Mirrors

Exterior Mirrors

Two remote controlled and heated mirrors (flat portion) are provided. The convex portion of the mirrors are manually adjusted. The controls for the mirrors are located in the driver's area.

Interior Mirrors

4 x 8 compound convex mirror, located on left-hand windshield pillar.

Entrance Door Electric Lock

The entrance door electric lock is operated by the remote that controls entry door lock.

Entrance Door Air Lock

An air-operated lock is installed at the top of the entrance door. The lock engages automatically when the coach reaches 3 mph and disengages when coach is slowed below 3 mph. Stainless steel assist handrails are provided at the entrance door area. Stepwell lights are provided to illuminate the stepwell area. Thermopane entrance door window with tinted gray glass 72% light transmissibility.

Entry Door Operation

Door Open

By momentarily depressing the upper half of door switch, upper door lock disengages from door and door open/close cylinder extends, pushing door to full open position. Switch does not need to be held to open door.

Door Close

By momentarily depressing lower half of door switch, door open/close cylinder retracts, pulling door to full closed position. Once door is closed, upper door lock extends into pocket at top of door.

NOTE: Switch does not need to be held to close door.

Driving

Once coach has reached 3 mph road speed, door operation circuit is disabled, maintaining door in closed position, regardless of whether door switch is actuated.

After dropping below 3 mph, door will resume normal operation.

Emergency Release

In the event that the door will not operate using the dash-mounted switch, an emergency release valve is located on top of the dash forward of the entry door. Depressing the knob will cause all air pressure to be exhausted from the door lock cylinder and the door open/close cylinder, allowing the door to be opened manually. Constant pressure against the door will be necessary to hold the door open to overcome the internal speed restrictors. To resume normal door operation, pull knob up to re-pressurize cylinders.

CAUTION! Stand clear of door when re-pressurizing.

Six-Way Power Seats and Seat Belts

Driver's Seat

The Express 4500 is equipped with a fully-adjustable Recaro Metro Seat. The driver's seat belt is an integral part of the seat assembly. Refer to Recaro documentation for full features, care, and operation information.

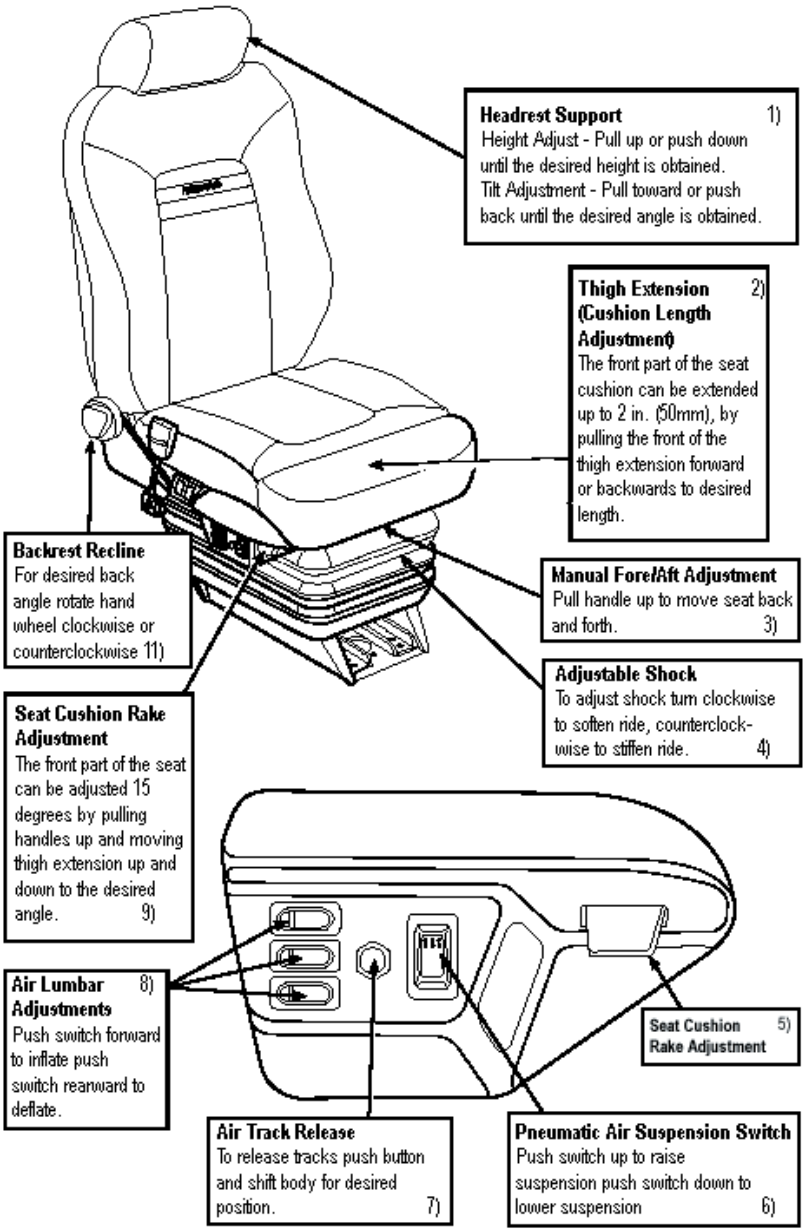
WARNING!! The driver's seat belt should be worn whenever the vehicle is being driven. Remember that the safety of all passengers is directly dependent upon the safety of the driver.

The seat should be adjusted appropriately for the individual operator. Adjustments should be made not only for comfort, but for optimum visibility and full access to bus controls. Control buttons for seat height and tilt, back tilt, and lumbar support are provided on a convenient control panel on the right side of the Recaro seat. These adjustments are air-actuated. Thus, the auxiliary tanks of the bus's air system must be pressurized in order for these seat controls to operate.

Other controls on the seat are mechanical, and therefore require no air pressure for operation. Individual controls for left and right armrest height are adjusted by knobs under the front end of each armrest. Fore and aft adjustment of the seat is also mechanical, and is accomplished by lifting the lock lever at the front underside of the seat cushion. For more information, refer to the Recarro documentation provided with your unit.

WARNING!! To avoid accidental momentary loss of control, do not attempt to adjust a driver's seat while the vehicle is in motion. If the engine is running, be sure the parking brake is on before adjusting seat height.

Seat Operation



Audible Outputs: Tl ounds listed in the table above. These s

Click: The click outp rn signal indicator is turned on, the Buzze

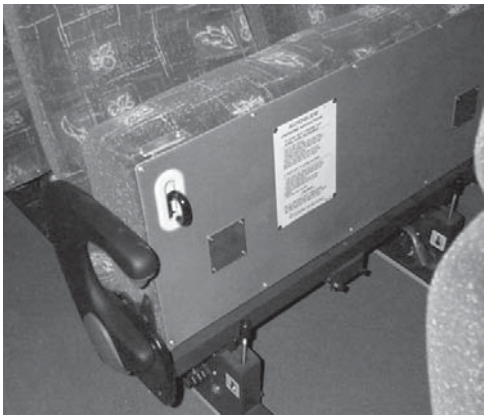
Single Chime: The s age Center will output 1.0 kHz for 1(ion is first activated, with a minimum sour

Double Chime: The iest. The Message Center will output 1.0 kHz for 1000 ms (including 800ms of decay), then output 1.0 kHz for 1000 ms (including 800 ms of decay) when the Wheel Chair Next Stop Request function is first activated, with a minimum sound pressure level of 85dB at 10cm.

Buzzer: The buzzer output is the primary audible output. The Message Center output 3.6 kHz +/- 0.5 kHz for as long as a buzzer function is activated, with a minimum sound pressure level of 90 dB at 10cm with 12 Volts applied.

Passenger Seats

The Passenger seats in the Express 4500 are American Model 2006 High Back Reclining Seats. These seats are built to provide positioning and convenience features for passenger comfort. The seats are mounted on floor and side panel channels which run the length of the bus. This allows some measure of customization of seat arrangements and spacing. However, any such alteration should be performed only by qualified service technicians and in full accordance with any regulations governing seat spacing. Also, if the seat spacing is altered, open sections of the floor tracks must be covered with seat track inserts, available from your Blue Bird parts distributor.

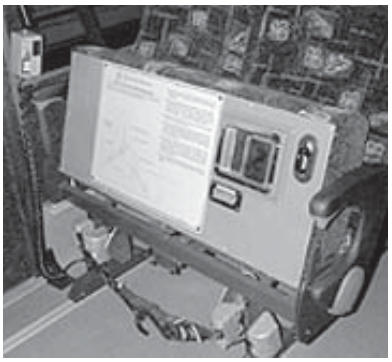


Slide Guide Seats

Some of the passenger seats located in proximity to the wheelchair lift door are equipped with flip-up cushions to provide access to the wheelchair constraint system. To lift the seat cushion, grasp the release handle mounted under the aisle-side seat and pull it forward to release the latch. Be sure the seat cushion locks securely in the upright position.

Wheelchair restraint instructions are mounted on the underside of the Flip Seat located immediately to the rear of the wheelchair lift door.

Basically two seats slide forward and the other flips up allowing enough room for securing the wheelchair.



Seat Maintenance

Regular seat inspection and maintenance is an important part of the operation regimen for vehicles used for passenger transport. At least every 90 days, inspect and retighten all bolts, and inspect upholstery for cuts and tears. Repair or replace as needed. Express 4500 seats are equipped with a special foam back pad. If the pad becomes damaged, it should be replaced with an approved replacement part. Any aftermarket replacements should be checked for compliance with Federal standards.

Seat Cleaning

Regular cleaning and care will prolong the life of the seats and improve the general appearance of the entire bus.

Everyday dirt and soil. may be removed with a soap and water solution. If the stain is persistent, a stiff bristle brush may be used. Fabric-covered seats should be rinsed with clean water after the stain is removed.

Paint, tar, and asphalt. Stains should be removed immediately using a damp cloth and kerosene. Rub gently, using small strokes. Rinse thoroughly. This type of stain may become permanent if not cleaned immediately.

Nail polish and lacquer-based stains. Soak up as much as possible with dry cloth immediately. Any remaining stain may be removed with a nonflammable cleaning fluid such as “Tuff Stuff” or “Armor All” cleanser. Rinse thoroughly with clean water.

Gum, grease, and shoe polish. Remove as much as possible immediately. If left for any length of time, shoe polish will stain permanently. Clean any remaining stain with “Tuff Stuff” or “Armor All” cleanser.

Ink. Remove stain immediately using a damp cloth and alcohol.

Optional Equipment Available

CB Receiver Transmitter

A forty channel, CB receiver/transmitter is available installed in your coach.

Closed Circuit Rear-Vision Camera

A color LCD rear view monitor is standard on the coach. This allows you to see behind coach. This is especially helpful when towing a vehicle, it allows driver to see behind and keep an eye on what is in tow.

1. **Power/Standby Button** – There are two possible modes of operation for turning the unit on/off. In manual mode, the power button is used to turn the unit on/off. In standby mode, the unit automatically turns on only when 12V is applied to the stand-by trigger wire. The power button features dual-illumination (bright and dim). In installations where the unit is not wired for standby operation and power is applied to the unit, the Power Button will dimly glow when the unit is off, allowing the user to easily find the control in low light. Illumination switches to full intensity when the unit is turned on.

1. **A/B Input Select Switch** – This control toggles the active display image back and forth between AV1 and AV2 inputs.
2. **Day/Night Mode Button** – This allows the unit to be switched between “Day” and “Night” LCD illumination modes. In the “Day” mode, the LCD backlight intensity is at maximum. In “Night” mode, the LCD backlight is dimmed to a preset level that is more suitable for low light operation.
3. **Picture Adjustment Menu Button** – Accesses the On-Screen Display (OSD) menu for four LCD picture adjustments (Brightness, Contrast, Color, and Tint). The first depress of the button accesses the “Brightness” adjustment. The Volume +/- controls adjusts the level, which is indicated by a bar graph at the bottom of the screen. Each consecutive depress of the Picture button accesses the adjustment screen for each picture adjustment. If no buttons are pressed within 6 seconds or controls other than the Picture and Volume buttons are pressed, the unit will exit the Picture Adjustment mode.
4. **Volume +** - Increases volume output.
5. **Volume –** - Decreases volume output.

Troubleshooting

SYMPTOM	CAUSE	SOLUTION
No power	No +12V accessory, no ground, mis-wired/reversed.	Replace circuit fuse, monitor has protection device built-in/ reset, check ground connections, verify power is being supplied.
Video/No audio	Blue/white audio trigger wire not powered, volume adjust down	Connect +12V ACC or reverse light circuit, turn volume adjustment up.
Monitor does not activate in reverse	blue standby wire not powered	Connect to reverse circuit +12V
Negative/dark video image	Low voltage, brightness adjustment down	Check voltage power and ground connections, turn brightness adjustment up.
No video/no audio	Camera connection	Check camera input selection, connection to camera and junction bow, correct camera connection/plugged incorrectly.
Vehicle battery drained	+12V ACC (red wire) connected to vehicle battery	Provide +12V ACC (red wire) power from switched circuit.

Notes:

Air Suspension

The Meritor Air Suspension differs greatly from conventional leaf or coil spring suspensions. It is designed to provide trouble-free operation, requiring minimal service and maintenance. This section is presented to provide the operator a general understanding of the air suspension's function and characteristics, and to assist in routine pre-operation inspection.

The Meritor air suspension uses pressurized air, drawn from the coach's air system, to inflate load carrying, shock absorbing air cushions mounted atop each of the vehicles' axles. There are eight such cushions on the coach; one on each side of the front axle; two on each side of the drive axle; and one on each side of the tag axle. Automatic height control valves regulate the air volume required for varying loads, and maintain a constant vehicle ride height by adding or exhausting air in the cushions as needed. The system's basic characteristic is its ability to provide a well-cushioned ride through a range of load conditions. The vehicle air pressure must be built up and maintained in excess of 100 psi to inflate the air springs before operating.

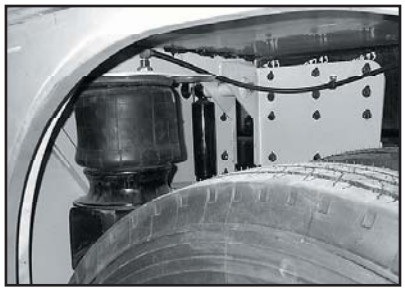
Most minor failures do not put the suspension out of operation or require roadside assistance. If immediate repair is not possible, the vehicle can be driven carefully to a service facility. If a suspension system component failure causes an air loss, a brake protection valve will automatically maintain a safe air brake pressure of 65 psi. If all air cushions go flat, rubber bumpers inside the air cushions carry the loaded vehicle. Mechanical stability through the suspension system allows the vehicle to be operated with care without excessive lean while air springs on only one side are pressurized.

As part of a daily outside inspection before operating the bus, visually inspect the suspension air cushions. With the vehicle parked on a level surface and engine running to maintain air pressure above 100 psi, check:

1. All air springs, to make sure they are equally firm.
2. The drive axle air spring height is 8.00 inches.
3. There is a clearance of at least two inches around the rubber air springs.

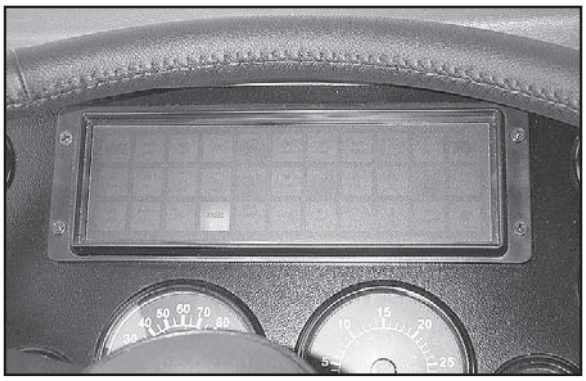
With the engine off:

1. Listen for any air leaks.
2. Check for any visible evidence of broken or abnormally worn parts
3. Check for any signs of wear due to insufficient clearance around air cushions or contact with other components.



Notes:

Kneeling Feature



The kneeling feature is designed to lower the front entrance door step for easier entry and exit by the passengers. The kneeling feature is controlled by a Kneel switch located on the driver's right side dash switch panel The bus transmission must be in neutral and the parking brake must be applied in order for the kneeling feature to function.

CAUTION! Always straighten the front wheels before using the kneeling feature. Damage can occur if the front wheels are turned sharply when the bus is kneeled, as certain parts of the bus body may contact the tires.

As indicated by the icon on the switch, pressing the switch downward kneels the bus. Air is released from the front air suspension bags very rapidly, allowing the entrance door step to drop three inches in three seconds. The horn sounds as a warning and a yellow indicator appears in the instrument panel.

After passengers have boarded or exited, the bus is raised to normal height by pressing the Kneel switch upward.

WARNING!! Always ensure that boarding passengers' feet are well clear of the boarding area before using the kneeling system.

WARNING!! Vehicles equipped with a kneeling feature can drop suddenly and without warning. Bus must be solidly supported under the main frame rails at the front of the bus before working under or around the bus where personal injury could occur.

Notes:

Antilock Brake System

A Bendix Antilock Brake System is supplied with your coach. This is a GEN 5 Cab-Mounted model that is mounted in the

D-zone of the coach. This section describes the cab mount version of Bendix's Generation 5 Antilock Brake System/Automatic Traction Control (ABS/ATC) systems.

This system is designed for:

- Tractors
- Trucks
- Buses
- Motor Coaches
- RVs

This section covers:

- ABS/ATC Operation
- System Components
- Service Procedures
- Diagnosis and
- Troubleshooting Procedures

If additional assistance is needed in your area call Bendix at 1-800-247-2725 or RoadRanger® at 1-800-826-4357.

These ABS controllers and systems were originally marketed by Eaton Corporation under the Eaton® brand name. For more information contact Bendix, your local authorized Bendix dealer, or RoadRanger®.

Antilock Braking Systems (ABS)

ABS-controlled braking ensures optimum vehicle stability while minimizing the stopping distance. During vehicle operation, the ABS Electronic Control Unit (ECU) continuously monitors all wheel speed sensors. Data input from the wheel speed sensors allows the ECU to:

- Detect impending wheel lock.
- Maintain optimum wheel slip during braking.
- Maximize vehicle stability while maintaining braking effectiveness.

ABS Operation

The ABS controls braking by operating the Pressure Modulator Valves. The ECU makes a new assessment of conditions and updates the control signal to the pressure modulator valves at the rate of 100 times per second.

When inactive, the pressure modulator valves provide straight-through-passages for supply air to the brake chambers. During ABS operation (an ABS "event"), the control unit operates the valves to override the supply of air to the chambers. During an ABS release, supply air is held off while the chambers are vented to the atmosphere. In hold mode, supply air is held off and chamber air is held constant. When required, air is applied to the chamber at a controlled rate by modulating the hold side of the modulator valve.

The ABS system itself does not apply additional braking power. Rather, the purpose of ABS is to limit brake torque to prevent locking that results in loss of lateral stability and increased stopping distances. Cautious driving practices such as maintaining adequate distances from the vehicle ahead are still essential to safe vehicle operation.

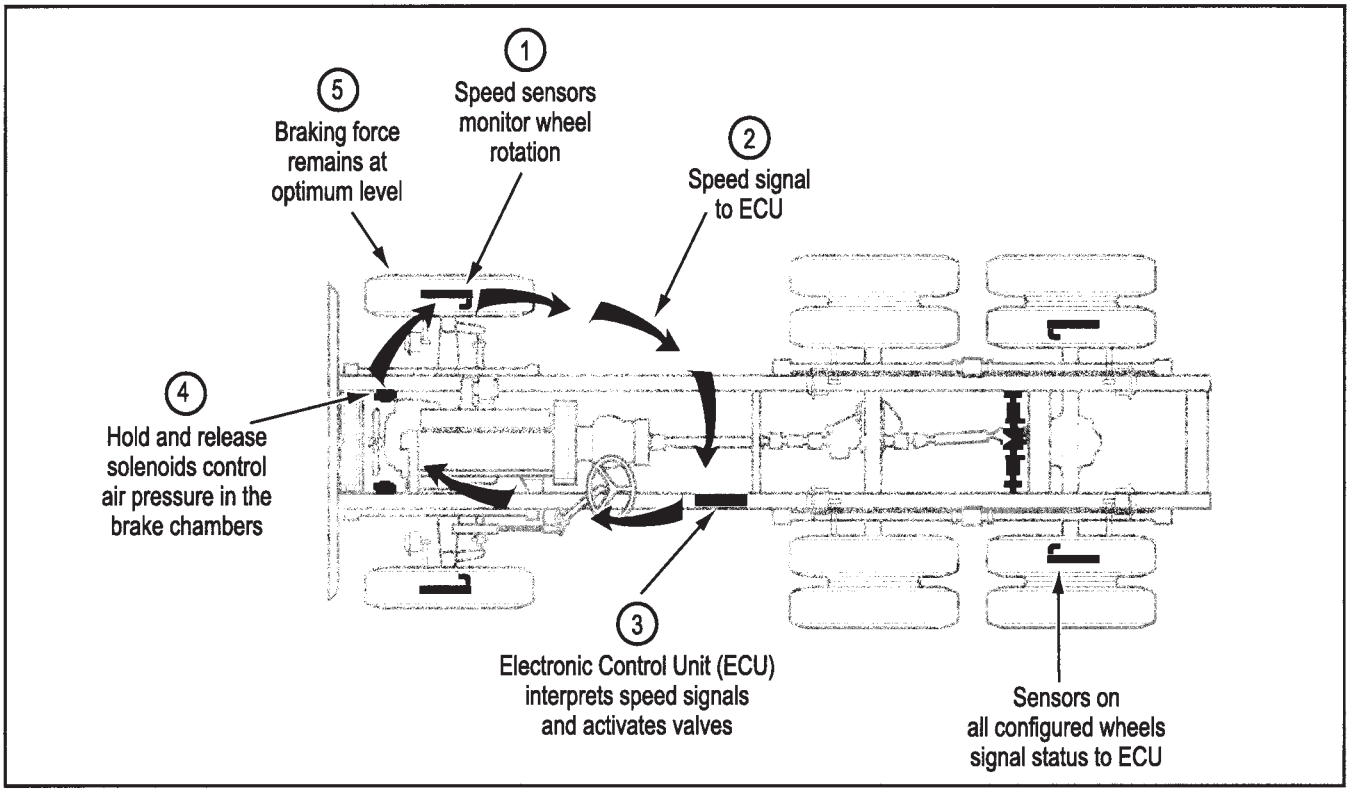


Figure 2 - Overview of ABS Operation

ABS Component Function

The ABS system operates as follows (see *Figure 2* above).

1. Speed sensors on each wheel monitor wheel rotation.
2. Each speed sensor communicates wheel rotation pulses to the central Electronic Control Unit (ECU).
3. The ECU receives speed sensor input, interprets the signal pulses, and calculates speed and acceleration rates for the wheels and the vehicle.
4. Based on speed sensor input, the ECU detects impending wheel lock and operates the ABS modulator valves as required for proper control. The modulator valves can be operated in either a release or a hold mode to regulate air pressure in the brake chambers.
5. Braking force is applied at a level which minimizes stopping distance while maintaining as much lateral stability as possible.

ABS Indicator Light

This lamp is the primary indicator of the ABS status.

- The ABS light illuminates steadily for a two second bulb-check whenever the switched ignition is ON. The ABS lamp turns OFF after the bulb-check if there are no ABS malfunctions present.
- The ABS light flashes on and off continuously when the off-highway mode is selected. (Special option for military and off-highway vehicles.)
- If the Warning Lamp remains ON, after the bulb-check, there is an ABS fault that requires service.

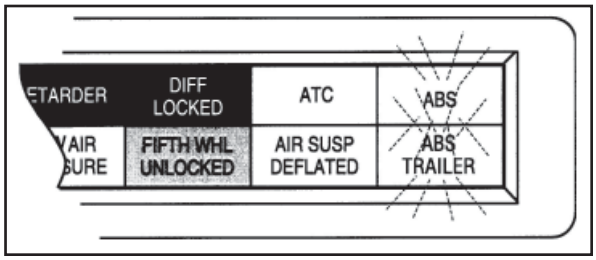


Figure 3 - ABS Indicator Light

NOTE: In the case of a speed sensor failure which has been corrected, the warning light will remain on until sensor output has been verified by the control unit. In this case it is necessary to move the vehicle above 5 mph before the warning light will turn off.

Automatic Traction Control (ATC) System

The ATC system is available on all Standard ABS ECU's. ATC is not available on Basic ECU's. It helps improve traction on slippery or unstable drive surfaces by preventing excessive wheel spin. ATC also enhances vehicle stability by prevention of power spin-out.

ATC Requires:

1. ATC Valve - Either a stand alone valve or a Rear Axle Valve Assembly with integral ATC solenoid may be used.
2. SAE J1922 or J1939 engine interface (the ABS ECU serial data interface must match the engine controller interface).
3. Brake Light Switch input.
4. ATC Indicator Light.

The Electronic Control Unit (ECU) must be configured for ATC operation either by using the diagnostic switch, an MPSI ProLink® hand-held tester or Eaton's ServiceRanger PC software.

ATC Operation

During periods of wheel slip, the Electronic Control Unit enters an Automatic Traction Control mode. There are various modes of Automatic Traction Control.

System Operation

- At speeds above 25 mph, the engine is throttled back via the SAE J1922 or SAE J1939 data link to control spin out.
- At speeds below 25 mph, both engine control and differential brake control are activated as required to control wheel slip. Once triggered, differential braking mode remains active regardless of vehicle speed.
- An optional mud and snow switch allows greater wheel spin (more torque) when activated. It is intended for adverse conditions, usually off-highway. Except for special cases, the switch is programmed for momentary operation. ATC reverts to normal operation when the switch is cycled a second time and whenever the system goes through a power-up cycle.

Component Function

When brake control is utilized, the ATC valve is activated, diverting supply tank air to the Modulator Valves on the drive axle(s). The Electronic Control Unit then activates the appropriate solenoids in order to apply a brake force to the spinning wheel. The Automatic Traction Control System cannot increase traction to a particular wheel; it can only utilize the available traction.

Thermal Protection

To prevent excessive brake and drum temperature resulting from brake activity, ATC incorporates a brake temperature estimation algorithm to determine when differential braking mode should be suspended. The differential braking function is re-enabled after a cool-down period.

ATC Indicator Light

The ATC Indicator operates when a vehicle is equipped with the optional Automatic Traction System.

- Gen 5 - Lights at key-ON and turns off after a 2-second lamp check. ATC is active after the lamp check.
- Flashes rapidly to indicate that ATC is active.
- Flashes slowly when the "mud-and-snow" mode is selected and then flashes more rapidly when the automatic traction control system operates.
- Remains ON if an engine data link failure occurs.

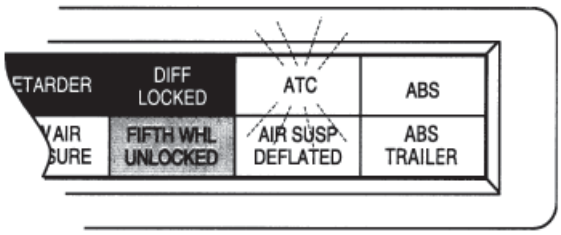


Figure 4 - ATC Indicator Light

NOTE: Some non-ATC equipped vehicles have an ATC light that is labeled as a spin light. It indicates when a low traction condition has been encountered. No control action is taken.

Component Overview

Bendix ABS components include:

- **Electronic Control Unit (ECU):** The ECU monitors and controls the ABS. It also diagnosis ABS malfunctions and stores failure-specific fault codes.
- **Pressure Modulator Valve (PMV):** This component regulates brake chamber air pressure. It houses the hold and release solenoids. A modulator valve is located near each brake chamber or pair of brake chambers that make up an ABS controlled wheel site.
- **Rear Axle Valve Assembly:** An assembly made up of two pressure modulator valves and a relay valve.
- **Wheel End Speed Sensor:** Single point variable reluctance (magnetic) sensor that generates an alternating voltage signal in response to the movement of teeth on a tone wheel.
- **ABS Light (Amber):** This indicator lamp, located on the driver instrument panel, warns the driver of ABS malfunctions. It is also capable of blinking diagnostic fault codes when the ECU is in the self-diagnostic mode.
- **In-Cab ABS Trailer Light:** This indicator lamp, located on the driver instrument panel, warns the driver of trailer ABS malfunctions. It is not capable of blinking diagnostic fault codes.
- **ATC Valve:** The traction control valve applies full system pressure to the relay valve during traction control operation to provide differential (side to side) braking at controlled drive axles.
- **ATC Light:** This indicator lamp, located on the driver instrument panel, lights to indicate loss of traction which is being managed by the Automatic Traction Control System.
- **Relay/Breaker Panel:** The OEM provides two circuit breakers and either one or two relays as part of the ABS. One relay is used for warning light control. A second (optional) relay may be used to control a retarder and/or lockup torque converter.
- **Diagnostic Port Connector:** The diagnostic port connector is an industry standard connector that is used to connect to the J1587 diagnostic link. This connector also provides power and ground for diagnostic test equipment.

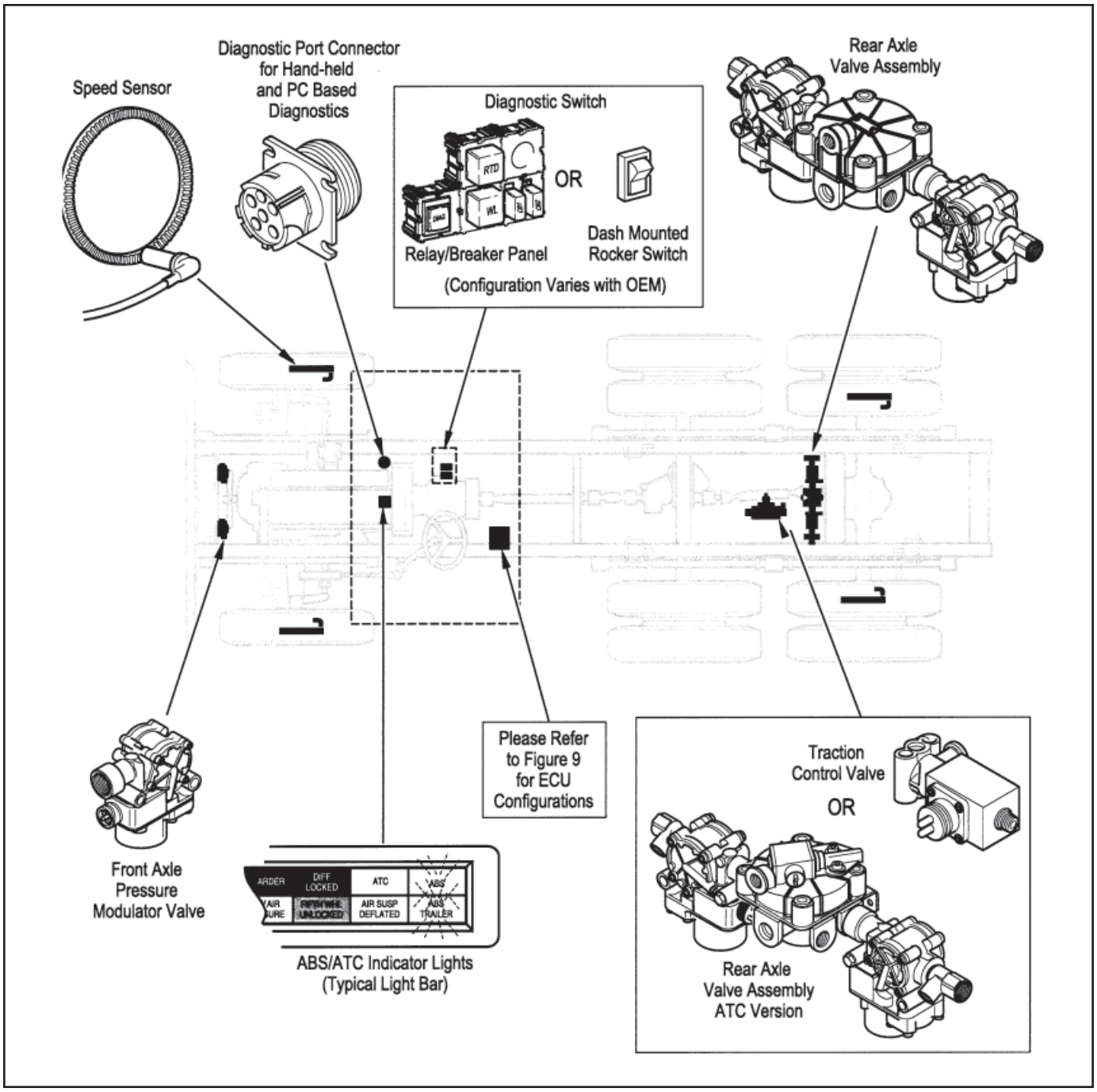


Figure 5 - ABS Components

Electronic Control Units (ECUs)

Identification

Frame mount ECUs are environmentally packaged versions of the related Generation 4 and 5 cab-mounted units (Standard, Basic). The circuitry and software is the same. Generation 5 units incorporate power line carrier (PLC) hardware,. ECUs are available in 4 and 6-channel versions with either J1922 or J1939 data links. There is also a 24-volt version. Further service information is available on www.bendix.com.

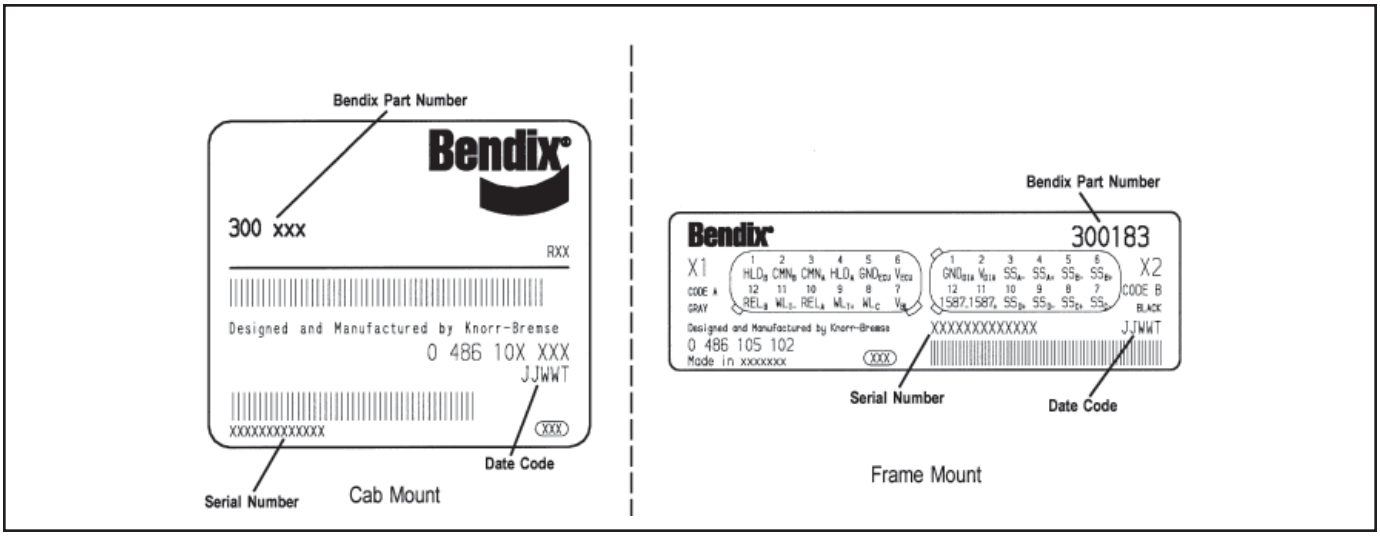


Figure 6 - Electronic Control Unit Identification Tags

NOTE: The coach uses the Cab Mount version on left of illustration above.

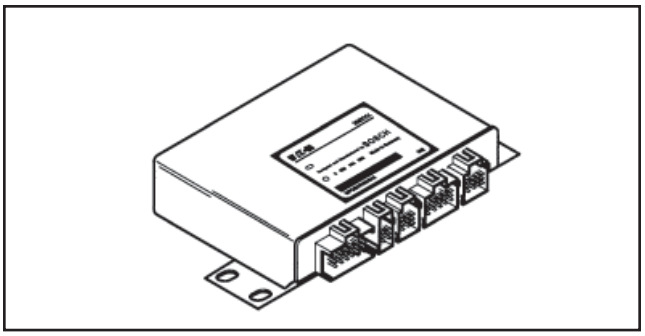


Figure 7 - Generation 5 Standard Cab Mount

ABS Valves

The ABS modulator valve controls air pressure to individual brake assemblies. Depending on the particular ABS configuration, a system may utilize three, four or six modulator valves. See Figure 8.

Each modulator valve contains two air control solenoids, which act as pilots to the hold and release diaphragms. The hold solenoid blocks inlet air to brake chambers; the release solenoid removes pressure from the brake. The 3-pin threaded connector has pins for the hold and release solenoid and a third, common terminal.

Rear Axle Valve Assemblies

Rear Axle Valve Assemblies are available for some applications depending on OEM preferences. They are combinations of two modulator valves and a relay valve. The assemblies are available in 4.0 and 5.5 PSIG versions, with or without an integral ATC solenoid.

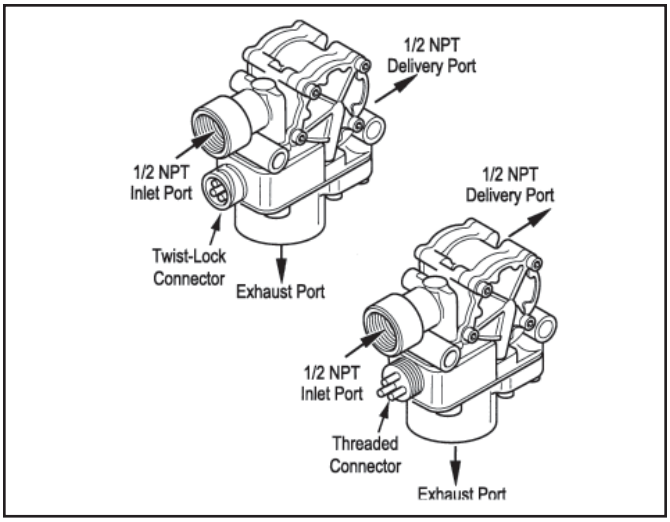


Figure 8 - Modulator Valve

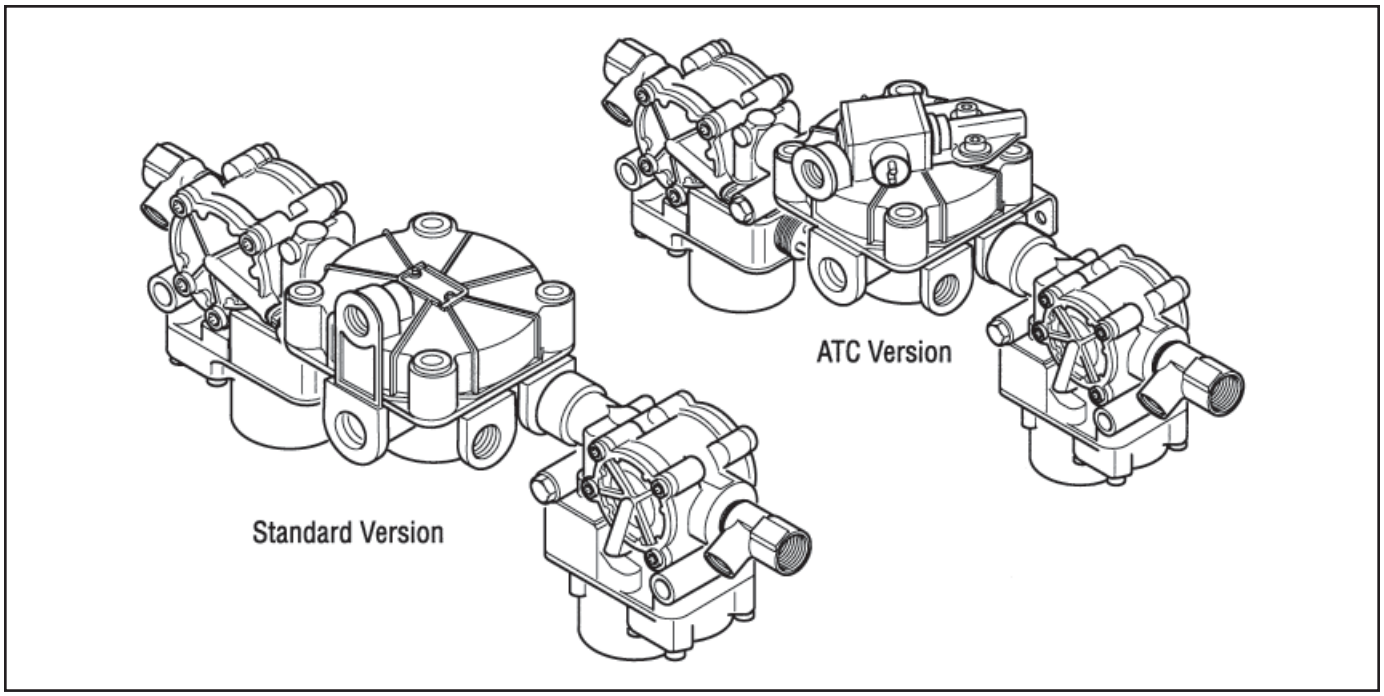


Figure 9 - Rear Axle Valve Assemblies, 4-Port ABS and ABS/ATC Versions Shown

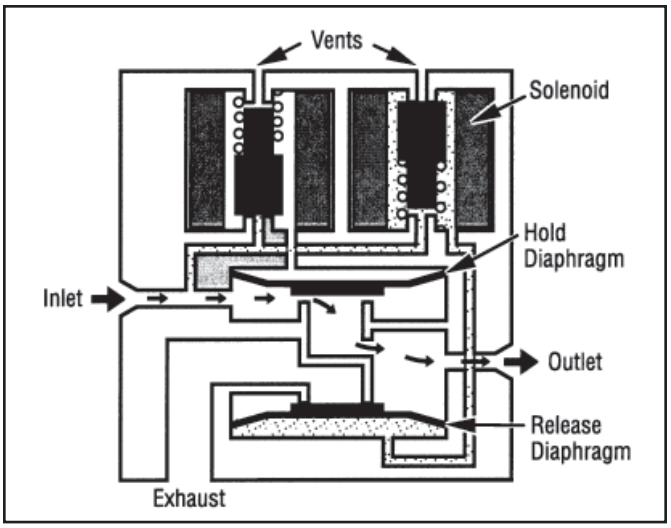


Figure 10 - Normal Apply and ABS/ATC Apply

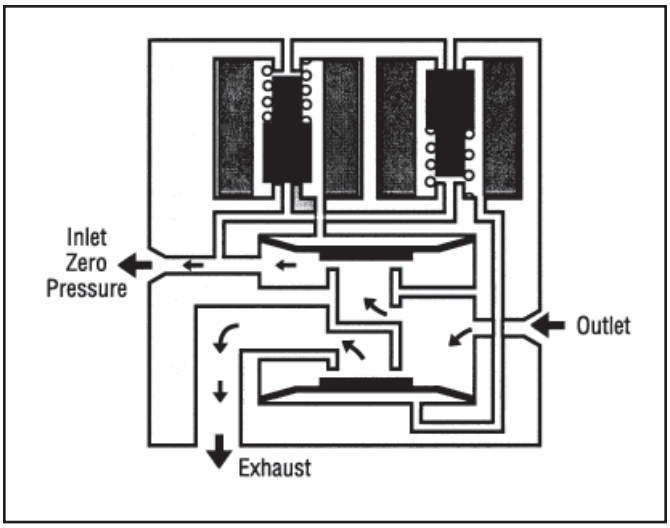


Figure 11 - Normal Release

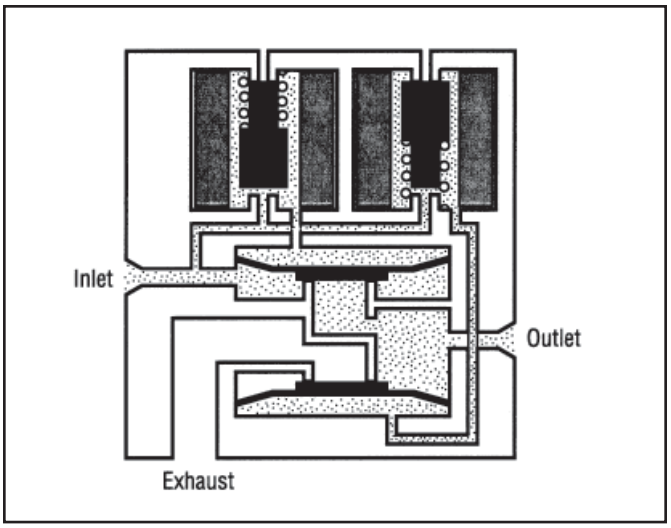


Figure 12 - ABS/ATC Hold

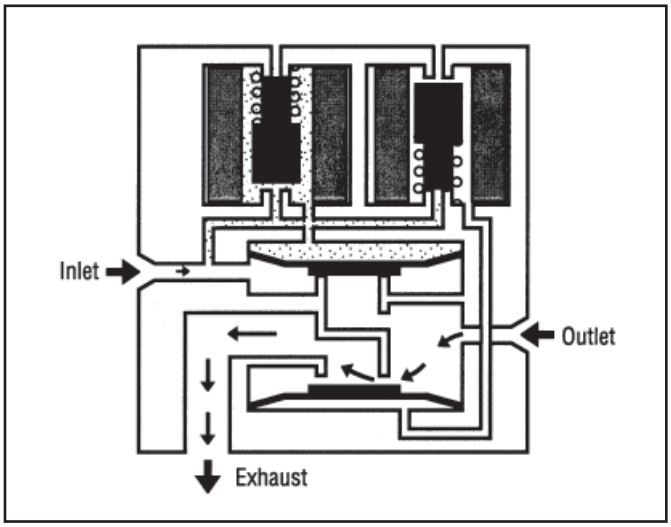


Figure 13 - ABS/ATC Release

Modulator Valve Operation Modes

1. **Apply** - Air flows straight through valve. Hold diaphragm is vented to allow air flow. Inlet pressure feeds behind release diaphragm to block the exhaust port. No solenoids are activated.
2. **Normal Release** - With quick release function, hold diaphragm is vented and there is no pressure at the inlet port. Air is allowed to flow from outlet to inlet. Since release diaphragm is not pressurized, air also flows out the exhaust port. No solenoids are activated.
3. **ABS/ATC Hold** - The hold solenoid is activated. Both diaphragms are pressurized. No air flows through the valve.
4. **ABS/ATC Release** - Both solenoids are activated. The hold diaphragm is pressurized, blocking the inlet air. The release diaphragm is vented, allowing air to flow from the outlet port back through the exhaust port.

Optional Front Axle Modules

An optional front axle module is available. It is an assembly of two modulator valves and a quick release valve. Three crack pressure settings are available:

- PSIG
- 3-4 PSIG
- 6-8 PSIG

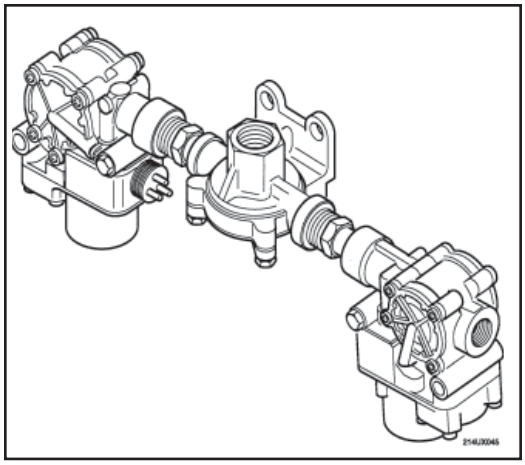


Figure 14 - Front Axle Module

Speed Sensors

Each wheel of an axle under direct ABS control is monitored by a speed sensor. Speed sensors for drive axles and steer axles may be different styles and installed in different locations.

Wheel End Sensors

For most applications, Bendix ABS uses standard wheel end sensors (See Figure 15). The front sensor is accessible on the inboard side of the steering knuckle. The rear drive axle sensor is accessible by removing the wheel and drum assembly.

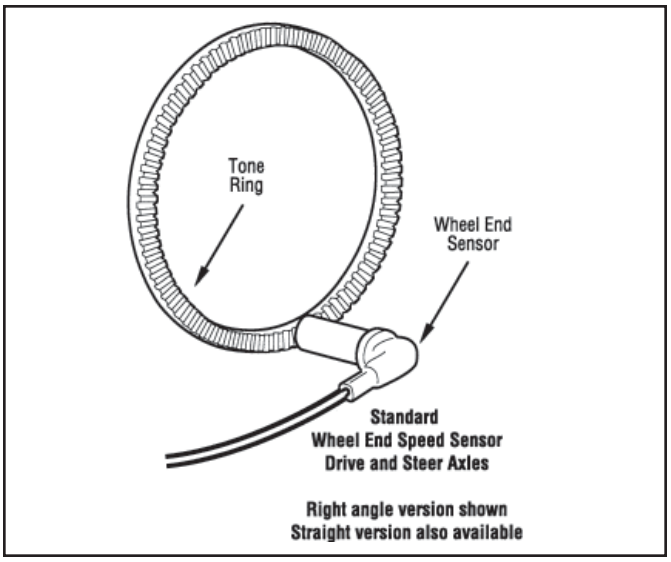


Figure 15 - Sensor Assembly

Wheel-end sensors are conventional, single point, variable reluctance sensors. These are often referred to as “magnetic sensors” or “magnetic pickups.” These sensors consist of a rod or pole piece surrounded by a coil of wire. A magnet is closely coupled to the pole piece and circulates a magnetic field through the coil. As the teeth of the tone ring rotate past the pole piece, the resistance (reluctance) to the magnetic field varies. The variable reluctance causes variations in the magnetic field which in turn induce a varying voltage in the coils which are wound around the pole piece.

Some general characteristics of variable reluctance, magnetic sensors are:

- The output voltage decreases as the air gap increases.
- The output voltage increases with the speed of the teeth past the pole piece.
- The output voltage waveform is independent of the direction of wheel rotation.

Wheel-End Sensors are protected with stainless steel metal sheaths. They are designed to fit within beryllium-copper friction sleeves which give them a self-adjustment feature.

