



DIVE LAB XLDS PRESSURE GAGE COMPARATOR MANUAL



Figure 1 Dive Lab Pressure Gage Comparator

1.0 Gage Comparator System:

The Dive Lab pressure gage comparator was originally intended and designed to compare the high and low pressure gages installed in, or used with, the Dive Lab Extreme Lightweight Diving System (XLDS) including the pneumofathometer ((pneumo) gages). The comparator can also be used to compare other “CLEAN” life support gages installed or removed from their system. The comparator system is a small suitcase size system that weighs approximately 38 LBs, and unlike deadweight testers where the gages need to be removed from the system and pressurized with water, the Dive Lab Comparator uses breathing quality air or high grade nitrogen as a test media to simply and easily compare all diving system gages without having to remove them from the system which eliminates and minimizes system generated contamination as well as reducing wear on the gage pipe threads. The system comes with two high precision digital test gages which are certified to have a full scale accuracy of 0.05% and allow for an unsurpassed level of on site (in the field) accuracy normally only achieved within a laboratory type test facility setting. The only disadvantage to the system is you are limited when testing the high pressure gages to the maximum supply pressure you have to work with. For many, this may be using a 3000 psig or maybe a 4250 psig SCUBA or SCBA cylinder. Regardless, pertaining to surface supplied diving consoles as long as you can compare the gages to within 20% of the maximum normal supply pressure, this will give a good assurance of the accuracy of gages being compared.

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1.1 Understanding Gage Calibration / Comparison:

The term calibration is often miss-used. The term calibrate means to adjust or correct to a certain standard or level of accuracy. Gage comparison is not calibration it is just comparison. Comparison identifies and quantifies the error in an instrument so a proper correction can be applied providing the error is constant and not erratic. If comparison shows that the readings are erratic then the gage must be repaired or replaced. Minor discrepancies can be quantified and noted.

1.2 Accurate Gage Comparison:

For accurate gage comparison, it is important to always use a master gage that has a full-scale accuracy at least 4 times greater than the gage being checked. As an example, a typical 2.5" diameter pressure gage as used in many support systems will usually have a stated accuracy of between 1.5-3% of the full-scale rating. This means a typical 5000 psig gage could be off as much as 75-150 psig and still be within specs. The master gage that you would need to use for comparison should have a stated accuracy at least 4 times greater than the gage being checked. This means you would use a master gage with an accuracy no less than 0.50 % (one half %), but better would be 0.25% test gage (one quarter of one percent). A 5000 psig master gage with a full-scale accuracy of 0.25% would have an allowable error of 12.5 psig over the 5000 psig span. The 5000 psig Druck® gage used on the Dive Lab comparator has a stated full-scale accuracy of 0.05%, this allows an error of up to 2.5 psig over 5000 psig range this makes it 5 times more accurate than a 0.25 gage and over 50 times the accuracy of a typical 3% stated accuracy pressure gage installed XLDS HP gage. The digital gages used in the Dive Lab comparator, are usually never off by more than 0.5 psig when they are recertified and a long service life can be expected.

1.3 Gage Comparator Manifold

The comparator basic system consists of a high pressure manifold and regulator assembly which acts as the foundation and mounting structure to which the HP test gage and whips attach to. The manifold is mounted to a plastic plate that mounts into a Pelican® case. The manifold and whip assemblies have a maximum rated working pressure of 5000 psig. In 2017, there was a separate LP whip assembly designed to be used strictly for pneumo gages which uses a small hand pump. With this system, the 300 psig gage is used for comparing the pneumo gages is used totally separate from the manifold. This new assembly can also be used with older gage comparators.

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Figure 2 Comparator manifold

2.0 High and Low Pressure Test Gage Assemblies:

There are two electronic digital test gages used with the system. These gages have a full scale accuracy of 0.05 % making gage comparison extremely accurate giving laboratory quality comparison. The 5000 psig gage has a ZCO O-ring attachment which mates to the main manifold. The type same ZCO fittings attach the inlet and outlet supply whips for quick easy interface. The 5000 psig gage is used for comparing the high and low-pressure gages or any gage up to 5000 psig. The 300 psig test gage is only used for testing the pneumo gages on the control console. The high-pressure gage attaches to the comparator manifold when testing HP gages but can also be mounted on the XLDS console to any of the low-pressure circuits to allow testing of the low pressure supply gages that monitor the divers umbilical supply pressure.

