GB-152-AF™

Gas Booster With Control Kit

Operation and Maintenance Manual

NSN 6685-01-529-6990 RN
(3 of 3)

This equipment described in this manual is designed and manufactured for the intended purpose of generating high pressure gas. Certain precautions need to be followed during installation and operation of this device. Reading and understanding this material is essential to the safe and correct operation of the unit.

Pressurized equipment is potentially dangerous. The equipment described in this manual generates and controls very high gas pressures. It should not be operated by anyone who has not become thoroughly familiar with this manual. Additional training in general and pressure specific safety procedures will help assure protection from harm or damage to personnel or property. Responsibility for the proper and safe operation of this instrument rests with the user.

High pressure liquids and gases are potentially hazardous. Energy stored in these liquids and gases can be released unexpectedly and with extreme force. High pressure systems should be assembled and operated only by personnel who have been instructed in proper safety practices.

This instrument is not to be operated in any other manner than that specified by the manufacturer.

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ABOUT THIS MANUAL

GB-152-AF is usually delivered as part of an PGC-10000-AF system which also includes an RPM4 A70M/A20M-AF reference pressure monitor and a GPC1-1000-AF pressure controller. The RPM4/HPMS and GPC1 have their own Operation and Maintenance Manuals.

Manual Conventions

(CAUTION) is used in throughout the manual to identify user warnings and cautions.

(NOTE) is used throughout the manual to identify operating and applications advice and additional explanations.

NOTES

1. INTRODUCTION

1.1 PRODUCT OVERVIEW

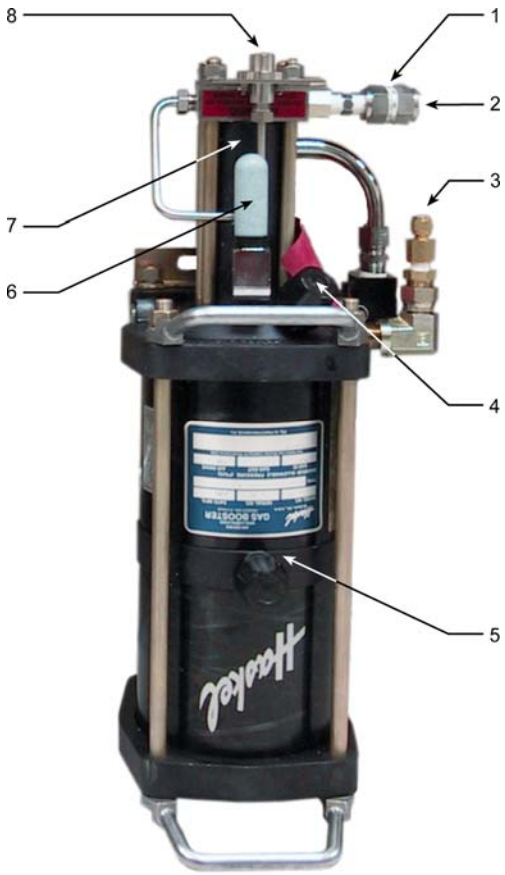
The GB-152-AF gas booster with control kit is intended to provide very high pressure gas supply in a PGC-10000-AF Pneumatic Gauge Calibration System.

The GB-152-AF includes a pneumatically driven, piston type, self-cycling gas booster. The gas booster boosts a lower pressure, generally supplied from a bottle (300 psi (20 MPa) minimum), to higher pressure. The booster is powered by drive air. The high pressure output is approximately equal to the drive air input times the nominal boosting ratio of 152. In the PGC-10000-AF system, the high pressure output is connected to the SUPPLY port of a GPC1-10000-AF Gas Pressure Controller.

The GB-152 also includes a drive air control kit and interconnecting tubing. The kit is on a bracket that can be mounted at a convenient location remote from the booster itself.

1.2 LOCATION AND DESCRIPTION OF THE COMPONENTS

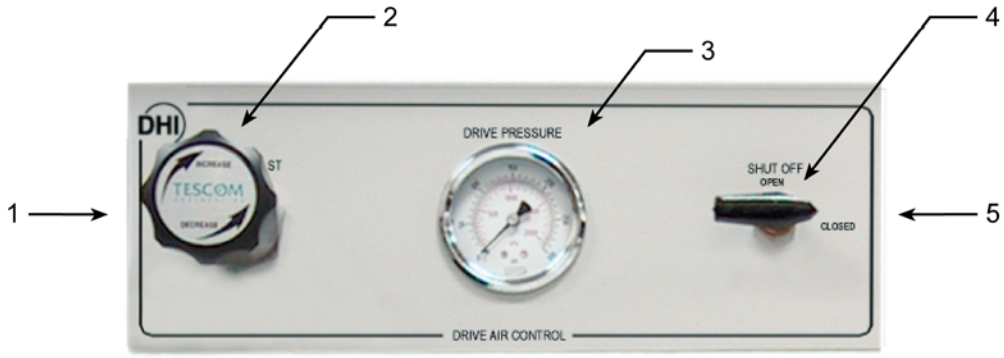
1.2.1 GAS BOOSTER



1. High pressure instrument gas filter
2. High pressure instrument gas supply port
3. Drive air supply port (from Drive Air Control Kit)
4. Breather port
5. Low pressure piston body
6. Muffler
7. High pressure piston body
8. High pressure output port