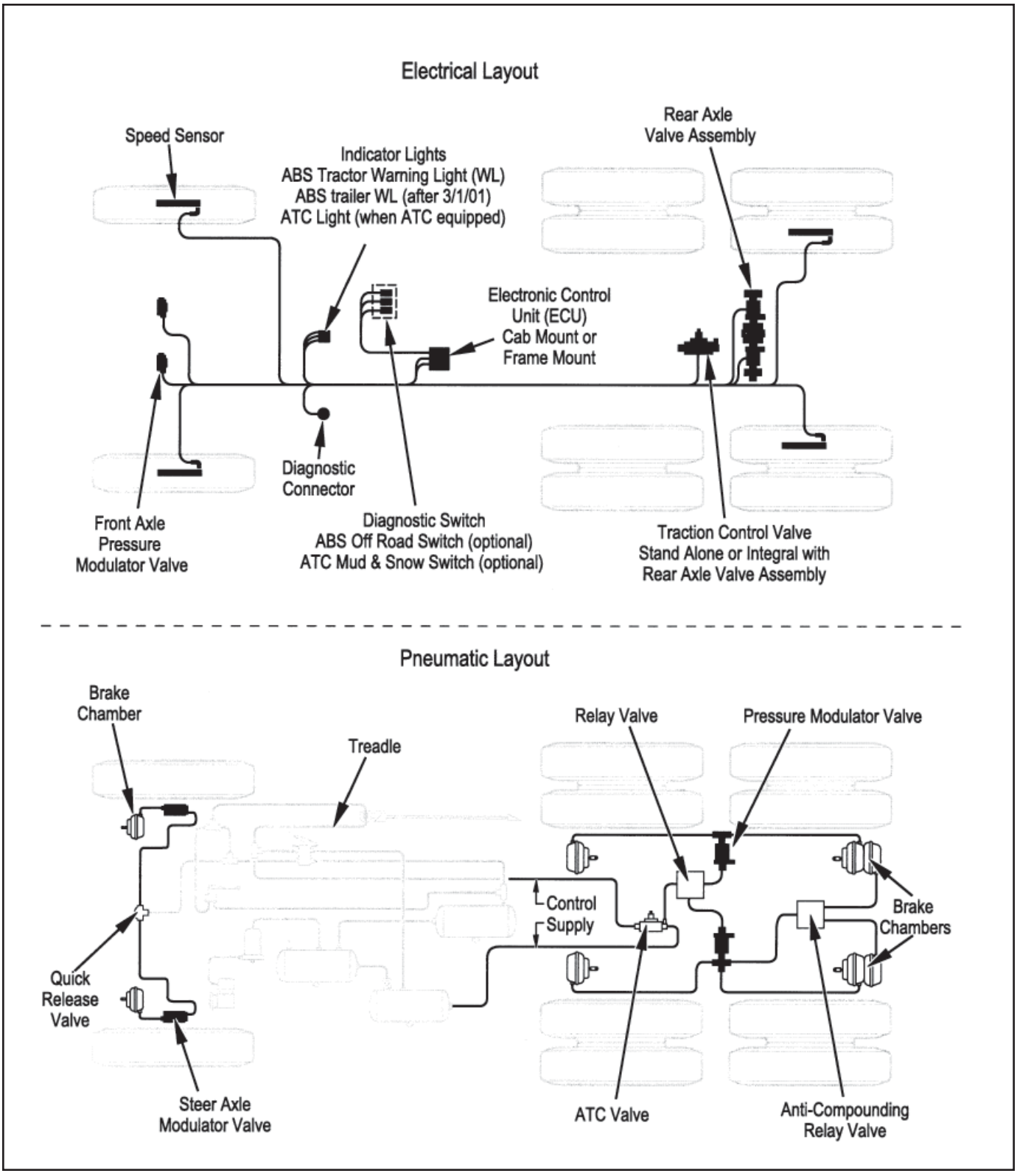


Figure 16 - Typical Electrical and Pneumatic Layouts

Diagnostics

An important feature of Bendix ABS is the system diagnostic capability. This section describes how to retrieve configuration information and error codes to troubleshoot ABS system faults. There are three ways to retrieve and display ABS configuration information and fault codes:

- **ServiceRanger PC Software:** Displays configuration information and fault codes on the PC monitor. Refer to the ServiceRanger PC software information later in this section.
- **ProLink Hand-Held Tester:** Displays configuration information and fault codes on the hand-held tester display. Refer to the hand-held tester information later in this section.
- **Diagnostic Switch:** Flashes configuration code and fault codes on the ABS indicator lamp. Refer to the Diagnostic Switch section found later in manual.

IMPORTANT! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following General Precautions should be observed at all times:

1. **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels.**
2. **Stop the engine when working around the vehicle.**
3. **If the vehicle is equipped with air brakes, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle.**
4. **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that removes all electrical power from the vehicle.**
5. **When working in the engine compartment the engine should be shut off. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
6. **Never connect or disconnect a hose or line containing pressure; it may whip. Never remove a component or plug unless you are certain all system pressure has been depleted.**
7. **Never exceed recommended pressures and always wear safety glasses.**
8. **Do not attempt to install, remove, disassemble or assemble a component until you have read and thoroughly understand the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
9. **Use only genuine Bendix replacement parts, components and kits. Replacement software, tubing, hose fittings, etc. should be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
10. **Components with stripped threads or damaged parts should be replaced rather than repaired. Repairs requiring machining or welding should not be attempted unless specifically approved and stated by the vehicle or component manufacturer.**
11. **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**

Troubleshooting Procedures

Figure 17 shows an organized approach to troubleshooting ABS faults. Follow the steps listed below to locate and correct ABS component and wiring problems.

1. Check that the ABS ECU configuration corresponds to the ABS components installed on the vehicle. Reconfigure the ECU if the configuration does not match the installed ABS components.
2. Access active fault code(s). Inactive (historical) faults are also reported and may provide additional information to aid in troubleshooting.
3. Look up the code description, the possible causes and the repair procedures provided in this section.
4. Perform the recommended repair procedures.
5. After the repairs are completed, clear all codes and check for any additional codes.

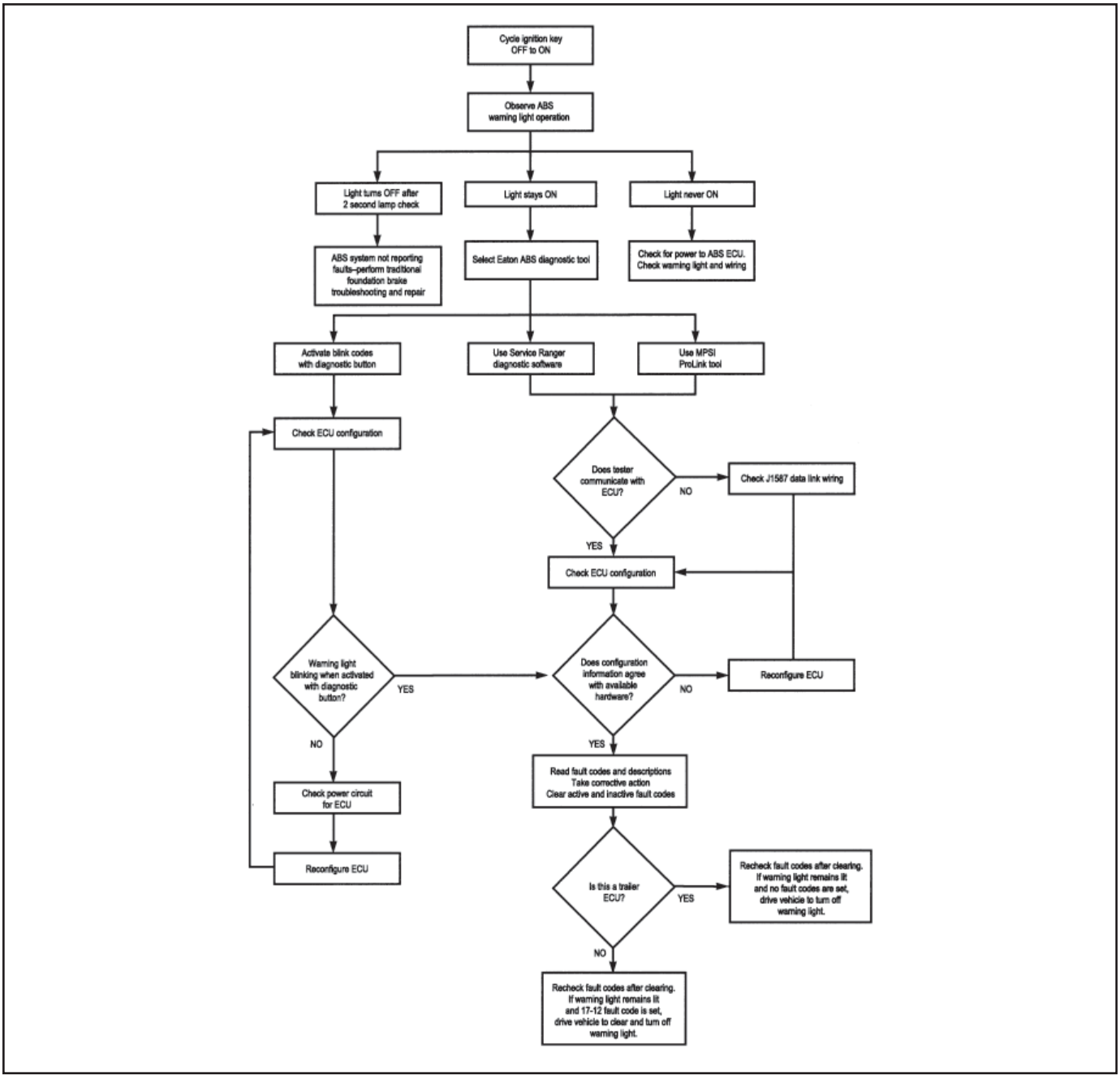


Figure 17 - Antilock Brake System Troubleshooting Chart

System Configuration

Available Configurations

A wide variety of system configurations are available (refer to Figure 18). It is important to be able to read system configurations and to be able to properly reconfigure a system when necessary.

When to Configure

ECUs are factory configured for the most common requirements. Basic systems are set up for 4s-4m operation with retarder control via retarder relay. Standard system are set up for 6s-4m operation with retarder control via engine data link. For applications other than these factory configurations (for example use of a retarder control relay, 4s-3m operation, 6s-6m operation or traction control), it is necessary to perform a configuration or "setup" process. This process sets up the ECU for the components that are installed so that proper control and fault tolerance will be implemented. The diagnostic switch, MPSI Pro-Link® tool or ServiceRanger PC software may be used to configure to a higher level (add components or functionality). If it is desired to move the configuration downward (fewer components than standard), the ProLink tool or ServiceRanger PC software must be used.

How to Configure

Use the "SYSTEM SETUP" menu with the MPSI Pro-Link® tool, the diagnostic switch (refer to Hand-Held Tester section later in manual for procedure) or ServiceRanger PC software. Use of the "SETUP" function will also clear inactive fault codes from the system. However it is recommended that the "CLEAR FAULT CODES" function be used for clearing inactive codes.

Verification

It is important to verify that the intended configuration has been obtained. Refer to Figure 20 for proper interpretation of configuration blink codes.

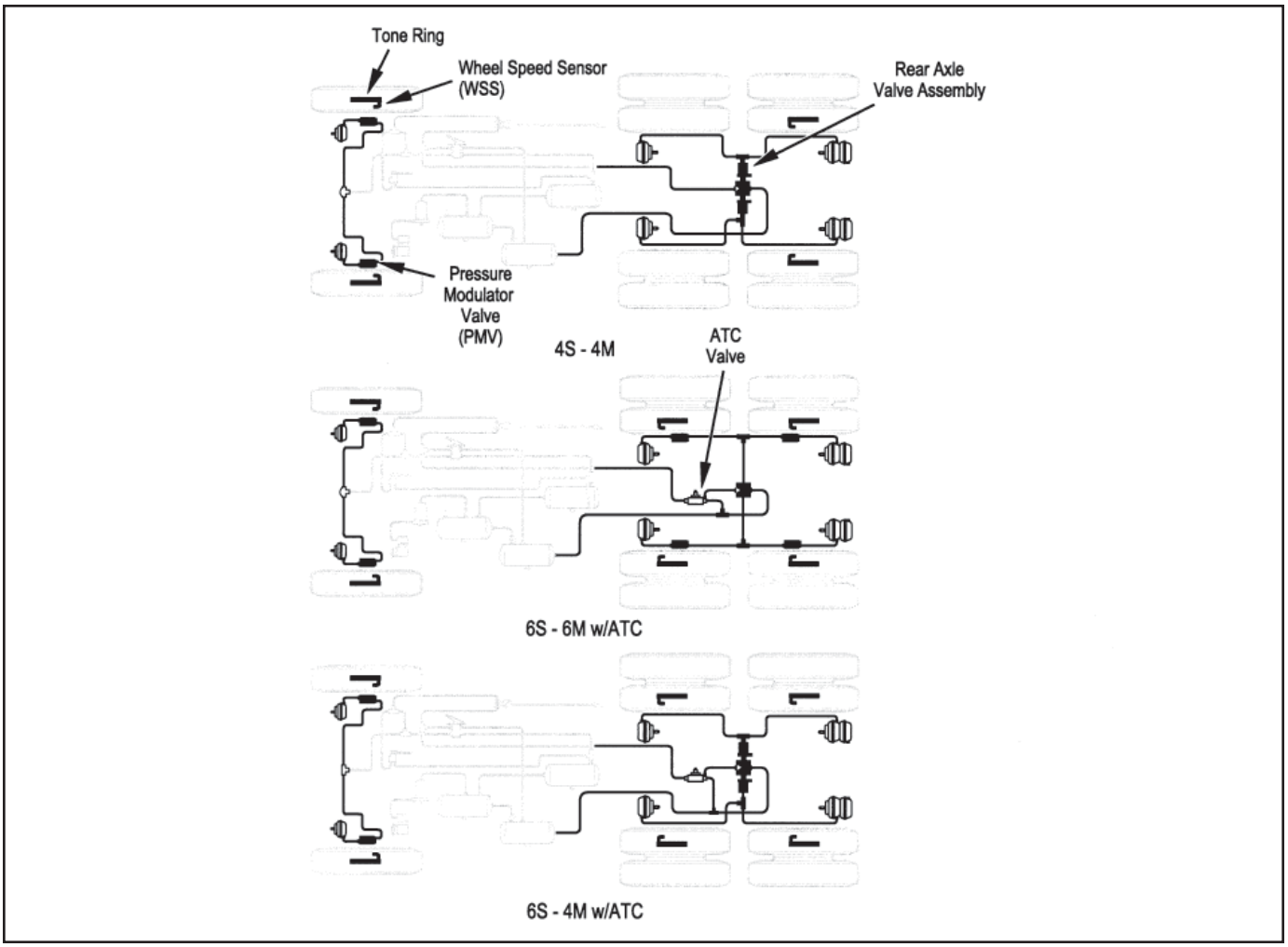


Figure 18 - Typical ABS Configurations

Test Equipment

Bendix recommends the use of the following products to troubleshoot the ABS system:

- A multimeter or digital volt-ohmmeter (DVOM).
- Eaton ServiceRanger PC software or an MPSI ProLink® hand-held tester.

Multimeter

A multimeter can be used to check:

- Speed sensor circuit resistance.
- PMV and ATC valve solenoid resistances.
- ABS power circuit voltages.
- Engine data link voltages.
- Retarder control relay.
- Wiring harness faults.

ServiceRanger PC Software

ServiceRanger PC Software can be used to read and clear error codes and obtain a short description of failures. The software can initiate test sequences for controller outputs and can also read system data such as voltage at the ECU, wheel speeds and output speeds.

CAUTION! Eaton ServiceRanger PC Software can activate output tests for all output devices. Since these tests can affect operation of the vehicle braking system, the ECU incorporates special safety protection. One axle must show zero speed or the test will be halted.

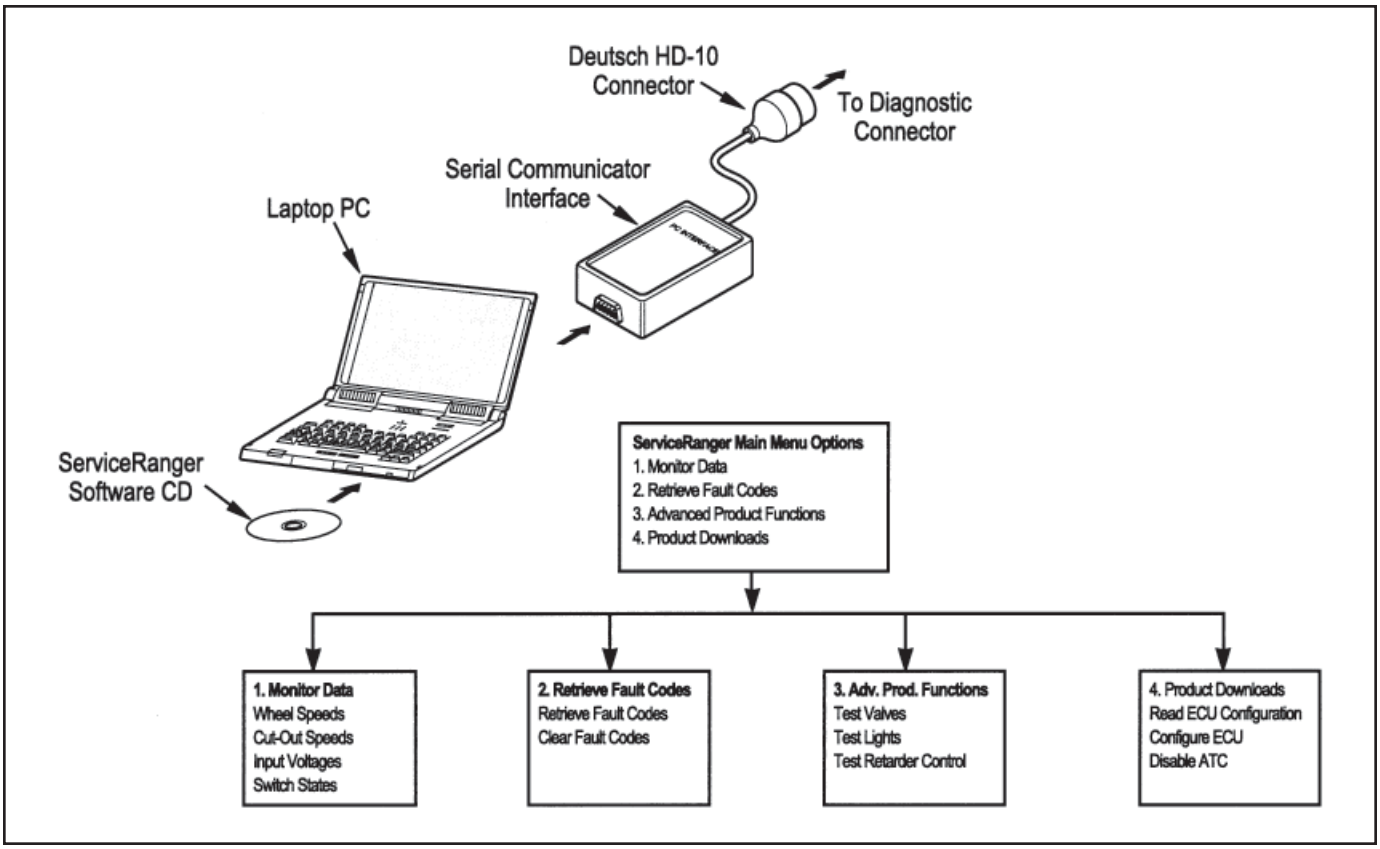


Figure 19 - ServiceRanger Menus and Hardware Setup

Hand-Held Tester

An MPSI ProLink® hand-held tester with Bendix proprietary cartridge can be used to read and clear error codes and obtain a short description of failures. The tester can initiate test sequences for controller outputs and can also read system data such as voltage at the ECU, wheel speeds and cutout speeds. A standard heavy duty truck cartridge may also be used, but cannot initiate test sequences.

CAUTION! The ProLink hand-held tester can activate output tests for all output devices. Since these tests can affect operation of the vehicle braking system, the ECU incorporates special safety protection. One axle must show zero speed or the test will be halted.

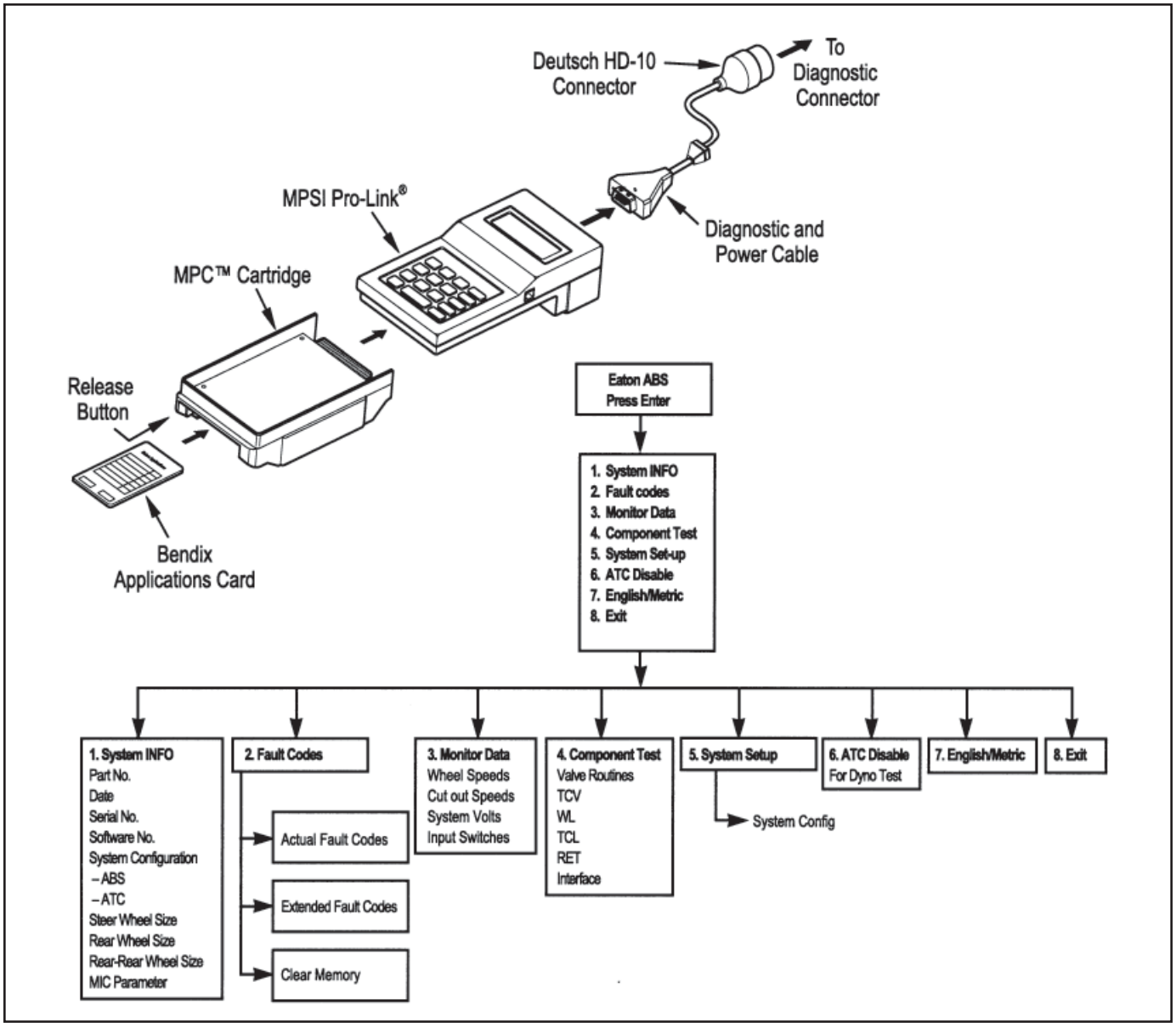


Figure 20 - Hand-Held Tester Menus and Set-Up

Diagnostic Switch

Blink Codes - System Configuration and System Faults.

By properly actuating ABS diagnostic button, configuration codes and fault codes can be retrieved as blinked sequences on the ABS warning light. Configuration codes are sequences of four blinked digits while fault codes appear as two blinked numbers. Refer to the charts beginning with Figure 21 for a description of these codes. To perform any of the activities listed below, simply follow the steps as given. If you make a mistake during one of the steps, stop and start over at the beginning of the procedure.

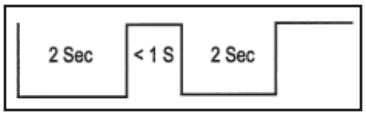
All blink codes are displayed by the ABS warning light only. The ATC light does not display blink codes.

NOTE: Before attempting any repairs:

1. Retrieve the configuration codes and fault codes (write them down).
2. Reconfigure the ECU if the configuration does not agree with the installed hardware. The ECU cannot be configured downward (components removed) with the diagnostic button. For example, a 6S-4M cannot be configured to 4S-4M. Downward configurations require the use of a ProLink tool or ServiceRanger software.
3. If the configuration is correct, clear the fault codes. The process for clearing the fault codes and reconfiguring the ECU is the same when using the diagnostic button.
4. Once again retrieve the fault codes. Only active codes will not be displayed.

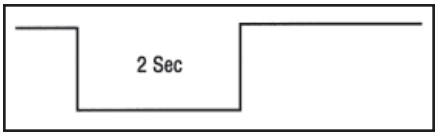
Reading Configuration Codes

- Turn the ignition key to “ON.”
- Press and hold the diagnostic button for two seconds and release.
- Without pause, press the diagnostic button a 2nd time for two seconds and release.
- Four-digit configuration code is retrieved and displayed.



Retrieving Fault Codes

- Turn the ignition key to “ON.”
- If vehicle is equipped with ATC, apply and release brakes once before proceeding.
- Press and hold the diagnostic button for two seconds and release.
- Two-number blink codes are retrieved and displayed.



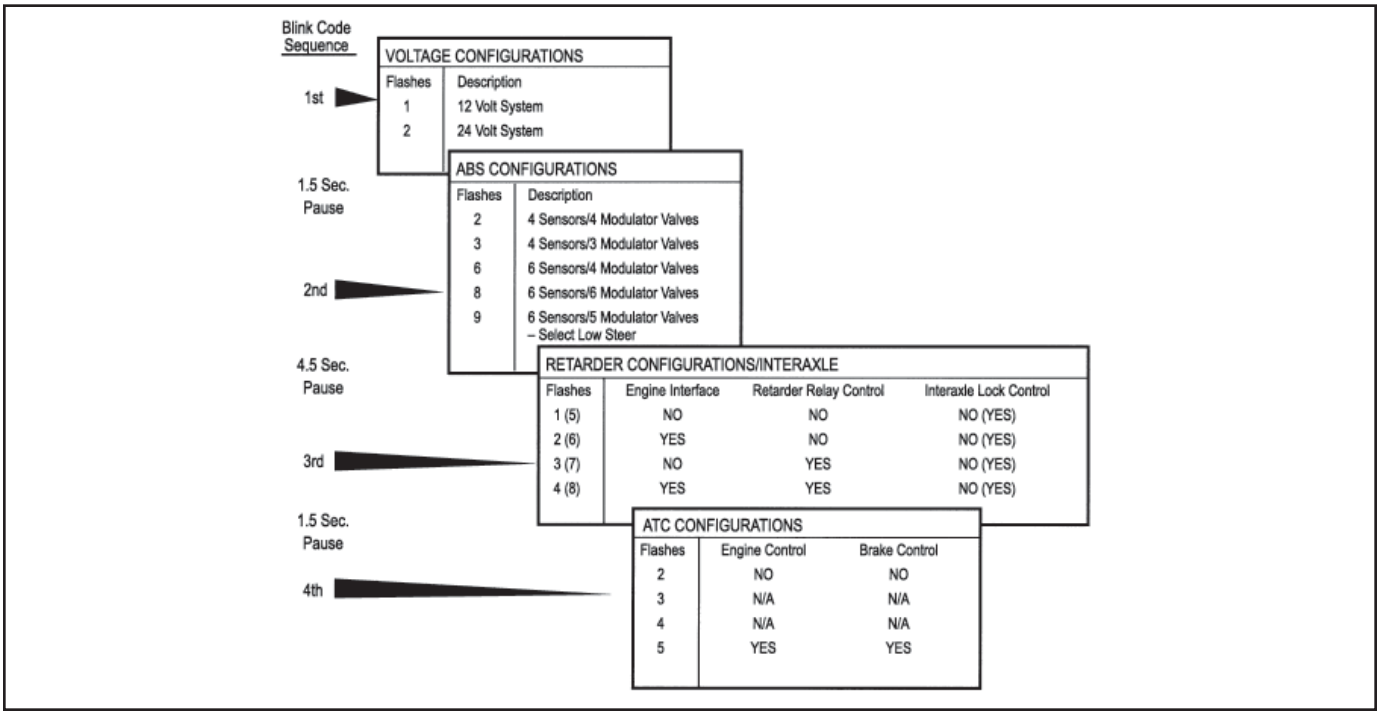
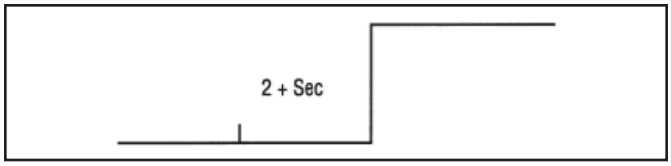


Figure 21 - Reading ABS Configuration Codes

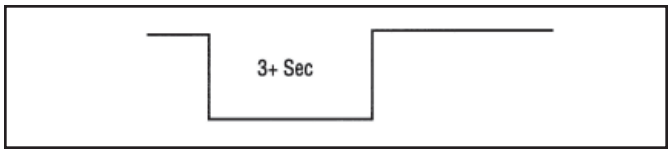
Clearing Fault Codes and/or System Configuration

- With the ignition “OFF” press and hold the diagnostic button.
- Turn the ignition key to “ON” while pressing the diagnostic button.
- Wait two seconds and release the diagnostic button.
- Press and release the brake pedal.
- ECU is reconfigured to match connected components and fault codes are cleared.
- Repeat the “Retrieving Fault Codes” procedure to verify that fault codes are cleared.



Disabling ATC for Dyno Testing

- Turn the ignition key to “ON.”
- Press and hold the diagnostic button for at least 3 seconds and release.
- ATC light turns “ON” and ABS light blinks 17 • 8 indicating ATC is disabled.
- At the next ignition cycle ATC will be reactivated.



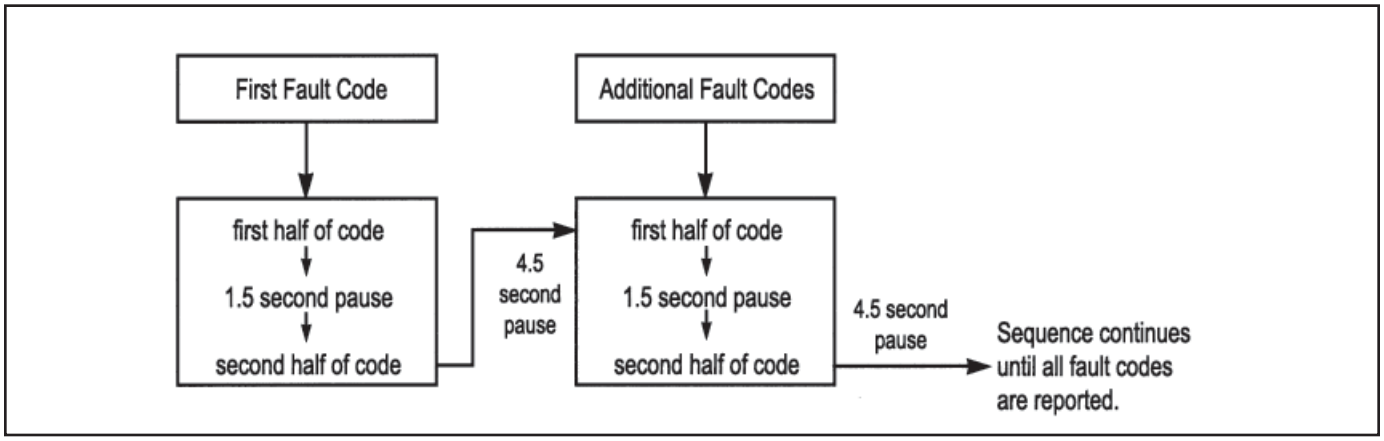


Figure 22 - Typical Blink Code Report

Blink Codes		MID 136 SID/FMI	Description	Location
1st	2nd			
1	1	-/-	No Trouble Found	
2	1	001/000	Sensor air gap too large	Left Steer Sensor
2	2	001/008	Air gap too large or sensor shorted.	
2	3	001/010	Speed Sensor signal is noisy.	
2	4	001/008	Wheel locked too long during an ABS cycle.	
2	5	001/008	High deceleration rate at wheel site or sensor shorted.	
2	6	001/012	Sensor shorted low or high or sensor open.	
2	7	001/012	Internal error at the sensor port of the ECU.	
2	8	001/002	Sensor in the wrong location for the system configuration.	
3	1	002/000	Sensor air gap too large	Right Steer Sensor
3	2	002/008	Air gap too large or sensor shorted.	
3	3	002/010	Speed Sensor signal is noisy.	
3	4	002/008	High deceleration rate at wheel site or sensor shorted.	
3	5	002/008	High deceleration rate at wheel site or sensor shorted.	
3	6	002/012	Sensor shorted low or high or sensor open.	
3	7	002/012	Internal error at the sensor port of the ECU.	
3	8	002/002	sensor in the wrong location for the system configuration.	
4	1	003/000	Sensor air gap too large	Left Rear Sensor
4	2	003/008	Air gap too large or sensor shorted.	
4	3	003/010	Speed Sensor signal is noisy.	
4	4	003/008	Wheel locked too long during an ABS cycle.	
4	5	003/008	High deceleration rate at wheel site or sensor shorted.	
4	6	003/012	Sensor shorted low or high or sensor open.	
4	7	003/012	Internal error at the sensor port of the ECU.	
4	8	003/002	Sensor in the wrong location for the system configuration.	
5	1	004/000	Sensor air gap too large.	Right Rear Sensor.
5	2	004/008	Air gap too large or sensor shorted.	
5	3	004/010	Speed Sensor signal is noisy.	
5	4	004/008	Wheel locked too long during an ABS cycle.	
5	5	004/008	High deceleration rate at wheel site or sensor shorted.	
5	6	004/012	Sensor shorted low or high or sensor open.	
5	7	004/012	Internal error at the sensor port of the ECU.	
5	8	004/002	Sensor in the wrong location for the system configuration.	
6	1	005/000	Sensor air gap too large.	Left Rear Sensor.
6	2	005/008	Air gap too large or sensor shorted.	
6	3	005/010	Speed Sensor signal is noisy.	
6	4	005/008	Wheel locked too long during an ABS cycle.	
6	5	005/008	High deceleration rate at wheel site or sensor shorted.	Left Rear Sensor.
6	6	005/012	Sensor shorted low or high or sensor open.	(continued).

Blink Codes		MID 136 SID/FMI	Description	Location
1st	2nd			
6	7	005/012	Internal error at the sensor port of the ECU.	
6	8	005/002	Sensor in the wrong location for hte system configuration.	
7	1	006/000	Sensor air gap too large.	Right Rear Sensor.
7	2	006/008	Air gap too large or sensor shorted.	
7	3	006/010	Speed Sensor signal is noisy.	
7	4	006/008	Wheel locked too long during an ABS cycle.	
7	5	006/008	High deceleration rate at wheel site or sensor shorted.	
7	6	006/012	Sensor shorted low or high or sensor open.	
7	7	006/012	Internal error at the sensor port of the ECU.	
7	8	006/002	Sensor in the wrong location for the system configuration.	
8	1	007/003	Short circuit from the release solenoid to voltage.	Left Steer Axle PMV.
8	2	007/004	Short circuit from the release solenoid to ground.	
8	3	007/005	Open circuit at the release solenoid.	
8	4	007/005	Open circuit on the common line to the valve.	
8	5	007/003	Short circuit from the hold solenoid to voltage.	
8	6	007/004	Short circuit from the hold solenoid to ground.	
8	7	007/005	Open circuit at the hold solenoid.	
8	8	007/002	System configuration is incorrect.	
8	10	151/014	Inter-axle differential control circuit shorted high.	IAD Circuit.
8	10	151/014	Inter-axle dffierential control circuit shorted low or open.	
9	1	008/003	Short circuit from the release solenoid to voltage.	Right Steer Axle PMV.
9	2	008/004	Short circuit from the release solenoid to ground.	
9	3	008/005	Open circuit at the release solenoid.	
9	4	008/005	Open circuit on the common line to the valve.	
9	5	008/003	Short circuit on the common line to the valve.	
9	6	008/004	Short circuit from the hold solenoid to ground.	
9	7	008/005	Open circuit at the hold solenoid.	
9	8	008/002	System configuration is incorrect.	
10	1	009/003	Short circuit from the release solenoid to voltage.	Left Rear Axle PMV.
10	2	009/004	Short circuit from the release solenoid to ground.	
10	3	009/005	Open circuit at the release solenoid.	
10	4	009/005	Open circuit on the common line to the valve.	
10	5	009/003	Short circuit from the hold solenoid to voltage.	
10	7	009/005	Open circuit at the hold solenoid.	Left Rear Axle PMV (cont.)
10	8	009/002	System configuration is incorrect.	
10 or 11	9	014/003	Common side of valves - stray voltage detected.	PMV Commons
10 or 11	10	014/003	Common side of valves shorted high.	

Blink Codes		MID 136 SID/FMI	Description	Location
1st	2nd			
10 or 11	11	014/004	Common side of the valves shorted to ground.	PMV Commons cont.
11	1	010/003	Short circuit from the release solenoid to voltage.	Right Rear Axle PMV.
11	2	010/004	Short circuit from the release solenoid to ground.	
11	3	010/005	Open circuit at the release solenoid.	
11	4	010/005	Open circuit on the common line to the valve.	
11	5	010/003	Short circuit from the hold solenoid to voltage.	
11	6	010/004	Short circuit from the hold solenoid to ground.	
11	7	010/005	Open circuit at the hold solenoid.	
11	8	010/002	System configuration is incorrect.	
12	1	011/003	Short circuit from the release solenoid to voltage.	Left Rear Axle PMV.
12	2	011/004	Short circuit from the release solenoid to ground.	
12	3	011/005	Open circuit at the release solenoid.	
12	4	011/005	Open circuit on the common line to the valve.	
12	5	011/003	Short circuit from the hold solenoid to voltage.	
12	6	011/004	Short circuit from the hold solenoid to ground.	
12	7	011/005	Open circuit at the hold solenoid.	
12	8	011/002	System configuration is incorrect.	
13	1	012/003	Short circuit from the release solenoid to voltage.	Right Rear Axle PMV.
13	2	012/004	Short circuit from the release solenoid to ground.	
13	3	012/005	Open circuit at the release solenoid.	
13	4	012/005	Open circuit on the common line to the valve.	
13	5	012/003	Short circuit from the hold solenoid to voltage.	
13	6	012/004	Short circuit from the hold solenoid to ground.	
13	7	012/005	Open circuit at the hold solenoid.	
13	8	012/002	System configuration is incorrect.	
14	5	018/003	Solenoid in ATC valve shorted high.	ATC Valve.
14	6	018/004	Solenoid in ATC valve shorted to ground.	
14	7	018/005	ATC valve open circuit.	
14	8	018/002	ATC valve found when it should not be present.	
14	12	249/002 or 231/002	Time-out or no connection to engine link (J1922/1939).	Data Link.
15	1	254/012	ECU internal fault.	ECU
15	2	253/012	ECU internal fault.	
15	3	253/013	ECU internal fault.	
15	4	253/012	ECU internal fault.	
15	5	254/002	ECU internal fault.	
15	6	254/002	ECU internal fault.	
15	7	254/002	ECU internal fault.	

Blink Codes		MID 136 SID/FMI	Description	Location
1st	2nd			
15	8	253/013	ECU Internal fault.	
15	9	231/012	ECU Internal fault.	
15	10	254/012	ECU internal fault.	
15	11	254/012	ECU Internal fault.	
16	1 or 5	251/004	Excessive voltage on PMV Power.	Power Circuits.
16	2 or 6	251/003	Low voltage found on PMV Power.	
16	3 or 7	251/005	No voltage found on PMV Power.	
16	4 or 8	251/005	Open circuit found on PMV Ground.	
16	9	251/004	Excessive voltage found on ECU Power.	
16	10	251/003	Low voltage found on ECU Power.	
16	11	251/002	Voltage difference between PMV Power inputs is too high.	
17	1	013/003	Retarder control releay shorted high or open circuit.	
17	2	013/004	Retarder control relay shorted to ground.	
17	3	249/002 or 231/002	J1922/1939 data link not functioning.	
17	4	249/002 or 231/002	J1922/1939 data link time out.	
17	5	253/013	Tire size, front to rear out of range.	
17	6	253/013	Tire size, out of range or parameter fault.	
17	7	-	Brake light switch not pushed at this power cycle.	
17	8	-	ATC system is disabled for dynamometer test.	
17	10	023/014	Warning light circuit is faulty.	
17	12	151/014	Sensor memory bit set, (A sensor fault has occurred, the ECU must read wheel speeds on all wheels to clear this fault.)	

Speed Sensor Troubleshooting

Follow the steps listed below to locate and correct sensor related ABS faults.

1. Access active fault code(s) using either the Blink Code procedure, with ServiceRanger or the Hand-held Tester procedure.
2. Look up the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.
5. If a sensor related fault has occurred, a code 17 • 12 will remain in the system until the vehicle has been driven.

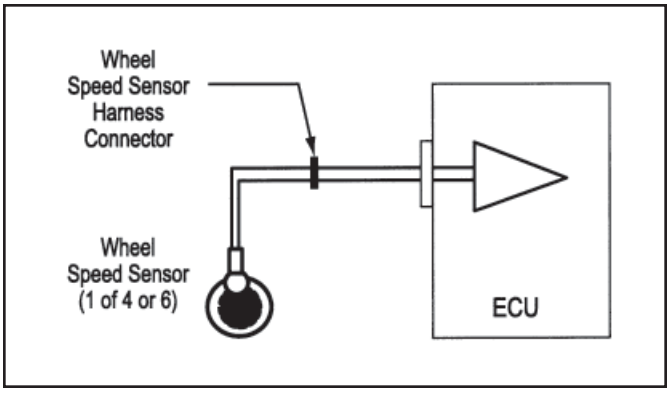
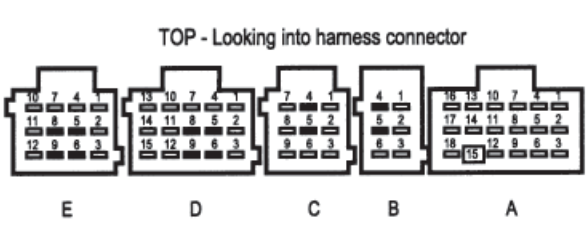
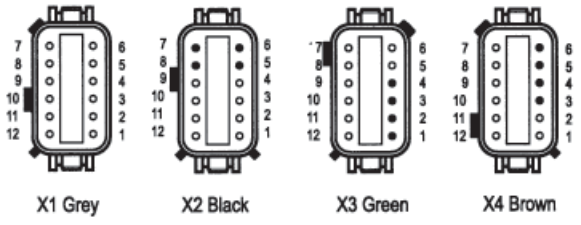


Figure 23 - Typical Wheel Speed Sensor Circuit





Harness Connector	PIN	Circuit Description
B (6-Way)	4	Speed Sensor (+) Left Steer
	5	Speed Sensor (-) Left Steer
C (9-Way)	4	Speed Sensor (+) Right Steer
	5	Speed Sensor (-) Right Steer
D (15-Way)	5	Speed Sensor (+) Left Rear
	6	Speed Sensor (-) Left Rear
	8	Speed Sensor (+) Right Rear
	9	Speed Sensor (-) Right Rear
E (12-Way) 6-channel Only	5	Speed Sensor (+) Left Rear Rear*
	6	Speed Sensor (-) Left Rear Rear*
	8	Speed Sensor (+) Right Rear Rear*
	9	Speed Sensor (-) Right Rear Rear*

*Not Used On Basic System

Harness Connector	PIN	Circuit Description
X2 (Black)	5	Speed Sensor (-) Right Steer
	6	Speed Sensor (+) Right Steer
	7	Speed Sensor (-) Left Steer
	8	Speed Sensor (+) Left Steer
X3 (Green)	1	Speed Sensor (-) Left Rear
	2	Speed Sensor (+) Left Rear
	3	Speed Sensor (-) Right Rear
	4	Speed Sensor (+) Right Rear
X4 (Brown) 6-channel Only	3	Speed Sensor (-) Left Rear Rear*
	4	Speed Sensor (+) Left Rear Rear*
	5	Speed Sensor (-) Right Rear Rear*
	6	Speed Sensor (+) Right Rear Rear*

*Not Used On Basic System

Speed Sensor Resistance Test

The correct resistance for the speed sensor circuit is between 950 ohms and 1900 ohms.

Measure resistance at the wheel location to check the speed sensor.

Measure resistance at the appropriate ECU harness connector pins to check the cable and speed sensor.

Note: Refer to the chart for pin identification.

Figure 24 - Wheel Speed Sensor Harness Circuit Descriptions and Resistance Test

The 17 • 12 Sensor Memory Fault Code

The ABS warning light indication and 17 • 12 fault code are provided to remind the service technician of the need to verify the performance of the ABS wheel speed sensors by driving the vehicle after servicing the sensors. ABS wheel speed sensors do not generate signals unless the wheels are turning. Because of this, certain sensor faults can only be detected when the vehicle is in motion.

The fault code 17 • 12 is generated after the initial sensor faults are cleared. The ABS warning light remains lit. The fault codes must be rechecked after clearing the sensor fault codes in order to see 17 • 12 reported.

A 17 • 12 fault code and ABS warning light signal for sensor fault cannot be cleared using ProLink, ServiceRanger software or the diagnostic button. They can only be cleared by driving the vehicle. The ABS ECU will clear the 17 • 12 blink code and turn off the ABS warning light when all active sensor fault issues are resolved and the vehicle is driven above 5 mph. The ABS ECU must detect speeds at all monitored wheels for the condition to clear.

Procedure:

1. Check fault codes.
2. Troubleshoot and eliminate cause for all faults.
3. Clear fault codes.
4. Check fault codes again (17 • 12 will be reported if sensor faults are cleared).
5. If 17 • 12 error code is reported, drive vehicle above 5 mph (ABS warning light will go out and 17 • 12 fault code will be cleared after a short period if all sensor signals are acceptable).

NOTE: If sensor faults still exist, the ABS warning light will remain lit. The faults will be logged once again after driving the vehicle. If more than one sensor site is affected, the faults may not be re-logged by the ECU until the vehicle has been driven and held above 20 mph for 3-5 minutes.

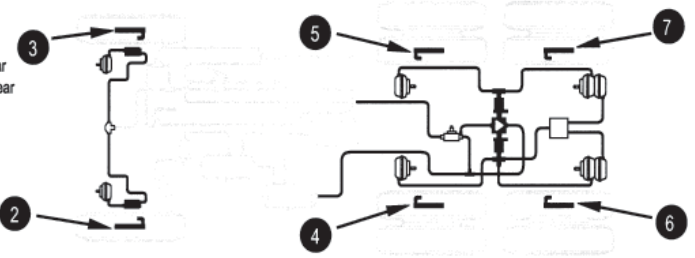
For more detailed troubleshooting, monitor the wheel speeds and cut-out speeds with ServiceRanger or a ProLink hand-held diagnostic tool. Troubleshoot and repair any speed sensor not reporting a wheel speed or showing a high cut-out speed.

Cut-out speeds are an indication of the strength of the sensor signal to the ECU and are proportional to air gap. Cut-out speeds should be in the range of 3-8 mph. Lower numbers indicate a stronger and better signal than higher numbers. High values indicate a sensor with an unreliable or non-existent signal.

Blink Code Sequence

1st

Flashes	Location
2	Left Steer
3	Right Steer
4	Left Rear
5	Right Rear
6	Left Rear Rear
7	Right Rear Rear



1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	Sensor air gap too large.	If necessary, clean and lubricate sensor. Press into mounting hole until it bottoms against tone wheel. Clear fault code and verify that fault is corrected by test driving the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared.
2	Air gap too large or sensor shorted.	Check sensor resistance. If sensor resistance is out of range, replace sensor. Clean and lubricate sensor. Press into mounting hole until it bottoms against tone wheel. Clear fault code and verify that fault is corrected by test driving the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared. Use approved lubricant.
3	Speed sensor signal is noisy.	Examine tone ring for damage. Replace tone ring and/or hub if necessary. Check wheel bearing adjustment. Adjust wheel bearings if necessary. Clear fault code and verify that fault is corrected by test driving the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared.
4	Wheel locked for excessive period of time during an ABS cycle.	Check mechanical function of brake. Check for kinked or restricted hoses. Clear fault code and verify that fault is corrected by test driving the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared.
5	Excessive rate of deceleration found at a wheel site.	Check for damaged tone ring or excessive run out. Repair tone ring and/or adjust wheel bearings. Clear fault code and test drive the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared.
6	Sensor connection shorted low or high or sensor is open.	Use an ohm meter to verify proper sensor resistance (Fig 24). Check harness for shorts or opens. Repair harness and/or replace sensor as necessary. Clear fault code and verify that fault is corrected by test driving the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared.
7	There is an internal error at the sensor port of the ECU.	Clear fault code and test drive the vehicle. The warning light will remain on until proper sensor output is detected even though the fault has been cleared. If fault recurs, or cannot be cleared, replace ECU.

Figure 25 - Speed Sensor Fault Code Troubleshooting Guide

Wheel End Speed Sensor Repair

Front Axle Speed Sensor

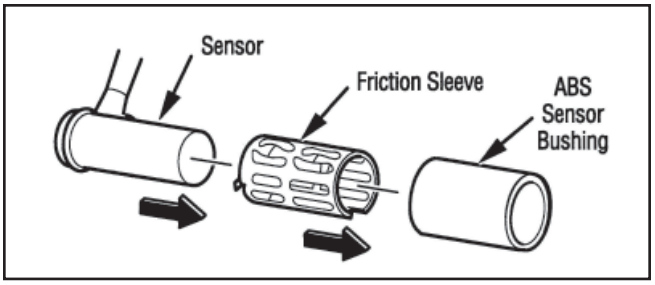
The front axle speed sensor is located on the inboard side of the steering knuckle.

CAUTION! Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed on Diagnostics of this manual.

CAUTION! Do not work under a vehicle supported by a jack.

