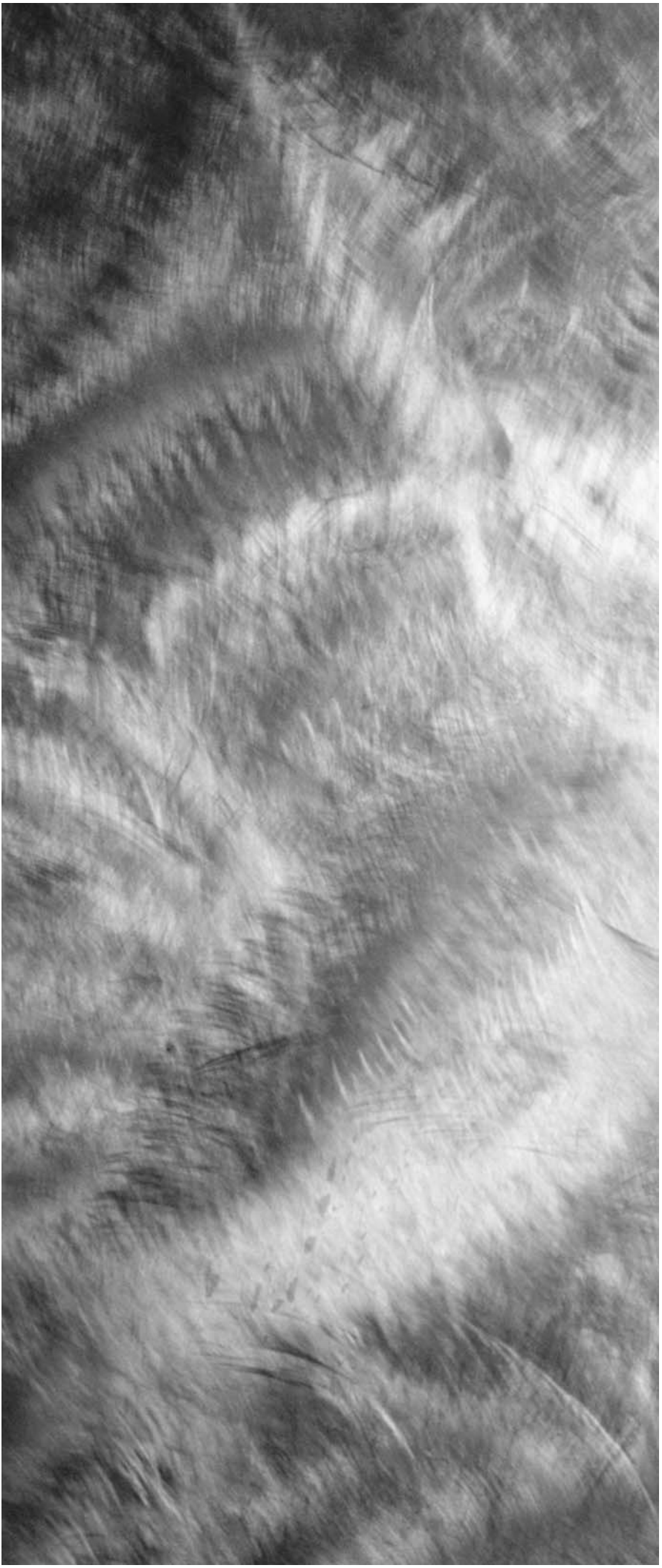


Haldex

Modal Power TK2

Installation and Service Manual

L30022
Rev. 9/98

Service Notes

This installation and service manual describes the correct installation and service procedures for Midland-Grau Antilock Brake Systems for Trucks, Tractors, Buses and Motor Coaches.

The information contained in this manual was current at the time of printing and is subject to change without notice or liability.

You must follow your company safety procedures when you install or service this equipment. Be sure you understand all procedures and instructions before you begin installing or servicing this equipment.

Midland-Grau uses the following types of notes to give warning of possible safety problems and to give information that will prevent damage to the equipment.

⚠ WARNING

A warning indicates procedures that must be followed exactly. Serious personal injury can occur if the procedure is not followed.

△ CAUTION

A caution indicates procedures that must be followed exactly. If the procedure is not followed, damage to equipment or components can occur. Serious personal injury can also occur in addition to damaged or malfunctioning equipment or components.

T

This symbol is used to indicate fasteners that must be tightened to a specific torque.

N NOTES

A note indicates an operation, procedure or instruction that is important. A note can also give information that will make installation and service quicker and easier.

> ⚠ ***ASBESTOS AND NON-ASBESTOS FIBER WARNING***
>
> ***Some brake linings contain asbestos fibers, a cancer and lung disease hazard. Some brake linings contain non-asbestos fibers whose long-term effects are unknown. Caution should be exercised in handling both asbestos and non-asbestos material.***

MODAL POWER TK2
Installation and Service Manual

Table Of Contents

1.0 General Operation of the Modal Power ABS and Traction Control Systems

The Midland-Grau Modal Power ABS/TC (Antilock Brake System/Traction Control) System is designed to provide all of the benefits of an antilock system during braking and assist the driver when accelerating the vehicle on slippery road conditions.

The **MODAL Power ABS** is made up of **Sensors** and **Exciters**, **ABS Modulator Valves**, and an **Electronic Control Unit** (ECU) to maximize the braking efficiency of the vehicle. The ECU monitors wheel speeds through the use of sensors and exciters that are mounted on the hubs of the vehicle. When the ECU detects excessive wheel deceleration (slip) during brake application, the air pressure in the brake chamber of the affected wheel(s) is reduced via the ABS Modulator Valve, allowing the wheel to accelerate. After eliminating the excessive wheel slip, the ECU gradually reapplies the pressure to maximize the braking effort. If the condition that caused the excessive wheel slip remains, the cycle is repeated until either the brake application or the vehicle is stopped. The ECU also communicates with any auxiliary brake features (such as engine and transmission retarder systems) to temporarily disable these during an ABS event.

With the Modal Power ABS/TC System there is an optional Traction Control System available. This feature is sometimes referred to as ASR (Anti-Slip Regulation). By adding one solenoid operated Brake Apply Valve (BAV) and an interface to the engine ECU the ABS components can function to provide drive axle traction control during acceleration. When the driver encounters a road condition where the drive axle wheels lose traction, the Traction Control System (TC) will automatically be activated. The ECU will detect the excessive drive wheel spin in relation to the non-driven wheel and communicate with the engine ECU to reduce the engine torque and at the same time activate the BAV to provide brake pressure to slow the slipping wheel. This will provide drive torque to the non-slipping wheel and move the vehicle. The brake pressure will be modulated automatically on the spinning wheel by the ABS valve to regulate the amount of wheel spin.

In the event the ABS System is not working, the system reverts to a basic air brake system and a warning light on the dash lights up to warn the driver that the ABS System is not working.

MODAL Power ABS is available in several configurations. The system can be configured as either 4S/2M (4 Sensor/2 Modulator), 4S/3M (4 Sensor/3 Modulator) or 6S/3M (6 Sensor/3 Modulator) Types. ABS/TC is available in the 4S/3M or 6S/3M configurations only. The ECU utilizes color coded and polarized electrical connections to make the installations virtually error free.

The Total On-board Diagnostic Display (TODD), integral to the ECU, can be used to troubleshoot the system rapidly without additional equipment. All diagnostic codes are in numerical format so that problems can be detected and repaired quickly. As an alternate to the TODD, an industry standard diagnostic tool, such as the Pro-Link 9000 can be used. Refer to Section 5.2.

Installation of MODAL Power ABS is easy and can be completed in four steps:

1. Installation of sensors.
2. Installation of ABS modulator valves.
3. Installation of the electrical system.
4. Final system checkout.

NOTE: This manual assumes that the following ABS decisions have been made and that you have purchased:

1. The system configuration has been established (4S/2M, 4S/3M or 6S/3M).
2. For the four sensor system on tandem rear axles– it has been decided which rear axle will receive the two sensors. Normally sensors should be placed on the axle that has the greatest tendency to lockup, i.e. the axle that is least loaded during braking. (Contact the vehicle manufacturer for further information concerning this.)
3. Whether to use relay type and/or inline type ABS modulating valves.
4. If there are any questions call Midland Engineering (1-800-643-2374).

2.0 Wheel Speed Equipment

MODAL Power TK2 ABS is retrofitable providing the installer starts with an ABS ready vehicle (that has exciters, sensor blocks and/or bushings on all the sensed wheels). Refer to figures 1 and 2 which describe the components that constitute an ABS ready axle.

All sensed wheels will require a 100 tooth exciter ring which is located on the seal end of the hub. The sensor is held in close proximity to the exciter ring by a sensor clip and a mounting block or bushing.

NOTE: Some axle manufacturers use in-axle sensors which package wheel speed sensing hardware inside the axle housing. In such cases contact Midland-Grau at 1-800-643-2374 to determine the system's compatibility with such sensors.

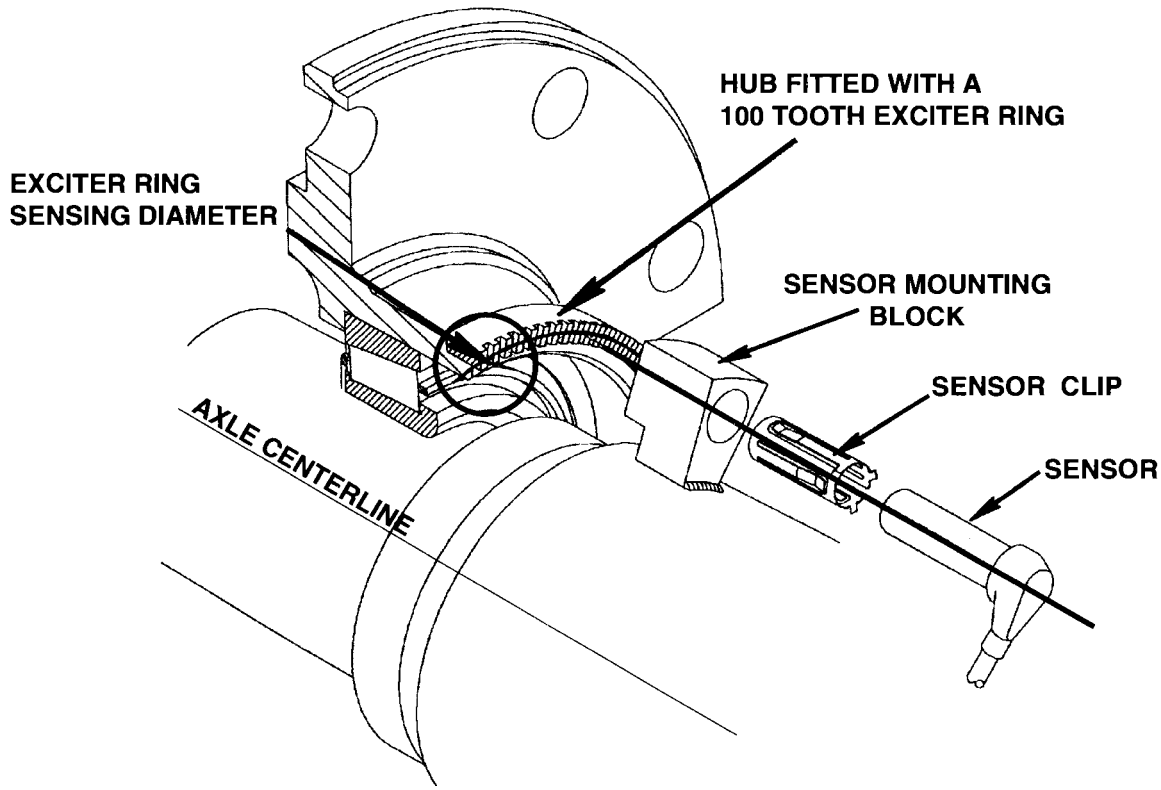


FIG. 1

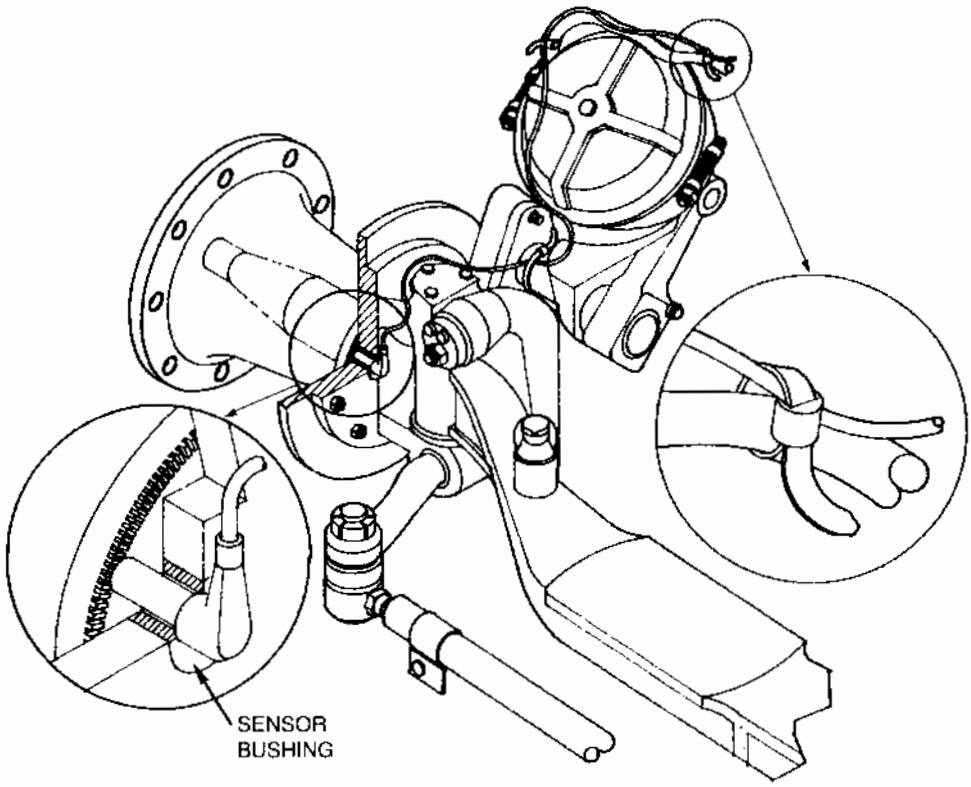


FIG. 2 TYPICAL STEER AXLE SENSOR CABLE ROUTING & CLAMPING

Δ **CAUTION:** The Sensor Cable is often routed through a vacant bolt hole in the brake spider or through a protective grommet installed in a brake dust shield. Provisions must be made to prevent chaffing and keep the cable away from moving brake components.

Ⓝ **NOTE:** When purchasing an ABS ready axle from an axle or vehicle manufacturer, clarify what the manufacturer will be supplying. Insure that all the necessary ABS components are included. Often the sensors and sensor clips are not included with an ABS ready axle. In such cases, specify Midland-Grau 100 tooth sensors and sensor clips with your system purchase.

Sensor Installation and Checkout

Please proceed directly to Section 2.3–Sensor Checkout, if axles include sensors as received.

2. 1 Sensor Installation–Outboard Drums

1. Remove the brake drum, leaving the hub installed.
2. Push the spring clip into the mounting block or bushing from the inboard side until the tabs are against the bushing or block.
3. Push the sensor into the spring clip until it touches the exciter.
4. Route the sensor lead through a vacant hole in the brake spider or a drilled hole in the backing plate of the brake assembly.

Δ **CAUTION:** Protect the sensor lead from sharp edges of the backing plate or brake spider hole (and other potential chaffing points) by using grommets or protective sheathing as required.

5. Secure the sensor lead to the axle between the spider and suspension and to a non-moving section of the suspension such as a U-bolt. Maintain at least a 1.5" clearance from all moving brake components.
6. Reinstall the brake drum per the axle manufacturer's specifications.
7. Repeat steps 1-6 for each additional sensor.

N **NOTE:** At no time should sensor/exciter gap exceed .020"

2.2 Sensor Installation–Inboard Drums

1. Remove the hub and drum assembly.
2. Push the spring clip into the mounting block or bushing from the inboard side until the tabs are against the bushing or block.
3. Push the sensor into the spring clip as far as possible.
4. Route the sensor lead through a vacant hole in the brake spider or a drilled hole in the backing plate of the brake assembly.

Δ **CAUTION:** Protect the sensor lead from sharp edges of the backing plate or brake spider hole (and other potential chaffing points) by using grommets or protective sheathing as required.

2.2 Sensor Installation–Inboard Drums (Cont.)

5. Secure the sensor lead to the axle between the spider and suspension and to a nonmoving section of the suspension such as a U-bolt. Maintain at least a 1.5" clearance from all moving brake components.
6. Install hub and drum assembly on axle carefully so the exciter ring is pushing against the sensor as bearings are tightened.

NOTE: Avoid rocking the hub and drum assembly to avoid bumping the sensor out of adjustment. Adhere to axle manufacturer's recommended torque and installation requirements.

7. Repeat steps 1-6 for each additional sensor.

NOTE: At no time should sensor/exciter gap exceed .020"

2.3 Sensor Checkout

1. Set up a voltmeter to readout in volts AC and connect it to the leads of one of the installed sensors.
2. Rotate the "sensed" wheel at approximately one revolution every two seconds.
3. The voltmeter must read greater than .28 volt.