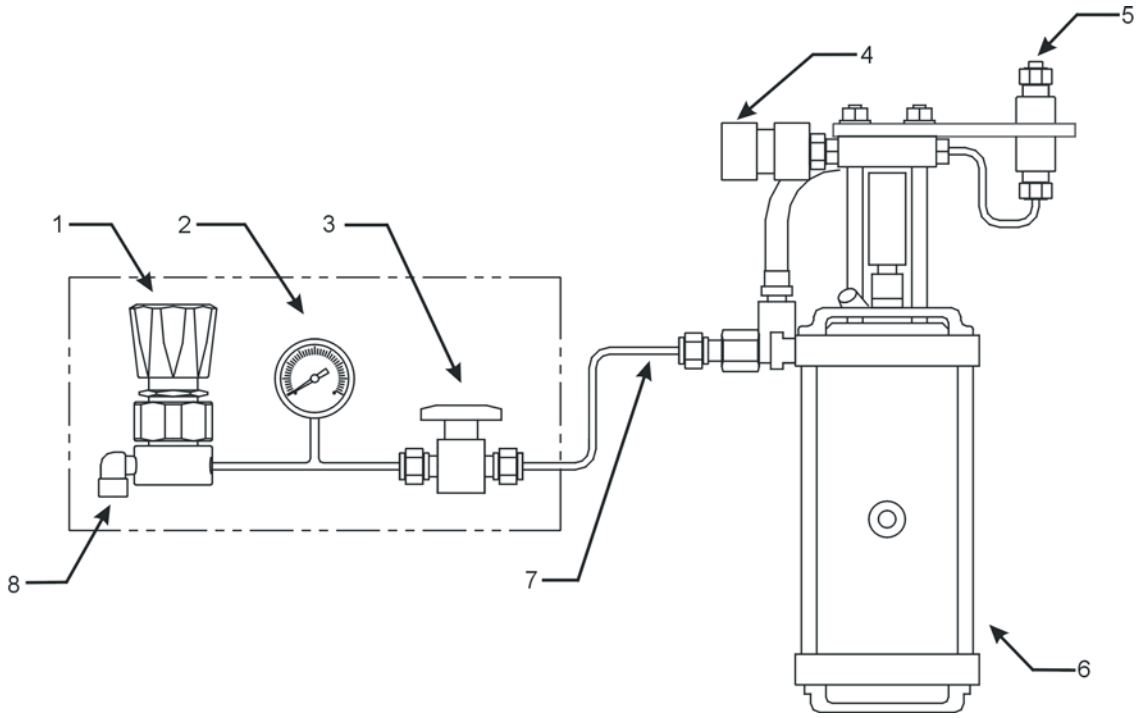
Figure 1. GB-152-AF Gas Booster

1.2.2 DRIVE AIR CONTROL KIT



1. Drive air supply connection (not visible)
2. Drive pressure adjust regulator
3. Drive pressure indication gauge
4. Drive air shut off valve
5. Drive air out connection, to booster (not visible)

Figure 2. Drive air control kit



1. Drive pressure adjust regulator
2 Drive pressure indicator gauge
3. Drive air shutoff valve
4. High pressure instrument gas supply port
5. High pressure outlet port (to GPC1-10000-AF SUPPLY port)
6. Booster pump
7. 1/4 in. PFA tubing
8. Drive air inlet port

Figure 3. System schematic

1.3 SPECIFICATIONS

Dimensions:	GB-152 Booster:	584 mm H x 241 mm W x 241 mm D (23 in. x 9.5 in. x 9.5 in.)
Weight:	GB-152 Booster:	16.4 kg (36 lbs)
	Drive Air Control Kit:	1.8 kg (4 lbs)
Pressure Supply Pressure Range:	Shop Drive Air:	75 psi (500 kPa) Maximum high pressure output is drive air pressure times 152
	High Pressure Supply Gas:	400 to 3 000 psi (3 to 20 MPa) Maximum high pressure output is high pressure supply times 25
Supply Flow Rates:	Shop Drive Air:	15 to 75 scfm (425 to 2 125 slm)
	High Pressure Supply Gas:	5 to 20 scfm (140 to 560 slm)
Pressure Connections:	Drive Air Supply Inlet:	1/4 in. NPT female
	High Pressure Gas Supply Inlet:	1/4 in. NPT female
	High Pressure Outlet:	DH 500 female (DH500 F is a gland and collar type fitting for coned and left hand threaded 1/4 in. (6 mm) OD tube, equivalent to AE F250C, HIP HF4, etc.)
Nominal Booster Piston Ratio:	GB-152 Booster:	152:1
PGC-10000-AF SYSTEM		
Temperature:	Operating:	18 to 28 °C
	Storage:	-20 to 70 °C
Relative Humidity:	Operating:	15 to 70%RH (non-condensing)
	Storage:	10 to 90%RH (non-condensing)

2. INSTALLATION

2.1 UNPACKING AND INSPECTION

The GB-152-AF booster is delivered enclosed in plastic bag and secured by foam in place in a corrugated box. The Drive Air Control Kit and Interconnections Kit are included in the same box.

Remove all parts from the shipping box and plastic bag. Be sure not to lose or discard the Drive Air Control Kit and Interconnections Kit.

Inspect all parts for damage. If damage is noted, report it to your Receiving Department for appropriate action.

A new GB-152-AF includes all items listed in Table 1.