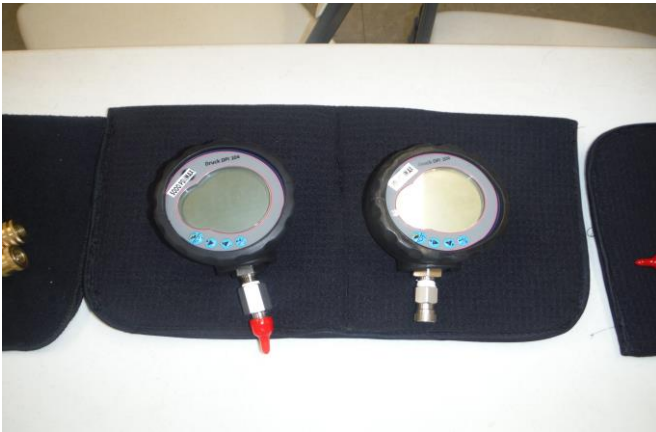


Figure 3 Druck® Test Gages 0-5000 and 0-300 psig

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2.1 Comparator HP Supply Whip Assembly:

The high pressure supply whip assembly that sends air from the test pressure source (usually a SCUBA cylinder) to the inlet of the comparator HP regulator. This whip is 48 inches long and has a DIN / "A" Yoke assembly on one end for the supply source and a female ZCO fitting on the other end that attaches to the male ZCO male fitting on the manifold regulator as shown in figure 4 below.



Figure 4 HP supply assembly

2.2 Comparator HP Outlet Whip Assembly:

The outlet whip and block assembly is used for supplying gas from the manifold to the HP and intermediate pressure gages being tested on the XLDS or KMAC. assemblies. This assembly is rated for a maximum working pressure of 5000 psig consists of a 48 inch long whip attached to a routing block assembly with three 24 inch long whips for attachment to the inlet of the XLDS console and or the KMAC. If the KMAC is being tested one whip can be plugged or the whip can be removed and the port plugged.

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Figure 5 Gage comparator outlet whip assembly set up for 3 diver XLDS

2.3 Pneumofathometer Gage Configuration:

The pnego gages on the XLDS, KMAC and other systems can be compared by using the pneumo assembly. Unlike earlier configurations, pre 2017 comparators, changes have been made that use a small hand pump. The hand pump configuration allows far greater control over in controlling the pressure increments.

With this configuration the hand pump assembly is connected to a three leg system that allows testing of the three XLDS gages or the two KMAC pneumo gages at the same time. Besides the XLDS and KMAC, the system can be configured and adapted to to work with other surface supplied systems as well chamber depth gages. For information and assistance call or E mail Dive Lab



Figure 6 Pneumo gage test components for XLDS, with blank plug attached

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3.0 XLDS Gage Comparison Testing Configuration and Line Up:

Warning: Only use diver's quality breathing air or a supply of high purity nitrogen for gage comparison. Never use oxygen or oxygen enriched gases or any other type of gas to supply the gage comparator. Using oxygen enriched gases could lead to a fire or explosion resulting in great bodily harm or death.

Warning: Only use this system for comparing gages that are used for life support equipment only. Do not use the XLDS comparator for comparing gages that have been used in systems that have not cleaned for breathing life support use.

Note: You will only be able to compare the HP gages to the highest supply pressure that is attached to HP inlet. For SCUBA tanks with "A" yokes this would be a maximum of 3500 psig and for DIN this could be as high as 4250 psig. The XLDS HP gages are 0-6000 gages. As a general rule, mechanical gages (analog gages) should not be pressurized to more than 80% of their range. Pressurizing to the full gage pressure can in time, stress the gage, causing gage error.

There are several ways the comparator can be used to compare the gages on the XLDS. The procedures explained herein is the way Dive Lab currently recommends the XLDS HP and LP gages be compared. This is not the only way that the gages can be compared however, we believe this procedure is a simple and efficient way to compare the HP and LP gages on the XLDS. As a general rule, it is best to compare the XLDS HP gages first, then once the HP gages have been compared you can proceed to testing the 0-600 psig LP gages. There are two ways the LP gages can be done one way is to secure the HP supply source vent the system, then remove the HP gage from the gage comparator and install it on one of the LP manifolds as shown in figure 7. With this configuration all three LP gages can be done at the same time. The high accuracy 0-5000 psig digital gage is used for both the HP and LP gages. The pneumo gages are compared with the 0-300 psig gage using the hand pump.