NOTE: If no voltage readout is obtained, connect an ohmmeter to the sensor leads. Sensor resistance should read between 980 and 2350 Ohms. Also, recheck sensor adjustment.

4. Repeat steps 1-3 for each remaining sensor.

3.0 ABS Air System Components

Two types of ABS valves can be used with the ABS System. One is the ABS relay valve which takes the place of the conventional service brake relay valve (refer to figures 3 and 4). The other valve is the ABS in-line valve which is installed in the delivery line between the conventional service relay valve and the brake chamber for the drive axle(s) and between the foot valve and the brake chamber for the steer axle. Refer to figures 5 and 6.

Δ **CAUTION:** Installation of the air brake system requires a basic knowledge of air brake system plumbing.

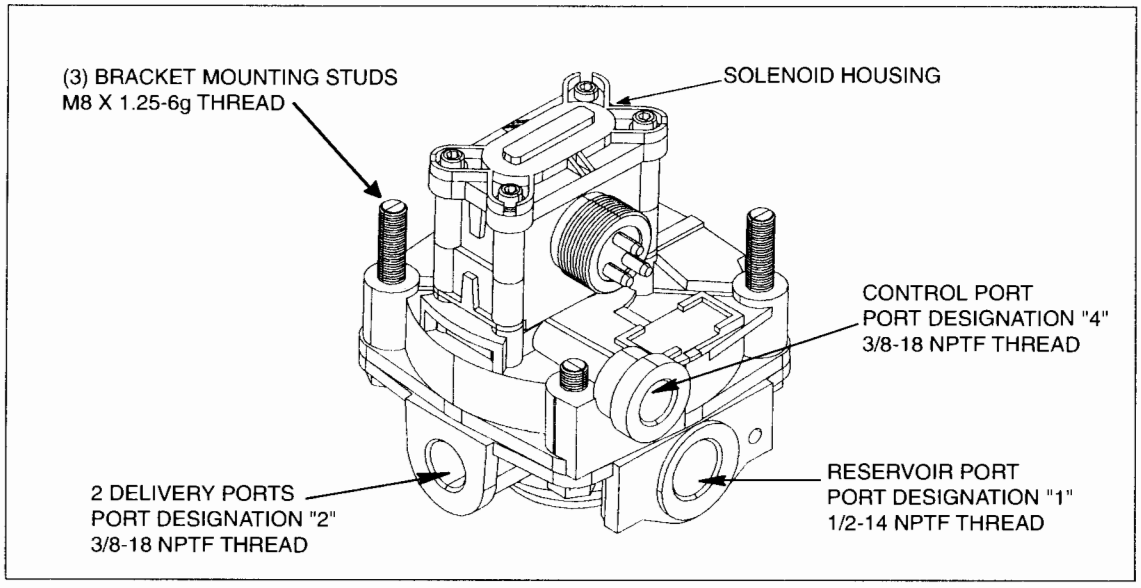
3.1 Installation of ABS Relay Valve

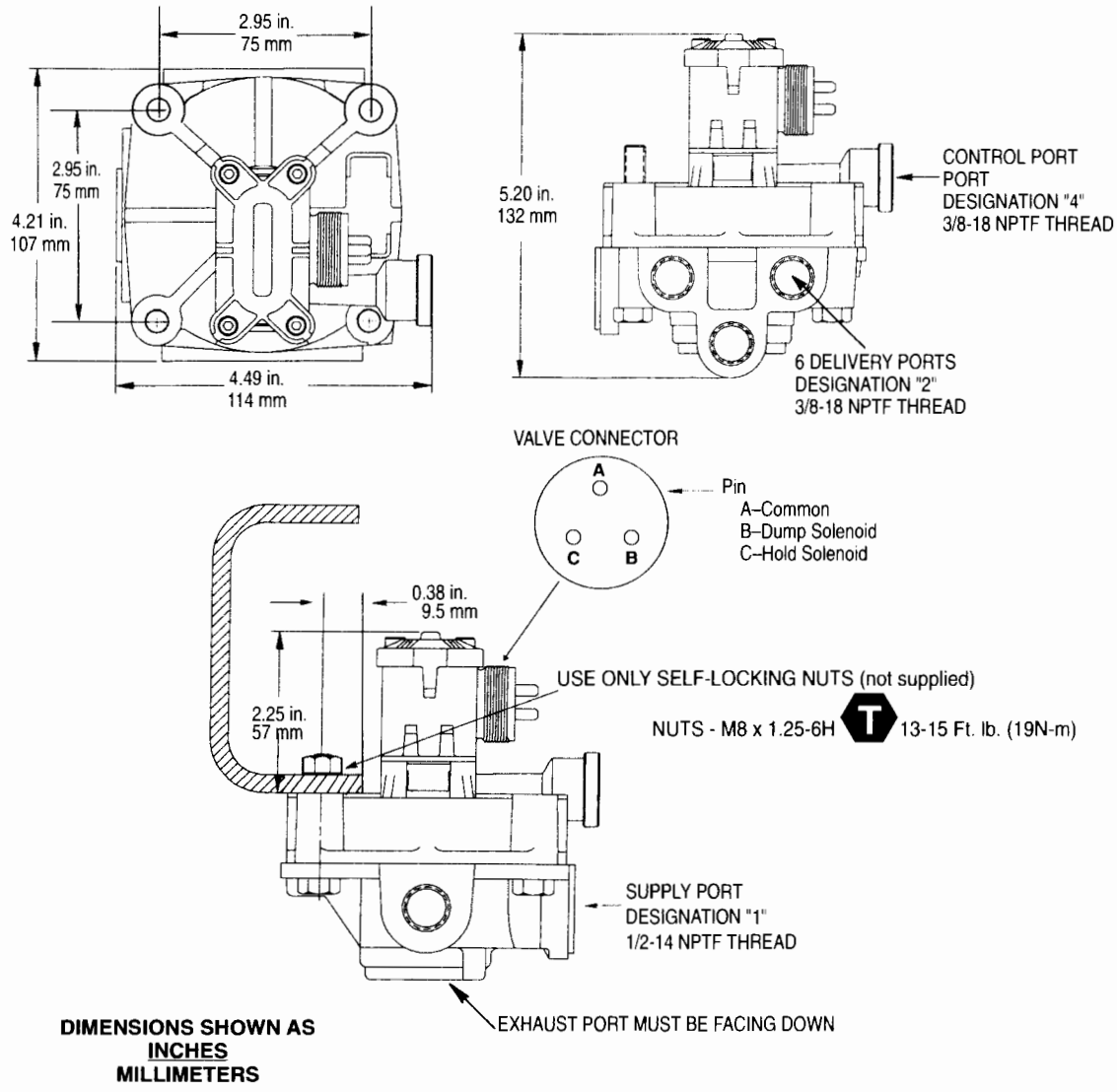
The ABS relay valves are shown in figures 3 and 4. Basic mounting and envelope dimensions are included in figure 4 for the two basic configurations offered: 2 delivery port and 6 delivery port.

The internal mechanical operation of the valve as well as the way it is plumbed into the system is identical to a conventional service relay valve.

Brake relay valves: The front service brakes are supplied and controlled by the secondary reservoir and foot valve circuit, while the rear service brakes are supplied and controlled by the primary reservoir and foot valve circuit. ABS relay valves are plumbed into the vehicle braking system just as any service relay valve. However, the delivery lines must be plumbed per Section 3.1.

FIG. 3 ABS RELAY VALVE





ABS Relay Valves - Varied views (Offered In 2 & 6 Port Configurations)

FIG. 4 ABS RELAY VALVE DIMENSIONS

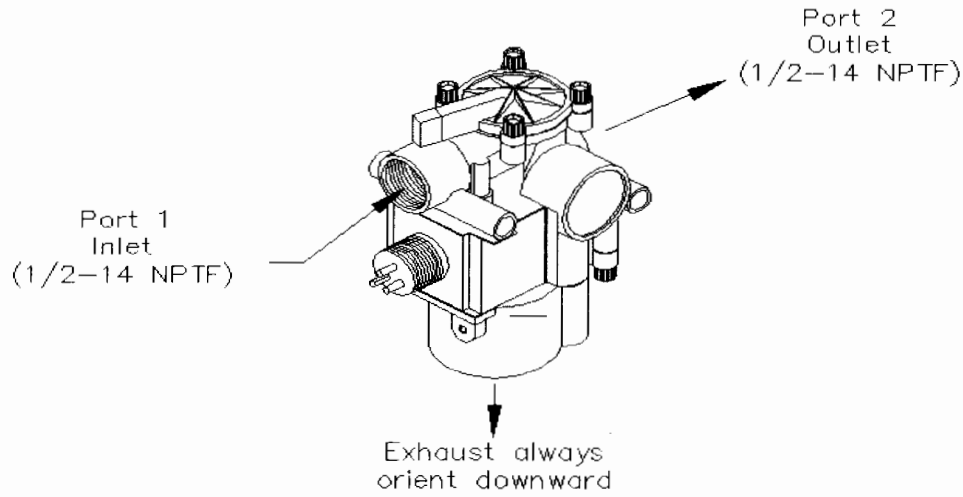


FIG. 5 ABS INLINE VALVE

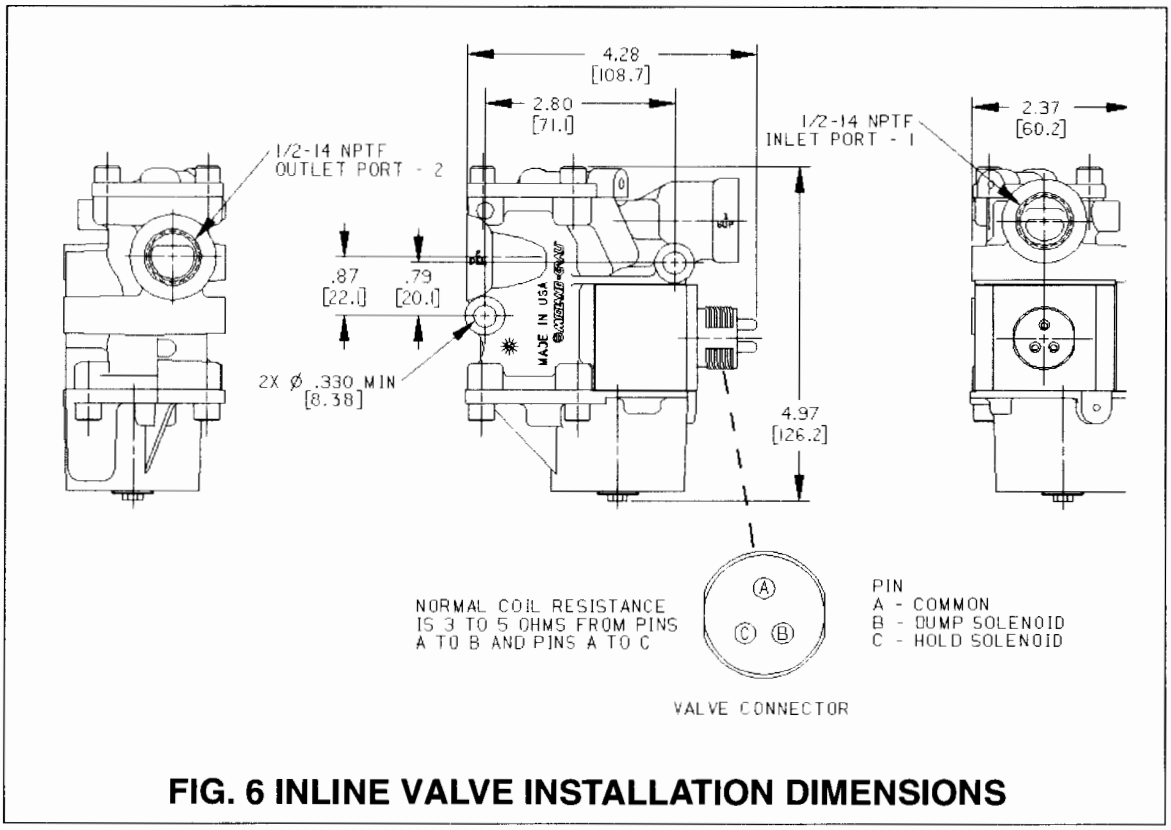


FIG. 6 INLINE VALVE INSTALLATION DIMENSIONS

3.1 Installing the ABS Relay Valve (Cont.)

1. Match your vehicle type, ABS configuration and ABS valve combination to the pneumatic system diagrams in figures 9 or 10. The diagrams depict the air system for 4 x 2 and 6 x 4 vehicles with two and three inline and/or relay type valves. This section refers to the ABS relay valve option only.

NOTE: To optimize ABS system performance, ABS relay valves should be mounted on the chassis as close to the brake chambers as possible. Delivery lines should be of equal length and a minimum of tees and fittings should be used. Carefully apply pipe sealant on all air fittings.

2. Plumb the control line to Port 4 of the ABS relay valve.
   - For the steer axle, the control line comes from the secondary side of the foot valve.
   - For the drive axle, the control line comes from the primary side of the foot valve.
   - Refer to figures 7, 9 and 10.
3. Plumb the supply line to port 1 of the ABS relay valve
   - For the steer axle, the supply line comes from the secondary reservoir.
   - For the drive axle, the supply line comes from the primary reservoir.
   - Refer to figures 7, 9 and 10.

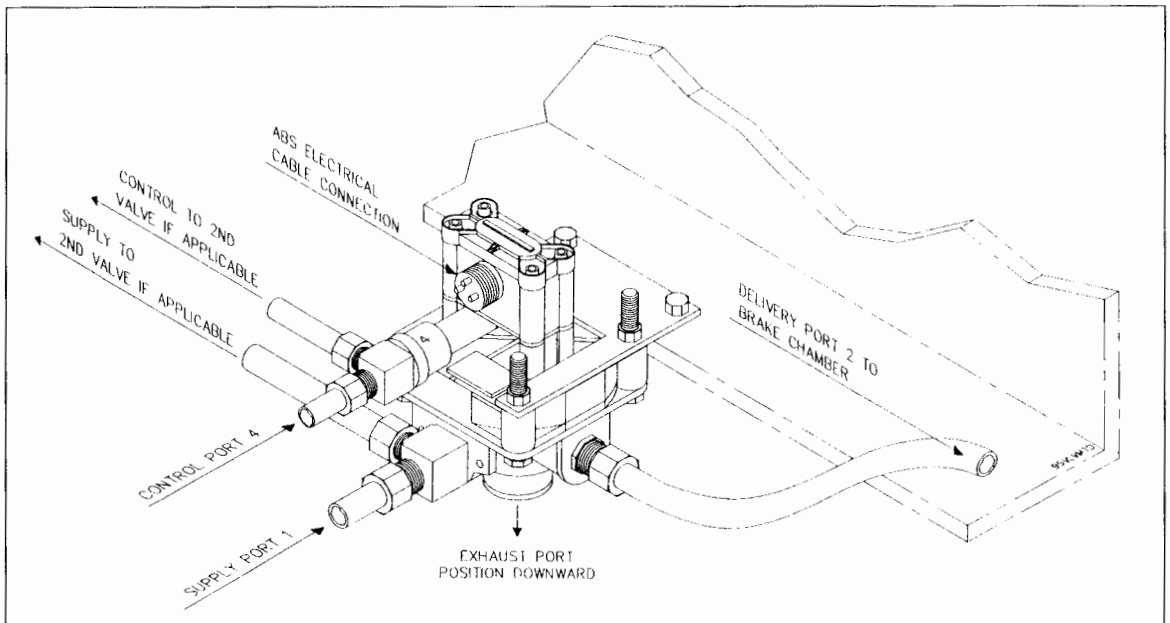


FIG. 7 TYPICAL ABS RELAY VALVE INSTALLATION

3.2 ABS Inline Valve Installation

1. Match your vehicle type, ABS configuration and ABS valve combination to the pneumatic system diagrams in figures 9 or 10. The diagrams depict the air system for 4 x 2 and 6 x 4 vehicles with two and three inline and/or relay type valves. This section refers to the ABS inline valve option only.

NOTE: To optimize ABS system performance, ABS inline valves should be mounted on the chassis as close to the brake chambers as possible. Delivery lines should be of equal length and a minimum of tees and fittings should be used. Carefully apply pipe sealant on all air fittings.

2. The ABS inline valve shown in figure 8 is located in the delivery line between the service relay valve and the brake chamber for the drive axle(s) and between the foot valve and brake chamber for the steer axle.
3. Mount the inline valve to the frame or cross-member using two 5/16 bolts.
4. Use the system diagrams in figures 9 or 10 for the proper air system plumbing information. To select the proper system diagram match your vehicle type, ABS configuration and ABS valve combination to one of these system diagrams. Also see figure 8.