Table 1. GB-152-AF Parts List

DESCRIPTION		PART NO.
GB-152-AF Gas Booster		402163
ACCESSORIES		
1 ea.	PGC-10000-AF Documentation Disk including: • RPM4/HPMS A70M/A20M-AF Operation and Maintenance Manual, p/n 550136 • GPC1-10000-AF Operation and Maintenance Manual, p/n 550135 • **GB-152-AF Operation and Maintenance Manual, p/n 550137**	402189 **(Shipped with RPM4/HPMS accessories in transport case)**
1 ea.	Drive Air Control Kit	400998
INTERCONNECTIONS KIT:		402162
2 m (6ft)	1/4 in. PFA tubing	101450-Z
1 ea.	Union, DH500	100295
1 ea.	Elbow, DH500	100168
1 ea.	Nipple, 6 in. (152 mm), DH500	100208
1 ea.	Nipple, 60 in. (1524 mm) x 1/8 in. (3 mm) with DH500 tips (coiled)	124199

2.2 PGC-10000-AF SYSTEM

GB-152-AF is usually delivered as the high pressure gas supply component of a PGC-10000-AF Pneumatic Gauge Calibration System. The PGC-10000-AF system includes:

- RPM4/HPMS A70M/A20M-AF: Reference pressure monitor and high pressure mounting system used as the pressure measuring reference of the calibration system.
- GPC1-10000-AF: Gas pressure controller used to set and adjust high pressure gas in the calibration system.
- GB-152-AF: Gas booster package used to supply gas pressure up to 10 000 psi (70 MPa) to the GPC1-10000-AF pressure controller.

Each of the three components of the PGC-10000-AF system has its own Operation and Maintenance Manual and individual setup and start up instructions. Figure 4 shows the typical setup configuration of the complete PGC-10000-AF system.

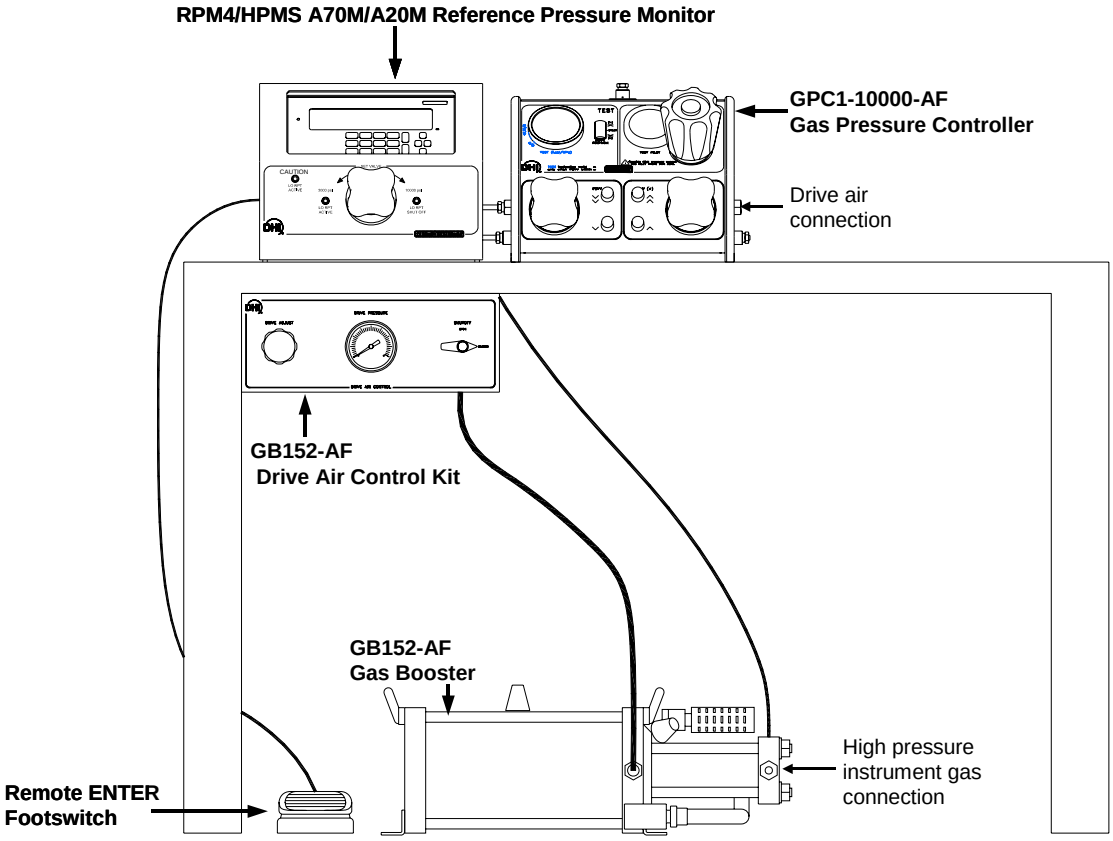


Figure 4. Typical PGC-10000-AF installation layout

2.3 SITE REQUIREMENTS

2.3.1 SITE

There are no special site requirements.

The GB-152-AF gas booster system is divided into two parts: the Gas Booster itself and the Drive Air Control Kit. The two parts are separated so that they may be installed separately.

The gas booster, which is large and relatively noisy, does not need to be accessed regularly. It is generally mounted out of the way, for example under and behind a work bench. The booster may be set horizontally or vertically.

Connections of gas supplies and output need to be considered carefully when selecting the installation site.

See Sections 2.2 and 2.4 for additional recommendations.

2.3.2 GAS SUPPLIES

Two sources of gas pressure are required to operate the gas booster. They are drive air (see Section 2.3.2.1) and high pressure instrument gas (see Section 2.3.2.2).

2.3.2.1 DRIVE AIR SUPPLY

The drive air supply provides power to operate the booster. The booster's very high pressure output is approximately the drive air pressure multiplied by 152. This supply is usually "shop" or "factory" air.

Drive air requirements are:

Flow rate:	15 scfm (425 slm) minimum
Cleanliness:	Not critical, use 60 micron filter
Humidity:	20 to 50 % RH. Do not use dry gas
Pressure:	75 psi (500 kPa)

Depending on the drive pressure set by the DRIVE ADJUST regulator, GB-152-AF may generate pressure over 70 MPa (10 000 psi). To limit the maximum pressure that can be generated by the booster, limit the drive air supply to the Drive Air Control Kit to 75 psi (500 kPa) (see Section 2.3.2.1).

