



# Pressure Gauge Comparator Manual KMAC Version

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## TABLE OF CONTENTS

	Pages
Introduction	3
Basic Comparison Rational	4
Computing Allowable Error	4
Fittings & Configuration	4
Component Lubrication	5
Gauge Comparator Configuration & Set Up	5
Setting Up For Testing KMAC Gauges	5-7
Comparing HP Gauges	7-8
KMAC Low Pressure Gauge Comparison	9
Comparing the KMAC Depth Gauges (Pneumo Gauges)	9-11
Other Gauge Comparison	11
Master Gauge Re-Certification	12
Kirby Morgan KMAC Adapters /Spare Parts/Forms	13-18



## INTRODUCTION

The Dive Lab pressure gauge comparator was originally designed to allow comparison of all the high, and low, pressure gauges installed or used with the Dive Lab Extreme Lightweight Diving System, (XLDS) including the pneumofathometer (pneumo) gauges. The comparator can also be used to compare other “CLEAN” life support gauges. The comparator system is a small suitcase size system that weighs approximately 38 LBs, and unlike deadweight testers where the gauges need to be pressurized with water then after testing cleaned and dried. The Dive Lab Comparator simply uses divers breathing quality air or high-grade nitrogen as a test media. Testing gauges in place with air or nitrogen allows easy, fast, comparison of all system gauges without having to remove them from the system, minimizing the possibility of introducing system generated contamination from breaking fittings loose as well as reducing wear on pipe thread components. The system comes with two high precision digital test gauges which have a certified full-scale accuracy of 0.05% and allow for at least a four to one accuracy comparison level for onsite (in the field) accuracy normally only achieved within a laboratory test facility setting.

The basic system consists of a high-pressure manifold and regulator assembly which acts as the foundation and mounting structure for the test gauges and whips. The comparator assembly has a maximum working pressure of 4350 psig, (300 bar) based on the working pressure of the HP hoses. All Comparators made after March 2015 have dual use interface whip assemblies which are rated 4350 psig, (300 bar) service, simplifying testing. The flow volume capability of the comparator has been limited so that things pressurize slowly. In 2020 Changes were also made in primarily to adapters and the separation of testing diver depth gauges (pneumo) using a hand

pump instead of the main manifold. These up-grade changes are available for older Dive Lab comparators. Contact Dive Lab for detail.

### CAUTION

When comparing the divers Pneumo gauges, use only the 300 psig Druck® test gauge. This gauge is only used with the hand pump. This gauge should only be used for comparing the Pneumo gauges or gauges less than 300 psig.

### DANGER

Never use oxygen or oxygen enriched gases to supply the gauge comparator. Using oxygen enriched gases could lead to a fire or explosion resulting in great bodily harm or death. Divers breathing air or a supply of high-grade nitrogen is the only gas that should be used for gauge comparison.

### WARNING

Always wear eye protection when working with the gauge comparator. A ruptured gauge or hose could pose a serious missal hazard which could result in bodily harm.

### WARNING

Do not use the comparator system to compare gauges that have been used for non-diver or breathing gas applications. Make sure only clean gauges are tested.

### CAUTION

Always open valves slowly. Even though the gage comparator has restrictors built into the HP supply assembly that limits flow, always open valves slowly.

## WARNING

Persons using this equipment should have a basic knowledge and experience working with high pressure air. Anyone having questions about using this equipment or any questions remotely involved please call or E-mail Dive Lab. www.divelab.com Tel: 850-235-2715

## CAUTION

The batteries in both digital gages should be changed at least once a year. Leaving old batteries in the gages could cause corrosion damage. Use only good quality alkaline batteries as recommended by the gage manufacturer. If you know you will not be using the comparator within the next three months, remove the batteries to be safe.

