PURE AIR MONITOR

PAM 94PS

INSTALLATION, MAINTANANCE AND USER MANUAL

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LE-TEHNIKA d.o.o.
Šuceva 27 , 4000 KRANJ - Slovenija
Tel.: +386 4 2020 280, Fax.: +386 4 204 2122
cryogenics@le-tehnika.si; http://www.cryocoolers.eu

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LIMITED HIGHEST OPERATING PRESSURE

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1 SYSTEM DESCRIPTION

Thermal imaging systems, with their ability to operate independently of ambient light, have brought a new dimension to modern civilian emergency services (surveillance). Within the imager, the IR detector requires cooling down to liquid air temperature of 77K. Where this cooling is accomplished by a Joule-Thomson mini-cooler it is essential to provide a source of compressed gas normally in the form of pure air. Worldwide manufacturers produce a comprehensive range of pure air bottle charging units to provide thermal imaging field support. These charging sets are robust, rugged, reliable and easy to maintain-meeting the exacting requirements of the modern services.
Bottle charging set comprises a lightweight air compressor capable of 6000 psig (412 bar) pressure duty, prime mover, purification system and bottle charging panel fitted with all necessary controls.
Air charging sets can also be fitted with an integrated pure air monitor, providing extra security that air purity is meeting required levels.

For efficient and reliable operation of the Joule-Thomson mini-cooler, it must be fed with high pressure air which has been purified to very exact standards (Def Stand 58-96). Solid particles above 5 microns or traces of other contaminants such as moisture and carbon dioxide would quickly cause a malfunction of the mini-cooler rendering the imager useless. Pure air Monitor PAM 94PS, set comprises Joule-Thomson fixed orifice minicooler, glass Dewar flask with electronic device and all necessary fittings, housing, and electrical connections.

The pure air monitor set checks the quality of pure air delivered to the monitor by measuring the gas flow with built in electronic flow meter. When the cooler is supplied with air at a constant pressure 3000 psig (206,84 bar), the flow gradually increases until some liquid gas is collected in the collection Dewar flask. When the collection flask is filled with liquid, the flow will increase to a stable maximum, so long as pressure and temperature remain constant and no contamination is present. In this case green light is on.

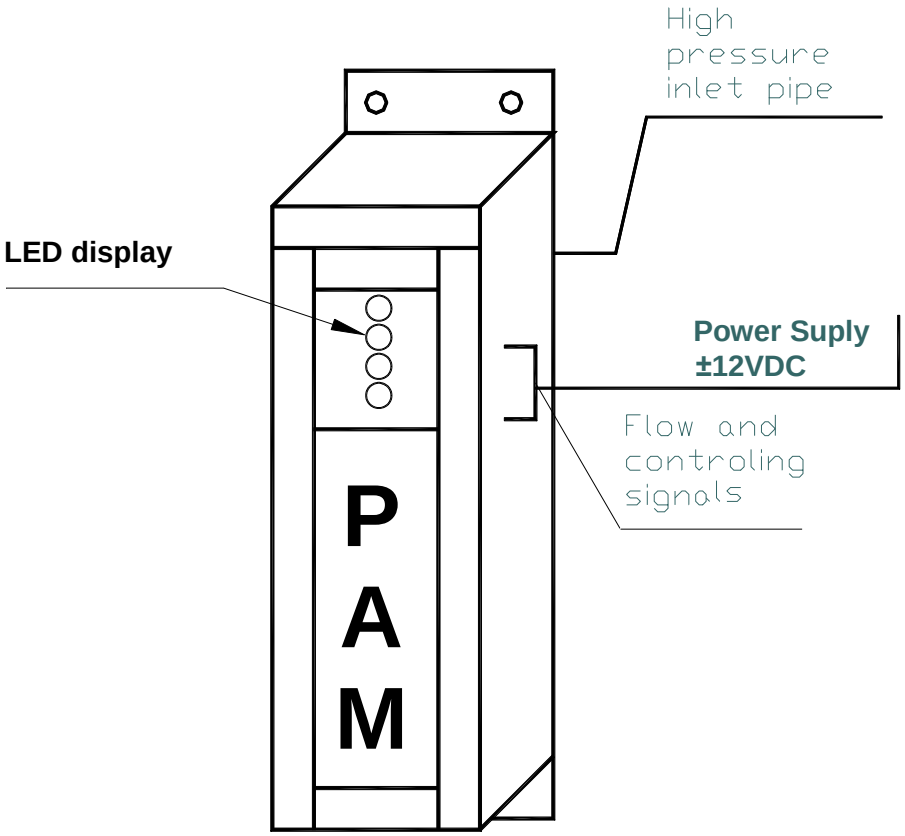
When the flow drops from a stable maximum, for 3% because of changes in pressure, ambient temperature or present of contaminants, yellow light will turn on. When the flow drops for approx. 21%, red light turns on. Non-return valve prevents contamination of minicooler with water vapour from the surroundings, during "off' period of the unit.

