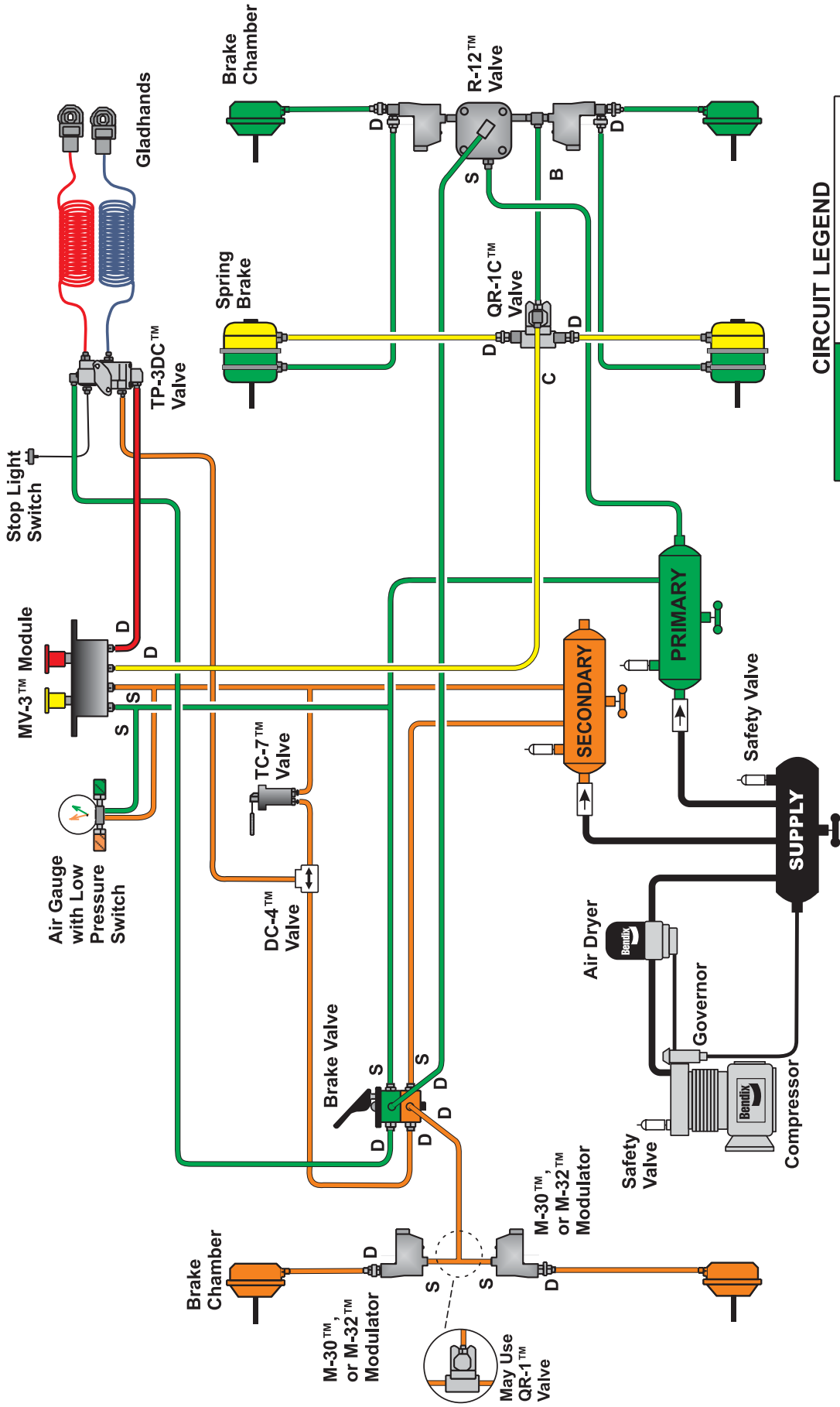


The Air Brake Handbook





CIRCUIT LEGEND

GREEN	Primary
ORANGE	Secondary
YELLOW	Parking
BLACK	Charging
RED	Park Supply



The Air Brake Handbook



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How to use the Air Brake Handbook

This nine-section handbook provides an introduction to the use and operation of Bendix air brake systems and devices.

Components are introduced and shown with typical system diagrams to show where they are used. As new components are introduced and their function explained, they gradually build up to a complete functioning air brake system.

Partial system-drawings, throughout the manual, assist in explaining of the use of the components. See the front inside cover for an example of a tractor system schematic in color.

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Sample Schematic inside front cover



DIN symbols are used in this handbook.

IMPORTANT

The systems presented in this manual are intended for illustrative purposes only and are not intended to be used for actual vehicle piping.

Air Brake System General Precautions

WARNING! 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. Always wear safety glasses.
2. Stop the engine and remove 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.
3. 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.
4. 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 an AD-IS™ air dryer system or a dryer reservoir module, be sure to drain the purge reservoir.
5. Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.
6. Never exceed manufacturer's recommended pressures.
7. 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.
8. Use only genuine Bendix® 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.
9. 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.
10. Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.
11. For vehicles with Antilock 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.

Section I: One-Page Introduction

Air Supply

The vehicle's compressor takes in filtered air, either at atmospheric pressure from the outside (or already at an increased pressure, from the engine turbocharger in some cases), and compresses it. The compressed air is delivered to the air dryer where water and a small amount of oil is removed. The air then travels into the air reservoirs ("air tanks") - typically delivered to a rear brake system reservoir and a front brake system reservoir as well as any attached trailer reservoirs. For each system, the air pressurizes the reservoir and the air hoses all the way to the next control valve, where the air pressure remains, ready to be used.

A vehicle may use compressed air for many tasks. Some examples are: to provide force for braking, to deliver air to a particular component, to off-load bulk goods, etc.

Normal Braking

When the driver applies the foot brake, a plunger within the foot brake valve moves, opening channels within the valve that allow the air pressure waiting there to pass through and be delivered to the rear and front brake systems. The pressure quickly increases in the brake chambers and applies force to the push rod, transferring the force to the S-Cam or air disc brake. (See page 22 for more about foundation brakes.) Frictional forces slow the wheels and the vehicle comes to a stop. When the brakes are released, the air in the brake chambers is able to be quickly released and enable the driver to drive away.

Vehicle Parking

Vehicles are parked using powerful springs which are part of the spring brake assembly, to engage the brakes and hold the vehicle in position. When the driver prepares to move away and releases the parking brake, the spring force is countered by the introduction of air pressure. Anti-compounding valve features in the system design help prevent the application of both the spring and service brakes together.

Antilock Braking Systems (ABS)

Most commercial vehicles use electronic Antilock Braking System (ABS) to help improve braking when excessive wheel slip, or wheel lock-up, is detected. Bendix® Electronic Control Units (ECUs) use patented technology to monitor wheel speeds (on all wheels equipped with speed sensors) and use ABS modulator valves to adjust or pulse the braking force being applied and released, many times per second, during an ABS event. ABS typically improves stability and steerability, and also reduces stopping distances on most surfaces.

In addition to the ABS features above, some recent model ECUs have a drag torque control feature which reduces driven-axle wheel slip (due to driveline inertia) by communicating with the engine's controller and increasing the engine torque.

Antilock Traction Control

In addition to the ABS function, some Bendix ECU models provide an Automatic Traction Control (ATC) feature which can help improve vehicle stability and traction during vehicle acceleration (at low speeds), and lateral stability while driving through curves.

Electronic Stability Program (ESP®)

Recent Bendix® ABS advances include ESP® which has the ability to apply brakes to individual wheel ends, and the trailer, to counteract the trailer "push" during maneuvers that may lead to loss of control or jackknifes on low to high friction surfaces (snow, rain, asphalt, concrete, etc.)

Roll Stability Program (RSP)

The Bendix Roll Stability Program (RSP), is an all-axle ABS solution that helps reduce vehicle speed by applying all vehicle brakes as needed, reducing the tendency to roll over. RSP focuses on reducing the vehicle's speed below the critical roll threshold during direction-changing maneuvers such as exit ramps and obstacle avoidance on dry, high friction surfaces.

Emergency Braking

In emergency situations where system air pressure is reduced or lost, government regulations require vehicles to meet specified stopping distances. As an example, some straight truck system designs use modulated parking-brake applications to bring the vehicle to a stop.