Note: The 0-300 psig gage is only used for comparing the pneumo gages and only using the hand pump as shown in figure 8.

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Figure 8 300 psi gage with pump

3.1 HP Gage System Comparison Set Up

Note: The following steps when done in order will insure the best results when comparing the HP gages.

1. On the gage comparator, insure the gage comparator regulator has been backed off counter clockwise and both the manifold inlet valve, and manifold vent valve have been shut.
2. Remove the protective plugs from both the 5000 psig digital test gage, and the gage comparator ZCO attachment point on the top of manifold, then attach and secure the 5000 psig digital test gage to the female ZCO fitting located on the top middle of the manifold as shown in fig 9 below.



Figure Fig 9 Accu Cal® Plus 5000 psig test gage

3. On the gage comparator, attach the HP “A” yoke / DIN supply whip assembly to the inlet of the gage comparator regulator as shown in figures 7 and 8, then turn on the the gage and zero as necessary. For in depth information and instructions on the digital gage operation consult the gage manual for the gage model being used.

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Figure 10 Comparator supply assembly

4. On the gage comparator attach the HP discharge whip assembly to the outlet fitting (elbow) of the gage comparator as shown in figure 9, below.



Figure 11 Comparator discharge whip assembly

5. On the XLDS console, remove the protective caps from each of the diver HP supply and umbilical outlet fittings. Inspect the HP inlet fitting and insure the O-ring is in place on each fitting, then attach the three short interface whips from the gage comparator to each of the three diver HP supply fittings Red, Green, and Yellow.
6. On the XLDS console back out fully Red, Green, and Yellow divers hand loader regulators counterclockwise until the hand wheels (knobs) spin freely with no resistance
7. On the XLDS, check shut Red, Green, and Yellow pneumo valves, then insure the three female quick connects for the pneumo's are open and not attached to the storage plugs.

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8. On the XLDS, shut XC-1 and XC-2 diver cross connect valves.
9. On the comparator, attach the HP supply source to the “A” yoke or DIN fitting for the XLDS HP gages this should be no more than 3500 psig if “A” yokes are used, and 4350 psig if DIN is being used
10. On the comparator “A” yoke DIN, insure the bleed knob is turned in fully and seated.

4.0 XLDS Comparing the High Pressure Gages

1. After completing the steps 1 thru 10 in 3.1 above, slowly open the valve from the HP source and bring up pressure to the comparator as noted on the comparator HP inlet gage.
2. On the comparator, slowly load the regulator by turning the knob in (clockwise) until the maximum supply pressure is reached for the XLDS this would be 3500 psig if “A” yokes are used with SCUBA cylinders, or up to 4250 psig (300 bar) if the DIN connections are used with 4250 psig SCUBA cylinders.
3. Slowly open the manifold inlet valve $\frac{1}{4}$ to $\frac{1}{2}$ turn and pressurize the manifold.
3. After the three gages reach their maximum pressure for the source pressure used, shut the manifold inlet valve and slowly open the manifold vent valve, this will vent the three XLDS gages to zero, then shut the vent valve and slowly open the manifold inlet valve and re-pressurize. Exercise the gages in this manner at least three times from zero to the maximum supply pressure being used, then back to zero to exercise and clear the gage gears of verdigris. This is common practice with all gear driven analog gages.
4. On the comparator, back off on the regulator counterclockwise and vent off all pressure then then load the hand loader regulator by turning the knob in slowly (clockwise) while watching the digital gage on the comparator. For the HP gages on the XLDS it is recommended to start at no less than more than 500 psig, then in 500 psig increments or to the highest pressure that will be used with the system. Load the regulator until the digital gage reads the desired test pressure use both the loader and the comparator vent valve as necessary to adjust the pressure on the master gage for each test pressure increment then lightly tap on each of the gages being checked on the XLDS and log the indicated value for each of the gages. Slowly Load the regulator by rotating the regulator knob in until the regulator outlet pressure matches the regulator inlet pressure to the maximum supply that the XLDS will be used at based on the supply bank pressure used.
5. To compare the HP gages, use the HP hand loader to slowly bring the pressure up to each 500 psig check point, another way, is to go slightly beyond the desired test point pressure that you are checking, then using the vent valve slowly bring the master gage to the exact desired test point pressure, then check the the three HP gages tapping lightly on each of the gages.
6. The HP gages should be checked in 500 psig increments or smaller. As each test increment is reached lightly tap on the gages being tested with your finger to settle the needle. Use the Dive Lab HP comparison log sheet to document and record the comparison. **Note:** *Customized log sheets can be made up by the by the user.*

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7. Upon completion of HP gage testing, back off on the gage comparator loader and vent all pressure from the system.