2.3.2.2 HIGH PRESSURE INSTRUMENT GAS

High pressure instrument gas is boosted by the booster and output from the booster high pressure **OUT** port.

High pressure instrument gas supply requirements are:

Flow rate:	5 scfm (140 slm) minimum
Cleanliness:	Use clean, dry instrument grade gases only.
Pressure:	400 to 3 000 psi (2 to 20 MPa) Maximum boosted pressure output is high pressure supply times 25.

2.4 INSTALLATION AND INITIAL SETUP

2.4.1 GENERAL CONSIDERATIONS

If the GB-151-AF is being installed as part of a PGC-10000-AF Pneumatic Gauge Calibration System, see Section 2.2.

The GB-152-AF gas booster system is divided into two parts: the gas booster itself and the Drive Air Control Kit. The two parts are separate so that they may be installed separately.

The gas booster, which is large and relatively noisy, does not need to be accessed regularly. It is generally mounted out of the way, for example under and behind a work bench. The booster may be set horizontally or vertically.

The Drive Air Control Kit allows local control of booster operation. The output pressure of the booster can be set by adjusting the drive air pressure and the **SHUTOFF** valve turns the booster ON and OFF. The Drive Air Control Kit is a bracket meant to be mounted at a location convenient to the operator, for example on the front of a work bench.

When selecting the site for installation of the GB-152-AF gas booster system, carefully consider access for the connections that need to be made (drive air to the Drive Air Control Kit, high pressure instrument gas to the booster, very high pressure gas output from the booster to the GPC1-10000-AF Gas Pressure Controller). Figure 4 presents a typical layout of a complete PGC-10000-AF system, including the GB-152-AF gas booster system.

The orientation of the booster is of no consequence to its operation. It may be installed vertically, horizontally or any combination of the two with no affect on performance or maintenance.

A variety of factors must be considered when determining where to locate the gas booster and the Drive Air Control Kit. Factors include, but are not limited to:

- If control over booster operation (ON/OFF, setting output pressure) by the operator is desired, locate the Drive Air Control Kit where it can be easily accessed.
- The high gas pressure being generated and associated safety concerns.
- The source of gas supplies (drive air supply and high pressure instrument gas supply).
- Point of use of output pressures.
- Noise levels. The booster operation is noisy.
- Vibration during use.

2.4.2 INSTALLATION

The installation of the gas booster system is broken down into four parts:

- Installation of the gas booster (see Section 2.4.2.1)
- Installation and connection of the Drive Air Control Kit (see Section 2.4.2.2)
- Connection of the booster high pressure instrument gas supply (see Section 2.4.2.3)
- Connection of the booster high pressure output (see Section 2.4.2.4)

2.4.2.1 BOOSTER INSTALLATION

To install the gas booster system, follow the steps below:

❶ Place the gas booster in the appropriate location (see Section 2.4.1).

❷ Consider the booster high pressure instrument gas supply and high pressure output connections. The booster may sit vertically or horizontally. Orientation does not affect operation.

❸ Use the mounting brackets attached to the booster to secure the booster to a fixed location if desired.

Due to the reciprocating nature of the booster, it is advised that shock mounts be used when rigidly mounting the booster.

2.4.2.2 DRIVE AIR CONTROL KIT INSTALLATION

To install the Drive Air Control Kit, follow the steps below:

❶ Identify an appropriate location for the Drive Air Control Kit bracket (see Section 2.4.1). Consider the routing of the tubing to the Control kit from the drive air supply and from the Control Kit bracket to the booster when selecting a location. The kit bracket is often mounted on the front bottom surface of a work bench. Figure 4 shows a typical installation configuration for a complete PGC-10000-AF system.

❷ Mount the Drive Air Control Kit bracket onto the desired location using the bracket mounting holes provided.

❸ Back off (rotate counterclockwise) the **DRIVE ADJUST** regulator and put the **SHUTOFF** valve in the OFF position.

❹ Connect the drive air supply to the 1/4 in. NPT F connection on the **DRIVE ADJUST regulator**. Use tubing rated for at least 150 psi (1 MPa) working pressure. See Section 2.3.2.1 for information on drive air supply requirements.

Maximum input pressure to the DRIVE ADJUST regulator is 150 psi (1 MPa). Pressures above this level may result in a failure that could damage the instrument and/or cause personal injury.

❺ Connect the Drive Air Supply Kit **SHUTOFF** valve output to the booster **DRIVE AIR INPUT** port using the 6 ft (2 m) length of 1/4 in. PFA tubing provided in the GB-152-AF accessories. Both fittings are 1/4 in. swage.

2.4.2.3 BOOSTER HIGH PRESSURE INSTRUMENT GAS SUPPLY CONNECTION

Connect a high pressure gas supply to the gas booster high pressure **IN** port. The **IN** port is a 1/4 in. NPT F fitting on the high pressure gas filter. Use a thread sealer to seal the connection. The high pressure gas supply should not exceed 3 000 psi (200 MPa). See Section 2.3.2.2 for additional information on high pressure gas supply requirements.

Pressure present at the High Pressure IN port will be present at the high pressure OUT port. Do not supply pressure to the high pressure IN port unless you are prepared for an equivalent pressure to be supplied to the high pressure OUT port.