## BASIC COMPARISON RATIONAL

Quite often there is confusion in the terms calibration and comparison as it refers to pressure gauges and other instruments. The term calibration primarily refers to comparing and physically adjusting a gauge or instrument to a known standard or condition. The term comparison refers to observing the differences between a gauge. Dive Lab produces the gauge comparator to allow users to accurately “compare” diving system gauges to an extremely accurate set of gauges that have a full-scale accuracy of 0.05%. The basic rule for accurate comparison is the master gauge being used to compare system gauges should have a certified accuracy of at least four times greater than the gauges being compared. Other than physically zeroing diver depth gauges to compensate for atmospheric pressure, making physical adjustments to system gauges is not covered and should not be attempted by persons that have not received formal gauge repair calibration training.

## COMPUTING ALLOWABLE ERROR

Typically, most mechanical (analog) gauges that have a diameter less than 3 inches have a stated accuracy between 2-3% full scale. Some gauge manufactures claim a 3-2-3 accuracy meaning that the first one third has up to a three percent possibility of error plus or minus, and the middle third of the scale has a two percent possibility of error plus or minus. Finally, the last third could be out of tolerance by three percent. This means a 5000 psig gauge with a 3% accuracy could be out of tolerance plus or minus by 150 psig. To determine the allowable error simply multiply the manufactures stated accuracy as a decimal by the range of the gauge. Example, a 600 psig analog gauge with a stated accuracy of 2% would go like this, 2% = 0.02 as a decimal, multiply 0.02 by 600 psi. Looks like this,  $0.02 \times 600 = 12$  psig allowable error. A 5000 psig gauge would be like this  $0.02 \times 5000 = 100$  psig allowable error. The most important thing is knowing where the gauge is in error, what the error is and is it a consistent error or random. Gauges with random error should be replaced, gauges with a known steady error that does not change can be compensated for.

## FITTINGS & CONFIGURATION



*KMAC Comparison System*



Figure 1 Pneumo Adapters & LP-8AN Adapter

### NOTICE

The pneumo adapter fittings shown in *Figure 1* and the KMAC LP-8AN adapter should only be used at pressures no more than 300 psig. The LP-8AN is attached to the KMAC LP supply.

## COMPONENT LUBRICATION

All O-Ring fittings, especially the fittings that use the spool pieces as shown in *Figure 2*, require occasional light lubrication to provide good sealing. All O-Rings should be lightly lubricated with Crystal Lube® or Tribolube® Oxygen Compatible Lubricant. When not in use keep hoses capped/plugged, and all fittings bagged.



Figure 2 Adapters with spool pieces

## GAUGE COMPARATOR CONFIGURATION & SET UP

There are several ways the comparator can be used to compare the gauges. This guide is specific in nature to the Kirby Morgan KMAC two diver air supply console and will primarily explain how to perform in place comparison of the high, and low-pressure gauges on the Kirby Morgan KMAC surface supply diving console. In addition, it will also demonstrate comparison of the diver depth gauge (Pneumo Gauges). This is basic instruction only, but is not the only configuration, or the only way that the gauges can be compared. This procedure is intended to be a simple and efficient way to compare the HP, LP and pneumo gauges on the KMDSI KMAC. Variations in this procedure can also be applied to other systems as persons using the system gain experience. Contact Dive Lab if you have any questions regarding the use of the comparator.

## SETTING UP FOR TESTING KMAC GAUGES

### NOTICE

The KMAC hand loader loads, and vents opposite of that of standard hand loaded pressure regulators. On the KMAC, back the regulator off, fully "clockwise" until the hand wheel spin freely.

### NOTICE

When using the adapters that use the spool piece, it is not necessary to tighten the fitting with a wrench. Hand tight is all that is needed.

1. Remove the protective caps from each of the diver umbilical outlet fittings.
2. Remove each pneumo protective caps.
3. Check shut, the two pneumo valves for Red and White divers.

4. Check shut, the diver umbilical supply valves for Red and White Divers umbilical supply valves.



Figure 3 Attaching "A" Yoke



Figure 4 Attaching "A" Yoke finger tight

5. Attach the "A" Yoke adapter fitting to one of the KMAC supply hoses as shown in *Figures 3 & 4* this aligns the HP source from the gauge comparator to the KMAC HP system.
6. Make sure the KMAC HP selector valve is lined up to the "A" yoke with circuit to be tested.