Removal

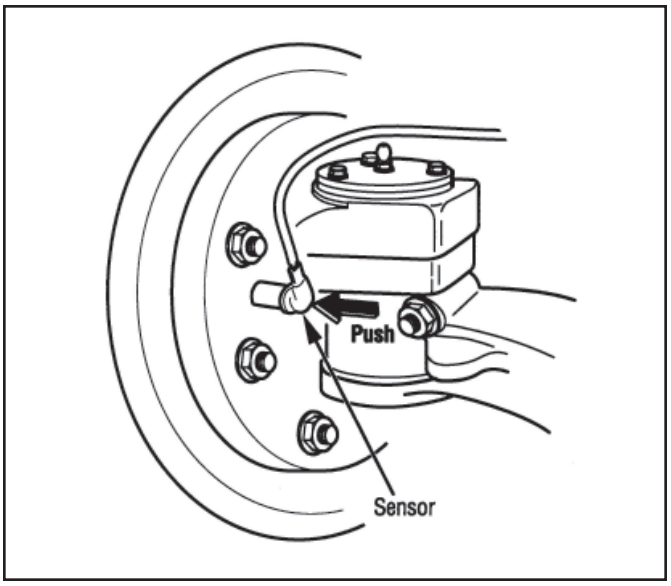
1. Disconnect sensor cable from harness.
2. Remove the sensor from the sensor bushing. (Do not pull on cable.)
3. Remove the speed sensor friction sleeve from the steer knuckle.



Installation

1. Install the sensor bushing with the flange stops towards the inboard side of the vehicle.
2. Apply high-temperature silicon-based grease to the body of the speed sensor.
3. Push the speed sensor completely into sensor bushing by hand until it stops against the tone ring. The speed sensor is properly installed and adjusted when it is touching the tone ring.

NOTE: The speed sensor must slide freely in and out of the mounting sleeve bore. Operating the vehicle with seized components will damage the speed sensor and the tone ring.



1. Test the installation.
2. Check the cable routing and connections.
3. Clear the codes. A 17 • 12 code will remain until the vehicle has been driven.
4. Test drive the vehicle and verify that the ABS warning lamp operates properly

Rear Axle Speed Sensor

The rear axle speed sensor located inside the brake drum and is only accessible by removing the wheel and drum assembly.

NOTE: For diagnostic and service information on in-axle speed sensors, please contact Dana Corporation.

CAUTION! Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed in Diagnostics section found earlier in manual.

CAUTION! Do not work under a vehicle supported by a jack.

Removal

1. Back off the slack adjuster to release the brake shoes.
2. Remove the wheel and tire assembly from the axle.
3. Remove the brake drum.
4. Remove the speed sensor with bushing from the mounting block on the axle housing. Use twisting motion and avoid pulling on the cable.
5. Disconnect any fasteners that hold sensor cable to other components and disconnect the speed sensor from the harness.

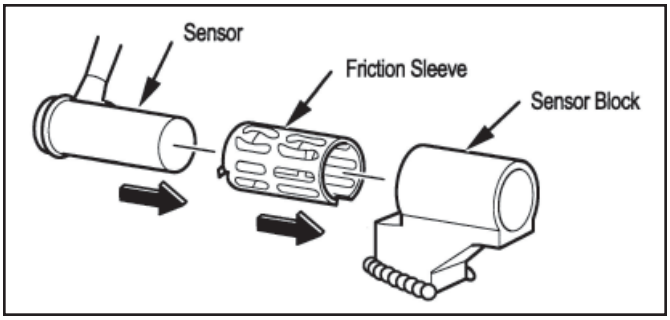


Figure 28 - Rear Speed Sensor Components

Installation

1. Install the sensor bushing with the flange stops toward the inboard side of the vehicle.
2. Apply a non-conductive grease lubricant to the body of the speed sensor.
3. Push the speed sensor completely into sensor bushing by hand until it stops against the tone ring. The speed sensor is properly installed and adjusted when it is touching the tone ring.

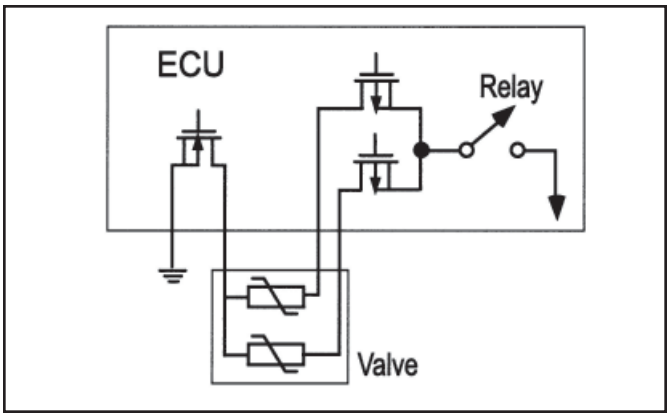
NOTE: The speed sensor must slide freely in and out of the mounting sleeve bore. Operating the vehicle with seized components will damage the speed sensors and the tone ring.

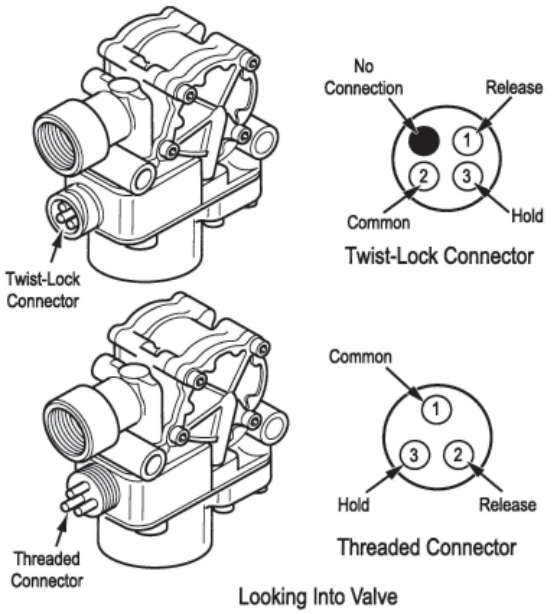
4. Route the cable to the frame.
5. Connect sensor cable to harness and install fasteners to hold the sensor cable in position.
6. Install the brake drum on the wheel hub.
7. Adjust the rear axle brakes.
8. Install the wheel and tire assembly and tighten the wheel nuts.
9. Test the installation.
10. Check the cable connections.
11. Clear the codes. A 17 • 12 code will remain until the vehicle has been driven.
12. Test drive the vehicle and verify that the ABS warning lamp operates properly.

Pressure Modulator Valve (PMV) Troubleshooting

Follow the steps listed below to locate and correct ABS modulator valve problems.

1. Access active fault code(s) using either the Blink Code procedure or the hand-held tester procedure.
2. Look up the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.





Measure From:	Measure To:	Resistance Range:
Common	Hold	3-8 Ohms
Common	Release	3-8 Ohms
HoldRelease	6-16 Ohms	

PMV Resistance Test

Measure resistance at the PMV location to check the valve.

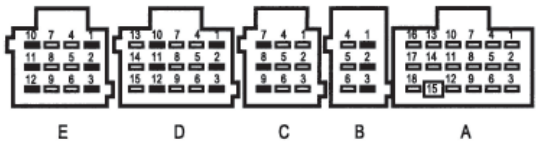
Measure resistance at the appropriate ECU harness connector pins to check the cable and valve.

Note: Refer to the chart for pin identification.

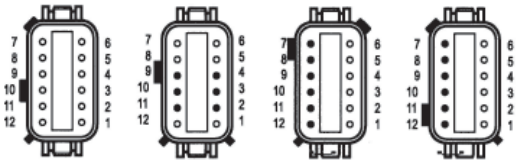
Figure 30 - PMV Harness Circuit Descriptions and Resistance Test

Cab Mount

TOP – Looking into harness connector



Frame Mount



Harness Connector	PIN	Circuit Description
B (6-Way)	1	PMV 1 (Release) Left Steer
	2	PMV 1 (Hold) Left Steer
	3	PMV 1 Common Left Steer
C (9-Way)	7	PMV 2 (Release) Right Steer
	8	PMV 2 (Hold) Right Steer
	9	PMV 2 Common Right Steer
D (15-Way)	1	PMV 3 (Release) Left Rear
	2	PMV 3 (Hold) Left Rear
	3	PMV 3 Common Left Rear
D (15-Way)	10	PMV 4 (Release) Right Rear
	11	PMV 4 (Hold) Right Rear
	12	PMV 4 Common Right Rear
E (12-Way) 6-channel Only	1	PMV 5 (Release) Left Rear Rear*
	2	PMV 5 (Hold) Left Rear Rear*
	3	PMV 5 Common Left Rear Rear*
E (12-Way) 6-channel Only	10	PMV 6 (Release) Right Rear Rear*
	11	PMV 6 (Hold) Right Rear Rear*
	12	PMV 6 Common Right Rear Rear*

*Not Used On Basic System

Harness Connector	PIN	Circuit Description
X2 (Black)	2	PMV 1 (Hold) Left Steer
	10	PMV 1 (Release) Left Steer
	11	PMV 1 Common Left Steer
X2 (Black)	3	PMV 2 (Release) Right Steer
	4	PMV 2 (Hold) Right Steer
	9	PMV 2 Common Right Steer
X3 (Green)	10	PMV 3 (Release) Left Rear
	12	PMV 3 (Hold) Left Rear
	11	PMV 3 Common Left Rear
X3 (Green)	7	PMV 4 (Release) Right Rear
	9	PMV 4 (Hold) Right Rear
	8	PMV 4 Common Right Rear
X4 (Brown) 6-channel Only	10	PMV 5 (Release) Left Rear Rear*
	12	PMV 5 (Hold) Left Rear Rear*
	11	PMV 5 Common Left Rear Rear*
X4 (Brown) 6-channel Only	7	PMV 6 (Release) Right Rear Rear*
	9	PMV 6 (Hold) Right Rear Rear*
	8	PMV 6 Common Right Rear Rear*

*Not Used On Basic System

Figure 31 - PMV Harness Circuit Descriptions and Resistance Test

Blink Code Sequence

1st

Flashes	Location		Flashes	Location	
8	PMV 1	Left Steer	11	PMV4	Right Rear
9	PMV 2	Right Steer	12	PMV5	Left Rear Rear
10	PMV 3	Left Rear	13	PMV6	Right Rear Rear

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	There is a short between the release solenoid and supply voltage.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
2	The is a short between the release solenoid and ground.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
3	There is an open circuit at the release solenoid.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
4	There is an open circuit in the common line to the valve.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
5	There is a short between the hold solenoid and supply voltage.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
6	The is a short between the hold solenoid and ground.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for short in wiring.
7	There is an open circuit at the hold solenoid.	Use multimeter to check that valve resistances are correct. If valve is OK check harness for open in wiring.
8	A valve has been found wired in the wrong location.	Check the control unit configuration and verify that valves are wired in the proper location for the configuration (Refer to Schematic).

1st

Flashes	Location
10 or 11	PMV Commons

1.5 Sec. Pause

2nd

Flashes	Condition	Action
9	Stray voltage has been found on the common line of one or more of the valves	Unplug ECU and check for voltage on the PMV common pins. If voltage is found, repair harness. If no problem is found in harness, replace ECU. Note: Before replacing ECU clear fault codes and verify that fault is still present (Refer to Schematic).
10	A short to supply voltage has been found on the common line of one or more of the valves	Unplug ECU and check for short to 12 volts on PMV common pins. If any are shorted to supply, repair harness. If no short is found in harness, replace ECU. Note: Before replacing ECU, clear fault codes and verify that fault is still present (Refer to Schematic).
11	A short to ground has been found on the common line of one or more of the valves	Unplug ECU and check for short to ground on PMV common pins. If any are shorted to ground, repair harness. If no short is found in harness, replace ECU. Note: Before replacing ECU, clear fault codes and verify that fault is still present (Refer to Schematic).

Figure 32 - PMV Fault Code Troubleshooting Guide

ABS Modulator Valve

Removal

1. Turn ignition switch to the OFF position, and apply parking brake.

CAUTION! Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed in Diagnostics section found earlier in manual.

2. Disconnect the wiring connector from the ABS valve.
3. Disconnect the air lines from the supply and delivery ports of the ABS valve.
4. Disconnect the valve mounting fasteners.
5. Remove the ABS valve.

NOTE: To service either modular valve or the relay valve, remove the entire assembly and then replace the individual components (valve).

Installation

1. Install the valve. Torque fasteners to manufacturers specification.
2. Connect air lines.
   - Supply to port 1 on valve.
   - Service brake chamber to delivery port 2.
3. Connect the wiring connector to the ABS valve.
4. Test the installation:

- Modulator Valve Leak Test - Make and hold brake application. No audible air leaks are permitted.
- Modulator Valve Component Test with Hand-Held Diagnostic Tool - Select valve routines. Verify proper valve location and operation with tool. Drive the vehicle and verify ABS warning lamp operates properly.

5. Make several brake applications and check for prompt brake chamber applications and release at the wheels. Check the cable connections.
6. Clear codes.
7. Drive the vehicle and verify that the ABS warning lamp operates properly.

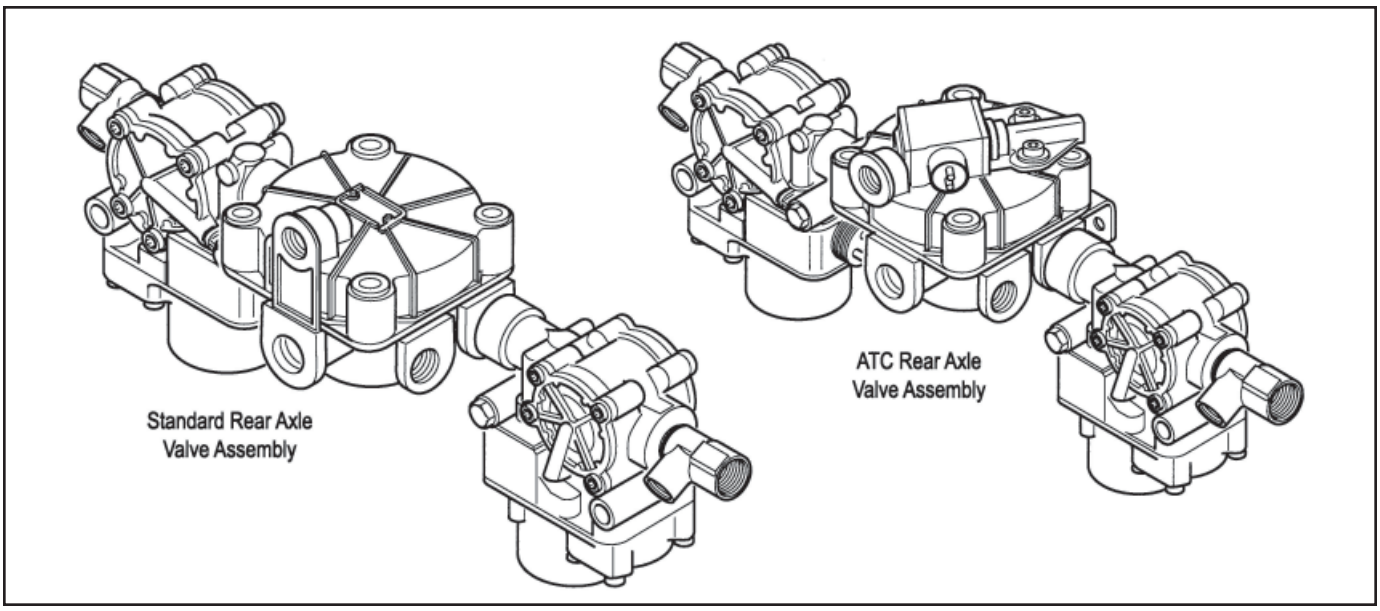


Figure 33 - Rear Axle Valve Assemblies - Standard and ATC Version Shown

Performance Test of the Relay Valve

CAUTION! Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed in Diagnostics section found earlier in manual.

1. Park vehicle on level surface and block wheels.
2. Release parking brake and fully charge the air system (governor cut out point).
3. Turn the engine OFF. Apply the service brake several times, then hold and check for prompt brake air chamber application and release at all wheels.
4. Apply brake, then hold. Coat outside of relay valve (where cover joins body) and connection between modulator valve and relay valve with a soap solution. No leakage is permitted.
5. If a sluggish response is noted at all wheels, inspect for kinked or obstructed air line leading to or from valve.
6. Increase system air pressure to governor cutoff. With the brakes released, coat exhaust port of relay valve with a soap solution. Leakage of a one-inch bubble in five seconds is permissible.
7. Depress foot valve and keep depressed. Coat exhaust port with a soap solution. Leakage of a one-inch bubble in three seconds is permissible.

Automatic Traction Control (ATC) Valve Troubleshooting

The following ATC troubleshooting pages provide the basic information necessary to: identify the fault code; locate the problem; review the possible cause(s); select the correct solution and utilize proper repair procedures.

Follow the steps listed below to locate and correct ATC problems.

1. Access active fault code(s) using either the Blink Code procedure or the hand-held tester procedure.
2. Lookup the code description, the possible causes and the repair procedures provided in this section.
3. Perform the recommended repair procedures.
4. After the repairs are completed, clear all codes and check for any additional codes.

Whether the ATC Valve is used as a stand-alone valve as shown in *Figure 34* or is integrated into the cover of a relay valve as shown in *Figure 33*, the troubleshooting procedure is the same.

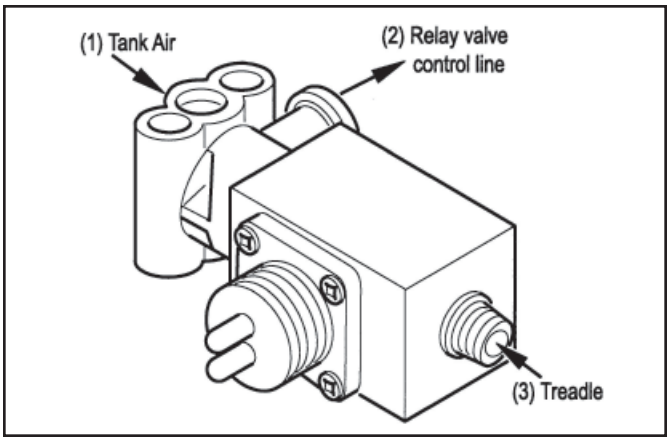
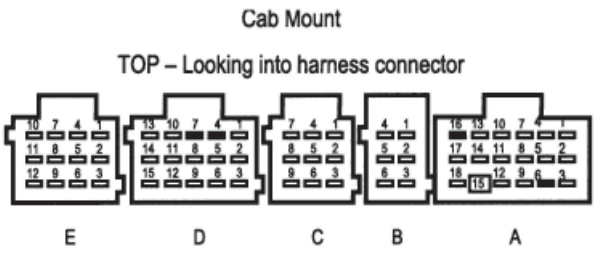
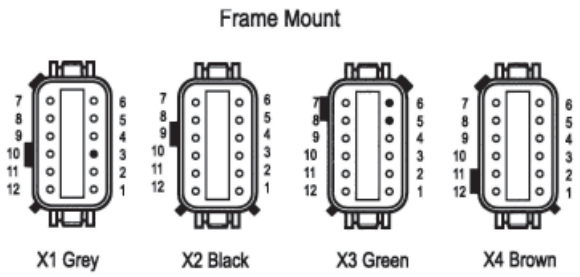


Figure 34 - ATC Valve





Harness Connector	PIN	Circuit Description
A (18-Way)	6	ATC Mud and Snow Switch
	16	ATCL (ATC Light)
D (15-Way)	4	ATC Valve +
	7	ATC Valve –

Harness Connector	PIN	Circuit Description
X1 (Grey)	3	ATCL (ATC Light/ATC Switch)
X3 (Green)	5	ATC Valve –
	6	ATC valve +

ATC Valve Resistance Test
The correct resistance for the ATC Valve circuit is between 9 and 15 ohms.
Measure resistance at the ATC Valve to check the valve.
Measure resistance at the appropriate ECU harness connector pins to check the cable and valve.

NOTE: Refer to the chart for pin identification.

Figure 35 - ATC Harness Circuit Descriptions and Resistance Test

Blink Code Sequence

Flashes	Location
14	ATC Valve

1st

1.5 Second Pause

2nd

Flashes	Condition	Response
5	Solenoid in ATC valve shorted high.	Use multimeter to check that valve resistances are correct (fig 35). If valve is OK check harness for open in wiring.
6	Solenoid in ATC valve shorted to ground.	Use multimeter to check that valve resistances are correct (fig 35). If valve is OK check harness for open in wiring.
7	ATC valve open circuit.	Use multimeter to check that valve resistances are correct (fig 35). If valve is OK check harness for open in wiring.
8	ATC valve found when it should not be present.	Verify proper system configuration and components. Clear faults. If error cannot be cleared or recurs, replace ECU.

Figure 36 - ATC Fault Code Troubleshooting Guide

ATC Valve Removal

CAUTION! Block wheels before beginning this procedure. Follow all standard safety procedures, outlined by, but not limited to, the General Precautions listed in Diagnostics section found earlier in manual.

1. Disconnect the wiring connector for the ATC valve.
2. Disconnect the air lines from the supply (port 1) and delivery port (port 2) and treadle (port 3) of the ATC valve.
3. Disconnect the valve mounting fasteners, and remove the valve.

Installation

1. Install the ATC valve. Torque fasteners to manufacturers specification.
2. Connect Air line supply (port 1) delivery port (port 2) and treadle (port 3) of the ATC valve.
3. Install the wiring connector to the ATC valve.
4. Test the installation.
   - Traction Control Valve - Leak Test:
   - Make and hold brake application. No audible air leaks are permitted.
   - Traction Control Valve Component Test with Hand-Held Diagnostic Tool:

Select Traction Control Valve
Verify Traction control light operation
Drive the vehicle and verify ABS warning lamp operates properly.

CAUTION! Do not start and engage the transmission with one wheel raised from the floor. With ATC, power will go to the wheel on the floor and cause the vehicle to move. See Disabling ATC for Dyno Testing section found earlier in manual to disable ATC for dyno testing.

Blink Code Sequence

	Flashes	Location
1st	14	ECU, Engine Interface

1.5 Sec. Pause

2nd

Flashes	Condition	Action
12	No connection found to engine data link (J1922/J1939).	Refer to electrical schematic. Check for proper connection of data link to ECU. Verify that polarity is correct. Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1922/J1939 (–) and a voltage between 2.5 and 5 volts on J1922/J1939 (+). If vehicle is not equipped with J1922/J1939 engine link, use diagnostic tool to reconfigure ECU.

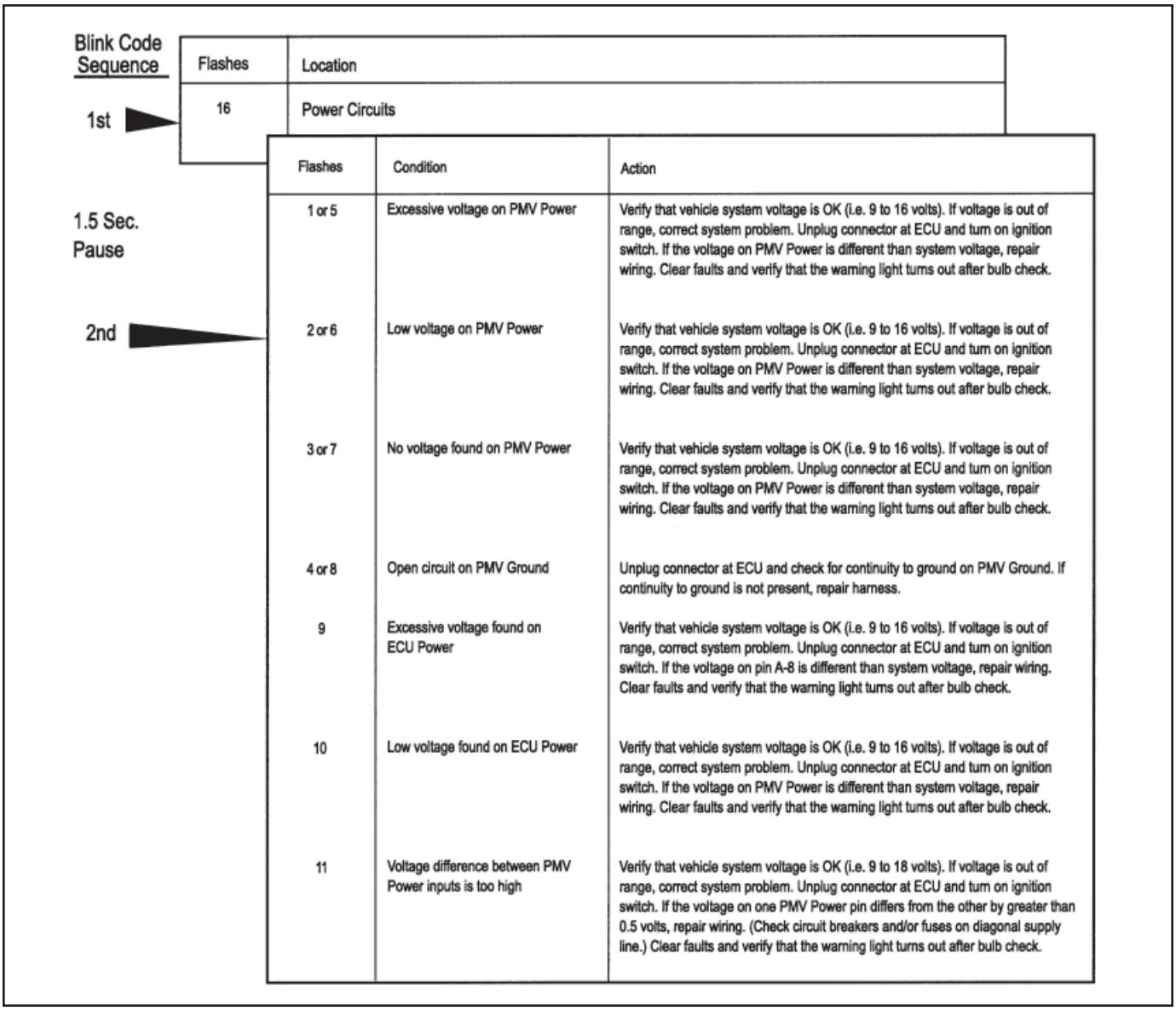
	Flashes	Location
1st	15	ECU

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1–11	ECU Internal Fault	If fault cannot be cleared, replace ECU.

Figure 37 - System and ECU Fault Codes Troubleshooting Guide



Blink Code Sequence

1st

Flashes	Location
16	Power Circuits

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1 or 5	Excessive voltage on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear faults and verify that the warning light turns out after bulb check.
2 or 6	Low voltage on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear faults and verify that the warning light turns out after bulb check.
3 or 7	No voltage found on PMV Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear faults and verify that the warning light turns out after bulb check.
4 or 8	Open circuit on PMV Ground	Unplug connector at ECU and check for continuity to ground on PMV Ground. If continuity to ground is not present, repair harness.
9	Excessive voltage found on ECU Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on pin A-8 is different than system voltage, repair wiring. Clear faults and verify that the warning light turns out after bulb check.
10	Low voltage found on ECU Power	Verify that vehicle system voltage is OK (i.e. 9 to 16 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on PMV Power is different than system voltage, repair wiring. Clear faults and verify that the warning light turns out after bulb check.
11	Voltage difference between PMV Power inputs is too high	Verify that vehicle system voltage is OK (i.e. 9 to 18 volts). If voltage is out of range, correct system problem. Unplug connector at ECU and turn on ignition switch. If the voltage on one PMV Power pin differs from the other by greater than 0.5 volts, repair wiring. (Check circuit breakers and/or fuses on diagonal supply line.) Clear faults and verify that the warning light turns out after bulb check.

Figure 38 - Power Circuit Fault Codes Troubleshooting Guide

Blink Code Sequence

Flashes	Location
17	Miscellaneous

1st

1.5 Sec. Pause

2nd

Flashes	Condition	Action
1	Retarder control relay shorted high or open circuit.	Use multimeter to verify proper voltage at the retarder control relay.
2	Retarder control relay shorted low. or open circuit	Use multimeter to verify proper voltage at the retarder control relay.
3	J1922/1939 data link not functioning. (Retarder)	Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1939/J1922 (–) and a voltage between 2.5 and 5.0 volts on J1939/J1922 (+). Refer to schematic and correct wiring harness as required.
4	J1922/1939 data link time out.	Unplug connector at ECU. There should be a voltage between 0 and 2.5 volts on J1939/J1922 (–) and a voltage between 2.5 and 5.0 volts on J1939/J1922 (+). Refer to schematic and correct wiring harness as required.
5	Tire size, front to rear out of range.	There is too great a difference in the rolling radius of the front and rear tires. Steer axle tire radius cannot be more than 20% above rears or 10% below. If the static loaded radius of the rear tires is outside the range 15.9 to 21.5 inches the ECU must be recalibrated using a diagnostic tool.
6	Tire size out of range or parameter fault.	There is too great a difference in the rolling radius of the front and rear tires. Steer axle tire radius cannot be more than 20% above rears or 10% below. If the static loaded radius of the rear tires is outside the range 15.9 to 21.5 inches the ECU must be recalibrated using a diagnostic tool.
7	Brake light switch not pushed at this power cycle.	Press brake pedal. If error does not clear, check for missing connection at brake light switch. If the brake is not applied you should measure the resistance of the brake light bulb (bulb broken?). If the brake is applied, you should measure vehicle system voltage. (i.e. 9...16v)
8	ATC system is disabled for dynamometer test.	Cycle ignition switch and ATC will be re-enabled.
10	Warning light short, low or open	Diagnostic switch may have been pressed for an excessive period of time (>30 seconds). If not check wiring associated with warning light.
12	Sensor memory bit is set	This fault should clear when the vehicle is driven and the ECU is able to read sensor output voltage. If this does not happen, verify that the sensors are properly adjusted (pressed full in to tone wheels.)

Note: For codes 17•3 and 17•4 the problem may be within the engine controller, another controller on the data link or within the wiring or connectors.

Figure 39 - Miscellaneous Fault Codes Troubleshooting Guide

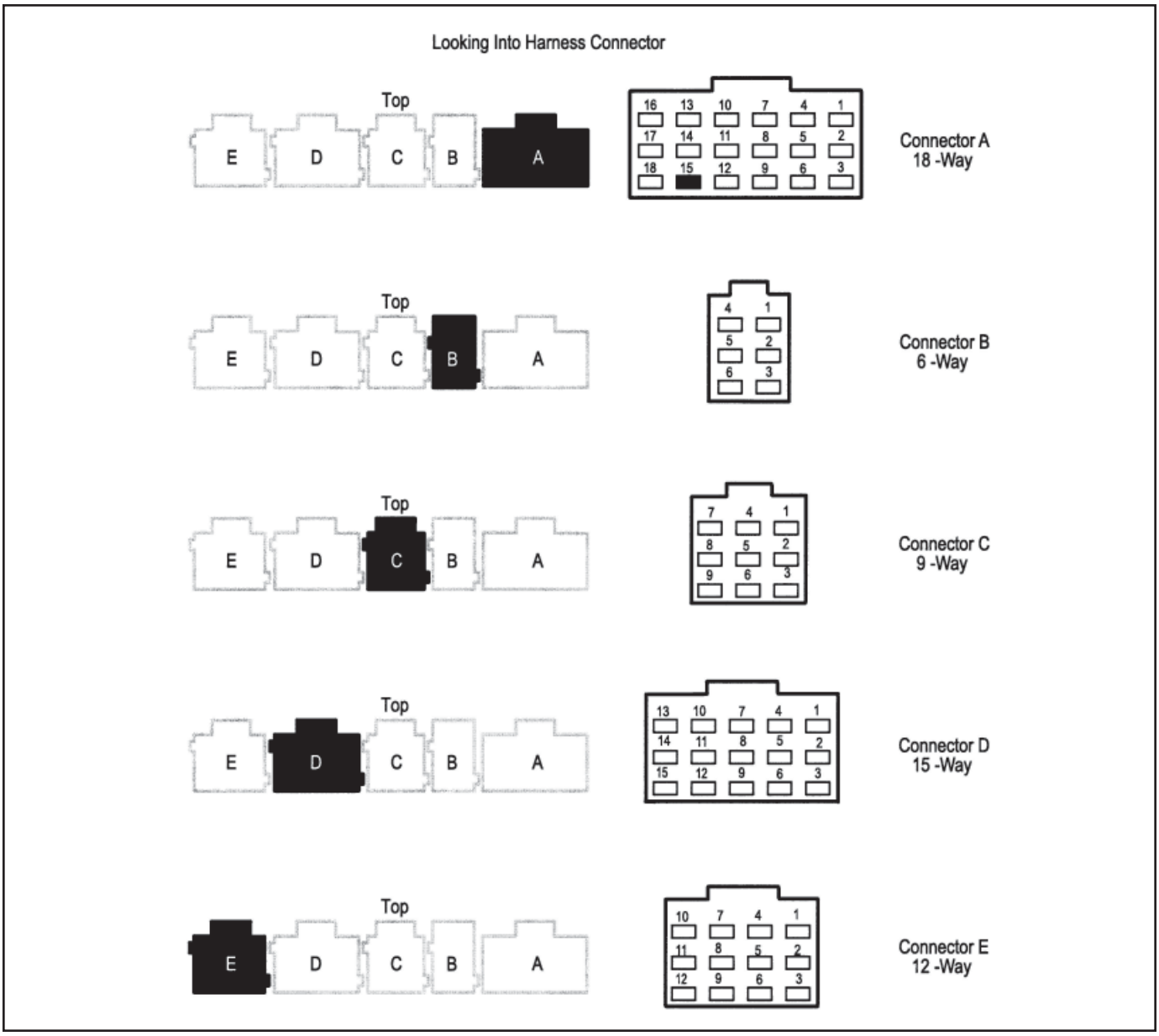


Figure 40 - Cab Mount ECU - Connector Layout

Cab Mount ECU Pin Identification

This section shows how to identify Cab Mount ECU harness connectors and pin locations. The charts provide a brief description of the signal carried by each pin.

ECU CONNECTOR	PIN	DESCRIPTION
A (18-Way)	1	J1922/J1939 -
	2	Gen-4 J1939 Shld/Gen-5 TWL
	3	J1922/J1939 +
	4	NC
	5	Off Road ABS Switch (ORS)
	6	ATC Mud & Snow Switch
	7	Ignition, Switched
	8	V Bat 2
	9	V Bat 1
	10	Ground - ECU
	11	Ground - Diagonal 2
	12	Ground - Diagonal 1
	13	SAE J1587-
	14	SAE J1587+
	15	NC, Interlock
	16	ATC Light
	17	Retarder Relay
	18	Warning Light/Diagnostic Switch
B (6-Way)	1	PMV1 (Left Steer), Rel Solenoid
	2	PMV1 (Left Steer), Hold Solenoid
	3	PMV1 (Left Steer), Common
	4	Speed Sensor 2 (Left Steer) +
	5	Speed Sensor 2 (Left Steer) -
	6	Brake Light Switch
C (9-Way)	1	NC
	2	NC
	3	NC
	4	Speed Sensor 3 (Right Steer) +
	5	Speed Sensor 3 (Right Steer) -
	6	NC
	7	PMV2 (Right Steer), Rel Solenoid
	8	PMV2 (Right Steer), Hold Solenoid
	9	PMV2 (Right Steer), Common

ECU CONNECTOR	PIN	DESCRIPTION
D (15-Way)	1	PMV3 (Left Rear), Rel Solenoid
	2	PMV3 (Left Rear), Hold Solenoid
	3	PMV3 (Left Rear), Common
	4	ATC Valve -
	5	Speed Sensor 4 (Left Rear) +
	6	Speed Sensor 4 (Left Rear) -
	7	ATC Valve +
	8	Speed Sensor 5 (Right Rear) +
	9	Speed Sensor 5 (Right Rear) -
	10	PMV4 (Right Rear), Rel Solenoid
	11	PMV4 (Right Rear), Hold Solenoid
	12	PMV4 (Right Rear), Common
	13	NC
	14	NC
	15	NC
E (12-Way)	1	PMV5 (Left Rear Rear), Rel Solenoid
	2	PMV5 (Left Rear Rear), Hold Solenoid
	3	PMV5 (Left Rear Rear), Common
	4	NC
	5	Speed Sensor 6 (Left Rear Rear) +
	6	Speed Sensor 6 (Left Rear Rear) -
	7	NC
	8	Speed Sensor 7 (Right Rear Rear) +
	9	Speed Sensor 7 (Right Rear Rear) -
	10	PMV6 (Right Rear Rear), Rel Solenoid
	11	PMV6 (Right Rear Rear), Hold Solenoid
	12	PMV6 (Right Rear Rear), Common

Figure 41 - Cab Mount ECU - Pin Identification Chart

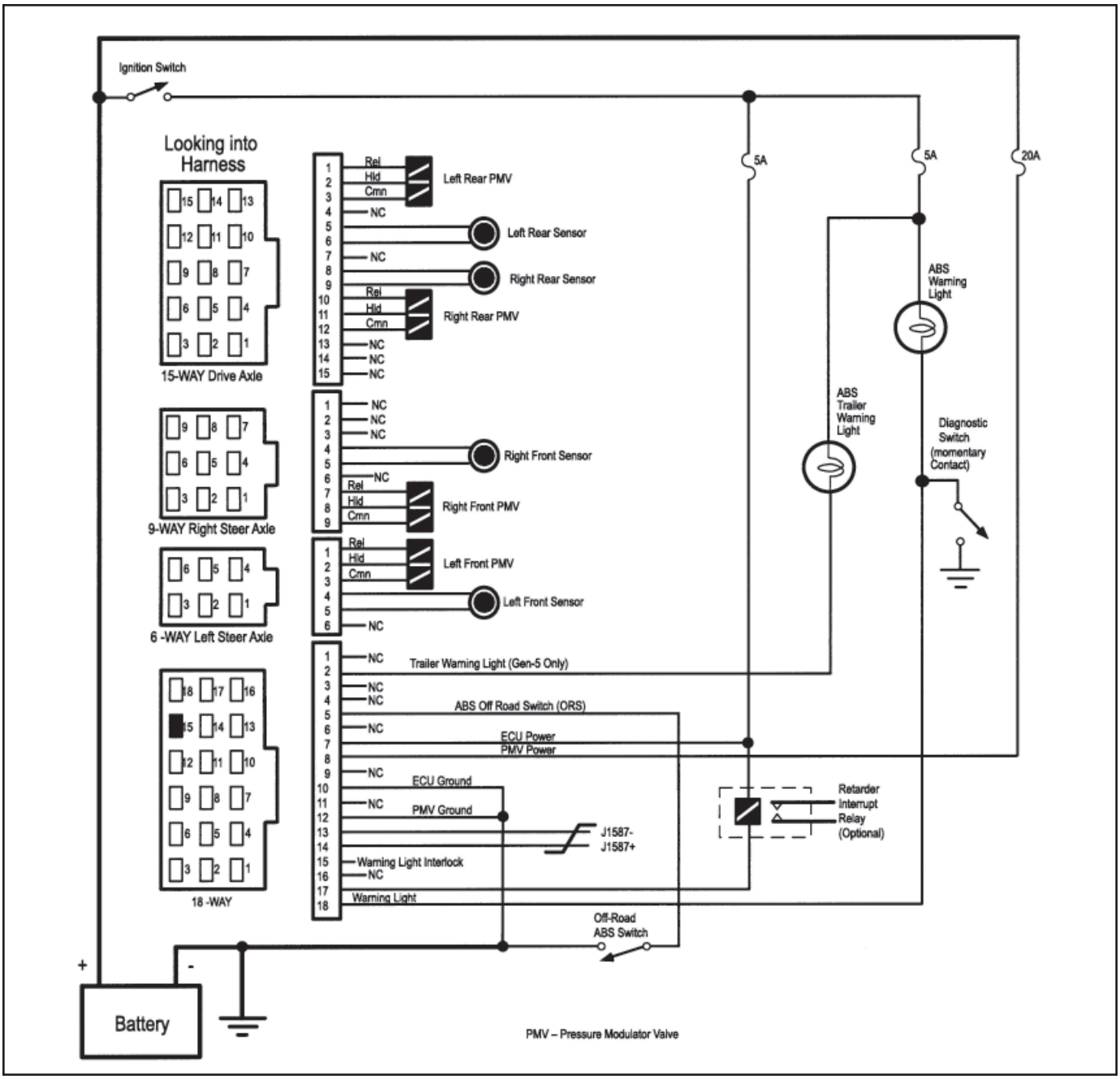


Figure 42 - Generation 4 and 5 Basic Cab Mount ABS Electrical Schematic

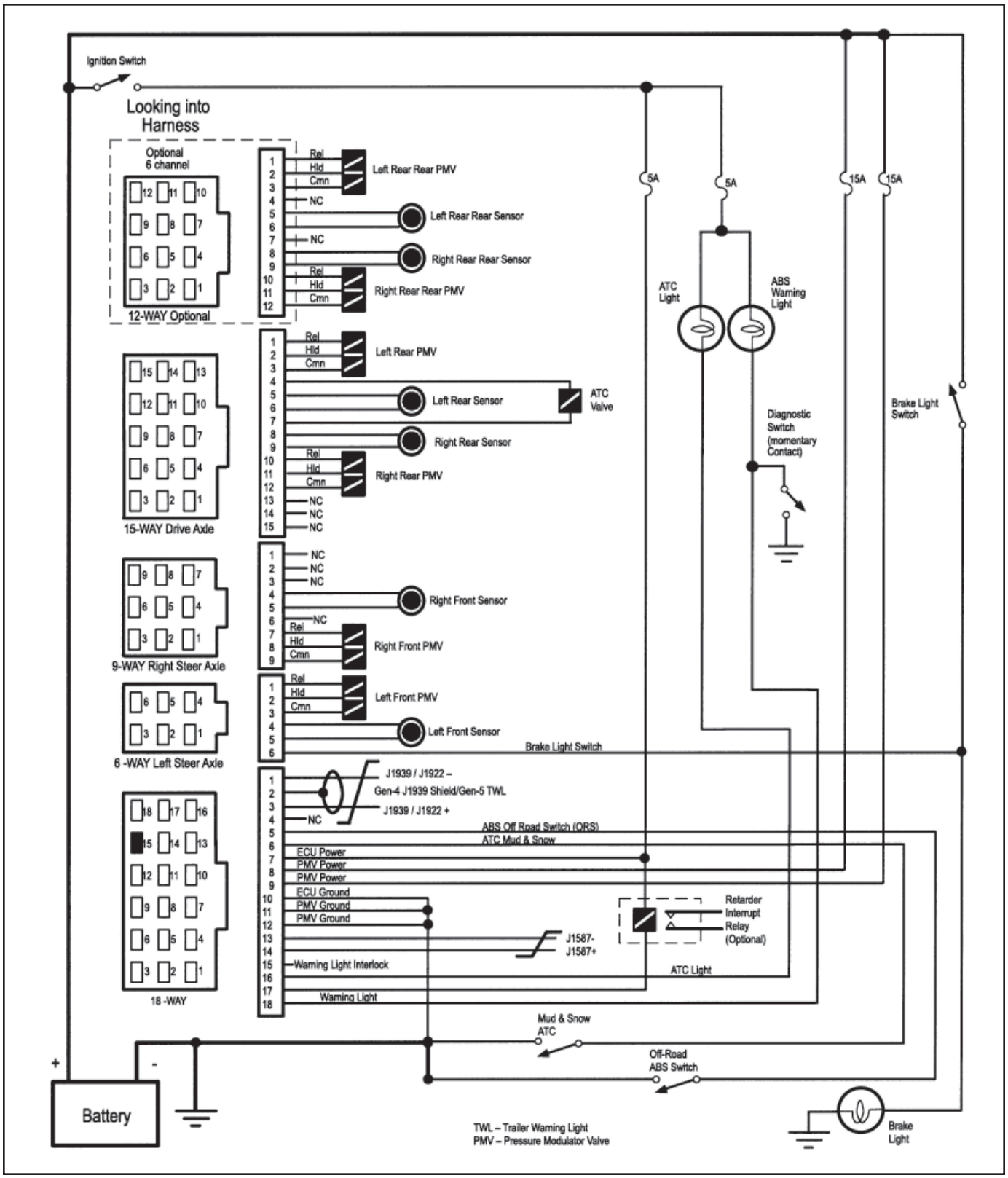


Figure 43 - Generation 4 and 5 Standard Cab Mount ABS Electrical Schematic

Air Brakes

A coach equipped with a dual air brake system consists of separate complete systems for the front and rear service brakes. A separate reservoir and air gauge is provided for each of these systems. A dual treadle valve is provided for operating the service brake system. In addition to providing excellent service brake performance, this dual brake system is equipped with safety features which allow the driver to use the emergency stopping system through the service brake treadle valve. In the event of a failure in the air reserve for the front brakes, the rear service brakes can still be applied using the treadle valve, since the two service brake systems operate independently. If there is a failure in the air reserve for the rear service brake system, the front service brakes and the rear spring brakes can be applied through the treadle valve. This allows the operator to use a normal method of braking during an emergency situation.

However, in the case of an air reserve failure, the low air pressure warning buzzer will sound and warning light will activate, and the respective air gauge on the dash will indicate which system has lost air pressure. The coach must not be operated under those conditions, but repaired before continuing operation.

The rear spring brakes can also be actuated by pulling the dash-mounted Parking Brake valve knob located on the lower portion of the instrument panel. These spring brakes cannot be fully released until the air reserve pressure is above 65 psi. These brakes are in the released position when the control valve is pushed in, and in the applied position when the control valve is out. If there is a loss in air pressure, the valve will automatically move to the brake applied position and cannot be released until the air reserve pressure has been replenished.

Schrader Valve

A Schrader valve is provided in the engine compartment to facilitate charging the air brake system using the common type of air hose found at service stations and garages. Charging the system in this manner should only be done for emergency or service-related temporary purposes, such as to be able to move a bus with an inoperative compressor or to operate the service brakes without the engine running.

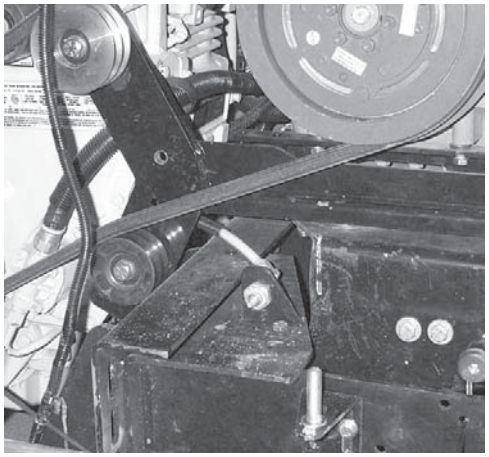


Figure 44 - Schrader Valve

Parking

Use the dash-mounted Parking Brake valve to apply the rear spring brake when parking the coach. When the parking brake is applied, and the ignition switch is On, a red dash-mounted light will warn the driver that the brake is applied.

CAUTION! Do not attempt to move bus before spring brakes are released.

Figure 45 - Parking Brake Valve

Draining Air Tanks

Condensation must be drained from all compressed air tanks regularly. The tanks on the Express 4500 are equipped with automatic valves which perform this purging during normal operation. An air dryer helps minimize water, oil, and other contaminants in before they reach the wet tank. The air dryer also has an automatic drain valve on its reservoir which ejects during the on-off cycle of the compressor. On valves with heating elements, freeze protection is operational when the ignition is turned on.

Releasing Spring Brakes Manually:

If air pressure fails in the brake system, a spring in the brake actuation chambers automatically applies the brakes. If system pressure cannot be reestablished, the service brakes on both sides of both rear axles must be released manually in order to move the coach.

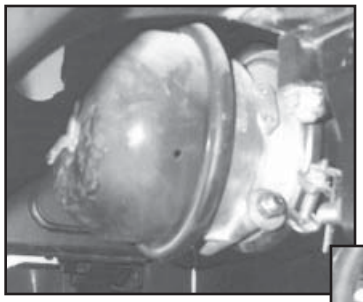


Figure 46 - Brake Pin Drive

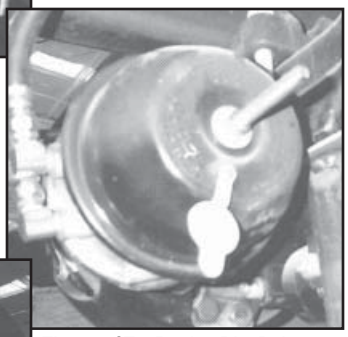


Figure 47 - Brake Pin Drive Installed

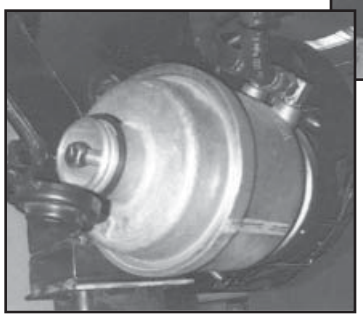


Figure 48 - Brake Release Tag Axle

WARNING!! Bus must be secured against accidental rolling with wheel chocks or by tow vehicle before brake springs are released manually. Failure to do so may result in bodily injury and/or property damage.

To manually release the drive axle brakes:

1. Remove the release stud tool and nut from the carrying pocket on the brake chamber assembly. There is one such tool for each of the two brakes.
2. Remove the access plug from the end of the spring chamber.
3. Insert the release stud through the opening in the chamber and into the spring pressure plate. Turn the release stud one quarter turn to engage the stud tangs with the slot in the pressure plate.
4. Keep the stud tangs engaged while installing the washer and nut on the outside end of the release stud. Tighten the nut until the spring is fully caged and the brake is fully released.
5. Repeat this procedure for the other side of the drive axle.

Do not loosen or remove the release stud and nut unless the brake chamber is completely assembled and is securely clamped. When air pressure is restored, remove the release stud and reinstall it in its carrying pocket.

To manually release the tag axle brakes:

1. Remove the access plug from the end of the spring chamber.
2. Using a socket wrench, tighten the exposed hex head end of the spring bolt. Tighten until the spring is completely caged and the brake is fully released.
3. Repeat this procedure for the other side of the tag axle.

Automatic Traction Control

The optional ATC (automatic traction control) function is available with all possible U12 ECU configurations. In addition to the required ABS components, ATC also requires a single ATC valve (for brake control) and an engine interface, SAE J1922/J1939 (for engine torque control). A brake switch input is also required and can be provided via the engine interface or wired directly from the brake light switch.