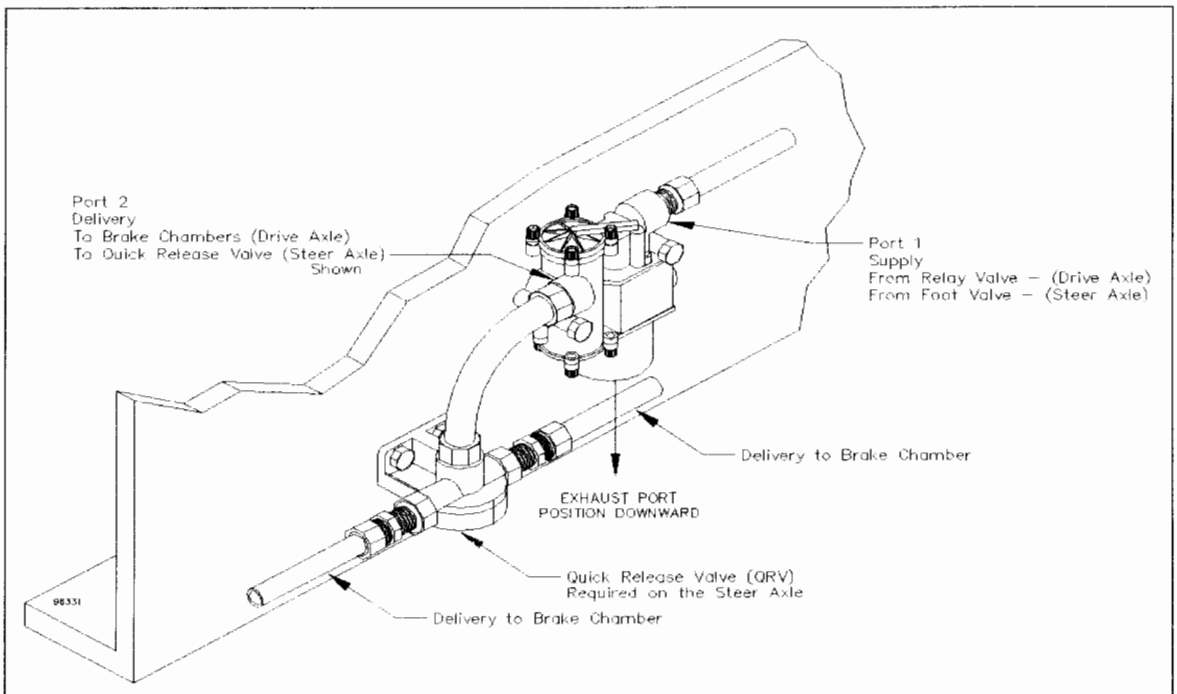
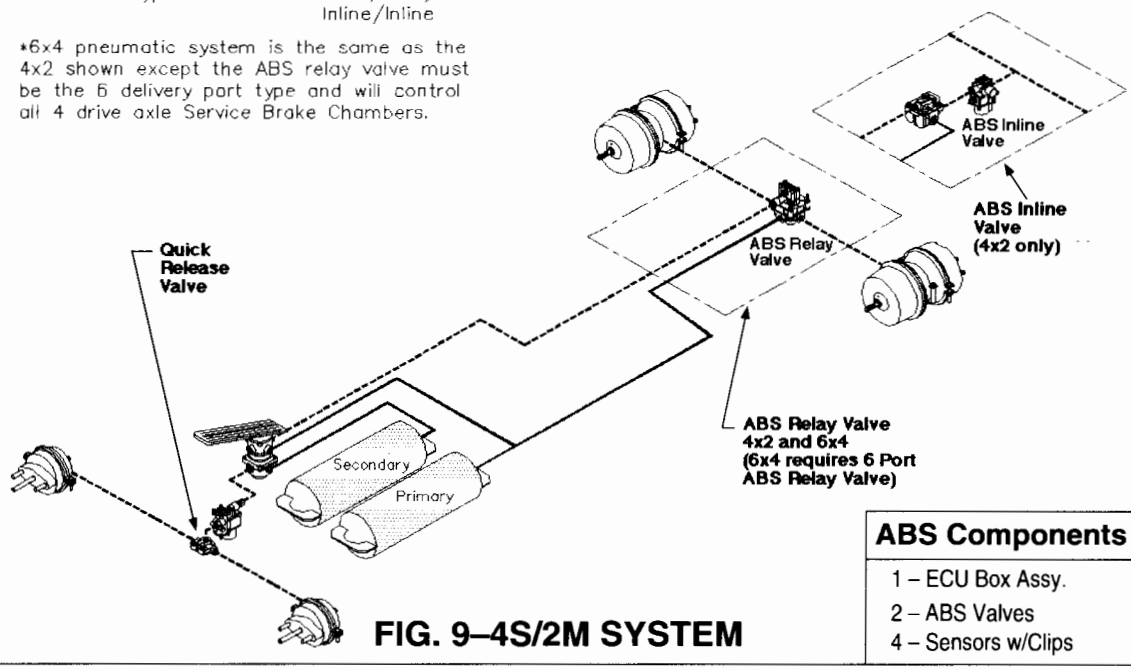


FIG. 8 TYPICAL ABS INLINE VALVE INSTALLATION

PNEUMATIC SYSTEM

Vehicle Type.....4x2 and 6x4*
ABS Configuration.....4S/2M
ABS Valve Types.....Inline/Relay
Inline/Inline

*6x4 pneumatic system is the same as the 4x2 shown except the ABS relay valve must be the 6 delivery port type and will control all 4 drive axle Service Brake Chambers.



ABS Components

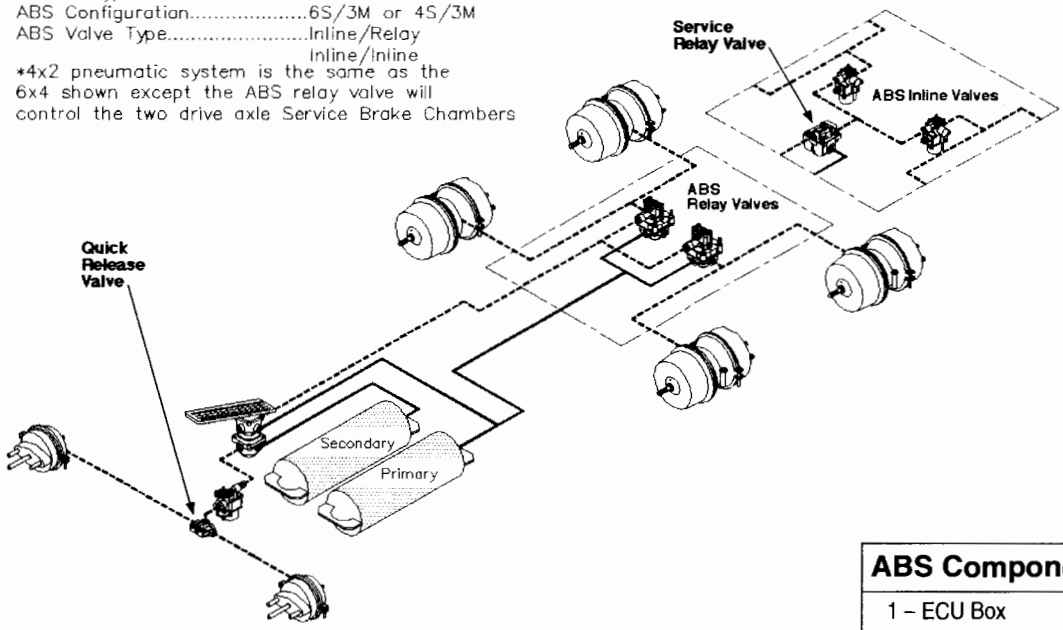
1 – ECU Box Assy.
2 – ABS Valves
4 – Sensors w/Clips

FIG. 9–4S/2M SYSTEM

PNEUMATIC SYSTEM

Vehicle Type.....*6x4 and 4x2
ABS Configuration.....6S/3M or 4S/3M
ABS Valve Type.....Inline/Relay
Inline/Inline

*4x2 pneumatic system is the same as the 6x4 shown except the ABS relay valve will control the two drive axle Service Brake Chambers



ABS Components

1 – ECU Box
3 – ABS Valves
4 or 6 – Sensors w/Clips

FIG. 10–6S/3M AND 4S/3M SYSTEMS

4.0 ABS Electrical Installation

Δ **CAUTION:** Installation of the electrical components requires a basic knowledge of electrical wiring.

This section will involve three areas which will complete the electrical system installation:

1. Mounting the ECU.
2. Routing the sensor and valve cables.
3. Vehicle interface: Power cable.

The ECU is housed in a weather protective box which can be installed inside the vehicle cab or mounted on the chassis.

4.1 Mounting the ECU

The MODAL ECU box

1. Envelope dimensions are shown in figure 11.

2. Must be mounted in the upright position as indicated on the box lid (see figure 19).

3. Must be located on the chassis where it can be readily serviced.

4. Must have sufficient clearance from chassis components to allow the box lid to be opened.

5. Must be mounted such that it is not in the direct path of wheel splash and is protected from flying stones and debris.

6. Should be located on the chassis so that harness lengths are minimized.

7. Can be mounted to a fabricated bracket attached to a frame cross member or bolted directly to the frame.

NOTE: The box door can be opened to allow access to the diagnostic display built into the ECU. Dimensions required for swing clearance and mounting are shown below.

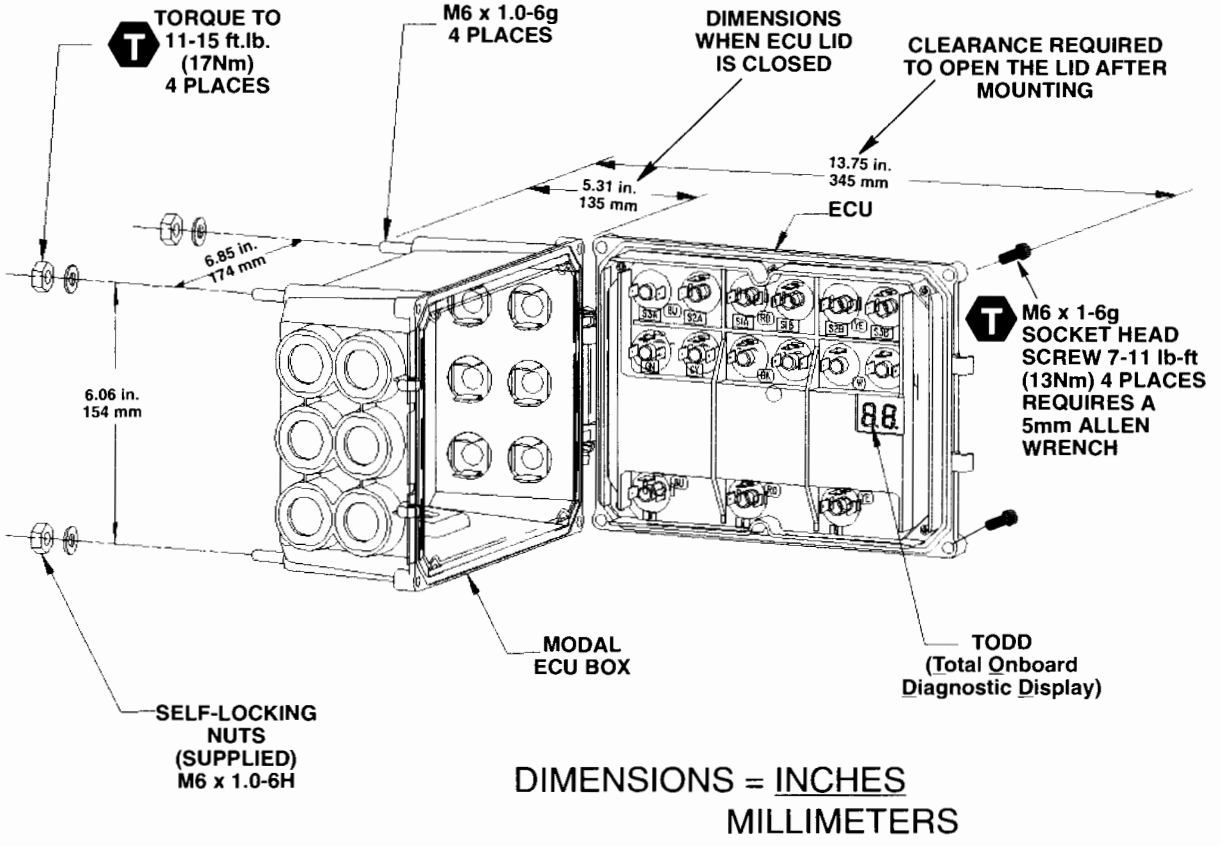
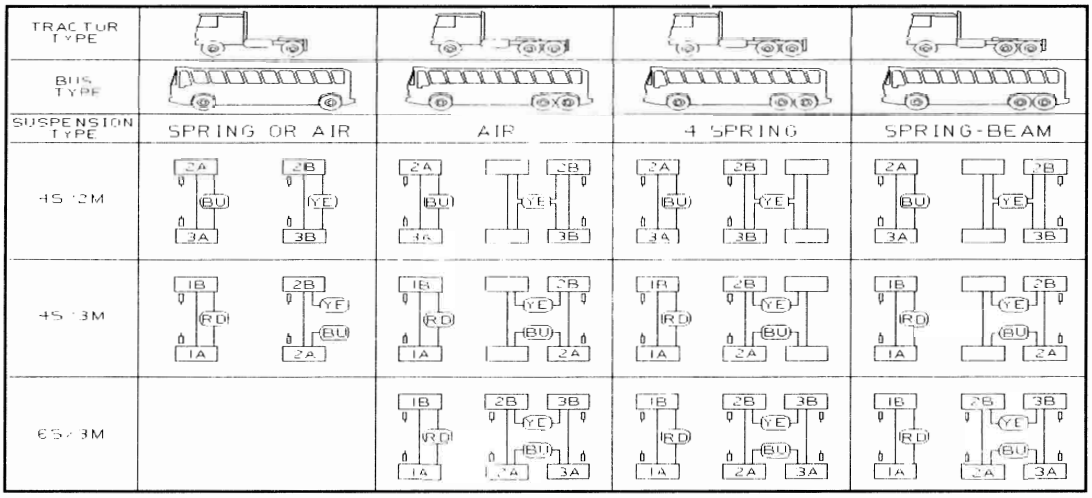


FIG. 11 ECU MOUNTING DIMENSIONS AND INFORMATION

NOTE: The ECU is designed to have an operating and storage temperature range of -40 to +176°F (-40 to +80°C).

4.2 Routing of ABS Valve and Sensor Extension Cables

Each sensor and ABS valve cable is color coded and labeled to ensure that it is installed in the correct location. Figure 12 depicts some general locations for sensor and ABS valve cables relative to various vehicles and system configurations.



KEY

1A – 1B 2A – 2B 3A – 3B		Indicates wheel and sensor positioning indentification. The label on the sensor extension cable will match the molded ECU cover. The color code on the label must be the same as the color of the valve controlling the wheels.
RD – Red BU – Blue YE – Yellow		Indicates the ABS valve and color code. The valve color is designated only by the label on the ABS valve cable. The color code for the valve must be the same as the color code on the sensor on the wheels being controlled by that ABS valve.
		Wheel speed sensors.

CAUTION–Per Federal regulations straight trucks and tractors that tow air-braked trailers cannot use the 4S/2M system.

FIG. 12 SENSOR IDENTIFICATION ABS VALVE COLOR CODE AND COMPONENT LOCATION

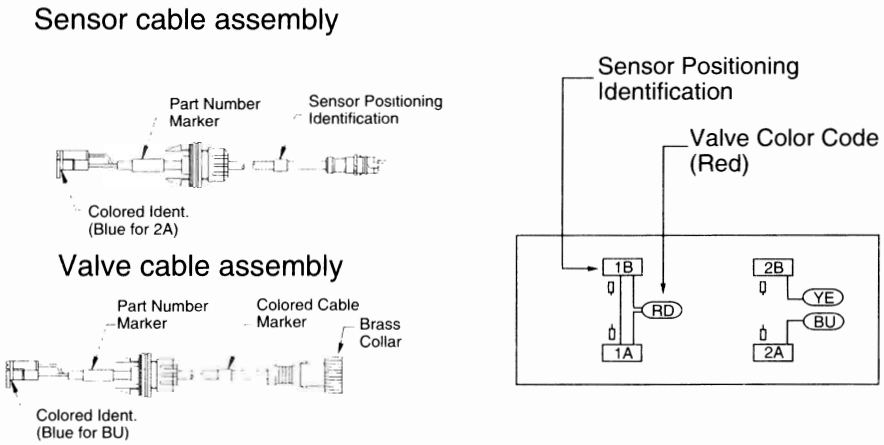


FIG. 13 SENSOR AND ABS VALVE CABLES

4.3 Sensor Extension and ABS Valve Cable Connections

Review the configuration pictorials for your system and vehicle type in figures 12 and 13.

1. Match the color coding for the ABS valve and ABS valve cable. Also, match the sensor positioning identification on the sensor extension cable with wheel location shown on the pictorial in figure 12.

N **NOTE:** It is very important for the proper operation of the ABS System that each sensor extension cable is connected to the proper sensor location. Observe the alphanumeric code on each sensor positioning identification, near the sensor connector, and match it to the position for that sensor on the pictorial for your vehicle in figure 12.

2. Connect the matching sensor extension cables and sensor cable terminations together. Connect the matching ABS valve cables and ABS valves together. Tighten the brass collar on the ABS valve cable securely to the ABS valve.

