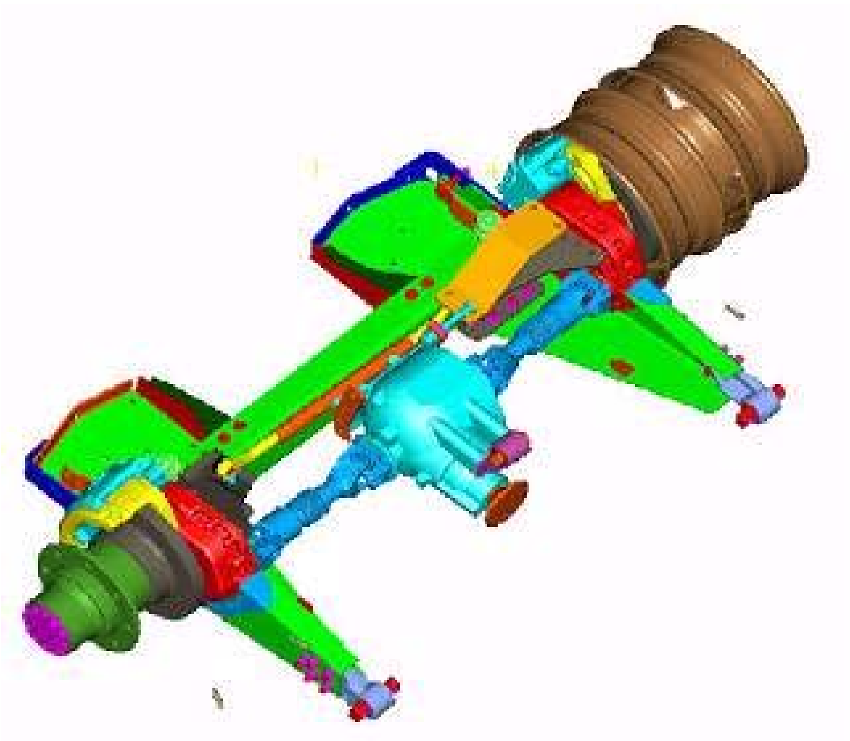


Figure 17

NOTE – The following parts are to be serviced by International dealers [torques shown]:

Table 3

(1L,1R)	2589051C1	Shaft, Axle	
(1L,1R)	2589512C1	Plug, Drain #8, Magnetic	48 Lb-Ft
(1L,1R)	2589511C1	Breather	
(1L,1R)	2589513C1	O-Ring, Drain #8	48 Lb-Ft
(1L,1R)	2589841C1	Washer, Yoke	
(1L,1R)	2589842C1	Nut, Lock, Yokes	400 Lb-Ft
(1L,1R)	2589510C1	Seal-Input	
(1L,1R)	2589843C1	Companion Flange - Input	
(1L,1R)	2644029R1	Gear Lube, SAE 75W-90 Synthetic (48 Ounces)	

5. DRIVE SHAFTING

Drive Shaft Combinations for 200”, 217” & 254” w.b.

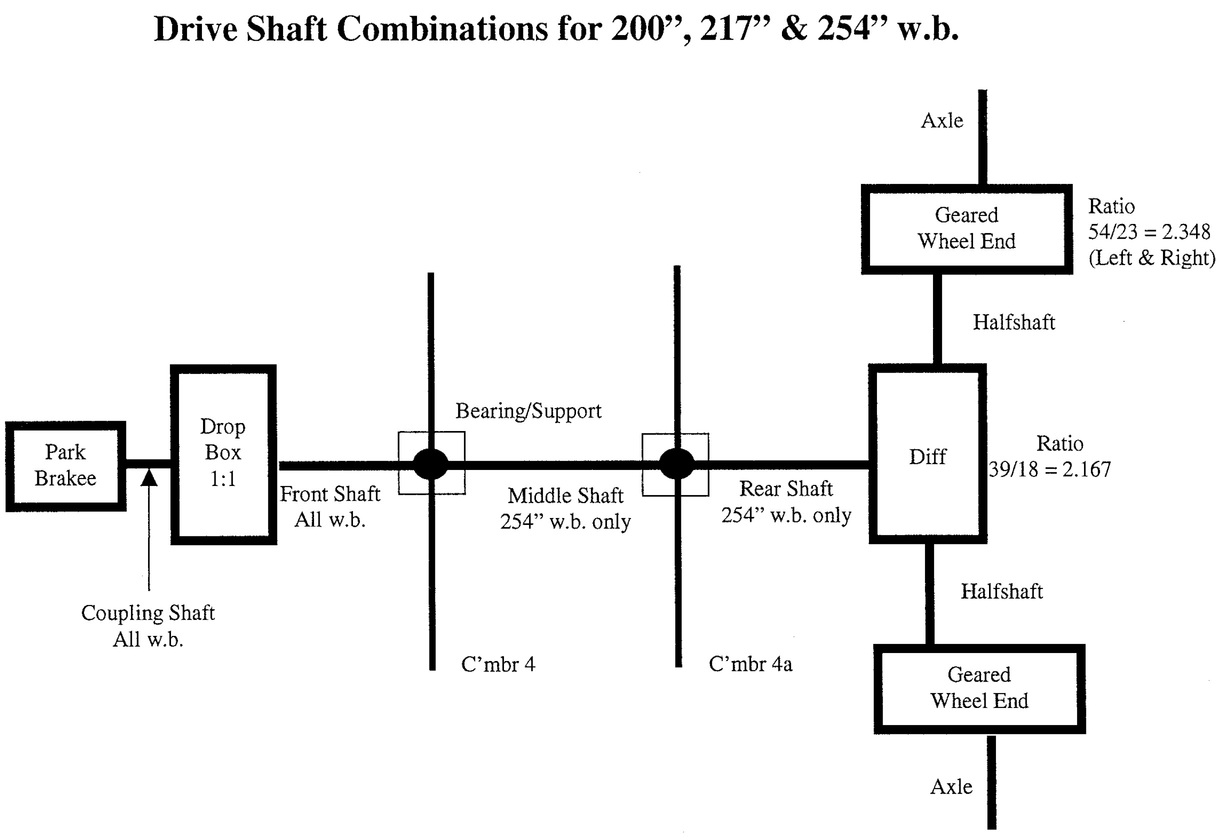


Figure 18

Table 4

Drive Shaft	200" WB	217" WB	254" WB
Coupling Shaft	2589025C91	2589025C91	2589025C91
Front Shaft	2589181C1	2589181C1	2589181C1
Middle Shaft	—	—	2589182C1
Rear Shaft	—	—	2589183C1
Half Shaft, Rt and Lt	2589047C91	2589047C91	2589047C91
Bearing Strap Kit	Dana 3-70-38X	Dana 3-70-38X	1658833C91
Ctr Support Bearing Mtg Bracket (Middle Shaft)	—	—	2589189C1
Ctr Support Bearing Mtg Bracket (Rear Shaft)	—	—	2589190C1
Balanced Drive Shaft Packages	2589180C91	2589184C91	2589186C91

