

Bendix® M-40QR™ and M-40HF™ Pressure Modulator Valves

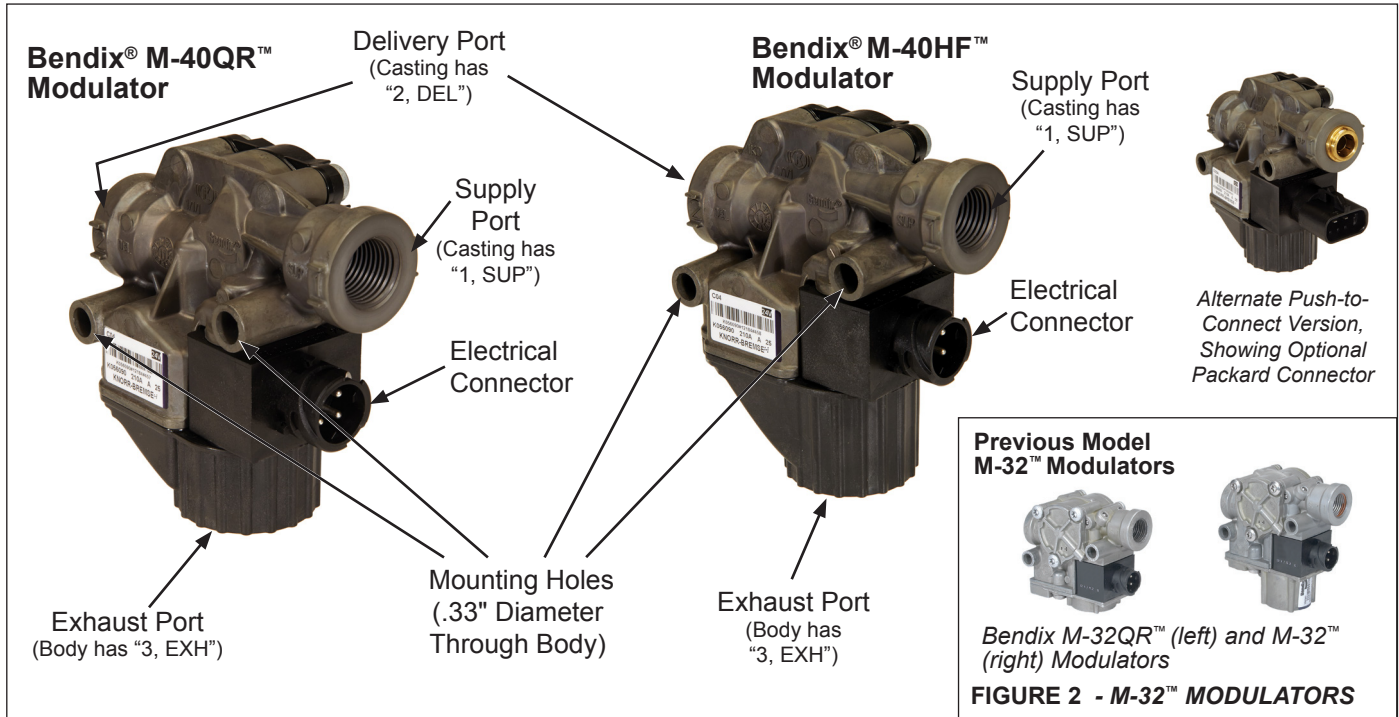


FIGURE 1 - M-40QR™ AND M-40HF™ PRESSURE MODULATOR VALVES

DESCRIPTION

The Bendix® M-40QR™ (quick release) and M-40HF™ (high flow) pressure modulator valves (PMVs) are high-capacity, on/off air valves that incorporate a pair of electrical solenoids for control. See Figure 1. The solenoids provide the electro-pneumatic interface between the vehicle's electronic control system and the air brake system. For example, the PMV is used to control the braking function of service actuators during antilock activity.