ATC Functional Data

Working range:

• Brake Control first time intervention	<25 MPH (40kph)
• Brake Control (needed	<25 MPH) 25 MPH up to Vmax
• Engine Control	Up to Vmas
• Engine Control Slip in ATC Deep Snow Mode	6 MPH +6%

Engine-controller Intervention

The ABS/ATC ECU communicates with the vehicle-engine ECU and informs it of the required reduction in injected fuel quantity. Depending upon the equipment fitted in the vehicle, the following interfaces are possible:

- SAE J1922
- SAE J1939

Deep Snow Mode

On surfaces like snow, mud or gravel, a Deep Snow Mode can be activated with a momentary ATC switch-connecting Pin X1-6 to ground. This mode allows greater drive wheel spin for better traction.

CAUTION! In the Deep Snow Mode, vehicle stability is reduced.

The system incorporates an automatic calibration function for tire sizes. Before this function has completed its calculations for tire size (applies particularly in case of tire-size change) differences in the calculated speeds can lead to engine-controller activity. This can be suppressed by operating the ATC Deep Snow Mode switch. The learning process is completed after the vehicle has been driven straight-ahead for several minutes. The Deep Snow Mode switch should be pushed again to return to the normal ATC function mode.

Stop Light Switch Evaluation

For all configurations with ATC, a stop light switch input to the ECU is required. The stop light switch input is not required for ABS only configurations, although for common wire harness designs it can be used. The main purpose of the stop light input information is to prevent ATC operation if the brake pedal is applied.

The stop light switch information can be delivered to the ECU either via direct wiring connection to the stop light switch (pin 6, connector x2) or via J-1939 with message CC/VS, source address 23d.

For the configuration “ABS with ATC”, when power is switched “on” the correct functioning of the SLS is checked by waiting for the transition from “operated” to “not-operated” when the brake pedal is pressed and released. If this transition does not take place after “Power On”, ATC is disabled and the ATC lamp remains on. The corresponding information is then available through blink codes or J1587 diagnosis.

This information is not stored permanently in the EEPROM. As soon as the brake pedal is pressed again the information disappears, the ATC lamp goes out, and the ATC function is enabled for operation.

If there is a fault in the SLS-information, or in the respective wiring (cable break, short-circuit to battery), the ECU is unable to detect the brake-pedal actuation. If the ATC lamp fails to go out even though the brake pedal has been actuated, and the SLS fault code is still displayed, this indicates a fault in the stop light switch or the wiring. ATC will remain disabled until the fault is corrected.

ATC Indicator Lamp

The ATC indicator lamp is illuminated in the following circumstances:

- At key-ON the lamp remains ON until the driver presses the brake pedal.
- When the Deep Snow Mode is selected, the lamp flashes ON and OFF slowly.
- During automatic traction control system operation, the lamp flashes ON and OFF rapidly.
- The lamp remains ON if the stop light has not activated since power-up, or if the stop light switch or the engine interface communication is not detected.
- When ATC is disabled for dyno testing, the lamp remains ON.

Heating and Air Conditioning

Introduction

This vehicle is supplied with a ThermoKing LRT-HP, LRT-SP Roof Air Conditioning unit. This section is intended for informational purposes only. The entire ThermoKing Maintenance and Parts manuals are supplied in the Maintenance manual that is supplied with this coach.

This section is to be used as an overview for basic operating and troubleshooting procedures. Please refer to the entire manual in the Maintenance Manual that is supplied with the coach if further assistance is required.

LRT-HP, LRT-SP Model Systems Matrix

NOTE: When calling the dealer or factory for information or parts please have the Bill of Material number for your particular unit handy.

LRT-HP

System #	Description	Cond/Evap B/M	Comp Kit	Install Kit	Grille Filter Kit	Fan Motor	Control Voltage	Schem/Wiring Diagram
920401	7.5 meter	099916/ 006541	720747	800009	720777	Spal	24 Vdc	1E11954/ 1E1955

LRT-SP

System #	Description	Cond/Evap B/M	Comp Kit	Install Kit	Grille Filter Kit	Fan Motor	Control Voltage	Schem/Wiring Diagram
920280	11 meter	006616/ 006615	720776	819990	720777	Spal	24 Vdc	1E1954/ 1E1955

Safety Precautions

NOTE: EPA Section 608 Certification is required to work on refrigeration systems.

Thermo King recommends that all services be performed by a Thermo King dealer. However, you should be aware of several general safety practices.

DANGER!! Denotes the possibility of serious injury or death.

WARNING!! Denotes the possibility of serious equipment damage or serious personal injury.

CAUTION! Denotes the possibility of minor to severe equipment damage or personal injury.

General Practices

DANGER!! Do not operate the compressor with the discharge valve closed. This condition increases internal pressure which can cause an explosion.

DANGER!! Never apply heat to a sealed refrigeration system or container. Heat increases internal pressure, which might cause an explosion.

DANGER!! Refrigerant in the presence of an open flame, spark or electrical short produces toxic gases that are severe respiratory irritants.

DANGER!! Keep your hands, clothing and tools clear of fans, pulleys, or belts when working on a unit that is running. Loose clothing might entangle moving fans, pulleys, or belts, causing serious injury or possible death.

DANGER!! Do not inhale refrigerant. Use caution when working with refrigerant or a refrigerant system in any confined area with a limited air supply, such as a bus or garage. Refrigerant displaces air and can cause oxygen depletion, resulting in suffocation and possible death.

WARNING!! Make sure your gauge manifold hoses are in good condition before using them. Never let them come in contact with moving belts, motors, engine pulleys or hot surfaces. Defective gauge equipment can damage components or cause serious injury.

WARNING!! Wear goggles or safety glasses when working around air conditioning systems or batteries. Refrigerant liquid, oil and battery acid can permanently damage your eyes.

WARNING!! Use extreme caution when drilling holes in the unit. Holes might weaken structural components. Holes drilled into electrical wiring cause a fire or explosion.

WARNING!! Use extreme caution when drilling holes in the unit. Holes might weaken structural components. Holes drilled into electrical wiring can cause a fire or explosion.

WARNING!! Exposed coil fins can cause lacerations. Service work on the evaporator or condenser coils is best left to a certified Thermo King technician.

WARNING!! Be careful when using ladders or scaffolding to install or service air conditioning systems. A work platform is recommended for servicing rooftop units. Follow the manufacturer's instructions, safety labels and warnings.

CAUTION! Make sure all mounting bolts are tight and are the correct length for their applications. Improper torque and incorrect bolt lengths can damage equipment.

CAUTION! If soldering is required, use dry nitrogen to purge the system during any solder operations. Refer to "*Using Pressurized Nitrogen*" at the end of Refrigeration Maintenance section.

Battery Removal Hazards

DANGER!! Disconnect the negative terminal (-) first when removing a battery. Connect the positive terminal (+) first when installing a battery.

This order is important because the frame is grounded to the negative battery terminal. If the negative terminal is still connected, a complete circuit exists from the positive terminal of the battery to the frame. Metal objects contacting the positive side and the frame simultaneously will cause sparks or arcing. If there are sufficient hydrogen gases emitted from the battery, an explosion might occur, causing equipment damage, serious injury, even death.

CAUTION! Use recommended procedures when servicing equipment. Improper procedures might damage equipment.

Engine Coolant Hazards

CAUTION! Do not use coolant "boosters" or anti-corrosion additives in older Thermo King units (five to seven years old) as it will deteriorate the rubber/neoprene parts/hoses. Contact your local Thermo King dealer for additional information.

CAUTION! Use a mixture of 50 percent antifreeze and 50 percent water in Thermo King bus air conditioning and heating units manufactured with heating coils. This blend prevents coil freezing and asissts in preventing corrosion buildup.

Electrical Hazards

WARNING!! Control circuits used by bus air conditioners are low voltage (12 or 24 volts dc). This voltage is not dangerous, but the large amount of amperage available from the alternator can cause severe burns if accidentally shorted to ground with metal objects, such as tools.

WARNING!! Do not wear jewelry, watches or rings because they increase the risk of shorting out electrical circuits and damaging equipment or causing severe burns.

WARNING!! Use caution when working with electrical circuits that have been capacitors. Some capacitors hold a significant charge that might cause burns or shocks if accidentally discharged. Make sure capacitors are discharged before working on electrical circuits.

CAUTION! When working with electrical circuits that contain microprocessors, always wear an ESD wrist strap (TK No. 204-622) and connect the opposite end to the chassis ground or CH terminal. This precaution will prevent electrostatic discharge from damaging circuits.

CAUTION! Certain service procedures on bus air conditioning equipment require that the system be de-energized. When this precaution is necessary, ensure the battery's master switch or service switch is turned off. Confirm that power has been removed before servicing. Equipment that is connected to power is dangerous to service.

Refrigerant Hazards

DANGER!! Do not use a Halide torch. When a flame comes in contact with refrigerant, toxic gases are produced that might cause suffocation, even death.

DANGER!! Store refrigerant in proper containers, out of direct sunlight and away from intense heat. Heat increases pressure inside storage containers, which can cause them to burst.

DANGER!! Do not use oxygen (0_2) or compressed air for leak testing systems. Oxygen mixed with refrigerant is combustible.

WARNING!! Wear protective garments and goggles or safety glasses when working with refrigerant to prevent frostbite and eye injuries.

WARNING!! Wear butyl lined gloves when handling refrigerant to prevent frostbite and eye injuries.

CAUTION! All charging using the newer refrigerants (Azeotropic blends) must be done in liquid state. Failure to do this will decrease system operating efficiency. Refer to the charging procedures found in this manual for your unit.

CAUTION! When recovering or transferring refrigerant, use a process that prevents refrigerant from escaping into the atmosphere. Refrigerant damages the earth's upper ozone layer.

CAUTION! Refrigerant in a liquid state evaporates rapidly when exposed to the atmosphere, freezing anything it contacts. Be careful when handling refrigerant to protect your skin from frostbite.

Refrigerant Oil Hazards

WARNING!! Protect your eyes from contact with refrigerant oil. The oil can cause serious eye injuries. Avoid prolonged or repeated contact with refrigerant oil. To prevent irritation, wash your hands and clothing thoroughly after handling the oil.

CAUTION! Do not mix refrigerant oils because that can cause system damage.

CAUTION! Use dedicated equipment to prevent contaminating the system with the wrong type of oil or refrigerant.

CAUTION! Thermo King uses a variety of compressor oils. Oil used in the system must be verified. Check ID label or Specification section in this manual for correct oil. Using incorrect oil will invalidate the warranty.

CAUTION! When servicing TK units, do not use equipment that might be contaminated with PAG oils.

CAUTION! Store refrigerant oil in an approved sealed container to avoid moisture contamination.

CAUTION! Do not expose refrigerant oil to the air any longer than necessary. The oil will absorb moisture, which results in much longer evacuation times and possible system contamination.

CAUTION! Wipe up spills immediately. Refrigerant oil can damage paints and rubber materials.

First Aid

Engine Coolant

Eyes: In case of eye contact, immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Ingestion: Do not induce vomitting. Immediately contact local poison control center or physician.

Refrigerant Oil

Eyes: Immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Ingestion: Do not induce vomitting. Immediately contact local poison control center or physician.

Refrigerant

In the event of frostbite, protect the frozen area from further injury, warm the area rapidly and maintain respiration.

Eyes: Immediately flush eyes with large amounts of water. CALL A PHYSICIAN.

Skin: Flush area with large amounts of warm water. Do not apply heat. Remove contaminated clothing and shoes. Wrap burns with dry, sterile, bulky dressing to protect from infection. CALL A PHYSICAN. Wash contaminated clothing before reuse.

Inhalation: Move victim to fresh air and use CPR (cardio pulmonary resuscitation) or mouth-to-mouth resuscitation to restore breathing, if necessary. Stay with victim until emergency personnel arrive.

Battery Acid

Eyes: Immediately flush with water for at least 15 minutes. CALL A PHYSICIAN. Wash skin with soap and water.

Specifications

Electrical Control (all units)

Software Version (IntelligAIRE II)	P3.0
Software Application File Software Configuration File	2C40104H03 2C40105H28
Control Panel Relays	
Type Voltage: Maximum Vdc @ 85C Voltage: Pull-In Resistance Coil Operating Current Contact Rating Restive: Normally Open (NO)	Double Pole Single Throw (DPST) 30.0 Vdc 14.4 Vdc 272 ± 10 ohms 88 mA 40 A @ 14 Vdc
Solenoid (Coolant) Valve	
Type Voltage Resistance	Normally closed 27 Vdc 38.4 ± 10 percent ohms @ 77 F (25 C)

Motors (all units)

Condenser Fan Motor Assemblies (3)	
Model Type Horsepower Voltage Current Draw - Full Load RPM - Full Load	Spal Axial VLL 0.273 hp 27 Vdc 10 amps 3300
Evaporator Fan Motor Assemblies (3)	
Model Type Horsepower Voltage Current Draw - Full Load RPM - Full Load	Spal Centrifugal Blower Motor VLL 0.36 27 Vdc 10 amps 3800
Fresh Air Damper Motor (Units with Fresh Air option only)	
Voltage	27 Vdc

Refrigerant-LRT-HP

Type	R-22, R407C, R134a
Refrigerant Charge (System)	See unit charging procedures in the Refrigeration Maintenance section.

Refrigerant-LRT-SP

Type	R134a
Refrigerant Charge (System)	See unit charging procedures in the Refrigeration Maintenance section.

Refrigerant Controls for R-22 and R407C

Condensor Pressure Switch	
Opens Closes	200 ± 20 psig (1379 ± 138 kPa) 300 ± 25/-0 psig (2068 ± 172/-0 kPa)
Expansion Valve	
Type Superheat Setting Connection	External equalizer with Strainer 10 to 15 F (6 to 9 C) Solder
Evaporator Pressure Regulator (EPR) (Orit 15)	
Type Adjusted Minimum Pressure	Pilot operated - adjustable 50 ± 1 psig (345 ± 7 kPa)
High Pressure Relief Valve	
Opens Closes	500 + 75/-15 psig (3447 + 517/-103 kPa) 400 psig (2758 kPa)

Refrigerant Controls for R134a Units

Condensor Pressure Switch	
Opens Closes	160 ± 7 psig (1103 ± 48 kPa) 200 ± 7 psig (1379 ± 48 kPa)
Expansion Valve	
Type Superheat Setting Connection	External equalizer with Strainer 10 to 15 F (6 to 9 C) Solder
Evaporator Pressure Regulator (EPR) (Orit 15)	
Type Adjusted Minimum Pressure	Pilot operated - adjustable 24 ± 1 psig (166 ± 7 kPa)
High Pressure Relief Valve	
Opens Closes	500 + 75/-15 psig (3447 + 517/-103 kPa) 400 psig (2758 kPa)

X430 Compressor, R-134a

Model		X430
Displacement		30 cid (492 cm^3)
Recommended Operating Range		800 to 3000 rpm
Oil Charge (Compressor)		119 oz. (3.5 liters)
Oil Type: R-134a (Solest 35)[1] [2]		Ester Base
Oil Pump Operating Pressure Range		15 to 45 psig (103 to 310 kPa)
Weight (w/Clutch and Service Valves)		115 lb (52 kg)
CAUTION: Failure to use correct Thermo King recommended oil will invalidate your warranty.		
X430 Compressor Clutch:	Type	Electromagnetic
	Voltage	27 Vdc
	Resistance[3]	12 ohms @ 100 F (38 C) 11.6 ohms @ 75 F (24 C) 11.2 ohms @ 50 F (10 C)
	Air Gap	0.45 ± 0.005 in. (1.143 ± 1.127 mm)
	Bearing Grease	Exxon Unirex N2[1]
	Rotation	Clockwise
	Pulley Diameter	7.75 OD
	Pulley Groove	2-5V
Low Pressure Cutout Switch		
	Opens	5-17 in. Hg vacuum
	Closes	1-7 psig (7-48 kPa)
High Pressure Cutout Switch		
	Opens	360 ± 10 psig (2482 ± 69 kPa)
	Closes	240 ± 20 psig (1655 ± 38 kPa)

1 Consult the Thermo King Parts Catalog for Part Number.
2 Failure to use the correct Thermo King-recommended oil will invalidate your warranty.
3 For additional information, refer to the “Clutch Coil Electrical Check” in the Clutch Maintenance section in this manual.

X430 Compressor, R-22, R407C

Model		X430
Displacement		30 cid (492 cm^3)
Recommended Operating Range		800 to 3000 rpm
Oil Charge (Compressor)		119 oz. (3.5 liters)
Oil Type for R22[1] [2]		Alkylbenzene
Oil Type for R407C[1] [2]		Ester Base
Oil Pump Operating Pressure Range		15 to 45 psig (103 to 310 kPa)
Weight (w/Clutch and Service Valves)		115 lb (52 kg)
CAUTION: Failure to use correct Thermo King recommended oil will invalidate your warranty.		
X430 Compressor Clutch:	Type	Electromagnetic
	Voltage	27 Vdc
	Resistance[3]	12 ohms @ 100 F (38 C) 11.6 ohms @ 75 F (24 C) 11.2 ohms @ 50 F (10 C)
	Air Gap	0.45 ± 0.005 in. (1.143 ± 1.127 mm)
	Bearing Grease	Exxon Unirex N2[1]
	Rotation	Clockwise
	Pulley Diameter	7.75 OD
	Pulley Groove	2-5V
Low Pressure Cutout Switch		
	Opens	5-17 in. Hg vacuum
	Closes	1-7 psig (7-48 kPa)
High Pressure Cutout Switch		
	Opens	470 ± 7 psig (3241 ± 48 kPa)
	Closes	375 ± 38 psig (2586 ± 262 kPa)

1 Consult the Thermo King Parts Catalog for Part Number.
2 Failure to use the correct Thermo King-recommended oil will invalidate your warranty.
3 For additional information, refer to the “Clutch Coil Electrical Check” in the Clutch Maintenance section in this manual.

Solder Applications

Components	Used for:	Details
Copper to copper or copper to brass	General refrigeration tubing connections	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 15% Silver TK No. 203-364 Use: Flux Type TK No. 203-365
Copper to stainless steel or brass to stainless steel	Hot water tubing connections of dissimilar metals	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

Components	Used for:	Details
Copper to copper or copper to brass	Hot water tubing connections	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 95% Tin and 5% antimony TK No. 204-167 Use: Flux Type TK No. 204-417
Copper to stainless steel or brass to stainless steel	Hot water tubing connections of dissimilar metals	Joint Clearances: 0.003 to 0.005 in. (0.076 to 0.127 mm) Use: Solder Type 35% Silver TK No. 203-366 Use: Flux Type TK No. 203-365

NOTE: Some units may be equipped with an evaporator pressure regulating valve (EPR). To reduce the chance of overheating the EPR valve, 95-5 solder or equivalent may be used.
Use 95-5 TK No. 204-167
Use Flux TK No. 204-417

Physical Specifications

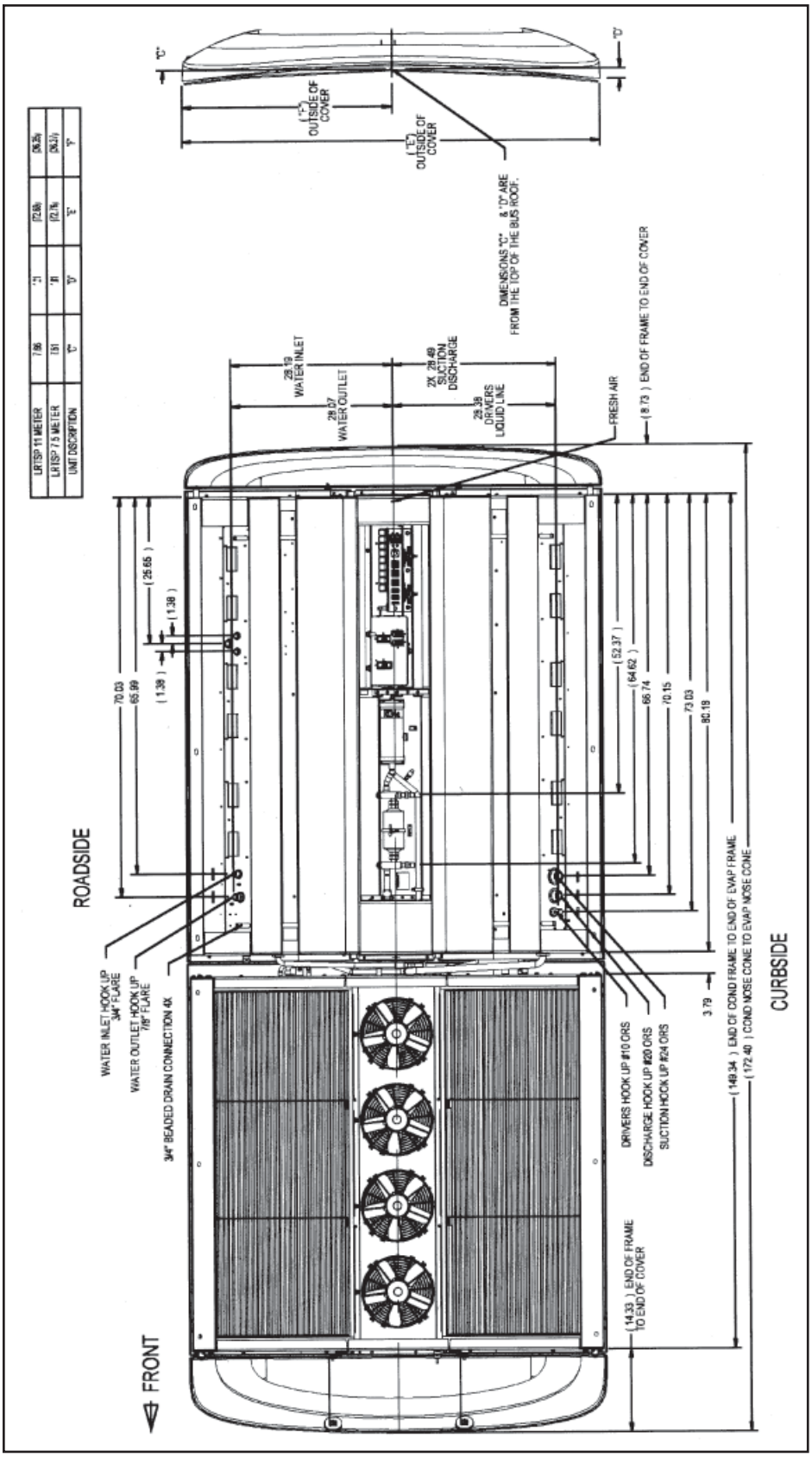


Figure 1: LRT-SP Dimensions

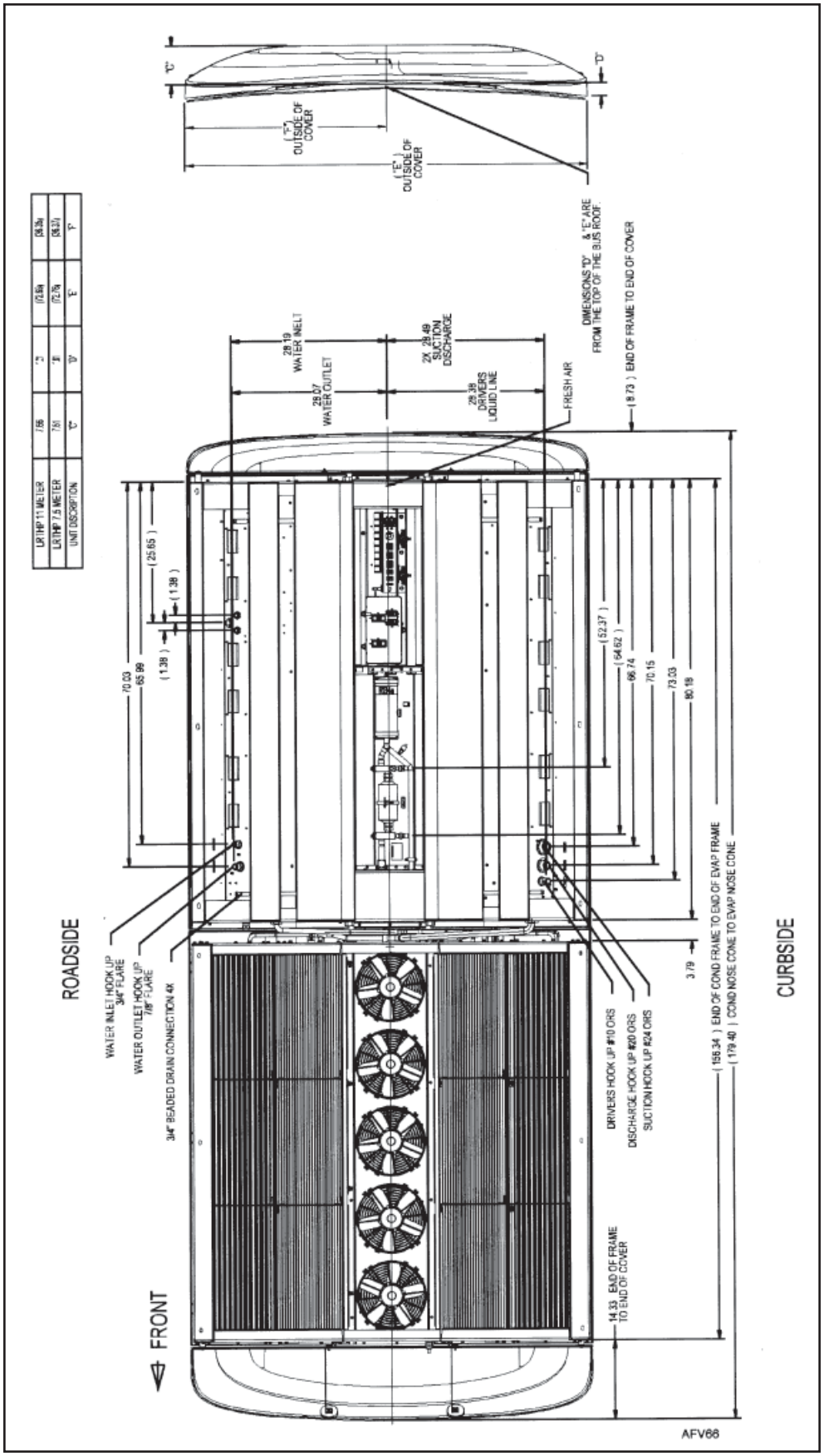


Figure 2: LRT-HP Outline Dimensions

General Description

Unit Overview

The LRT-HP and LRT-SP are roof-mounted air conditioning units with a low, aerodynamic profile designed for inner city and tour buses. Units are available in a 7.5 or 11 m radius base. The SP is a medium capacity unit, and the HP is a high capacity unit.

Thermo King IntelligAIRE™ II

The IntelligAIRE™ microprocessor controls temperatures in up to three zones. It has a base module, an optional display module, and up to four expansion modules. It has an RS232 interface for downloading data to a PC. For more information, see the "IntelligAIR II" section in the Maintenance Manual.

X430 Compressor

The X430 is a 30 cid (491.6 cm3), four-cylinder, V-type, reciprocating compressor. Maximum operating speed is 3000 rpm. The compressor is belt-driven by the bus engine through the electric clutch. Large grease cavities provide bearing lubrication. A grease fitting in the front seal allows lubrication without disassembly.

Cutout switches provide protection from high and low refrigerant pressures. Suction and discharge service valves with gauge manifold ports provide easy servicing.

Serial Number Locations

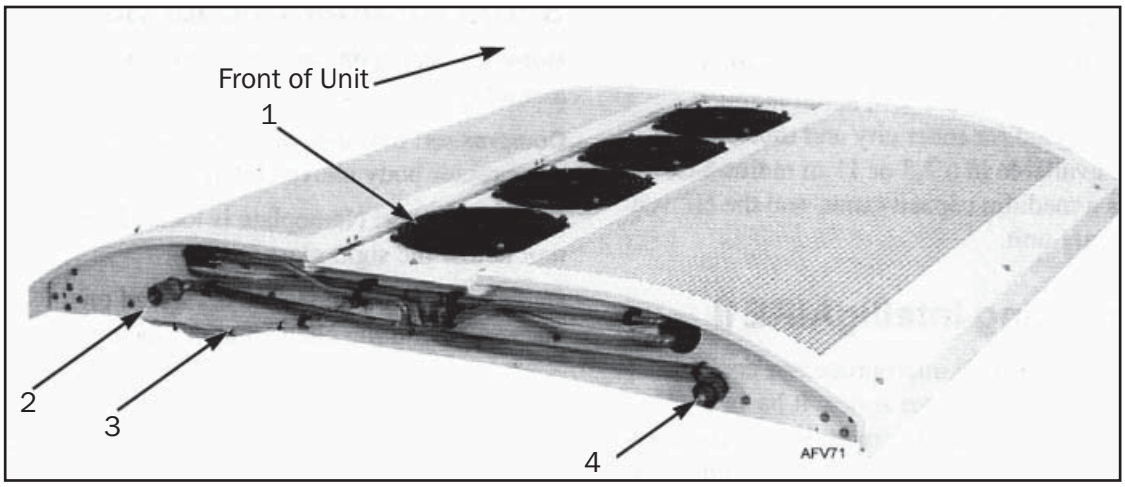
Motors: Located on back of motor housing assembly.

Compressor: Stamped on plate attached to compressor body above clutch.

Unit Evaporator: Nameplate is located inside of unit below the sight glass.

Unit Condenser: Nameplate is located on the curbside mounting channel under the cover.

Photos and Illustrations



1.	Condenser Fan (4)	3.	Electrical Harness
2.	Liquid Line	4.	Discharge Line

Figure 3: LRT-SP Condenser, Evaporator Connection Lines Shown

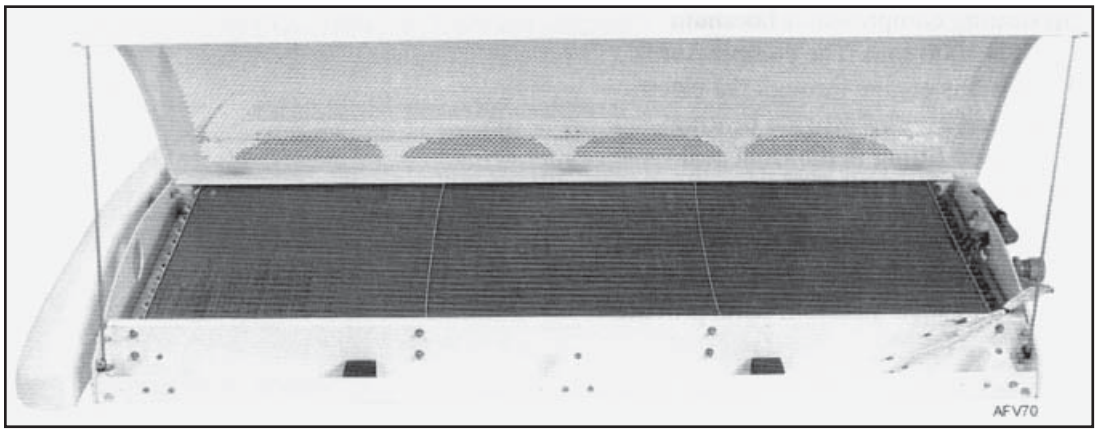
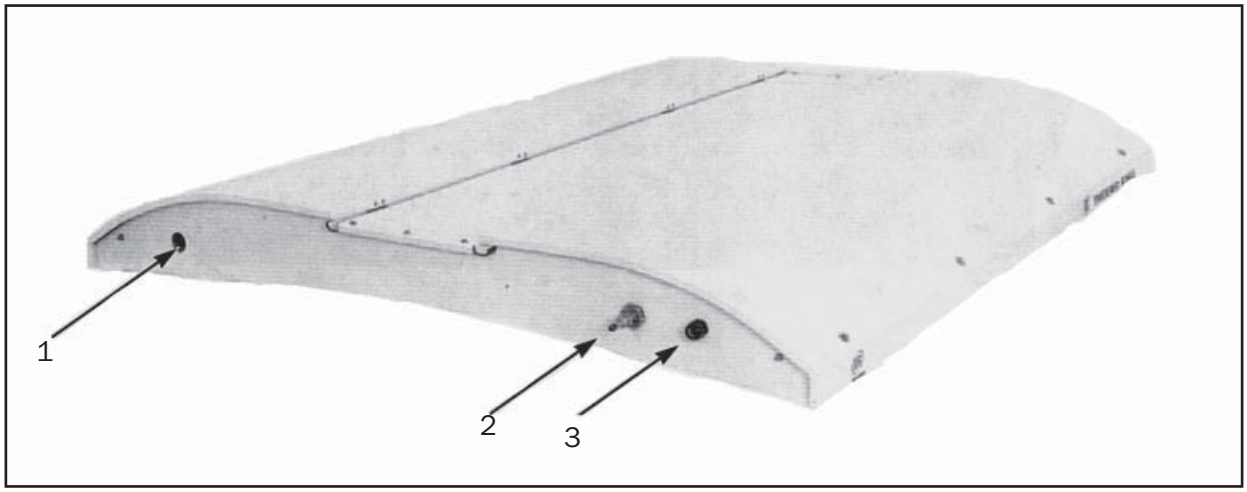
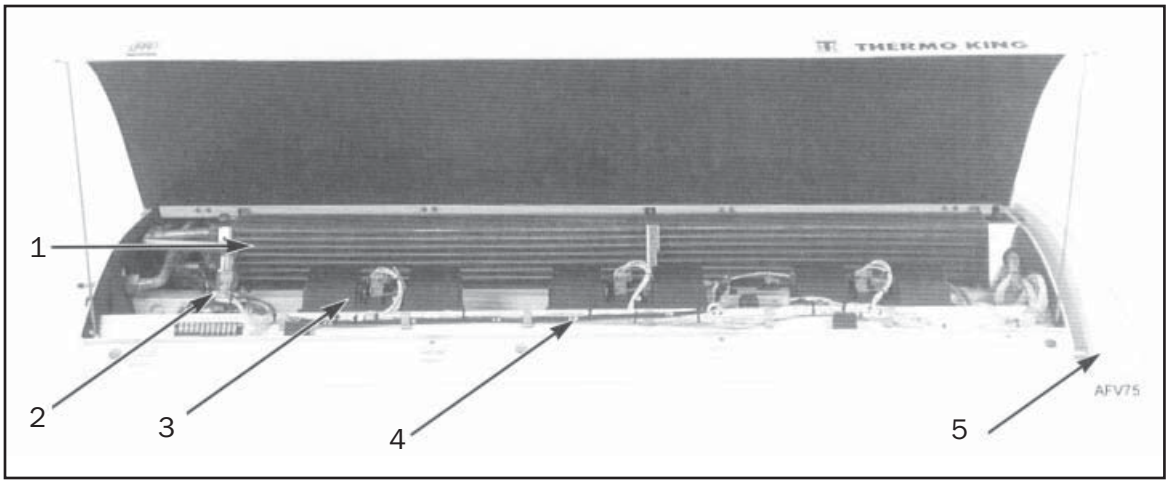


Figure 4: Condenser Coil



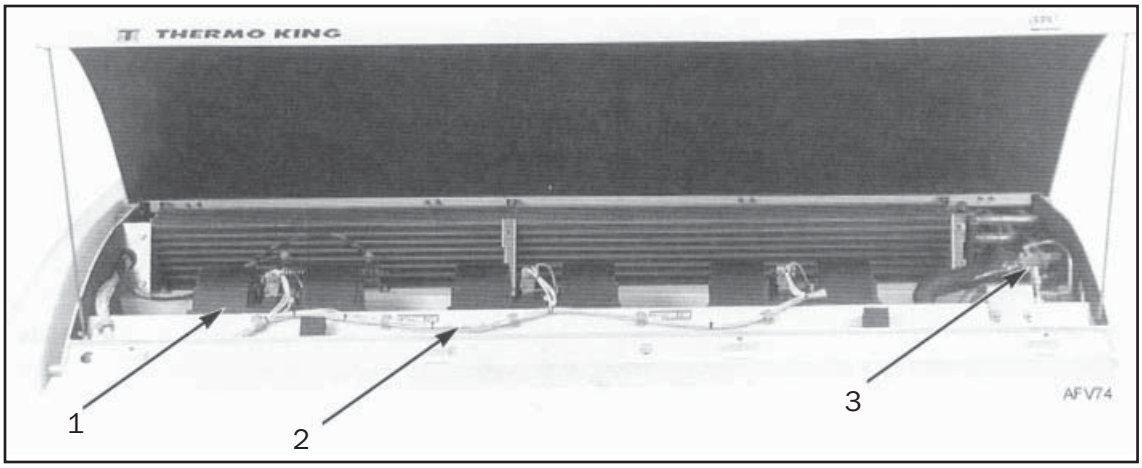
1.	Discharge Line	2.	Liquid Line
3.	Electrical Harness Connector (to Condenser)		

Figure 5: LRT Evaporator



1.	Evaporator Coil	2.	Coolant Valve
3.	Blower (3)	4.	Electrical Harness
5.	Rear Nose Cone		

Figure 6: LRT-SP Evaporator, Roadside View



1.	Blower (3)	2.	Electrical Harness
3.	EPR Valve and EPR Valve Shutoff Valve		

Figure 7: LRT-SP Evaporator, Curbside View

Driver Controls
Mode Switch (MSW) (Bus OEM Supplied)

When this switch is provided by the OEM, its function is to allow the driver to select the mode of operation for the HVAC system. Available modes include, Cool, Vent, Heat, and Automatic. When not provided, the IntelligAIRE control system will operate the HVAC system in the Automatic mode.

For buses equipped with the Programmable Logic Controller (PLC), the PLC uses the input from the mode switch and then energizes the appropriate circuit into the microprocessor controller system so the HVAC system will function in the desired mode.

NOTE: Refer to bus OEM maintenance manuals for information on PLC and associated control logic.

Driver Defrost Switch (DDS) (OEM Supplied)

When heat is selected for the front defrost/heater unit, the DDS activities the boost pump (BP).

Fan Switch (FSW) (OEM Supplied)

This switch controls blower speed in Heat or Vent mode. Two switch settings are provided, High speed and Low speed.

Unit Controls

IntelligAIRE™ II Control System

This unit uses the IntelligAIRE™ II microprocessor controller. The IntelligAIRE™ II interface allows you to easily download alarm codes for troubleshooting, and to easily upload programs for new configurations. It has a completely sealed control panel for maximum safety and durability, and can be used to control up to three temperature zones. See the microprocessor controller section in this manual for more information.

Ambient Temperature Sensor (ATS)

The ATS monitors outside air temperature and sends a signal to the controller, enabling the controller to select Cool or Heat mode, when running in Auto mode operation.

Return Air Temperature Sensor (RTS)

The RTS is located in the evaporator section. It monitors the return air temperature from inside the bus and sends a signal to the controller, regulating the compartment air temperature and humidity.

Coil Temperature Sensor (CTS)

The CTS monitors the evaporator coil temperature and sends a signal to the controller. If the coil temperature drops too low, the controller stops the compressor to prevent the evaporator coil from freezing. The controller starts the compressor after the coil temperature rises enough to keep the evaporator coil from freezing.

Water (Coolant) Temperature Sensor (WTS)

The WTS is a standard sensor on IntelligAIRE™ II systems that prevents the blowers from operating until the coolant is warm enough to heat the bus interior.

Condenser Pressure Switch (CPS)

The condenser pressure switch monitors the discharge (condenser) pressure. When the discharge pressure reaches the switch setpoint, it changes the condenser fan speed.

Evaporator Pressure Regulator (EPR)

The EPR valve is installed on the suction line and controls the pressure in the evaporator coil to prevent the coil from icing. See *"Specifications"* for the EPR pressure setting.

System Controlled Components

Coolant Valve

This coolant valve controls the flow of engine coolant to the evaporator heater coils.

Boost Pump (OEM Supplied)

The boost pump increases the flow of engine coolant to the heating coil or driver defrost heater.
Evaporator Blower Motors
These motors turn the blower wheels that pull the compartment air through the filters and evaporator/heater coils to provide conditioned air to the passenger compartment.

Evaporator Blower Motors

These motors turn the blower wheels that pull the compartment air through the filters and evaporator/heater coils to provide conditioned air to the passenger compartment.

Condenser Fan Motors

These motors turn the fans that draw air through the condenser coils. As this airflow passes through the condenser coils, it cools and condenses the refrigerant inside the condenser coils.

Compressor Clutch

The compressor clutch is an electromagnetic device that engages the belt-driven pulley to the engine belt-driven compresser.

Unit Indicators

Liquid Line Sight Glass

The liquid line sight glass shows the flow of liquid refrigerant leaving the drier. A clear sight glass with an occasional bubble indicates normal flow. A stream of bubbles indicates a low refrigerant charge, or an obstruction in the system.

The moisture indicator (dry eye) in the liquid line sight glass shows the level of moisture in the system by changing color. Check the color of the indicator against the color decal on the sight glass. The dry eye in the sight glass is GREEN when the system is dry and YELLOW when the system is wet (contains excessive moisture).

Compressor Oil Sight Glass

The compressor oil sight glass indicates the level of compressor oil in the compressor sump.

Unit Protection Devices

High Pressure Relief Valve

A high pressure relief valve is installed in the refrigerant tubing system to vent excessive pressure buildup if necessary.

Low Pressure Cutout Switch (LPCO)

The LPCO switch is a pressure sensitive switch located in the suction line or the suction manifold. If the suction pressure drops below the switch setpoint, the switch will open to stop the compressor. If the switch stays open for more than 60 seconds, the IntelligAIRE controller shuts down the compressor and logs Alarm Code 11.

High Pressure Cutout Switch (HPCO)

The HPCO switch is a pressure sensitive switch located in the compressor head or discharge manifold. If the discharge pressure exceeds the switch setpoint, the switch will open to stop the compressor. If the switch stays open for more than 2 seconds, the IntelligAIRE controller shuts down the compressor and logs Alarm Code 10.

Compressor Discharge Sensor (CDS)

The IntelligAIRE controller monitors the compressor discharge temperature through the CDS. If the compressor discharge temperature exceeds 300°F (149°C) for 30 minutes, the controller logs Alarm Code 08. If the compressor discharge temperature exceeds 320°F (160°C) for one minute, the controller shuts down the compressor and logs Alarm Code 12.

Circuit Breakers and Fuses

For more details, see the schematic diagram in this manual.

Fuse/CB	Amps	Protects
Fuse (not included)	150	Battery circuit (OEM Supplied)
CB1	85	Evaporator Fan Motors
F1, F3, F5	30	Evaporator Fan Motors
F2, F4, F6	20	Evaporator Fan Motors
CB2	85	Condenser Fan Motors
F7-F11	15	Condenser Fan Motors
F12	10	Power Inputs to Clutch Circuit
F13	15	Power Inputs to Boost Pump Circuit
14	10	Power Inputs to Unit Control

Figure 8: Circuit Breakers and Fuses

IntelligAIRE™ II Controller

IntelligAIRE™ II Overview

The Thermo King IntelligAIRE™ II is a microprocessor-based controller for bus HVAC systems. It can have a standard display, a deluxe display, or no display, and can control temperatures in up to three zones.

IntelligAIRE II Features

IntelligAIRE II features include:

- Temperature setpoints for three zones (standard and deluxe display)
- Return air and ambient temperature display in three zones (standard and deluxe display)
- Cool, heat, and vent mode operation in three zones (deluxe display only)
- Internal air flow control in three zones (deluxe display only)
- Fresh air damper control in three zones (deluxe display only)
- Driver control of heat, cool, defrost, vent, and blower speed (deluxe display only).

IntelligAIRE II RS-232 PC Interface

The IntelligAIRE II has an RS-232 interface to a computer for use by service technicians. This diagnostic interface:

- Displays and saves alarm codes
- Stores, accesses, and tracks alarm code history
- Accesses hourmeter readings for the compressor, evaporator, and unit run hours
- Tests the system by manually or automatically cycling system outputs
- Displays and monitors system inputs
- Installs software upgrades by flash load rather than by changing a software EPROM.

IntelligAIRE II Components

The IntelligAIRE II is a component-based system that allows expansion of features and temperature control zones. The IntelligAIRE II consists of the following components:

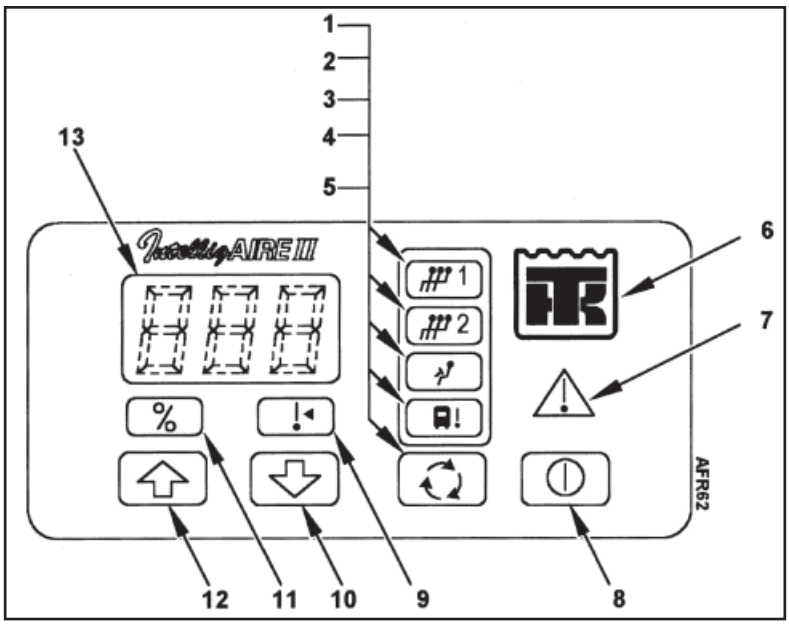
Base Module: The base module contains the main system controller. It communicates with the display module and expansion modules (if applicable) via an SAE J1939 CAN bus.

Expansion Modules: Based on application, a unit can have up to 4 expansion modules that can support additional passenger zones, floor heat zones, or provide expanded driver control.

Display Module (Optional): The display module provides a user interface. It is available in standard and deluxe versions. See the next section for the display panel description.

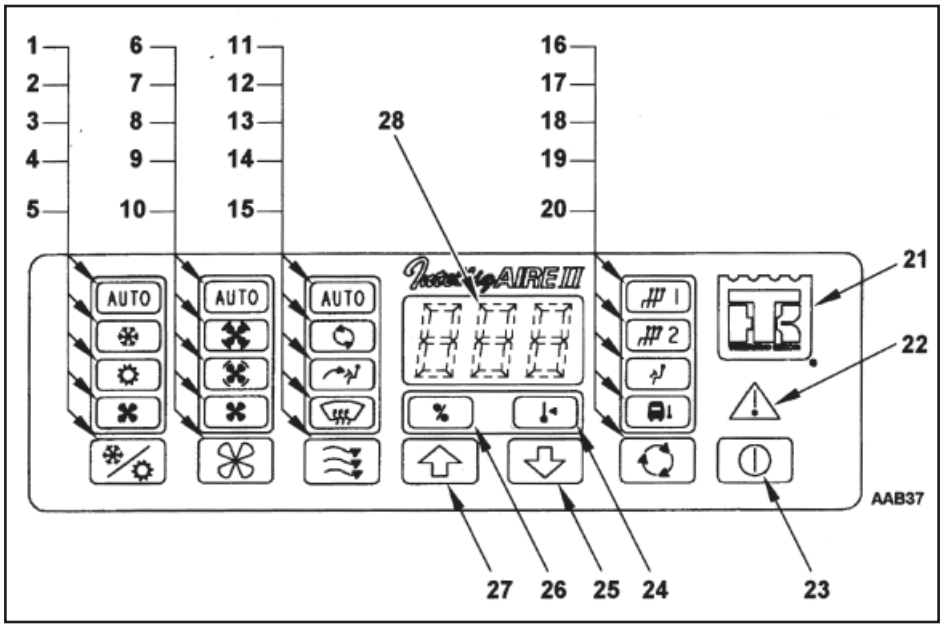
Display Module Description

Display modules are available in a standard version (shown in Figure 9 below) and a deluxe version (shown in Figure 10). The display module consists of touch keys, an LED display, and display indicators. Keys and indicator lights are as follows:



1.	Passenger Zone 1 Return Air Temperature Indicator	8.	On/Off Key
2.	Passenger Zone 2 Return Air Temperature Indicator	9.	Setpoint Indicator
3.	Driver's Zone Return Air Temperature Indicator	10.	Down Arrow Key
4.	Ambient Air Temperature Indicator	11.	Percent Indicator
5.	Display Select Key	12.	Up Arrow Key
6.	Thermo King Logo Key	13.	LED Display
7.	Warning Indicator		

Figure 9: Standard Display Module



1.	Auto Mode Indicator	15.	Damper Select Key
2.	Cool Mode Indicator	16.	Passenger Zone 1 Return Air Temperature Indicator
3.	Heat Mode Indicator	17.	Passenger Zone 2 Return Air Temperature Indicator
4.	Vent Mode Indicator	18.	Driver's Zone Return Air Temperature Indicator
5.	Operating Mode Select Key	19.	Ambient Air Indicator
6.	Auto Fan Speed Indicator	20.	Display Select Key
7.	High Fan Speed Indicator	21.	Thermo King Logo Key
8.	Medium Fan Speed Indicator	22.	Warning Indicator
9.	Low Fan Speed Indicator	23.	On/Off Key
10.	Fan Speed Select Key	24.	Setpoint Indicator
11.	Auto Damper Indicator	25.	Down Arrow Key
12.	Recirculate Mode Indicator	26.	Percent Indicator
13.	Driver's Panel Air Indicator	27.	Up Arrow Key
14.	Defrost Indicator	28.	LED Display

Figure 10: Deluxe Display Module

On/Off Key: Turns the controller on and off. (If the bus has an OEM-supplied switch, this button is ignored.)

NOTE: The controller does a self-chck when turned on. Display functions are not available until after the engine is running.

Operating Mode Select Key: On a deluxe display module, selects operating mode: Auto, Cool, Heat, or Vent. The default mode is Auto. Press this key to select other modes. On a standard display module, the bus OEM may provide a mode selection switch.

Fan Speed Select Key: Selects evaporator fan speed: Auto, High, Medium, or Low. The default mode is Auto Press this key to select other fan speeds. Available speeds depend on configuration.

Damper Select Key: Selects damper position. The default mode is Auto. In Auto mode, the passenger zone damper opens when the inside temperature is within a few degrees of setpoint. The passenger zone damper has two modes: Auto and Recirculate. The driver zone has up to four modes, depending on the number of damper actuators installed. Select the following modes with the Damper Select key:

Auto: Fresh air damper is controlled automatically. Panel air and defrost dampers are closed.

Recirculate: Fresh air damper, panel air damper, and defrost damper are closed.

Panel: Fresh air damper and panel air damper are opened. Defrost damper is closed.

Defrost: Fresh air damper and defrost damper are opened. Panel air damper is closed.