Vision Systems

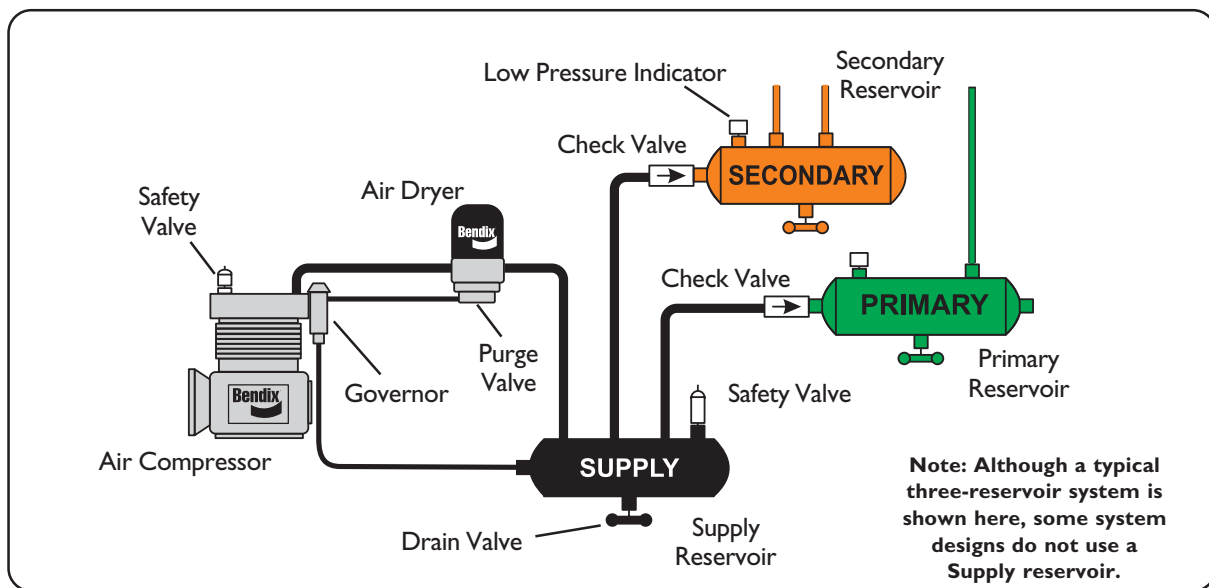
Bendix offers video camera systems that help drivers back vehicles up safely, assist drivers with viewing what is in their blind spots around their vehicles, as well as infrared XVision® night vision camera systems that provide drivers advanced warning of obstacles in their pathway at night by seeing 3 to 5 times further than their standard headlights. All of our camera systems can be purchased individually to meet drivers' specific needs or can be purchased as a total system to provide a complete 360 degree 24/7 video camera system for drivers.

*ESP is a registered trademark of Daimler Chrysler.

Section 2: The Charging System

The charging system consists of:

- An **air compressor**
 - A **governor**, to control when the compressor needs to build, or stop building, air for the system and also to control the air dryer purge cycle
 - An **air dryer**, to remove water and oil droplets from the air
 - **Reservoirs** (or “air tanks”) to store air to be used for vehicle braking, etc.
- **Safety valves** to protect against excessive pressure in the system in the event that a charging system component malfunction occurs, e.g. a line blockage
 - **Single check valves** to maintain a one-way flow of air into the reservoirs. This arrangement protects the contents from being drained in the event of an upstream loss of pressure
 - **Low pressure indicators** to alert the driver whenever a reservoir has less than a pre-set amount of air available



Bendix Air Compressors

The air compressor is the source of energy for the air brake system.

Usually driven by the vehicle engine, the air compressor builds the air pressure for the air brake system. The air compressor is typically cooled by the engine coolant system and lubricated by the engine oil supply. (Certain models have self-lubricated and/or air-cooled versions available.) Note: Air compressor shafts can rotate in either direction.

The vehicle's compressor draws in filtered air, either at atmospheric pressure from the outside (or already at an increased pressure, from the engine turbocharger where permitted), and compresses it.

The brake system needs a supply of compressed air between a preset maximum and minimum. The governor (along with a synchro valve for the Bendix® DuraFlo™ 596 air compressor) monitors the air pressure in the supply reservoir and controls when the compressor needs to pump air into the air system (also known as the “air build cycle” - the compressor is “running loaded”) and when the compressor should simply turn over without building pressure (“running unloaded”). When the air pressure becomes greater than that of the preset “cut-out”, the governor controls the unloader mechanism of the compressor to stop the compressor from building air and also causes the air dryer to purge. As the service reservoir air pressure

drops to the “cut-in” setting of the governor, the governor returns the compressor back to building air and the air dryer to air drying mode.

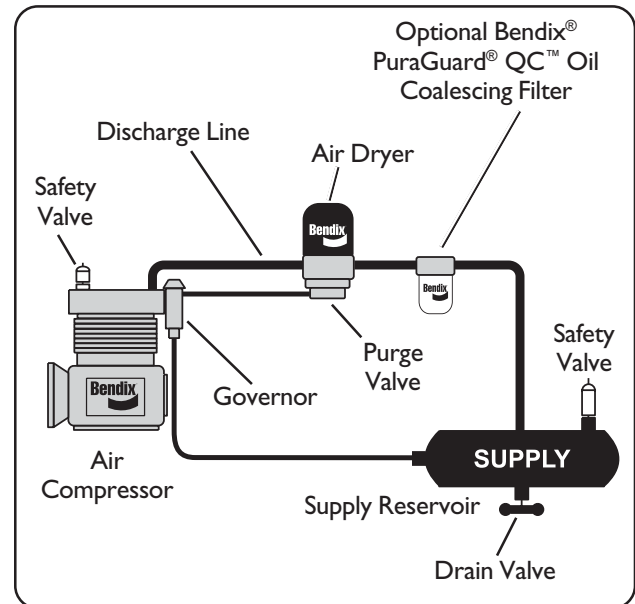
As the atmospheric air is compressed, all the water vapor originally in the air is carried along into the air system, as well as a small amount of the compressor lubricating oil as vapor.

The duty cycle is the ratio of time the compressor spends building air to the total engine running time. Air compressors are designed to build air (run “loaded”) up to 25% of the time. Higher duty cycles cause conditions (such as higher compressor head temperatures) that affect air brake charging system performance. These conditions may require additional maintenance and lead to a higher amount of oil vapor droplets being passed along into the air brake system. Factors that add to the duty cycle are: air suspension, additional air accessories, use of an undersized compressor, frequent stops, excessive leakage from fittings, connections, lines, chambers or valves, etc. See page 9 for compressor maintenance and usage guidelines. Use the BASIC™ test (p/n 5013711) where the amount of oil present in the air brake system is suspected to be above normal.

The discharge line allows the air, water-vapor and oil-vapor mixture to cool between the compressor and air dryer. The typical size of a vehicle's discharge line, (see table on page 9) assumes a compressor with a normal (less than 25%) duty cycle, operating in a temperate climate. See Bendix and/or vehicle or air dryer manufacturer guidelines as needed.

When the temperature of the compressed air that enters the air dryer is within the normal range, the air dryer can remove most of the charging system oil. If the temperature of the compressed air is above the normal range, oil as oil-vapor is able to pass through the air dryer and into the air system. Air dryer inlet temperatures play a key role in air system cleanliness and air dryer performance. Larger diameter discharge lines and/or longer discharge line lengths can help reduce the temperature.

The discharge line must maintain a constant slope down from the compressor to the air dryer inlet fitting to avoid low points where ice may form and block the



flow. If, instead, ice blockages occur at the air dryer inlet, insulation may be added here, or if the inlet fitting is a typical 90 degree fitting, it may be changed to a straight or 45 degree fitting. For more information on how to help prevent discharge line freeze-ups, see Bendix Bulletins TCH-08-21 and TCH-08-22. Shorter discharge line lengths or insulation may be required in cold climates.

The air dryer contains a filter that collects oil droplets, and a desiccant bed that removes almost all of the remaining water vapor. The compressed air is then passed to the air brake service (supply) reservoir. The oil droplets and the water collected are automatically purged at the dryer when the governor reaches its “cut-out” setting.