The modulator consists of a die cast metal and plastic body that houses one normally-open solenoid, one normally-closed solenoid, and an inlet and exhaust diaphragm valve. A three-pin weather-resistant electrical connector is an integral part of the modulator solenoid assembly and delivers the vehicle controller's commands to the modulator. Two mounting holes are provided for frame or crossmember mounting of the valve.

The Bendix M-40QR modulator is the direct replacement for the Bendix M-32QR modulator (See Figure 2). The Bendix M-40QR modulator has a bias valve to provide an internal quick-release function.

The supply, delivery and exhaust ports on the Bendix M-40 modulators have embossed identification codes.

Port ID	Air Hose Connection	Function
1, SUP	Supply	Air enters from a valve (typically foot, relay or quick release).
2, DEL	Delivery	Air is delivered to the service actuators.
3, EXH	Exhaust	Air is vented to the atmosphere.

FIGURE 3 - PORT DESIGNATION AND FUNCTION

APPLICATIONS

Bendix M-40 modulators may be used for various purposes on a vehicle including ABS and stability interventions. In applications using these PMVs, an external quick release valve may also be required, depending on the system design. Where the modulator is used for individual wheel control applications, it is typically the last control valve through which air passes on its way to the service brake actuator. See Figure 4 for a typical system schematic.

GENERAL SAFETY GUIDELINES



WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS



TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following guidelines should be observed **AT ALL TIMES**:

- ▲ Park the vehicle on a level surface, apply the parking brakes and always block the wheels. Always wear personal protection equipment.
- ▲ Stop the engine and remove the ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. 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.
- ▲ 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.
- ▲ If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system, a Bendix® DRM™ dryer reservoir module, or a Bendix® AD-9si™ air dryer, be sure to drain the purge reservoir.
- ▲ Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
- ▲ You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.
- ▲ Never exceed manufacturer's recommended pressures.
- ▲ 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.
- ▲ Use only genuine Bendix® brand replacement parts, components and kits. Replacement hardware, tubing, hose, fittings, etc. must be of equivalent size, type and strength as original equipment and be designed specifically for such applications and systems.
- ▲ Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.
- ▲ Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
- ▲ For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.
- ▲ The power **MUST** be temporarily disconnected from the radar sensor whenever any tests **USING A DYNAMOMETER** are conducted on a Bendix® Wingman® Advanced™-equipped vehicle.