6. AIR MANAGEMENT SYSTEM

Overview

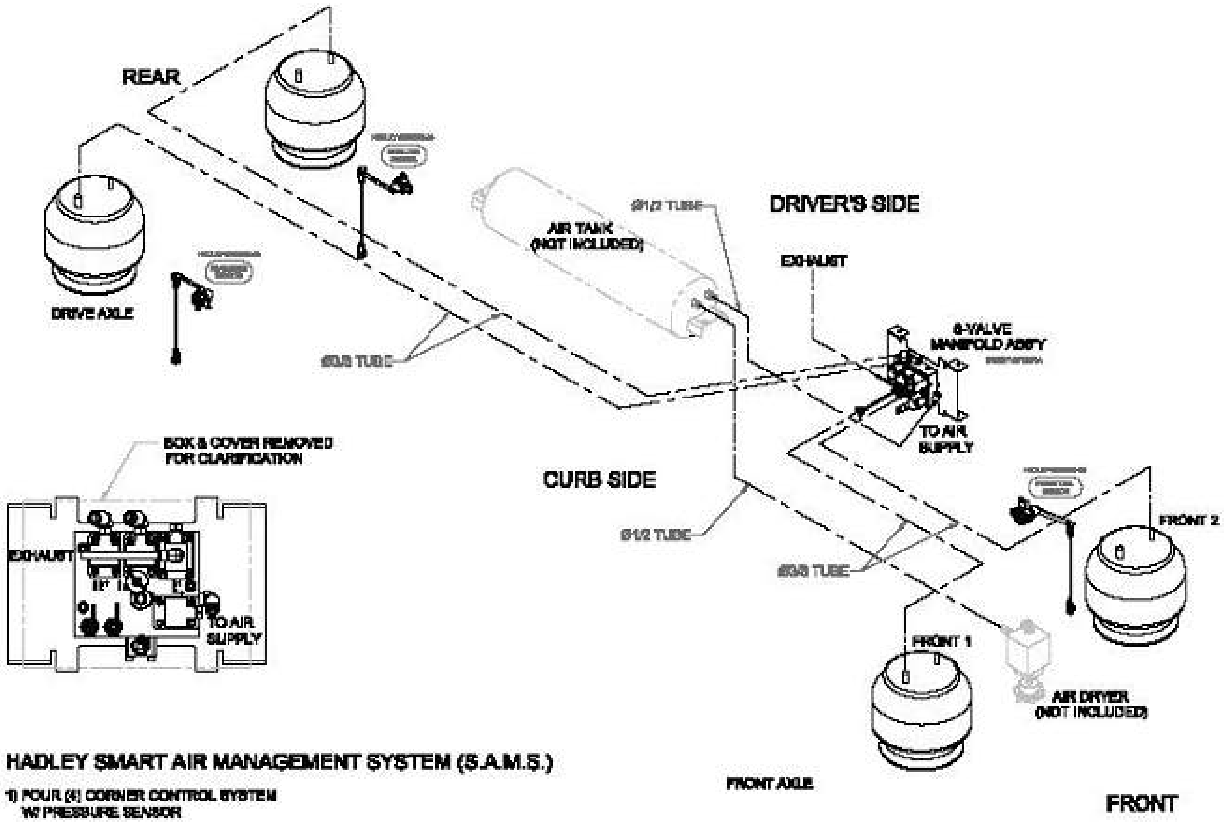


Figure 19

For more information, refer to the Hadley Smart Air Management System — Owner and Service Manual.

7. AIR SUSPENSION (FRONT)

Refer to Firestone Front "Air Suspension Evaluation Criteria" below.

Firestone AIRIDE® AIR SPRINGS

Air Spring Warranty Evaluation Criteria

Firestone air springs are designed to provide years and thousands of miles of trouble free service. The durability of Firestone air springs is such that they will often outlast other maintenance items on your suspension, such as bushings, shocks, leveling valves or regulators.

Airide® springs by Firestone are warranted to be free of material defects and/or workmanship for various periods of time, depending upon the application. Free replacements may be provided by the original manufacturer, manufacturer's representative or dealer, or by any Firestone air spring distributor. All labor and incidental costs associated with replacing the defective air spring are the responsibility of the purchaser, or end user.

Firestone Industrial Products Company offers a complete line of Airide springs, with replacement springs available for virtually every vehicular air suspension system.

Since each individual air spring is closely examined and pressure tested at the factory, the vast majority of premature failures and consequent warranty returns are found not to be defective, but fail because of abuse caused by other problems associated with the suspension.

Before you install a new air spring, you should carefully examine the old one to determine what caused it to fail. If it was due to a defect in the suspension system, then the new air spring will also fail unless you correct the problem.

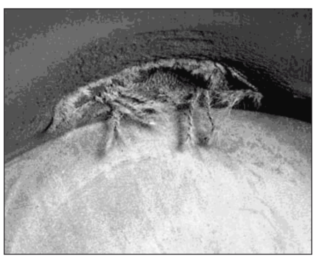
The information on the next two pages was developed to illustrate the types of failures that may occur, and to assist you in determining the cause and corrective action required.

Figure 20

Firestone AIRIDE® AIR SPRINGS

When applied and maintained properly, *Airide®* springs can provide thousands of miles of trouble-free service. Most failures are caused by a lack of suspension maintenance or improper application. This is a guide to common air spring failures that are *not* covered by warranty.

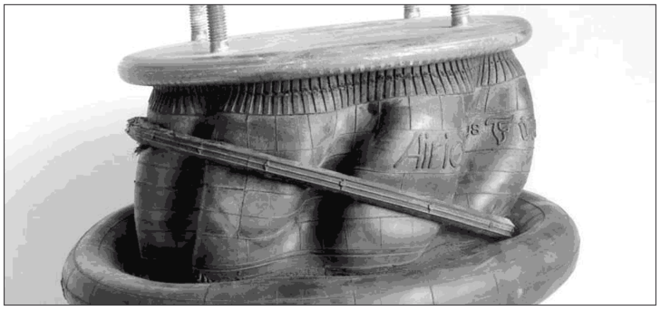
MISALIGNMENT



Appearance or Condition
- Off-center bumper contact
- Same as abrasion or bottoming out

Possible Causes
- Worn bushing
- Improper suspension installation

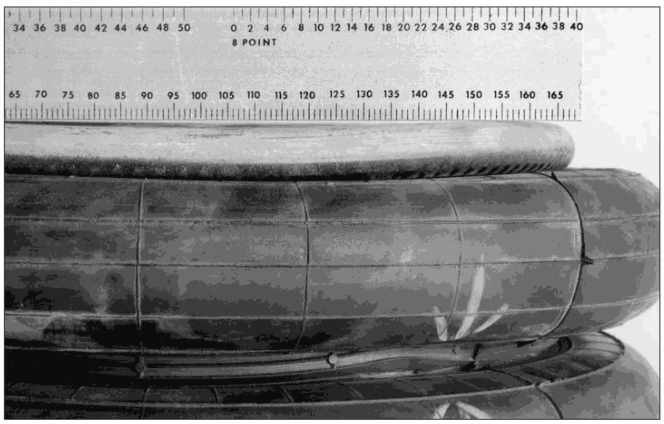
LOOSE GIRDLE HOOP



Appearance or Condition
- Rubber bellows distorted and girdle hoop torn loose

Possible Causes
- Running at extended positions with low air pressure

BOTTOMING OUT



Appearance or Condition
- Bead plate concave
- Internal bumper loose
- Hole in girdle hoop area (convoluted)
- Hole in bead plate junction area
- Leaking around blind nuts

Possible Causes
- Broken or defective shock absorber
- Defective leveling valve
- Overloaded vehicle
- Pressure regulator set too low
- Wrong air spring (too tall)

Figure 21

WARRANTY EVALUATION CRITERIA

ABRASION

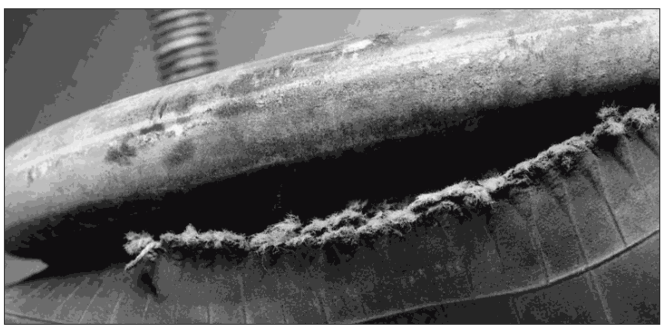
Appearance or Condition

- Hole rubbed into side of bellows
- Hole in bellows area that rolls over piston (reversible sleeve style)

Possible Causes

- Structural interference, such as:
  - -broken shock
  - -loose air line
  - -misalignment
  - -worn bushings
- No air pressure (reversible sleeve style)
- Foreign material (sand, rocks, etc.)
- Wrong air spring

CIRCUMFERENTIAL CUTS



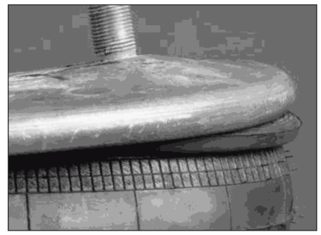
Appearance or Condition

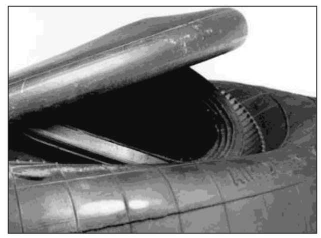
- Bellows cut in circle at bead plate junction
- Bellows cut in circle at piston junction (reversible sleeve style)

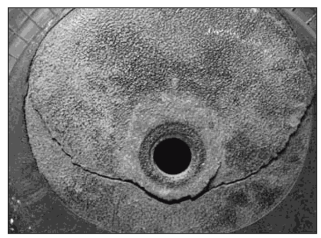
Possible Causes

- High pressure, fully extended for long periods of time
- Impact in compressed position

OVER EXTENSION







Appearance or Condition

- Bead plate convex, especially around blind nuts or studs
- Rubber bellows separated from bead plate
- Leaking at blind nuts or studs
- Leaking at end closure (reversible sleeve)
- Loose girdle hoop on con-voluted style

Possible Causes

- Broken or wrong shock absorber
- Defective leveling valve
- Ride position too high
- Defective upper stop (lift)
- Wrong air spring (too short)

Figure 22

PREVENTIVE MAINTENANCE CHECKLIST

Listed below are items that can be checked when the vehicle is in for periodic maintenance.

Never attempt to service the air suspension on a truck or trailer with the air springs inflated.

1 Inspect the O.D. of the airspring. Check for signs of irregular wear or heat cracking.

2 Inspect air lines to make sure contact doesn't exist between the air line and the O.D. of the air spring. Air lines can rub a hole in an air spring very quickly.

3 Check to see that there is sufficient clearance around the complete circumference of the air spring while at its maximum diameter.