For vehicles with accessories that are sensitive to small amounts of oil, we recommend installation, downstream of the air dryer, of a Bendix® PuraGuard® QC™ oil coalescing filter to minimize the amount of oil present.

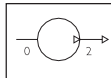
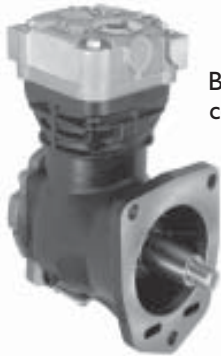
See the Bendix Advanced Compressor Troubleshooting Guide (BW1971) or the compressor’s Service Data sheet, available online at www.bendix.com for more information.

Single-Cylinder Compressors

BX-2150™
air
compressor



BA-921™ air
compressor



Two-Cylinder Compressors



Tu-Flo® 700 air
compressor



Tu-Flo® 501 air
compressor



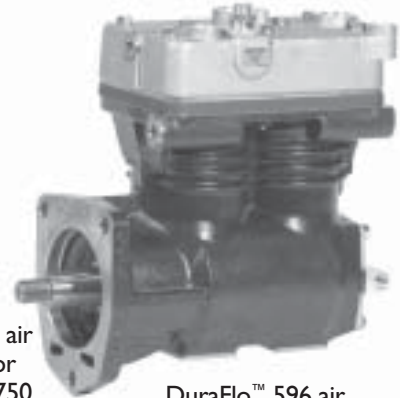
Tu-Flo® 500 air
compressor



Tu-Flo® 400 air
compressor



Tu-Flo® 550 air
compressor
or Tu-Flo® 750
air compressor
(exterior view
is the same)



DuraFlo™ 596 air
compressor or BA-922™ air
compressor (exterior view is
very similar)

Compressor
Comparison by
Displacement

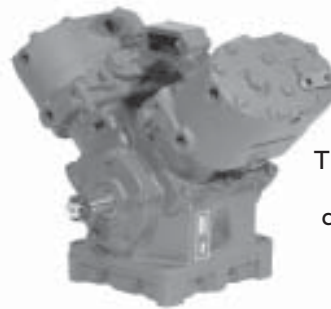
	Displacement CFM @ 12500 RPM	Cylinders	Engine/self- lubricated avail.?	Turbo inlet option?	Water/air- cooled avail.?
Tu-Flo® 400 Compressor	7.25	2	Both	Y	Both
BX-2150™ Compressor	9.5	1	Eng.	Y**	Water
Tu-Flo® 500 Compressor	12	2	Eng.	Y	Water
Tu-Flo® 501 Compressor	12	2	Both	Y	Both
Tu-Flo® 550 Compressor	13.2	2	Eng.	Y	Water
Tu-Flo® 700 Compressor	15.5	2	Eng.	Y	Water
BA-921™ Compressor	15.8	1	Eng.	Y**	Water
Tu-Flo® 750 Compressor	16.5	2	Eng.	Y	Water
Tu-Flo® 1000 Compressor*	24	4	Both	Y	Both
DuraFlo™ 596 Compressor	27	2	Eng.	N	Water
BA-922™ Compressor	31.6	2	Eng.	N	Water
Tu-Flo® 1400 Compressor*	32	4	Eng.	Y***	Water

*Special use.
e.g. Tank trailer
pump-off

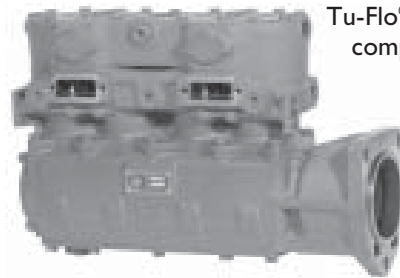
**Uses Inlet
Check Valve

***Uses Inlet
Regulating
Valve

Four-Cylinder Compressors



Tu-Flo® 1000
air
compressor



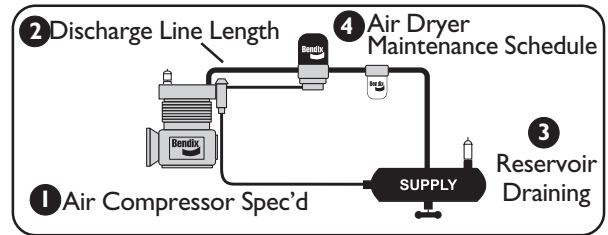
Tu-Flo® 1400 air
compressor

For compressor Service Data Sheet directory see pages 63-64.

Maintenance Schedule and Usage Guidelines

Regularly scheduled maintenance is the single most important factor in maintaining the air brake charging system. The table below is an introduction to the maintenance intervals for air brake charging systems. See your compressor and/or air dryer Service Data sheet for more information.

If you are concerned that a compressor may be passing oil, use the BASIC™ Test Kit: Order Bendix P/N 501371 I.



<p>Low Air Use e.g. Line haul single trailer without air suspension, air over hydraulic brakes.</p> <p>Compressor with less than 15% duty cycle (builds air pressure 15% or less of the engine running time.)</p> <p>(5 or less axles)</p>	<p>Low Air Use e.g. Line haul single trailer with air suspension, schoolbus.</p> <p>Compressor with up to 25% duty cycle (builds air pressure up to 25% of the engine running time.)</p> <p>(5 or less axles)</p>	<p>High Air Use e.g. Double/triple trailer, open highway coach/RV, (most) pick-up & delivery, yard or terminal jockey, off-highway, construction, loggers, concrete mixer, dump truck, fire truck.</p> <p>Compressor with up to 25% duty cycle</p> <p>(8 or less axles)</p>	<p>High Air Use e.g. City transit bus, refuse, bulk unloaders, low boys, urban region coach, central tire inflation.</p> <p>Compressor with up to 25% duty cycle</p> <p>(12 or less axles)</p>
<p>1 Examples of Typical Compressors Spec'd^a</p>			
<p>Bendix® BA-921™ air compressor</p>		<p>Bendix® Tu-Flo® 750 air compressor</p>	
<p>Bendix® Tu-Flo® 550 air compressor</p>		<p>Bendix® BA-922™ air compressor</p>	
<p>2 Discharge line: 6 ft. @ ½ in. I.D. (oil carry-over control suggested upgrade^b: 9ft. @ ⅝ in.)</p>		<p>2 Discharge line: 9 ft. @ ½ in. I.D. (oil carry-over control suggested upgrade^b: 12ft. @ ⅝ in.)</p>	
<p>3 Drain Reservoirs Every Month - 90 Days</p>		<p>3 Drain Reservoirs Every Month</p>	
<p>4 Replace Air Dryer Cartridge Every 3 Years^c</p>		<p>Replace Every 2 Years^c</p>	<p>Replace Every Year^c</p>
<p>Oil Passing Concerns?</p>	<p>Use the BASIC™ Test Kit: Order Bendix P/N 501371 I BASIC™ test acceptable range: 3 oil units per month.</p>		<p>Use the BASIC™ Test Kit: Order Bendix P/N 501371 I BASIC™ test acceptable range: 5 oil units per month.</p>

a. Note: Compressor and/or air dryer upgrades are recommended in cases where duty cycle is greater than the normal range (for the examples above). For certain vehicles/applications, where turbo-charged inlet air is used, a smaller size compressor may be permissible.

b. To counter above normal temperatures at the air dryer inlet, (and resultant oil-vapor passing upstream in the air system) replace the discharge line with one of a larger diameter and/or longer length. This helps reduce the air's temperature. If

sufficient cooling occurs, the oil-vapor condenses and can be removed by the air dryer. Discharge line upgrades are not covered under warranty. Note: To help prevent discharge line freeze-ups, shorter discharge line lengths or insulation may be required in cold climates. See Bendix Bulletins TCH-08-21 and TCH-08-22, for more information.

c. With increased air demand the air dryer cartridge needs to be replaced more often.

Governors and Components

The **Governor** monitors the air pressure in the supply reservoir and operates the compressor unloading mechanism to control whether the compressor builds air pressure or not.

The **Bendix® D-2™ governor** is an adjustable piston-type valve available preset to a choice of pressure settings.

The pressure range between the cut-in and cut-out pressure is designed into the governor and is not adjustable. The D-2™ governor may be direct-mounted to the compressor or remote-mounted as desired. Specialized governors are available for vehicles needing a governor adapted to abnormally high or low temperatures, as well as a “weatherproof” model.