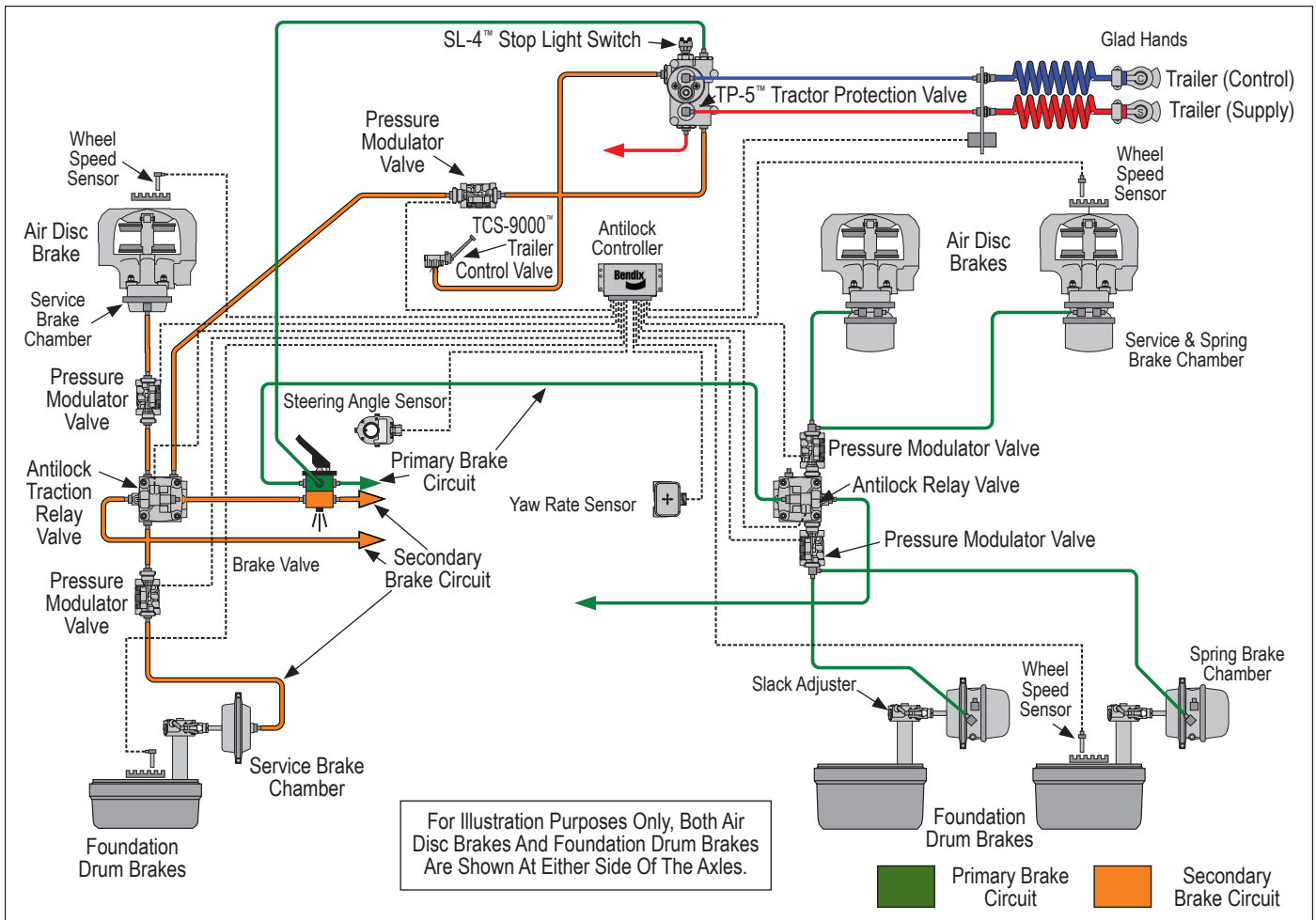


FIGURE 4 - TYPICAL SYSTEM DIAGRAM (4S-4M SYSTEM SHOWN)

PRESSURE MODULATOR VALVE (PMV) AND TRACTION CONTROL VALVE (TCV) CHUFF TEST

A wiring harness connects the vehicle modulators to the controller. The ABS controller is able to simultaneously, and independently, control the individual modulators.

Bendix® Electronic Control Units (ECUs) perform a Bendix-patented PMV and TCV Chuff Test. The Chuff Test is an electrical and pneumatic PMV test that can assist maintenance personnel in verifying proper PMV wiring and installation. This test is performed only when the vehicle is stationary (if the vehicle moves, the Chuff Test will not be performed).

NOTE: If there are any active Diagnostic Trouble Codes (DTCs), the stop lamp cross-check portion of the Chuff Test will not be carried out until all DTCs are fully diagnosed and corresponding repairs are successfully conducted. The ESP/ATC dash indicator lamp ATC/ESP Lamp — a lamp that indicates when stability functions, including traction control, roll stability program or yaw control are operating — will also be illuminated when there are active ABS, ATC or ESP DTCs. (See the Glossary on page 8 for more information on these terms.)

See Figure 5. When ignition power is applied, each modulator solenoid is briefly energized. If the air system is fully charged — and the service brake pedal is depressed during ignition — the modulator creates a single, sharp audible “chuff” of air pressure. Bendix ECUs will perform a PMV Chuff Test on all installed modulators in the order shown in Figure 5. The pattern will then repeat itself.