N **NOTE:** Typically the ECU case comes with pre-installed cables. Steps 3 and 4 are described for those exceptions where making these ECU connections may be necessary.

3. Route the ECU connectors on the other end of the extension cables through the holes in the ECU box. Align the flats on the cable clickfit housing with the flats in the ECU box and push on the clickfit housing and nut until the tabs "click" into place. Refer to figure 14. This is necessary to insure that the O- ring will seat correctly in the ECU box.

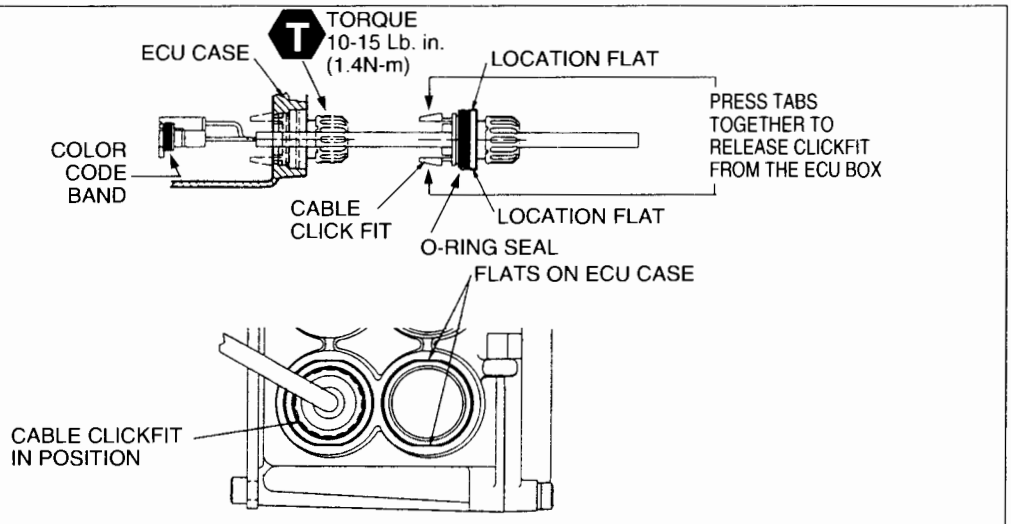


FIG. 14 CLICKFIT ASSEMBLY

4.3 Sensor Extension and ABS Valve Cable Connections (Cont.)

4. Attach the extension cable ECU connectors to the ECU board terminals. The sensor and ABS valve cable connectors have a color coded band which will match a connector on the ECU board with a round colored button at its center. Refer to figure 15. Note that the sensor connectors are on the top row and the valve connectors are on the bottom row.

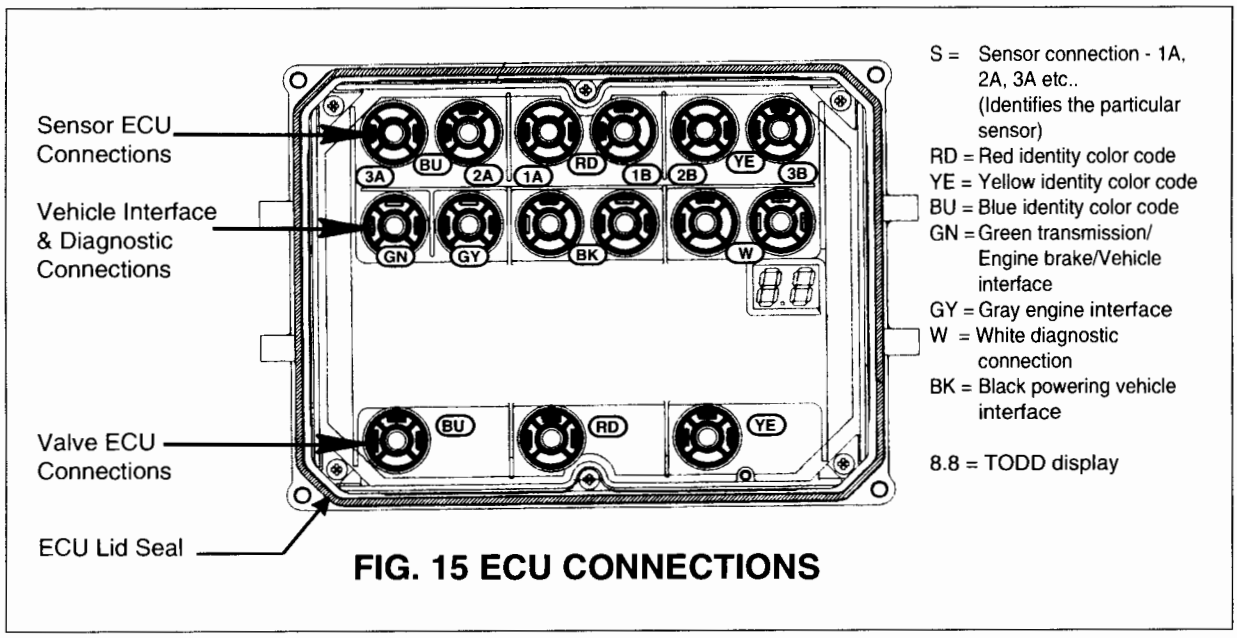


FIG. 15 ECU CONNECTIONS

Figure 16 further defines the ECU individual terminal functions and shows the A, B and C terminal locations.

SENSORS

CONN. & PIN LOC.	FUNCTION
1B	Sensor 3A Hi (BU)
1C	Sensor 3A Lo (BU)
2A	Sensor 2A Lo (BU)
2B	Sensor 2A Hi (BU)
3B	Sensor 1A Hi (RD)
3C	Sensor 1A Lo (RD)
4A	Sensor 1B Lo (RD)
4B	Sensor 1B Hi (RD)
5B	Sensor 2B Hi (YE)
5C	Sensor 2B Lo (YE)
6A	Sensor 3B Lo (YE)
6B	Sensor 3B Hi (YE)

VEHICLE INTERFACE VALVES & DIAGNOSTICS

CONN. & PIN LOC.	FUNCTION
7A	Retarder - (GN)
7B	Retarder + (GN)
7C	BAV + (GN)
8B	Engine Data + (GY)
8C	Engine Data - (GY)
9A	B - Permanent (BK)
9B	B + Permanent (Unswitched) (BK)
10A	B + Switched W/TC LIght (BK)
10B	B + Switched (BK)
10C	B + Switched W/ABS Light (BK)
11B	Diagnostic Data - (WH)
12A	Diagnostic Sense (WH)
12B	Diagnostic B + Supply (WH)
12C	Diagnostic Data + (WH)

CONN. & PIN LOC.	FUNCTION
13A	Valve Common (BU)
13B	Valve Dump (BU)
13C	Valve Hold (BU)
14A	Valve Common (RD)
14B	Valve Dump (RD)
14C	Valve Hold (RD)
15A	Valve Common (YE)
15B	Valve Dump (YE)
15C	Valve Hold (YE)

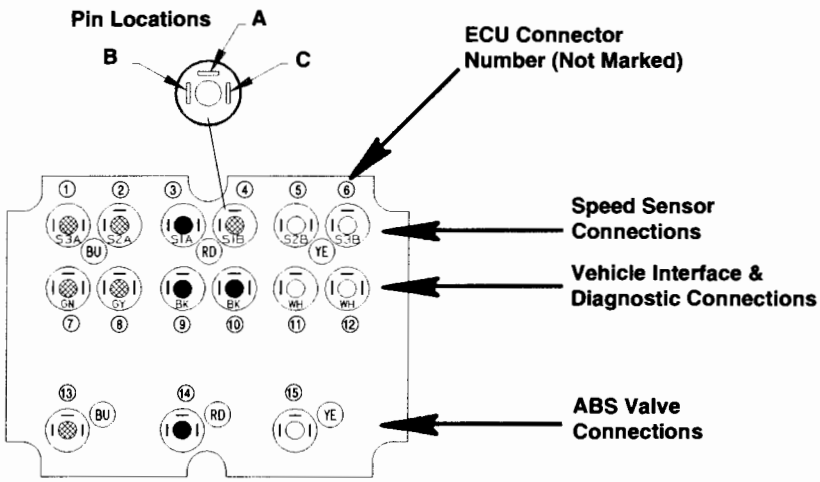


FIG. 16 ECU CONNECTIONS

4.4 The ABS Power Cable

The power cable can have as many as 12 individual wires depending on the options selected for your ABS system.

NOTE: Typically the power cable comes installed in the ECU box. The following information is provided for those exceptions when making the ECU connections may be necessary.

The other end of the 14 pin connector terminates into multiple ECU connectors which must be fed through an opening in the ECU box. Attach the clickfit housing to the ECU box. Refer to Section 4.3, Item 3. Attach the power cable ECU connectors to the middle row of terminals on the ECU board (labeled "Vehicle Interface and Diagnostic Connections" in figure 15). Match the color band on the connector with the color button in the middle of the ECU board terminals.

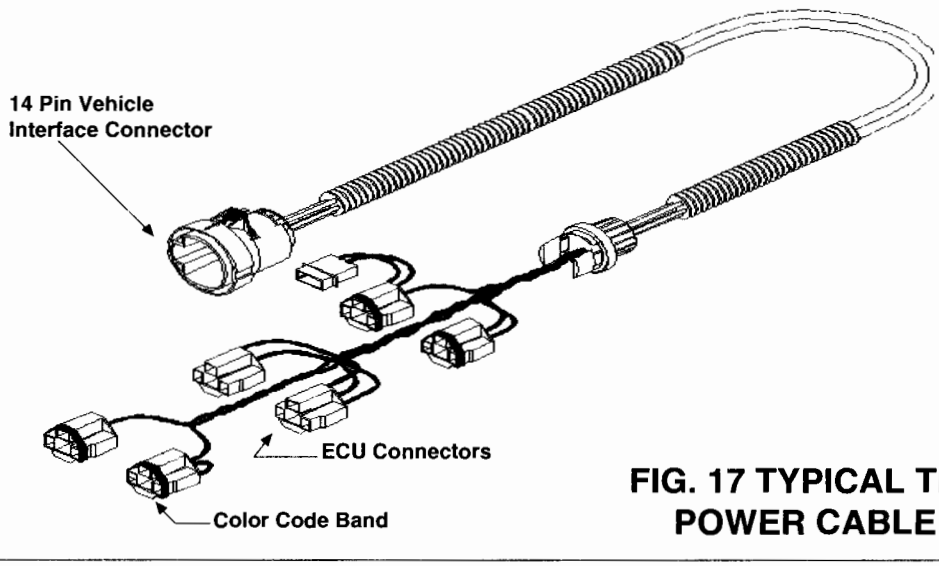


FIG. 17 TYPICAL TK2 POWER CABLE

Figure 18 shows the pin locations for a 14 pin connector and describes the function of each. It also shows the ECU connectors and defines them by connector number (the number in the circle). These connector numbers correlate with the ECU board connector numbers shown in figure 16.

TK2 Modal Power ABS
Power Cable Vehicle Interface

PIN LOCATION - FUNCTION	DESCRIPTION
14 – Battery Positive	• 12V dc Power for all ABS/TC components (Must Be Fused–20 Amps Max.)
13 – Battery Negative	• Common Ground for all ABS/TC components
12 – Auxiliary Brake Circuit; Common	• Common Contact Of Auxiliary Brake Relay, When the Electrical Relay Is Self Contained
11 – Auxiliary Brake (+)	• 12V dc Signal to Actuate a Remote Auxiliary Brake Circuit
10 – Ignition Switch Circuit	• 12V dc Ignition Switched Power for the ECU (Must Be Fused–5 Amps Max.)
9 – TC Lamp/Switch Circuit	• TC Lamp and Switch Circuit
8 – ABS Lamp Circuit	• ABS Warning Lamp and Switch Circuit
7 – Auxiliary Brake Circuit; NC	• Normally Closed Contact of Auxiliary Brake Relay When the Electrical Relay Is Self Contained
6 – Auxiliary Brake Circuit; NO	• Normally Open Contact of Auxiliary Brake Relay When the Electrical Relay Is Self Contained
5 – SAE J1587 Diagnostic Data (-)	• Diagnostic Information Along the SAE J1587/J1708 Data Bus–Signal Negative Circuit
4 – SAE J1922 Engine Data (-)	• Engine Communication Along the SAE J1922/J1708 Data Bus–Signal Negative Circuit
3 – Not Used	• Not Used
2 – SAE J1587 Diagnostic Data (+)	• Diagnostic Information along the SAE J1587/J1708 Data Bus–Signal Positive Circuit
1 – SAE J1922 Engine Data (+)	• Engine Communication Along the SAE J1922/J1708 Data Bus–Signal Positive Circuit

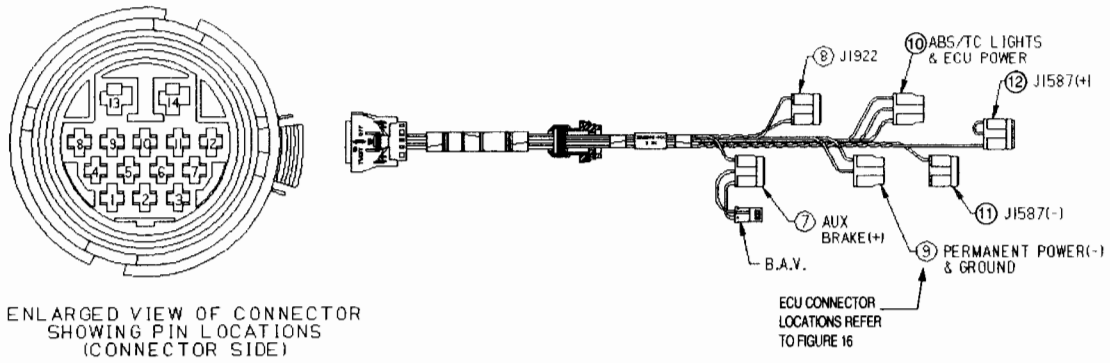


FIG. 18 TK2 POWER CABLE CONNECTOR PIN IDENTIFICATION

ELECTRICAL PARAMETERS OF TK2 HARNESS CONNECTIONS

Connection Name	Retarder Common	Retarder Relay	J1922 'A'	J1922 'B'	Battery Negative	Battery Positive (Perm.)	TC Lamp & Switch	Battery Positive (Ign. Sw.)	ABS Lamp	J1587 'B'	J1587 'A'
Power Cable Pin No.	N/A	11	1	4	13	14	9	10	8	5	2
ECU Connector	7A	7B	8B	8C	9A	9B	10A	10B	10C	11B	12C
Nominal Voltage	0V	+12V	0V/+5V	0V/+5V		+12V	B+	+12V	B+	0V/+5V	0V/+5V
Minimum Voltage	0V	0V	+250mV	+250mV		+8V	+0.7V	+8V	+0.7V	+250mV	+250mV
Maximum Voltage	0V	B+	+4.25V	+4.25V		+16V	B+	+16V	B+	+4.25V	+4.25V
Steady State Current	150mA (Typ.) During 'ABS' 1.5A (Typ.) During 'TC'	150mA (Typ.) During 'ABS'	0.25mA	0.25mA		Dependent on ABS Activity	0.27A (ON) *@ B+ = 12V* w/ SAE type 194 bulb.	160mA *@ B+ = 12V*	0.27A (ON) *@ B+ = 12V* w/ SAE type 194 bulb.	0.25mA	0.25mA
Minimum Current			As Steady State when Connected to Data Bus	As Steady State when Connected to Data Bus			0.18A	120mA *@ B+ = 16V*	0.18A	As Steady State when Connected to Data Bus	As Steady State when Connected to Data Bus
Inrush Current						Negligible	3A	20A for 0.1ms	3A		
Leakage Current	0.5mA (Max.) + 0.5mA (Min.)	0.5mA (Max.)	N/A	N/A		Less than 100µA when Controller Is Shut Down.			5mA	N/A	N/A
Reverse Voltage Protection		-36V	-0.5V	-0.5V		Controller Will Shut Down if Supply is Reversed & this Connection Will Be Isolated from the Circuit.	>200V	>200V	>200V	-0.5V	-0.5V

4.5 Securing All ABS Cables

1. Secure the sensor extension cable to a portion of the suspension which does not flex relative to the axle beam or housing such as the U-bolt.
2. Route the sensor extension cable toward the brake chamber securing it to the axle and the brake chamber support bracket with tie wraps.

   Δ **CAUTION:** Ensure that the cable is clear from moving brake chamber and slack adjuster components. Also allow sufficient cable length for full chassis jounce and rebound.
3. Route the cable along the service brake hose to the modulator valve, securing the lead to the brake hose every 6 inches (150mm).
4. Route the power cable and the valve and sensor extension cables along the frame rail to the ECU box, securing the leads every 12 inches with tie wraps.
5. When securing the cables near the ECU box, allow a "drip loop" as shown in figure 19.