The D-2A™ governor is a non-adjustable version of the D-2™ governor.

The **D-2™/SV-1™ governor module** is a special combination device used with the Bendix® DuraFlo™ 596 air compressor to provide the fast-rising unloader signal needed by this compressor.

Safety Valves are used in an air brake system to protect against excessive air pressure buildup and to sound an audible alert. Safety valves are available in both adjustable (e.g. the Bendix® ST-1™ valve) and non-adjustable (e.g. ST-3™, ST-4™ valve) styles, in various pressure settings, and for various port sizes. Maximum service system air pressure allowed by government regulation is typically 150 psi. Various safety valve settings are used at different points in the charging and treatment system.

Specifically designed for use in compressors, ST-4™ safety valves are installed in an extra compressor head discharge port, if available, or in the discharge line near the compressor, to prevent compressor damage in the event of discharge line blockage.

An **Inlet Regulating Valve** (or “IRV”) is typically used on multi-cylinder compressors which receive their input air supply from the pressurized side of the engine turbocharger. The IRV, which is generally mounted to the compressor inlet, is designed to regulate compressor inlet pressure to 10 PSI or less. The outlet flange of the IRV can be mounted to all Bendix® Tu-Flo® compressors except the Bendix® Tu-Flo® 300 compressor. The IRV may not be used in conjunction with single cylinder compressors.



Inlet Check Valves (or “ICV”) are used on naturally aspirated compressors to prevent oil mist from entering the inlet line during the unloaded cycle. The inlet check valve either mounts to the intake side of the compressor (and must be used in conjunction with an inlet valve stop or inlet adapter), or may be mounted remotely.

Reservoirs (or “air tanks”) serve the air brake system as a storage tank for compressed air. The reservoir size is selected by the vehicle manufacturer to provide an adequate amount of air for use by the braking system and other control devices.

Bendix reservoirs are built in accordance with SAE specifications and are available in various sizes in both single and double compartment design configurations, and are certified to comply with government regulations (such as FMVSS 121).

Reservoir draining devices are installed in air brake reservoirs, and allow liquid contaminants collected to be drained off. Vehicles without air dryers are normally drained each day. Vehicles which have Bendix desiccant air dryers should be drained every 30-90 days. [Tip: The presence of water may indicate that the air dryer cartridge may need to be replaced. Other potential sources of water in the reservoirs are: when shop air has been used to fill the system, an excessive duty cycle, or excessive air leakage.]

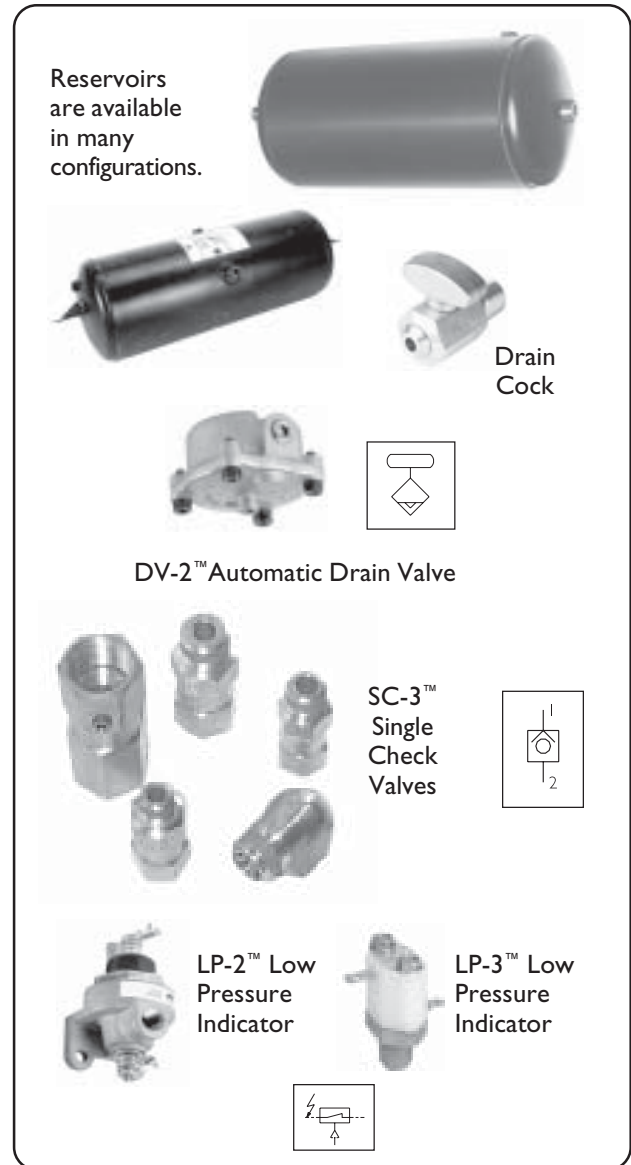
Manual draining devices consist of drain cocks which require manual operation at the point at which they are installed. Drain cocks are available in various styles and pipe thread sizes. [Tip: Always drain contents slowly for best results.]

The Bendix® DV-2™ automatic reservoir drain valve is a completely automatic draining device. It is installed directly into the end or bottom drain port of the reservoir and does not require any additional control lines. It is available in either an end-port or bottom-port version, and with or without a (12v or 24v) heater. These are most suitable for systems without a desiccant air dryer.

Single Check Valves

The in-line single check valve allows air flow in one direction only. Several sizes and configurations are available to accommodate various piping arrangements. Single check valves are used in air brake systems to prevent loss of remaining system pressure if another reservoir, or hose etc. upstream in the system fails.

For double check valves and pressure protection valves, see page 14.



Low Pressure Indicators

Low pressure indicators are pressure-operated electro-pneumatic switches that are designed to complete an electrical circuit and actuate a warning light and buzzer for the driver in the event air pressure in the service brake system is below a minimum level for normal operation. The low pressure indicator is available in various pressure settings, is not adjustable, and is generally used in conjunction with a dash mounted warning lamp or warning buzzer or both.

Air Dryers

The air dryer is an in-line filtration system that removes both water vapor and oil droplets from the compressor discharge air after it leaves the compressor. This results in cleaner, drier air being supplied to the air brake system, and aids in the prevention of air line and component freeze-ups in winter weather.

Air dryers typically use a replaceable cartridge containing a desiccant material and an oil separator. Most of the oil droplets are removed by the oil separator as the air passes into the air dryer. The air then moves through the desiccant material which removes most of the water vapor.

When the air pressure in the supply air tank reaches the required level, the governor makes the compressor stop building air and allows the air dryer's "purge cycle" to begin. During the purge cycle the desiccant material is regenerated (its ability to remove water is renewed) by a reversal of the saturation process. A small amount of dry air passes back through the desiccant material and the water that has been collected, as well as any oil droplets collected by the oil separator, are purged out through the base of the dryer. It is normal to see a small amount of oil around the purge valve.