4 Inspect the O.D. of the piston for buildup of foreign materials. (On a reversible sleeve style air spring, the piston is the bottom component of the air spring).

5 Correct ride height should be maintained. All vehicles with air springs have a specified ride height established by the O.E.M. manufacturer. This height, which is found in your service manual, should be maintained within 1/4". This dimension can be checked with the vehicle loaded or empty.

6 Leveling valves (or height control valves) play a large part in ensuring that the total air spring system works as required. Clean, inspect and replace, if necessary.

7 Make sure you have the proper shock absorbers and check for leaking hydraulic oil and worn or broken end connectors. If a broken shock is found, replace it immediately. The shock absorber will normally limit the rebound of an air spring and keep it from overextending.

8 Check the tightness of all mounting hardware (nuts and bolts). If loose, re-torque to the manufacturer's specifications. Do not over-tighten.

CLEANING

9 **APPROVED**

Approved cleaning media are soap and water, methyl alcohol, ethyl alcohol and isopropyl alcohol.

NON-APPROVED

Non-approved cleaning media include all organic solvents, open flames, abrasives and direct pressurized steam cleaning.

The total inspection process described on this page can be done in just a matter of minutes. If you find one of the above conditions exists, please take corrective action to ensure that it is fixed properly. It will save you both time and money.

Firestone
World's Number 1 Air Spring.
FIRESTONE INDUSTRIAL PRODUCTS COMPANY

Figure 23

8. AIR SUSPENSION (REAR)

Refer to Firestone Front "Air Suspension Evaluation Criteria" below.

Air Suspension Maintenance Vehicle Check-List

* Check air lines and fittings for leaks: rubbing on air spring.

* Check proper clearance around air spring when inflated. Generally, a minimum of 1-1/2" will allow for the increased diameter which occurs in heavy jounce.

* Periodically, check suspension for proper ride height. This dimension should be maintained +/- 1/4" to protect the springs and shocks from over-extension or frequent bottoming out of the suspension.

* When doing routine vehicle maintenance, block up the suspension and check for irregular wear or material build-up on the flexmember. Clean, if necessary, using a non-petroleum based cleaning solution.

* Check rolling lobe piston for material build-up. Hardened debris on the piston will shorten spring life and should be removed as part of your regular maintenance.

* Check shock absorbers for any signs of leaking hydraulic fluid, broken end connections, worn bushings or cylinders, and over extension.

* Periodically, check nuts and bolts for proper torque. See manufacturer's manual for specific recommendations.

* Check height control valve to see that it is functioning properly. Clean or replace, if necessary. A properly maintained valve will save hundreds of dollars in unneeded maintenance expense.

Routine inspection of all of the above, according to a pre-determined mileage maintenance schedule will extend the life of your vehicle and reduce your overall maintenance expense.

GOODYEAR
ENGINEERED PRODUCTS

Figure 24

9. HADLEY SMART AIR MANAGEMENT SYSTEM

9.1. DESCRIPTION

System Scope

The Hadley system is designed to maintain a predetermined vehicle ride height automatically and provides a means to temporarily lower or raise the ride height, when necessary. The system provides for side to side height control on respective axles containing two height sensors, as well as front to back control. A visual indication is also provided to determine mode selection and system malfunction detection.

System Definition

The Smart Air Management System (SAMS) contains three vehicle height sensors, a pneumatic manifold assembly, an electronic control unit (ECU), the necessary wire harnessing, an LED, two user supplied switches, and the necessary vehicle interface hardware to provide the defined modes of operation. One switch will serve as control power ON/OFF and the second for temporarily raising the vehicle to overcome an obstacle (lift-off). The location and mounting of these switches will be at the discretion of the integrator. The angle sensors will be mounted on the vehicle frame in a 3-point configuration: rear (2); front (1). 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 LED (light emitting diode). The LED will serve as a visual indication of the selected mode status and provide error code display. Functionally, the system will provide the following modes of operation; i.e., normal, front kneel, rear kneel, and lift-off. This information is further defined in the following sections.

Normal Mode

In order to enter this mode of operation, the Power ON/OFF switch needs to be “ON” while operating the vehicle. This mode of operation 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 three 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 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 three sections.

> ⚠ **WARNING – When towing, jacking, or raising the vehicle for service, the Power ON/OFF switch must be turned to the “OFF” position. This will prevent the SAMS system from operating and eliminating the potential for unexpected suspension movement.**

Front Kneel Mode

This mode of operation is automatically performed by the system ECU when the proper conditions have been satisfied. The ECU will automatically lower the front of the vehicle when the “passenger loading door” is opened, the power ON/OFF switch is turned “ON”, and the engine running. The ECU will lower the front of the vehicle in order to reduce the passenger step height for entering the vehicle and the LED will blink slowly as a visual indication the front kneel mode is active.

The front of the vehicle will lower until a preset pressure is reached. This pressure does not completely exhaust the air in the front airbags, which allows the system to more quickly raise the front of the vehicle, when returning to the normal mode of operation. The system automatically returns to the normal vehicle ride height when the “passenger loading door” is closed.

This mode of operation is automatically enabled by an active low signal (ground) being detected by the SAMS ECU on the system’s control wiring harness green wire (door open) and does not require any further interaction from the vehicle operator. This mode is automatically cancelled by the ECU and returns the system to normal ride height when an active low signal is detected on the system’s control wiring harness violet wire (door close) and does not require any further interaction from the vehicle operator.

Rear Kneel Mode

This mode of operation is automatically performed by the system ECU when the proper conditions have been satisfied. The ECU will automatically lower the rear of the vehicle when the “passenger loading door” is open (front kneel mode is active), the power ON/OFF switch is turned “ON”, the “ramp extend” switch is activated, and the engine running. The ECU will then lower the rear of the vehicle to allow wheel chair access to the vehicle and the LED will blink slowly as a visual indication the rear kneel mode is active.

This mode of operation will lower the rear of the vehicle to a pre-determined position. This position does not completely exhaust the air in the rear airbags, which allows the system to more quickly raise the rear of the vehicle, when the “ramp retract” switch is activated. The system ECU automatically returns the rear of the vehicle to the normal vehicle ride height as the operator is retracting the vehicle ramp.

This mode of operation is automatically enabled by an active low (ground) signal being detected by the SAMS ECU on the system’s control wiring harness **green wire** (door open) and **yellow wire** (ramp extend) and does not require any further interaction from the vehicle operator. This mode is automatically cancelled by the ECU and returns the rear of the vehicle to the normal ride height when an active low signal is detected on the system’s control wiring harness **blue wire** (ramp retract) and does not require any further interaction from the vehicle operator.

Lift–Off Mode

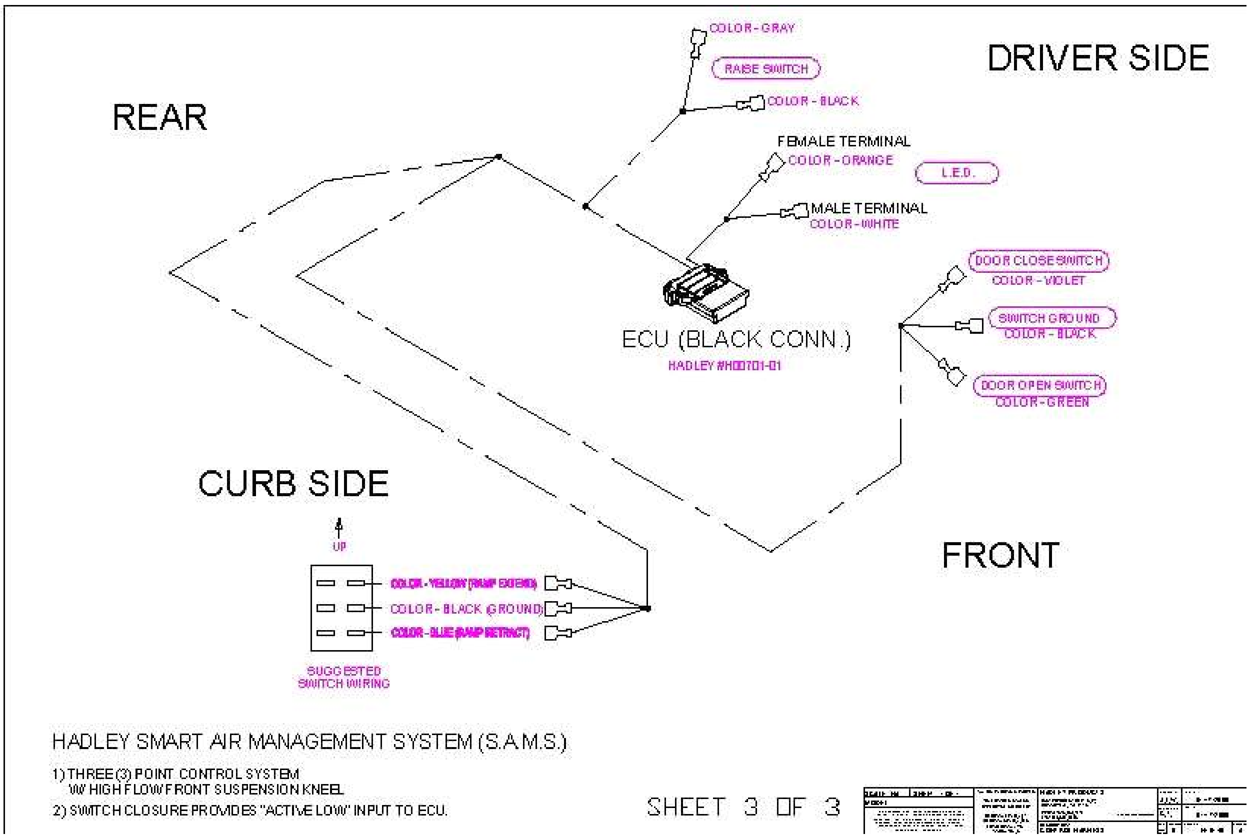
This mode of operation is used for “temporarily” increasing the normal vehicle ride height. The mode of operation is not automatic and must be selected by the operator of the vehicle. This mode of operation is manually activated by actuating the user supplied “lift-off” switch, with the power ON/OFF switch turned “ON,” and the engine running. Once activated, the LED will blink slowly as a visual indication the lift-off mode is active.