The instrument is composed of two units:

- PAM section, including fixed orifice Joule Thomson cryogenic micro cooler, glass Dewar vessel, glass protective tube, pressure sensor, housing, connection with ¼” thread on the end, and electric wires (1000 mm) for connection of electronic part,

- Electronic section of PAM94PS, with plastic housing, signalling LED lights, trimmer for setting or eventual recalibration and connection to DC Power Source and pressure sensor.

Main components are present on Picture 1



Picture 1: Instrument with corresponding connections

The PAM section is connected to the pure side of compressed air system over a solenoid valve and pressure regulator, keeping the proper input pressure on the required level. These two elements are not part of this PAM.
A part of clean compressed air passes the fixed orifice Joule Thomson cooler integrated into glass Dewar vessel. Expanding to the ambient pressure the air cools down and – after the make time period – starts to liquefy. Due to the heat losses of the surroundings, the liquefied air evaporates again. The gas is collected in glass cylinder and the gas flow measured by electronic gas flow meter. With partly contaminated filters of the compressor the flow through JT orifice will be reduced due to deposit of impurities on the nozzle. Reduced gas flow means corresponding pressure drop change. The change of the pressure drop, registered by the pressure sensor, is transformed into electric signal commanding the system over the electronic part of the instrument.

There are several moments in the operation of the system which have to be treated specifically.

- At the beginning we fill the high pressure system to pressure above 3000 psi (207 bar)
- We can now open the INLET valve and allow compressed air at constant pressure to flow into PAM.
- At beginning, red LED lights are glowing, until the JT cooler reached the stationary state. At that moment gas flow increases, red lights switch off, then yellow and after green LED turns on.
- Whole process takes about 3 minutes.
- Additional 1 hour is needed to stabilize the system

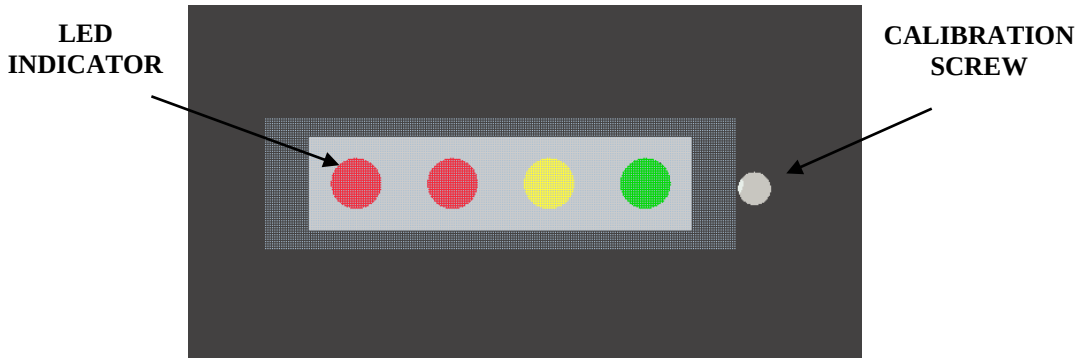
2 ELECTRONIC UNIT TECHNICAL DESCRIPTION

Electronic unit enables us to monitor pure air filter status and indicate that with LED signal lights. The LED's are set on the following way. Switching between green and yellow LED is done by 3% of pure air gas flow drop from nominal value. At 18 - 22% of gas flow drop the red lights are turned on. It is time to change the filter units then.