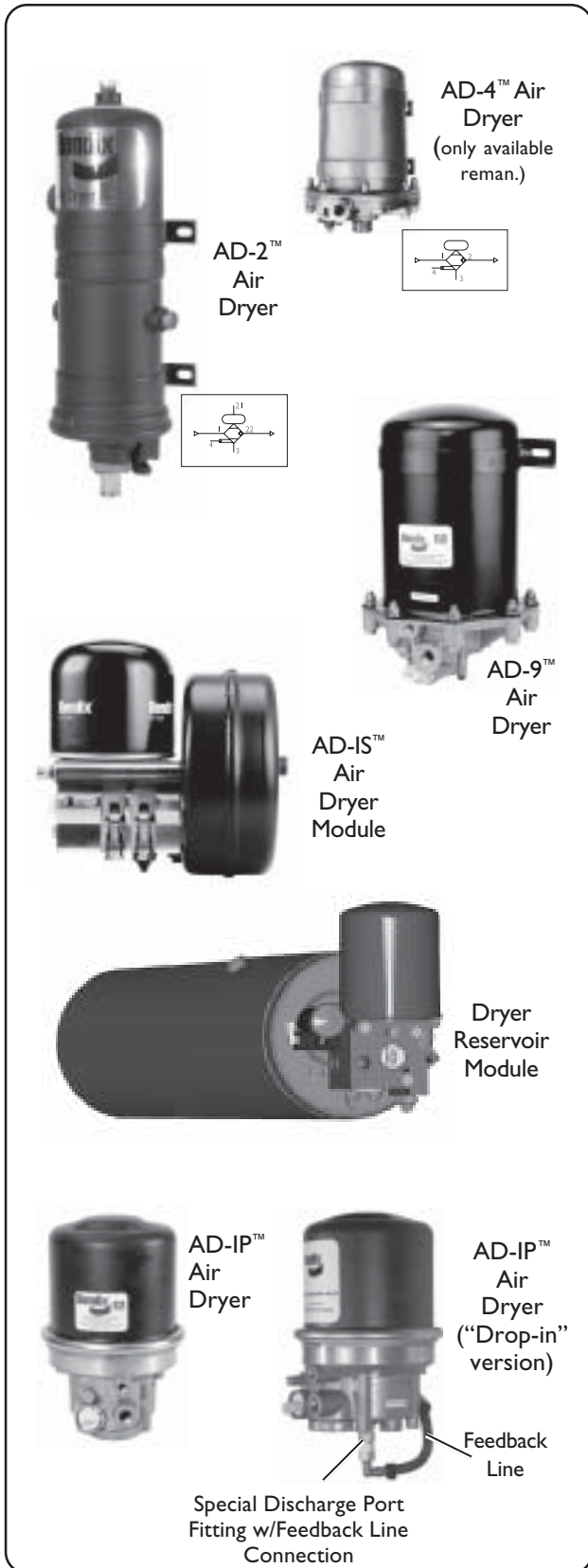
The air dryer end cover is typically equipped with an (12 or 24 volt) integral heating element.

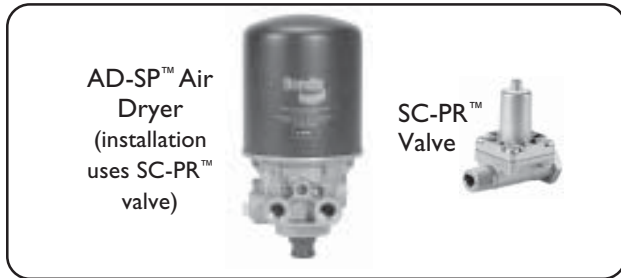
The **AD-2™**, **AD-4™**, **AD-9™** and **AD-IP™** air dryers are designed with an internal storage ("purge volume") of dry air for the purge cycle.

The **AD-IS™** air dryer is an integral purge air dryer module, which includes a spin-on desiccant cartridge, governor, reservoir and charging valve components in a module. These have been designed as an integrated air supply system. The **DRM™** module includes an AD-IS™ integrated solution air dryer, a reservoir (including a separate purge reservoir section), a governor, and four pressure protection valves as an integrated air supply system.

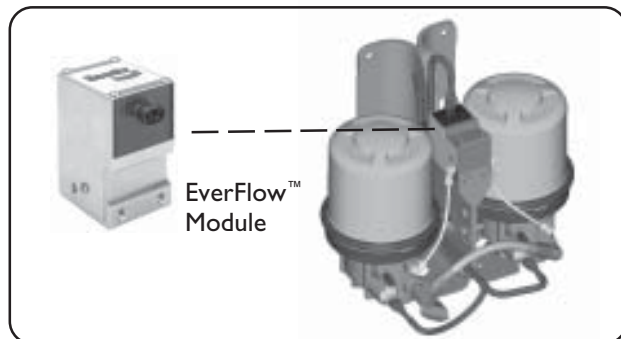
"Extended Purge" air dryers are designed with an extra amount of air storage internally that is used to assist in the purge cycle. An example is the **AD-IP™ EP** air dryer.

Several Bendix air dryers are available in specialized **"Drop-in"** versions designed especially for air systems that use either the Holset (Cummins) Type E or QE air compressor. These Holset compressors utilize an unusual unloading system that requires that air pressure remain in the discharge line during the entire unloaded cycle of the compressor. For example, the AD-IP™ "Drop-in" version is shown here.





The **AD-SP™ air dryer** uses a small amount of air from the supply and front axle (secondary) reservoirs to perform the purge function. Because of this difference, the AD-SP™ air dryer is smaller and lighter than air dryers that have their purge volume within the dryer canister. An **SC-PR™ Single Check Protection Valve** is used in conjunction with the AD-SP™ air dryer. The SC-PR™ single check protection valve is a combination of two separate devices, a single check valve and a pressure protection valve that allows limited flow in the opposite direction. It serves as a means of protecting the air pressure in the front axle service reservoir, since it will only allow its air supply to be used to help purge the AD-SP™ air dryer if the pressure is above a certain preset level.

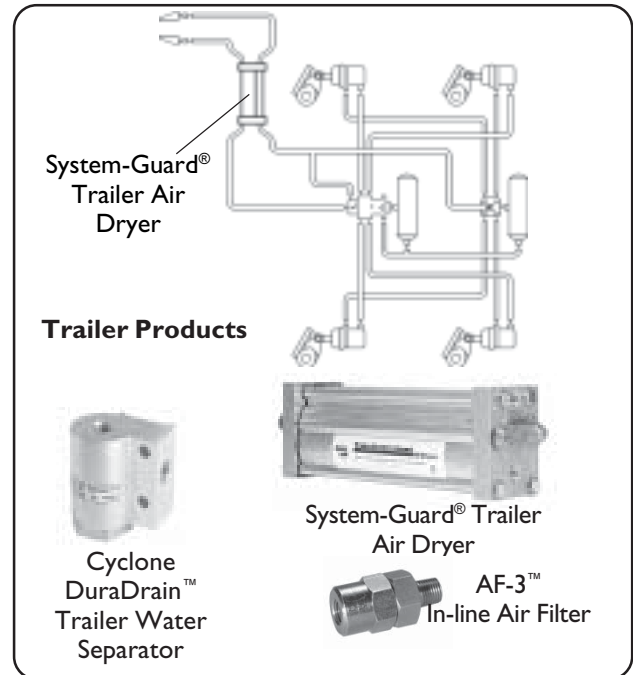


EverFlow™ Module

The EverFlow™ air dryer module is used for air dryer systems where a vehicle needs a continuous flow of air, such as for bulk unloaders and central tire inflation. As stated earlier, air dryers need to go through a purge cycle periodically to refresh the moisture-removing desiccant material. EverFlow™ air dryer modules have two air dryers plumbed in parallel that take turns supplying air, resulting in a continuous, uninterrupted supply.

System-Guard® Trailer Air Dryer

The System-Guard® trailer air dryer removes moisture and contaminants from the trailer air system. It is designed to protect the trailer air brake system when, for short periods of time, the trailer is pulled by vehicles without an air dryer or during times when the trailer is disconnected from the tractor. It does not take the



place of a dryer normally located on the power unit, but acts as a buffer to remove moisture during wet times and gives up moisture during dry times.



PuraGuard® Filters

The PuraGuard® QC™ oil coalescing filter (and its predecessor PuraGuard® system filter) are for high air use vehicles such as transit buses and refuse trucks. Installed downstream of the air dryer, these filters use a replaceable filter element mounted within a sump housing to remove oil aerosols before they can enter the air system. A drain valve allows periodic maintenance.

Cyclone DuraDrain™ Trailer Water Separator

The Cyclone DuraDrain™ trailer water separator is installed in the trailer control and/or supply lines near the gladhands. It self-purges liquid contaminants, contains solid contaminants and improves the life of the trailer system components.

AF-3™ In-line Air Filter

The AF-3™ in-line air filter screens out foreign material from trailer air lines.

A **double check valve** is used in the air system when a single function or component must receive air from, or be controlled by, the higher of two sources of pressure. An internal disc or shuttle moves in response to the higher air pressure and allows that air source to flow out of the delivery port. It is recommended that double check valves be mounted so that the shuttle (or disc) operates horizontally.

While not strictly part of the charging system, the **DS-2™ double check valve and stop light switch** (shown on this page) performs the function of both a stop lamp switch and a double check valve. In some vehicle brake systems, it is used to detect air pressure from either brake circuit source, and will operate the stop lamp switch, lighting the stop lamps.

Auxiliary Systems

Vehicle auxiliary components and systems (air actuated wipers, suspension, etc.) requiring compressed air must wait until the reservoirs in the charging system have reached a predefined minimum pressure, sufficient for braking purposes. Once the system has reached the preset minimum, pressure protection valves open to supply auxiliary systems.