### NOTICE

For simplicity, its best to compare the HP gauges on the KMAC first, then after the HP gauges have been compared proceed to the LP gage. Always do the pneumo gauges last.

### WARNING

The KMAC is rated for a maximum of 232 bar (3350 psig). Do not exceed this pressure.

7. On the gauge comparator, ensure the gauge comparator hand loader regulator has been backed off counter clockwise.
8. Check shut manifold inlet valve.
9. Check shut the vent valve.



Figure 5 - Installed 5000 psig Master Gauge

10. Install the 5000 psig digital test gauge on the manifold as shown in *Figure 5*, then lightly tighten with 11/16 wrench the force of three fingers on the wrench.

### NOTICE

This is an O-ring face seal fitting and does not require excessive tightening.

11. Attach the female end of the 4 foot whip outlet assembly, to the outlet fitting of the manifold making sure, first that a spool piece is in place. Thread the whip nut all the way down on the fitting hand tight only. See *Figures 6 & 7*.



Figure 6 Attaching the comparator outlet assembly



Figure 7 Outlet assembly attached finger tight

12. Remove one of the 24" inch hose's and install a 7/16 port plug into outlet block assembly.
13. Attach the other 24" hose on the "A" yoke adapter, making sure a spool piece is in place and the nut threads all the way down flat against the fitting as shown in *Figure 3 & 4* hand tighten this connection only.
14. Attach the HP supply assembly ZCO fitting to the inlet of the comparator as shown in *Figure 8*. Lightly tighten with an 11/16 open end wrench, with the force of 3 fingers.



*Figure 8 HP Supply attachment*

15. Attach the "A" or DIN fitting to an HP supply, ensure the vent bleed is shut.

### NOTICE

The KMAC HP system is rated for a maximum high-pressure supply of 3350 psig.

## COMPARING HP GAUGES

### NOTICE

You can only check gauges to the highest pressure you have on hand. The KMAC has 5000 psig HP gages however the system is only rated for a maximum supply of 3350 psig. Normally for high pressure control delivery systems the most important gage accuracy is from 2000 psig and down to 300 psig.

### NOTICE

The 5000 psig Druck gauge turns on using the left button. The gage should only be zeroed with no pressure on the system. To zero, press and hold the far right button until the word done appears.

### NOTICE

The master gages time out after 10 minutes and require restarting. Re-zeroing is not necessary. Do not re-zero if the gauge is under pressure.



*Figure 9 Powering up the gauge*



*Figure 10 Zeroing the gauge*

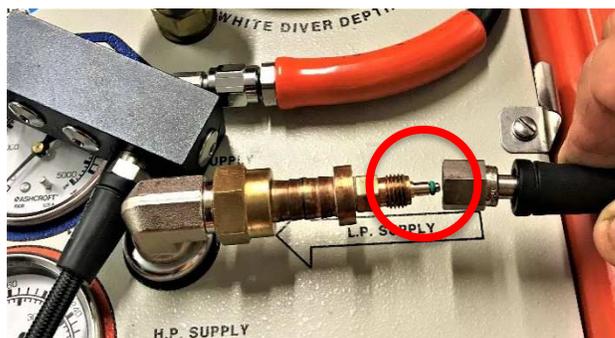
### NOTICE

Ensure that there is no pressure on the gauge before zeroing.