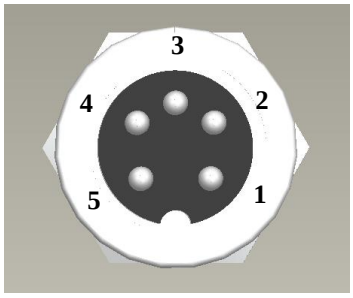
Signal out connector:

PIN assignment (Picture 3)

PIN	Description	Wire Color
1	GND	White
2	Calibration signal (0-5V)	Yellow
3	LED state signal (0,03V:Green - 1,45V:Yellow - 9,80V:Red LED)	Green
4	Not assigned	NA
5	12V DC	Brown



Picture 2: Front panel of electronic unit



Picture 3: Signal connector - male, front side

Technical data

- Electric Power supply 12 V DC
- Normal AIR flow, at 3000 psig (206,84 bar) and ambient temperature of 20°C, is between 11,6 and 14,2 Nl/min (or 12,7 and 15,6 Sl/min).
- Max pressure is 230bar AIR

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Dimensions

- L x B x H = 230 x 57 x 66 mm
- On the Back side is 20mm deep gas inlet connector ¼" BSP
- Weight 930 gr.

Options:

- Signal transmission on distance (light or sound) automatic switch-off of the compressor in case of impurities in pressure system.
- Different operating gas possibilities (Nitrogen N2, Argon Ar) see Appendix B

3 OPERATION

PAM 94 PS operates on the following way:
Compressor operates on maximal operating pressure, i.e.420 bar (6000psi). The pressure regulating valve set on 207 bar (3000psi) controls the actual pressure at PAM inlet. The compressed air, passing through the filter group I, is cleaned of all contaminants (water vapour, carbon dioxide, hydrocarbons, mechanical particles etc.). The auxiliary gas flow, passing the instrument, changes it's structure according to the actual contamination of the filters. The air passes Joule Thomson cryogenic cooler in the PAM, liquefies and evaporates again. The real flow is in dependence with gas contamination and therefore with filter quality. Pressure sensor on the bottom of PAM unit reacts to the pressure changes, provoked by the change of gas flow or indirectly by filter contamination. The actual voltage changes are transferred to the electronic part to be used as the data for signalizing and controlling the operation of the system.
The electric signal is transferred to the electronic unit, which is factory set on the following values:
Gas flow reduction of 3% will signalize the first alert flow drop and the yellow signal lamp will start to lit.
Flow reduction of 21% will signalize the limit flow drop and the red signal lamp will start to lit. This flow drop shall appear in time frame of 3 hours according standard.
It is time to stop the filling and change the filter units.

Finally, at the start of the system (beginning of operation), PAM would signalize wrong data (red or yellow) due to the low starting pressure of the system and needed time for JT cooler to reach operating conditions. Therefore some time will be necessary to reach the normal operating conditions. It is estimated that a time delay of 3 min is enough for that phase. Additional 1 hour is needed to stabilize the system. PAM94PS will start to show actual situation in the system after that period of time.

4 COMPRESSED AIR QUALITY

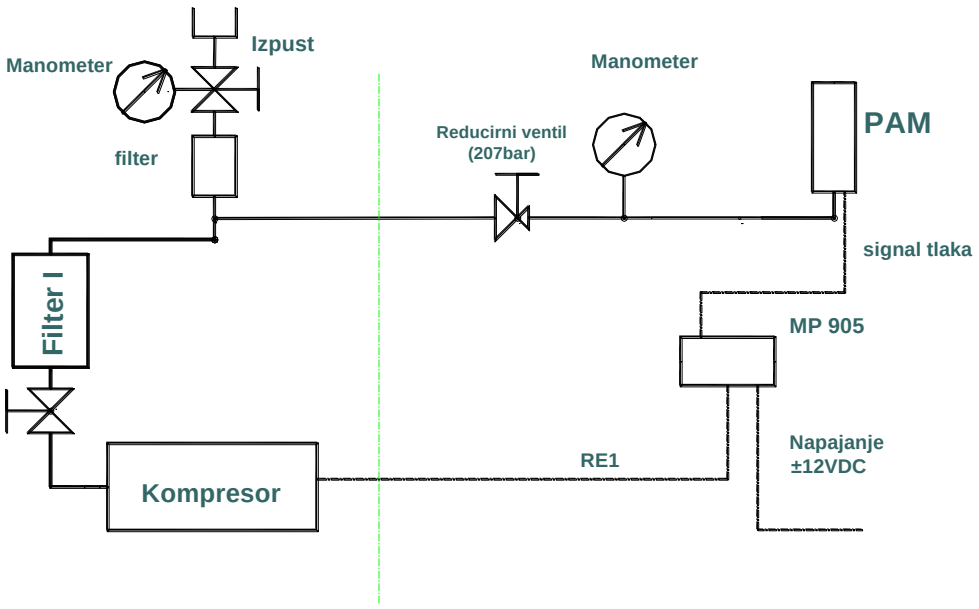
The instrument for compressed air quality control PAM will operate smoothly when the quality of air in the system corresponds to the document GWL(A)/SIP/6/34/70 issue 2 from April 1986.Na according to Def Stan 58-96. According to these papers, the air is considered as pure when:

The water vapour content has dew point, when expanded to 1bar is not higher than -70°C,
Carbon dioxide content should not exceed 1 ppm (by weight),
Total hydrocarbons content should not exceed 0,05ppm (by weight),
Material particles should not exceed a size of 5µm.