Display Select Key: Selects the display temperature shown on the display: Passenger Zone 1 Return Air Temperature, Driver Zone Return Air Temperature, or ambient air temperature. The standard default display is Passenger Zone 1 Return Air Temperature. Press the Display Select key to view other temperatures.

NOTE: The ambient temperature can alert the driver to possible icing on some road surfaces.

Up and Down Arrow Keys: Increase and decrease the setpoint temperature for the selected zone. In the Standard Display of return air temperature, pressing the Up or Down key displays the setpoint for the selected zone. Subsequent key presses increase or decrease the setpoint.

Warning Indicator Display: If a warning light stays on after the system has powered up, there is a malfunction occurring. A yellow warning indicates a Check or Log alarm. The system is operable, but should be investigated. A red warning indicates a Shutdown alarm. The unit will not run and should be checked immediately. See *"Alarm Code Display Mode"* later in this section.

Modes of Operation

Auto Mode

NOTE: For more information on the thermostat sequence, see the schematic diagram in the Maintenance Manual.

In Auto mode, the controller selects Cool or Heat mode based on the ambient temperature, return air temperature, and setpoint.

If the ambient temperature is below 55°F (12.7°C), the unit operates in Heat Mode. The unit stays in Heat Mode as long as the return air temperature is between 4.5°F (2.5°C) degrees above setpoint and 2.5°F (1.4°C) degrees below setpoint. If the return air temperature goes 4.5°F (2.5°C) degrees above the setpoint for more than ten minutes, the unit switches to Cool Mode.

If the ambient temperature is above 60°F (15.6°C), the unit operates in Cool Mode. The unit stays in Cool Mode if the return air temperature is between 2.5°F (1.4°C) above setpoint and 4.0°F (2.2°C) below setpoint. If the return air temperature goes below 4.0°F (2.2°C) for more than ten minutes, the unit switches to Heat Mode.

Cool Mode (Reheat)

In Cool mode with Reheat, the compressor runs continuously. Setpoint is maintained by passing hot engine coolant through the heater coil. The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Cool Mode (Cycling Clutch)

In Cool mode with Cycling Clutch, the compressor cycles on and off to maintain setpoint. A timer prevents the compressor from rapid cycling by setting a minimum off time (60 seconds). The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Vent Mode

In Vent mode, the evaporator blowers run at the speed determined automatically by the microprocessor or manually by the driver. The compressor, boost pump, and coolant valve are off.

Heat Mode

In Heat mode, setpoint is maintained by passing hot engine coolant through the heater coil. The evaporator blowers remain off until the engine coolant temperature rises to 105°F (41°C), as measured by the WTS (water temperature sensor) located on the inlet coolant tube. The evaporator fan speed is controlled automatically by the microprocessor or manually by the driver.

Operating Procedures

Selecting Displays

The Standard Display of Passenger Zone 1 Return Air Temperature displays when the unit is turned on.

To select other displays:

- Press the Display Select key. The indicator above the Display Select key lights, indicating which temperature is displayed: Passenger Zone 1, Passenger Zone 2, Driver Zone, or Ambient.

Viewing and Changing Setpoints

To view and change setpoints:

1. Press the Display Select key to select the desired zone. The indicator above the Display Select key lights, indicating which temperature is displayed: Passenger Zone 1, Passenger Zone 2, Driver Zone, or Ambient.
2. To view the setpoint for the selected zone, press the Up or Down Arrow key once. the setpoint indicator flashes, indicating that setpoint is displayed.
3. Press the Up key to raise the setpoint. Press the Down key to lower the setpoint. When the desired setpoint displays, wait approximately 5 seconds. The display returns to the temperature for the selected zone, indicating that the setpoint has changed.

Selecting Operating Modes (Deluxe Display Module Only)

The default operating mode is Auto. To select a different mode, press the Operating Mode Select key. The indicator above the Operating Mode Select key lights, indicating which mode is selected: Auto, Cool, Heat, or Vent.

Selecting Fan Speed (Deluxe Display Module Only)

The default fan speed is Auto. To select a different fan speed, press the Fan Speed Select key. The indicator above the Fan Speed Select key lights, indicating which mode is selected: Auto, High, Medium, or Low.

Selecting Damper Settings (Deluxe Display Module Only)

The default damper setting is Auto for the passenger zones and Fresh Air for the driver zone. To select a different damper setting, press the Damper Select key. The indicators above the Damper Select key indicate which modes are selected. Auto and Recirculate are available for the passenger zones. Fresh Air, Recirculate, Panel Air, Defrost and Normal or available for the driver zone.

IntelligAIRE II Diagnostics

Setup Mode

When accessed through the display module, Setup mode is view-only. To change settings, you must use a PC with SMART-Pac™ software.

1. To enter the Setup Mode, press and hold both the Up and Down Arrow keys down for approximately 5 secons. [Un] appears, indicating the unit is in Setup Mode. Normal operation stops when the unit is in Setup Mode.
2. To scroll through the Setup Mode features, press the Display Select key. The features appear in the order shown here:

Programmable Features (Setup Mode)

Display	Programmable Feature
Un	Units of Measure (F = Fahrenheit or C = Celsius)
CC	Clutch Control (rh or Cy)
HC	High Cool Setpoint Limit
LC	Low Cool Setpoint Limit
HH	High Heat Setpoint Limit
LH	Low Heat Setpoint Limit
HA	High Auto Mode Setpoint Limit
LA	Low Auto Mode Setpoint Limit

3. When the desired feature displays, press the Up or Down Arrow key to display the current value.
4. To return to Standard Display mode, press the TK Logo key.

Calibration Mode

When accessed through the display panel, the Calibrate Mode is view-only. To change settings, you must use a PC with SMART-Pac™ software. Consult the unit schematic diagram to determine which input is being displayed. For example, on the schematic diagram, Analog Input 13 is the ATS. When [A13] is displayed in Calibration mode, it is the current reading of the ATS.

1. To enter Calibration Mode, press and hold the Up Arrow key and the TK Logo key for approximately 5 seconds [Axx] appears, indicating the unit is in Calibration Mode. Normal unit operation stops when the unit is in Calibration Mode.
2. To scroll through the Calibration Mode features, press the Display Select key. The display shows [Axx] for analog inputs, [Uxx] for analog outputs, and [Pxx] for potentiometers on the servo actuators.
3. When the desired feature displays, press the Up or Down Arrow key to view its value.

   The analog input reading on the display is converted to the units associated with the analog input. If an input is not adjustable, it will display "__".

   The analog output reading on the display is the percentage of the full-scale output voltage 0.0 to 5.0 Vdc. You can measure output voltage with a voltmeter.
4. To return to Standard Display mode, press the TK Logo key.

Service Test Mode

Service Test Mode allows a service technician to verify the operation of relays, contactors, motor controllers, coolant valves, and modulating valves.

1. To enter Service Test Mode, press and hold the Down Arrow key and the Display Select key for approximately 5 seconds. [Pt] appears, indicating the unit is in Service Test Mode. Normal unit operation stops when the unit is in Service Test Mode.
2. To scroll through the Service Test Mode options, press the Display Select key. The test options appear in the order shown below.
3. When the desired test displays, press the Up or Down Arrow key to select the test.

   If an output or function is not enabled in the configuration, the test for that feature is skipped.
4. To exit Service Test Mode and return to the Standard Display, press the TK Logo key.

Service Tests (Service Test Mode)

Display	Service Tests
Pt	Pretrip Test
rt	Relay Test
Ft	Functional Test
EFx	Variable Evaporator x Fan Speed Control Test
CF	Variable Condenser Fan Speed Control Test
CUx	Variable Coolant Valve x Control Test
dPx	Variable Damper Position x Control Test

Pretrip Test

To initiate the Pretrip Test, press either the Up or Down Arrow key when [Pt] is shown in the display. The test stops if any alarm codes are generated. At the end of the test, the display shows [PAS] (pass) or [FAL] (fail). Pretrip tests are as follows:

1. **Relay Test:** Sequentially cycles each enabled output on for 5 seconds.
2. **Variable Output Tests (CF, EFx, CUx, dPx):** Sequentially increment each enabled output from 0 to 100 percent in 10 seconds.

   If the compressor has not been enabled in the configuration, the test will jump to step 4.
3. **Cool High Test:** The temperature delta for each enabled zone must be at least a preset amount in a preset time period. If discharge air temperature sensors are not installed, the return air temperature for each enabled zone drops at least a preset amount in a preset time period.

   If the boost pump is not enabled in the configuration, the test jumps to step 5.
4. **Heat High Test:** The temperature delta for each enabled zone must be at least a preset amount in a preset time period. If discharge air temperature sensors are not installed, the return air temperature for each enabled zone rises at least a preset amount in a preset time period.
5. **Test Complete:** The display shows [PAS] (pass) or [FAL] (fail).
6. To return to Standard Display mode, press the TK Logo key.

Relay Test

The Relay Test manually energizes each relay output one at a time, allowing relays to be latched on for diagnosis by a technician.

1. To initiate the Relay Test, press either the Up or Down Arrow key when [rt] appears in the display. When initiated, the Relay Test turns on the first relay.
2. To scroll through the relay tests, press either the Up or Down Arrow key. The output on the digital display is turned on and all other outputs are turned off. Consult the unit schematic diagram to determine what component is controlled by each output. The controller has time limits for outputs that can cause damage if left on too long.
3. To exit the Relay Test at any time, press the Display Select key.

Functional Test

These tests allow the technician to force the unit into a particular operating mode, regardless of setpoint or return air temperature sensor readings.

1. To initiate the Functional Test, press either the Up or Down Arrow key when [Ft] appears in the display.
2. To scroll through the Functional Tests, press either the Up or Down Arrow key. The Functional Test Features appear in the order shown in the table below.
3. To exit the Functional Test at any time, press the Display Select key.

Functional Test Features

Display	Auto Test Feature
CH	Cool High
Cn	Cool Medium
CL	Cool Low
HH	Heat High
Hn	Heat Medium
HL	Heat Low
UH	Vent High
Un	Vent Medium
UL	Vent Low

Variable Output Tests

The Variable Output test energizes the device connected to the selected output with a 0 percent drive signal or position signal. [00] appears in the display.

1. To initiate the Variable Output Test, press either the Up or Down Arrow key when [EFx], [CF], [Cux], or [dPx] appears in the display.
2. Press the Up or Down Arrow keys to increase or decrease the drive signal or position signal for the selected output. Each key press changes the signal and the reading in the display by 1 percent.
3. To exit the Variable Output Test at any time, press the Display Select key.

Hourmeter and Real Time Clock Display Mode

1. To enter Hourmeter Display Mode, press and hold the Display Select key for approximately 5 seconds. [Un] appears, indicating the unit has entered the Hourmeter Display Mode. Normal unit operation stops when the unit is in Hourmeter Display Mode.
2. Release the Display Select key to view the hourmeter readings. The controller automatically scrolls through the displays.

   Each record is displayed in several parts, with each part being displayed for 1 second. Each part is described below.

Total Unit Hour Format

Un	Hr	XX	YY	ZZ

Evaporator Hour Format

EP1	Hr	XX	YY	ZZ
EP2	Hr	XX	YY	ZZ
EP3	Hr	XX	YY	ZZ

Compressor Hour Format

CP	Hr	XX	YY	ZZ

The underlined symbols display as shown. The non-underlined symbols are replaced with numbers according to the following legend:

Digit Legend

XX	=	Most significant two digits of hour total
YY	=	Middle two digits of hour total
ZZ	=	Least significant two digits of hour total

For example, a Total Unit Hours reading of 187 hours would appear as:

Example of 187 Total Unit Hours

Un	Hr	00	01	87

When all hourmeters have displayed, the Display Module scrolls through the time and date for the real time clock:

Real Time Clock Format

rtc		
Hr	XX	Hour-24 Hour Format
UtE	XX	Minute
nth	XX	Month
dAy	XX	Day of Month
yr	XX	Year

3. To modify time or date parameters:
   a. Press the Up or Down Arrow key while the parameters are displayed. The display blinks, indicating the Modify mode.
   b. Press the Display Select key to scroll through each selection for the clock.
   c. To modify the displayed selected, press the Up or Down Arrow key. After scrolling through all the parameters, the system will return to Standard Display Mode. If more than 5 seconds pass between key presses during the modify mode, the system returns to Standard Display Mode and the real time clock settings will not change.
4. To exit the Hourmeter Display Mode, press the TK Logo key.

Alarm Code Display Mode

Displaying Alarm Codes

1. To enter the Alarm Code Display Mode, press and hold the Thermo King Logo key for 5 seconds. The display changes to the most recent alarm code.
2. To scroll through the alarm codes, press the Display Select key.
3. To clear the displayed alarm code, press the Up or Down Arrow key. Two dashes (- -) display, indicating the alarm is cleared. See the table “Alarm Codes” on next page for alarm code descriptions.
4. To exit Alarm Code Display Mode, press the TK Logo key.

Types of Alarm Codes

Log: Indicates a service timer has expired. The alarm code reappears until the timer is reset.

Check: Indicates a system fault that requires attention but is not serious enough to shut the unit down. You can clear a Check Alarm only after the alarm condition no longer exists.

Shutdown: Indicates a serious system fault that causes the unit to shut down. You can clear a Shutdown Alarm at any time, but the alarm will re-occur if the alarm condition is not corrected.

Alarm Codes

Code	Type	Description
00		No Alarm Codes Present
01	Check	Coolant Temperature Sensor (WTS) - reading out-of-range
02	Check	Evaporator Coil Temperature Sensor (CTS) - reading out-of-range
03	Check	Return Air Temperature Sensor (RTS) - reading out-of-range
04	Check	Discharge Air Temperature Sensor (DTS) - reading out-of-range
05	Check	Ambient Air Temperature (ATS) - reading out-of-range
06	Check	Compressor Discharge Temperature Sensor (CDS) - reading out-of-range
07	Check	Low Heating Capacity
08	Check	Compressor Discharge Temperature Warning
09	Check	Low Cooling Capacity
10	Shutdown	High Pressure Shutdown
11	Shutdown	Low Pressure Shutdown
12	Shutdown	Compressor Discharge Temperature Shutdown
13	Shutdown	Condenser Fan Motor Drive - drive fault
14	Shutdown	Evaporator Fan Motor Drive - drive fault
15	Check	Compressor Clutch - output fault
16	Check	Boost Pump (BP) - output fault
17	Check	Condenser High Speed - output fault
18	Check	Condenser Low Speed - output fault
19	Check	Condenser Variable Speed - output fault
20	Check	Loader/Unloader Solenoid 1 (LV1/US1) - output fault
21	Check	Loader/Unloader Solenoid 2 (LV2/US2) - output fault
22	Check	Condenser Pressure Transducer (CPT) - reading out-of-range
25	Check	Evaporator High Speed - output fault
26	Check	Evaporator Medium Speed - output fault
27	Check	Evaporator Low Speed - output fault
28	Check	Evaporator Variable Speed - output fault
29	Check	Liquid Valve (LLV) - output fault
30	Check	Modulating Liquid Valve (MLV) - output fault
31	Check	Coolant Valve (CV) - output fault
32	Check	Variable Coolant Valve - feedback fault
33	Check	Floor Coolant Valve - output fault
34	Check	Floor Variable Coolant Valve - feedback fault
35	Check	Fresh Air Damper - output fault
36	Check	Variable Fresh Air Damper - feedback fault
40	Check	Base Module (ECM) - internal fault
41	Check	Base Module (ECM) Battery Power - input fault
42	Check	Base Module (ECM) Control Power - input fault
43	Check	Base Module Compressor Power - input fault
44	Check	Base Module Boost Pump (BP) Power - input fault
50	Check	Expansion Module 1 (EPM) - internal fault
51	Check	Expansion Module 1 (EPM) Battery Power - input fault

Alarm Codes (continued)

Code	Type	Description
52	Check	Expansion Module 1 (EPM) Control Power - input fault
60	Check	Expansion Module 2 (EPM) - internal fault
61	Check	Expansion Module 2 (EPM) Battery Power - input fault
62	Check	Expansion Module 2 (EPM) Control Power - input fault
70	Check	Expansion Module 3 (EPM) - internal fault
71	Check	Expansion Module 3 (EPM) Battery Power - input fault
72	Check	Expansion Module 3 (EPM) Control Power - input fault
80	Check	Expansion Module 4 (EPM) - internal fault
81	Check	Expansion Module 4 (EPM) Battery Power - input fault
82	Check	Expansion Module 4 (EPM) Control Power - input fault
90	Log	Condenser/Compressor Service Timer - has expired
91	Log	Evaporator 1 Service Timer - has expired
92	Log	Evaporator 2 Service Timer - has expired
93	Log	Evaporator 3 Service Timer - has expired
95	Check	Display Module (DDM) - not responding
96	Check	Expansion Module 1 (EPM) - not responding
97	Check	Expansion Module 2 (EPM) - not responding
98	Check	Expansion Module 3 (EPM) - not responding
99	Check	Expansion Module 4 (EPM) - not responding
102	Check	Passenger Zone 1 Evaporator Coil Temperature Sensor (CTS1) - reading out-of-range
103	Check	Passenger Zone 1 Return Air Temperature Sensor (RTS1) - reading out-of-range
104	Check	Passenger Zone 1 Discharge Air Temperature Sensor (DTS1) - reading out-of-range
107	Check	Passenger Zone 1 Low Heating Capacity
109	Check	Passenger Zone 1 Low Cooling Capacity
114	Check	Passenger Zone 1 Evaporator Inverter - drive fault
125	Check	Passenger Zone 1 Evaporator High Speed - output fault
126	Check	Passenger Zone 1 Evaporator Medium Speed - output fault
127	Check	Passenger Zone 1 Evaporator Low Speed - output fault
128	Check	Passenger Zone 1 Evaporator Variable Speed - output fault
129	Check	Passenger Zone 1 Liquid Valve (LLV1) - output fault
130	Check	Passenger Zone 1 Modulating Liquid Valve (MLV1) - output fault
131	Check	Passenger Zone 1 Coolant Valve - output fault
132	Check	Passenger Zone 1 Variable Coolant Valve - feedback fault
133	Check	Passenger Zone 1 Floor Coolant Valve - output fault
134	Check	Passenger Zone 1 Floor Variable Coolant Valve - feedback fault
135	Check	Passenger Zone 1 Fresh Air Damper - output fault
136	Check	Passenger Zone 1 Variable Fresh Air Damper - feedback fault
202	Check	Passenger Zone 2 Evaporator Coil Temperature Sensor (CTS2) - reading out-of-range
203	Check	Passenger Zone 2 Return Air Temperature Sensor (RTS2) - reading out-of-range
204	Check	Passenger Zone 2 Discharge Air Temperature Sensor (DTS2) - reading out-of-range
207	Check	Passenger Zone 2 Low Heating Capacity
209	Check	Passenger Zone 2 Low Cooling Capacity

Alarm Codes (continued)

Code	Type	Description
214	Check	Passenger Zone 2 Evaporator Inverter - drive fault
225	Check	Passenger Zone 2 Evaporator High Speed - output fault
226	Check	Passenger Zone 2 Evaporator Medium Speed - output fault
227	Check	Passenger Zone 2 Evaporator Low Speed - output fault
228	Check	Passenger Zone 2 Evaporator Variable Speed - output fault
229	Check	Passenger Zone 2 Liquid Valve (LLV2) - output fault
230	Check	Passenger Zone 2 Modulating Liquid Valve (MLV2) - output fault
231	Check	Passenger Zone 2 Coolant Valve - output fault
232	Check	Passenger Zone 2 Variable Coolant Valve - feedback fault
233	Check	Passenger Zone 2 Floor Coolant Valve - output fault
234	Check	Passenger Zone 2 Flor Variable Coolant Valve - feedback fault
235	Check	Passenger Zone 2 Fresh Air Damper - output fault
236	Check	Passenger Zone 2 Variable Fresh Air Damper - feedback fault
302	Check	Driver Zone Evaporator Coil Temperature Sensor (CTS3) - reading out-of-range
303	Check	Driver Zone Return Air Temperature Sensor (RTS3) - reading out-of-range
304	Check	Driver Zone Discharge Air Temperature Sensor (DTS3) - reading out-of-range
307	Check	Driver Zone Low Heating Capacity
309	Check	Driver Zone Low Cooling Capacity
314	Check	Driver Zone Evaporator Inverter - drive fault
325	Check	Driver Zone Evaporator High Speed - output fault
326	Check	Driver Zone Evaporator Medium Speed - output fault
327	Check	Driver Zone Evaporator Low Speed - output fault
328	Check	Driver Zone Evaporator Variable Speed - output fault
329	Check	Driver Zone Liquid Valve (LLV3) - output fault
331	Check	Driver Zone Coolant Valve - output fault
332	Check	Driver Zone Variable Coolant Valve - feedback fault
333	Check	Driver Zone Floor Coolant Valve - output fault
334	Check	Driver Zone Floor Variable Coolant Valve - feedback fault
335	Check	Driver Zone Fresh Air Damper - output fault
336	Check	Driver Zone Variable Fresh Air Damper - feedback fault
337	Check	Driver Zone Panel Air Damper - output fault
338	Check	Driver Zone Variable Panel Air Damper - feedback fault
339	Check	Driver Zone Defrost Air Damper - output fault
340	Check	Driver Zone Variable Defrost Air Damper - feedback fault

Maintenance Inspection Schedule

On the following pages you will find a abbreviated maintenance schedule. If you need more information the entire section is reprinted in the Maintenance Manual that is supplied with your coach.

Coordinate the maintenance inspection schedule with the Bus Preventive Maintenance Schedule. See Thermo King Bus A/C Preventive Maintenance forms TK 40809 for more information.

NOTE: Thermo King reserves the right to deny warranty coverage on claims due to lack of maintenance or neglect. Claims in question must be supported by maintenance records.

NOTE: See the appropriate section either in this manual or the Maintenance Manual for instructions on how to correctly perform required maintenance.

Off Season Operation of Bus Air Conditioning System

In order for the A/C system to be ready for operation, normal preventive maintenance is necessary. Operate all systems periodically, especially during the off season. By operating the system weekly for short intervals (5 to 10 minutes) year round, the internal parts of the compressor will remain lubricated. Off-season operation also helps reduce compressor shaft seal leakage and allows early detection of refrigerant loss.

Prior to operating the compressor during winter months, you must warm up the coach interior to normal operating temperature (60 to 76°F [15 to 21°C]). Unless this precaution is taken, liquid refrigerant might be forced into the compressor, causing severe damage.

Electrical

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
	Semi-Annually		Check evaporator blower motors speed, voltage and amperes (all motors)
	Semi-Annually		Check condenser fan motor speed, voltage and amperes (all motors).
		•	Check thermostat cycle sequence on all modes (e.g., cool/reheat, vent/heat).
		•	Visually inspect alternator drive belts for excessive wear, tension and alignment
		•	Clean alternator, check for signs of corrosion, and check wire connections.
		•	Clean control panel area and return air sensor with compressor air **NOTE:** ***These may need to be cleaned more frequently.***
		•	Check boost pump (OEM supplied) motor operation, and inspect brushes (when equipped).
		•	Inspect wires and terminals for damage or corrosion. If corrosion is present, clean terminals with electrical contact cleaner.
		•	Check condenser pressure switch/condenser motor high and low speed operation.
		•	Check high pressure cutout and low pressure cutout switches.

Refrigeration/Heating

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•	•	Check refrigerant charge. make sure discharge pressure is 250 psig (1724 kPa) on R-22 and R-407C systems and 150 psig (1034 kPa) on R-134a systems. The ball in the top receiver tank sight glass should be floating and the liquid line sight glass (if equipped) should be full and clear - no bubbles. Charge: OK_____, Needs charging_____ **NOTE:** ***This should be done twice monthly during air conditioning season.***
•	•	•	Inspect condition of refrigerant hoses and tubing.
•	•	•	Inspect for leaks of refrigerant and oil.
•	•	•	Check dry eye in the liquid sight glass for moisture content.
•	•	•	Check compressor oil level and color (¼ to ¾ way up on sight glass after 15 minutes of operation - X430 compressor).
	•	•	Install service gauge manifold set and check system operating pressures, temperatures and suction line conditions.
		•	Check compressor oil for acidity.
		•	Check compressor efficiency.
		•	Check compressor oil pump pressure.
		•	Check evaporator pressure regulator (EPR) valve operation.
		•	Replace filter-drier (liquid line dehydrator). **NOTE:** ***The filter-drier should be changed anytime the system is opened.***
		•	Check hot water control valve operation.

Structural

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•		Inspect condenser coil for cleanliness.
•	•		Inspect evaporator coil for cleanliness.
•	•	•	Visually inspect unit for loose, damaged, or broken parts.
•	•	•	Clean or replace return air filter (more frequently if necessary).
	Semi-Annually		Lubricate evaporator fanshaft bearings (Shell Alvania EP2).
		•	Clean condenser and evaporator drains. Make sure the evaporator drain hose check valves (kazoos) are in place and in good condition.
		•	Visually inspect engine coolant hose and hose clamp condition on heater coil system.
		•	Clean condenser and evaporator coils.
		•	Check engine coolant for antifreeze protection down to -30 °F (-34 °C) to prevent heater coil freeze up.
		•	Tighten compressor, unit, and fan motor mounting bolts and brackets (more frequently if necessary).
		•	Check condenser air seals.

X430 Compressor Clutch

Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually	Check condition of or service the following:
•	•	•	Inspect clutch armature for wear and overheating caused by slippage.
•	•	•	Inspect compressor drive belts for excessive wear, tension and alignment (refer to bus manufacturer and/or belt supplier for proper tension).
	•	•	Check clutch air gap 0.045 ± 0.005 in. (1.143 ± 0.127 mm) and surface flatness - X430 compressor.
		•	Steam clean compressor and clutch.
		•	Check clutch coil resistance and voltage.
		•	Lubricate X430 compressor clutch bearing (Exxon Unirex N2).

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Inspect evaporator blower motor bearings, speed, voltage, and amperage. See "Specifications" section for normal readings. Bearing: OK_____, Replace_____ Speed_____rpm, Voltage_____Vdc, Amperage_____amps	**Semi-Annually**		
Inspect condenser fan motor bearings, speed, voltage and amperes. See "Specifications" section for normal readings. Bearings: OK_____, Replace_____ Speed_____rpm, Voltage_____Vdc, Amperage_____amps	**Semi-Annually**		
Check thermostat cycle sequence on all modes (e.g., cool/vent, cool/reheat, and vent/heat). OK_____ Diagnosis thermostat/unit_____			•
Visually check alternator belt wear, alignment and tension. Condition: OK_____, Replace_____ Alignment: OK_____, Adjusted_____ Tension: OK_____, Adjusted_____			•
Clean alternator, check for signs of corrosion, and check wire connections.			•
Clean control panel area and return air sensor.			•
Check boost pump motor (OEM supplied) operation, voltage, and inspect brushes. Voltage_____Vdc Brushes: OK_____, Replace_____ Operation: OK_____, Replace motor_____			•
Inspect all wires and terminals for damage or corrosion.			•
Check condenser pressure switch (CPS)/condenser fan motor high and low speed operation. See "Specifications" section for normal readings. CPS opens at_____psig CPS closes at_____psig			•

WARNING!! Take precautions to ensure the unit and the bus will not accidentally start while you are servicing the system.

Refrigeration Maintenance

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Check refrigerant charge. Make sure discharge pressure is 250 psig (1724 kPa) on R-22 and R-407C systems and 150 psig (1034 kPa) on R-134a systems. The ball in the top receiver tank sight glass should be floating and the liquid line sight glass (if equipped) should be full and clear - no bubbles. Charge: OK_____, Needs charging_____ **NOTE:** ***Check this twice monthly during air conditioning season.***	•	•	•
Visually check refrigerant hoses and tubing for signs of deterioration or chafing. Hoses and tubing OK_____ Hoses and/or tubing need replacement_____ Specify which ones_____	•	•	•
Visually inspect for leaks of refrigerant and oil No leaks_____, Leaks detected_____	•	•	•
Check dry eye in the liquid line sight glass for moisture content. OK_____, Perform system cleanup_____	•	•	•
Check compressor oil level and color (¼ to ½ sight glass after 15 minutes of operation).	•	•	•
Install service gauge manifold set. Record operating pressures, temperatures, and suction line condition. Suction: Fast Idle_____psig, Full Throttle_____psig Discharge: Fast Idle_____psig, Full Throttle_____psig Ambient_____F, Return Air_____F, Suction Line_____			•
Check compressor oil for acidity. Safe_____, Marginal_____, Acidic_____			•
Check compressor efficiency. OK_____, Replace or rebuild compressor_____			•
Check evaporator pressure regulator (EPR) valve operation. See “Specifications” section for normal readings. _____psig.			•
Replace filter-drier (liquid line dehydrator) a minimum of once a year or any time the system is opened.			•
Check hot water control (coolant) valve operation. OK_____, Repair or Replace_____			•

Safety

WARNING!! Make sure the unit and bus cannot start while servicing the system.

Many service procedures are regulated by federal, state, and local laws. EPA certified technicians must perform regulated refrigeration service procedures using approved equipment and complying with all federal, state, and local laws.

NOTE: The complete recommended maintenance for your unit can be found in the Maintenance Manual that is supplied with your coach.

Structural Maintenance

Maintenance Inspection Schedule

Procedures	Monthly 6,000 Miles (10000 km)	Quarterly 18,000 Miles (30000 km)	Annually
Inspect condenser coil for cleanliness.	•	•	•
Inspect evaporator/heater coil for cleanliness.	•	•	•
Inspect outer areas of the unit for loose, damaged, or broken parts. OK_____, Make repairs_____ Specify defect_____	•	•	•
Clean or replace return air filter (more frequently if necessary).	•	•	•
Clean condenser and evaporator drains. Make sure that the evaporator drain hose check valves (kazoos) are in place and in good condition.	•	•	•
Check the engine coolant hoses and hose clamp condition on heater coil system.			•
Clean condenser and evaporator coils.			•
Chck engine coolant for antifreeze protection down to -30°F (-34°C) to prevent heater coil free up. Antifreeze protection _____F, (_____C)			•
Tighten compressor, unit, and fan motor mounting bolts and brackets (more frequently if necessary).			•
Check condenser air seals.			•

WARNING!! Ensure the unit and the bus will not start while you are servicing the system.

NOTE: The complete recommended maintenance for your unit can be found in the Maintenance Manual that is supplied with your coach.

Clutch Maintenance (X426, X430, X640 Compressors)

Quarterly Clutch Maintenance

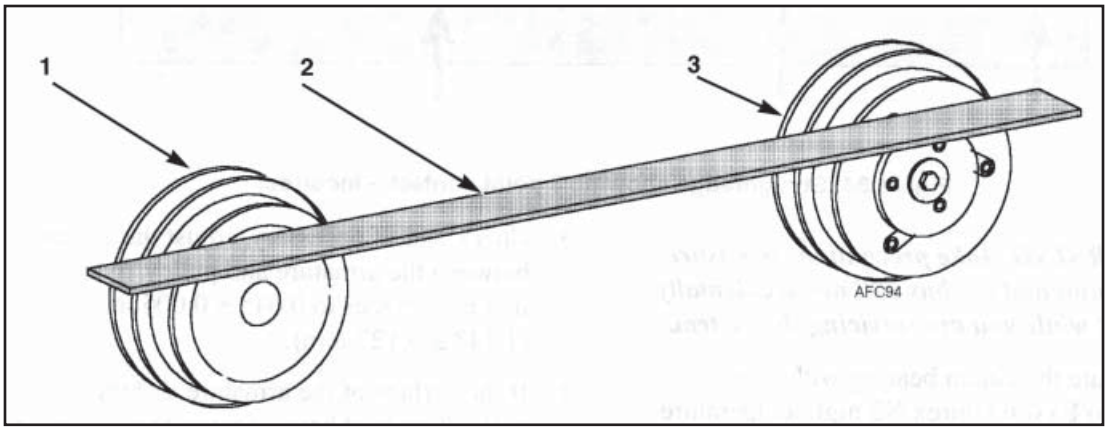
Checking Alignment

NOTE: To prevent the unit compressor/clutch from being accidentally started from the driver's control section while performing preventive maintenance procedures, turn the bus service switch to OFF.

It is important to check pulley alignment quarterly. Properly aligned belts last longer.

1. Using a straightedge, check pulley/belt alignment. Lay a straightedge across the front of both pulleys. See *Figure 81* below.
   a. Straightedge must make contact on 4 points. See *Figure 82* below for clarification.
   b. Incorrect alignment increases pulley and bearing wear. See *Figures 83 and 84* on following page for illustrations of incorrect alignment.

If pulleys are aligned incorrectly, adjust compressor base.



1.	Engine Pulley
2.	Straightedge
3.	Compressor Pulley

Figure 81: Checking Pulley Alignment with Straightedge 3/4 View

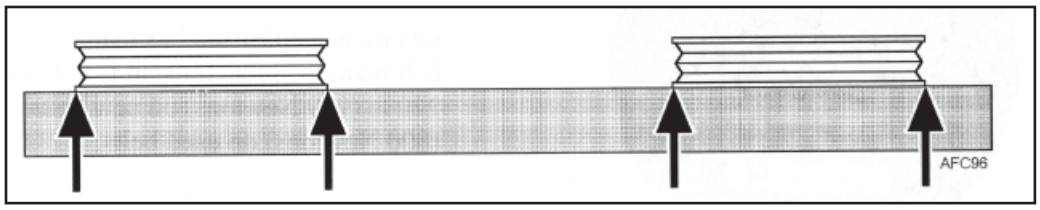


Figure 82: Straightedge Alignment Showing 4 Points of Contact - Correct

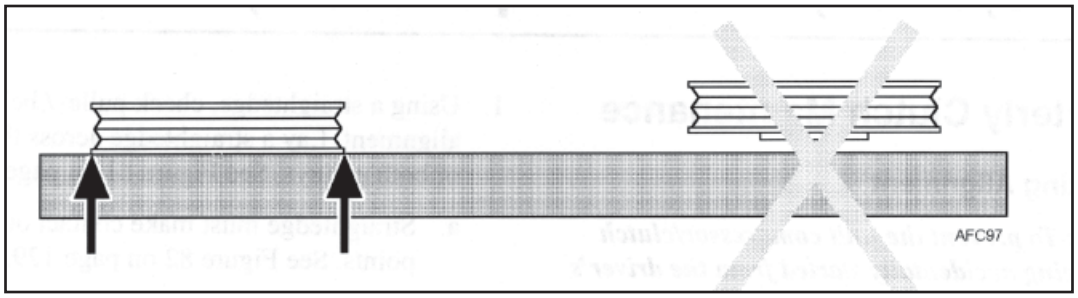


Figure 83: Straightedge showing 2 point contact - Incorrect

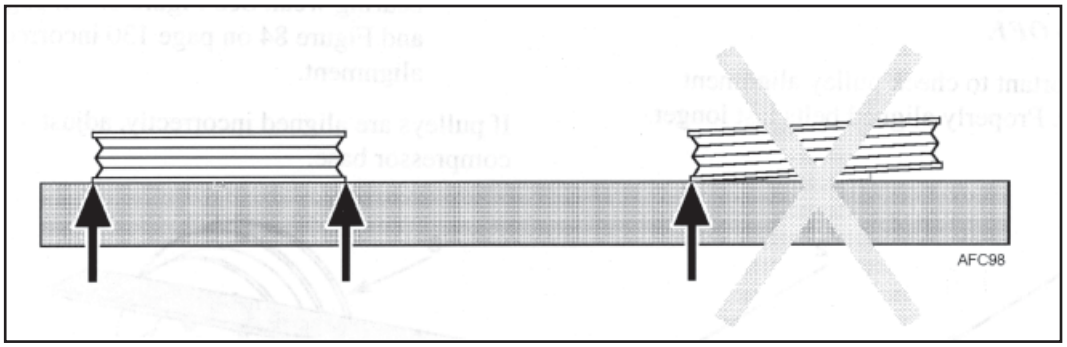


Figure 88: Straightedge showing 3 point contact - Incorrect

WARNING!! Take precautions to ensure the unit and the bus will not accidentally start while you are servicing the system.

2. Lubricate the clutch bearing with 1 oz. (28 gm) Exxon Unirex N2 high temperature grease (TK No. 204-476). Do not over lubricate.

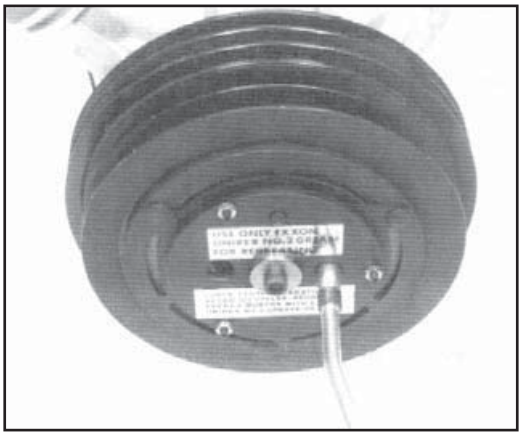


Figure 85: Greasing Clutch

NOTE: Use only Exxon Unirex N2 high temperature grease (TK No. 204-476).

3. Check and, if necessary, adjust the air gap between the armature and pulley/flywheel mating surfaces to 0.045 ± 0.005 in. (1.143 ± 0.127 mm).
4. If the surface of the armature and the pulley/flywheel have grooves from wear, an alternate method may be used. Turn the air gap adjusting screws in until the mating surfaces touch. Turn out each screw 1-½ turns. This should provide an air gap of 0.045 ± 0.005 in. (1.143 ± 0.127 mm).
5. Adjust the drive belts to the tension recommended by the bus manufacturer or the belt manufacturer. Tension is not to exceed 220 lb (979 N·m) on new belts and 180 lb. (800 N·m) on used belts.

Annual Clutch Maintenance

With the compressor in the bus, perform the following annually.

1. Check the clutch voltage: The normal reading is 24 Vdc. The minimum reading acceptable is 20 Vdc.
2. Check the field coil resistance (ohms) and current draw (amps); refer to "*Clutch Coil Electrical Check*" section for more information.

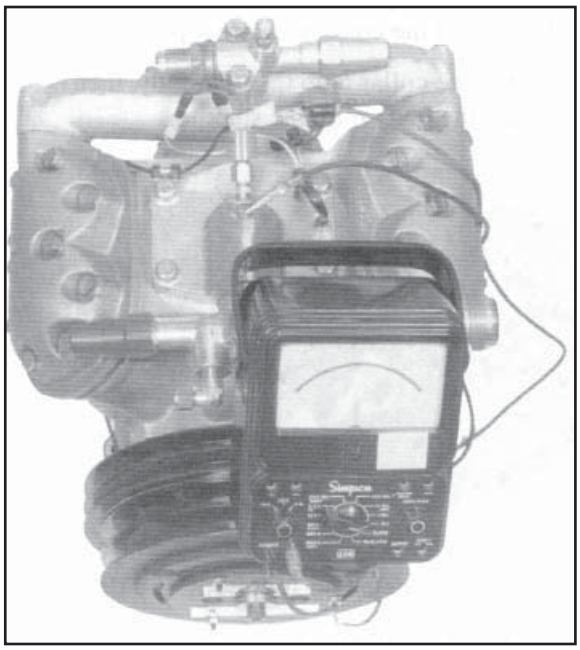
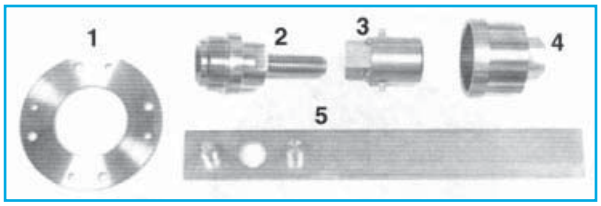


Figure 86: Checking Clutch Field

3. Remove the armature and check the mating surfaces for flatness and signs of excessive wear; refer to "*Clutch Inspection*" section to follow.
4. Remove the front seal and check the condition of the grease (refer to "*Clutch Disassembly*" section below). Lubricate as required and reinstall the seal (refer to "*Clutch Reassembly*" section).
5. Using a dial indicator, check the horizontal pulley/flywheel run out (side-play). The maximum allowable runout is 0.010 in. (0.254 mm).

Clutch Disassembly

NOTE: To properly disassemble the clutch, use TK Clutch Puller (refer to Tool Catalog TK 5955). Do not attempt to pull the clutch pulley by using a standard puller tool attached around the outer perimeter of the pulley. The pulley will be warped and rendered unusable.



1.	Collar	4.	Body
2.	Spindle	5.	Wrench
3.	Bearing Nut Driver		

Figure 87: Clutch Puller

1. Hold the clutch from turning by using a spanner in the holes provided in the armature and remove the armature retaining bolt.
2. Using the spindle portion of the body and spindle tool, install the threaded spindle into the clutch armature. Be sure the crankshaft key is flush with the end of the compressor crankshaft before installing the spindle (or cleaning the threads). If the armature threads are dirty or damaged, use a ¾x10 tap to restore them.
3. Use a 1-¼ in. wrench, or a crescent wrench, and turn the spindle in until the armature is free. Taking care not to lose the crankshaft key, remove the armature.

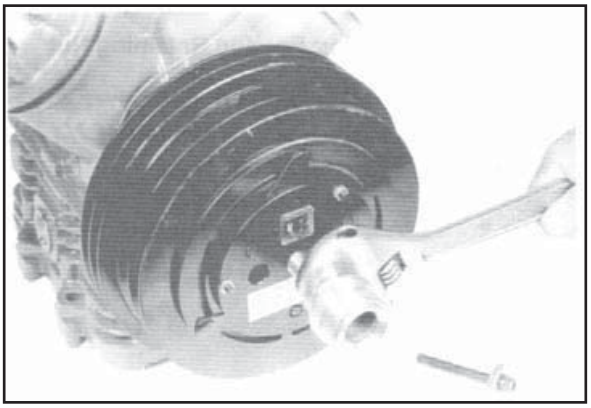


Figure 88: Removing Armature

4. Remove the four screws fastening the seal assembly.

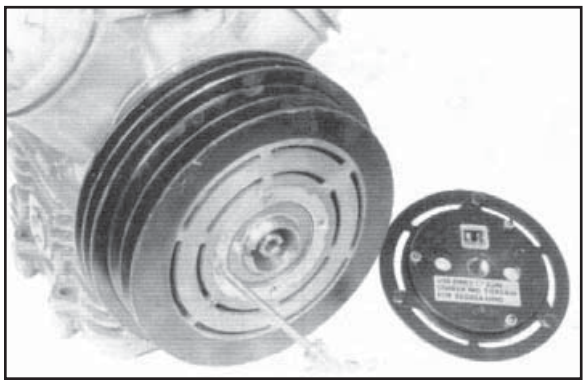


Figure 89: Removing Seal Assembly

5. Pry the front seal assembly out and clean the old grease from the front cavity.
6. Install the bearing nut driver. Using a 1-⅛ in. wrench, remove the bearing retainer nut.

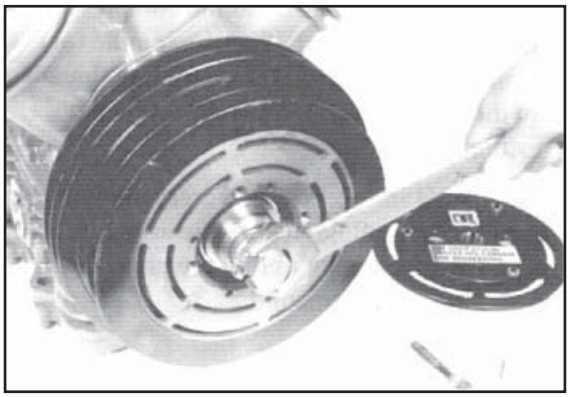


Figure 90: Removing Bearing Retaining Nut

NOTE: If the key in the bearing nut driver becomes worn, replace it with a section of ¼ in. key stock.

7. Reverse the spindle and screw it into the inner threads of the compressor seal plate hub.
8. Install the collar onto the tool body, then screw the body onto the spindle.

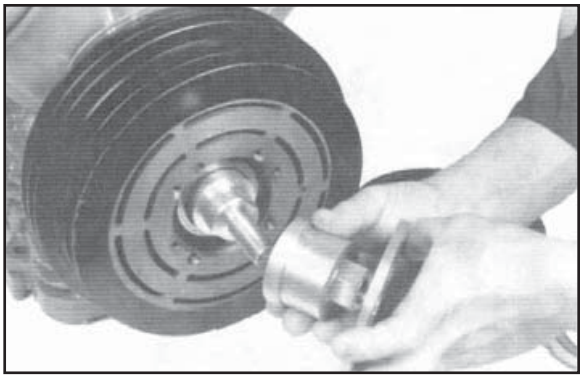


Figure 91: Installing Tool Body and Collar

9. Secure the collar to the clutch pulley (or flywheel on propshaft clutches) with four ¼-20 bolts.

Figure 92: Securing Collar to Pulley

10. Back the tool body off the spindle. Allow the pulley to rotate to prevent scoring the bearings. As the tool body backs off, the clutch pulley and bearing will be pulled off along with the collar.

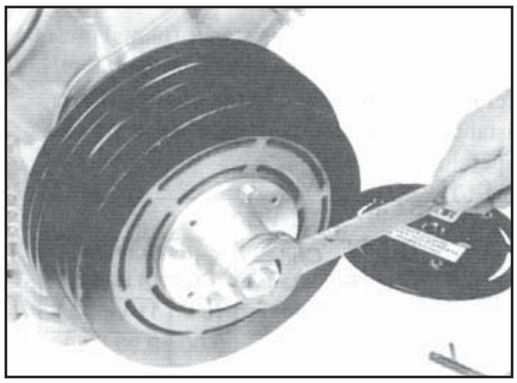


Figure 93: Removing Pulley

11. Remove the rear seal and internal snap ring from the clutch pulley. Using a press, remove the clutch bearing.
12. If necessary for repair or replacement, remove the field coil.

Clutch Inspection

Pulley and Armature Mating Surface Condition

Check the mating surfaces as follows:

1. Using a straightedge and 0.010 in. (0.254 mm) feeler gauge, check the armature and pulley (or flywheel) mating surfaces for warpage. Use the following guidelines to determine the course of action to follow.
   a. If no more than 20% of the pulley surface is warped over 0.010 in. (0.254 mm), the component may still be used without the need for any surface machining. If the armature is warped, replace it.
   b. If warpage exceeds 0.010 in. (0.254 mm) from 20 to 50% over the face of the armature and/or pulley (flywheel), the armature should be replaced. The pulley may be resurfaced; refer to "*Resurfacing Operation*".
   c. Warpage exceeding 0.010 in. (0.254 mm) over more than 50% of the armature and/or pulley surface means the armature should b replaced and the pulley may have to be replaced. Make an attempt to resurface the pulley (see "*Resurfacing Operation*"). It may be possible to restore the pulley to a usable condition. Check again for warpage after the resurfacing operation is complete. If the pulley still fails to meet specification, replace it.
2. Check the mating surfaces of both components for excessive grooving. A slight amount of grooving is acceptable. However, if the galled portions on the mating surfaces project more than 0.010 in. (0.254 mm), replace the armature and attempt to resurface the pulley (see "*Resurfacing Operation*" section to follow).

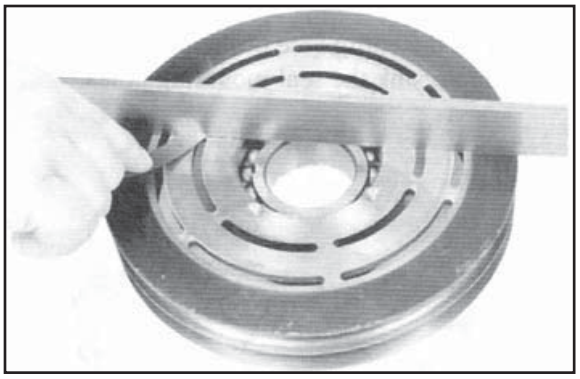


Figure 94: Checking for Warpage

Resurfacing Operation

NOTE: Machining of the mating surfaces of the pulley (flywheel) should be done on a precision machine tool such as a lathe or automotive brake grinding machine.

Perform the machining operation as follows:

1. Using a micrometer, measure the thickness of the outer edge of the pulley (flywheel). Mark the dimension down to use for future reference.

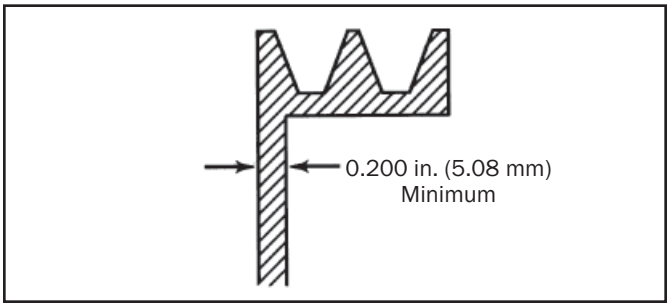
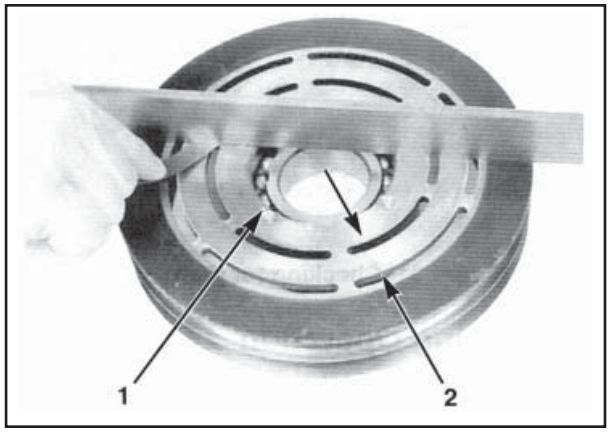


Figure 95: Pulley Thickness

NOTE: Minimum pulley thickness is 0.200 in. (5.08 mm) when machining is complete. If the pulley thickness is less than 0.200 in. (5.08 mm), replace the pulley.

NOTE: If the center portion of the pulley (out to the outside of the four chamfered center holes) is higher than the outer perimeter surface area of the pulley, the pulley mating surface has been previously machined. Determine the difference in height between the two surfaces and add this dimension to the thickness measurements of the outer perimeter of the pulley. This will ensure that too much material will not be removed from the pulley.

2. Install the pulley into the tool to be used for machining.
3. Machine the entire face of the pulley. Re-countersink the seal mounting holes.



1.	Seal Mounting Holes
2.	Machined Surface

Figure 96: Pulley Surface

4. DO NOT remove more than 0.025 in. (0.635 mm) of the pulley mating surface. Remove approximately 0.005 in. (0.127mm) each cut until 90% of the surface is cleaned up. If this cannot be done without machining more than 0.025 in. (0.635 mm) off the pulley, replace the pulley. Removal of more than 0.025 in. (0.635 mm) of material will weaken the pulley and cause it to fail during operation. Stop the machine occasionally and measure the pulley thickness to determine the amount of material removed. Subtract the dimension acquired from the original dimension to find the amount of material removed.