The vehicle by design has a low profile for easier accessibility. By activating this mode of operation, the vehicle ride height will be increased “temporarily” to provide additional ground clearance. This will increase the normal ride height by approximately 1.5 to 2 inches and the system will stay at this position for approximately 30 seconds. This time should allow the vehicle operator sufficient time to clear the desired obstacle. After this time period has elapsed, the system ECU will automatically return the vehicle to the normal ride height. If additional time is required, the operator will need to re-initiate the mode. Additionally, the vehicle operator could hold the “lift-off” mode switch in the activated position. This would extend the temporary raised position time, thereby keeping the vehicle raised to the preset ground clearance height for additional time intervals.

Activating the “lift-off” switch applies an active low (ground) signal to the gray wire of the system control wiring harness. This active low signal will cause the ECU to override the normal ride height and **temporarily** raises the vehicle the predefined distance. The system will remain in this mode of operation for the preset time interval and then will automatically return the vehicle to the normal ride height and does not require any further interaction from the vehicle operator.

NOTE – In order to assist with loading the vehicle for transport shipping, the "lift-off" mode may be utilized. After activating the mode and loading the vehicle onto the transport, immediately turn the ON/OFF switch to the "OFF" position. This will allow the system to remain in this mode while transporting the vehicle to provide additional clearance beneath the vehicle.

NOTE – The below schematic illustrates the control harness wiring as defined in the previous associated sections for mode operation. This harness is necessary to integrate the vehicle hardware signals with the SAMS ECU.



Visual Indicator (LED)

As explained in earlier sections of this document, if either the front kneel mode, rear kneel mode, or lift-off mode of operation is selected, the system supplied LED will flash. This section further clarifies the visual rate of the blink and the associated system mode of operation or interpreted function.

- Short blink – long pause: either the front kneel mode, lower kneel mode, or lift-off mode has been selected
- No blink (LED off): the vehicle is operating at the normal mode and is at normal ride height
- Blinking not defined above: the ECU has detected a problem and is blinking an error code

NOTE – The following section provides more information regarding the 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 system supplied LED in such a manner as to represent a two-digit code. The first number of the two-digit 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 the two-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 LED. A list of potential error codes and their probable cause are as follows:

- 11 (eleven) – Rear Driver Height Sensor
- 12 (twelve) – Rear Curb Height Sensor
- 13 (thirteen) – Front Axle Height Sensor
- 14 (fourteen) – System Pressure Error
- 21 (twenty-one) – Door Open Switch and Door Close Switch are Both Activated
- 22 (twenty-two) – Ramp Extend Switch and Ramp Retract Switch are Both Activated
- 23 (twenty-three) – Lift Mode Switch and Ramp Extend Switch are Both Activated
- 24 (twenty-four) – Lift Mode Switch and Door Open Switch are Both Activated
- 31 (thirty-one) – Door Closed Switch and Ramp Extend Switch are Both Activated
- 32 (thirty-two) – Door Open Switch and Ramp Retract Switch are Both Activated

NOTE – Each time the engine is started, the LED will be illuminated for approximately 15 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 LED. This is a normal "power-up" function and should not be confused with a system problem.

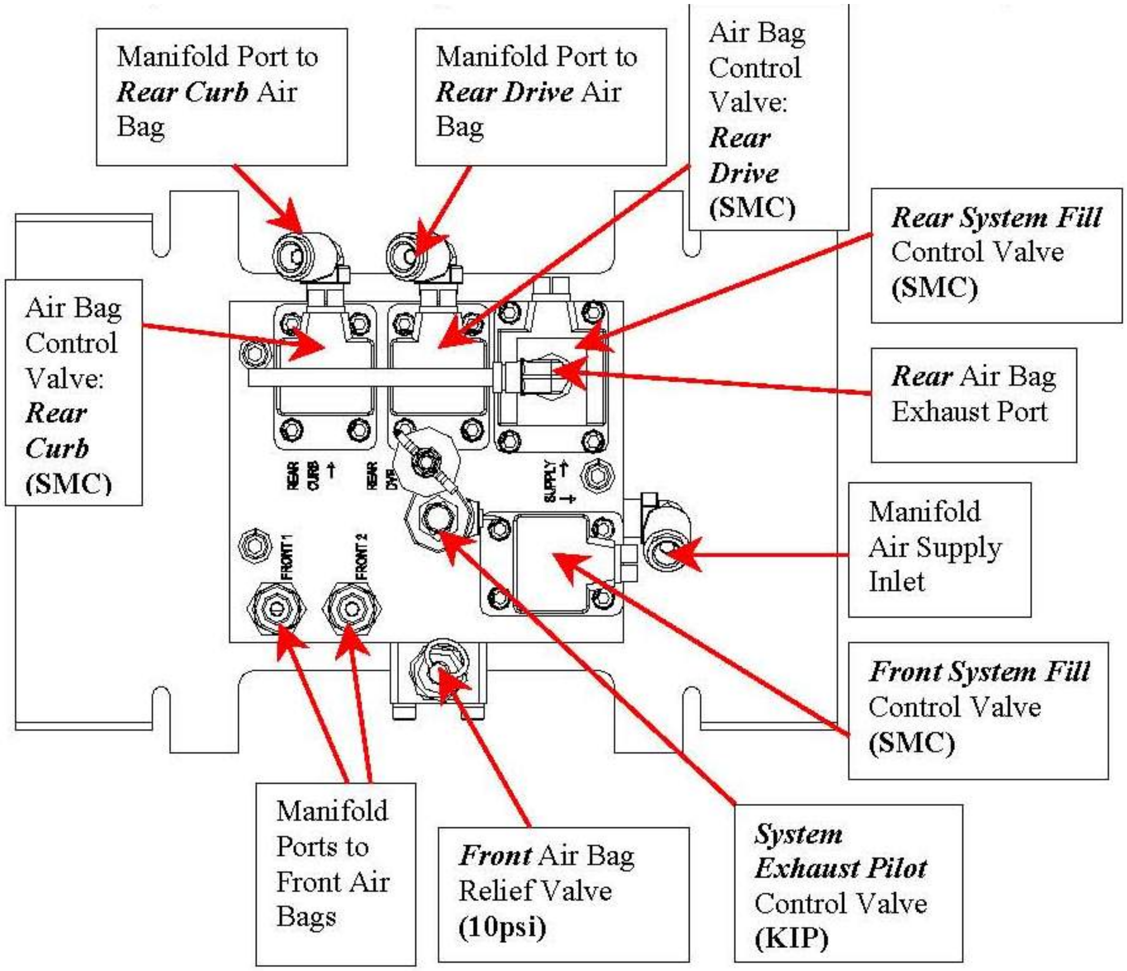
9.2. SAMS MANIFOLD AND VALVES

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

Theory of Operation

The manifold is an electro-pneumatic device used to control the air flow within the SAMS system. The number of valves used is dependant upon system requirements. The valves typically provide two-position control and are of a coil actuated design. The Smart Air Management System requires two valves for air bag control. 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 below illustration identifies the individual components used on the SAMS manifold assembly.



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 the system operating requirements. The ECU receives signals from the system components, i.e. height sensors, operator control switches, and the respective vehicle hardware components (switches) to establish the mode of operation and to provide the desired system control and sustain the desired vehicle ride height.

With no power applied to the manifold “control” valve coils, they are in a de-energized condition. This allows an internal spring to decompress (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.

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.

NOTE – The ports of the manifold contain a mesh screen to help prevent air contaminants from entering the manifold. However, it is possible for the screen to become damaged and allow contaminants 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.

Symptom Summary

The following symptoms summarize how system performance can be affected by contaminants entering the manifold.