Normally the producers of gas filters declare the nominal life cycle of the gas filter units to 100 fillings of 0.6l bottles to 4000 psi. Under condition, that we make bottle filling log (Nr. of working hours and Nr. of bottles) it is allowed, to do an occasional monitoring by first 50 bottle filling and continuous monitoring in the second half of filter lifetime.

5 SCHEME OF HIGH PRESSURE AIR GENERATOR WITH PAM94 PS

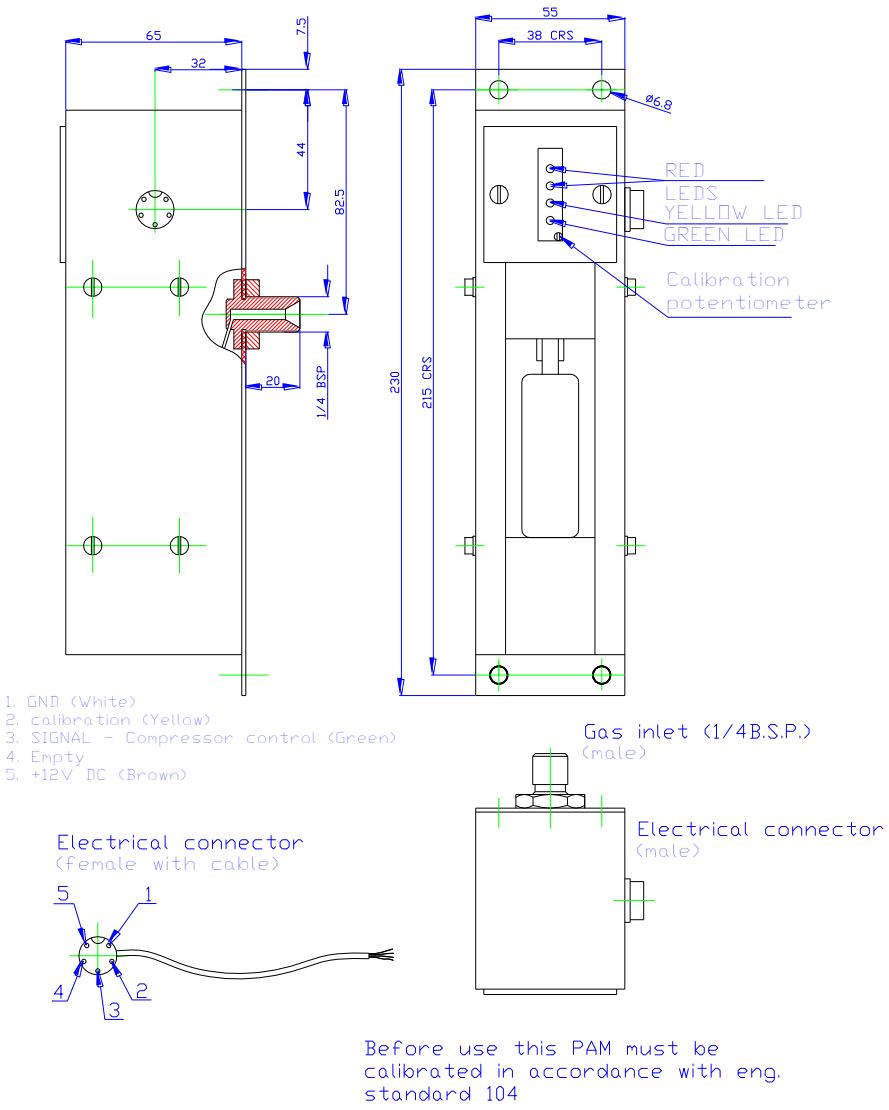
As we can see in the Figure bellow, we take smaller part of the gas away and lead that gas over the pressure regulator to PAM, which signalling us according the quality of air by appropriate signalling lamp (LED) .