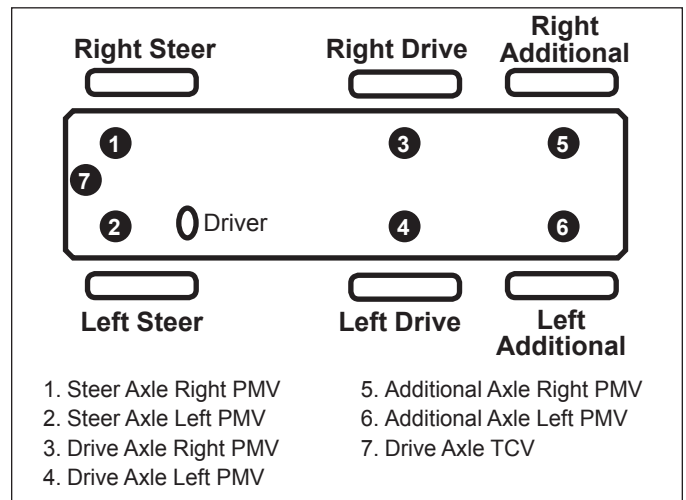


FIGURE 5 - TYPICAL VEHICLE ORIENTATION AND CHUFF SEQUENCE

If equipped with a Bendix® EC-60® (or later) advanced controller, following the completion of the second round of PMV & TCV Chuff Tests, the controller (if configured to do so) will perform a test to cross-check the trailer PMV operation with the vehicle stop lamps. If the trailer PMV circuit is mis-wired (including the steer axle TCV), the PMV will exhaust a large amount of air, or none at all.

ANTILOCK OPERATION

GENERAL

See Figure 6.

The first four rows of this table show normal vehicle braking where the PMV does not intervene. In the case of a rapid, non-antilock release of the brakes (e.g. if the driver releases the brakes after a severe brake application), the Bendix® M-40QR™ PMV assists the quick release of the brakes by being the point at which the air is exhausted.

The final four rows of the table show the actions taken during an antilock braking event.

OPERATION

	Mode	Modulator Type	Hold Solenoid State	Exhaust Solenoid State	Description
Normal Braking	Normal, Non-Antilock, Brake Application	HF and QR	De-energized	De-energized	Air pressure supplied to the modulator exits the modulator delivery port and flows to the service brake chambers.
	Non-Antilock Hold	HF and QR	De-energized	De-energized	When the desired air pressure is attained in the service brake chambers, the air pressure in the system levels off.
	Normal, Non-Antilock, Relatively "slow" Brake Release	HF and QR	De-energized	De-energized	Air from the brake chambers moves back through the modulator in the reverse direction as it flowed during application. Simultaneously, a small amount of air will generally be expelled from the modulator exhaust port.
	Rapid, Non-Antilock, Exhaust (e.g., the driver releases the brakes after a severe brake application)	QR	De-energized	De-energized	The internal bias piston blocks air from the brake chamber from moving back through the modulator. Instead, all the air is exhausted out the modulator exhaust port.
HF		De-energized	De-energized	Air from the brake chambers moves back through the modulator in the reverse direction as it flowed during application. Simultaneously, air will be expelled from the modulator exhaust port.	
During Antilock Braking Event	Antilock Apply	HF and QR	De-energized	De-energized	Air pressure supplied to the modulator exits the modulator delivery port and flows to the service brake chambers.
	Antilock Exhaust	HF and QR	Energized	Energized	Air from the brake chambers exhausts through the modulator exhaust port.
	Antilock Hold	HF and QR	Energized	De-energized	The modulator prevents supply air from passing through the modulator and, at the same time, prevents air from the brake chambers from exhausting.
	Antilock "Reapply"	HF and QR	De-energized	De-energized	The modulator re-applies air to the brakes in the same manner it did during a non-antilock event.

FIGURE 6 - BENDIX® M-40QR™ AND M-40HF™ MODULATORS: OPERATIONAL MODES

ANTILOCK APPLY MODE

If a service brake application is made and the antilock system detects an impending wheel lockup, the antilock controller will make a controlled brake application using the modulator.