Symptom 1: Should the **front system fill control valve** plunger become contaminated or the plunger stick “open”, it is possible for air to leak past the plunger and continuously fill the front air bags. This would cause the front 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 front of the vehicle.

Symptom 2: Should the **system exhaust pilot control valve** become contaminated or the plunger stick “open”, it is possible for air to leak past the plunger and continuously exhaust the front air bags. This would cause the front of the vehicle to continuously creep “downwards” and result in the SAMS system constantly making corrections to raise the front 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 front of the vehicle would sag.***

Symptom 3: Should the front **rear system fill control valve plunger AND the rear drive air bag control valve** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously fill the air bag on the rear drive side of the vehicle. This would cause the rear drive side of the vehicle to continuously creep “upwards” while the vehicle is in operation, and result in the SAMS system constantly making corrections to lower this corner of the vehicle.

Symptom 4: Should the front **rear system fill control valve plunger AND the rear curb air bag control valve** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously fill the air bag on the rear curb side of the vehicle. This would cause the rear curb side of the vehicle to continuously creep “upwards” while the vehicle is in operation, and result in the SAMS system constantly making corrections to lower this corner of the vehicle.

Symptom 5: Should the front **rear system fill control valve plunger AND BOTH rear air bag control valves** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously fill the air bags on the rear curb side and the rear drive side of the vehicle. This would cause the rear curb side and the rear drive side 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 rear of the vehicle.

Symptom 6: Should the **system exhaust pilot control valve AND the rear drive air bag control valve** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously exhaust the front air bags and the rear drive air bag. This would cause the front of the vehicle and the rear drive of the vehicle to continuously creep “downwards” and result in the SAMS system constantly making corrections to raise the front and rear drive side 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 front of the vehicle AND the rear drive of the vehicle would sag.***

Symptom 7: Should the **system exhaust pilot control valve AND the rear curb air bag control valve** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously exhaust the front air bags and the rear curb air bag. This would cause the front of the vehicle and the rear curb of the vehicle to continuously creep “downwards” and result in the SAMS system constantly making corrections to raise the front and rear curb side 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 front of the vehicle AND the rear curb of the vehicle would sag.***

Symptom 8: Should the **system exhaust pilot control valve AND BOTH REAR air bag control valves** become contaminated or the plungers stick “open”, it is possible for air to leak past the plungers and continuously exhaust the front air bags and the rear air bags. This would cause the front and rear of the vehicle to continuously creep “downwards” and result in the SAMS system constantly making corrections to raise the front and rear 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 entire vehicle would sag.***

NOTE – External leaks, such as loose air fittings, defective air bags, or leaks in the tubing 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, and glycerin mix onto the external system components. If an air leak is present, air bubbles will be created in the applied solution.

If any of these conditions are 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.

Pneumatic Operation

The System Definition section of this document defines this SAMS system as a 3-point system. This definition can be summarized through the utilization of three height sensors for monitoring the vehicle ride height: one in the front and two in the rear. The configuration in this manner requires both front air bags to work together simultaneously to either raise or lower the entire front of the vehicle, while the rear air bags have the ability to work separately from of one another, thereby controlling the rear corners of the vehicle independently. To provide the 3-point system control the manifold has been designed to provide unique pneumatic control as outlined in the following sections.

Pneumatic Control – Front

When it becomes necessary to raise the front of the vehicle, the ECU will energize the front system fill control valve by applying 12VDC to the respective coil (refer to the illustration at the beginning of this section for reference). 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” passage within the manifold. This will allow system air to flow from the manifold air supply inlet, through the manifold, and out through ports front1 and front2, through the associated tubing and into the front air bags, thereby raising the front of the vehicle. When the desired position has been reached, the ECU will remove power from the valve coil, the internal spring will decompress (expand), and the plunger will seal off the associated manifold port. This sealing action will sustain the desired front ride height until system adjustment becomes necessary.

When it becomes necessary lower the front of the vehicle, the ECU will energize the system exhaust pilot control valve by applying 12VDC to the respective coil (refer to the illustration at the beginning of this section for reference). The same magnetic principles and mechanical factors apply, thereby the plunger moves to open the respective “exhaust” passage in the manifold. This passage, when opened, allows air to flow from the front air bags, to ports front 1 and front 2, through the manifold, to the front air bag quick exhaust port of the manifold. Threaded into this port of the manifold is a pressure relief valve, with a spring tension of 10 psi. The pressure within the air bags (typically 95 – 130 psi) is stronger than the mechanical spring tension and causes the internal mechanism to unseat. This will allow the pressure to exhaust through the relief valve until the front air pressure equalizes with the spring tension. At that point, the spring tension will be strong enough to allow the internal mechanism of the relief valve to seat. This type of design allows the front air bags to exhaust quickly and to a predetermined air pressure, thereby keeping the air bags preloaded for re-inflation.

Pneumatic Control – Rear

The raising or lowering of the front of the vehicle requires the ECU to simply energize the coil of the respective valve to fill (inflate) or exhaust the front air bags, thereby providing a single point of control. However, raising or lowering the rear of the vehicle requires more sophisticated system control. The system must provide independent operation of the rear air bags to provide dual-point control. The accumulated front and rear system control of this nature provides 3-points of control, referred to in this document as a 3-point system.

NOTE – To better understand the sequence of events necessary to raise the rear of the vehicle, this discussion will focus on each side of the vehicle independently. Refer to the illustration at the beginning of this section for reference.

When it becomes necessary to **raise the rear drive** side of the vehicle, a two-valve operation sequence is required. The ECU will energize the **rear system fill control valve and the rear drive air bag control valve** by applying 12VDC to the respective coils. With 12VDC applied to the coils, current flows through the windings and creates respective electro-magnetic fields. These magnetic fields are stronger than the existing spring pressures that hold the valve plungers against their valve seats within the manifold. The strength of the magnetic fields will cause the plungers to move inside the body of the valve assemblies, compressing the springs, and open the respective passages within the manifold. This will allow system air to flow from the manifold air supply inlet, through the manifold, and out through the rear drive manifold port, through the associated tubing and into the rear drive air bag, thereby raising the rear drive of the vehicle. When the desired position has been reached, the ECU will remove power from the valve coils, the internal springs will decompress (expand), and the plungers will seal off the associated manifold port. This sealing action will sustain the desired rear drive ride height until system adjustment becomes necessary.

When it becomes necessary to **raise the rear curb** side of the vehicle, a two-valve operation sequence is required. The ECU will energize the **rear system fill control valve and the rear curb air bag control valve** by applying 12VDC to the respective coils. With 12VDC applied to the coils, current flows through the windings and creates respective electro-magnetic fields. These magnetic fields are stronger than the existing spring pressures that hold the valve plungers against their valve seats within the manifold. The strength of the magnetic fields will cause the plungers to move inside the body of the valve assemblies, compressing the springs, and open the respective passages within the manifold. This will allow system air to flow from the manifold air supply inlet, through the manifold, and out through the rear curb manifold port, through the associated tubing and into the rear curb air bag, thereby raising the rear curb of the vehicle. When the desired position has been reached, the ECU will remove power from the valve coils, the internal springs will decompress (expand), and the plungers will seal off the associated manifold port. This sealing action will sustain the desired rear curb ride height until system adjustment becomes necessary.

NOTE – To better understand the sequence of events necessary to lower the rear of the vehicle, this discussion will focus on each side of the vehicle independently. Refer to the illustration at the beginning of this section for reference.

When it becomes necessary to **lower the rear drive** side of the vehicle, a two-valve operation sequence is required. The ECU will energize the **system exhaust pilot control valve and the rear drive air bag control valve** by applying 12VDC to the respective coils. The same magnetic principles and mechanical factors apply, thereby the plungers move to open their respective passages within the manifold. This will allow air to flow from the rear drive side air bag, through the associated tubing, into the rear drive air bag manifold port, and out the rear air bag exhaust port, thereby lowering the rear drive of the vehicle.

When the desired position has been reached, the ECU will remove power from the valve coils, the internal springs will decompress (expand), and the plungers will seal off the associated manifold port. This sealing action will sustain the desired rear drive ride height until system adjustment becomes necessary.

When it becomes necessary to **lower the rear curb** side of the vehicle, a two-valve operation sequence is required. The ECU will energize the **system exhaust pilot control valve and the rear curb air bag control valve** by applying 12VDC to the respective coils. The same magnetic principles and mechanical factors apply, thereby the plungers move to open their respective passages within the manifold. This will allow air to flow from the rear curb side air bag, through the associated tubing, into the rear curb air bag manifold port, and out the rear air bag exhaust port, thereby lowering the rear curb of the vehicle. When the desired position has been reached, the ECU will remove power from the valve coils, the internal springs will decompress (expand), and the plungers will seal off the associated manifold port. This sealing action will sustain the desired rear curb ride height until system adjustment becomes necessary.

Valve Servicing

The “control” valves (SMC) 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 and ground wire (if applicable) from the harness connector.
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 re-install, slide the coil over the valve body and re-install the clip.
7. Install and crimp new pins on the coil wires.
8. Re-install the wires in the harness connectors and reconnect the harness connectors.