5.0 XLDS Low Pressure Gage Line Up

Note: After comparing the HP gages, each of the three LP pressure gages can be compared with the same basic configuration by passing air thru Red divers circuit to all three LP gages after aligning the system using the steps below.

1. Insure the three pneumo valves are shut,
2. Check shut ALP-1R, ALP2G, and ALP-3Y.
3. Open XC1, and XC2
4. Insure Red, Green and Yellow regulators have been backed off.
5. Slowly load the gage comparator regulator to between 600-700 psig.
6. Slowly open the gage comparator inlet valve.
7. Load Red divers XLDS regulator until the LP gage reads between 375-390 psig, all three LP gages on the XLDS should slowly rise. After they reach at least 375 psig, shut the comparator manifold inlet valve, then open ALP-1R on the XLDS and vent the entire system to zero.
8. Shut ALP-1R, and then slowly open the manifold supply valve and re-pressurize the gage comparator and XLDS as before in step 6. Repeat this step at least three time to exercise the LP gages.

Note: the system is now lined up and ready for comparing Red Green and yellow LP gages to at least 390 psig.

9. Very slowly load the gage comparator hand loader until the digital gage reaches the first test point which should be 50 psig. Use Red Diver pneumo valve to vent off any over pressure.
10. Complete step 9 for each 50 psig test point and document on the gage comparison sheet.

Note: The relief valves on Red, Green, and Yellow diver's circuits are set to start relieving at 390 to 400 psig. If the relief starts relieving at a pressure less than 390 psig, the relief can be re-adjusted for a higher pressure to facilitate gage comparison after witch the reliefs can be reset to the desired pressure.

11. Slowly load the comparator regulator while watching the digital HP digital test gage. Stop at the desired test points and compare the digital test gage to all three XLDS low pressure gages. Lightly tap on each gage being compared then document the comparison. If you overshoot the desired pressure you can vent

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off lightly thru one of the pneumo valves then shut.

12. It is recommended to check the LP gages in no less than 50 psig increments to at least 375 psig.

Note: *There is no need to compare the XLDS gages above 400 psig because the system is not used at pressures greater than 400 psig.*

13. Once the LP gages have been compared, back off on comparator regulator and vent the system.
14. Back off on Red Divers XLDS regulator until the hand wheel spins freely and vent off all pressure.

6.0 Comparing the XLDS Depth Gages Using the Hand Pump:

The first few gage comparators that Dive Lab made were configured so that the LP digital test gage installed in the center of Green Divers manifold using the 3/8" straight thread O-ring port.

After 2016 things were changed and the gage is now attached to a small "T" assembly that connects the digital test gage and a small bicycle hand pump to the pneumo QD circuit and allows pressurization of all three gages at the same time. The hand pump allows very fine and accurate control during the comparison process.

Caution: *The 300 psig gage and hand pump are only intended to use for testing pneumo gages and should never be attached to the comparator manifold or gage damage could occur from inadvertent over pressure.*

1. Insure there is zero pressure on Red, Green, and Yellow's LP gages and the three pneumo gages valves are shut, then mate Red, Green, and Yellow female quick connects to the triple plug adapter as shown in figure 16.

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Figure 12 Pneumo Triple plug adapter attached to the gage and pump

Note: There are two Schrader valves on the small manifold that the pump attaches to. The hand pump is only attached to the Schrader valve that has the flush tip as shown in Figure 17. The other Schrader valve has the tip extending out of the threaded shoulder and is for venting off pressure only.

2. Attach the Pneumo QD assembly as shown in figure 16 below



Figure 16 QD blank adapter



Figure 17 Schrader vent valve
(Note the tip sticking out, this is the vent valve)

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3. Attach the hand pump by screwing it onto the flush Schrader valve until finger tight as shown in figure 17. Attach the 300 psig test gage to the other end as shown in figure 18 below.