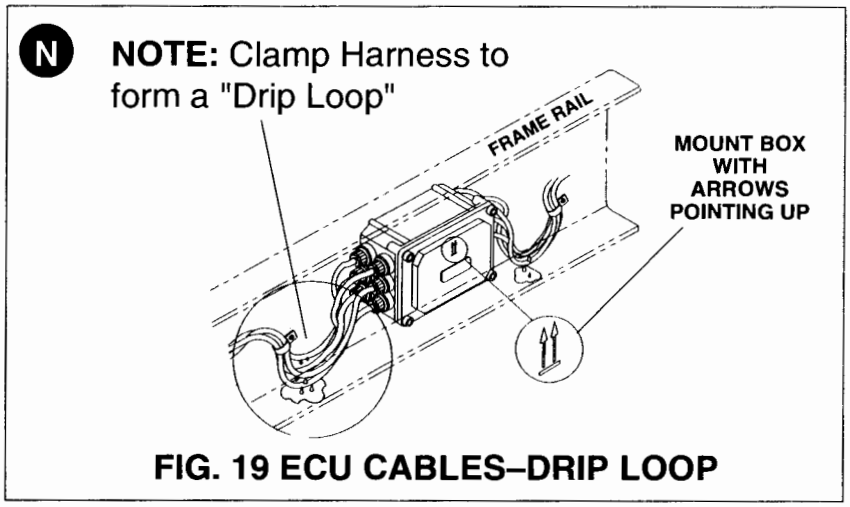


FIG. 19 ECU CABLES–DRIP LOOP

6. All excess cable, if any, should be secured as shown in figure 20.

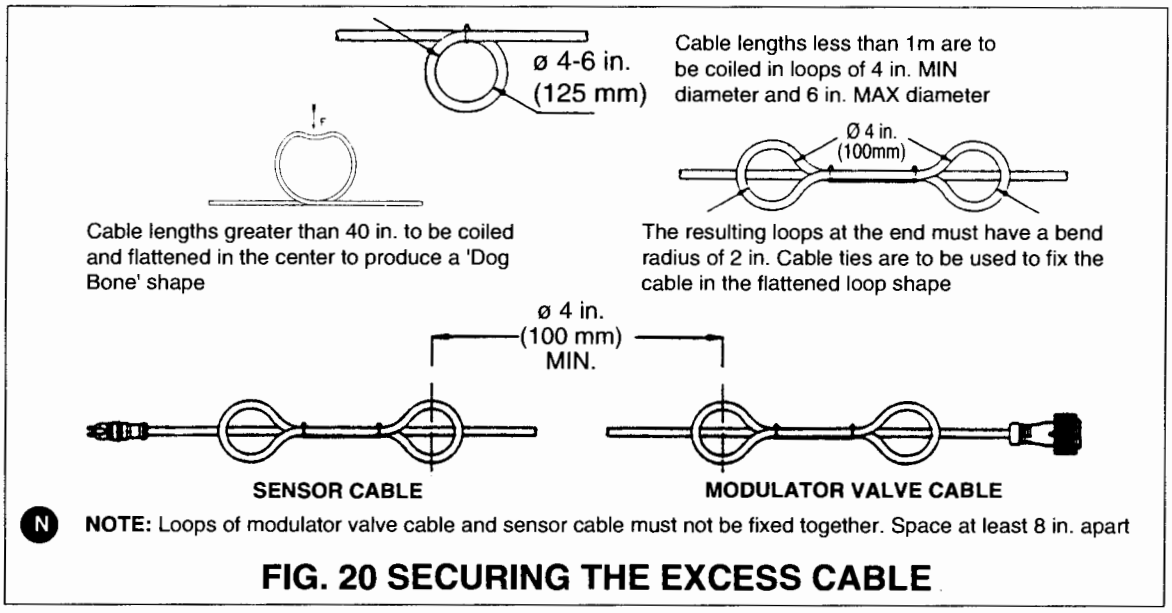


FIG. 20 SECURING THE EXCESS CABLE

4.6 Dual Connector ECU Box Assembly Installation

The electrical cables extending from the ECU box terminate into two 21-pin sealed connectors that may be bulkhead mounted. One connector includes all the wiring required by the ABS ECU routed to the front of the vehicle while the second connector contains the wiring routed to the rear of the vehicle.

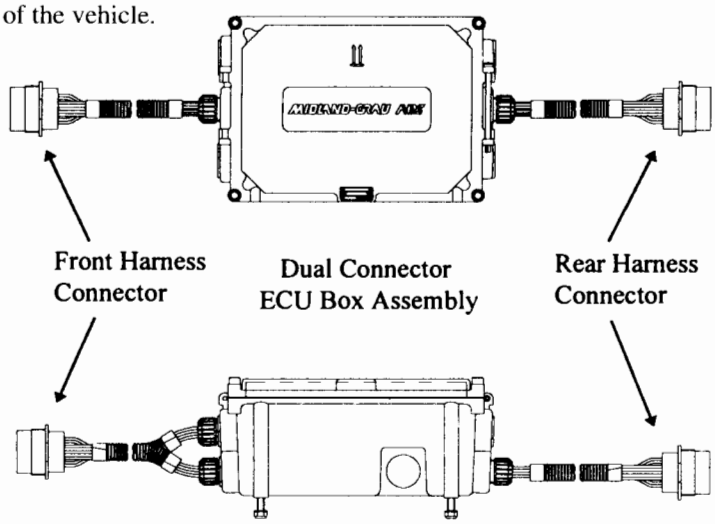
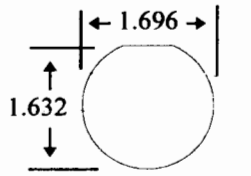


Figure 1A



Bulkhead Cutout Dimensions

Figure 2A

1.0 INSTALLATION

The Dual Connector ECU Box Assembly has the same mounting stud pattern and requires the same space as the TK2 ECU Box Assembly shown in Figure 11 of the TK2 ABS Manual, L30022. The front connector has a split harness that terminates into two clickfit housings where it enters the ECU Box. The rear connector terminates into a single clickfit housing.

1.1 The front and rear harness connectors may be mounted to a bulkhead. Refer to Figure 2A for mounting hole dimensions. Retain the connector with the lock washer and nut. Torque the nut to 100 lb. in.

1.2 If the connectors are not bulkhead mounted, they should be clamped or tie strapped to the mounting bracket, frame, or crossmember somewhere near the middle of the convoluted tubing that surrounds the harness wires.

1.3 To mate the vehicle harness to the ABS harness, lineup the blue line on the OD of the vehicle connector with the flat on the ECU connector. Rotate the knurled portion of the vehicle connector 1/4 turn clockwise. You will feel and hear the pieces snap into the locked position. If the ECU connector is not bulkhead mounted, you will have to hold it in place while making the connection. To unmate the connectors, reverse the above procedure.

2. SERVICING

The dual connector ECU requires no routine maintenance but should be checked for mounting integrity, road damage, etc. when performing normal vehicle maintenance.

SERVICEABLE COMPONENTS INCLUDE:

- ECU
- FRONT WIRING HARNESS
- REAR WIRING HARNESS

2. SERVICING (Continued)

2.1 SERVICING THE ECU OR THE ECU BOX .

Follow the procedure defined in the L30022 TK2 ABS Manual, Section 6.4.

2.2 SERVICING THE FRONT OR REAR WIRING HARNESS.

Follow the procedure defined in the L30022 TK2 ABS Manual, Section 6.5 with the additions or deletions as noted below.

1. In step 4 of Section 6.5 the cable need only be disconnected from the vehicle wiring harness at the 21 pin connector (reference Section 1.3 above).
2. Inside the ECU, the number 7B terminal must be removed from the No. 7 connector. Refer to Figure 16. Remove the No. 7 connector from the ECU terminals. Place the thin blade of a small flat screw driver between the inside surface of the plastic housing and the terminal as shown in Figure 3A. This will release the locking tab of the terminal. Pull gently on the wire to dislodge the terminal from the housing . Note how the terminal is oriented in the connector.
3. After installing the new cable(s), the 7B termina must be inserted into No. 7 connector, in the "B" position. Orient the terminal as it was when removed in step 2 above. A "click" can be heard when the terminal is seated properly. Plug the No. 7 connector onto the No. 7 connection position on the ECU. Refe to Figure 16.
4. Reconnect the Front and Rear 21 pin connectors
5. Perform system checkout procedures per Sectior 5.1 of the L30022 TK2 ABS manual.

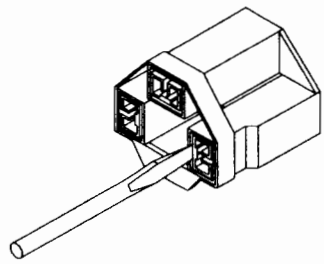


Figure 3A

3. TROUBLESHOOTING

The following is a cross reference tabulation between the 14 pin Power Cable Connector, in the L30022 TK2 ABS Manual, and the 21 pin Front connector in this addendum.

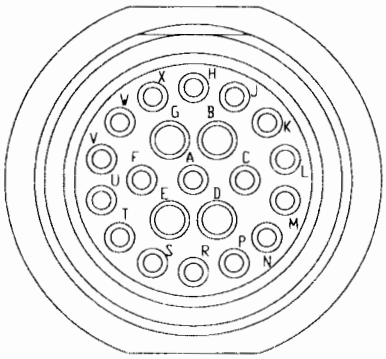
14 PIN CONNECTOR TERMINAL POSITION	FUNCTION	21 PIN CONNECTOR TERMINAL POSITION
9	TRACTION CONTROL LIGHT	A
8	ABS LIGHT	C
13	BATTERY NEGATIVE	D
14	BATTERY POSITIVE	E
10	IGNITION SWITCH	F
2	SAE J1587 POSITIVE	M
5	SAE J1587 NEGATIVE	N
11	AUX. BRAKE POS.	T
1	SAE J1922 POSITIVE	U
4	SAE J1922 NEGATIVE	V

The above tabulation can be used when troubleshooting the ABS per Section 5 of Manual L30022.

EXAMPLE: Figure 21 in the L30022 ABS Manual refers to 14 pin connector ,pin 10. From the above tabulation we see that this is the ignition switch positive wire and is terminal "F" for the 21 pin Front connector.

All other terminal functions are shown in Figure 4A. on the next page.

Front Harness Connector Terminal Position and Function



TERM	FUNCTION	WIRE COLOR	AWG
A	TRACTION CONTROL LIGHT	DK. GREEN	18
C	ABS LIGHT	YELLOW	18
D	BATTERY NEGATIVE	WHITE	12
E	BATTERY POSITIVE	BLACK	12
F	IGNITION SWITCH	RED	18
H	SENSOR 1A LOW	BROWN	18
J	SENSOR 1B HI	BLACK	18
K	SENSOR 1B LOW	BROWN	18
M	DIAGNOSTIC DATA LINK- POS	DK. BLUE	18
N	DIAGNOSTIC DATA LINK- NEG	GRAY	18
P	RED ABS VALVE- DUMP	RED	16
R	RED ABS VALVE- COMMON	BLACK	16
S	RED ABS VALVE- HOLD	YELLOW	16
T	AUX. BRAKE POSITIVE	LT. GREEN	18
U	CONTROL DATA LINK- POS	PURPLE	18
V	CONTROL DATA LINK- NEG	PINK	18
W	CONTROL DATA LINK- SHIELD	SILVER	18
X	SENSOR 1A HI	BLACK	18

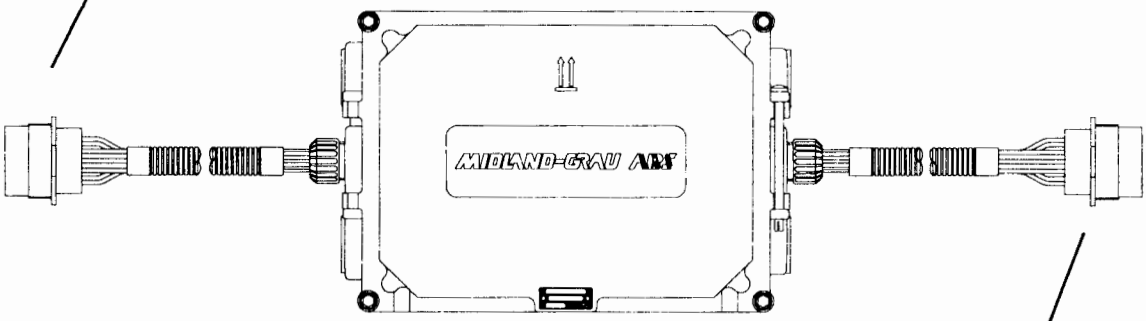
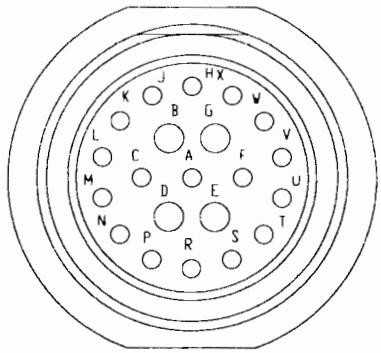


Figure 4A

TERM	FUNCTION	WIRE COLOR	AWG
A	T. C. VALVE POSITIVE	BLUE	16
C	SENSOR - 3B HI	BLACK	18
F	SENSOR - 3A HI	BLACK	18
H	T. C. VALVE GROUND	BROWN	16
J	SENSOR -2B HI	BLACK	18
K	SENSOR - 2B LOW	BROWN	18
L	SENSOR - 3B LOW	BROWN	18
M	YELLOW ABS VALVE- DUMP	RED	16
N	YELLOW ABS VALVE- COMMON	BLACK	16
P	YELLOW ABS VALVE- HOLD	YELLOW	16
S	BLUE ABS VALVE- DUMP	RED	16
T	BLUE ABS VALVE- COMMON	BLACK	16
U	BLUE ABS VALVE- HOLD	YELLOW	16
V	SENSOR - 3A LO	BROWN	18
W	SENSOR -2A LOW	BROWN	18
X	SENSOR -2A HI	BLACK	18



Rear Harness Connector Terminal Position and Function

5.0 ABS System Checkout, Troubleshooting and Corrective Action

After the Modal Power ABS Installation is complete, it is important to verify that the system has been installed properly by performing the following tests.

5.1 System Checkout

1. Warning Light (W/L) Sequence

- Turn the ignition key to the run position and observe the ABS warning lamp.
- The warning light should come on, turn off and remain off.
- If this does not happen refer to figure 21 for troubleshooting procedures.

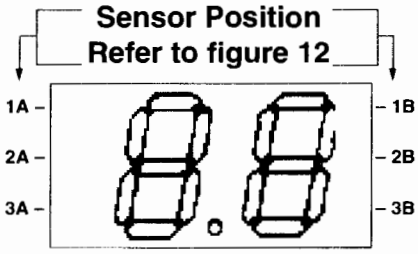
NOTE: If the checkout test meets the requirements, proceed to the next test. If not, perform the corrective action and retest. Turn the ignition key to off after each test.

2. ABS Valve Blowdown

- Charge the vehicle air reservoirs. Turn the key off.
- Actuate the brake pedal and hold.
- Turn the ignition key to the run position.
- Each ABS valves will emit a single exhaust pulse in sequence–front axle first, then rear axle. If there are two rear valves the left (road side) valve will exhaust first followed by the right (curb side) valve.
- If the blowdown sequence is not correct, refer to figure 25 for trouble-shooting procedures.

3. Sensor Position Verification

- Turn the ignition to the run position. Rotate each sensed wheel individually at approximately 1 rev./sec. while observing the TODD.



TODD Diagnostic Display

When a wheel is rotated, a horizontal segment will illuminate indicating the output from that sensor.

- The spun wheel will produce a bar at a defined sensor position on the read out. To determine if this is correct, correlate the readout information with the spun wheel position defined in figure 12.
- If the spun wheel position on the readout does not agree with the position defined in figure 12, refer to figure 26 for troubleshooting procedures.

4. On-The-Road Test

- Drive the vehicle above 6 mph.
- If the warning light stays off above 6 mph the system is OK.
- If the warning light turns on above 6 mph there is a problem. Refer to figure 24 for troubleshooting procedures.