WARNING – System operating pressures are typically 95-130 psi. Steps should be taken to relieve pressure from the system prior to removing any valve assembly from the manifold.

The system exhaust pilot control valve (KIP) is threaded into its respective manifold location. Care must be taken when removing the valve so as not to lose the O-ring that is installed in the body of the manifold or the spring loaded plunger located inside the valve assembly. The O-ring creates a positive seal between the valve assembly tapered surface and the body of the manifold, thereby preventing air leakage around the threaded portion of the valve body.

The valve body and coil assembly are assembled as a single unit. If the coil is ever found to be defective, then the replacement of the entire valve assembly will be required.

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 one lead in the wiring harness connector of the coil to be tested. Next, connect the black lead of the multimeter to the other 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 on the four manifold “control” valves (SMC). The display on the multimeter should read approximately 15 to 18 ohms of resistance on the system exhaust pilot control valve (KIP). 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.

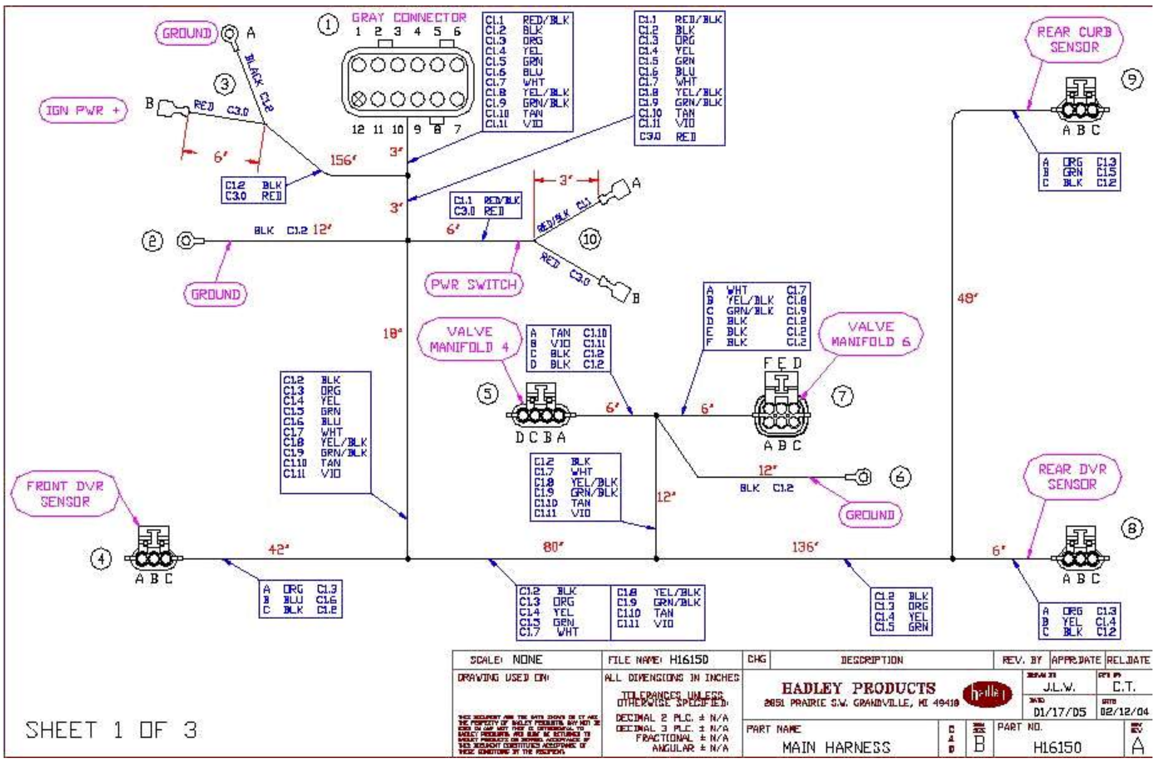
NOTE – Prior to disconnecting the manifold wiring harness to perform the continuity check, be sure power has been completely removed from the SAMS system. This is done by turning the power ON/OFF switch to the “OFF” position and turning the ignition to the “OFF” position. This prevents the SAMS system from operating when the engine is not running. The control valves (SMC) typically require 1.2Amps of current and the KIP valve requires 0.6Amps of current, either of which could drain a battery if energized with the engine “OFF” and the charging system not in operation.

The SAMS system requires 12VDC for proper system operation. The ECU uses the 12VDC supplied by a 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 various 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. Depending upon system requirements the ground may also be provided via the ECU or a separate wiring harness ground wire may be used.

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 ground is present. Refer to the SAMS wiring diagram to determine the power and ground wires associated with the respective system.

NOTE – The vehicle system DC voltage is polarity sensitive. Therefore the digital multimeter red lead needs to be connected to positive (system power: 12VDC) and the black lead connected to negative (system ground). However, the coils used on the SAMS manifold valves are not polarity sensitive.

The below schematic illustrates the SAMS power connections, manifold coil connections, and the connections for the height sensors for the 3-point system control.



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 (see Appendix A and B respectively for additional information). 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.

9.3. 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

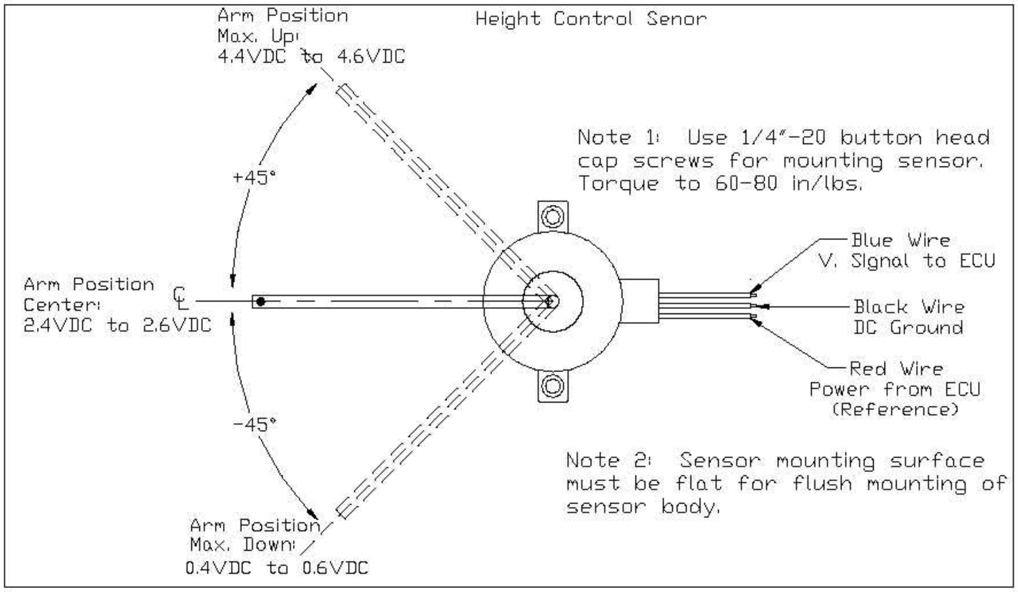
The height sensor is used by the system ECU (electronic control unit) to monitor and control the vehicle ride height. The sensor arm moves in reaction to the suspension movement and provides a voltage signal that is proportional to the ride height at any given time. Typically, while the vehicle is in operation, the ECU will default to and maintain a programmed ride height. The system design requires a three sensor configuration: one front sensor and two rear sensors to provide the 3-point control.

The sensor contains three wires (red, black, blue) that interface with the system ECU through the supplied main wiring harness. 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 +45 degrees of rotation from the center position. At the +45 degrees 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 -45 degrees of rotation from the center position. At the -45 degrees of rotation, the voltage on the sensor's blue wire would be approximately 0.4VDC to 0.6VDC. 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 90 degrees of movement. In other words, from the center position, a change in the ride height of +45 degrees to -45 degrees 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 and 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 be 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 system vehicle wiring harness center wire configuration is as follows:

Wiring harness blue wire = front sensor connector
Wiring harness yellow wire = rear drive sensor connector
Wiring harness green wire = rear curb 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 system supplied LED. 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 main 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 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 +45 degrees of rotation from center is reached. At the +45 degrees of rotation, the voltage should read approximately 4.4VDC to 4.6VDC. If rotation continues above 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 -45 degrees of rotation from center is reached. At the -45 degrees of rotation, the voltage should read approximately 0.4VDC to 0.6VDC. If rotation continues below 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.