Figure 18 300 psig digital gage installed for pneumo testing

4. With the pneumo configuration as shown in Figure 18 below using the hand pump, pump up the system until the digital test gage reads between 90 and 100 psig. The three pneumo gages should track together and should show just over 200 fsw then vent the system to zero using one of the three umbilical supply valves or by depressing the Schrader valve. Exercise the gages in this manner at least two or three times prior to taking readings.
5. Repeat step 5 at least two times to exercise the gages, then vent all pressure, and zero the three pneumo gages using a small screw driver. Zero the pneumo gages by lining up the mirrored back ground to the needle and the lines on the bezel and adjusting using a small screw driver.
6. After the XLDS pneumo gages have been exercised, slowly pressurize the test gage to the desired increments as shown on the Dive Lab pneumo comparison sheet shown on page.
7. Dive Lab recommends checking in descending order in 5, 10, 15 and 20 foot, then every 10 fsw to the deepest depth of 200 fsw, then in 20 fsw increments back to 20 fsw. After 20 fsw, recheck 15, 10 and 5 foot.
8. After checking and documenting the results, insure all pressure is vented, then remove the digital test gage. Cap/plug all fittings to maintain cleanliness.

7.0 Care and Storage of the Gage Comparator:

The gages as well as all hoses and attachment fittings must be plugged and capped to maintain foreign material exclusion. The gages should be inserted in the padded fabric pouches, and test fittings should

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be placed in bags and sealed. The supply and outlet hose assemblies should also be placed in the fabric padded cases.

8.0 Yearly Digital Gage Certification:

The two digital gages are considered test standard gages and because of their high accuracy they must only be compared by those that have the capability and equipment necessary to perform the certified comparison. Dive Lab has the gages certified by INNOCAL prior to commissioning the system. Dive Lab recommends sending the gages back to INNOCAL once a year for re-certification. Before sending the gages carefully remove the adapters from the gages and store. Cap the end of the gages with plastic caps and carefully wrap up and pad the gages to prevent shipping damaged. Prior to sending the gages back, contact Innocal by phone or e-mail and fill out the required forms. When the gages come back from Innocal, remove and replace the 9 volt battery in each of the gages. Normally the battery will last at least a full year. Changing the battery at least once a year will minimize the possibility of damaged from acid leakage.



Figure 19 Single gage adapter

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DIVE LAB, INC. HIGH PRESSURE GAUGE COMPARISON

Document #THPGC0015

Date Tested: _____ **Gauge DL Test Gauge Used:** _____

System _____

Gauge Range: 0 - 5000 psig

Stated Accuracy: 2.5%

HP	GREEN	RED	YELLOW
500			
1000			
1500			
2000			
2500			
3000			
3500			
4000			
4500			
5000			

REMARKS: _____

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DIVE LAB, INC. DEPTH GAUGE COMPARISON

Test Gauge used: _____ Date Last Certified _____

System Ser#				System Ser#			System Ser#				PSIG	
RED FSW	DOWN	UP	PASS / FAIL	GREEN FSW	DOWN	UP	PASS / FAIL	YELLOW FSW	DOWN	UP		PASS / FAIL
5				5				5				2.225
10				10				10				4.45
15				15				15				6.67
20				20				20				8.9
30				30				30				13.35
40				40				40				17.8
50				50				50				22.25
60				60				60				26.7
70				70				70				31.15
80				80				80				35.6
90				90				90				40.05
100				100				100				44.5
110				110				110				48.95
120				120				120				53.4
130				130				130				57.85
140				140				140				62.3
150				150				150				66.75
160				160				160				71.2
170				170				170				75.65
180				180				180				80.1
190				190				190				84.55
200				200				200				89

REMARKS: _____ DATE _____

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Generic Pressure Gage Comparison Test

Test Gauge Used Make/Model	Serial Number	Range	Stated Accuracy	Last Certified

Gage Being Tested Make/Model	Serial Number	Range	Stated Accuracy

Actual	Indicated Value	Indicated Value	Remarks
100			
150			
200			
250			
300			
350			
400			
450			
500			
550			
600			
650			
700			

Print Name:	Signature:	Date:

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Rev 5/2018

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Rev 04/2018