   Do not machine pulley face to a perfectly smooth finish (64 finish maximum smoothness allowed) or slippage may result.

Clutch Coil Electrical Check

Coil current (amps) and resistance (ohms) must be checked with the coil at a certain temperature. Refer to the charts below to obtain the proper resistance and current readings at different coil temperature readings.

12 Vdc				
Coil Temperature	Coil Resistance (Ohms)	dc Voltage Current (amps)		
		10V	11V	12V
50°F (10°C)	2.8	3.60	3.90	4.30
75°F (24°C)	2.9	3.45	3.80	4.15
100°F (38°C)	3.0	3.30	3.70	4.00

NOTE: Values are nominal for test conditions. 10% variation is acceptable.

24 Vdc					
Coil Temperature	Coil Resistance (Ohms)	dc Voltage Current (amps)			
		20V	22V	24V	27V
50°F (10°C)	11.2	1.80	1.95	2.15	2.42
75°F (24°C)	11.6	1.73	1.90	2.08	2.33
100°F (38°C)	12.0	1.65	1.85	2.00	2.25

NOTE: Values are nominal for test conditions. 10% variation is acceptable.

Clutch Bearing

Use the following criteria when determining whether bearing can be greased or it should be replaced.

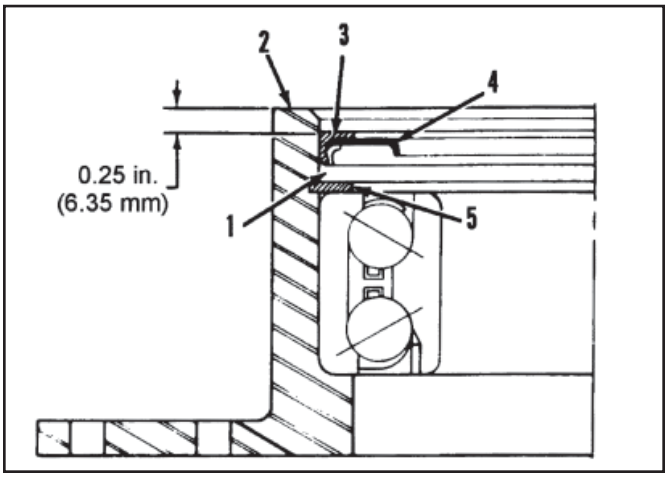
1. The bearing, (refer to the Parts Manual included in the Maintenance Manual) is manufactured especially for Thermo King and has special internal clearances.

NOTE: Only genuine Thermo King bearings should be used. Reduced bearing life will result if genuine Thermo King bearings are not used.

2. If wear is evident, replace the bearing.
3. Regrease the bearing by using Exxon Unirex N2 high temperature grease (TK No. 204-476).

Clutch Reassembly

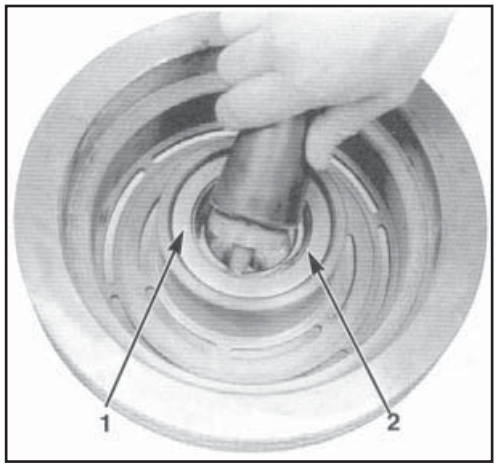
1. Install the new bearing (refer to Parts Manual for Bearing and Seal Kit), but press only on the outer race. Pressing the inner race will damage the bearing. Warming the pulley/flywheel will allow an easier fit. Install internal snap ring.
2. Install new rear seal (refer to Parts Manual). The seal should be seated 0.25 in. (6.35 mm) into the clutch pulley.



1.	Grease Cavity	4.	Teflon Seal
2.	Inner Hub Face	5.	Seal Ring
3.	Outer Seal Support		

Figure 97: Side View of Pulley Bearing Assembly Showing Rear Seal Position

3. Pack rear seal cavity about 1/3 full of Exxon Unirex N2 high temperature grease (TK No. 204-476).



1.	Seal
2.	Grease Cavity

Figure 98: Packing Rear Seal Cavity

4. To facilitate later installation of the key, rotate the compressor crankshaft so the keyway faces up.

NOTE: On 7.75 in. O.D. diameter pulleys, a bearing spacer must be installed on the compressor seal plate before the pulley is installed. See Figure 109 for clarity.

5. Screw the spindle into the inner threads of the compressor seal plate hub. Reverse the tool body and press the clutch pulley back onto the compressor seal plate hub. Ensure the bearing inner race seats on the shoulder of the hub.

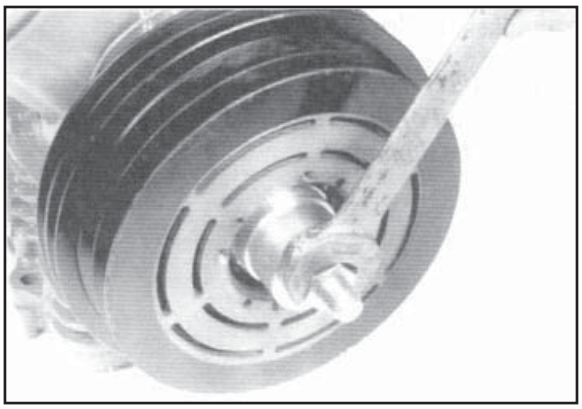


Figure 99: Pressing on Pulley

6. Reinstall the bearing retainer nut. Use the nut driver to assist in torquing it to 100 ft-lb (135 N·m).

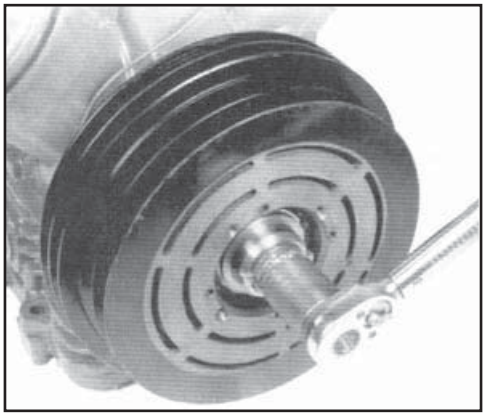


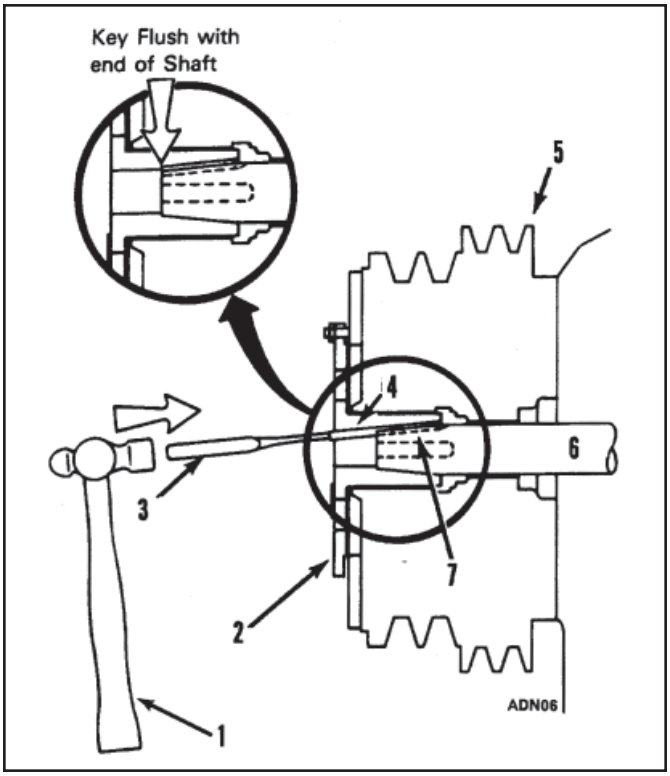
Figure 100: Reinstalling Pulley

7. Pack the front cavity behind the front seal 1/3 full with Exxon Unirex N2 high temperature grease (TK No. 204-476).
8. Place o-ring (refer to Parts Manual) onto back of front seal assembly and reinstall the seal.

NOTE: Check the armature threads to be sure they are cleaned and not damaged before reassembling. If the armature threads are dirty or damaged, use a ¾ x 10 tap to restore them.

9. Install the armature on the taper of the compressor crankshaft. Align the keyways of both the crankshaft and armature hub. Place the crankshaft key into the keyway slot and gently tap wiht a flat punch until the crankshaft key is flush with the end of the crankshaft. See the following illustrations.

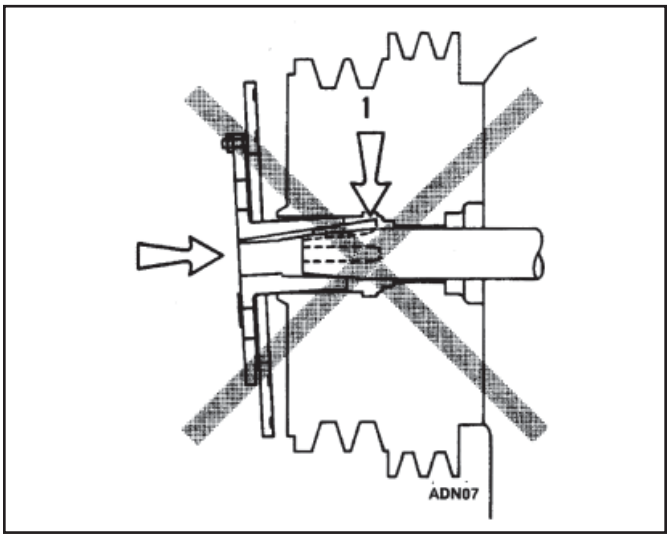
CAUTION! Do not push the key in past the end of the crankshaft or the armature will be damaged.



1.	Hammer	5.	Pulley
2.	Armature	6.	Crankshaft
3.	Flat Punch	7.	Shaft Keyway
4.	Key		

Figure 101: Correct

CAUTION! Forcing the armature on the crankshaft will cause damage and misalignment.



1.	Misaligned Key

Figure 102: Incorrect

CAUTION! DO NOT tighten the hub and armature until the crankshaft key is flush with the end of the crankshaft. Failure to do so will cause misalignment of the crankshaft key resulting in a wobbly hub and armature assembly and ultimately clutch failure.

10. After the crankshaft key is properly installed, torque the clutch retaining screw to 45 ft-lb (61 N·m).

NOTE: Be sure the taper portion of the washer I.D. is installed with the largest I.D. toward the screw head.

11. Check and adjust the air gap between the armature and pulley. The air gap should be 0.045 ± 0.005 in. (1.143 ± 0.127 mm). See *"Air Gap"* section on following page.

Air Gap

Air gap inspection and adjustment should be scheduled monthly during the air conditioning season.

Setting Air Gap with New Components

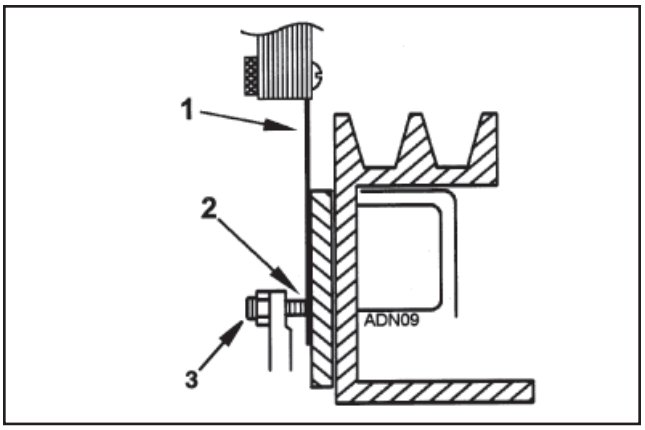
For a new armature and a new or resurfaced pulley/flyweel the air gap is set as follows:

1. Loosen the lock nuts on the three Allen head screws.
2. Adjust the Allen head screws to get an air gap of 0.045 ± 0.005 in. (1.143 ± 0.127 mm) between the mating surfaces of the armature and the pulley/flywheel.
3. Tighten the lock nuts. Make sure the Allen head screws do not turn by holding them with an Allen wrench (see Figure 105).

Air Gap Check

Once the clutch pulley surface wears, it is impractical to check the air gap between the armature plate and pulley with a feeler gauge. The feeler gauge will measure from the top of the worn pulley ridge to the armature plate and not the true air gap between the armature plate and the pulley front face. Check air gap in the following method:

1. Energize clutch coil with appropriate voltage if practical, or mate the surfaces by pushing in on the armature by hand.
2. Check air gap between the three adjusting screws and armature plate using a 0.045 in. (1.143 mm) feeler gauge.



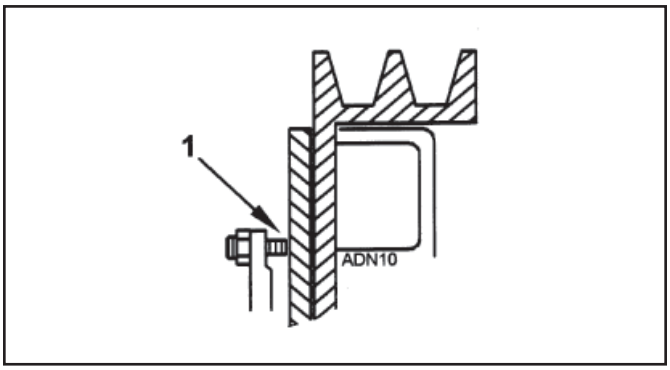
1.	Feeler Gauge
2.	Air Gap Measured Here
3.	Adjusting Screw Assembly

Figure 103: Air Gap Measurement

3. If the air gap is greater or less than 0.045 ± 0.005 in. (1.143 ± 0.127 mm), the clutch is in need of adjustment.

Air Gap Adjustment

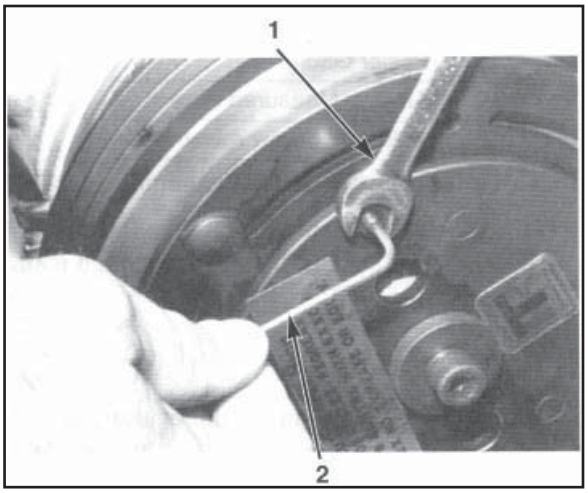
1. Loosen the locknuts on the three adjustment screws.
2. Energize clutch coil with appropriate voltage if practical, or mate the surfaces by pushing in on the armature by hand.
3. Using a 3/32 in. (2.4 mm) Allen wrench, turn each adjustment screw in clockwise (CW) until the screw bottoms out on the armature plate.



1.	Allen Screw Bottoms Out

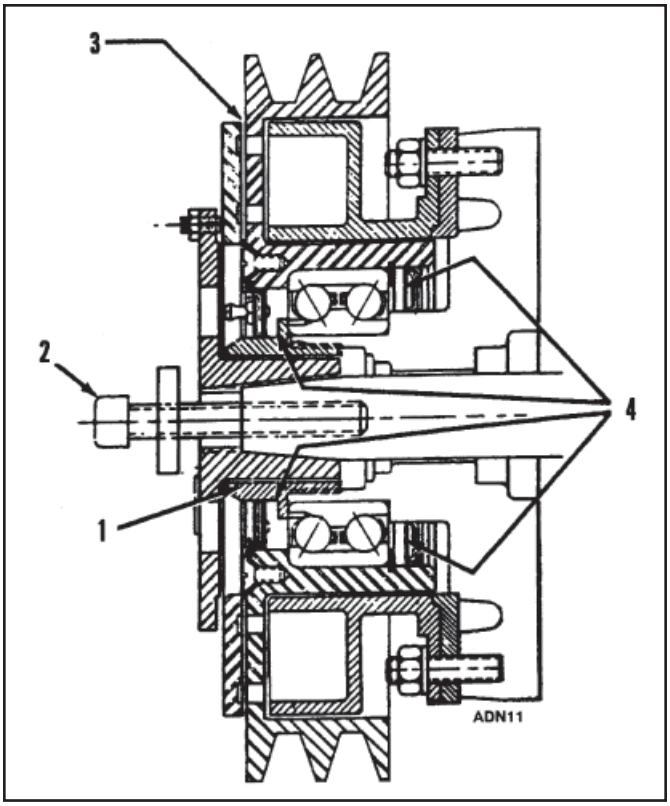
Figure 104: Air Gap Adjustment Bottoms Out

4. Back each adjusting screw out counterclockwise (CCW) 1-½ turns. This equals a 0.045 in. (1.143 mm) air gap.
5. Double check air gap with feeler gauge (see *Figure 103*).
6. Tighten the lock nuts. Make sure the adjusting screws do not turn by holding them with an Allen wrench.



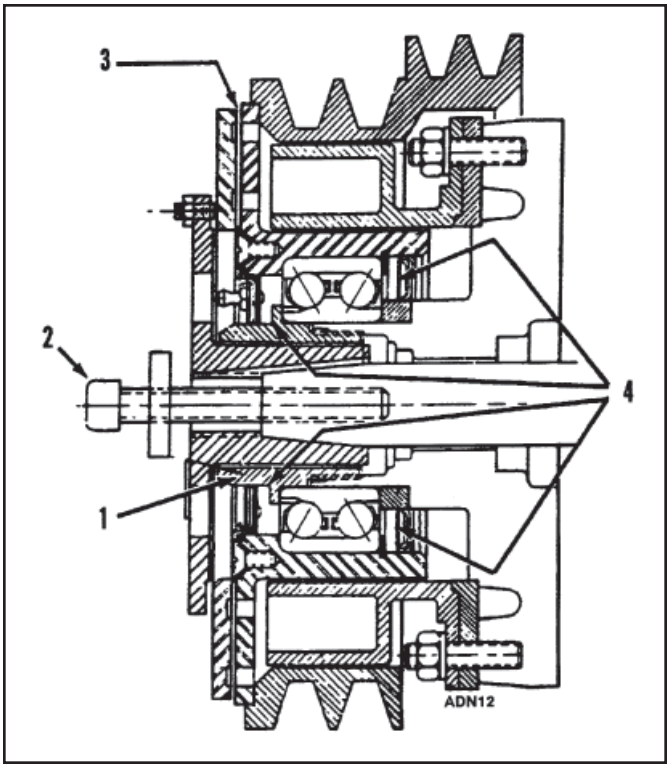
1.	Wrench Tightening Locknut
2.	3/32 in. (2.4 mm) Allen wrench

Figure 105: Air Gap Adjustment Procedure



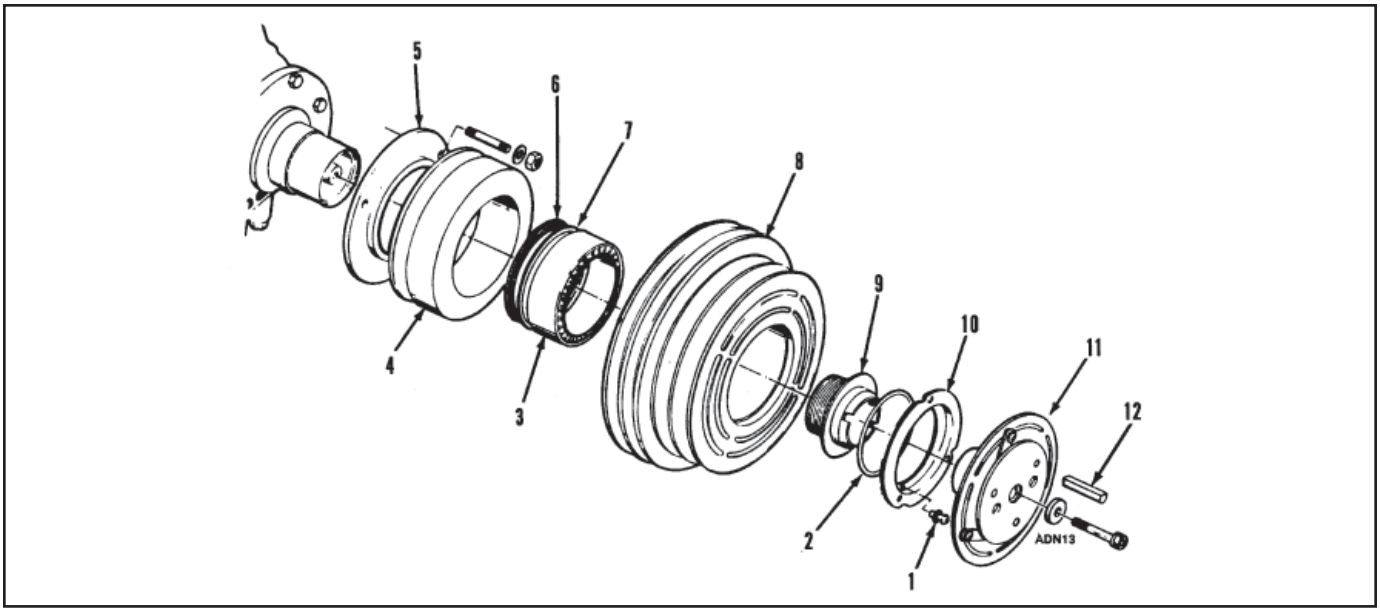
1.	Torque to 100 ft-lb (135 N·m) (Bearing Retaining Nut)
2.	Torque to 45 ft-lb (61 N·m)
3.	Set Air Gap at 0.045 ± 0.005 in. (1.143 ± 0.127 mm)
4.	Fill Cavity 1/3 Full with Grease, Exxon Unirex N2 high temperature grease (TK No 204-476)

Figure 106: Clutch Assembly - 8.0 in., 9.0 in and 9.0/10 in. Diameter Pulley



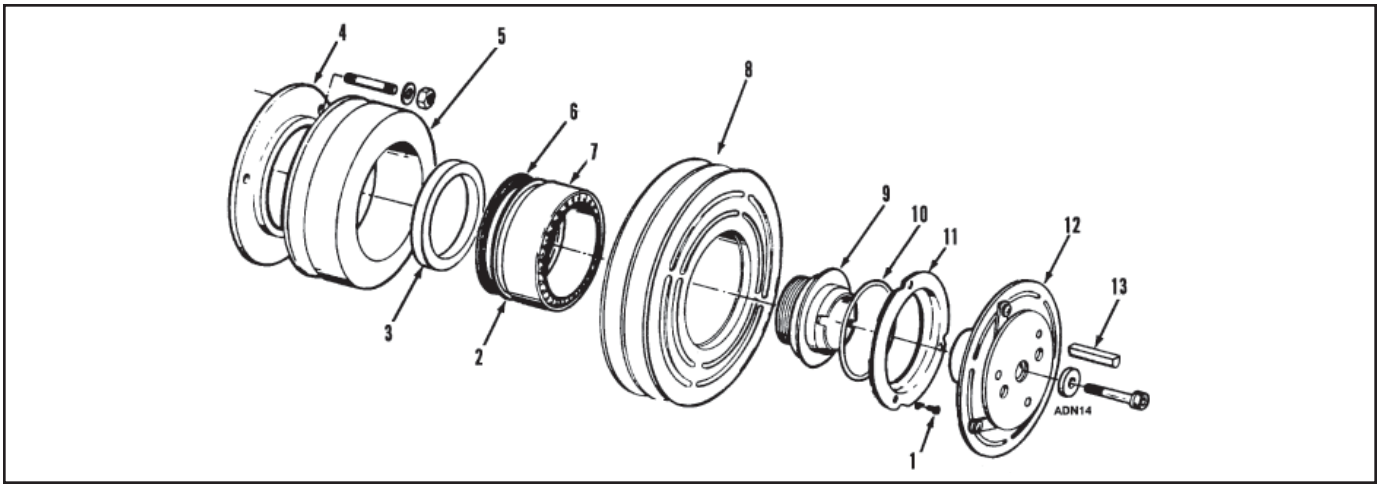
1.	Torque to 100 ft-lb (135 N·m) (Bearing Retaining Nut)
2.	Torque to 45 ft-lb (61 N·m)
3.	Set Air Gap at 0.045 ± 0.005 in. (1.143 ± 0.127 mm)
4.	Fill Cavity 1/3 Full with Grease, Exxon Unirex N2 high temperature grease (TK No 204-476)

Figure 107: Clutch Assembly - 7.75 in./8.9 in. Diameter Pulley



1.	Grease Fitting	7.	Bearing Retaining Ring
2.	O-ring	8.	Pulley
3.	Bearing	9.	Bearing Retaining Nut
4.	Field	10.	Front Seal
5.	Aluminum Flux Shield	11.	Hub and Armature
6.	Rear Seal	12.	Shaft Key

Figure 108: 9 in. Pulley Assembly



1.	Grease Fitting	8.	Pulley
2.	Bearing Retaining Ring	9.	Bearing Retaining Nut
3.	Bearing Spacer	10.	O-ring
4.	Aluminum Flux Shield	11.	Front Seal
5.	Field Assembly	12.	Hub and Armature
6.	Rear Seal	13.	Shaft Key
7.	Bearing		

Figure 109: 7.75 in. Pulley Assembly

Allison B Series Transmission

The Allison B500 World Automatic Transmission is an electronically controlled transmission providing six forward speeds and one reverse. Fourth gear provides a 1-to-1 ratio. Sixth gear is an overdrive with a 0.64-to-1 ratio. With an Allison equipped vehicle, it is not necessary to select the right moment to upshift or downshift during changing road, traffic, or load conditions. The Allison B500 does it for you. However, knowledge of the gear ranges and when to select them will make vehicle control and your job even easier.

The transmission and selector must be in Neutral (N) to start the engine. The transmission and shift selector will return to Neutral when engine is stopped and power is switched off. If it does not return to N, or if it starts in any other gear, the unit has malfunctioned. Seek service immediately.

WARNING!! If the operator leaves the vehicle, even momentarily, while the engine is running, it is very important to leave the transmission in neutral, with the parking brake and/or emergency brakes set and properly engaged, and the wheels chocked. The vehicle may move suddenly and unexpectedly if these precautions are not taken.

WTEC III Electronic Control System

The WTEC III Control System is standard on all MD, HD and B Series transmissions starting in 1998. The system consists of the following five major components connected by customer-furnished wiring harnesses:

- Electronic Control Unit (ECU)
- Engine throttle position sensor (or direct electronic communications link)
- Three speed sensors
- Remote shift selector
- Control module (which contains solenoid valves, a pressure switch, and an optional oil level sensor).

The following items transmit information to the ECU:

- The throttle position sensor (TPS) or engine-to-transmission communication link
- Speed sensors
- Pressure switch
- Shift selector

The ECU processes this information and then sends signal to actuate specific solenoids located on the control module in the transmission. These solenoids control the oncoming and offgoing clutch pressures to provide closed-loop shift control by matching rpm during a shift to a previously established desired profile that is programmed into the ECU.

A feature of WTEC III controls is “autodetect.” Autodetect is active during a predetermined number of engine starts, depending upon the component or sensor being detected. These engine start cycles begin from when the transmission is installed during vehicle manufacture. Autodetect searches for the presence of the following transmission components or source of data inputs:

Retarder	Present, Not Present
Oil Level Sensor (OLS)	Present, Not Present
Throttle	Analog, J1587, J1939
Engine Coolant Temperature	Analog, J1939, J1587

Seek help from your nearest Allison Transmission service outlet when any of the above items are present, but are not responding properly.
Another feature of the MD, HD and B Series transmission is its ability to adapt or “learn” as it operates. Each shift is measured electronically, stored and used by the ECU to adapt or “learn” the optimum conditions for future shifts.

NOTE: If the shift quality of low mileage vehicles, or vehicles with new or recalibrated ECU is unacceptable, follow the procedure in SIL 16-WT-96 to properly restore good shift quality.

NOTE: Allison WTEC III electronic control systems are designed and manufactured to comply with all FCC and other guidelines regarding radio frequency interference/electromagnetic interference (RFI/EMI) for transportation electronics. Manufacturers, assemblers, and installers of radio-telephone or other two-way communication radios have the sole responsibility to correctly install and integrate those devices into Allison MD, HD and B Series transmission-equipped vehicles to customer satisfaction.

The ECU is programmed to provide the most suitable operating characteristics for a specific application. This manual does not attempt to describe all of the possible combinations. The information contained herein describes only the operating characteristics most frequently requested by vehicle manufacturers.

Torque Converter

The torque converter consists of the following three elements:

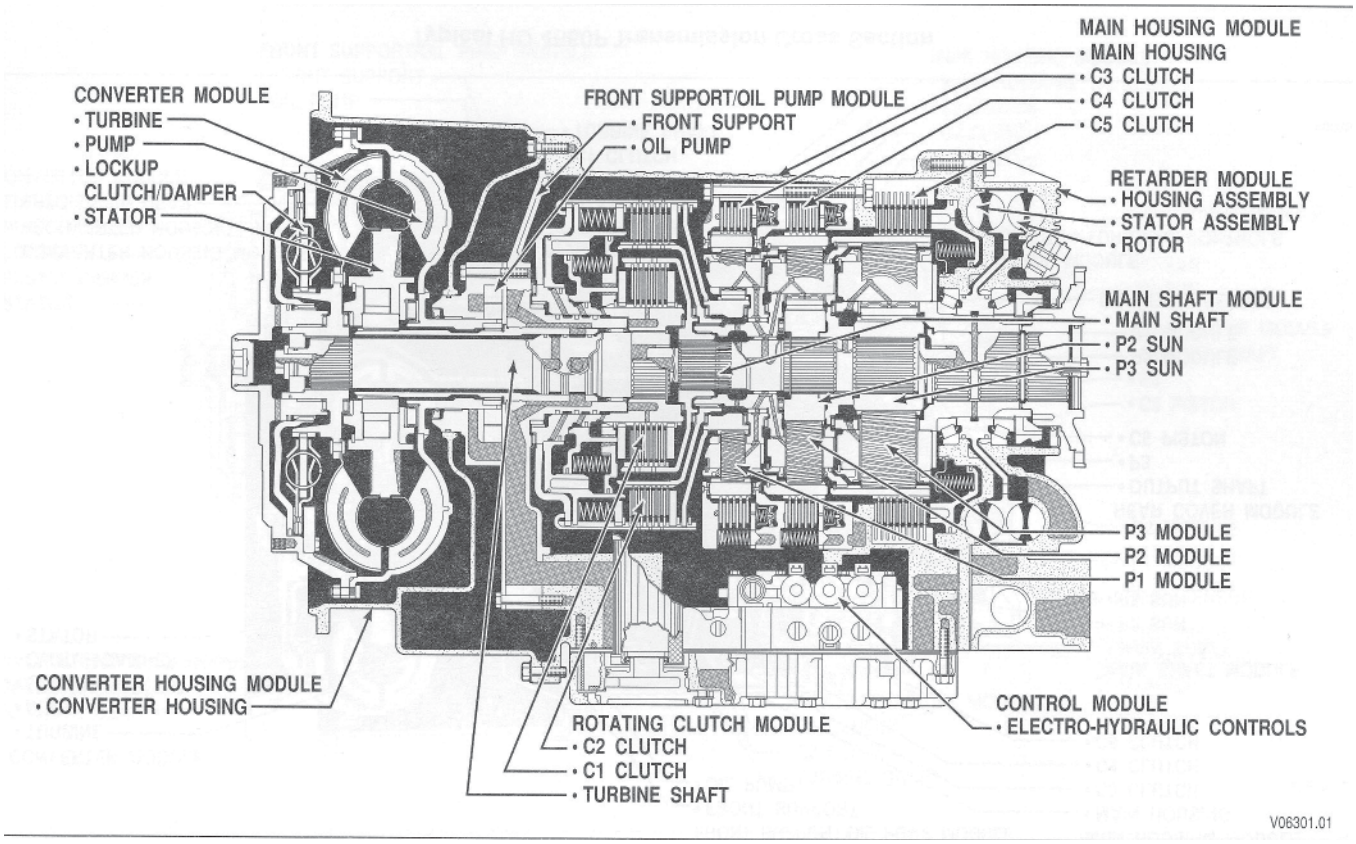
- Pump - input element driven directly by the engine.
- Turbine - output element hydraulically driven by the pump.
- Stator - reaction (torque multiplying) element.

The torque converter acts as a torque multiplier or fluid coupling. Torque multiplication occurs when the pump turns faster than the turbine. Torque multiplication decreases and stops as the turbine approaches the speed of the pump and the stator begins to rotate with the pump and turbine. The torque converter now functions as a fluid coupling.

The lockup clutch is located inside the torque converter and consists of the following three elements:

- Piston - driven by the engine
- Backplate - driven by the engine
- Clutch plate/torsional damper - located between the piston and backplate and splined to the converter turbine.

The lockup clutch/torsional damper is engaged and released in response to electronic signals from the ECU providing a direct drive from the engine to the transmission gearing. This eliminates converter slippage and provides maximum fuel economy and vehicle speed. The lockup clutch releases at low speeds or when the ECU detects conditions requiring it to be released. The torsional damper absorbs engine torsional vibration to prevent transfer through the power train.



Typical B 500R Transmission Cross Section

Planetary Gears and Clutches

A series of three helical planetary gear sets and shafts provides the mechanical gear ratios and direction of travel for the bus. The planetary gear sets are controlled by five multi-plate clutches that work in pairs to produce six forward speeds and one reverse speed. The clutches are applied and released hydraulically in response to electronic signals from the ECU to the appropriate solenoids.

Cooler Circuit

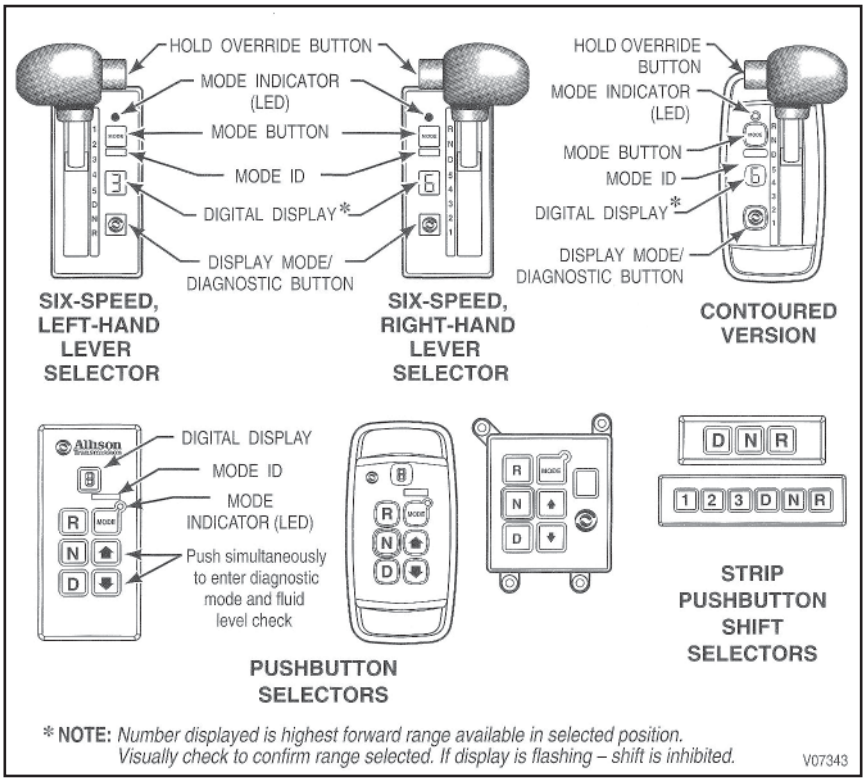
Transmission fluid is cooled by an integral (transmission-mounted) or remote-mounted oil cooler. Connections to the cooling circuit are located at the front or rear of the transmission to facilitate installation of remote cooler lines. On shallow sump models, only rear ports are available. On retarder models, only rear cooler ports may be used. The integral cooler is located on the lower rear portion of the transmission, replacing the remote cooler manifold. Integral cooler oil ports are internal requiring only coolant to be routed to and from the cooler.

A new feature has been added on all retarder-equipped transmissions. Modification of the retarder housing allows the addition of either a remote or integral cooler for transmission sump fluid in addition to retarder out fluid. A cover is placed over the sump cooling ports when the provision is not used. The sump cooler ports are located on the lower right rear face of the retarder housing. These ports became available on the MD, B 300, B 400 Series in April, 2000, and on the HD and B 500 Series in July 2000.

Retarder

The self-contained retarder is at the output of the transmission and consists of a vaned rotor that rotates in a vaned cavity. The rotor is splined to and driven by the output shaft. An external accumulator holds transmission fluid until the retarder is activated. When the retarder is activated, the fluid in the accumulator is pressurized by the vehicle air system and directed into the retarder cavity. The interaction of the fluid with the rotating and stationary vanes causes the retarder rotor speed, and hence the output shaft to decrease and slow the vehicle or to limit speed on a downhill grade.

When the retarder is deactivated, the retarder cavity is evacuated and the accumulator is recharged with fluid.



Typical WTEC III Shift Selectors

Pushbutton Shift Selector

(Full-Function, Non Strip-Type)

The push-button shift selector has R, N, D, ↓, ↑, a MODE button, and a digital display.

R Pushbutton - Press this button to select Reverse.

N Pushbutton - Press this button to select Neutral.

D Pushbutton - Press this button to select Drive. The highest forward range available will appear in the digital display window. The transmission will start out in the lowest available forward range and advance automatically to the highest range.

↑,↓ **(Arrow) Buttons** - When a lower range is desired, after D (Drive) has been pressed, press the ↓ (Down) arrow button until the desired range is shown in the display window. Likewise, if the transmission is held in a low range by the ↓ (Down) arrow, press the ↑ (Up) arrow to request the next higher range. Continuous pressing of either the ↑ (Up) or ↓ (Down) arrow buttons will request the highest or lowest range available.

Access fluid level data and diagnostic codes with the pushbutton selector by press the ↑ (Up) and ↓ (Down) arrow buttons at the same time. Refer to the section Fluid Level Check Using the Pushbutton Lever Shift Selector, for further information.

NOTE: Fluid level information is displayed (if an optional oil level sensor is present) after the first simultaneous press. Press both buttons again to obtain diagnostic data.

MODE Button - The MODE button may allow the driver to enable a secondary shift schedule or other special function that has been previously programmed into the electronic control unit at the request of the OEM. The name of the special function (ECONOMY) should appear on the MODE ID label adjacent to the MODE button. Press the MODE button activates the ECONOMY shift schedule and illuminates the MODE INDICATOR (LED). Other special functions which may be activated by the MODE button are D1 selection or PTO enable. The MODe button is also used to view diagnostic code information. After viewing the first diagnostic code which appears in the digital display, press the MODE button to view the 2nd diagnostic code logged. Repeat this procedure to view the 3rd, 4th, and 5th code positions. The code displayed is active when the MODE INDICATOR (LED) is illuminated.

NOTE: Visually check the digital display whenever a new button is pushed to be sure that the range selected is shown (i.e. if the N (Neutral) button is pressed, N should appear in the digital display).

Digital Display - During normal operation, when D (Drive) is selected, the digital display shows the highest forward range attainable for the shift schedule in use. Abnormal operation is also indicated by the digital display. When all segments of the digital display are illuminated for more than 12 seconds, the ECU did not complete initialization.

When the digital display is blank, there is no power to the selector. When the display shows a “ ” (cateye), a selector-related fault code has been logged.

Conditions which illuminate the CHECK TRANS light will disable the shift selector and the digital display will show the range actually attained. See Check Trans Light section later in manual for more information.

The transmission will not shift into range if a CHECK TRANS code is active. When the display shows either R or D has been requested and the display is flashing, the requested range has not been achieved due to an inhibit function.

Some inhibit functions are vehicle-related and will not result in diagnostic codes. Some examples are mentioned in the Range Selection section which follows. Check for active codes if no other inhibit function has been located. Once D (Drive) is attained, the transmission will shift into the lowest range programmed for the D (Drive) position, usually first.

Display Mode/Diagnostic Button - Allows access to optional fluid check information and diagnostic code information. Press the display mode/diagnostic button once to obtain transmission fluid level information (when an oil level sensor is present) and a second time to obtain diagnostic code information.

WARNING!! If you leave the vehicle and the engine is running, the vehicle can move suddenly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures:

- Put the transmission in N (Neutral)
- Ensure that the engine is at low idle (500-800 rpm)
- Apply the parking brake and emergency brakes and make sure they are properly engaged
- Chock the wheels and take any other steps necessary to keep the vehicle from moving.

WARNING!! R (Reverse) may not be obtained due to an active inhibitor. Always apply the service brakes when selecting R (Reverse) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When the "R" is flashing, it indicates that the shift to R (Reverse) is inhibited. Check for active diagnostic codes if R (Reverse) is not obtained. See Downshift and Direction Change Inhibitor Feature later in the manual.

CAUTION! Do not idle in R (Reverse) for more than five minutes. Extended idling in R (Reverse) may cause transmission overheating and damage. Always select N (Neutral) whenever time at idle exceeds five minutes.

NOTE: Visually check the digital display window whenever a button is pushed or the lever is moved to be sure the range selected is shown (i.e. if the N (Neutral) button is pressed, N should appear in the digital display). A flashing display indicates that the range selected was not attained due to an active inhibit.

NOTE: Completely stop the vehicle and let the engine return to idle before shifting from a foreward range to Reverse or from Reverse to a forward range. The digital display will display R when Reverse is selected.

WARNING!! When starting the engine, make sure the service brakes are applied. Failure to apply the service brakes may result in unexpected vehicle movement.

WARNING!! Vehicle service brakes, parking brake, or emergency brake must be applied whenever N (Neutral) is selected to prevent unexpected vehicle movement. Selecting N (Neutral) does not apply vehicle brakes, unless an auxiliary system to apply the parking brake is installed.

WARNING!! If you let the vehicle coast in N (Neutral), there is not engine braking and you could lose control. Coasting can also cause severe transmission damage. To help avoid injury and property damage, do not allow the vehicle to coast in N (Neutral).

Use N (Neutral) when you start the engine, to check vehicle accessories, and for extended periods of engine idle operation (longer than five minutes). For vehicles equipped with the pushbutton selector, Neutral is selected by the ECU at startup. The digital display will show N when Neutral is selected. Always select N (Neutral) before turning off the vehicle engine.

WARNING!! D (Drive) may not be obtained due to an active inhibitor. Always apply the service brakes when selecting D (Drive) to prevent unexpected vehicle movement and because a service brake inhibit may be present. When the "D" is flashing, it indicates that the shift to D (Drive) is inhibited. Check for active diagnostic codes if D (Drive) is not obtained. See Downshift and Direction Change Inhibitor Feature later in the manual.

CAUTION! Do not idle in D (Drive) for more than five minutes. Extended idling in D (Drive) may cause transmission overheating and damage. Always select N (Neutral) if time at idle is longer than five minutes.

NOTE: Turn off the vehicle HIGH IDLE switch, if present, before shifting from N (Neutral) to D (Drive) or R (Reverse). D (Drive) or R (Reverse) will not be attained unless the shift is made with the engine at idle. Also, be aware of other interlocks that would prevent obtaining D (Drive) or R (Reverse). Examples are "wheelchair lift not stored" and "service brakes not applied" (service brake interlock present).

The transmission will initially attain first range when D (Drive) is selected (except for those units programmed to start in second range). As vehicle speed increases, the transmission will upshift automatically through each range. As the vehicle slows, the transmission will downshift automatically through each range. The digital display will show the highest range available in D (Drive).

Upshifting and Downshifting

Occasionally, road conditions, load, or traffic conditions will make it desirable to restrict the automatic shifting to a lower gear. For example, progressively lower gears provide progressively greater engine braking effect when on long downhill grades.

Upshift (up arrow) and Downshift (down arrow) buttons enable the operator to restrict the automatic shifting range of the transmission to the next higher or lower gear, respectively. For example, after starting normally, with the transmission in Drive (D), the display panel indicates 6 as the highest gear which the transmission will automatically shift to. Pressing the down arrow once will cause the 6 to change to a 5, and the transmission will not automatically upshift beyond 5th gear. When the upshift/downshift arrows are used, the display panel indicates the current highest gear to which the transmission will automatically shift. For downhill operation, however, the transmission may upshift above the highest selected gear when the engine governed speed is exceeded and damaging engine over-speed is a possibility.

1st Gear. Use first gear when pulling through mud or deep snow, when maneuvering in tight spaces, or while driving up or down steep grades. First gear provides the vehicle with its maximum driving power and maximum engine braking power.

Downshift/Reverse Inhibitor Feature

Although there is no limitation on up-shifting, there is on downshifting and on shifts from Neutral into Drive or Neutral into Reverse. If such a shift is selected when the engine speed or throttle position is too high, the ECU will prevent the shift from occurring until a lower engine speed is reached. If idle speed is too high, shifts to Drive or Reverse may be inhibited. A continuous "beep" tone is emitted when the Inhibitor feature is activated by improper shifts.

Shift Modes

The times at which the automatic transmission shifts gears are determined by engine speed (RPM) and load conditions. The Mode button of the transmission control panel allows the operator to alter the shifting behavior somewhat toward favoring earlier or later gear shifts relative to engine speed. Two shifting modes are standard: Performance and Economy. The initial mode at startup is Performance Mode. Pressing the Mode button switches the transmission to Economy Mode, which can result in greater average fuel economy, for example, on routes where roads are relatively flat rather than hilly.

A Check Transmission warning light is in the driver's instrument panel. Any conditions resulting in the Check Transmission light will disable the transmission control pad and no tones will be heard.

Driving Tips

Check Trans Light

The electronic control system is programmed to inform the operator of a problem with the transmission system and automatically take action to protect the operator, vehicle and transmission. When the Electronic Control Unit (ECU) detects a problem condition, the ECU restricts shifting, turns on the CHECK TRANS light on the instrument panel, and registers a diagnostic code.

NOTE: For some problems, diagnostic codes may be registered without the ECU activating the CHECK TRANS light. Your Allison Transmission authorized service outlet should be consulted whenever there is a transmission-related concern. They have the equipment to check for diagnostic codes and to correct problems which arise.

Each time the engine is started, the CHECK TRANS light will illuminate, then turn off after a few seconds. This momentary lighting is to show that the status light circuits are working properly. If the CHECK TRANS light does not illuminate during ignition, or if the light remains on after ignition, the system should be checked immediately.

Continued illumination of the CHECK TRANS light during vehicle operation (other than start-up) indicates that the ECU has signaled a diagnostic code. Illumination of the CHECK TRANS light is accompanied by a flashing display from the shift selector. The shift selector display will show the actual range attained and the transmission will not respond to shift selector requests.

The indications from the shift selector are provided to inform the operator that the transmission is not performing as designed and is operating with reduced capabilities. Before turning the ignition off, the transmission may be operated for a short time in the selected range in order to "limp home" for service assistance. Service should be performed immediately in order to minimize the potential for damage to the transmission.

When the CHECK TRANS light comes on and the ignition switch is turned off, the transmission will remain in N (Neutral) until the condition causing the CHECK TRANS light is corrected.

Generally, while the CHECK TRANS light is on, upshifts and downshifts will be restricted and direction changes will not occur. Lever and pushbutton shift selectors do not respond to any operator shift requests while the CHECK TRANS light is illuminated. The lockup clutch is disengaged when transmission shifting is restricted or during any critical transmission malfunction.

Diagnostic Codes

Diagnostic codes are numerical indications relating to a malfunction in transmission operation. Each code consists of a two-digit main code and a two-digit subcode. These codes are logged in a list in the ECU memory with the most severe or otherwise most recent code listed first. A maximum of five codes (numbered d1-d5) may be listed in memory at one time. As codes are added, the oldest nonactive code is dropped from the list. If all codes are active, the code with the lowest priority that is not included on the severity list is dropped from the list. Access to the diagnostic codes and code information is through the pushbutton and lever shift selectors, the Pro-Link® Diagnostic Data Reader, or ATDT™.

The ECU separately stores the active and historical (nonactive) codes. An active code is any code that is current in the ECU decision-making process. Historical codes are codes that are retained in the ECU's memory and will not necessarily affect the ECU decision-making process. Historical codes are useful in determining if a problem is isolated, is intermittent, or results from a previous malfunction.

When the diagnostic mode is entered, the first code (position d1) is displayed as follows (each display item lasts for about one second): d,1, main code (two digits displayed one-at-a-time), subcode (two digits displayed one-at-a-time), sequence repeats. Press the MODE button momentarily to display codes for position d2-d5 in the same manner. After a fixed number of ignition cycles, a code may be deleted from memory if it has not recurred. The shift selector diagnostic mode will end automatically after two minutes without operator input.

Diagnostic Code Display Procedure

Diagnostic codes can be read and cleared by two methods:

- With the ATDT™ or Pro-Link® 9000 Diagnostic Data Reader. The use of the ATDT™ or Pro-Link® 9000 diagnostic tool is described in the instruction manual furnished with each tool.
- With the pushbutton or lever shift selector

Pushbutton Shift Selector

To Begin the Diagnostic Process:

- Bring the vehicle to a stop at a safe location.
- Apply the parking brake

To Display Stored Codes:

- Simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons once to access the diagnostic display mode - press the buttons twice if a transmission oil level sensor is installed.
- Observe the digital display for codes (codes will appear one digit at a time)
- Press the MODE button to see the next code - repeat for subsequent codes.

NOTE: Be sure to record all codes displayed before they are cleared. This is essential for troubleshooting.

To Clear Active Indicators and Resume Vehicle Operation: Press and hold the MODE button for approximately three seconds until the mode indicator (LED) flashes. Release the MODE button and active indicators such as the CHECK TRANS light will not be illuminated. Some codes are self-clearing and others require ignition cycles to clear.

Accelerator Control

WARNING!! To help avoid injury or property damage caused by sudden movement of the vehicle, do not make shifts from N (Neutral) to D (Drive) or R (Reverse) when the throttle pedal is depressed. If you shift while the throttle is depressed too far, the transmission will only engage if the throttle pedal is released in the next three seconds. This may cause a sudden movement of the vehicle. Leaving the throttle pedal depressed longer than three seconds causes the transmission to remain in N (Neutral). Avoid this condition by making shifts from N (Neutral) to D (Drive) or R (Reverse) only when the throttle is closed.