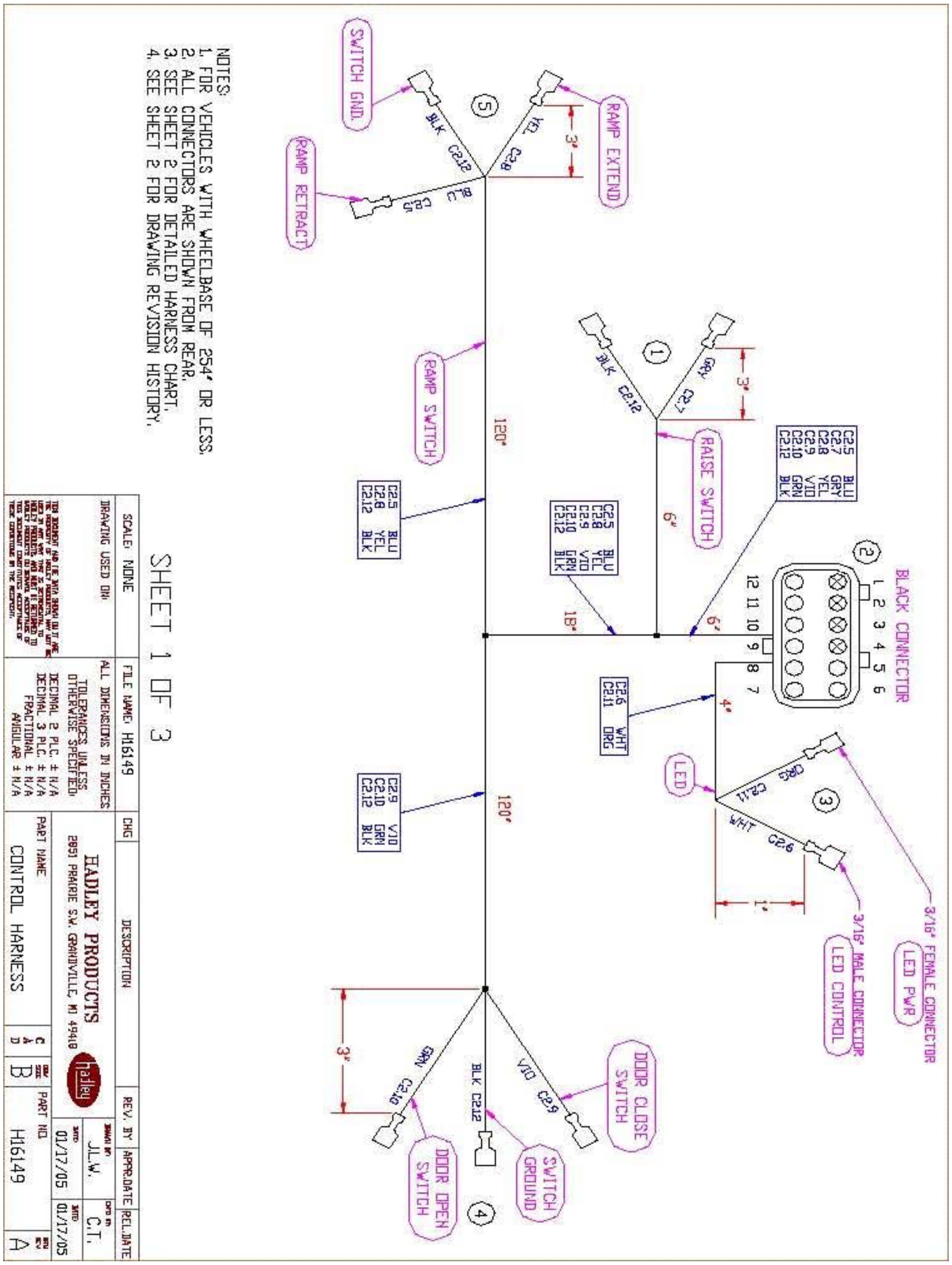
NOTE – When replacing the sensor (or upon re-installation in the event of a satisfactory test), be sure to adhere to the installation instructions mentioned earlier in this document. Proper installation is necessary to prevent damaging the sensor. Proper sensor operation is necessary to provide accurate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

Summary

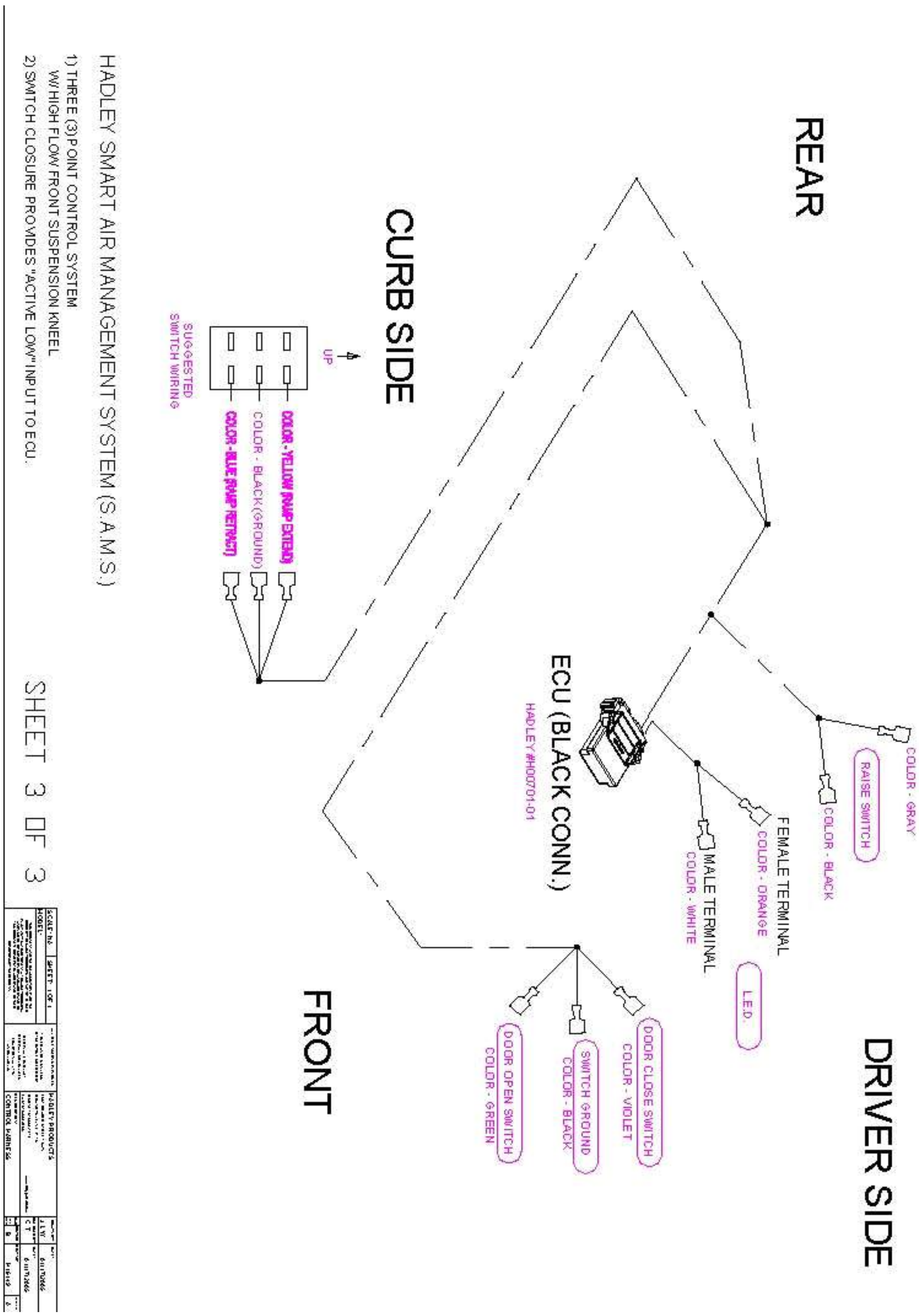
This completes the basic installation, operation, and troubleshooting information on the height control sensor. All information contained in this document is of equal importance and should not be ignored. Time spent by installation and service personnel to better understand component operation will ensure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