2.4.2.4 BOOSTER HIGH PRESSURE OUTPUT CONNECTION

If the GB-152-AF is part of a PGC-10000-AF Pneumatic Gauge Calibration System, the booster high pressure **OUT** port is connected to a GPC1-10000-AF Gas Pressure Controller **SUPPLY** port (see the GPC1-10000-AF Operation and Maintenance Manual). The GB-152-AF includes an interconnection kit with fittings necessary to connect the high pressure **OUT** port to a GPC1.

To connect the GB-152-AF high pressure **OUT** port to the GCP1 **SUPPLY** port**,** proceed as follows:

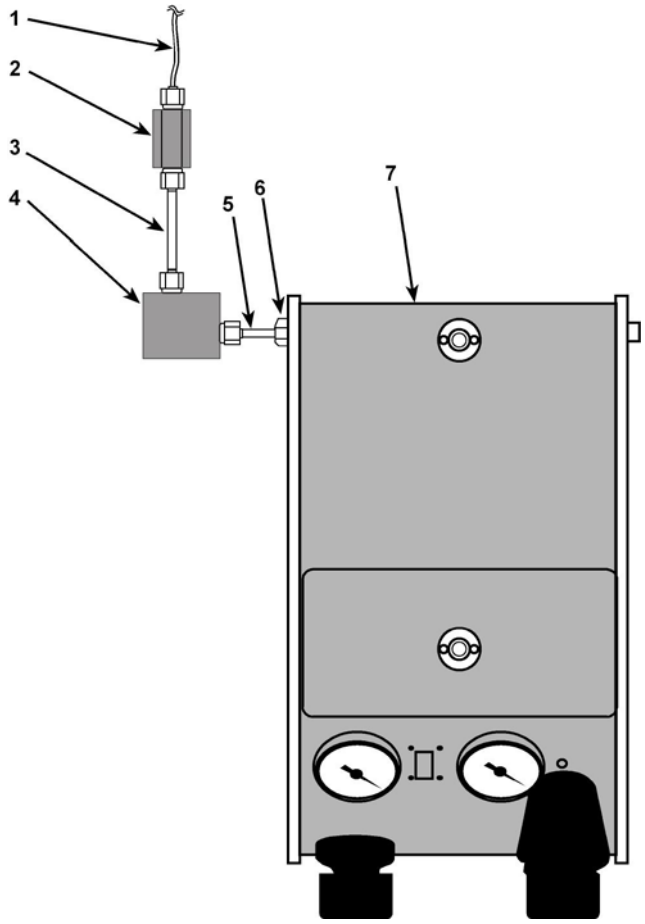
❶ Remove the orange plastic dummy plug from the DH500 fitting in the GB-152 **OUT** port. Retain the collar that is on the plug.

Remove the orange plastic dummy plug from the DH500 fitting in the GPC1-10000-AF **SUPPLY** port.

❷ Refer to Figure 5. Use the tubing and fittings supplied in the GB-152-AF interconnections kit (see Table 1):

- Connect the DH500 2.75 in. (70 mm) nipple to the DH500 elbow.
- Connect the DH500 6 in. (152 mm) nipple to the DH500 union.
- Connect the union/6 in. nipple assembly to the open connection on the elbow/2.75 in nipple assembly.
- Connect the 2.75 in. nipple end of the just completed assembly to the GPC1 **SUPPLY** port.
- Connect the 60 in. (1524 mm) x 1/8 in. nipple with DH500 tips to the open connection on the DH500 union of the assembly that is already connected to the GPC1.
- Connect the other end of the 60 in. x 1/8 nipple to the high pressure **OUT** port of the GB-152-AF.

❸ Test that all fittings tightened before applying pressure.



1. 60 in. x 1/8 in. nipple with DH500 tips (to GB-152-AF high pressure **OUT** port)
2. DH500 union
3. 6 in. DH500 nipple
4. DH500 elbow
5. 2.75 in. DH500 nipple
6. GPC1-10000-AF **SUPPLY** port
7. GPC1-10000-AF

Figure 5. Connection of GB-152-AF high pressure OUT port to GPC1-10000-AF SUPPLY port

Depending on the drive pressure set by the DRIVE ADJUST regulator, GB-152-AF may generate pressure over 70 MPa (10 000 psi). To limit the maximum pressure that can be generated by the booster, limit the drive air supply to the Drive Air Control Kit to 75 psi (500 kPa) (see Section 2.3.2.1). Be sure to connect the booster high pressure output using fittings and tubing rated for the maximum expected pressure that is to be output from the booster. Always use a DH500 or equivalent tube on the DH500 F high pressure OUT port connection.

2.5 INITIAL START UP

After installing the gas booster (see Section 2.4.2), perform the initial start up as follows:

❶ Supply drive air: Check that the Drive Air Control Kit **SHUTOFF** valve is in the **OFF** position and that the **DRIVE ADJUST** regulator is set to zero (fully counterclockwise). Apply drive pressure to the **SHUTOFF** valve (see Section 2.3.2.1 for information on drive air supply requirements).

Depending on the drive pressure set by the DRIVE ADJUST regulator, GB-152-AF may generate pressure over 70 MPa (10 000 psi). To limit the maximum pressure that can be generated by the booster, limit the drive air supply to the Drive Air Control Kit to 75 psi (500 kPa) (see Section 2.3.2.1).

❷ Supply high pressure instrument gas: Check that all connections to the high pressure **IN** and **OUT** ports are secure. Apply high pressure gas to the high pressure **IN** port (see Section 2.3.2.2 for information on high pressure instrument gas).

Ensure the high pressure supply does not exceed 3 000 psi (20 MPa). Pressure above this may result in a failure that could damage the instrument and/or cause personal injury.