1. Press and hold the ON button, on the HP gauge, until it comes on, and then zero if necessary using the far button on the right.
2. Slowly open the valve on the HP cylinder source and bring up full pressure to the gauge comparator.
3. It is best to exercise the KMAC gauges several times for a more accurate reading. To do this, slowly open the inlet valve on the comparator manifold, then load the hand loader by rotating the knob clockwise, to the full high pressure of the source, keep in mind it may take 30 seconds or so for the KMAC HP gauge to fully pressurize.
4. Next, secure the air source at the inlet of the gauge comparator and vent the manifold and KMAC to zero pressure. Again, pressurize the KMAC by opening the comparator manifold valve to full pressure then vent again after 3 cycles of pressure and vent you can then start gauge comparison.
5. Using the gauge comparison sheet for the HP gauges, we recommend checking in a descending order at least at 300, 500, 1000, 1500, 2000, 2500 and 3000 psig, then in an ascending order check each test spot again and document on the test sheet. Lightly taping on the gauge with your finger is permissible.
6. Once the first HP gauge has been compared, secure the air at the inlet of the gauge comparator manifold, then open the manifold vent and vent down the comparator and KMAC HP circuit. This circuit is now complete.
7. Attach the "A" Yoke adapter to the other HP KMAC HP circuit and position the KMAC HP

selector valve for that circuit, then complete steps 3 - 5 for the other circuit.

8. After completing HP gauge comparison, back off the comparator regulator, vent off all pressure on the gauge comparator and KMAC, then remove the "A" Yoke adapter from the KMAC and the whip, and install the KMAC LP-8 fitting on the whip and then to the KMAC as shown in *Figure 11*. Tighten the large nut using 7/8 inch open end wrench, using the force of 3 fingers. Ensure the spool piece is in place and hose is finger tight.



*Figure 11 Attaching the pneumo test system*

9. Ensure the KMAC HP selector valve is in the off zone as shown in *Figure 12*.



*Figure 12 The KMAC HP off zone*

### KMAC LOW PRESSURE GAUGE COMPARISON

1. Ensure the comparator regulator is backed off counterclockwise and the manifold supply is shut and the vent valve at the right end of the manifold is open.
2. Ensure all pressure has been vented from the KMAC.
3. Attach the LP supply adapter LP-8 AN as shown in *Figure 11*.
4. Attach the 24" hose from the comparator outlet whip *Figure 11*.
5. Exercise the KMAC LP gauge by slowly bringing up pressure on the comparator hand loader to 275 psig, then shut the comparator manifold supply valve, and vent off all pressure from the comparator, and KMAC LP system this can be done best by using one of the KMAC umbilical supply valves as the vent. Exercise the LP gauge at least three times. Using the comparator inlet supply and vent valve.
6. Compare the LP gauge descending order first, starting at 100 psig, then 150,200,250 and finally 275 psig. Next repeat the check in ascending order of 250,200,150,100.
7. Once the LP gauge has been compared secure the air supply at the source, then vent the KMAC and comparator by opening one of the KMAC umbilical outlet valves and the comparator vent valve.
8. Back off, counterclockwise the gauge comparator hand loader, then remove the HP supply whip from the ZCO O-ring fitting at the

hand loader. Cap and plug the all open ends to prevent contamination.

9. Remove the outlet supply whip assembly and cap and plug all fittings.

### COMPARING THE KMAC DEPTH GAUGES (PNEUMO GAUGES)

The KMAC pneumo gauges are tested using the 300 psig Druck<sup>®</sup> master gauge with the special attached interface assembly. In 2020 Dive Lab made up a slightly different set up that makes testing the pneumo gauges even easier. The system uses an improved hand pump and gauge manifold interface system shown in *Figure 13*.



*Figure 13 Leak Checking the Pneumo Test System*

#### NOTICE

*Figure 12* shows how to configure the pneumo test system for a quick leak check, prior to attaching to the KMAC pneumos.

#### NOTICE

*Figure 13* shows the pump, gauge and whips all attached. The two short whips are connected using a union that has two spool pieces. This set up allows for pressure testing the circuit before checking the pneumo gages.

The two 24 inch long, high-pressure whips mate to two low pressure brass adapters that then mate directly to the KMAC pneumo fittings which are size - 04, 37°AN. *Figure 14.*



*Figure 14 The pneumo test assembly components*



*Figure 15 Attaching the pneumo test system*

### NOTICE

The only time two whips on the outlet assembly is used is when you are comparing the two KMAC pneumo gauges.