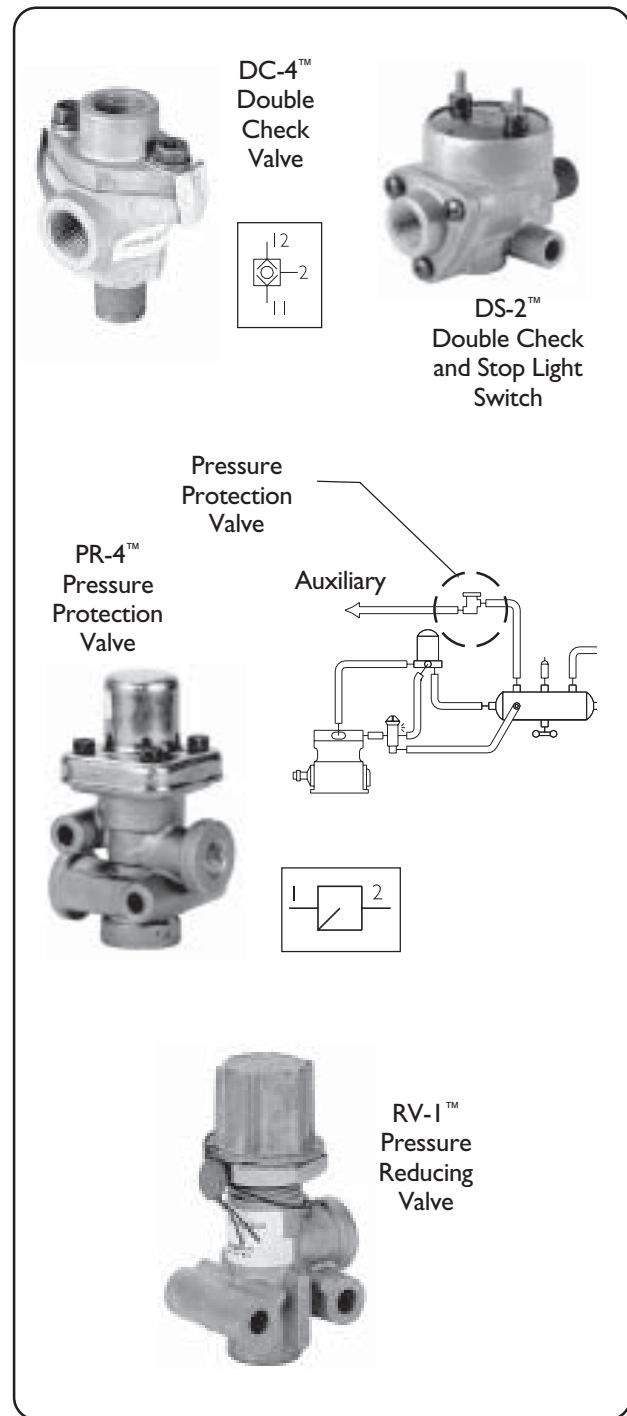
Pressure Protection Valves

The **pressure protection valve** is a normally-closed pressure sensitive control valve. These valves can be used in many different applications but are typically used to protect or isolate one reservoir from another, by closing automatically at a preset pressure. The valve is also commonly used to delay the filling of auxiliary reservoirs until a preset pressure is achieved in the primary or braking reservoirs. Pressure protection valves allow air to be "shared" between two reservoirs above the closing setting of the valve. The sharing ceases when pressure drops below the closing pressure of the valve and the reservoirs are then isolated from each other.

The **PR-2™ pressure protection valve** is externally adjustable, while the **PR-4™ pressure protection valve** (shown) has a fixed setting. Both valves are available in various factory preset pressure settings. The **PR-3™ pressure protection valve** differs from the two previously mentioned since its design includes a check valve preventing air return.

Pressure Reducing Valves

The **pressure reducing valve** is used in various applications where a constant set air pressure lower than supply pressure is required. A typical application is an air operated accessory that requires less than system pressure for operation. The **RV-1™ pressure**



reducing valve (shown) is available in a wide range of pressure settings and can be manually adjusted. The **RV-3™ pressure reducing valve** is available with factory preset pressure settings only and cannot be manually adjusted.



Audio Visual Programs

Number to Order	Description	Package Quantity	Cost \$ Per Item	Format
Air Brake Systems				
BW1673	Four-part Video System Training with Workbooks	1 set	30.00	VHS/Book
BW1678	Workbook for BW1673	5	2.00	Book
BW1957	Four-part Video only	1	15.00	VHS
BW2219	Vision systems installation	1	5.00	VHS
BW2324	Air Leakage	1	10.00	VHS

Brochures & Product Sheets

Actuating Devices

BW2116	Spring Brake	25	0	Product Sheet
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Air Dryers

BW2023	AD-IP™ System-Guard® Air Dryer	25	0	Product Sheet
BW2075	PuraGuard® System Filter	25	0	Product Sheet
BW2076	EverFlow™ Air Dryer Control Module	25	0	Product Sheet
BW2088	AD-9™ System-Guard® Air Dryer	25	0	Product Sheet
BW2213	AD-IS™ Air Dryer	25	0	Product Sheet

Air Disc Brakes

BW2015	Air Disc Brakes	25	0	Brochure
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AntiLock

BW2019	Truck/Tractor/Bus AntiLock Braking Systems	25	0	Product Sheet
BW2020	Trailer AntiLock Braking Systems	25	0	Product Sheet

Hydraulics

BW1399	Troubleshooting the Vacuum Hydraulic Brake System	25	0	Brochure
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Modules

BW2096	Dryer Reservoir Module	25	0	Product Sheet
BW2132	Autobrake Product Sheet	25	0	Product Sheet

Slack Adjusters

BW1268	ASA-5™ Automatic Slack Adjuster	25	0	Brochure
BW1641	ASA-5™ Installation Template	10	0	Template
BW2216	SureStroke™ Indicator	25	0	Product Sheet

Valves

BW2047	Genuine Bendix Valves	25	0	Product Sheet
BW2197	BVA-85™ Brake Valve Actuator	25	0	Product Sheet
BW2215	Coreless™ Valves	25	0	Product Sheet

Vision

BW2245	Vision	25	0	Brochure
BW2246	Vision	25	0	Product Sheet

Catalogs/Service Manuals/CDs

BW1114	Quick Reference	25	0	Catalog
BW1419	FMSI Book	1	1.25	Catalog
BW2231	Truck Products Catalog	5	0	Catalog
BW9000	Air & Hydraulic Catalog Complete	1	15.00	Catalog
BW9001	Air & Hydraulic Complete Catalog w/o Binder	1	12.00	Catalog
BW9100	Air Parts Catalog Only	1	10.00	Catalog
BW9200	Hydraulic Parts Catalog Only	1	10.00	Catalog

Service Information

BW2031	Service Manual - CD	1	5.00	CD
BW5057	Air Brake Handbook	10	0	Handbook
BW9600	Service Data Manual Complete	1	15.00	SD



Number to Order	Description	Package Quantity	Cost \$ Per Item	Format
Binders				
BW1532	Empty Binder for Catalog, Service Manual & Bulletins . . .	1	5.00	Catalog
Troubleshooting Cards & Wall Charts				
Systems-Air				
BW902	Bus System Wall Chart	3	1.25	Wall Chart
BW1555	Air Pressure Balance Test	10	0	Card
BW1231	Dual Systems Wallchart	3	1.25	Card
BW1396	Dual Systems Troubleshooting Card	25	1.25	Card
BW1397	Coach w/DD-3™ Park System & Coach w/Spring Brake Park System	25	1.25	Card
BW1779	Troubleshooting Charging & Air Supply Systems	25	1.25	Card
Systems-Hydraulic				
BW1398	Vacuum Hydraulic Wall Chart	3	1.25	Wall Chart
BW1611	Power Hyd. Brake Systems Wall Chart	3	1.25	Wall Chart
BW1705	Hydraulic Brake Booster System Card w/Troubleshooting	25	1.25	Card
AntiLock				
BW1742	MC-12™ Trailer AntiLock System Troubleshooting Card	25	1.25	Card
BW1959	MC-12™ Trailer ABS - Troubleshooting Card	50	2.50	Card
BW1982	EC-17™ Troubleshooting Card	50	2.50	Card
BW2175	EC-30™ Troubleshooting Card	25	1.25	Card
BW2187	MC-30™ Troubleshooting Card	25	1.25	Card
Cores				
BW1299	Core Group	3	0	Wall Chart
BW1330	Mini Core Chart	25	0	Wall Chart

Bendix reserves the right to limit quantities and cannot guarantee availability.