❸ Adjust the **DRIVE ADJUST** regulator: Rotate the **DRIVE ADJUST** regulator knob (clockwise) while observing the set pressure on the **DRIVE** gauge. Set the drive pressure to the maximum desired high pressure output divided by the booster ratio (152 for GB-152-AF). Do not set the regulator to more than 65 psi (450 kPa). Remember that when the **SHUTOFF** valve is in the **ON** position, the booster will operate until the high pressure output is equal to the drive air setting times the booster ratio.

The DRIVE ADJUST regulator is NOT self venting so it cannot be used to set pressure lower than the current pressure when the SHUTOFF valve is OFF. If you overshoot the desired set point, set the SHUTOFF valve to ON until the DRIVE pressure is lower than your desired setting. Then set the SHUTOFF valve to OFF and use the regulator to adjust the pressure in the ascending direction.

❹ Generate high pressure: Check that the booster high pressure output is properly connected. If it is connected to a GPC1-10000-AF, be sure the GPC1's **INLET** valve is closed. Set the **SHUTOFF** valve to the **ON** position. The booster will begin to cycle and will continue to cycle until it stalls. When it stalls, the high pressure output is roughly equal to the drive pressure setting times the booster's ratio (152:1).

3. OPERATION

3.1 GENERAL OPERATING PRINCIPLE AND INFORMATION

The purpose of the GB-152-AF booster is to automatically boost gas pressure to very high pressure. The value of very high pressure that is generated depends on the drive air pressure setting. The unit generates high pressure using a Pneumatically Operated Gas Booster Pump and a Drive Air Control Kit.

GAS BOOSTER PUMP

The booster pump is a Pascal press utilizing two pistons connected together on the same axis having a normal area ratio of 152:1. The booster is a two-stroke, single stage reciprocating pump that generates gas pressure 152 times greater than the shop drive air applied to the pump. The pump operates automatically, provided drive air is supplied to the **DRIVE ADJUST** regulator and the regulator is set to at least 140 kPa (20 psig). Operation is continuous until the outlet pressure is 152 times the shop drive air pressure. Then, the opposing forces within the pump are in equilibrium and the pump stalls. For example, using a GB-152-AF with the drive air pressure set to 45 psi (300 kPa), the pump will run until the high pressure output reaches approximately 152 x 45 = 6840 psi.

The drive air (low pressure) section of the booster consists of a piston, cylinder, air cycling valve, pilot valve and vent section. This section provides the reciprocating action and compression force needed to operate the booster and generate the high pressure gas. Drive air is channeled to the appropriate side of the piston (compression or suction stroke) by the air cycling valve. When the piston reaches full stroke, a pilot valve is mechanically activated causing the air cycling valve to change position. Shop drive air is routed to the opposite side of the piston reversing piston direction where a second pilot valve is activated repeating the process.

The high pressure section of the booster consists of a small piston and an inlet/outlet check valve assembly. The small piston moves forward and backward with the air drive piston. During the suction stroke (backward movement), the outlet check valve closes and the inlet check valve opens letting supply high pressure gas enter the compression chamber. During the compression stroke, the inlet check valve closes and the outlet check valve opens letting boosted gas out of the pump.

The compression ratio of the high pressure piston is 25:1 (for both models). Maximum output pressure is limited by the instrument gas supply pressure. For example, with 300 psi applied, maximum output pressure cannot exceed 300 x 25 = 7 500 psi.

3.2 OPERATION

Once the gas booster has been set up and the initial start up is completed, operation is very simple.

There are two possible operator actions:

- Setting the booster output pressure (see Section 3.2.1).
- Turning the booster ON and OFF (see Section 3.2.2).

3.2.1 SETTING THE BOOSTER OUTPUT PRESSURE

Depending on the drive pressure set by the DRIVE ADJUST regulator, GB-152-AF may generate pressure over 70 MPa (10 000 psi). To limit the maximum pressure that can be generated by the booster, limit the drive air supply to the Drive Air Control Kit to 75 psi (500 kPa) (see Section 2.3.2.1).

The booster output pressure is determined by the value of the drive air pressure. The approximate booster output will be the drive air pressure times 152.

To set the drive air pressure, adjust the **DRIVE ADJUST** regulator:

❶ With the **SHUTOFF** valve in the ON position, adjust the regulator counterclockwise while observing the **DRIVE** gauge to decrease pressure to a value lower than the desired set pressure. This is necessary because the regulator is not self-venting.

❷ Put the **SHUTOFF** valve in the OFF position.

❸ Rotate the **DRIVE ADJUST** regulator knob clockwise while observing the set pressure on the **DRIVE** gauge. Set the drive pressure to the maximum desired high pressure output divided by the booster ratio (152:1). For example, if the desired high pressure output of the GB-152-AF is 10 000 psi, set the drive air pressure to 10000/152 = 66 psi. Remember that when the **SHUTOFF** valve is in the **ON** position, the booster will operate until the high pressure output is equal to the drive air setting times the booster ratio.

To correctly set the pressure, gas flow must not occur. If flow is present in the circuit when the regulator is adjusted, the pressure will increase when flow is reduced. If the setpoint is exceeded, see Section 3.2.2.

The booster will run automatically, continuously until the high pressure output is equal to the drive pressure times 152. Set the drive pressure very carefully to avoid generating higher output pressures than desired which could be dangerous. Do not apply more than 10 000 psi (70 MPa) to the GPC1-10000-AF SUPPLY port.

3.2.2 TURNING THE BOOSTER ON AND OFF

The booster is turned ON and OFF using the **SHUTOFF** valve of the Drive Air Control Kit. The **SHUTOFF** valve controls the supply of drive pressure to the booster.

Set the **SHUTOFF** valve to the ON position to supply drive pressure to the booster and cause it to operate.