In order to control the brake application, the coils of the two solenoid valves contained in the modulator are energized or de-energized in a pre-programmed sequence by the antilock controller. When a solenoid coil is energized, and — depending on whether the exhaust or hold solenoid is energized — it either opens or closes, thereby causing the exhaust or reapplication of air pressure to the brake actuator. The solenoids in the modulator are controlled independently by the Electronic Control Unit (ECU).

Before ABS systems, drivers would sometimes “pump the brakes” in order to attempt to prevent wheel lock-up and maintain vehicle control. In the case of an ABS braking system, the antilock controller is able to apply and release the brakes using the modulators, automatically, with far greater speed and accuracy. Depending on the number of modulators used, some systems are able to apply braking power to wheels independently.

ANTILOCK EXHAUST MODE

When wheel lock is detected or imminent, the antilock controller energizes the supply and exhaust solenoids in the modulator.

Further delivery of air to the brake chamber is prevented, and air is allowed to exhaust through the exhaust port.

ANTILOCK HOLD MODE

The antilock controller will place the modulator in the hold position when information from the wheel speed sensors shows that the correct wheel speed (braking force) has been attained. The antilock controller will also place the modulator in the hold position — prior to entering the reapply mode — when it detects recovery from a locked wheel condition.

In this mode of operation, the exhaust passage is sealed, holding the air pressure in the brake chamber at that level. At the same time, no application air is permitted to flow to the brake chamber.

The modulator can enter both the antilock exhaust or reapply mode from the antilock hold mode depending on the needs of the antilock controller.

ANTILOCK “REAPPLY” MODE

If the antilock controller senses that wheel speed has increased sufficiently enough to allow re-application of braking pressure, without further wheel lock-up, it permits the supply air to re-apply air to the brakes in the same manner it did during a non-antilock event.

PREVENTIVE MAINTENANCE

GENERAL

Read and follow the General Safety Guidelines on page 2 of this document.

Perform the tests and inspections presented at the prescribed intervals. If the modulator fails to function as described, or if the leakage is excessive, replace it with a new Bendix® brand unit, available at any authorized parts outlet.

EVERY MONTH, 10,000 MILES OR 350 OPERATING HOURS

1. Remove any accumulated contaminants and visually inspect the exterior for excessive corrosion and physical damage.
2. Inspect all air hoses and wire harnesses connected to the modulator for signs of wear or physical damage. Replace as necessary.
3. Test air line fittings for leakage and tighten or replace as necessary.
4. Perform the routine OPERATION & LEAKAGE TESTS described below.

OPERATION & LEAKAGE TESTS

OPERATION TEST

This test uses the Chuff Test (described on page 3).

To properly test the function of the modulator will require two (2) service technicians.

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to governor cut out.
2. Turn the engine ignition key to the OFF position then make and hold a full brake application.
3. With the brake application held and one (1) service technician posted at one (1) of the modulators, turn the vehicle ignition key to the ON position. ONE OR TWO SHORT bursts of air pressure should be noted at the modulator exhaust. Repeat the test for each modulator on the vehicle. If at least a single burst of exhaust is not noted or the exhaust of air is **prolonged** and **not short, sharp** and **well defined**, perform the Electrical Tests.

LEAKAGE TEST

1. Park the vehicle on a level surface and block or chock the wheels. Release the parking brakes and build the air system to full pressure.
2. Turn the engine OFF and make 4 or 5 brake applications and note that the service brakes apply and release promptly.
3. Build system pressure to governor cut-out and turn the engine OFF.
4. After determining the pressure loss with the brakes released (2 psi/minute allowed), make and hold a

full service brake application. Allow the pressure to stabilize for one minute.