Service Data Sheets

Download from www.bendix.com, order (like parts) by BW number,
or order the complete Service Data Catalog (BW9600)

Device	SD number ...	(BW #)	Device	SD number ...	(BW #)
A-18™ Trailer ABS			EC-14™ Antilock Controller Assy	SD-13-4784	.. (BW1670)
(Gen 4™ and Gen 5™ ABS)	SD-13-4757	.. (BW2262)	EC-15™ Antilock Controller Assy	SD-13-4785	.. (BW1663)
A2LS™ Hydraulic Drum Brakes			EC-16™ Antilock Traction ECU	SD-13-4787	.. (BW1726)
With Parking	SD-20-6608	.. (BW1601)	EC-17™ Antilock Traction ECU	SD-13-4788	.. (BW1910)
AD-1™ & AD-2™ Air Dryers	SD-08-2403	.. (BW1597)	EC-30™ Antilock Traction ECU	SD-13-4815	.. (BW2160)
AD-4™ Air Dryer	SD-08-2407	.. (BW1450)	EC-60™ ABS/ATC Controllers	SD-13-4863	.. (BW2428)
AD-9™ Air Dryer	SD-08-2412	.. (BW1627)	ET-2™ Electronic Throttle	SD-15-4106	.. (BW1650)
AD-IP™ Air Dryer	SD-08-2414	.. (BW1811)	ET-S™ & ET-S2™ Suspended		
AD-IS™ Air Dryer	SD-08-2418	.. (BW2234)	Electronic Treadles	SD-15-4111	.. (BW1837)
AD-SP™ Air Dryer	SD-08-2415	.. (BW1777)	FD-1™ Fan Clutch	SD-09-8501	.. (BW1451)
AF-3™ In-line Filter Assembly	SD-08-2401	.. (BW2263)	FD-2™ Fan Clutch	SD-09-8503	.. (BW1598)
AH-1B™ Air Hydraulic Intensifier	SD-11-1326	.. (BW1599)	FD-3™ TorqueMaster Fan Clutch	SD-09-8504	.. (BW1452)
AH-4™ Air Hydraulic Intensifier	SD-11-1357	.. (BW1455)	FD-L™ Fan Clutch	SD-09-8505	.. (BW1603)
Air Disc Brake	SD-23-7550	.. (BW2000)	Gen 4™ and Gen 5™ ABS for		
Air Horns	SD-06-130	.. (BW1592)	Trucks, Tractors, and Buses	SD-13-4746	.. (BW2261)
AR-1™ Antilock Relay Valve	SD-13-4795	.. (BW1665)	Hydro-Max Power Brake System	SD-20-6602	.. (BW1485)
AR-2™ Antilock Relay Valve	SD-13-4796	.. (BW1672)	IRV™ Inlet Regulating Valve	SD-01-3408	.. (BW1552)
ASA-5™ Automatic Slack Adjuster	SD-05-1269	.. (BW1602)	LP-2™ & LP-3™ Low Pressure		
ATR-IDC™ Antilock Traction			Indicators	SD-06-1600	.. (BW1447)
Relay Valve	SD-13-4811A	.. (BW1969)	LQ-2™ Valve & TW-1™ Control		
ATR-1™ Antilock Traction			Valve	SD-03-950	.. (BW1439)
Relay Valve	SD-13-4811	.. (BW1794)	LQ-3™ & LQ-4™ Front Axle Ratio		
ATR-2™ Antilock Traction			Valves	SD-03-951	.. (BW1573)
Relay Valve	SD-13-4812	.. (BW1791)	LQ-5™ Bobtail Ratio Valve	SD-03-953	.. (BW1625)
BP-1™ Brake Proportioning Valve	SD-03-952	.. (BW1554)	M-12™ Antilock Modulator	SD-13-4772	.. (BW1669)
BP-R1™ Bobtail Proportioning			M-21™ Antilock Modulator	SD-13-4793	.. (BW1664)
Relay Valve	SD-03-1067	.. (BW1624)	M-30™ Antilock Modulator Assy	SD-13-4830	.. (BW2085)
BX-2150™ Compressor	SD-01-331	.. (BW1424)	M-32™ and M-32QR™ Antilock		
C-5™ Cut-Out Cock	SD-07-2601	.. (BW1596)	Modulator Assemblies	SD-13-4870	.. (BW2335)
D-2™ Governor	SD-01-503	.. (BW1425)	Manual Slack Adjuster	SD-05-1200	.. (BW1453)
DD3® & SD-3™ Safety Actuators	SD-02-4600	.. (BW1563)	MC-11™ Trailer Antilock	SD-13-4761	.. (BW1671)
Double Anchor Pin Cam Brakes	SD-22-3260	.. (BW1459)	MC-12™ Trailer Antilock	SD-13-4762	.. (BW1667)
Double Check Valves	SD-03-2202	.. (BW1846)	MC-30™ Trailer ABS Controller Assy	SD-13-4834	.. (BW2189)
DRM™ Dryer Reservoir Module	SD-98-9808	.. (BW1948)	MV-2™ Module Control Module	SD-03-3412	.. (BW1584)
DuraFlo™ 596 Compressor	SD-01-670	.. (BW1845)	MV-3™ Module Dash Control Module	SD-03-3415	.. (BW1613)
DV-2™ Automatic Reservoir			Piggyback Spring Brake	SD-02-4500	.. (BW2106)
Drain Valve	SD-03-2501	.. (BW1457)	PP-1™, PP-2™, PP-5™, PP-8™, &		
E-10PR™ Retarder Control			RD-3™ Push-Pull Type Control Valves	SD-03-3611	.. (BW1578)
Brake Valve	SD-03-832	.. (BW2159)	PP-3™ Trailer Supply Valve	SD-03-3613	.. (BW1437)
E-12™ & E-15™ Dual Brake Valve	SD-03-826	.. (BW1622)	PP-7™ Trailer Supply Valve	SD-03-3617	.. (BW1579)
E-14™ Dual Brake Valve	SD-03-828	.. (BW1666)	PP-DC™ Park Control Valve	SD-03-3619	.. (BW1739)
E-2™ & E-3™ Brake Valve	SD-03-812	.. (BW1564)	PR-2™, PR-3™ & PR-4™ Pressure		
E-5™ Dual Brake Valve	SD-03-816	.. (BW1565)	Protection Valves	SD-03-2010	.. (BW1440)
E-6™ & E-10™ Dual Brake Valve	SD-03-817	.. (BW1427)	PuraGuard® QC™ Oil Coalescing Filter	SD-08-187B	.. (BW2396)
E-7™ Dual Brake Valve	SD-03-818	.. (BW1428)	PuraGuard® System Filter	SD-08-187	.. (BW2084)
E-8P™ & E-10P™ Dual Brake Valve	SD-03-830	.. (BW2066)	QR-1C™ Quick Release Valve		
EC-13™ Antilock Controller Assy	SD-13-4783	.. (BW1823)	w/Double Check	SD-03-904	.. (BW1585)