Set the **SHUTOFF** valve to the OFF position to interrupt drive pressure to the booster and stop its operation.

When the booster is OFF, the high pressure supply is still present at the high pressure gas OUT port. This feature makes it easy to operate using the high pressure supply only when the booster is not needed.

Emergency shut-down of the gas booster pump can be performed at any time by closing the Drive Air Control Kit SHUTOFF Valve. This will prevent further generation of gas pressure by the pump but WILL NOT NECESSARILY reduce pressure to high pressure point-of-use.

NOTE

4. MAINTENANCE AND ADJUSTMENTS

4.1 MAINTENANCE

GB-152-AF gas booster packages require no routine maintenance or adjustments.

NOTES

5. TROUBLESHOOTING

5.1 GENERAL INFORMATION

Before using this trouble shooting section, the operator should be thoroughly familiar with the AG-152-AF gas booster system.

For problems not covered in this section or direct technical assistance, please contact a **DHI** Authorized Service Provider (see Section 6, Table 2).

5.2 BOOSTER WILL NOT RUN

The booster is a pneumatically operated pump. The reciprocating action is caused by an imbalance of forces within the pump due to the opposing drive air pressure and the high pressure gas supply that is being boosted. If the booster is not operating, it means that all forces are equal or that the pistons are seized.

- Check that the Drive Air Control Kit **SHUTOFF** valve is in the ON position. If not, set the valve fully to the ON position.
- Check that drive air pressure supply is actually present at the **DRIVE ADJUST** regulator inlet connection. If not, ensure drive air is supplied at the proper pressure and flow value (see Section 2.3.2.1).
- Check that the **DRIVE ADJUST** regulator is set to a pressure of 20 psig (150 kPa) or higher and that minimum flow requirements are met (see Section 2.3.2.2).
- Check that there are no gas leaks in the drive air circuit supplying the **DRIVE ADJUST** regulator. Repair any existing leaks.
- Check that gas is not continuously venting from the exhaust muffler. If gas is venting through the muffler, see Section 5.8.
- Check that the booster is not in a stalled state. If the booster is stalled, determine the reason and remedy. A stalled state occurs when the pressure in the high pressure section of the booster is equal to the pressure in the low pressure section times the ratio (152). A stall can only occur if the high pressure circuit is plugged.

5.3 BOOSTER RUNS TOO SLOWLY

A slow running booster means that the pump itself is running slowly which also causes the pressure to be generated slowly.

- Check that the drive air **SHUTOFF** valve is in the ON position. If not, set the valve fully to the ON position.
- Check that the **DRIVE ADJUST** regulator is set to a pressure of 20 psig (150 kPa) or higher and that minimum flow requirements are met (see Section 2.3.2.2).
- Check that there are no restrictions in the shop drive air supply circuit that would prevent adequate air flow (see section 2.3.2.1). Remove any restrictions. If a filter is installed on the shop drive air circuit, it may cause an excessive flow restriction.
- Check that there are no leaks in the shop drive air circuit. Repair any existing leaks.

5.4 PRESSURE GENERATES TOO SLOWLY OR NOT AT ALL

A slow running booster will cause the pressure to be generated slowly. Ensure that the booster is running properly (see Section 5.3). Then follow the sequential steps below:

- Check that the high pressure gas supply is not below 300 psi (2 MPa). If the supply is too low, increase supply pressure. Speed of booster pressure generation is directly related to the pressure of the high pressure instrument gas supply. For example, pressure will be generated twice as fast with instrument gas supply of 2 000 psi (14 MPa) than with 1 000 psi (7 MPa).
- Check that there are no restrictions in the high pressure gas supply line to the booster. If a restriction exists, remove it. Restriction may be a valve not fully opened, a regulator with a low flow constant (CV), an inline filter, small diameter tubing, etc.
- Check that there are no leaks in the high pressure line from the booster **OUT** port to the point-of-use. Repair any leaks.
- Check that the inlet and outlet check valves in the high pressure booster piston are operating properly. Make sure the high pressure gas supply to the booster **IN** port is 300 psi (2 MPa) or greater and the drive air is set to at least 60 psi (400 kPa). Close the drive air **SHUTOFF** valve. Shutoff the high pressure **OUT** port near the port or, better yet, plug the port directly with a DH500 plug.
  Open the drive air **SHUTOFF** valve. The booster should cycle several times then stall. If the booster does not stall, a failure of the booster check valves is the most likely cause. In this case, the booster needs service. Contact a **DHI** Authorized Service Provider.

5.5 BOOSTER RUNS (CYCLES) CONTINUOUSLY

The booster is a pneumatically operated pump. The reciprocating action is caused by an imbalance of forces within the pump due to the opposing drive air pressure and the high pressure instrument gas supply that is being boosted. If the booster runs continuously, and there is no problem with the check valves (see Section 5.4), it means that the forces do not equalize.

- Check that the high pressure supply to the booster **IN** port is at least 300 psi (2 MPa). If not, ensure that supply meets required specifications (see Section 2.3.2.2).
- Check that the high pressure circuit connected to the booster **OUT** port is not open to atmosphere or doesn't have a severe leak.
- If the shop drive air supply pressure is above 40 psig (250 kPa), adjust to below this limit. If the booster stops running, increase high pressure supply to **IN** port instrument gas supply and try again.

5.6 CANNOT ACHIEVE DESIRED PRESSURE

- Check that the high pressure gas supply to the booster **IN** port is set above 300 psi (2 MPa) (the minimum value). In some cases, the minimum pressure supply is 600 psi (40 MPa). If in doubt, increase instrument gas supply to 600 psi (40 MPa).
- Check that the drive air is set at the correct value and that it is supplied to the booster. See Section 2.3.2.1.
- Check that no leaks exist in any of the pressure circuits. Repair any existing leaks.