5. Begin timing pressure loss for two minutes while watching the dash gauges for a pressure drop. The leakage rate for the service reservoirs should not exceed four (4) psi within two minutes for a single vehicle, six (6) psi. within two minutes for a tractor/trailer, and eight (8) psi within two minutes for a tractor with two trailers.
6. If either circuit exceeds the leakage values above, apply soap solution to the exhaust port of the modulators and any other components in the respective circuit.
7. The leakage at the exhaust port of most Bendix components, including M-40™ modulators, should not exceed a one-inch bubble in three seconds. If leakage at the modulator is determined to exceed the maximum limits, replace the modulator.

ELECTRICAL TESTS

1. Before testing the solenoid assembly of a suspect modulator, its location on the vehicle should be confirmed using the troubleshooting procedure for the specific antilock controller in use. (See the Service Data Sheet available on www.bendix.com document library.)
2. Proceed to the modulator in question and inspect its wiring connector. Disconnect the connector and test the resistance between the pins **on the modulator**. Refer to Figure 7.

A. HOLD to SOURCE (41-42):

12V systems: Read 4.8 to 5.6 Ohms.

24V systems: Read 13.9 to 16.3 Ohms.

B. EXHAUST to SOURCE (41-43):

12V systems: Read 4.8 to 5.6 Ohms.

24V systems: Read 13.9 to 16.3 Ohms.

C. Individually test the resistance of each pin to vehicle ground and note there is NO continuity.

If the resistance readings are as shown, the wire harness leading to the modulator may require repair or replacement. Before attempting repair or replacement of the wire harness, refer to the test procedures specified for the antilock controller in use for possible further testing that may be required to substantiate the wire harness problem. If the resistance values are **not as stated**, replace the modulator.