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Device	SD number ..	(BW #)	Device	SD number ..	(BW #)
QR-L™ Quick Release Valve – Inline	SD-03-906 ..	(BW1808)	TC-2™ Trailer Control Brake Valve	SD-03-813 ..	(BW1430)
QRN-2™ Quick Release Valve	SD-03-907 ..	(BW1786)	TC-4™ Modulating Control Valve	SD-03-4503 ..	(BW1566)
QR-N™ Quick Release Valve	SD-03-905 ..	(BW1586)	TC-6™ Trailer Control Brake Valve	SD-03-821 ..	(BW1567)
QRV™ & QR-1™ Quick Release Valve	SD-03-901 ..	(BW1442)	TC-7™ Trailer Control Brake Valve	SD-03-824 ..	(BW1568)
R-12DC™ Relay Valve with Biased			TE-1™ Trailer Emergency Stop Light		
Double Check	SD-03-1068 ..	(BW1933)	Switch	SD-06-1801 ..	(BW1595)
R-12P™ Pilot Relay Valve	SD-03-1063 ..	(BW1711)	TP-2™ Tractor Protection Valve	SD-03-3651 ..	(BW1436)
R-12™ & R-14™ Relay Valve	SD-03-1064 ..	(BW1431)	TP-3DC™ Tractor Protection Valve		
R-6™ Relay Valve	SD-03-1060 ..	(BW1432)	w/Double Check	SD-03-3656 ..	(BW1760)
R-7™ Modulating Valve	SD-03-4504 ..	(BW1445)	TP-3™ Tractor Protection Valve	SD-03-3652 ..	(BW1572)
R-8P™ Pilot Relay Valve	SD-03-1061A ..	(BW1660)	TP-4™ Tractor Protection Valve	SD-03-3653 ..	(BW1438)
R-8™ Relay Valve	SD-03-1061 ..	(BW1569)	TP-5™ Tractor Protection Valve	SD-03-3655 ..	(BW1575)
RE-6™ & RE-6NC™ Relay			TR-2™, TR-3™ & TR-4™ Inversion		
Emergency Valves	SD-03-1151 ..	(BW1570)	Valves	SD-03-4650 ..	(BW1581)
Reservoirs	SD-04-400 ..	(BW1590)	Trailer System-Guard™ Air Dryer	SD-08-2416 ..	(BW2083)
RV-1™ Pressure Reducing Valve	SD-03-3510 ..	(BW1577)	Tu-Flo® 400, 500 & 1000 Compressors	SD-01-326 ..	(BW1420)
RV-3™ Pressure Reducing Valve	SD-03-3515 ..	(BW1587)	Tu-Flo® 501 Compressor	SD-01-337 ..	(BW1421)
RV-4™ Pressure Reducing Valve	SD-03-3520 ..	(BW1588)	Tu-Flo® 550 Compressor	SD-01-333 ..	(BW1639)
SC-1™ Single Check Valves	SD-03-2201 ..	(BW1441)	Tu-Flo® 600 Compressor	SD-01-336 ..	(BW1560)
SC-3™ In-Line Single Check Valve	SD-03-2205 ..	(BW1892)	Tu-Flo® 700 Compressor	SD-01-335 ..	(BW1422)
Single Anchor Pin Cam Brake	SD-22-3250 ..	(BW1458)	Tu-Flo® 750 Compressor	SD-01-344 ..	(BW1637)
SL-3™ & SL-4™ Stop Light Switches	SD-06-1800 ..	(BW1593)	TW-1™, TW-3™, TW-4™, TW-5™ &		
SL-5™ Switch & DS-2™ Stop Light			TW-6™ Two Way Control Valves	SD-03-3602 ..	(BW1580)
Switch & Combined Stop Light Switch &			TW-N™ Two Way Control Valve	SD-03-3672 ..	(BW1444)
Double Check Valves	SD-06-1804 ..	(BW1594)	Type 9, 12, 16, 20, 24 & 36 Brake		
SR-1™ Spring Brake Valve	SD-03-4508 ..	(BW1589)	Chambers	SD-02-1302 ..	(BW1426)
SR-2™ Trailer Spring Brake Valve	SD-03-4510 ..	(BW1435)	Type 9, 12, 16, 20, 24, 36 & 50		
SR-4™ Spring Brake Control Valve	SD-03-4514 ..	(BW1571)	Rotochambers	SD-02-1336 ..	(BW1561)
SR-5™ Trailer Spring Brake Valve	SD-03-4516 ..	(BW1680)	WS-20™ Antilock Wheel Speed Sensor	SD-13-4754 ..	(BW1662)
SR-7™ Spring Brake Modulating Valve	SD-03-9043 ..	(BW2271)	WS-24™ Antilock Wheel Speed Sensor	SD-13-4860 ..	(BW2364)
ST-1™ & ST-3™ Safety Valves	SD-03-1901 ..	(BW1583)	XVision® Vision System	SD-19-5160 ..	(BW2212)
SV-1™, SV-3™ & SV-4™ Synchro Valve &					
Trailer Release Valves	SD-03-4020 ..	(BW1574)			

Contact Bendix

For questions about troubleshooting, part number cross-reference, etc. call the Tech Team at 1-800-AIR-BRAKE or e-mail to TBS.TechTeam@bendix.com

See the Contacts area of www.bendix.com for contact information for Bendix dealers and distributors, Service Engineers, and Account Managers.

For ABS questions, please e-mail to ABS@Bendix.com.

For all other inquiries, please e-mail to info@bendix.com.

About Bendix Commercial Vehicle Systems LLC

We supply air brake charging and control systems and components, vehicle modules, and leading-edge safety technologies under the Bendix® brand name for medium- and heavy-duty trucks, tractors, trailers, buses and other commercial vehicles in North America, Europe and Australia. Employing more than 1,800 people, Bendix is headquartered in Elyria, Ohio, with manufacturing plants in the U.S. and Mexico.

We are part of a global organization with technical and manufacturing centers worldwide, and remain on the leading edge of new product development and applications engineering.

Bendix products are backed by our TechTeam - a team of air brake experts who staff our 1-800-AIR-BRAKE (1-800-247-2725) hotline.

We also invite you to visit www.bendix.com for all the latest information on our products.

Our Service Engineers provide on- and off-site technical training. See the Training area of [bendix.com](http://www.bendix.com) for a list of current dates and locations.

A Brief History of Bendix Commercial Vehicle Systems LLC

- 1869: Westinghouse Air Brake Company established in Wilmerding, Pa., to manufacture air brakes invented by George Westinghouse.
- 1924: Westinghouse air brake system (including Broussouse compressor) applied to International Harvester Coach in Akron, Oh.
- 1927: Bendix Corporation formed by automotive engineer Vincent Bendix. Company produces "Safety Servo" vacuum brake under the Braggs-Kliesrath name.
- 1930: Bendix-Westinghouse Automotive Air Brake Company established following the merger of Bendix Corp. and Westinghouse Automotive Air Brake. Headquarters located in Wilmerding, Pa.
- 1934: Bendix-Westinghouse takes automotive air brake worldwide by establishing licensing agreements with Westinghouse companies in France, Germany, Italy and England.
- 1941: Bendix-Westinghouse establishes new headquarters in Elyria, Oh.
- 1949: WWII accelerates developments, and air braking becomes standard on all heavy trucks, tractor-trailers, buses, fire trucks and off-highway vehicles.
- 1960: Automatic slack adjusters, air dryers, dual brake valves and first generation antilock braking systems are under development.
- 1969: Bendix Corporation acquires 100 percent ownership of Bendix-Westinghouse.
- 1973: Bendix-Westinghouse becomes Bendix Heavy Vehicle Systems Group, a division of Bendix Corporation.
- 1975: Bendix dual air brake system becomes standard for the National Highway Traffic Safety Administration's Federal Motor Vehicle Safety Standard (FMVSS) 121.
- 1980: Bendix establishes worldwide parts distribution center and remanufacturing operation in Huntington, In.
- 1982: Bendix Corporation merges with Allied Corporation and the division becomes an operating unit of Allied Automotive, an independent supplier to the worldwide automotive industry under the brand names of Bendix®, Fram® and Autolite®.
- 1986: The Bendix Heavy Vehicle Systems Group of Allied merges with Bendix Limited European truck air brake operation establishing Bendix Heavy Vehicle Systems Group-Europe. Allied Corporation acquires Signal operations establishing AlliedSignal Inc. as the division's parent company.
- 1989: Bendix Heavy Vehicle Systems Group-Europe acquires truck air brake operation of Magneti Marelli, strengthening European operations.
- 1999: AlliedSignal merges with Honeywell International. The new company continues to offer Bendix® brand name air brake and control systems and components under its Honeywell Commercial Vehicle Systems unit. Honeywell operates Honeywell Commercial Vehicle Systems as a joint venture with Knorr-Bremse AG of Munich, Germany. Honeywell owns 65 percent of the unit. Knorr-Bremse owns 35 percent.
- 2002: Knorr-Bremse assumes 100 percent ownership of Honeywell Commercial Vehicle Systems from Honeywell International Inc. The company changes its legal name to Bendix Commercial Vehicle Systems LLC.