*Figure 16 Attaching the outlet assembly*

Figure 15 shows attaching the outlet assembly to the LP gauge for pneumo testing.



*Figure 17 The Schrader vent valve*

The longer of the two Schrader is used as a vent valve, and can be lightly tapped on with a small wrench or a screw driver handle to make very fine increment changes. The short Schrader on the right side of the gauge assembly is where you attach the hand pump.

Exercise the pneumo gauges by pressurizing to 150-200 FSW at least 3 times, then vent the gauges to zero and adjust each gauge face for zero using a small screw driver by lining up the gauge needle the with the mirror and gauge face. *Figure 18.*



Figure 18 Zeroing the gauge

### NOTICE

The 300 psig test gage reads out in PSIG. Use the pressure conversion column on the far right of the test documentation sheet. Check the depth gages down (Descending depth) at 5,10,15 and 20 feet then check in no less than 20 foot increments to the maximum depth the system will be used. Document the comparative readings on the depth gage test sheet. Check the gages both in both descending and ascending.

Upon completion of comparison vent all pressure from the KMAC and the comparator, then cap and plug all fittings and stow all equipment to prevent damage and contamination.

### OTHER GAUGE COMPARISON

The gauge comparator can be used to compare other life support gauge up to 4350 psig (300 bar) up to 10 dive submersible pressure gauge assemblies can be tested at one time by attaching them to 7/16 ports up to 6 on the main comparator manifold and up to three using the outlet supply block. Most diving life

support gauges have a male NPT fitting. This is usually the case with recompression chamber gauges as well as compressor gauges. Individual gauges that have 1/4" MNPT stems can be installed in the special gauge adapter which can then interface with one of the whips as shown in *Figures 19 & 20*.



Figure 19 Attaching loose gauge adapter



Figure 20 Various gauges that can be tested

When testing individual pipe thread gauges, the gauge threads should be cleaned of old Teflon<sup>®</sup> tape, then gauge re-taped starting one thread back with one and a half, to two wraps of tape under tension. The gauge should be threaded into the adapter approximately two turns by hand, and one and a half to two turns with a wrench. Avoid over tightening.



## MASTER GAUGE RE-CERTIFICATION

Dive Lab recommends that you send your two master gauges in for recertification at least every 24 months and/or whenever accuracy may be questioned. The Druck® DPI 104 gauges are high quality digital strain gauges that do not just go out of tolerance like mechanical gauges, Dive Lab has seen an excellent history with these gauges.

Dive Lab recommends sending the gauges to Innocal Calibration Services. Innocal will provide the customer with a NIST traceable detailed calibration report for each gauge tested. They have a fast turn-around time. Innocal usually has a fast turn-around time. In addition, once you are in their system you can access your previous calibration history anytime online.

Contact Info: [www.innocalsolutions.com](http://www.innocalsolutions.com)

Tel: 866-466-6225

# KIRBY MORGAN KMAC ADAPTERS /SPARE PARTS/FORMS



High Pressure "A" Yoke Adapter  
3500 PSIG Max



Universal 1/4 FNPT Adapter  
5000 PSIG Max



LP-8AN Low Pressure Gauge Adapter  
300 PSIG Max



Pneumofathometer adapters  
300 PSIG Max



Leak Test Union



7/16 Dust Plugs (spare) with  
-012 90 Durometer O-Rings

Spool Pieces (spare) with  
90 Durometer O-Rings

-012 O-Rings (spare)  
90 Durometer

-010 O-Rings (spare)  
90 Durometer



Dust Plugs (spare)



Dust Plugs (spare)



Dust Plugs (spare)



Dust Plugs (spare)



Tribolube Oxygen  
Compatible



Hand Pump



Teflon Tape



High Pressure Supply Assembly



High Pressure Outlet Supply  
Assembly



CERTIFICATION SHEET

# DEPTH GAUGE COMPARISON for KMAC

Test Gauge Used	Date Last Certified	System Serial #

Diver 1

Diver 2

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

Print Name	Signature	Date