Troubleshooting Guide–ABS Warning Light (W/L)

Refer to Section 5.1.1

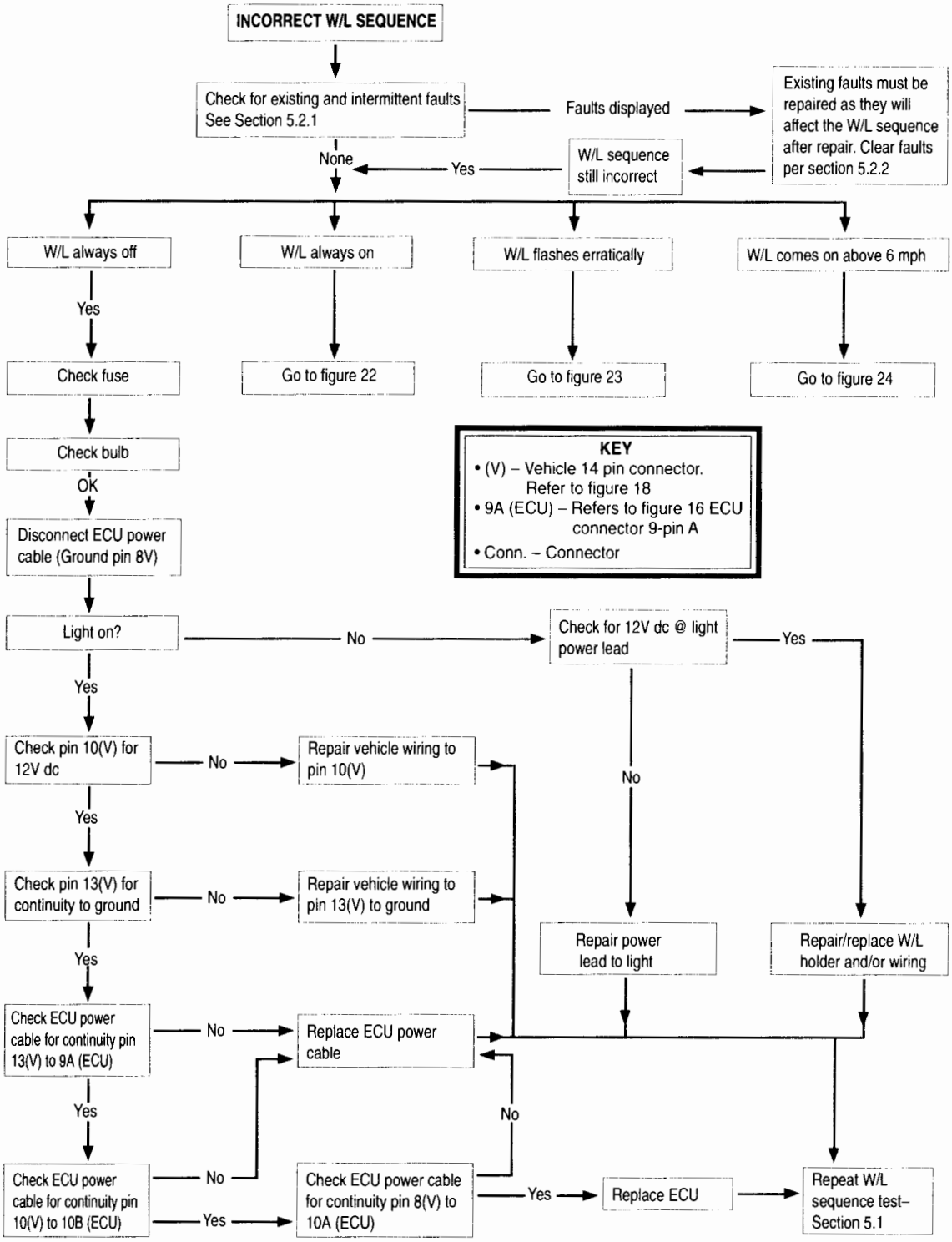


FIG. 21

Troubleshooting Guide–ABS Warning Light (W/L)

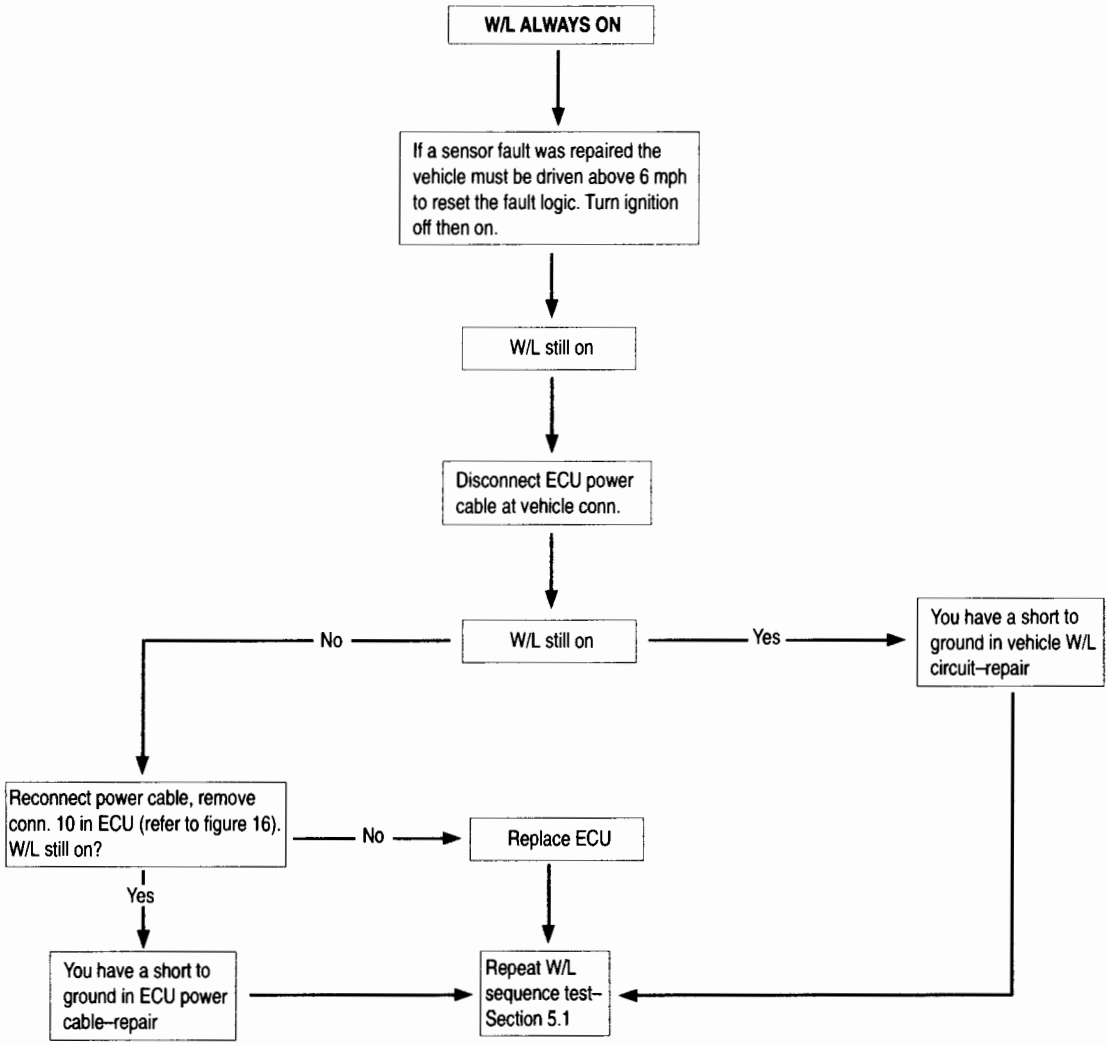


FIG. 22

Troubleshooting Guide–ABS Warning Light (W/L)

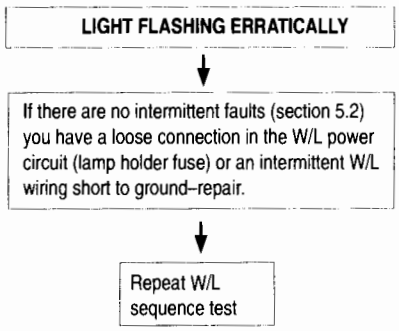


FIG. 23

Troubleshooting Guide–ABS Warning Light (W/L)

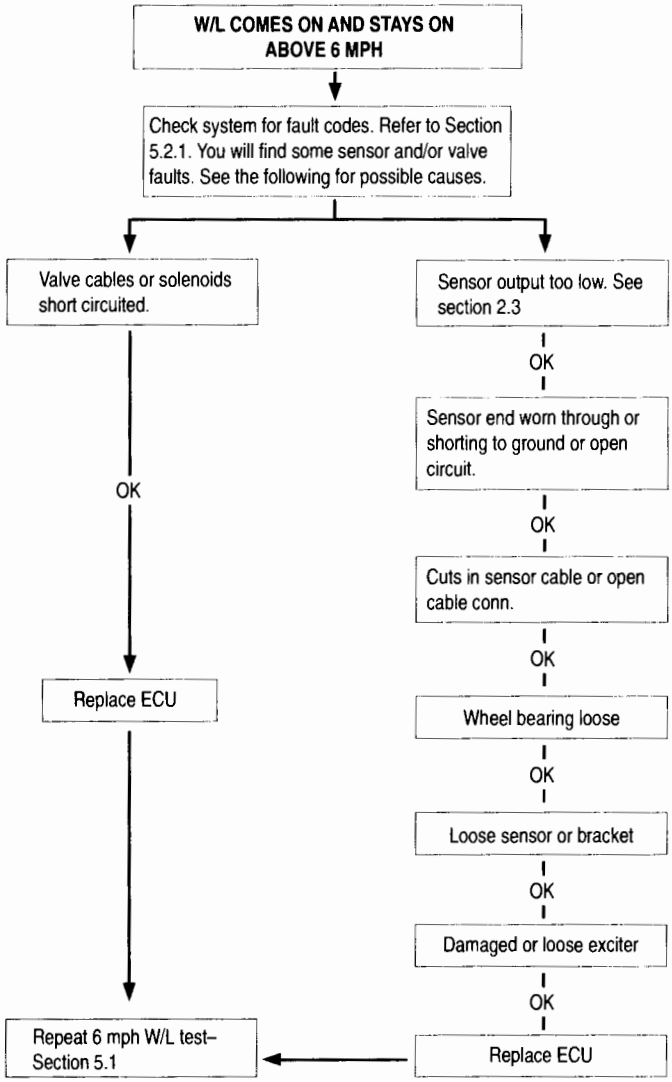


FIG. 24

Troubleshooting Guide–ABS Valve

Refer to Section 5.1.2

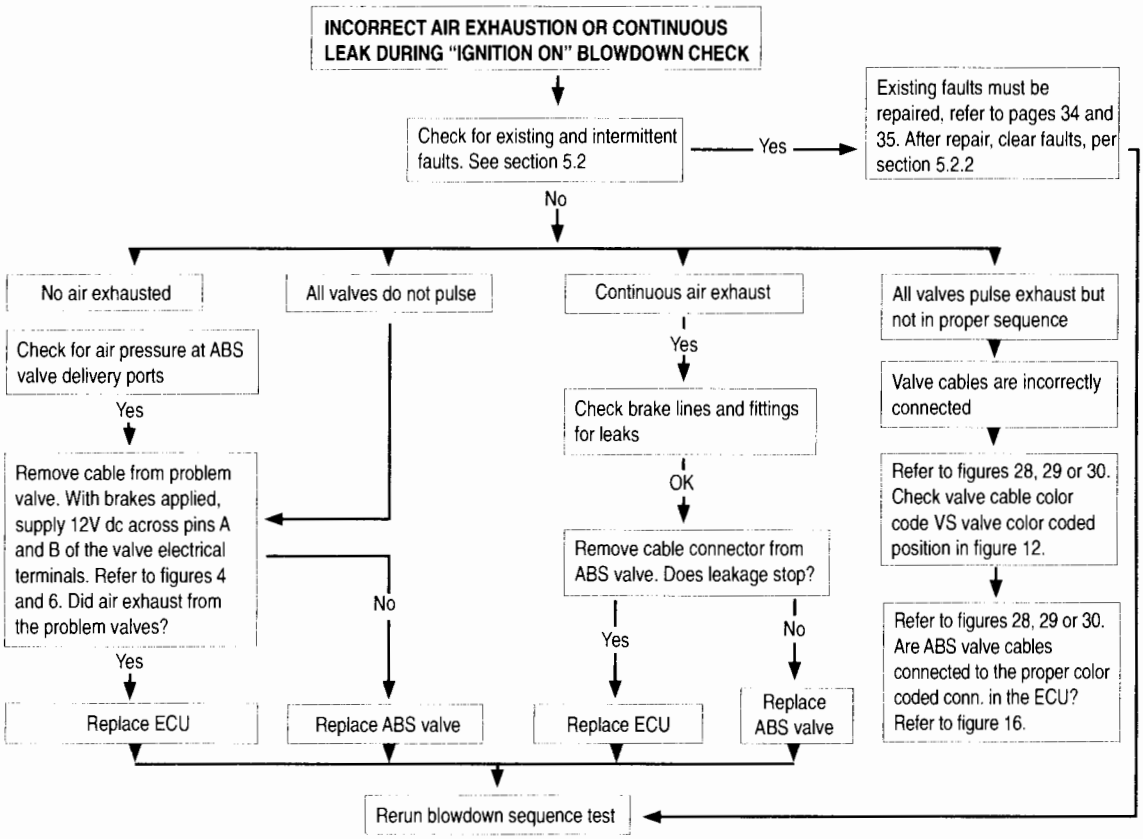


FIG. 25

Troubleshooting Guide–ABS Sensor Position

Refer to Section 5.1.3

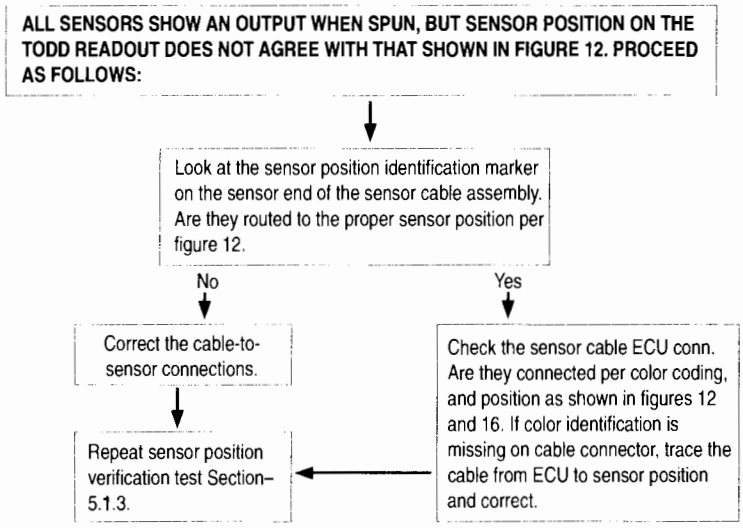


FIG. 26

5.2 Diagnostic/Fault Codes

MODAL Power ABS problems can be located quickly by looking at the diagnostic fault codes stored in the ECU. There are two methods for looking at the fault codes. An SAE J1587 Std. compatible diagnostic tool (see figure 27) will define the problem with a brief statement on the readout screen. Locate this statement in the Diagnostics Code Listing in he Manual. For possible causes refer again to the Diagnostic Code Listing and the "causes" statement under most of the diagnostic sections.

The TODD (Total Onboard Diagnostic Display) will give a fault code number on the readout. This code can be correlated to a possible cause by using the TODD code.

Common components are grouped together and below most of these groupings is a list of possible causes.

Types of Faults

When a fault occurs it is stored in the ECU memory at the time of occurrence. If the fault continues to exist, it is called a permanent fault and will cause a partial or total ABS shutdown until it is repaired. If the fault is intermittent, it can cause a partial or total ABS shutdown. But, if the ignition is turned OFF then back ON, and the intermittent fault is not active the ABS will be fully functional. However, the intermittent fault is stored and can be viewed using the procedure in Section 5.2.2. Intermittent faults can return at any time, so it is advisable to examine the component for signs of the intermittent problem.

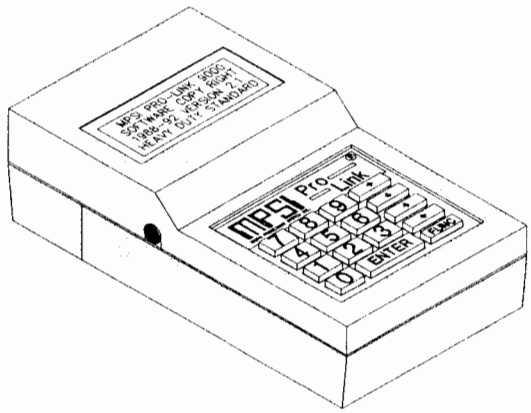


FIG. 27 STANDARD REMOTE DIAGNOSTIC TOOL

5.2.1 Checking for Diagnostic/Fault Codes

Checking Stored Faults Using the Industry Standard Remote Diagnostic Tool

1. Connect the standard remote diagnostic tool to the vehicle SAE J1587 diagnostic bus communications port.
2. Turn the ignition key to the ON position.
3. Proceed to read all current and stored faults per the tool manufacturer's directions.

NOTE: The fault code **"Special Instructions"** which may appear on your diagnostic tool signifies that a component has been added to the antilock system that is not recognized by the ECU. Either remove the component or replace the ECU with one that is properly configured.

4. Turn the ignition to the OFF position.
5. If a fault is shown, refer to the Diagnostic Code Listing, right-hand column under "Standard Diagnostic Code." For possible causes refer to the left-hand column and the "Causes" statement under most of the diagnostic sections.
6. Repair any problems indicated by the fault.
7. After completing the repair, clear all faults per Section 5.2.2.

Checking Stored Faults Using the TODD

1. Turn the ignition key to the ON position.
2. 07 will be displayed in the TODD if the system is wired properly and no permanent faults exist.
3. If a fault code number is displayed, refer to the Diagnostic Code Listing, left-hand column under TODD codes. Refer to the "Possible Cause" column and the "Causes" statement under most of the diagnostic sections.
4. Turn the ignition key to the OFF position.
5. Repair any problem indicated by the TODD code.
6. After completing the repair, clear all faults per Section 5.2.2.