Picture 4: Scheme of high-pressure air generator with built in PAM for gas quality monitoring

6 INTEGRATION OF PAM TO HIGH PRESSURE AIR GENERATOR

The JT unit is mounted on the compressor frame in any position (controlled vertical position is not required!). The compressor system is furnished with PAM connection after the filter sections. The connection includes a solenoid valve and a pressure regulating valve, set on 207 bar. The PAM capillary tube is connected to the pressure regulator connection, sealed with bonded seal of adequate quality and size.



Picture 5: PAM dimensions and locations of the holes for integration with high-pressure system

7 SIGNALING PARAMETERS SETTINGS

As explained above that the instrument is factory set for AIR to the following signalling values:

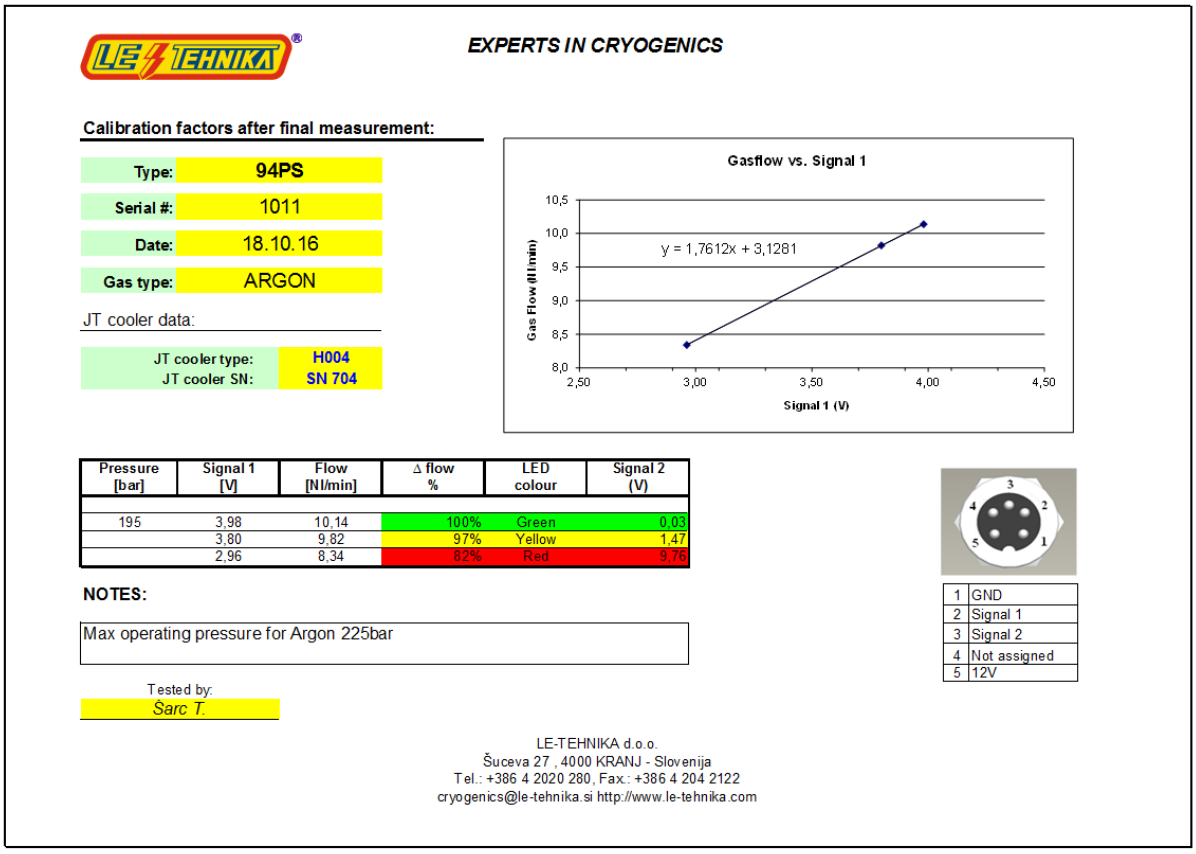
- At 3% of gas flow drop will activate the yellow lamp signal, signalling that we must become careful, because system is near the filter capacity.

- At 21% of gas flow drop will activate the red lamps signal – system has reached the highest level of filter contamination, we must stop the compressor (filling system) and change the filter units according the instruction for that activity.

It may happen that the pre-set values should be changed for any reason. The producer may register more accurate signalling values, the Client's requests can change, the actual ambient conditions may provoke another setting etc.
The electronic unit enables to change the factory setting, if and when necessary.