5.7 LEAKS

Pressure leaks are the most common problem found in pressure handling equipment. Normally, the first step is to determine if the leak is within the booster or outside of the unit.

- To determine if the leak is within the unit, disconnect at the booster high pressure **OUT** port and plug it. Establish similar conditions under which the leak was observed and determine if the leak is still present. For small leaks, it may be necessary to install an appropriate pressure sensing device at the **OUT** port. In some cases, it is useful to perform simple leak checks on the most common outside sources before disconnecting the test system. Note that leaks inside the booster are unusual unless there has been some disassembly.
- More than one leak can exist in a system. Fixing one leak does not guarantee a leak tight system. Therefore, continue executing the troubleshooting procedures until all leaks are located and corrected. Since it is impractical to produce a troubleshooting guide that will cover every conceivable leak, the source of your leak may not be covered in this guide.
- Check all fittings and components for leaks. Use leak detection fluid for small leaks. Tighten loose fittings or replace damaged fittings. Repair or replace leaking regulators.

Never tighten a fitting while it is under pressure. If pressure is in the system and the fitting should fail while being tightened, you or those around you may be injured.

Do not over-torque the DH500 fittings that are inside the booster. To do so will damage them, requiring their replacement. Recommended torque on a DH500 fitting gland is 15 Nm.

It is possible that a leak exists in the high pressure section of the gas booster. These leaks are very difficult to isolate and detect. If no leaks can be found following the above procedures, it is likely the problem is within the booster. Contact a **DHI** Authorized Service Provider for assistance (Section 6, Table 2).

5.8 GAS CONTINUOUSLY VENTS THROUGH EXHAUST MUFFLER

When the booster does not run and gas is venting through the muffler, the boosters air cycling valve (spool valve) is stuck between its toggle points. This is normally caused by a low gas flow rate. There are two methods for restoring proper operation. It is recommended to perform them in the order below:

- Put the drive air **SHUTOFF** valve in the OFF position. Plug the booster high pressure **OUT** port. Increase drive air pressure, using the **DRIVE ADJUST** regulator**,** to 65 (450 kPa). Put the drive air **SHUTOFF** valve into the ON position quickly. If the booster begins to operate normally, set the drive air **SHUTOFF** valve to OFF and reset the regulator to previous settings. Repeat the process until the booster begins normal operation.
- Put the drive air **SHUTOFF valve** in the OFF position. Plug the booster high pressure **OUT** port. Increase drive air pressure using the **DRIVE ADJUST** regulator to 65 (450 kPa). Remove the exhaust muffler and use your hand to plug the vent port. Put the drive air **SHUTOFF** valve into the ON position quickly. When the build-up of pressure begins to leak past your hand, quickly remove it. If the booster begins to operate normally, set the drive air **SHUTOFF** valve to OFF, reinstall the muffler and reset regulators to previous settings. Repeat the process until the booster begins normal operation.

If normal operation cannot be restored, contact a **DHI** Authorized Service Provider.

6. WARRANTY STATEMENT

6.1 WARRANTY STATEMENT

Except to the extent limited or otherwise provided herein, **DH Instruments, Inc.** (**DHI**) warrants for one year from purchase, each new product sold by it or one of its authorized distributors, only against defects in workmanship and/or materials under normal service and use. Products which have been changed or altered in any manner from their original design, or which are improperly or defectively installed, serviced or used are not covered by this warranty.

DHI and any of its Authorized Service Providers' obligations with respect to this warranty are limited to the repair or replacement of defective products after their inspection and verification of such defects. All products to be considered for repair or replacement are to be returned to **DHI**, or its Authorized Service Provider, freight prepaid, after receiving authorization from **DHI** or its Authorized Service Provider.
The buyer assumes all liability vis-à-vis third parties with respect to its acts or omissions involving use of the products. In no event shall **DHI** be liable to purchaser for any unforeseeable or indirect damage, it being expressly stated that, for the purpose of this warranty, such indirect damage includes, but is not limited to, loss of production, profits, revenue, or goodwill, even if **DHI** has been advised of the possibility thereof, and regardless of whether such products are used individually or as components in other products.

Items returned to **DHI** under warranty claim but determined to not have a defect covered under warranty or to not have a defect at all are subject to an evaluation and shipping charge as well as applicable repair and/or calibration costs.

The provisions of this warranty and limitation may not be modified in any respect except in writing signed by a duly authorized officer of **DHI.**

The above warranty and the obligations and liability of **DHI** and its Authorized Service Providers exclude any other warranties or liabilities of any kind.

Table 2. DHI Authorized Service Providers

DH INSTRUMENTS, INC. AUTHORIZED SERVICE PROVIDERS			
COMPANY	**ADDRESS**	**TELEPHONE, FAX & EMAIL**	**NORMAL SUPPORT REGION**
DH Instruments, Inc.	4765 East Beautiful Lane Phoenix AZ 85044-5318 USA	Tel 602.431.9100 Fax 602.431.9559 cal.repair@dhinstruments.com	Worldwide
Minerva I.P.&M. B.V.	Handelsweg 13 Postbus 76-1270 AB Huizen NETHERLANDS	Tel 31/35.52.54.997 Fax 31/35.52.64.560 info@minervaipm.com	European Union
Ohte Giken, Inc. Technology Center	258-1, Nakadai Kasumigaura-machi, Niihari-Gun, Ibaraki 300-0133	Tel 81/29.840.9111 Fax 81/29.840.9100 tech@ohtegiken.co.jp	Japan/Asia

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