5.2.2 Checking and Removing Stored Faults from Memory

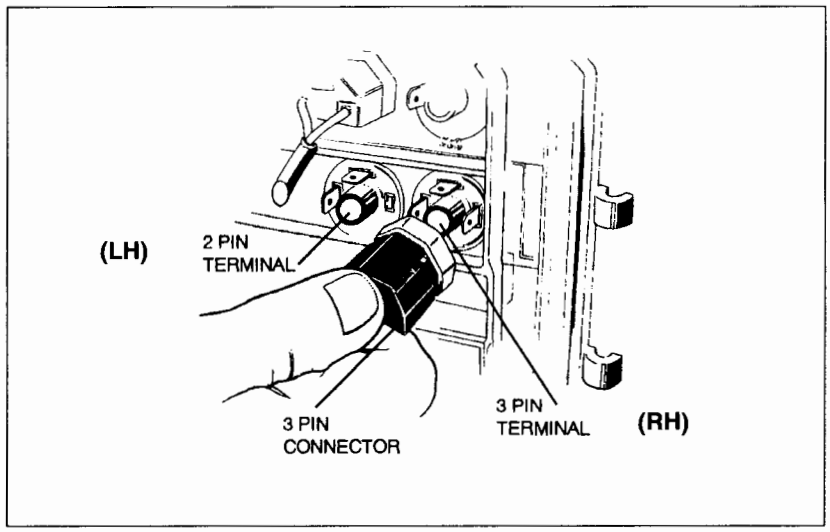
When a fault occurs, the corresponding fault code is stored in the ECU memory. Even after the fault has been detected and fixed, the fault remains in the memory until it is removed. The fault code can be removed or cleared from the memory using either of the following procedures:

Using the Standard Remote Diagnostic Readout

1. Connect the standard diagnostic tool to the vehicle serial communications port.
2. Follow the directions of the diagnostic tool to view and clear current and stored fault codes.

Using the TODD

1. Turn the ignition key to the ON position.
2. The ECU has (2) white diagnostic connectors, a 2 pin (LH) and a 3 pin (RH), both identified with a "W" and a white dot. These connectors can be used to view stored faults. Remove both white diagnostic connectors from their terminals on the ECU. See figure below.



5.2.2 Checking and Removing Stored Faults from Memory (Cont.)

Using the TODD (Cont.)

3. Touch the 3 pin (RH) white diagnostic connector onto the 2-pin (LH) white diagnostic terminal. The TODD will show the last code to be stored. Ignore the "db" symbol which is briefly shown to indicate that contact has been made.
4. Each time the 3 pin connector is removed from and replaced onto the 2 pin terminal, a previously stored code will be displayed. Repeat step 2 multiple times to scroll through all fault codes. When all fault codes have been displayed, CA will appear. Remove and replace the 3 pin connector onto the 2 pin terminal one more time. If the CA appears again this is an invitation to erase the stored codes.
5. You can erase stored codes by removing the 3 pin connector from the two pin terminal, touching it onto the 3 pin terminal, then placing it back onto the 2 pin terminal. When contact is made with the 3 pin terminal, "db" will flash on the display briefly followed by CA.
6. A series of fault codes will flash on the display followed by 07. If a code other than 07 is displayed, a system fault still exists and must be corrected.
7. Return the 2 and 3 pin connectors onto their respective terminals.
8. Perform ABS System Checkout (Section 5.0) to include ROAD TEST.

MODAL POWER TK2 DIAGNOSTIC CODES

TODD CODE	POSSIBLE CAUSE	STANDARD DIAGNOSTIC CODE
00	Normal Running/No Fault	None
01	A Sensor/Wiring Open or Short Circuit Axle 1	Sensor, Axle 1 Left, Current Low
02	B Sensor/Wiring Open or Short Circuit Axle 1	Sensor, Axle 1 Right, Current Low
03	A Sensor/Wiring Open or Short Circuit Axle 2	Sensor, Axle 2 Left, Current Low
04	B Sensor/Wiring Open or Short Circuit Axle 2	Sensor, Axle 2 Right, Current Low
05	A Sensor/Wiring Open or Short Circuit Axle 3	Sensor, Axle 3 Left, Current Low
06	B Sensor/Wiring Open or Short Circuit Axle 3	Sensor, Axle 3 Right, Current Low
CAUSES:	Sensor Connector Loose, Cable Damaged, Sensor Damaged, Pinched Cable.	
07	System OK But All Sensors Have No Output. Drive Above 6 mph. Sensor Bars Will Appear If Sensor Is OK.	None
08	Retarder Relay Coil or Wiring Open Circuit.	Retarder Control Relay, Current Low
09	Retarder Relay Coil or Wiring Short Circuit.	Retarder Control Relay, Voltage Low
OE	Warning Light Circuit Fault. Open or Short Circuit.	Warning Light Bulb, Current Low
OF	TC Light Circuit Fault. Open or Short Circuit.	ASR Light Bulb, Current Low

LOW SENSOR OUTPUT GROUP

11	A Sensor System Faulty, Axle 1	Sensor, Axle 1 Left, Out of Calibration
12	B Sensor System Faulty, Axle 1	Sensor, Axle 1 Right, Out of Calibration
13	A Sensor System Faulty, Axle 2	Sensor, Axle 2 Left, Out of Calibration
14	B Sensor System Faulty, Axle 2	Sensor, Axle 2 Right, Out of Calibration
15	A Sensor System Faulty, Axle 3	Sensor, Axle 3 Left, Out of Calibration
16	B Sensor System Faulty, Axle 3	Sensor, Axle 3 Right, Out of Calibration
CAUSES:	Sensor Worn, Maladjusted Sensor, Wiring Open or Short Circuit.	

INTERMITTENT LOW SENSOR OUTPUT GROUP

21	A Sensor System Faulty, Axle 1	Sensor, Axle 1 Left, Intermittent
22	B Sensor System Faulty, Axle 1	Sensor, Axle 1 Right, Intermittent
23	A Sensor System Faulty, Axle 2	Sensor, Axle 2 Left, Intermittent
24	B Sensor System Faulty, Axle 2	Sensor, Axle 2 Right, Intermittent
25	A Sensor System Faulty, Axle 3	Sensor, Axle 3 Left, Intermittent
26	B Sensor System Faulty, Axle 3	Sensor, Axle 3 Right, Intermittent
CAUSES:	Loose Sensor, Connection, Bracket, or Exciter, Dented Exciter, Maladjusted Sensor, or Worn Sensor Cable Insulation.	

DATA LINK–RETARDER TRACTION CONTROL

30	J1922 Data Link–Open Circuit	J1922 Data Link, Bad Device/Component
31	J1922 Data Link–Erratic Data	J1922 Data Link, Intermittent
32	J1922 Retarder Control Erratic	J1922 Data Link, Abnormal Update Rate
33	Traction Control Disabled	ASR Light Bulb–Bad Device/Component

ONE WHEEL WITH SLOW RECOVERY

41	Slow Recovery Of One Wheel Of Red Channel	PMV, Axle 1 Left, Mechanical Fault
42	Slow Recovery Of One Wheel Of Blue Channel	PMV, Axle 2 Left, Mechanical Fault
43	Slow Recovery Of One Wheel Of Yellow Channel	PMV, Axle 2 Right, Mechanical Fault
CAUSES:	Slow Brake Release, Check Foundaton Brake For Mechanical Faults, Dry Bearings, Broken Springs, Restricted Piping, Check For Kinks And Blockage Etc., Check For Correctly Wired Sensor And Modulator Solenoids, Incorrect Piping or Modulator Fault.	

OPEN CIRCUIT MODULATOR SOLENOID

50	BAV Valve	Diff 1, ASR Valve, Mechanical Fault
51	BAV–Open Circuit	Diff 1, ASR Valve, Current Low
52	BAV–Valve Short Circuit	Diff 1, ASR Valve, Voltage Low
53	BAV–Output Shorted	Diff 1, ASR Valve, Current High

MODAL POWER TK2 DIAGNOSTIC CODES

TODD CODE	POSSIBLE CAUSE	STANDARD DIAGNOSTIC CODE
	OPEN CIRCUIT MODULATOR SOLENOID	
61	Hold Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Hold, Current Low
62	Hold Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Hold, Current Low
63	Hold Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Hold, Current Low
67	Dump Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Dump, Current Low
68	Dump Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Dump, Current Low
69	Dump Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Dump, Current Low
	SHORT CIRCUIT MODULATOR SOLENOID	
71	Hold Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Hold, Voltage Low
72	Hold Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Hold, Voltage Low
73	Hold Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Hold, Voltage Low
77	Dump Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Dump, Voltage Low
78	Dump Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Dump, Voltage Low
79	Dump Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Dump, Voltage Low
	MODULATOR SOLENOID WIRING OR SHORT TO B+	
80	Poor Insulation In Any Modulator Solenoid Or Wiring	Power Supply Intermittent
81	Hold Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Hold, Voltage High
82	Hold Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Hold, Voltage High
83	Hold Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Hold, Voltage High
87	Dump Solenoid Circuit Fault, Red Channel	PMV, Axle 1 Left Dump, Voltage High
88	Dump Solenoid Circuit Fault, Blue Channel	PMV, Axle 2 Left Dump, Voltage High
89	Dump Solenoid Circuit Fault, Yellow Channel	PMV, Axle 2 Right Dump, Voltage High
	SUPPLY VOLTAGE GROUP	
90	Supply Voltage At The Controller Is Less Than 9V When Solenoids Are Energized	Power Supply Voltage Low
91	Faulty Supply Or Fuse Blown	Power Supply Mechanical Fault
92	Supply Voltage At Controller Is Greater Than 16V	Power Supply Voltage High
93	Master Control Short Circuit	Master Control Relay Mechanical Fault
	CONFIGURATION GROUP	
A0	Relay Logic Axle 1	None
A1	Relay Logic Axle 2	None
A2	Retarder Relay Added-Should Not Be	Retarder Control Relay, Special Instructions
A4	J1922 Engine Retarder Added-Should Not Be	None
A5	J1922 Engine Communication Added-Should Not Be	J1922 Data Link, Special Instructions
A7	Brake Apply Valve Added-Should Not Be	Diff 1 ASR Valve, Special Instructions

CONFIGURATION CODES

TODD CODES	FUNCTION	SENSORS	MODULATORS USED
C2	4S/2M	S3A, S2A, S2B, S3B	BLUE, YELLOW
C3	4S/3M	S2A, S1A, S1B, S2B	RED, BLUE, YELLOW
C4	6S/3M	S3A, S2A, S1A, S1B, S2B, S3B	RED, BLUE, YELLOW
CA	Invitation To Erase The Memory (Not A Configuration)		
CF	Unacceptable Combination Of Sensors And Solenoids		
Blank Display	No Supply On Ignition Switched Line, Fuse Blown		
Sensor Bar	Bar Displayed on TODD-Sensor Is OK, Bar Not Displayed-Sensor Output Is Too Low		

SUNDRY CODES

db **Indicates That Electrical Contact Has Been Made When Using ECU Diagnostic Connectors To Display Diagnostic Codes. The Symbol Is Displayed Between Stored Codes on the TODD.**

NOTE: If a code is displayed and after following the recommended procedure no fault is found, the ECU should be replaced.

6.0 SERVICING THE ABS SYSTEM COMPONENTS

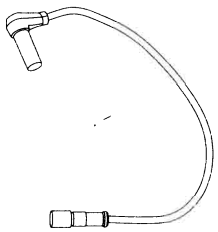
The ABS system components require no routine maintenance but should be checked periodically as you would check your standard brake system components for mounting integrity, road damage, air leaks, etc.

This section will cover service replacement of ABS components should they become damaged. We will also suggest inspection activities that can be performed while doing normal vehicle maintenance or servicing.

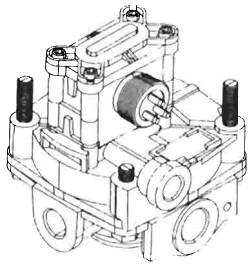
NOTE: When servicing is completed the ABS system operation should be checked per Section 5.1.

6.1 ABS Service Components

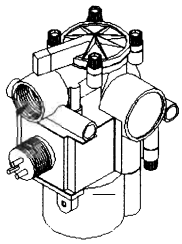
The ABS components shown below are available for service replacement through your local Midland Brake distributor.



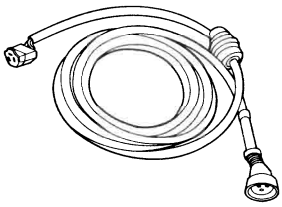
Sensor Assembly and Spring Clip



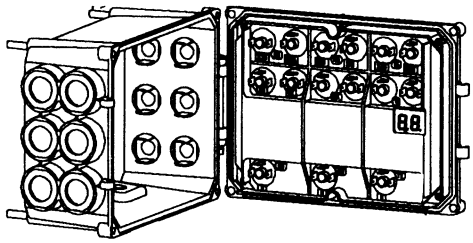
ABS Relay Valve



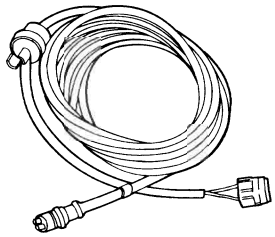
ABS Inline Valve



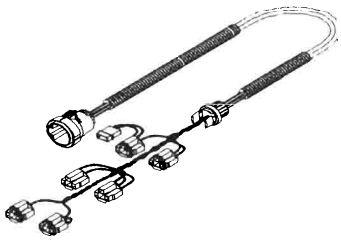
ABS Valve Cable



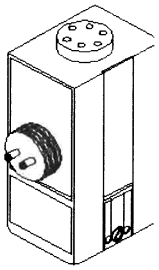
ECU Box with ECU



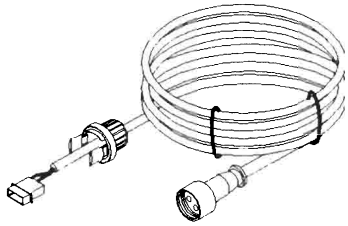
ABS Sensor Cable



ABS Power Cable



Traction Control Brake Apply Valve



Traction Control Cable– Brake Apply Valve

6.2 Servicing the Sensor and Exciter Ring

NOTE: Anytime the brake drums are removed, clean the sensor and exciter and inspect them for damage, wear and mounting integrity.

1. Remove the hub.
2. Clean all dirt and debris from the exciter ring.
3. Inspect the exciter ring for damaged or missing teeth. If damaged, replace the hub and exciter or consult the vehicle or hub manufacturer for instructions for replacing the exciter.
4. Remove the sensor from the bushing or sensor block using a twisting motion. DO NOT pull on the cable.
5. Remove the spring clip from the bushing or sensor block.
6. Clean all dirt and debris from the sensor, sensor spring clip, bushing and block.
7. Inspect the sensor for excessive wear, punctured case, chafed wires or other damage. Normal coil resistance for the sensor is between 980 and 2350 Ohms. If damaged, replace the sensor by cutting the cable ties securing the sensor wire to the axle and disconnecting the sensor from the sensor extension cable.
8. Install the sensor as directed in Section 2.1 or 2.2.

CAUTION: Sensor/Exciter runout or gap is not to exceed .020 in. Excessive wheel lash or wheel end-play is unacceptable.

9. Check the sensor output per Section 2.3.
10. Perform system checkout per Section 5.1, Items 1, 3 and 4.

6.3 Servicing the ABS Valve

NOTE: Inspect the ABS valve for leaks after any work has been done on the valve or air lines to the valve. Also inspect the ABS valves anytime you do a routine inspection of the vehicle brake system.

1. Fully charge the air system.
2. Apply the service brakes and listen for audible leaks at the valve.
3. If audible leaks are heard at the valve, apply a soap solution or suitable leak detector to determine the leak's origin.

6.3 Servicing the ABS Valve (Cont.)

4. If the leak is determined to be from the connection to the valve, tighten the fittings. If this does not stop the leak, disconnect the air line, clean the pipe threads and apply a high quality thread sealant. Reconnect and properly tighten the air line to the valve. Do not use teflon tape.
5. If the leak is determined to be from the valve body or if the leak persists, replace the valve.

ABS Valve Removal:

1. Drain all vehicle air reservoirs.

⚠ *WARNING* Removing any pressurized air fittings or lines can result in injury. Drain all air lines prior to maintenance. Always wear eye protection.

2. Remove any cable ties securing the valve cable to the ABS valve.
3. Unscrew the nut of the valve cable from the ABS valve solenoid.
4. Disconnect the valve air lines from the ABS valve. Mark the original port location on each air line to ensure proper re-connection.
5. Remove the ABS valve.

ABS Valve Installation:

1. Install the valve per Section 3.1 (ABS relay valve) or 3.2 (ABS inline valve).
2. Check the air system for leaks.
3. Test the system per Section 5.1, Items 1 and 2.

6.4 Servicing the ABS ECU and ECU Box

N **NOTE:** When performing routine vehicle inspections check the ECU box assembly for the following:

1. Ensure all cable sealing nuts are securely tightened to prevent water entering the box.
2. Ensure all ECU lid retaining bolts are tightened to 7-11 ft. lb.