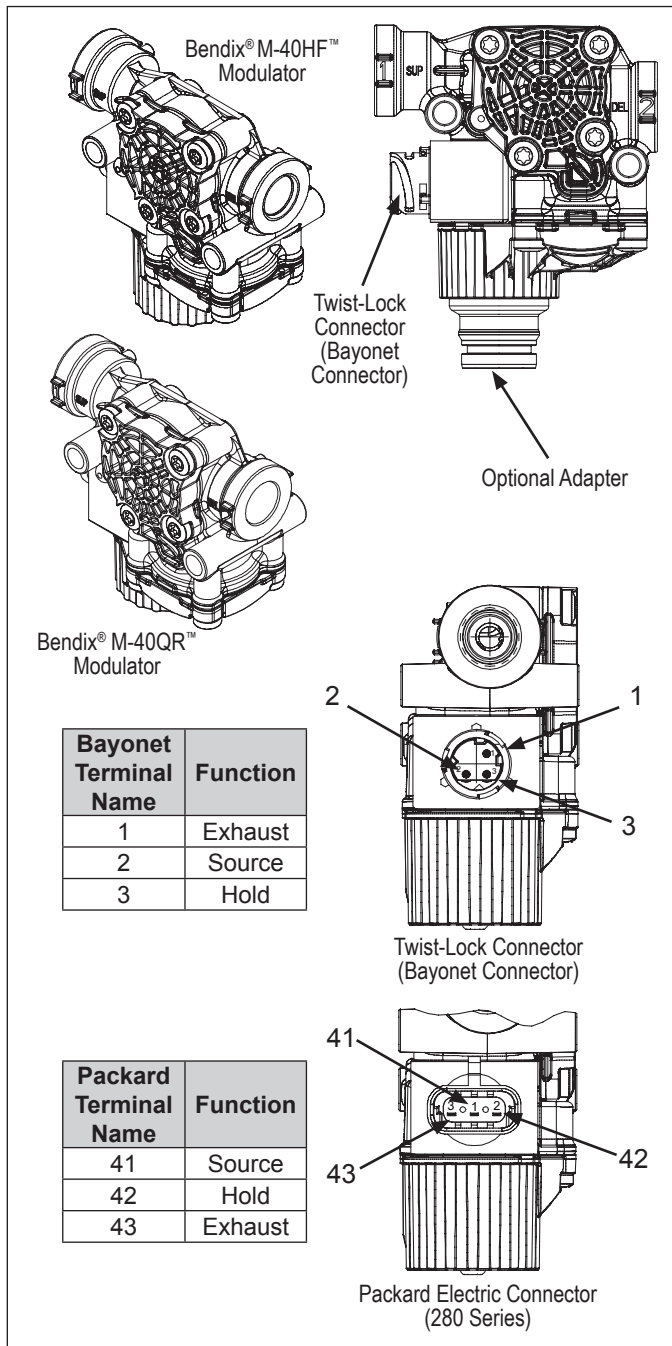


FIGURE 7 - EXTERIOR VIEWS AND ELECTRICAL CONNECTIONS

MODULATOR REMOVAL

1. Locate the modulator that will be replaced and clean the exterior.
2. Identify and mark or label all air hoses and their respective connections on the valve to facilitate ease of installation.
3. Disconnect both air lines and the electrical connector.
4. Remove the modulator from the vehicle.
5. Remove any air hose fittings present. **These fittings will be re-used in the replacement modulator.**

MODULATOR INSTALLATION

1. Install all previously-removed air hose fittings, making certain thread-sealing material does not enter the valve.
2. Install the assembled valve on the vehicle.
3. Reconnect both air lines to the valve using the identification marks made during step 5 of *Modulator Removal*.
4. Reconnect the electrical harness to the modulator.
5. After installing the valve, test all air fittings for excessive leakage and tighten as needed.

TECHNICAL INFORMATION

Mode	Modulator Type
Port Options	Supply Port (from brake, relay or quick release valve): 1/2" NPT
	Delivery Port (brake actuator): <ul style="list-style-type: none"> • 1/2" NPT • Push-to-connect for 1/2" tubing
Solenoid Voltage	12 Volts DC Nominal, optional 24 Volt available.
Weight	1.35 pounds
Maximum Operating Pressure	150 psi gauge
Operating Temperature Range	-40°F (40°C) to 185 degrees Fahrenheit. [A short-term operating temperature of 230°F (110°C) for up to 10% of the valve's lifetime is acceptable.]
Pressure Differential	1 psi maximum (supply to delivery)
Mounting Hole Sizes	0.33" diameter through body