9.4. HARNESS SCHEMATICS

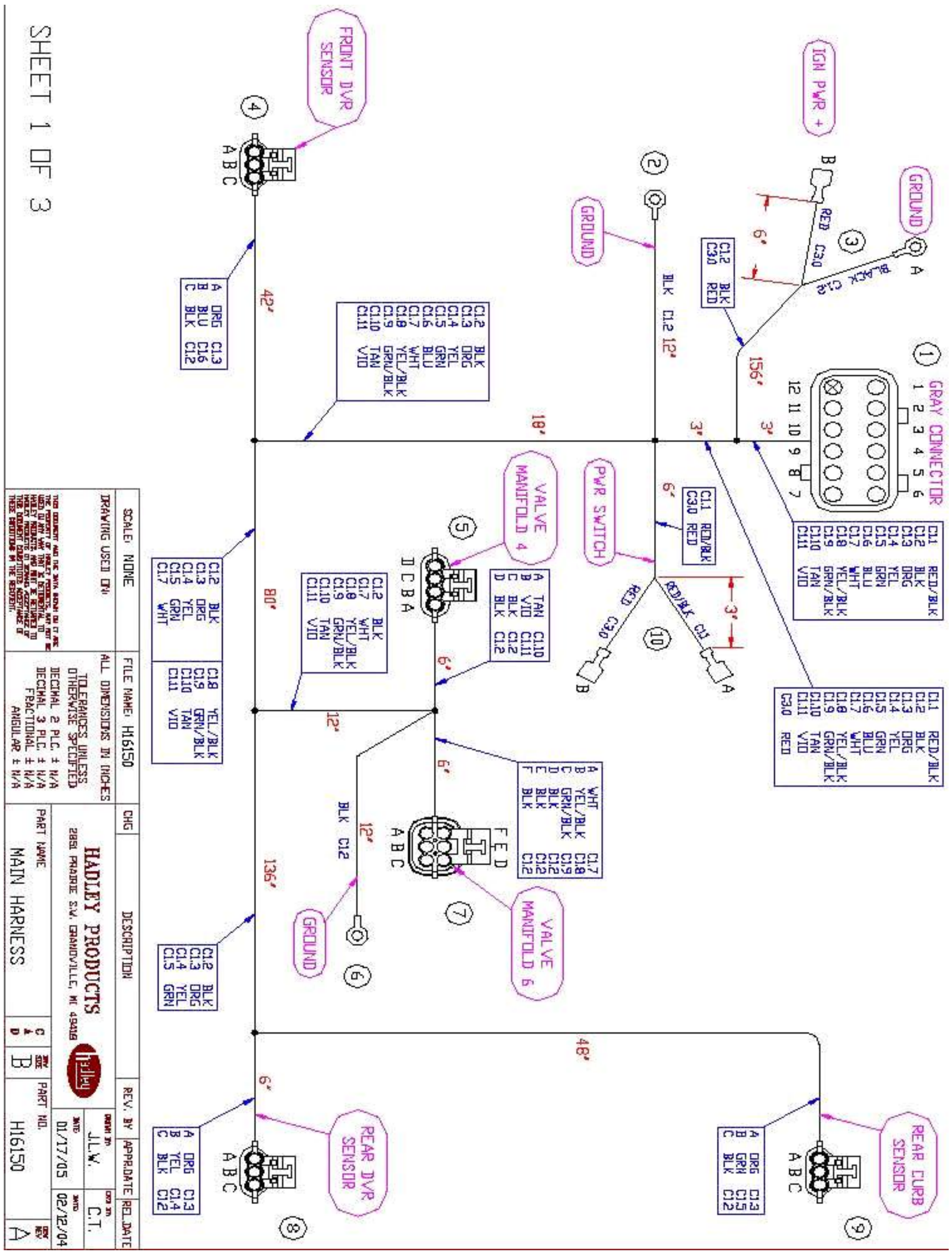
SAMS Control Harness Schematic



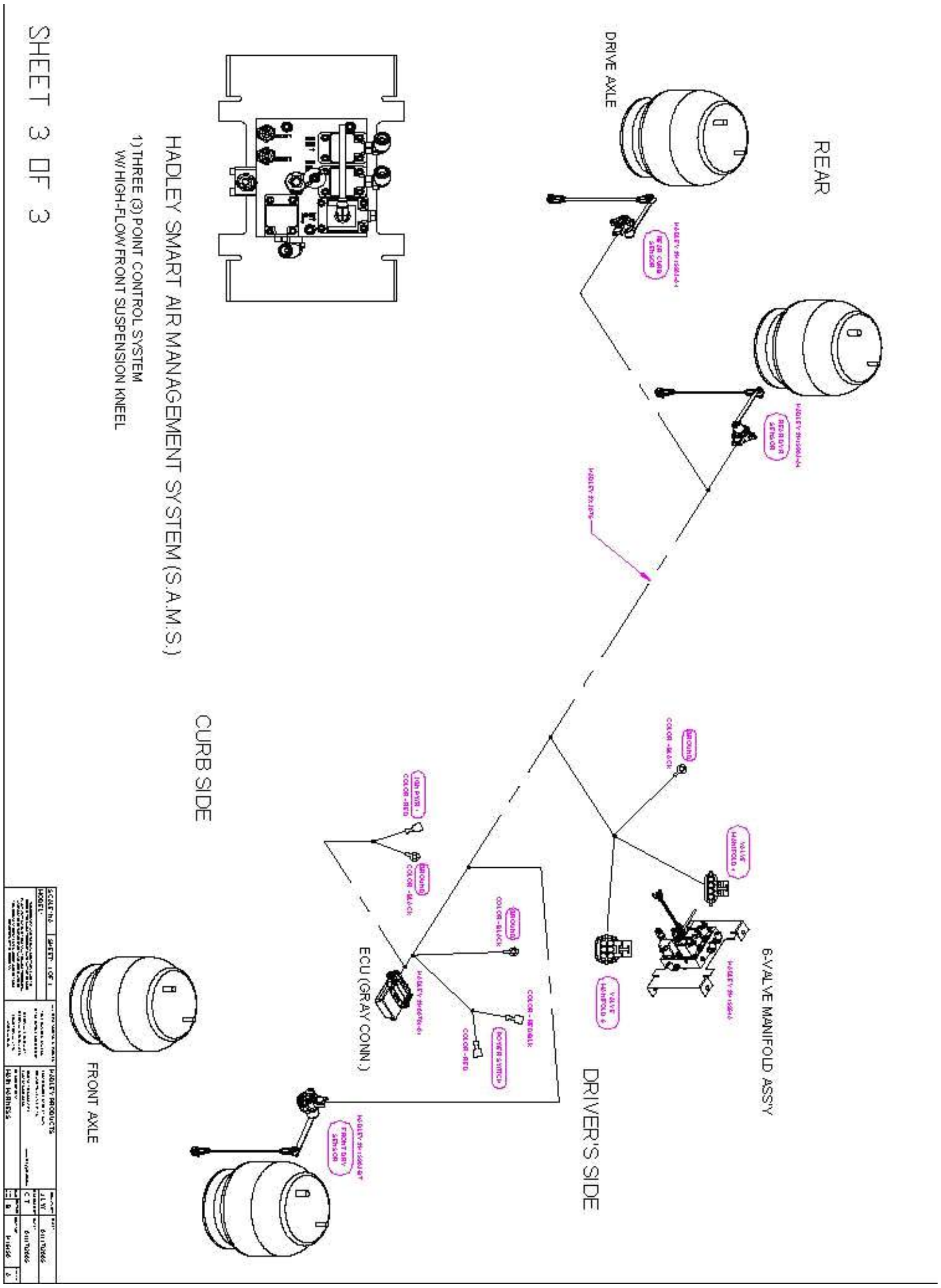
SAMS Control Harness Layout



SAMS Main Harness Schematic



SAMS Main Harness Layout



9.5. 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 main harness connector and its associated sensor connection:

    - **Blue Wire** = Front Sensor Connector
    - **Yellow Wire** = Rear Drive Sensor Connector
    - **Green Wire** = Rear Curb 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 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.

9.6. APPENDIX B — SAMS PNEUMATIC INSTALLATION PRECAUTIONS

1. Be sure the air supply provides sufficient pressure to allow for proper system operation, typically 95 – 130 psi. 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 Rear DVR (Drive) = Rear Driver Air Bag

   C. Manifold Rear Curb = Rear Curb Air Bag

   D. Manifold Front1 and Front2 = Front Air Bags

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. Allow sufficient bend radii, where applicable, to prevent sharp bends and kinks in the tubing. The tubing manufacturer recommends a minimum bend radius of 1-1/4” 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.

    NOTE – 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). 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.

    NOTE – 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.

9.7. APPENDIX C — SAMS HEIGHT SENSOR ARM AND 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.

Table 5 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"

Table 5 Height Sensor Arm Selection Table (cont.)

Jounce or Rebound Maximum Suspension Travel	Actual Lever Length Needed
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

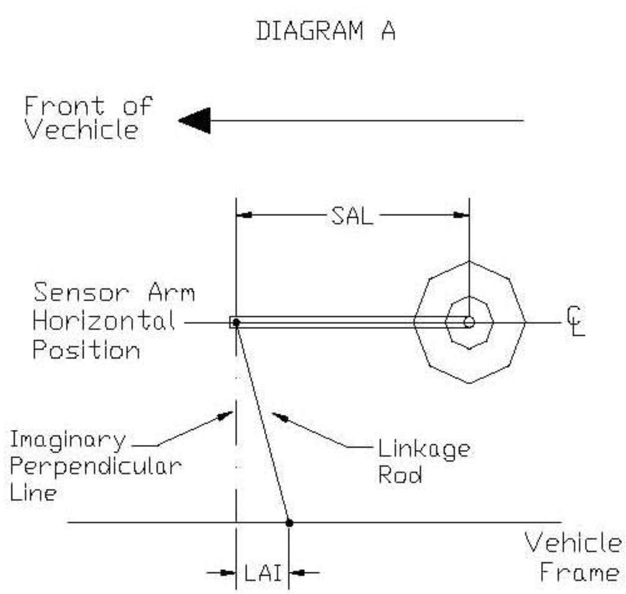


TABLE A

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 system supplied LED will flash. The flashing LED 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.