The position of the accelerator pedal influences the timing at which automatic shifting occurs. When the pedal is fully depressed, upshifts will occur automatically at high engine speeds. A partially depressed position of the pedal will cause the upshifts to occur at lower engine speeds. An electronic throttle position signal tells the ECU how much the operator has depressed the pedal. Excessive throttle position affects directional change shifts (shifts from N (Neutral) to D (Drive) or R (Reverse).)

Downshift and Direction Change Inhibitor Feature

NOTE: Turn off the vehicle HIGH IDLE switch, if present, before shifting from N (Neutral) to D (Drive) or R (Reverse). The shift from N (Neutral) to D (Drive) or R (Reverse) is inhibited when engine speed is above idle.

There is no speed limitation on upshifting, but there is on downshifting and for shifts which cause a direction change such as D (Drive) to R (Reverse) or R (Reverse) to D (Drive).

Manual range downshifts will not occur until a programmed value of output speed is reached. When a range downshift is manually selected and the transmission output speed is above the programmed value of the selected range, the transmission will stay in the range it was in even though a lower range was requested. Apply the vehicle service brakes or a retarding device to reduce the transmission output speed to the programmed value so the shift to the lower range will occur.

Directional shifts, D (Drive) to R (Reverse) or R (Reverse) to D (Drive), will not occur if selected when throttle position, engine speed, or transmission output speed is above the calibration limit for a calibration time period. The current calibration time period for engine speed is 0.5 second and for throttle position and output speed is three seconds.

Shifts from N (Neutral) to D (Drive) or R (Reverse) are also inhibited when the ECU has been programmed (by input/output function) to detect that auxiliary equipment is in operation and the shift should not be allowed.

When a directional shift is inhibited, the ECU will put the transmission in N (Neutral). The digital display, if present, will flash the letter of the range selected (D or R). Reselect D (Drive) or R (Reverse) when engine throttle, engine speed, and transmission output speed are below the calibration value. With a pushbutton selector, just depress the desired pushbutton again. With a lever selector, move the lever to N (Neutral) and then to the desired range.

When a direction change shift is requested and the engine throttle, engine speed, and transmission output speed drop below the calibration value during the calibration time interval, the shift to D (Drive) or R (Reverse) will occur. For example, if the transmission output speed was just above the calibration limit when R (Reverse) was selected, but dropped below the limit during the next three seconds, the shift to R (Reverse) would occur (assuming the engine was at idle and throttle was closed).

Using the Engine to Slow the Vehicle

WARNING!! If you just downshift or just use service brakes when going downhill, you can lose control and cause injury and property damage. To help avoid loss of control, use a combination of downshifting, braking, and other retarding devices. Downshifting to a lower transmission range increases engine braking and helps you to maintain control.

The transmission has a feature to prevent automatic upshifting above the lower range selected. However, during downhill operation, if engine governed speed is exceeded in the lower range, the transmission may upshift to the next higher range. This will reduce braking and could cause a loss of control. Apply the vehicle brakes or other retarding device to prevent exceeding engine governed speed in the lower range selected.

To use the engine as a braking force, select the next lower range. If the vehicle is exceeding the maximum speed for this range, use the service brakes and/or retarder to slow the vehicle. When a lower speed is reached, the ECU will automatically downshift the transmission.

Engine braking provides good speed control for going down grades. When the vehicle is heavily loaded, or the grade is steep, it may be desirable to preselect a lower range before reaching the grade. If engine-governed speed is exceeded, the transmission will upshift automatically to the next range.

Cold Weather Starts

All MD, HD and B Series transmissions are programmed to restrict full operation until specific temperatures are reached. Refer to the following chart for temperature restrictions.

Sump Oil Temperature	Check Trans Light	Operation
-32°C (-25°F) to -7°C (19°F)*	OFF	Neutral, Reverse, Second
-7°C (19°F)*	OFF	Full operation in all ranges

NOTE: When sump temperature is below 10°C (50°F), and transmission fluid is C-4 (not DEXRON® or TransSynd™), follow this procedure when making directional change shifts:

- To shift from forward to reverse; select N (Neutral) and then R (Reverse).
- To shift from reverse to forward; select N (Neutral) and then D (Drive), or other forward range.

Failure to follow this procedure may cause illumination of the CHECK TRANS light and then transmission operation will be restricted to N (Neutral).

Transmission operation at cold ambient temperatures may require preheating or the use of a lower viscosity transmission fluid. Refer to RECOMMENDED AUTOMATIC TRANSMISSION FLUID AND VISCOSITY GRADE section later in this manual.

Driving on Snow or Ice

WARNING!! Using the retarder on wet or slippery roads may cause loss of traction on the drive wheels - your vehicle may slide out of control. To help avoid injury or property damage, turn the retarder enable to OFF when driving on wet or slippery roads.

NOTE: The retarder is automatically disabled whenever the vehicle's ABS (antilock brake system) is active. However, in case the ABS system malfunctions, it is recommended that the retarder enable switch, if present is disabled.

If possible, reduce the vehicle speed and select a lower range before traction is lost. Select the range that will not exceed the speed you expect to maintain.

Accelerate or decelerate very gradually to prevent loss of traction. It is very important to reduce speed gradually when a lower range is selected. It is important that you reach the lower range selected before attempting to accelerate. This will avoid an unexpected downshift during acceleration.

High Fluid Temperature

The transmission is considered to be overheated when any of the following temperatures are exceeded.

Sump fluid	121°C (250°F)
Fluid to cooler	149°C (300°F)
Retarder out fluid	165°C (330°F)

If the sump fluid temperature reaches 128°C (262°F) the ECU will inhibit operation in the higher ranges ("EMERGENCY" vehicles are not affected).

If the transmission overheats during normal operations, check the fluid level in the transmission. (Refer to the Fluid Check Procedures as described in the Care and Maintenance Section of the manual.)

If the engine temperature gauge indicates a high temperature, the transmission is probably overheated. Stop the vehicle and check the cooling system. If it appears to be functioning properly, run the engine at 1200-1500 rpm with the transmission in N (Neutral). This should reduce the transmission and engine temperatures to normal operating levels in 2 or 3 minutes. If temperatures do not decrease, reduce the engine rpm.

CAUTION! The engine should never be operated for more than 30 seconds at full throttle with the transmission in range and the output stalled. Prolonged operation of this type will cause the transmission fluid temperature to become excessively high and will result in severe overheat damage to the transmission.

If the engine temperature indicates a high temperature, an engine or radiator problem is indicated. If high temperature in either the engine or transmission persists, stop the engine and have the overheating condition investigated by maintenance personnel.

Parking Brake

WARNING!! Take the following precautions so that unexpected, possible sudden vehicle movement is avoided. Whenever it becomes necessary to leave the vehicle, even momentarily, while the engine is in operation, place the transmission shift selector in N (Neutral) (or for special pumping operations, disconnect drive to the wheels), set the parking brake and/or emergency brakes, and chock the wheels.

The parking brake is only intended to secure an unattended vehicle with the engine ignition OFF. Always maintain the vehicle parking brake system according to the manufacturer's specifications. The parking brake may not have sufficient capacity to restrain a vehicle with the engine running and the transmission in a forward or reverse range. As indicated in the above WARNING when the vehicle is unattended and the engine is in operation, the transmission must be in N (Neutral) (or for special pumping operations, drive to the wheels disconnected) with the brakes fully applied and the wheels chocked.

Towing or Pushing

CAUTION! Failure to lift the driving wheels off the road, disconnect the driveline, or remove the axle shafts before pushing or towing can cause serious transmission damage.

The engine cannot be started by pushing or towing. Before pushing or towing do one of the following:

- Disconnect the driveline
- Lift the drive wheels off the road
- Remove the axle shafts from the drive wheels.

Be sure to cover the wheel openings to prevent loss of lubricant and entry of dust and dirt if the axle shafts are removed. An auxiliary air supply will usually be required to actuate the vehicle brake system.

Cruise Control Operation

Operating an Allison WTEC III equipped vehicle on cruise control may cause the transmission to shift cycle if the cruise control is set close to a scheduled shift point. One of the following actions may eliminate shift cycling:

- Select a different shift schedule by pushing the MODE button on the shift selector.
- Select a lower range by pushing the ↓ (Down) arrow or moving the lever on the shift selector.
- Change the cruise control speed setting away from the shift point.

The engine brake on some vehicles equipped with an Allison WTEC III transmission may be controlled by the transmission ECU. With this configuration, the transmission will automatically select a lower range when the engine brake is applied or the throttle is near idle position.

Operating a vehicle in cruise control with engine brake turned-on, controlled by the transmission ECU, may cause unwanted application of the engine brake when the cruise control decelerates for downhill grades. Operator may choose to turn off cruise control to eliminate unwanted condition.

Turning Off the Vehicle

Be sure to always select N (Neutral) prior to turning off the vehicle engine.

Power Takeoff Operation

Engine-Driven Power Takeoff (PTO)

CAUTION! Do not exceed the engagement and operational speed limits imposed on the driven equipment during the operation of the PTO.

If a PTO is present, it will normally be mounted on either the left or right side of MD, B 300, and B 400 models. There is also an option to have the PTO mounted on the left side or top of the transmission. On HD and B 500 models, the PTO will be located on the left side or on the top of the transmission. The PTO drive gear is engine-driven and therefore provides direct engine power. The PTO can be operated when the vehicle is either moving or stopped.

The PTO gear is in constant mesh with the drive gear in the converter housing. However, the PTO may either be constant drive (output always powered) or clutched drive. When the PTO is clutch driven, the clutch is part of the PTO not the transmission. A clutch drive PTO is powered only when the PTO clutch is engaged.

Be sure that the limits for PTO engagement speed and operational speed are not exceeded. Consult the vehicle manufacturer's literature for these speed limits. Also, all MD, HD, and

B-equipped vehicles with PTO enable have engagement and operational speed limits programmed into the ECU to help protect PTO equipment. Some speed limits have default values which are programmed out of the operating range and will need to be set for your particular PTO duty cycle. Consult your vehicle manufacturer to see if your transmission has been programmed and what operational limits have been established.

When the programmed engagement speed is exceeded, the PTO will not engage. The PTO engagement must be retired after the speed has been reduced. When operational speeds (either engine or transmission output) are exceeded, the PTO will deactivate and the PTO engagement process must be repeated.

Care and Maintenance

Periodic Inspections

The Allison MD, HD and B Series transmissions require minimum maintenance. Careful attention to the fluid level and the connections for the electronic and hydraulic circuits is most important.

Do the following periodic inspection:

- Keep the transmission clean for easier inspection.
- Make periodic checks for loose bolts and fluid leaks around fittings, lines, and transmission openings.
- Check the condition of the electrical wiring harnesses regularly.
- Check the engine cooling system occasionally for evidence of transmission fluid that would indicate a faulty oil cooler.
- Report any abnormal condition to your maintenance personnel.

Prevent Major Problems

Help the WTEC III control system oversee the operation of the transmission. Minor problems can be kept from becoming major problems if you notify an Allison Transmission distributor or dealer when one of these conditions occur:

- Shifting feels odd
- Transmission leaks fluid
- Unusual transmission-related sounds

NOTE: Changes in sound caused by normal engine thermostatic fan cycling, while climbing a long grade with a heavy load, may be mistaken for transmission-related sounds.

- CHECK TRANS light comes on frequently.

Importance of Proper Fluid Level

It is important that proper fluid level be maintained at all times because the transmission fluid cools, lubricates, and transmits hydraulic power. If the fluid level is too low, the converter and clutches do not receive an adequate supply of fluid. If fluid level is too high, the fluid can aerate. Aerated fluid can cause the transmission to shift erractically or overheat.

The MD, HD and B Series transmissions have an optional oil level (OLS) sensor that allows the operator to obtain an indication of fluid level from the shift selector. However, no oil level sensor diagnostics take place unless the OLS is "autodetected" by the WTEC III control system. Frequently check for the presence of oil level diagnostics if the transmission is known to contain an OLS. If an OLS is not detected during a fixed number of starts, the WTEC III system concludes that no OLS is present. If an OLS is known to be present, but has not been detected, then troubleshooting of the OLS circuit is required. After the OLS circuit is repaired, reset "autodetect" or manually select the OLS function using the ATDT™ or Pro-Link®.

NOTE: To correctly check the transmission fluid level using the dipstick, the transmission fluid must be at operating temperature. The oil level sensor method of checking the fluid level compensates for transmission fluid temperature between 60°C-104°C (140°F-220°F). Any temperature below 60°C (140°F) or above 104°C (220°F) will result in an INVALID FOR DISPLAY condition.

Fluid Level Check Using the Pushbutton or Lever Shift Selector

The transmission must be equipped with the optional oil level sensor to be able to read fluid level information.

NOTE: The pushbutton and lever selectors can display one character at one time.

- Park the vehicle on a level surface, shift to N (Neutral), and apply the parking brake.
- Pushbutton shift selector - If equipped with an oil level sensor, simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons.
- Lever shift selector - If equipped with an oil level sensor, press the display mode button one time.

NOTE: The fluid level check may be delayed until the following conditions are met:

- The fluid temperature is above 60°C (140°F) and below 104°C (220°F).
- The transmission is in N (Neutral)
- The engine is at idle.
- The transmission output shaft is stopped. (The vehicle has been stationary for approximately two minutes to allow the fluid to settle.)

The indication of a delayed fluid level check is a "-" in the display window followed by a numerical countdown display. The countdown, starting at 8, indicates the time remaining in the two minute setting period.

- Correct Fluid Level - "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "o,K," The "o,K" display indicates the fluid is within the correct fluid level zone. The sensor display and the transmission dipstick may not agree exactly because the oil level sensor compensates for fluid temperature.

NOTE: Fluid level diagnostic displays occur one character at a time.

- **Low Fluid Level** - "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "Lo" ("Lo" represents "Low Oil Level") and the number of quarts the transmission fluid is low. Example: "2" indicates 2 additional quarts of fluid will bring the fluid level within the middle of the "oK" zone.
- **High Fluid Level** - "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "HI" ("HI" represents "High Oil Level") and the number of quarts the transmission is overfilled. Example: "1" indicates 1 quart of fluid above the full transmission level.
- **Invalid for Display** - "o,L" is displayed ("o,L" represents "Fluid (Oil) Level Check Mode"), followed by "-" and a numerical display. The numerical display is a fault code and indicates conditions are not proper to receive the fluid level information, or that there is a system malfunction. The fault codes that may be encountered are shown in Table 2 below.

Display	Cause of Code
o,L, -, 0,X	Setting time too short
o,L, -, 5,0	Engine speed (rpm) too low
o,L, -, 5,9	Engine speed (rpm) too high
o,L, -, 6,5	Neutral must be selected
o,L, -, 7,0	Sump fluid temperature too low
o,L, -, 7,9	Sump fluid temperature too high
o,L, -, 8,9	Output shaft rotation
o,L, -, 9,5	Sensor failure*
*Report sensor failure display to a distributor or dealer in your area (check the telephone directory for an Allison Transmission distributor or dealer near you).	

Table 2 - Oil Level Fault Codes

CAUTION! Low or high fluid level can cause overheating and irregular shift patterns. These conditions can damage the transmission if not corrected.

NOTE: To exit the fluid level display mode, press any range button on the pushbutton shift selector, or press the display mode (diagnostic) button twice on the lever shift selector.

Fluid Level Check Using the Strip Pushbutton Shift Selector

The transmission must be equipped with the optional oil level sensor to be able to read fluid level information.

NOTE: The strip pushbutton selector has no display capability. Fluid level information can only be obtained by using the ATDT™ or Pro-Link® 9000.

Park the vehicle on a level surface and shift to N (Neutral). Apply the parking brake and/or emergency brakes.

Obtain oil level information by following the procedure in the ATDT™ User Guide, GN3433EN, or Pro-Link® 9000 manual or by using the OEM-supplied auxiliary display.

Fluid level information may be delayed when certain conditions are not met. The ATDT™ or Pro-Link® 9000 will display a message showing which conditions have not been met. These conditions are:

- Settling time too short
- Engine speed (rpm) too low
- Engine speed (rpm) too high
- N (Neutral) must be selected
- Sump fluid temperature too low (below 60°C or 140°F)
- Sump fluid temperature too high (above 104°C or 220°F)
- Output shaft rotation

Manual Fluid Check Procedure

WARNING!! If you leave the vehicle and the engine is running, the vehicle can move suddenly and you or others could be injured. If you must leave the engine running, do not leave the vehicle until you have completed all of the following procedures:

- Put the transmission in N (Neutral)
- Ensure that the engine is at low idle (500-800 rpm)
- Apply the parking brake and emergency brakes and make sure they are properly engaged
- Chock the wheels and take any other steps necessary to keep the vehicle from moving.

Clean around the end of the fill tube before removing the dipstick. This will aid in preventing dirt or foreign matter from entering the hydraulic system, which can cause valves to stick, undue wear of transmission parts, or clogged passages. Check the fluid level by the following procedure and report any abnormal level to your maintenance personnel.

Cold Check

The Cold Check determines if the transmission has enough fluid to be operated safely until a Hot Check can be made.

CAUTION! DO NOT start the engine until the presence of sufficient transmission fluid has been confirmed. Remove the transmission fluid dipstick and be sure that the static fluid level is near the HOT FULL mark.

A cold check may be made when the fluid 16°-49°C (60°-120°F). Before the engine is started, pull the transmission dipstick and confirm that the transmission fluid level is near the HOT RUN mark.

To perform a COLD CHECK, do the following:

- Start the engine and run it at idle (500-800 rpm) in N (Neutral) for about one minute.
- Move the vehicle to a level surface, put transmission in N (Neutral), and set the parking brake.
- With the engine idling (500-800 rpm), shift to D (Drive) and then to R (Reverse) to clear air from the hydraulic circuits.
- Shift to N (Neutral) and leave engine at idle.
- Remove the dipstick and wipe clean. Reinsert the dipstick into the transmission.
- Remove the dipstick and check the fluid level. If the fluid on the dipstick is within the COLD RUN band, the level is satisfactory. If the fluid level is not within this band, add or drain fluid as necessary to bring the level within the COLD RUN band.
- Perform a Hot Check at the first opportunity after normal operating temperature
- (71°-93°C; 160°-200°F) is reached.

CAUTION! The transmission must not be operated for extended periods of time until a Hot Check has verified proper fluid level. Transmission damage can result from extended operation at improper fluid level conditions.

CAUTION! An accurate fluid level check cannot be made unless the engine is idling (500-800 rpm) in N (Neutral), the transmission fluid is at the proper temperature, and the vehicle is on a level surface.

Hot Check

The transmission fluid must be hot to ensure an accurate check because the fluid level rises as temperature increases.

To perform a HOT CHECK, do the following:

- Be sure fluid has reached normal operating temperature (71°-93°C; 160°-200°F). If a transmission temperature gauge is not present, check fluid level when the engine water temperature gauge has stabilized and the transmission has been operated under load for at least one hour.
- Park the vehicle on a level surface and shift to N (Neutral). Apply the parking brake and allow the engine to idle at 500-800 rpm.
- Remove the dipstick and wipe clean. Reinsert the dipstick into the transmission.
- Remove the dipstick and check the fluid level. The safe operating level is anywhere within the HOT RUN band on the dipstick.
- If the level is not within this band, add or drain fluid as necessary to bring the level within the HOT RUN band.
- Be sure fluid level checks are consistent. Check the fluid level more than once and if readings are not consistent, check to be sure that the transmission breather is clean and not clogged. If readings are still inconsistent, contact the nearest Allison distributor or dealer.

Recommended Automatic Transmission Fluid and Viscosity Grade

Hydraulic fluids (oils) used in the transmission are important influences on transmission performance, reliability, and durability. TranSynd™ and DEXRON® III fluids are recommended for all MD, HD, and B Series applications.

TranSynd™ is a full synthetic transmission fluid developed by Allison Transmission and Castrol Ltd. This fluid meets Allison specifications for Severe Duty and Extended Drain Intervals. TranSynd™ is fully qualified to the Allison TES 295 specifications and is available through Allison distributors and dealerships.

To ensure the fluid is qualified for use in Allison transmissions, check for the DEXRON® III license numbers on the container or consult the lubricant manufacturer. Consult your Allison Transmission dealer or distributor before using other fluid types.

CAUTION! Disregarding minimum fluid temperature limits can result in transmission malfunction or reduced transmission life.

When choosing the optimum viscosity grade of fluid, duty cycle, preheat capabilities, and/or geographical location must be taken into consideration. Table 3 lists the minimum fluid temperatures at which the transmission may be safely operated without preheating. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in neutral for a minimum of 20 minutes before attempting range operation.

Viscosity Grade	Ambient Temperature Below Which Preheat is Required	
	Celsius	Fahrenheit
SAE 0W-20* or TranSynd™	-30	-22
DEXRON® III	-27	-17
SAE 10W	-20	-4
SAE 15W-40	-15	5
SAE 30	0	32
SAE 40	10	50
*"Artic" as defined by MIL-L-46167B		

Table 3 - Minimum Operating Temperature for Transmission Fluid

Keeping Fluid Clean

CAUTION! Do not use containers or fillers for transmission fluid that have been used for any antifreeze solution. Antifreeze and coolant solutions contain ethylene glycol which, if introduced into the transmission, can cause the clutch plates to fail.

It is absolutely necessary that transmission fluid be clean. The fluid must be handled in clean containers to prevent foreign material from entering the transmission.

Fluid and Internal Filter Change Interval Recommendations

CAUTION! Transmission fluid and filter change frequency is determined by the severity of transmission service. More frequent changes may be necessary than recommended in the general guidelines when operating conditions create high levels of contamination or overheating.

Allison requires all MD, HD and B Series transmissions to have the main filter (not the lube filter or fluid) changed after the first 5,000 miles (8000 km) or 200 hours of operation, whichever comes first. Refer to SIL 10-TR-99, latest revision, for convention kit and fluid information. Refer to Mechanic's Tips (MT3004EN), latest version, for location of the main filter and the filter change procedure.

Table 4 is given only as a general guide for fluid and filter change intervals for MD 3000/B 300/B 400 Series transmissions.

Table 5 is given only as a general guide for fluid and filter change intervals for HD 4000/B 500 Series transmissions.

Schedule 1 - Recommended Fluid and Filter Change Intervals (Non-TranSynd™/Non-TES 295 Fluid)							
SEVERE VOCATION				GENERAL VOCATION			
Fluid	Filter			Fluid	Filter		
	Main	Internal	Lube/Aux.		Main	Internal	Lube/Aux.
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40,000 km) 12 Months 1000 Hours	25,000 Miles (40,000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40,000 km) 12 Months 1000 Hours

NOTE: The following recommendations in Schedule 2 are based upon the transmission containing 100% of TranSynd™ fluid. MD/HD Product Line Filter change intervals in Schedule 2 are only valid with the use of Allison Transmission Gold series filters. Flushing Machines are not recommended or recognized due to variation and inconsistencies with ensuring removal of 100% of the used fluid.

Schedule 2 - Recommended Fluid and Filter Change Intervals (TranSynd™/TES 295 Fluid)							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

Table 4 - Transmission Fluid and Filter Change for MD 3000/B 300/B 400

NOTE: Change fluid/filters after recommended mileage, months, or hours have elapsed, whichever occurs first.
Severe Vocation: All Retarders, On/Off Highway, Refuse, Transit, and Intercity Coach with duty cycle greater than one (1) stop per mile.
General Vocation: Intercity Coach with duty cycle less than or equal to one (1) stop per mile and all other vocations.

Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Transmission protection and fluid change intervals can be optimized by the use of fluid analysis. Filters must be changed at or before recommended intervals.

Schedule 1 - Recommended Fluid and Filter Change Intervals (Non-TranSynd™/Non-TES 295 Fluid)							
SEVERE VOCATION				GENERAL VOCATION			
Fluid	Filter			Fluid	Filter		
	Main	Internal	Lube/Aux.		Main	Internal	Lube/Aux.
12,000 Miles (20 000 km) 6 Months 500 Hours	12,000 Miles (20 000 km) 6 Months 500 Hours	Overhaul	12,000 Miles (20 000 km) 6 Months 500 Hours	25,000 Miles (40,000 km) 12 Months 1000 Hours	25,000 Miles (40,000 km) 12 Months 1000 Hours	Overhaul	25,000 Miles (40,000 km) 12 Months 1000 Hours

NOTE: The following recommendations in Schedule 2 are based upon the transmission containing 100% of TranSynd™ fluid. MD/HD Product Line Filter change intervals in Schedule 2 and 3 are only valid with the use of Allison Transmission Gold series filters. Flushing Machines are not recommended or recognized due to variation and inconsistencies with ensuring removal of 100% of the used fluid.

4 Inch Control Module (3.5 Inch Approximately) - Requires Filter Kit p/n 29540494							
Schedule 2 - Recommended Fluid and Filter Change Intervals (TranSynd™/TES 295 Fluid)							
75,000 Miles (120 000 km) 36 Months 3000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	75,000 Miles (120 000 km) 36 Months 3000 Hours	Overhaul	75,000 Miles (120 000 km) 36 Months 3000 Hours

Schedule 3 - Recommended Fluid and Filter Change Intervals (Non-TranSynd™/Non-TES 295 Fluid)							
SEVERE VOCATION				GENERAL VOCATION			
Fluid	Filter			Fluid	Filter		
	Main	Internal	Lube/Aux.		Main	Internal	Lube/Aux.
50,000 Miles (80 000 km) 24 Months 2000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours	150,000 Miles (240 000 km) 48 Months 4000 Hours	50,000 Miles (80 000 km) 24 Months 2000 Hours	Overhaul	50,000 Miles (80 000 km) 24 Months 2000 Hours

Table 5 - Transmission Fluid and Filter Change for MD 4000/B500 Series

NOTE: Change fluid/filters after recommended mileage, months, or hours have elapsed, whichever occurs first.
Severe Vocation: All Retarders, On/Off Highway, Refuse, Transit, and Intercity Coach with duty cycle greater than one (1) stop per mile.
General Vocation: Intercity Coach with duty cycle less than or equal to one (1) stop per mile and all other vocations.

Local conditions, severity of operation or duty cycle may require more or less frequent fluid change intervals that differ from the published recommended fluid change intervals of Allison Transmission. Transmission protection and fluid change intervals can be optimized by the use of fluid analysis. Filters must be changed at or before recommended intervals.

CAUTION! Transmission fluid and filters must be changed whenever there is evidence of dirt or a high temperature condition is indicated when the transmission fluid is discolored, has a strong odor or has exceeded oil analysis limits shown in Table 6.

Fluid Analysis. Transmission protection and fluid change intervals can be optimized by monitoring fluid oxidation according to the tests and limits shown in Table 6. Consult your local telephone directory for fluid analysis firms. To ensure consistent and accurate fluid analysis, use only one fluid analysis firm.

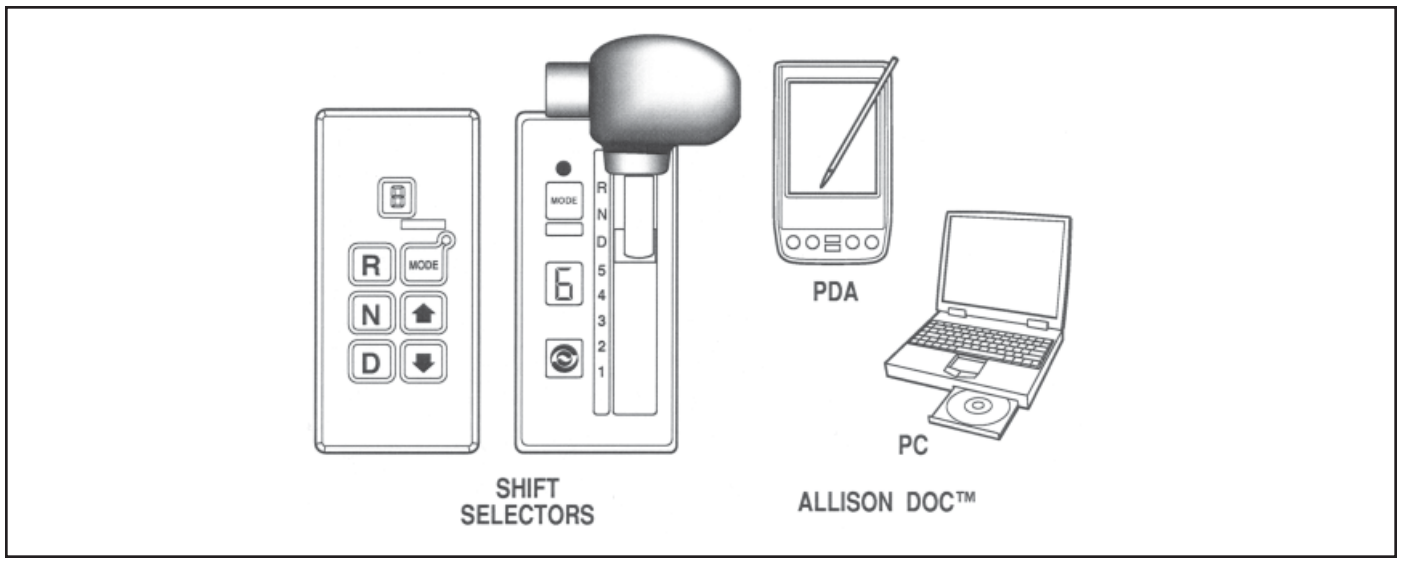
Test	Limit
Viscosity	25% change from new fluid
Total Acid Number	3.0* change from new fluid
Solids	2% by volume maximum
*mg of KOH to neutralize a g of liquid.	

Table 6 - Fluid Oxidation Measurement Limits

Diagnosis

Diagnostic Codes

Continued illumination of the CHECK TRANS light during vehicle operation (not start-up) indicates the ECU has signaled a diagnostic code. Poor performance may activate a code without illuminating the CHECK TRANS light. Up to five diagnostic codes can be recorded. Diagnostic codes can be read and cleared by two methods: by using the ATDT™ or Pro-Link® 9000 Diagnostic Tool or by using the shift selectors shown below. Use of the ATDT™ or Pro-Link® 9000 Diagnostic Tool is described in the instruction manual furnished with each tool. Code reading, clearing methods, and complete code descriptions are presented in the WTEC III Troubleshooting Manual, TS2979EN available online at: http://www.allisontransmission.com/publications/TS_listings.jsp .



Shift Selector/ATDT™/Pro-Link® 9000 Diagnostic Tool

Customer Service

Owner Assistance

The satisfaction and goodwill of the owners of Allison transmissions are of primary concern to Allison Transmission Division (ATD), its distributors, and their dealers.

As an owner of an Allison transmission, you have service locations throughout the world that are eager to meet your parts and service needs with:

- Expert service by trained personnel
- Emergency service 24 hours a day in many areas
- Complete parts support
- Sales teams to help determine your transmission requirements
- Product information and literature

Normally, any situation that arises in connection with the sale, operation, or service of your transmission will be handled by the distributor or dealer in your area (check the telephone directory for the Allison Transmission service outlet nearest you).

Refer to the Worldwide Sales and Service Directory (SA2229EN) for the current listings of Allison Transmission authorized distributors and service dealers. This directory is available from SGI, Inc. or go on the internet at: http://www.allisontransmission.com/locator/index.jsp

We recognize, however, that despite the best intentions of everyone concerned, misunderstandings may occur. To further assure your complete satisfaction, we have developed the following three-step procedure to be followed in the event a problem has not been handled satisfactorily.

Step One - Discuss the problem with a member of management from the distributorship or dealership. Frequently, complains are the result of a breakdown in communication and can quickly be resolved by a member of management. If you have already discussed the problem with the Sales or Service Manager, contact the General Manager.

All ATD dealers are associated with an ATD distributor. If the problem originates with a dealer, explain the matter to a management member of the dealership with whom the dealer has his service agreement. The dealer will provide his ATD distributor's name, address, and telephone number on request.

Step Two - When it appears the problem cannot be resolved readily at the distributor level without additional assistance, contact the Allison Transmission Regional Office responsible for the local distributor. You will be assisted by a member of the Regional Service Manager's staff, depending on the nature of your problem.

For prompt assistance, please have the following information available,

- Name and location of authorized distributor or dealer
- Type and make of equipment
- Transmission model number, serial number, and assembly number (if applicable). This data is available on the nameplate located on the right side of the transmission. Also provide the ECU calibration identification number (CIN) which is located elsewhere in the vehicle.
- Transmission delivery date and accumulated miles and/or hours of operation
- Nature of problem
- Chronological summary of unit's history

Step Three - If you contacted a regional office and you are still not satisfied, present the entire matter to the Home Office by writing to the following address or calling the phone number below:

Manager, Warranty Administration - PF9
Allison Transmission
P.O. Box 894
Indianapolis, IN 46206-0894
Phone: 1-800-524-2303

The inclusion of all pertinent information will assist the Home Office in expediting the matter. If an additional review by the Home Office of all the facts involved indicates that some further action can be taken, the Regional Office will be advised.

When contacting the Regional or Home Office, please keep in mind that ultimately the problem will likely be resolved at the distributorship or dealership utilizing their facilities, equipment, and personnel. Therefore, it is suggested the above steps be followed in sequence when experiencing a problem.

Your purchase of an Allison Transmission product is greatly appreciated, and it is our sincere desire to assure complete satisfaction.

To obtain a complete Owner's Guide from Allison go to the Allison website at:

http://www.allisontransmission.com/publications/pubs/OM2995EN.jsp

Periodic Inspection and Care

Clean and inspect the exterior of the transmission at regular intervals. Severity of service and operation conditions determine the frequency of these inspections. Inspect the transmission for:

- Loose bolts - transmission and mounting components
- Fluid leaks - repair immediately
- Loose, dirty, or improperly adjusted throttle sensor linkage
- Damaged or loose hoses
- Worn, frayed, or improperly routed electrical harnesses
- Worn or out-of-phase driveline U-joints and slip fittings.

CAUTION! When welding on the vehicle:

- DO NOT WELD on the vehicle without disconnecting the ECU from all control system wiring harness connectors.
- DO NOT WELD on the vehicle without disconnecting ECU battery power and ground leads.
- DO NOT WELD on any control components.
- DO NOT CONNECT welding cables to any control components.

A label describing on-vehicle welding precautions is available from your authorized Allison service dealer and should be installed in a conspicuous place. A vehicle used in a vocation that requires frequent modifications or repairs involving welding ***must*** have an on-vehicle welding label.

IMPORTANT NOTE: Be sure to check transmission fuel level on a regular basis. Transmission fluid cools, lubricates, and transmits hydraulic power. Always maintain proper fluid level. If fluid level is too low, the torque converter and clutches do not receive an adequate supply of fluid and the transmission overheats. If the level is too high, the fluid aerates - causing the transmission to shift erratically and overheat. Fluid may be expelled through the breather or dipstick tube when the fluid level is too high.

Transmission Fluid Check

Electronic Fluid Check Procedure: If the transmission you are maintaining has an oil level sensor, fluid level information can be displayed on the shift selector. If the transmission does not have an oil level sensor refer to Manual Fluid Check Procedure further in this manual.

Displaying Fluid Level Information. Use the following procedure to display fluid level information:

- For a pushbutton shift selector: Simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons.
- For a lever shift selector: Press the DISPLAY MODE button.

Oil (Fluid) Level Mode. A two minute countdown begins after entering oil level mode. The display flashes and an 8, 7,. . .1 count occurs during the two minute countdown. Oil level information displays after the countdown and when the following conditions are met:

- Engine at idle
- Sump oil at operating temperature
- Transmission output shaft stopped
- Transmission in neutral
- Oil level sensor functioning properly

Shift Selector Display. After two minutes the shift selector will display the fluid level data as in the following examples:

CODE	MEANING OF CODE
OL OK OK	Oil level is correct
OL LO 01	Oil level is one quart low - or as many quarts as needed
OL HI 01	Oil level is one quart high - or as many quarts as overfilled

The shift selector can only display two characters at a time. One character is displayed under the MONITOR label and one under the SELECT label. The oil level information is sequentially displayed as in the following examples:

If the oil level is correct -

Select	Monitor
0	L
0	K
0	K

If the oil level is low -

Select	Monitor
0	L
L	0
0	1

If the oil level is high -

Select	Monitor
0	L
H	I
0	1

NOTE: Failure to meet any of the above conditions stops the two minute countdown. One of the following codes displays on the shift selector to show the reason for the countdown interruption. Once all conditions have been met, the countdown resumes where it stopped.

CODE	CAUSE OF CODE
50	Engine rpm too low
59	Engine rpm too high
65	Neutral not selected
70	Sump oil temperature too low
79	Sump oil temperature too high
89	Output shaft rotation
95	Sensor failure
	- Engine Speed
	- Output Speed
	- Temperature
	- Oil Level

If oil level cannot be checked and a code is issued indicating the reason, the following type display appears:

Select	Monitor
0	L
--	--
5	9

NOTE: Report sensor failure to a distributor or dealer in your area. Check the telephone directory for an Allison Transmission distributor or dealer near you.

Exiting the Oil Level Display Mode.

- For a pushbutton shift selector:
  Press any range selection button.
- For a lever shift selector:
  Press the DISPLAY MODE button, or select a range.

Manual Fluid Check Procedure. Clean all dirt from around the end of the fluid fill tube before removing the dipstick. Do not allow dirt or foreign matter to enter the transmission. Dirt or foreign matter in the hydraulic system may cause undue wear of transmission parts, make valves stick, and clog passages. Check the fluid level using the following procedure and record the level in your maintenance log.

WARNING!! When checking the fluid level, be sure the transmission is in N (neutral), the parking brake and/or emergency brake is set properly, and the wheels are chocked. Unexpected and possible sudden vehicle movement may occur if these precautions are not taken.

Cold Check Procedure. The purpose of the cold check is to determine if the transmission has enough fluid to be operated safely until a hot check can be made.

CAUTION! The fluid level rises as fluid temperature increases. DO NOT fill above the "COLD RUN" band if the transmission fluid is below normal operating temperatures.

- Park the vehicle on a level surface. Apply the parking brake and chock the wheels.
- Run the engine for at least one minute. Shift to D (Drive), then to N (Neutral), and then shift to R (Reverse) to fill the hydraulic system. Finally, shift to N (Neutral) and allow the engine to idle (500-800 rpm).
- With the engine running, remove the dipstick from the tube and wipe clean.
- Insert the dipstick into the tube and remove. Check the fluid level reading. Repeat the check procedure to verify the reading.
- If the fluid level is within the "COLD RUN" band, the transmission may be operated until the fluid is hot enough to perform a "HOT RUN" check. If the fluid level is not within the "COLD RUN" band, add or drain as necessary to bring it to the middle of the "COLD RUN" band.
- Perform a hot check at the first opportunity after the normal operating temperature of 71°C-93°C (160°F-200°F) is reached.

Hot Check Procedure

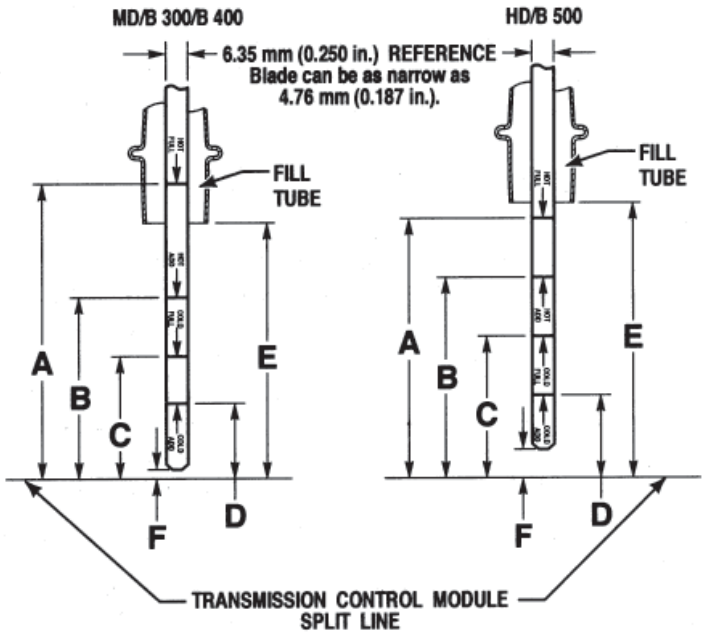
CAUTION! The fluid must be hot to ensure an accurate check. The fluid level rises as temperature increases.

- Operate the transmission in D (Drive) range until normal operating temperature is reached:
  - » Sump temperature 71°C-93°C (160°F-200°F)
  - » Converter-out temperature 82°C-104°C (180°F-220°F)
- Park the vehicle on a level surface and shift to N (Neutral). Apply the parking brake and chock the wheels. Allow the engine to idle (500-800 rpm)
- With the engine running, remove the dipstick from the tube and wipe clean.
- Insert the dipstick into the tube and remove. Check fluid level reading. Repeat the check procedure to verify the reading.

NOTE: Safe operating level is within the "HOT RUN" band on the dipstick, (see fig. 1). The "HOT RUN" band is between the "HOT FULL" AND "HOT ADD" marks.

- If the fluid level is not within the "HOT RUN" band, add or drain as necessary to bring the fluid level to within the "HOT RUN" band.

Consistency of Readings. Always check the fluid level at least twice and with the engine running. Consistency is important to maintaining accuracy of the reading. If inconsistent readings persist, check the transmission breather to be sure it is clean and unclogged.



OIL SUMP	TRANSMISSION/SUMP	DIMENSION	DIMENSION	DIMENSION	DIMENSION	DIMENSION	DIMENSION
	DESCRIPTION	A	B	C	D	E	F**
N/A	All HD/B500	106.7 mm (4.20 in.)	76.2 mm (3.00 in.)	66.0 mm (2.60 in.)	*	132.6 mm (5.22 in.)	13.8 mm (0.54 in.)
2.00 in.***	B300/B400 "STANDARD"	101.6 mm (4.00 in.)	73.7 mm (2.90 in.)	50.8 mm (2.00 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
4.00 in.***	B300/B400 "DEEP OPTIONAL"	101.6 mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
2.00 in.***	MD3060/3560 "SHALLOW OPTIONAL"	101.6 mm (4.00 in.)	73.7 mm (2.90 in.)	50.8 mm (2.00 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
4.00 in.***	MD3060/3560 "STANDARD"	101.6 mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)
7.00 in.***	MD3070PT "STANDARD"	101.6 mm (4.00 in.)	63.5 mm (2.50 in.)	45.7 mm (1.80 in.)	*	86.6 mm (3.41 in.)	5.9 mm (0.23 in.)

Figure 1 - Standard WT Series Dipstick Markings

NOTE: Calibrate level marking locations with respect to transmission control module split line and fill tube.
Illustration not to scale.
*Dimension determined by installation.
**Reference dimension only. Actual dimension to be determined by installation.
***Reference drawing AS66-60.
****Reference drawing AS67-60.

NOTE: When filling the transmission be sure to lay dipstick in a clean place to avoid foreign material and contaminants from entering the transmission.

TranSynd™ is a fully synthetic transmission fluid developed by Allison Transmission and Castrol Ltd. This fluid meets Allison specifications for Severe Duty and Extended Drain Intervals. TranSynd™ is fully qualified to the GM DEXROM®-III and Allison C4 specifications and is available through Allison distributors and dealerships.

Hydraulic fluid (oils) used in the transmission are important influences on transmission performance, reliability, and durability. DEXRON®-III and TranSynd™ fluids are recommended for use in the MD, HD and B Series transmissions.

Some DEXRON®-III fluids are also qualified as Type C-4 fluids. To ensure the fluid is qualified for use in Allison transmission, check for a DEXRON®-III or C-4 fluid license or approval numbers on the container, or consult the lubricant manufacturer. Consult your Allison Transmission dealer or distributor before using other fluid types. Fluid types such as Type F and universal farm fluids may or may not be properly qualified for use in your Allison transmission.

CAUTION! Disregarding minimum fluid temperature limits can result in transmission malfunction or reduced transmission life.

When choosing the optimum viscosity grade of fluid to use, duty cycle, preheat capabilities, and/or geographical location must be taken into consideration. The following table lists the minimum fluid temperatures at which the transmission may be safely operated without preheating the fluid. Preheat with auxiliary heating equipment or by running the equipment or vehicle with the transmission in Neutral for a minimum of 20 minutes before attempting range operation.

Viscosity Grade	Ambient Temperature Below Which Preheat is Required	
	Celsius	Fahrenheit
MIL-L-46167	-51	-60
MIL-L-2104D	-32	-25
SAE 0W or TranSynd™	-30	-22
DEXRON®-III	-27	-17
SAE 10W	-20	-4
SAE 10W-30	-20	-4
SAE 15W-40	-15	5
SAE 30W	0	32
SAE 40W	10	50

Transmission Fluid and Filter Change Intervals

Frequency. Transmission fluid and filter change frequency is determined by the severity of transmission service. See Table 1 as a general guide. More frequent changes may be necessary when operation conditions create high levels of contamination or overheating.

SEVERE VOCATION			GENERAL VOCATION		
Oil	Filters		Oil	Filters	
	Main	Lube/ Auxiliary		Main	Lube/ Auxiliary
Required Initial Filter Change Interval (All Fluids)					
	8000 km (5,000 Miles) 200 Hours	8000 km (5,000 Miles) 200 Hours		8000 km (5,000 Miles) 200 Hours	8000 km (5,000 Miles) 200 Hours
Recommended Fluid and Filter Change Intervals (Non-TranSynd™ Fluids)					
19 300 km (12,000 Miles) 6 Months 500 Hours	19 300 km (12,000 Miles) 6 Months 500 Hours	19 300 km (12,000 Miles) 6 Months 500 Hours	40 200 km (25,000 Miles) 12 Months 1000 Hours	40 200 km (25,000 Miles) 12 Months 1000 Hours	40 200 km (25,000 Miles) 12 Months 1000 Hours
Recommended Fluid and Filter Change Intervals (TranSynd™ Fluid)					
80 400 km (50,000 Miles) 24 Months 2,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours	160 900 km (100,000 Miles) 48 Months 4,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours

Table 1 - Transmission Fluid and Filter Change

SEVERE VOCATION			GENERAL VOCATION		
Oil	Filters		Oil	Filters	
	Main	Lube/ Auxiliary		Main	Lube/ Auxiliary
Modified Fluid and Filter Change Intervals (Mixture* of TranSynd™ and Non-TranSynd™ Fluids)					
40 200 km (25,000 Miles) 12 Months 1,000 Hours	40 200 km (25,000 Miles) 12 Months 1,000 Hours	40 200 km (25,000 Miles) 12 Months 1,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours	40 200 km (25,000 Miles) 12 Months 1,000 Hours	80 400 km (50,000 Miles) 24 Months 2,000 Hours
*Mixture is defined as the quantity of fluid remaining in the transmission after a standard fluid change combined with the quantity of TranSynd™ that is required to fill the transmission to the proper level. A mixture of TranSynd™ vs. Non-TranSynd™ other than as defined in this paragraph does not meet the requirements that permit eligibility for the TranSynd™ fluid and filter change intervals.					
NOTE: Change fluid/filters after recommended distance, months, or hours have elapsed, whichever occurs first.					
Severe Vocation: All Retarders, On/Off Highway, Refuse, Tour Coach and Transit **General Vocation:** All Others					

Table 2 - Transmission Fluid and Filter Change

Abnormal Conditions. Transmission fluid must be changed whenever there is evidence of dirt or a high temperature condition. A high temperature condition is indicated by the transmission fluid being discolored or having a strong odor, or by fluid analysis. Local conditions, severity of operation, or duty cycle may require more or less frequent fluid or filter change intervals.

Fluid Analysis. Transmission protection and fluid change intervals can be optimized by monitoring fluid oxidation according to the tests and limits shown in Table 3.

Test	Limit
Viscosity	±25% change from new fluid
Total Acid Number	+3.0* change from new fluid
Solids	2% by volume maximum
*mg of KOH to neutralize a g of fluid.	

Table 3 - Fluid Oxidation Measurement Limits

Transmission Fluid Contamination

Fluid Examination. At each fluid change, examine the drained fluid for evidence of dirt or water. Normal condensation will appear in the fluid during operation.

Water. Obvious water contamination of the transmission fluid or transmission fluid in the cooler (heat exchanger) water indicates a leak between the water and fluid areas of the cooler. Inspect and pressure test the cooler to confirm the leak. Replace leaking coolers.

NOTE: Cooler water can also be contaminated by engine oil; be sure to locate the correct source of cooler water contamination.

Engine Coolant. Engine coolant in the transmission hydraulic system requires immediate action to prevent malfunction and possible serious damage. Completely disassemble, inspect, and clean the transmission. Remove all traces of the coolant, and varnish deposits resulting from engine coolant contamination. Replace friction clutch plates contaminated with engine coolant (ethylene glycol).

Metal. Metal particles in the fluid (except for the minute particles normally trapped in the oil filter) indicate internal transmission damage. If these particles are found in the sump, the transmission must be disassembled and closely inspected to find their source. Metal contamination requires complete transmission disassembly. Clean all internal and external hydraulic circuits, cooler, and all other areas where the particles could lodge.

CAUTION! If excessive metal contamination has occurred, replace the oil cooler and visually inspect all bearings in the transmission.

Transmission Fluid and Filter Change Procedure

NOTE: Do not drain the transmission fluid if only filters are being replaced.

1. **Drain Fluid.**
   - Drain the fluid when the transmission is at operating temperature - 71°C-93°C (160°F-200°F). Hot fluid flows quicker and drains more completely.
   - Remove the drain plug from the control module and allow the fluid to drain into a suitable container.
   - Examine the fluid as described in *Transmission Fluid Contamination* section.
2. **Replace Filters.**
   - Remove twelve bolts, two filter covers, two O-rings, two square cut seals, and two filters from the bottom of the control module (refer to *Figure 2*)

NOTE: Lubricate only the O-ring inside the filter cartridges.

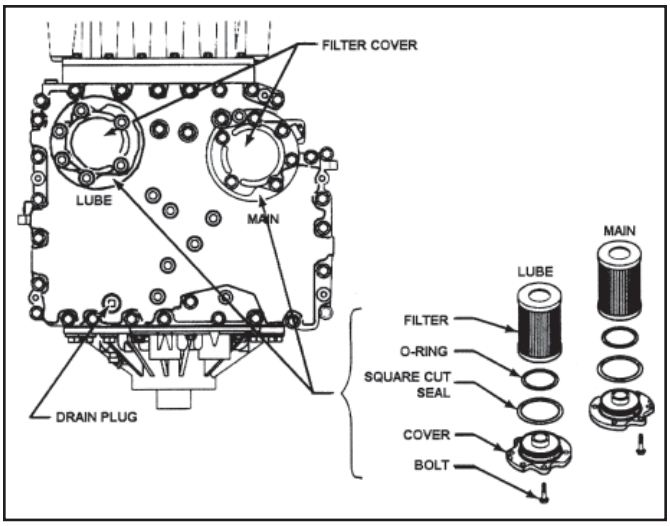


Figure 2 - Location of Filters for Service

- Pre-lube and install an O-ring on each cover assembly. Install a square cut seal on each cover assembly. Install the filters onto the cover assemblies.