FIGURE 8 - BENDIX® M-40QR™ AND M-40HF™ MODULATORS

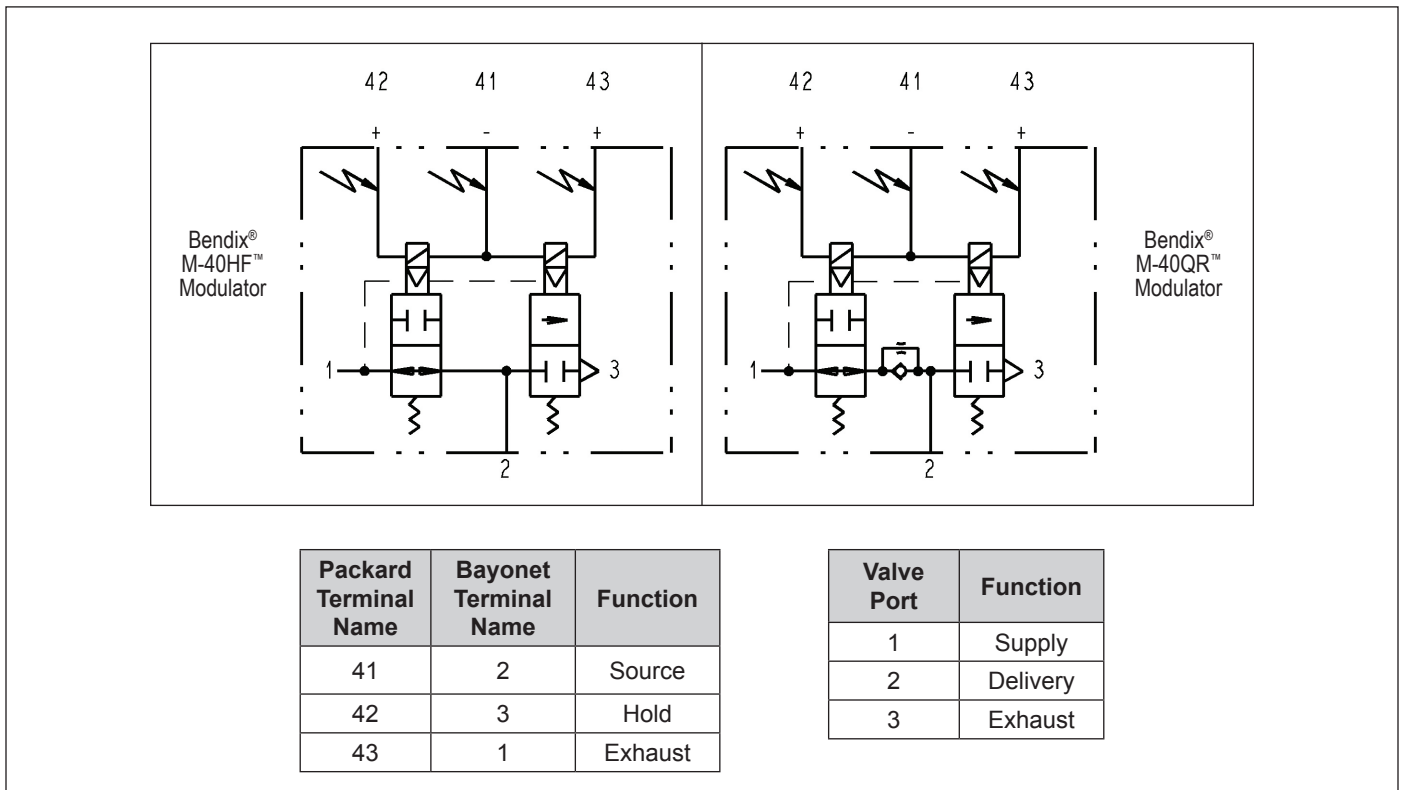


FIGURE 9 - BENDIX® M-40QR™ AND M-40HF™ MODULATORS DIN SYMBOL

GLOSSARY

See the Service Data Sheet for the vehicle's Electronic Control Unit for more information.

ABS — Antilock Brake System.

ABS Event — Impending wheel lock situation that causes the ABS controller to activate the modulator valve(s).

ABS Indicator Lamp — An amber lamp which indicates the operating status of an antilock system. When the indicator lamp is on, ABS is disabled and the vehicle reverts to normal brake operation.

ATC — Automatic Traction Control. An additional ABS function in which engine torque is controlled and brakes are applied differentially to enhance vehicle traction.

ATC/ESP Lamp — A lamp that indicates when stability functions, including traction control, roll stability program or yaw control are operating.

ECU — Electronic Control Unit.

ESP — Electronic Stability Program. Full stability function that includes RSP & YC subfunctions.

Diagnostic Trouble Code — A condition that interferes with the generation or transmission of response or control signals in the vehicle's ABS system that could lead to the functionality of the ABS system becoming inoperable in whole or in part.

J1939 — A high speed data link used for communications between the ABS ECU engine, transmission and retarders.

PMV — Pressure Modulator Valve. An air valve which is used to vent or block air to the brake chambers to limit or reduce brake torque.

QR — Quick Release. Quick release valves allow faster release of air from the brake chamber after a brake application.

RSP — Roll Stability Program. An all-axle ABS solution that helps reduce vehicle speed by applying all vehicle brakes as needed, reducing the tendency to roll over.

SAS — Steering Angle Sensor.

YC — Yaw Control. Helps stabilize rotational dynamics of vehicle.

YRS — Yaw Rate Sensor.



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