The pressure difference between yellow and red signal (i.e.18%) can only be changed by producer experts on Client's special request.

The actual circumstances will justify eventual re-setting of PAM.
For the procedure of re-setting see APPENDIX A of these instructions.



Picture 6: Measurement report with calibration factors

8 MAINTENANCE

Generally, no particular maintenance of the instrument is required, if the working gas is not contaminated and the instrument kept in original packing till the integration.

If the instrument will be exposed to contaminated air or found not properly packed (damaged packing), it is necessary to blow the instrument through with clean air at low pressure (20 to 30 bar). If the bad operation of the instrument is registered during operation, PAM has to be warmed up to the ambient temperature before blowing the instrument through. This procedure will defrost the nozzle and clean the Joule Thomson cooler.

The procedure is the following:

1. Start the compressor and maintain the pressure bellow 30 bar in the system.
2. Be sure that the valve before PAM is opened, so the gas can flow through the PAM.
3. Low pressure on the inlet prevents the cooler to start cooling.
4. Procedure should take at least 30 minutes.
5. Now you can fill the system to operating pressure above 3000psi (207±1 bar)
6. PAM is ready for new measurements (green LED should glow after 3min of operating)
7. If this has not happened repeat the steps 1 to 4 of the procedure

No other interventions except the eventual changes of factory set signalling values are allowed. In case of any problem or additional requests the Client has to contact the producer describing the fault or new requirement in details.

9 APPENDIX A – Calibration procedure

Original test data and curves for AIR are shipped with every PAM 94 PS. First is dependency of signal from electronic flow meter regarding to actual gas flow. There are also the polynomial coefficients presenting this dependency. The signal from the el. Flow meter is connected to PIN 2 (see Fig 3.) On second leaf of test data, there are values of flow (Air) and correspondent signal voltage for 100%, for 97% (green-yellow) and for 79% - 84% (Yellow-red).
These data are needed for PAM calibration. You have to connect parallel an additional calibrated PAM otherwise.

Calibration steps:

1. Visually inspect the PAM 94PS in accordance to Fig.3
2. Connect the PAM 94PS to 207 bar (3000psi) clean air source as it is normally connected (Fig.4). Inlet stop valve shall be closed initially.
3. Connect the PAM 94PS on the12VDC electrical power supply
4. Connect the signal for calibration (PIN2) to the voltmeter, to be able to read the signal voltages.
5. Open STOP valve to pressurise the PAM 94PS to 207 bar (3000 psi).
6. Check the signal voltage after 5 minutes and put it down. This shall be referenced value U100 and green LED's shall illuminate on PAM display.
7. Calculate the GasFlow100 (NL/min) with the polynomial coefficients given in the above mentioned test data for this PAM (conversion signal to gas flow).
8. Calculate the GasFlow97 (NL/min) =97% of GasFlow100 (NL/min) and calculate with the polynomial coefficients given in the same test data (conversion gas flow to signal) the appropriate signal U97
9. Slowly drop down the inlet pressure so long that the calibration signal voltage will be equal to U97. The transition from GREEN to Yellow shall happen at this point. If not turn the potentiometer so long that you will found this transition.(clockwise direction drops the transition threshold)
10. Recheck U100 at full pressure (3000psi).
11. If something is still not OK repeat the steps 5 to 9.

Note:
If you want to use the manufacturer data, you have to use very pure air and make a calibration at laboratory conditions, otherwise (using other gas instead) the voltage values will slightly differ.

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10 APPENDIX B – Operating with different gases

PAM unit can be used also for measurement of other gases. If customer needs this option beside AIR, calibration data report can be made for Nitrogen or Argon gas. In this case some additional precautions must be taken in consideration during operation.

1. For different gas also different operating pressure is set. Never exceed maximum allowable pressure for specific gas. For orientation max signal voltage must not exceed 4,4V. See table below!
2. For different gas also duration of measuring varies because of different specific density, and operating temperatures of gas.
3. For different gas limits and signals on LED indicator are different. Limit 3% is constant, but limit 21% differs.

Gas	Operating pressure [bar]	Max pressure [bar]	Measurement duration [h]
AIR	207	230	3
Nitrogen	214	235	3
Argon	195	215	3,5

Original test data and curves for specific gas configuration is shipped with every PAM 94 PS. Additional data for different gases are added on request at order of the unit.

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END OF DOCUMENT