CAUTION! Do not use the bolts to draw filter covers to the sump. This can damage the covers, seals or sump.

- Install filter and cover assemblies into the filter compartment. Align each filter/cover assembly with the holes in the channel plate/sump. Push the cover assemblies in by hand to seat the seals.
- Install six bolts into each cover and tighten to 51-61 N • m (38-44 lb. ft.)
- Replace the drain plug O-ring. Install the plug and tighten to 25-32 N • m (18-24 lb. ft.)

3. **Refill Transmission**. The amount of refill fluid is less than the amount used for the initial fill. Fluid remains in the external circuits and transmission cavities after draining the transmission. After refill, check the fluid level using the procedure described in *Transmission Fluid Check* section.

Transmission	Sump	PTO	Initial Fill*		Refill*	
			Liters	Quarts	Liters	Quarts
B300/400	Standard	N/A	21	22	13	14
B300/400	Deep	N/A	27	29	19	20
B500	Standard	Yes	41	43	37	39
B500	Standard	No	38	40	25	26
B500	Deep	Yes	48	51	37	39
B500	Deep	No	45	48	34	36
HD 4060/4560	Standard	Yes	48	51	37	39
HD 4060/4560	Standard	No	45	48	34	36
HD 4060/4560	Shallow	Yes	41	43	37	39
HD 4060/4560	Shallow	No	38	40	25	26
MD 3060/3560	Standard	No	24.5	26	18	19
MD 3070/PT**	Standard	Yes	37	39	30	32

*Approximate quantity, does not include external lines and cooler hose.
**The sump is 7.00 inches deep

Table 4 - Transmission Fluid Capacity

Fluid Leak Diagnosis

Finding a Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, or hydraulic fluid from a specific vehicle system.
2. Operate the vehicle to reach normal operating temperature and park the vehicle. Inspect the vehicle to identify the source of the leak. Refer to the following list for possible points of fluid and their causes.

Transmission mating surfaces:

» Attaching bolts not correctly tightened
» Improperly installed or damaged gasket
» Mounting face damaged

Housing leak:

» Filler pipe or plug seal damaged or missing
» Filler pipe bracket dislocated
» Oil cooler connector fittings loose or damaged
» Output shaft seals worn-out or damaged.
» Pressure port plugs loose.
» Porous casting

Leak at converter end:

» Converter seal damaged
» Seal lip cut (check converter hub for damage)
» Garter spring missing from seal
» Converter leak in weld area or O-ring seal
» Porous casting

Fluid comes out of fill tube:

- » Overfilled - incorrect dipstick
- » Plugged vent
- » Water or coolant in fluid - fluid will appear milky
- » Incorrect electronic fluid level indication
- » Drain-back holes plugged

3. Visually inspect the suspected area. Inspect all the gasket mating surfaces for leaks.
4. If the leak still cannot be identified, then clean the suspected area with a degreaser, steam, or spray solvent. Clean and dry the area. Operate the vehicle for several miles at varying speeds. Inspect the vehicle for leaks. If the source of the leak is still not identified, use powder method, and/or black light and dye method as explained below.

Powder Method

- Clean the suspected area.
- Apply an aerosol-type white powder.
- Operate the vehicle under normal operating conditions.
- Visually inspect the suspected area and trace the leak path over the white powder surface to the source.

NOTE: Dye and black light kit is available for finding leaks. Refer to the manufacturer's directions when using the kits. See kit directions for the color of the fluid dye mix.

Black Light and Dye Method

- Pour the specified amount of dye into the transmission fill tube.
- Operate the vehicle in normal operating conditions.
- Direct the black light toward the suspected area. The dyed fluid will appear as a brightly colored path leading to the source.

Repairing the Leak

Once the leak has been traced back to its source, inspect the leaking part for the following conditions, and repair the leaking part.

- **Gaskets:**
  - » Fluid level/pressure is too high
  - » Plugged vent or drain-back holes
  - » Improperly tightened fasteners or dirty/ damaged threads
  - » Warped flanges or sealing surfaces
  - » Scratches, burrs, or other damage to a sealing surface
  - » Damaged or worn-out gasket
  - » Cracked or porous casting
  - » Improper sealant used (where applicable)
- **Seals:**
  - » Fluid level/pressure is too high
  - » Plugged vent or drain-back holes
  - » Damaged seal bore
  - » Damaged or worn-out seal
  - » Improper installation
  - » Cracks in component
  - » Output shaft surface scratched, nicked or damaged
  - » Loose or worn-out bearing causing excess seal wear
- **Sealing Flange:**
  - » Inspect the sealing flange for bends; replace the sealing flange if bent.

Breather

Location and Purpose

The breather is located on top of the transmission converter housing. The breather prevents air pressure buildup within the transmission and its passage must be kept clean and open.

Maintenance

The amount of dust and dirt encountered will determine the frequency of breather cleaning. Use care when cleaning the transmission. DO NOT SPRAY STEAM, WATER, OR CLEANING SOLUTION DIRECTLY AT THE BREATHER. Spraying steam, water, or cleaning solution at the breather can force the water or cleaning solution into the transmission.

Replacement

Always use a wrench of the proper size to remove or replace the breather. Pliers or a pipe wrench can crush or damage the stem and produce metal chips which could enter the transmission. Tighten the breather to 12-16 N • m (9-12 lb ft).

Troubleshooting

DO NOT SHIFT Light

The Do Not Shift light is usually located on the vehicle's instrument panel. When the light is "ON" and accompanied by eight seconds of short beeps from the shift selector, shifts are being restricted by the ECU.

- This occurs when the ECU senses abnormal conditions.
- During this time, the "Select" digit on the shift selector is blank.
- The transmission may continue to operate with inhibited shifting.
- The ECU will not respond to shift selector requests.
- Direction changes and shifts to and from neutral will not occur. If the lever shift selector is moved while DO NOT SHIFT is indicated, a continuous alarm sounds. This alarm continues until the shifter is moved back to the position it was in when the light came on initially.
- If ignition is turned "OFF" and then "ON" while the DO NOT SHIFT light is displayed, the transmission will remain in neutral until the code is cleared.

Any time the DO NOT SHIFT light is displayed, the ECU logs to a diagnostic code in memory. These diagnostic codes can be accessed through the shifter display or a diagnostic tool.

NOTE: Diagnostic codes can be logged without illuminating the DO NOT SHIFT light. This occurs when the ECU senses a problem, but determines the problem won't cause immediate transmission damage or dangerous performance.

Diagnostic Codes Overview

Code List Position	Main Code	Sub Code	Active Indicator	Ignition Cycle Counter	Event Counter
d1	21	12	YES	00	10
d2	41	12	YES	00	04
d3	23	12	NO	08	02
d4	34	12	NO	13	01
d5	56	11	NO	22	02
Displayed on shift selector			YES = MODE ON Displayed	Accessible by Pro-Link® diagnostic tool only	

Diagnostic codes are listed in memory. Up to five codes can be stored, with the most recent code listed first.

Diagnostic codes consist of a two-digit main code and a two-digit sub code.

- Main codes are listed first and provide the general condition or area of fault detected by the ECU.
- Sub codes are listed second and provide specific areas or conditions within the main code that caused the occurrence.
- Example - Code 13 12: 13 indicates a problem with ECU voltage; 12 indicates the problem was caused by low voltage.
- Example - Code 21 12: 21 indicates a problem with throttle position sensor signal; 12 indicates the throttle position sensor signal was low.

When using the shift selector to retrieve trouble codes, the illumination of the MODE ON indicator on the shift selector indicates that the code displayed is currently active. If the MODE ON indicator is not illuminated with the displayed code, the code is inactive. In the normal operating mode, the MODE ON display indicates secondary mode operation.

- The Ignition Cycle Counter determines when inactive diagnostic codes are automatically cleared from the code list. The counter is incremented each time a normal ECU powerdown occurs (ignition turned off). Inactive codes are cleared from the code list after the counter reaches 25.
- The Event Counter counts the number of occurrences of a diagnostic code. If a code is already in the code list and the code is again detected, that code is moved to position D1, the active indicator is turned on and the Ignition Cycle Counter is cleared, and 1 is added to the Event Counter.
- You can access the ignition cycle counter and event counter information through Pro-Link diagnostic tool only.

Clearing The Trouble Codes Using Shift Selector

During installation, “false” codes can be recorded in the electronic control’s memory. You must clear these codes prior to road testing the vehicle. Use the shift selector to clear the codes. Refer to *Figure 3*.

- Enter the diagnostic mode on pushbutton selectors by pressing the “up” and “down” arrow buttons simultaneously. (Press twice if there is an oil level sensor present.)
- Enter the diagnostic mode on level selectors by momentarily pressing the “Display” button. (Press twice if there is an oil level sensor present.)
- To clear all active indicators, press and hold the MODE button approximately 3 seconds until a tone sounds once.
- To remove all codes, press and hold the MODE button for approximately 10 seconds until the shift selector tone sounds twice.

Retrieving Troubleshooting Codes

During installation, “false” diagnostic codes can be recorded in the electronic control’s memory. Clear these codes before road testing the vehicle. After road testing the vehicle, check for the codes. Retrieve the codes by using the shift selector. Refer to Figure 3.

- Enter diagnostic mode.
- The display will list the code’s logged position (d1, d2, d3, etc), then follow with the main code and a sub code (this repeats every 2 seconds until the “MODE” button is pushed again).
- Momentarily push the “MODE” button to move to the next code stored in memory.
- When you have retrieved all the codes, the display will return to the first code listed and repeat the sequence. RECORD ALL THE CODES.

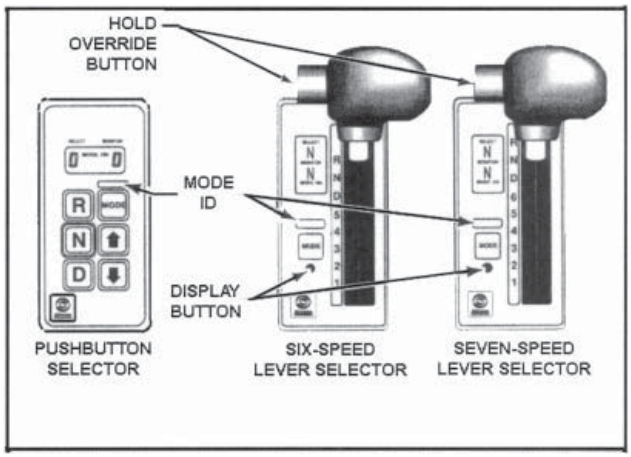


Figure 3 - Shift Selector

Troubleshooting Intermittent Diagnostic Codes

Intermittent codes are a result of conditions which are not always present.

When conditions causing the code exist, the code is logged in memory. The code stays in memory until it’s manually cleared or cycled out.

When intermittently occurring codes exist, check for the following items:

- Dirty, damaged harness connectors and terminals.
- Terminals not fully seated in connectors.
- Damaged harnesses (due to poor routing, chafing, excessive heat, tight bends, etc.).
- Improperly mounted electric control components.
- Poor connector seals (where applicable).
- Exposed harness wires.
- EMI generating components and accessories.

To help locate intermittent, it sometimes helps to place the appropriate tester on the suspect component or circuit and simulate operating conditions - wiggle, pull, bump, and bend while watching the tester.

Exiting Diagnostic Mode

To exit the diagnostic mode, do one of the following:

- Do nothing; wait until the calibrated time has passed and the system automatically returns to normal operation.
- Using a pushbutton shift selector, simultaneously press the ↑ (Up) and ↓ (Down) arrow buttons.
- Using a pushbutton shift selector, press D (Drive), N (Neutral), or R (Reverse).
- Using a lever shift selector, press the DISPLAY MODE button.
- Using a lever shift selector, move the shift lever to any position other than the one it was in when the diagnostic display mode was activated.

Safety Features

Seat Belts and Restraint Systems

Driver's Seat

The coach is equipped with a fully-adjustable Recaro 2006 Seat. The driver's seat belt is an integral part of the seat assembly. Refer to Recaro documentation for full features, care, and operation information.

WARNING!! The driver's seat belt should be worn whenever the vehicle is being driven. Remember that the safety of all passengers is directly dependent upon the safety of the driver.

The seat should be adjusted appropriately for the individual operator. Adjustments should be made not only for comfort, but for optimum visibility and full access to bus controls. Control buttons for seat height and tilt, back tilt, and lumbar support are provided on a convenient control panel on the right side of the Recaro seat. These adjustments are air-actuated. Thus, the auxiliary tanks of the bus's air system must be pressurized in order for these seat controls to operate.

Other controls on the seat are mechanical, and therefore require no air pressure for operation. Individual controls for left and right armrest height are adjusted by knobs under the front end of each armrest. Fore and aft adjustment of the seat is also mechanical, and is accomplished by lifting the lock lever at the front underside of the seat cushion. For more information, refer to the Recarro documentation provided with your unit.

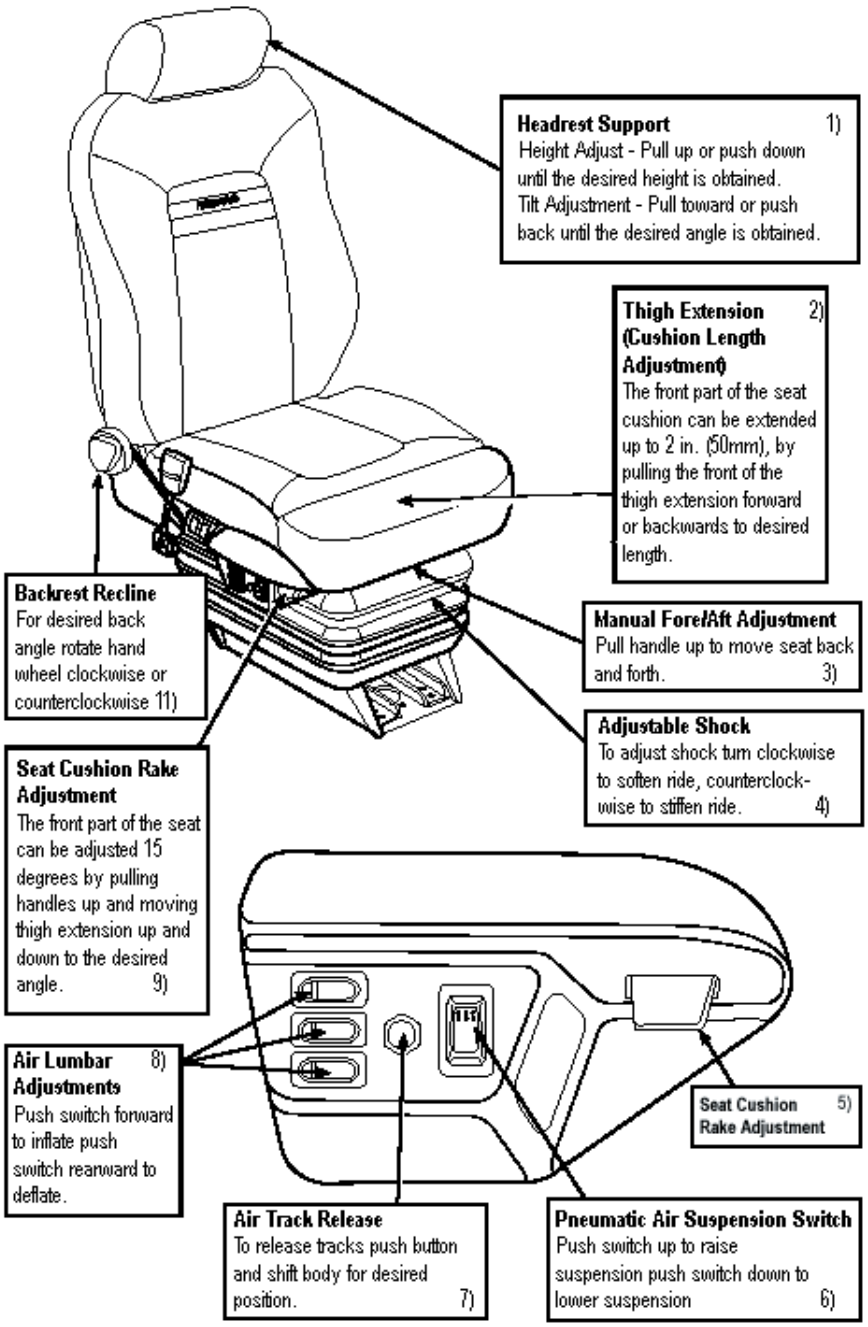
WARNING!! To avoid accidental momentary loss of control, do not attempt to adjust a driver's seat while the vehicle is in motion. If the engine is running, be sure the parking brake is on before adjusting seat height.

Seat Belts

Inspect all seat belts and their attachment points on a weekly basis. Check seat belt buckles and adjustability for proper operation. If necessary, lubricate buckles with a graphite lubricant. Any buckle found to be faulty in any way, must be replaced immediately. If there are any defects in the seat belt strap webbing (i.e., torn or frayed), the seat belt must be replaced immediately. When cleaning seat belts, hand-wash the webbing with only warm water and mild soap. Rinse thoroughly and dry in the shade. Do not bleach or re-dye seat belts, because such processing may severely weaken the strap materials.

WARNING!! Be sure the lap belt is fitted snugly around the hips, not the waist. Failure to do so may increase the chance of injury in the event of a collision.

Seat Operation



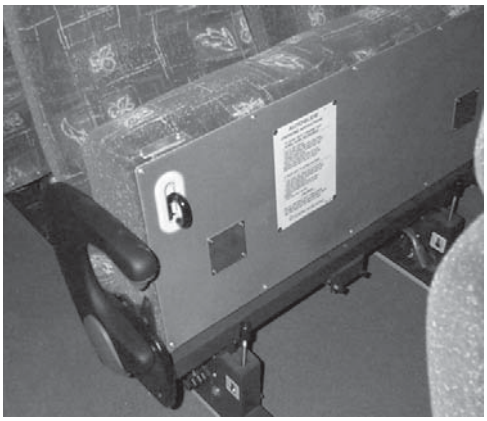
Passenger Seats

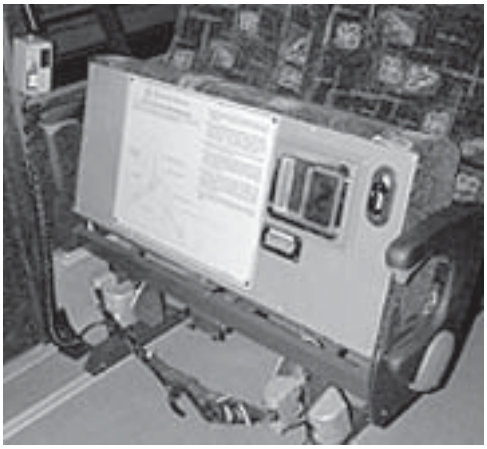
The Passenger seats in the coach are American Model 2006 High Back Reclining Seats. These seats are built to meet Federal Motor Vehicle Safety Standards and provide positioning and convenience features for passenger comfort. The seats are mounted on floor and side panel channels which run the length of the bus. This allows some measure of customization of seat arrangements and spacing. However, any such alteration should be performed only by qualified service technicians and in full accordance with any regulations governing seat spacing. Also, if the seat spacing is altered, open sections of the floor tracks must be covered with seat track inserts, available from your Blue Bird parts distributor.

Jump Seats

Some of the passenger seats located in proximity to the wheelchair lift door are equipped with flip-up cushions to provide access to the wheelchair constraint system. To lift the seat cushion, grasp the release handle mounted under the aisle-side seat and pull it forward to release the latch. Be sure the seat cushion locks securely in the upright position.

Wheelchair restraint instructions are mounted on the underside of the Jump Seat located immediately to the rear of the wheelchair lift door.





Seat Maintenance

Regular seat inspection and maintenance is an important part of the operation regimen for vehicles used for passenger transport. At least every 90 days, inspect and retighten all bolts, and inspect upholstery for cuts and tears. Repair or replace as needed. Express 4500 seats are equipped with a special foam back pad. If the pad becomes damaged, it should be replaced with an approved replacement part. Any aftermarket replacements should be checked for compliance with Federal standards.

Seat Cleaning

Regular cleaning and care will prolong the life of the seats and improve the general appearance of the entire bus.

Everyday dirt and soil. may be removed with a soap and water solution. If the stain is persistent, a stiff bristle brush may be used. Fabric-covered seats should be rinsed with clean water after the stain is removed.

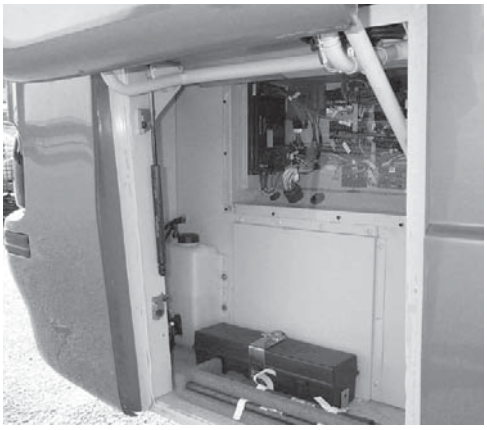
Paint, tar, and asphalt. Stains should be removed immediately using a damp cloth and kerosene. Rub gently, using small strokes. Rinse thoroughly. This type of stain may become permanent if not cleaned immediately.

Nail polish and lacquer-based stains. Soak up as much as possible with dry cloth immediately. Any remaining stain may be removed with a nonflammable cleaning fluid such as “Tuff Stuff” or “Armor All” cleanser. Rinse thoroughly with clean water.

Gum, grease, and shoe polish. Remove as much as possible immediately. If left for any length of time, shoe polish will stain permanently. Clean any remaining stain with “Tuff Stuff” or “Armor All” cleanser.

Ink. Remove stain immediately using a damp cloth and alcohol.

Emergency Equipment



Many individual states or provinces have specific laws governing emergency equipment. Your unit may have some or all of the items listed below. Because of variations in option packages, the placement of this equipment inside the bus may vary from the standard installations shown. It is important for you to know the locations of all the emergency equipment on your bus, and to be sure your units always conform to the regulations of the regions in which it is operated. Furthermore, it is important for you to read all literature, labels, and any other written materials supplied by the equipment manufacturers. Be sure you familiarize yourself with all aspects of the emergency equipment before operating the coach.

Fire Extinguishers

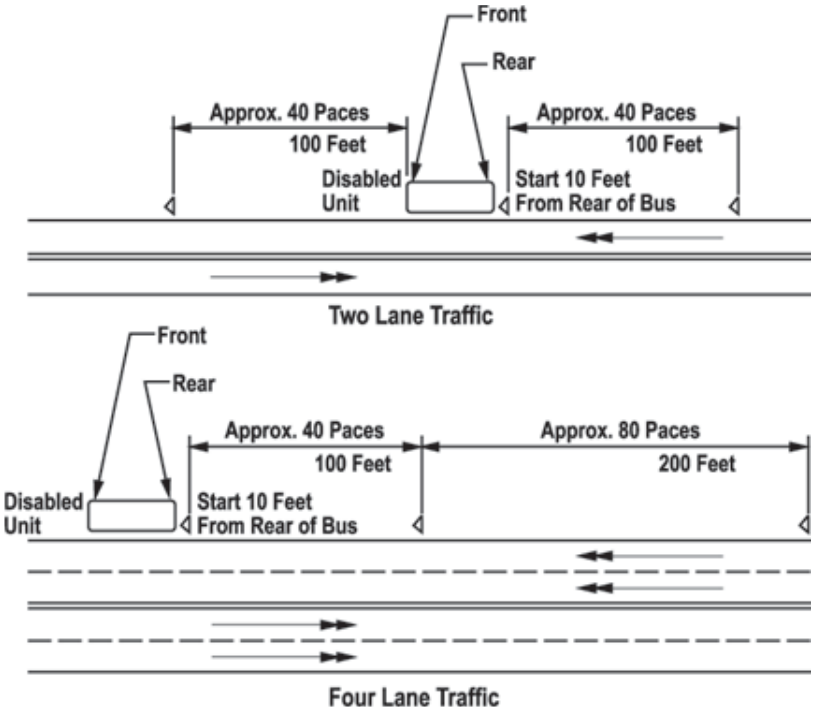
The fire extinguisher is mounted on the floor to the left of the driver’s seat. Your unit may be equipped with a 2.75, 4.5, 5, or 6-pound extinguisher. Inspect the pressure gauge every 30 days or as required by individual state fire laws to make sure the unit is fully charged. Inspect mounting fasteners periodically to be sure they are tight, and be sure you are familiar with their release operation.

First Aid Kit

The first aid kit is attached to the left wall panel just behind the driver's seat. Size and contents of first aid kits vary by option package or differing state specifications. The contents of the kit should be inspected weekly. Check expiration dates on any medications contained. Replace any contents which have been opened or otherwise had their sanitary packaging compromised.

Triangular Warning Devices

For states in which they are required, triangular warning devices are located in the driver's luggage compartment. Inspect contents of the kit (as well as the mounting fasteners) every 30 days, or as required by local code.



Lug Wrench

The lug wrench is located in the driver's luggage compartment. Inspect the installation-mounting fasteners every 30 days to ensure that the installation is accessible, unobstructed, and tight.

Spare Tire Carrier

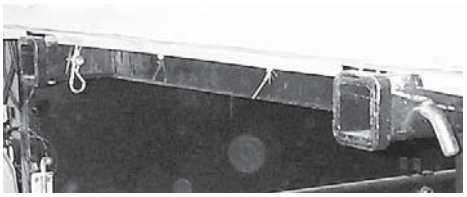
The coach is equipped with a front overhang spare tire carrier. The tire is mounted on a slide out tray behind the front bumper. To gain access, first remove the center bumper panel.
Open the luggage compartment door located below the driver's side window and locate the spare tire crank assembly. Place the lug wrench socket on the hex headed shaft, then, turn clockwise, and disengage the ratchet angle. Then slowly lower the tire by turning counterclockwise.

WARNING!! To help avoid personal injury and/or property damage if a blowout or other tire damage occurs, obtain expert tire service help if you can. An inflated tire and rim can be very dangerous when misused or worn out. Many accidents, some fatal, have resulted from improper handling and operation of bus rims and wheels. Therefore, it is of the utmost importance that all precautions be carefully followed by all persons servicing bus rims and wheels to avoid personal injuries and costly damage.

If you must remove the wheel to change a tire, the following precautions must be followed:

- At all times, keep away from beneath tire and vehicle.
- If the tire looks as if it may contain air under pressure, stand to the side and check whether the wheel assembly appears normal by comparing it to another wheel assembly on the vehicle.
- If you are not fully expert on wheel replacement procedures, or do not have the proper tools and equipment, again, do not attempt to raise the vehicle, or remove or install the tire and wheel assembly. Obtain expert tire service help.

Tow Eyes



A set of two tow eyes are contained in the Driver's Luggage Compartment. When used, these are inserted into receiver sockets at the front or rear of the bus.

- Remove the front center bumper panel and locate the two receiver sockets.
- Remove the cotter pin and the hitch pin which are in the sockets.
- Insert Tow Eyes into both of the receiver sockets.
- Replace the hitch pins and cotter pins.

CAUTION! Never tow or push a vehicle equipped with an Allison automatic transmission, until the rear drive shaft has been removed, or unless the rear wheels have been raised off the ground. Do not tow by front axle. Do not tow by front or rear bumpers. Tow eyes are designed to tow with both tow eyes simultaneously. Do not attempt to tow with only one tow eye.

WARNING!! Extreme caution should be exercised when the drive shaft is removed on a unit equipped with air brakes. The parking brake becomes inoperative when the drive shaft is disconnected. Do not leave the bus unattended until appropriate measures have been taken to prevent vehicle movement. Use only appropriate jack stands supporting frame rails when under bus.

Entrance Door Lock

The entrance door has an air-operated lock installed at the top of the entrance door. The lock engages automatically when the coach reaches 3 mph and disengages when coach is slowed below 3 mph. Rubber assist handles are provided at the entrance door area. Stepwell lights are provided to illuminate the stepwell area. Thermopane entrance door window with tinted gray glass 72% light transmissibility.

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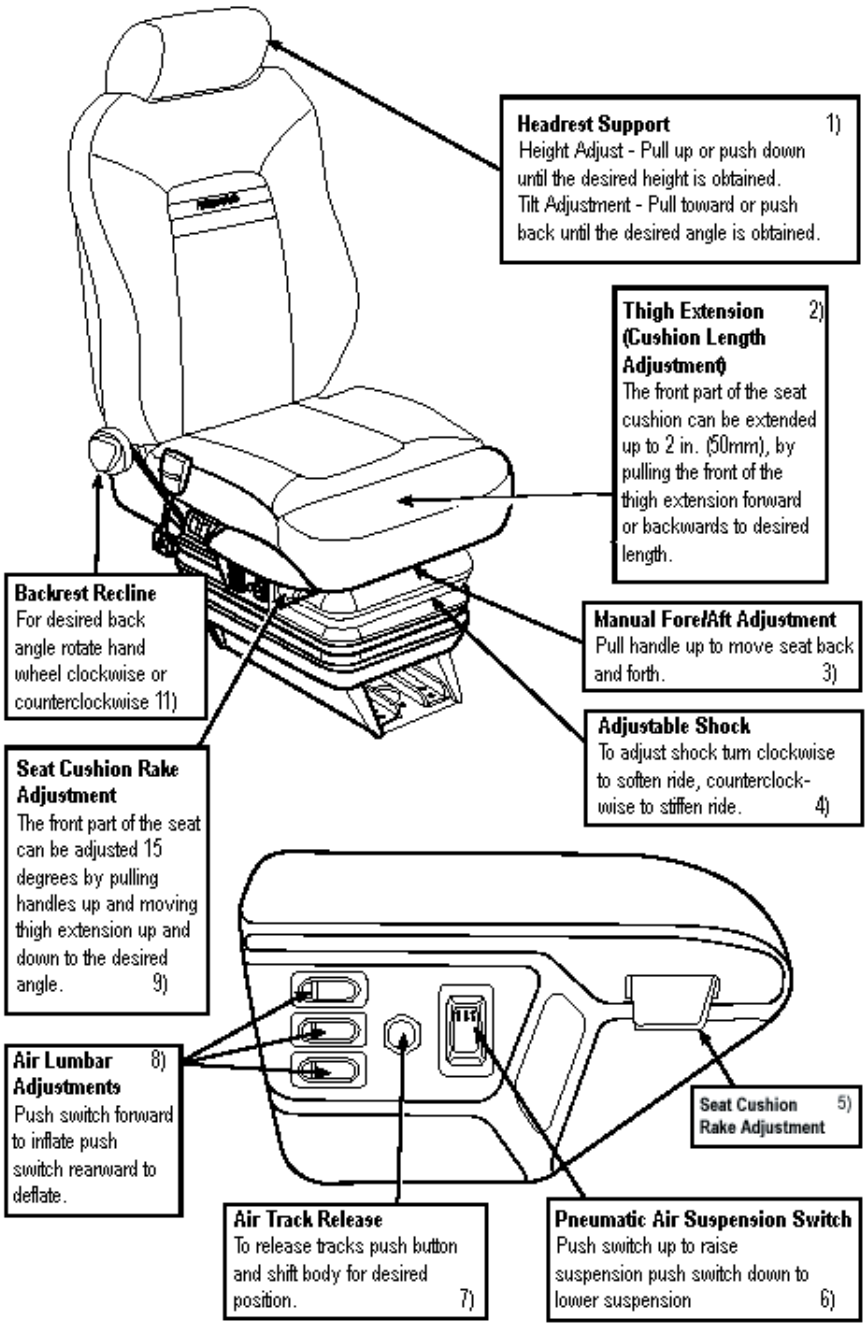

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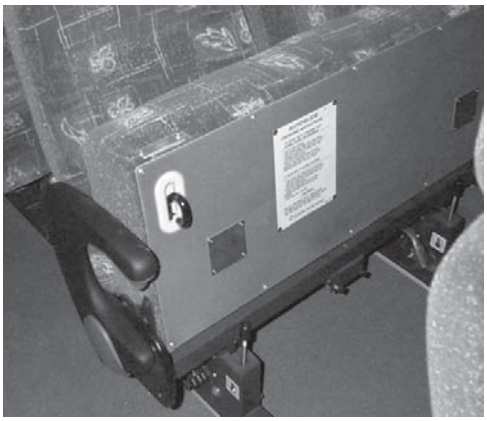

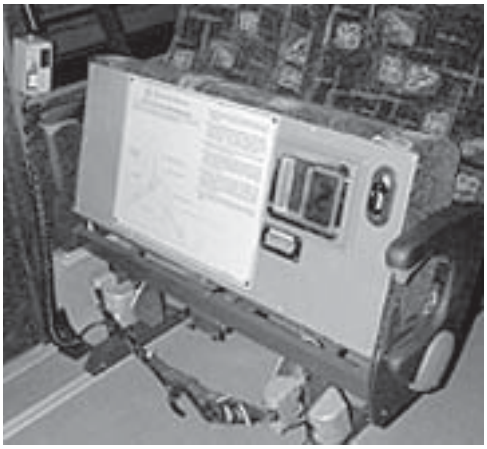

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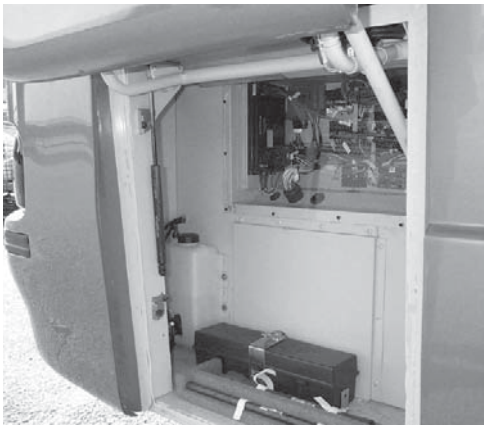
Emergency Equipment



Many individual states or provinces have specific laws governing emergency equipment. Your unit may have some or all of the items listed below. Because of variations in option packages, the placement of this equipment inside the bus may vary from the standard installations shown. It is important for you to know the locations of all the emergency equipment on your bus, and to be sure your units always conform to the regulations of the regions in which it is operated. Furthermore, it is important for you to read all literature, labels, and any other written materials supplied by the equipment manufacturers. Be sure you familiarize yourself with all aspects of the emergency equipment before operating the coach.

Fire Extinguishers

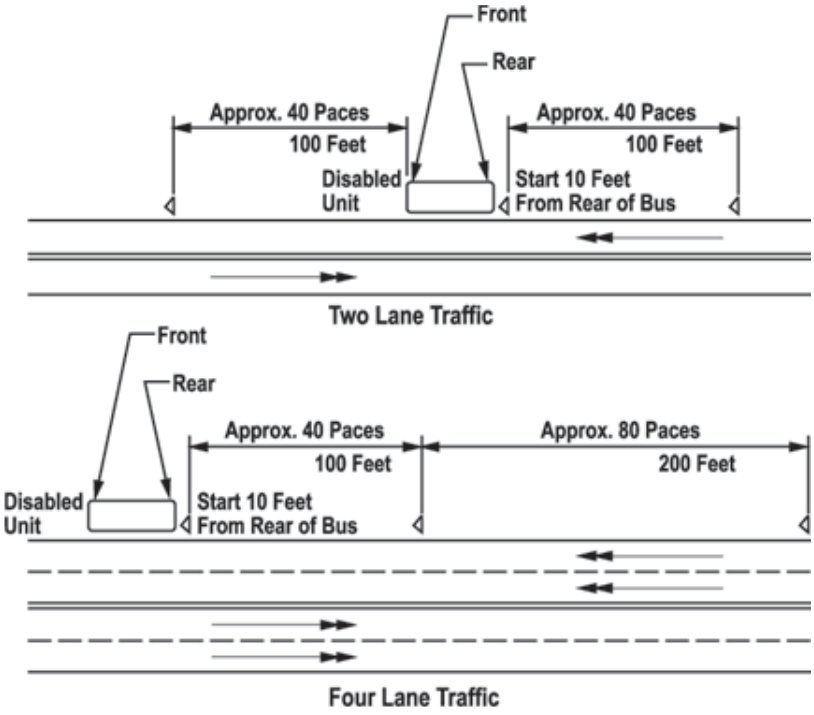
The fire extinguisher is mounted on the floor to the left of the driver’s seat. Your unit may be equipped with a 2.75, 4.5, 5, or 6-pound extinguisher. Inspect the pressure gauge every 30 days or as required by individual state fire laws to make sure the unit is fully charged. Inspect mounting fasteners periodically to be sure they are tight, and be sure you are familiar with their release operation.

First Aid Kit

The first aid kit is attached to the left wall panel just behind the driver's seat. Size and contents of first aid kits vary by option package or differing state specifications. The contents of the kit should be inspected weekly. Check expiration dates on any medications contained. Replace any contents which have been opened or otherwise had their sanitary packaging compromised.

Triangular Warning Devices

For states in which they are required, triangular warning devices are located in the driver's luggage compartment. Inspect contents of the kit (as well as the mounting fasteners) every 30 days, or as required by local code.



Lug Wrench

The lug wrench is located in the driver's luggage compartment. Inspect the installation-mounting fasteners every 30 days to ensure that the installation is accessible, unobstructed, and tight.

Spare Tire Carrier

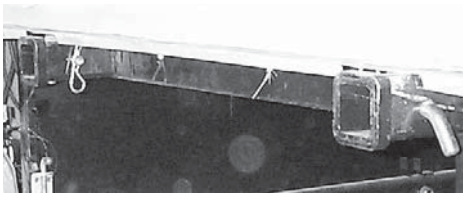
The coach is equipped with a front overhang spare tire carrier. The tire is mounted on a slide out tray behind the front bumper. To gain access, first remove the center bumper panel.
Open the luggage compartment door located below the driver's side window and locate the spare tire crank assembly. Place the lug wrench socket on the hex headed shaft, then, turn clockwise, and disengage the ratchet angle. Then slowly lower the tire by turning counterclockwise.

WARNING!! To help avoid personal injury and/or property damage if a blowout or other tire damage occurs, obtain expert tire service help if you can. An inflated tire and rim can be very dangerous when misused or worn out. Many accidents, some fatal, have resulted from improper handling and operation of bus rims and wheels. Therefore, it is of the utmost importance that all precautions be carefully followed by all persons servicing bus rims and wheels to avoid personal injuries and costly damage.

If you must remove the wheel to change a tire, the following precautions must be followed:

- At all times, keep away from beneath tire and vehicle.
- If the tire looks as if it may contain air under pressure, stand to the side and check whether the wheel assembly appears normal by comparing it to another wheel assembly on the vehicle.
- If you are not fully expert on wheel replacement procedures, or do not have the proper tools and equipment, again, do not attempt to raise the vehicle, or remove or install the tire and wheel assembly. Obtain expert tire service help.

Tow Eyes



A set of two tow eyes are contained in the Driver's Luggage Compartment. When used, these are inserted into receiver sockets at the front or rear of the bus.

- Remove the front center bumper panel and locate the two receiver sockets.
- Remove the cotter pin and the hitch pin which are in the sockets.
- Insert Tow Eyes into both of the receiver sockets.
- Replace the hitch pins and cotter pins.

CAUTION! Never tow or push a vehicle equipped with an Allison automatic transmission, until the rear drive shaft has been removed, or unless the rear wheels have been raised off the ground. Do not tow by front axle. Do not tow by front or rear bumpers. Tow eyes are designed to tow with both tow eyes simultaneously. Do not attempt to tow with only one tow eye.

WARNING!! Extreme caution should be exercised when the drive shaft is removed on a unit equipped with air brakes. The parking brake becomes inoperative when the drive shaft is disconnected. Do not leave the bus unattended until appropriate measures have been taken to prevent vehicle movement. Use only appropriate jack stands supporting frame rails when under bus.

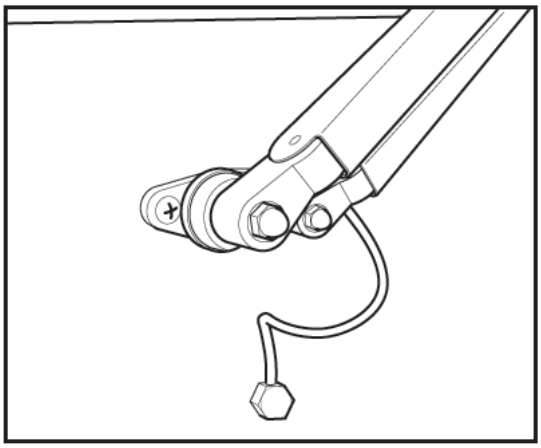
Entrance Door Lock

The entrance door has an air-operated lock installed at the top of the entrance door. The lock engages automatically when the coach reaches 3 mph and disengages when coach is slowed below 3 mph. Rubber assist handles are provided at the entrance door area. Stepwell lights are provided to illuminate the stepwell area. Thermopane entrance door window with tinted gray glass 72% light transmissibility.

Windshield Wipers

The coach comes with dual two-speed electronic intermittent wipers with non-glare arms and blades. Wiper arms are parallelogram. Wipers have a delay position with the delay control on the lower dash. A washer fluid reservoir fill is located in the road side front compartment. Reservoir has a 2-2.5 gallon capacity.

Basic Procedures

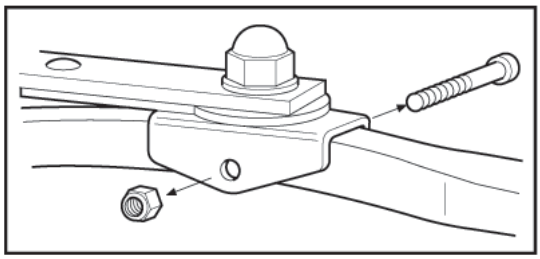


Wiper Arm Removal and Installation

To replace the wiper arm assembly:

1. Operate the wipers briefly, stopping the blades in the normal park position.
2. Lift the wiper away from windshield so that the spring pressure will not work against you while you remove the mounting nuts.
3. Remove the cap nuts, which secure the wiper arm to the wiper and the idler arm to the idler shaft.
4. Take note of the angle at which the wiper arm is mounted upon the splined shaft. Remove the wiper arm and place the. new arm (Blue Bird Part No. 1983600) over wiper shaft making sure the new arm is replaced at the same angle.
5. Replace original cap nuts on shafts and tighten.

Wiper Blade Assembly Replacement



To replace wiper blade assembly:

1. Loosen the lock nut on the mounting pivot bolt.
2. Remove the bolt and pull the wiper assembly loose from wiper arm.
3. Replace the wiper assembly (Blue Bird Part No. 1974070) using the original bolt and lock nut. Tighten lock nut securely, but do not over-tighten so as to compress the saddle. Blade must be free to pivot within the saddle. Threading the lock nut until it is flush with the pivot bolt's end will give a secure and serviceable installation.

Notes:

Waste System

Introduction

The bus comes equipped with a Monogram Sanitation Toilet with Clear Rinse Pump.

Operation

The waste tank is precharged with water to a predetermined level. A deodorant chemical should be added to the precharge.

When the flush button is depressed, compressed air flows into the upper pump chamber. The compressed air pushes the pump diaphragm downward displacing the fluid in the lower pump chamber for rinsing the bowl. Releasing the flush button reverses the air flow and allows the diaphragm to return to the starting position. As the diaphragm moves upward, the air in the upper chamber is exhausted through an air flow governor. A spring is used to return the diaphragm to its original position. As the diaphragm moves upward fluid is drawn through the pin filter into the lower chamber for the next flush cycle. A complete flush cycle takes approximately sixty seconds.

Servicing intervals for the System are determined by the bus operator.

During servicing, the tank is rinsed, contaminated fluid is eliminated from the pump and the tank precharged in the shortest time possible for any system. For best results, a minimum static water pressure of 50 PSIG (3.5 bar) is recommended. To further minimize service time, higher pressures may be used.

NOTE: Air pressure to the System is regulated between 5 and 7 PSIG (0.3 and 0.5 bar).

Components

The toilet consists of the following components:

- Trim Plate
- Bowl with Flapper
- Pump Hanger
- Clear Rinse Pump with Pin Filter
- Return Hose
- Rinse Hose
- Hose Clamps

Maintenance

There is no scheduled maintenance with this model toilet.

Notes:

General Inspection

To ensure safety and convenience and to minimize operating costs, the Operator should establish a routine inspection regimen. Any suspected malfunctions or defects should be reported to maintenance personnel and corrected before further operation of the vehicle.

Daily Inspection

- Check fuel level.
- Drain air tanks (cold weather).
- Check engine oil level.
- Check coolant level.
- Check automatic transmission fluid level.
- Check hydraulic reservoir level.

Outside the coach

- Clean the windshield, mirrors, front windows, headlights, taillights, directional lights, and stop lights.
- Check that the exhaust tailpipe is not obstructed.
- Check tire pressure and treads.
- Check for missing wheel lug nuts.
- Ensure that area under the coach is clear.
- Inspect the general outside appearance for cleanliness. Identifying markings (license plate, motor home number, etc.) must be clean and clear.
- Ensure that exterior mirrors are clean and properly adjusted.

Inside the coach:

- Inspect for general cleanliness of seats and floors.
- Make sure steps and aisles are dry and unobstructed.
- Verify that all emergency exits open and close properly.
- Check emergency equipment and first aid kit.
- Make sure that fire extinguisher is in place and properly charged.
- Clean windows and windshield around driver's area.
- Ensure that exterior mirrors and clean and properly adjusted.

Starting the engine:

1. Be sure parking brakes are on.
2. Put transmission in neutral.
3. With key switched on, check fuel gauge. Check brake warning buzzer or light, and neutral safety switch.
4. Start engine. Look and listen for trouble signs; check gauges.

With the engine running, check (from driver's seat):

- Mirrors, interior and stepwell lights, and service door seal.
- Watch for any unusual feeling or sound from steering, brakes, and other controls. See that brake pedal has normal height and feel and that the brake gauge is reading correctly.
- Check Parking Brake operation by releasing and resetting it.
- Check horn, defroster and heater blowers, and windshield wiper operation.
- Check signals and lights for proper operation before driving away:
  - Right and left turn signals in front and rear.
  - Flasher warning lights in front and rear.
  - Headlight high and low beams.
  - Stoplights and taillights.
  - Hazard flasher.

Final check while the coach is starting to move:

- Check that seatbelt is secure.
- Check that brake action feels sure and positive; not spongy.
- Watch for any unusual feeling, behavior, or noises in steering and check that the bus is generally under control and tracking straight.
- Brake to a stop and check all gauges.

REMEMBER: Safety on the road depends on you. Observe weather and road conditions and drive accordingly. Be physically and mentally alert. When backing up near pedestrians or in congested areas, use outside monitor or director. Look around before driving away from where you are parked and observe all traffic rules and regulations.

Weekly Inspection:

- Adjust brakes.
- Drain air tanks (warm weather).
- Check tire tread and inflation pressure.
- Inspect seat belts and buckles.
- Inspect outside lights for proper operation.

Maintenance Schedule

Monthly or 1,000 Miles

- Inspect all emergency equipment and mounting fasteners. Inspect fire extinguisher to see if fully charged, and check contents of first aid kit(s) for freshness, sterility, full supply, and expiration dates.
- Inspect tires for correct pressure, and check for signs of wear. Torque outer wheel nuts to
- 450-500 foot-pounds (610-675 N•m).
- Inspect window latches and slides for proper operation and secure closure.
- Inspect seat frames for secure attachment to the floor and wall.

Monthly or 3,000 Miles

- Check fuel system (Drain fuel and contaminants, if required).
- Check battery water level.
- Inspect brake chambers.

3 Months or 5,000 Miles

- Lubricate all hinges and window latches for ease of operation.
- Lubricate all window channels with silicone or graphite.
- Change main heater air filter (depending on operating conditions).
- Lubricate hinge and latch mechanisms on access doors.
- Inspect heater valves to verify proper function.
- Change engine oil and oil filter.
- Inspect fuel cap, tank, and fuel lines.
- Inspect engine fuel tank vents.
- Inspect engine air filter, replace if required.
- Inspect driveshaft.
- Lubricate universal joint and slip joint.
- Lubricate brake camshaft, king pins, tie rod ends, and slack adjusters.

The Chelsea "PTO" provides for the hydraulic pump shaft splines and PTO coupler to be lubricated to aid in the prevention of wear and possible premature spline failure.

Recommended maintenance schedule for PTO is 3 months or every 5,000 miles
(whichever comes first).
PTO should be lubricated with special grease (p/n 0029995) until grease purges from the vent on top of PTO assembly.

NOTE: PTO lubrication fitting located on PTO shaft end opposite of hydraulic pump mounting.

3 Months or 24,000 Miles

- Inspect Bendix air dryer.
- Check for loose or disconnected electrical connections and damaged wiring.
- Check the vehicle brake warning system.

6 Months or 6,000 Miles

- Check lubricant level in rear axle.
- Inspect rear axle vent.
- Clean and/or replace air compressor filters.
- Check power steering fluid level.
- Lubricate steering drag rod.
- Check single and double check valves.
- Lubricate spring pin.
- Inspect alternator.
- Clean battery posts.
- Disassemble and clean the air compressor governor and repair, as required.
- Clean and lube treadle valve.
- Change engine fuel filter.
- Clean and lubricate accelerator treadle valve.

12 Months or 12,000 Miles

- Complete Quarterly Maintenance Checklist.
- Bleed all air from heaters.
- Tighten all heater hose clamps.
- Check heater hoses, motor wheels, and fans on heaters.
- Clean heater core.
- Inspect power steering pump.
- Inspect steering gear.
- Lubricate steering column.
- Check front and rear suspension bolt torque.
- Inspect suspension system and components.
- Inspect radiator hoses.
- Pressure-test engine cooling system.
- Check heater panels and housing.

12 Months or 24,000 Miles

- Check air tank pop-off valves.
- Change automatic transmission filter.
- ChaDenge internal automatic transmission filter.
- Inspect automatic transmission vent.
- Change power steering reservoir filter.
- Change lubricant in rear axle.

24 Months or 24,000 Miles

- Clean radiator.
- Change thermostat.
- Clean relay valves, spring brake valves, parking brake valves, and quick release valves.
- Clean pressure protection valves.

These checklists are suggested. They do not replace or supersede local or state required driver inspection procedure.