MODAL Power ECU Removal and Re-Installation:

1. Remove the four socket head ECU retaining bolts (5mm A/F hexagon key) which hold the ECU lid to the box and swing open the lid from the non-hinged side.
2. Disconnect the inline connectors and the connectors from the terminals of the ECU by pulling on the connector housing.
3. After removing all the connections to the ECU, swing the lid completely open until the lid is no longer hinged by the hinge pin and remove the lid.
4. If the ECU box is to be replaced, remove all cable clickfit assemblies per figure 14. Remove the four mounting nuts and remove the box. Install the new box. Tighten the mounting nuts to 11–15 ft. lb. torque. Install the cable clickfit assemblies per figure 14.
5. Re-hinge the original or replacement ECU by reversing the lid removal procedure.
6. Reconnect the connectors by matching the color coded bands on the connector housing to the colored buttons located on the ECU. The inline connectors are keyed for easy assembly. Sensor connections are located on the top row. Valve connections are located on the bottom row. Vehicle interface connections are on the middle row of connec tions. Refer to figure 15.

NOTE: Sensor cables have 2 wires while valve cables have 3. Noting this difference and using the color code and terminal orientation is all that is required to ensure correct re-connection.

7. Check to make sure the lid seal is correctly located and coat the seal with a film of Molykote 55M grease. Refer to figure 15. Replace seal if damaged.
8. Close the ECU lid and re-torque the ECU socket head retaining bolts to 7-11 lb-ft in a cross pattern starting at the lower bolt on the hinged side.

NOTE: After reconnecting all the connectors to the ECU, perform the proper checkout procedure shown in Section 5.1, Items 1, 2 and 3.

9. Perform the system checkout procedure per Section 5.1.

6.5 Servicing the ABS Electrical Cables

NOTE: ABS cables should be inspected anytime a normal vehicle inspection is performed. Look for signs of chafing or missing cable ties. Chafed or damaged cables should be replaced.

1. Remove the four socket head ECU retaining bolts (5mm A/F hexagon key) which hold the ECU lid to the box and swing open the lid from the non-hinged side. Refer to figure 11.
2. Identify the ECU connection for the cable to be replaced and remove the connector from the ECU terminals by pulling on the connector housing. Refer to figures 12 and 15.
3. From inside the box, press the cable seal assembly tabs together to release cable seal assembly from ECU box and pull the cable out of the box. See Figure 14.
4. Cut the cable ties along the cable routing path and properly disconnect the cable from the ABS component.

NOTE: The clickfit assembly on the cable has an O-ring on it which seals it in the ECU box. Refer to figure 14. There is another seal under the click fit nut which seals the cable. The nut must be hand tight (10–15 in. lb.).

Installing the New Cable

1. Reconnect the new cable to the proper ABS component.
2. Route the cable according to the cable routing steps listed in Sections 4.3 and 4.4 of this manual.
3. Reconnect the connectors by matching the color coded bands on the connector housing to the colored buttons located on the ECU. Sensor connections are located on the top row. Valve connections are located on the bottom row. Vehicle interface connections are on the middle row of connections. All inline con nections are keyed for one way only reconnection. Refer to Sec tions 4.3 and 4.4.
4. Perform checkout procedure shown in Section 5.1, Items 1, 2, and 3.
5. Check to make sure the lid seal is correctly located and coat the seal with a film of Molykote 55M grease. Replace seal if damaged.

6.5 Servicing the ABS Electrical Cables (Cont.)

Installing the New Cable (Cont.)

6. Close the ECU lid and re-torque the ECU socket head retaining bolts to 7–11 ft. lb. in a cross pattern starting at the lower bolt on the hinged side.
7. Perform the ABS system checkout procedure per Section 5.1.

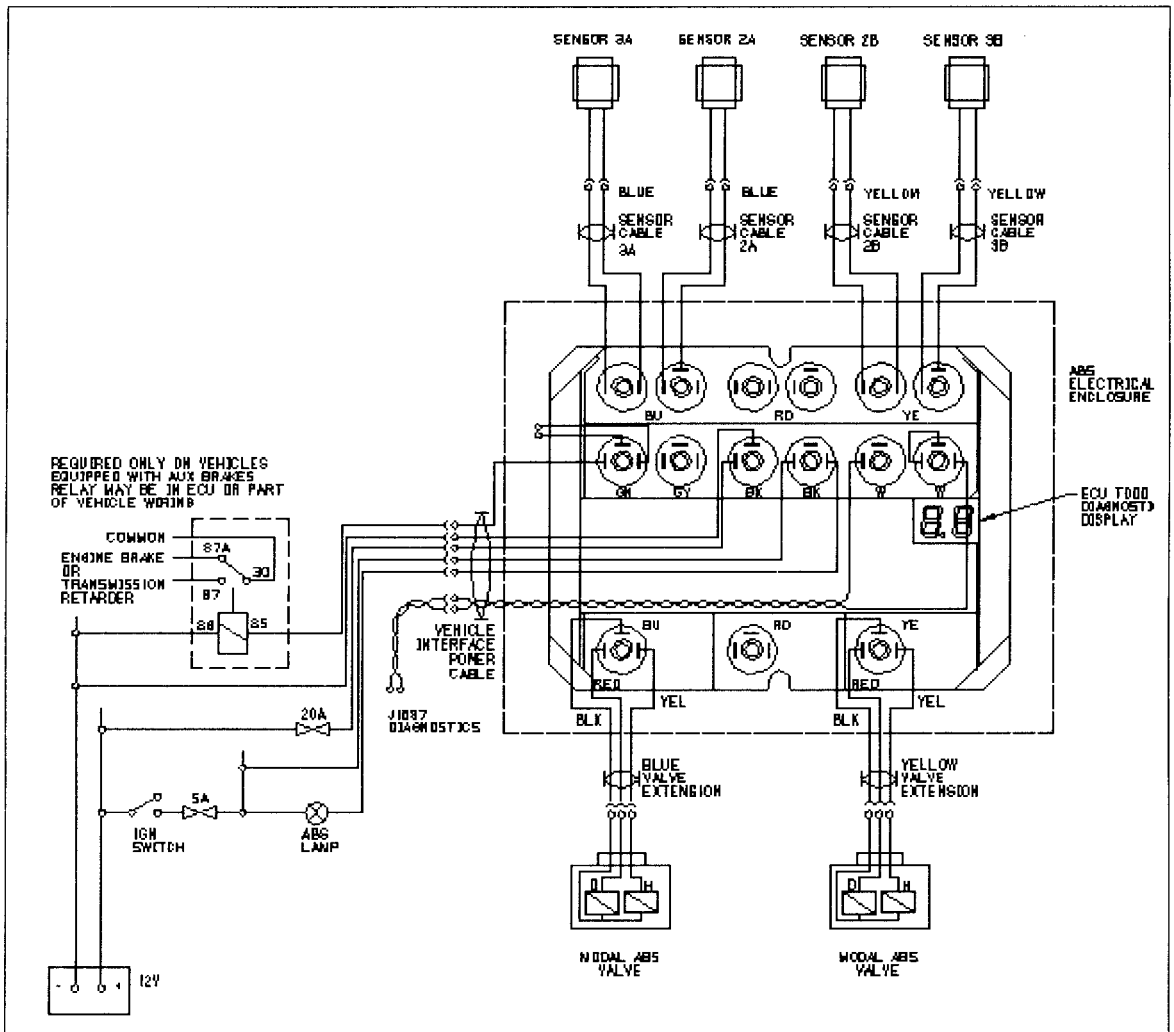


FIG. 28 ABS TO VEHICLE ELECTRICAL INTERFACE 4S/2M ABS CONFIGURATION

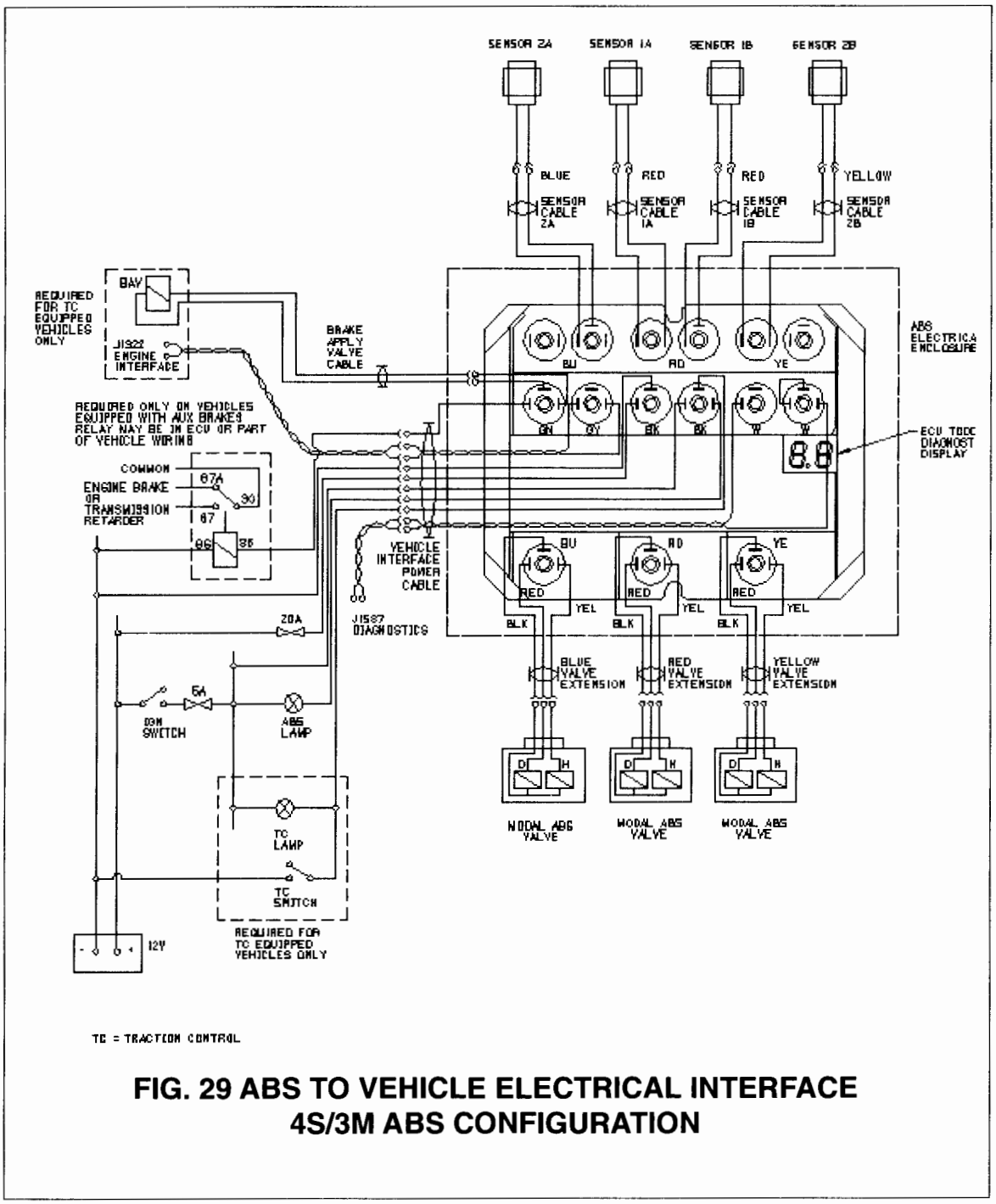


FIG. 29 ABS TO VEHICLE ELECTRICAL INTERFACE
4S/3M ABS CONFIGURATION

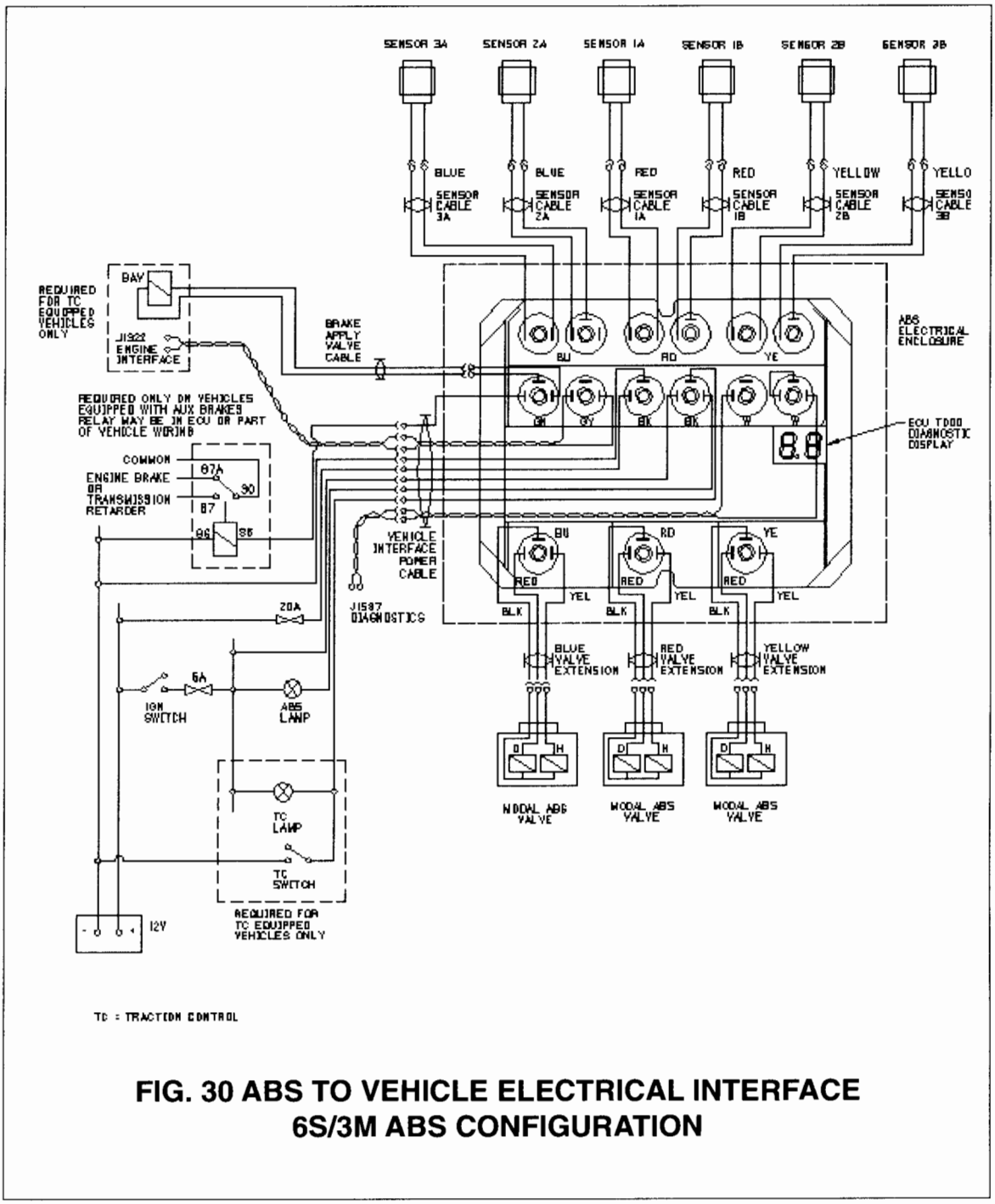


FIG. 30 ABS TO VEHICLE ELECTRICAL INTERFACE
6S/3M ABS CONFIGURATION

7.0 Glossary

ABS Inline Valve — This valve is located in the service brake delivery line near the wheel brake chamber and modifies brake pressure during an ABS event.

ABS Relay Valve — This valve performs the service relay valve function as well as the ABS valve function to modify brake pressure during an ABS event.

BU — Refers to blue, the required color coding for modulator, sensors, and ECU terminals for that particular channel.

Channel — The electrical connection between the ECU and modulator. The number of ABS control channels is the same as the number of modulators fitted.

Configuration — The arrangement of ABS components for any given installation. Also refers to the number of valves and sensors employed in the anti lock system.

ECU — The electronic control unit of the anti lock brake system which is housed in the MODAL power ECU box lid.

Exciter Ring — A gear tooth steel ring fitted in the hub, brake drum or rotor in conjunction with the sensor to generate an electrical signal proportional in frequency to wheel speed.

M — Refers to an ABS modulator valve which is an air valve with an integral on/off solenoid.

MODAL — Refers to **Mod**ular **A**nti **L**ock.

MODAL ECU Box — The environmental container into which all of the electrical cables pass for connection to the ECU.

7.0 Glossary (Cont'd)

PMV	**P**ressure **M**odulator **V**alve–Another term for the ABS relay and inline valves.
RD	Refers to red, the required color coding for modulator, sensors, and ECU terminals for that particular channel.
S	Refers to a sensor.
Sensor	A magnetic device mounted in the brake or hub assembly used in conjunction with the exciter to generate an electrical signal proportional to wheel speed.
Standard Remote Diagnostic Tool	Hand held diagnostic tool which connects to the vehicle serial communication port to read ABS/TC diagnostic faults.
TC	Traction control.
TODD	**T**otally **O**nboard **D**iagnostics **D**isplay. A 2 digit LED (light emitting diode) display contained in the ECU.
YE	Refers to yellow, the required color coding for modulator, sensors and ECU terminals for that particular channel.
1A, 1B, 2A, 2B, 3A, 3B	Refers to labeled sensor connections on the ECU. The alphanumeric lettering matches the vehicle wheel positions in the appropriate configuration pictorials shown in figure 12.
4S/2M	Four sensor and two modulator antilock system configuration.
4S/3M	Four sensor and three modulator antilock system configuration.
6S/3M	Six sensor and three modulator antilock system configuration.