Air Pressure Sensors

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.....Air Pressure Sensors.....

1. Measuring Air Pressure

Skye air pressure sensors will measure the absolute pressure of the air they are exposed to. Each has sealed inside it a reference pressure that is close to being a perfect vacuum and the atmospheric pressure is measured relative to this. Between the vacuum and the atmosphere is the diaphragm of the sensor and the stress in this is in fact what is measured. The strain is recorded by a series of tiny strain gauges configured in a type of bridge circuit. As the atmospheric pressure changes, so does the strain in and hence resistance of these devices. Thus the output of the whole sensor changes. With models SKPS 800 and 820 the output is not great and a suitable amplifier must be used, e.g. the input of a DataHog, MiniMet . HydroSense or other meter, logger or readout unit with a differential input. A differential input is required because the output of the sensors is the difference between its two outputs and not the voltage between an output and ground. Neither of these two sensor outputs can be connected to ground since doing this would effectively short out half of the bridge circuit.

SKPS 810 incorporates a power and output amplifier, which means that it will give a high level (0 to 5 or 0 to 2 volt) output into a single ended input of a logger or chart recorder.

As suggested above the Air pressure sensor will measure the pressure of the air it is surrounded by. It will, if used at sea level, give values as recorded by meteorological reports or similar sources. If it is used at heights greater than sea level then the values it gives will be proportionately less than published data. This is because many readings of barometric pressure are corrected to be as though they had been read at sea level. Such a correction allows the direct comparison of readings taken by observers at various altitudes to observe the progress of weather patterns. The variation of air pressure with altitude depends on a variety of factors, chiefly air temperature and water content, but a good correction can be made by adding to the reading given by the sensor an offset as follows.

Sea level offset to be added (millibars) = station height (metres) * 0.118 (mbars / m)

In other words the air pressure decreases by approximately 0.118 millibars per metre above sea level. This is reasonable for most ground based stations.

This effect can of course be used to measure height (aircraft rely on it) as long as changes in barometric pressure are allowed for.

2. Electrical considerations of sensor use

2.a SKPS 800

The sensors give an output between their output leads proportional to barometric pressure. This is a relatively small value compared with the excitation voltage required, but if connected correctly is very stable and precise. The value of the output voltage is made up from two components. By far the largest of the two components is the result of the sensitivity of the device multiplied by the applied air pressure. The second component is a constant offset, either positive or negative that represents the residual output of the device if a vacuum (i.e. zero air pressure) were applied to it. This zero offset is added to the first component to give the output of the sensor. i.e. :-

Sensor Output (mV) = [Applied Pressure (mbar) * Device sensitivity (mV per mbar)] + Zero Offset of the device (+/- mV)

Please note that the supply voltage must be a steady precise DC supply otherwise readings will be in error.

The output voltage of the sensors is of moderate impedance and for them to work correctly they should only be connected to reading devices (loggers/meters etc.) with an input impedance of 100K ohms or greater. Most modern loggers etc. have input impedances much greater than this and should thus work well.

In order to minimise errors due to extremes of temperature it is recommended wherever possible to locate the sensor in as constant a temperature environment as possible. At room temperature thermal errors are minimal and if the sensor can be located at or around room temperature this is ideal. It will be found that the SKPS 800 is very temperature stable and is thus well suited to logging where large temperature excursions apply.

The response time of all sensors is less than 100 microsecs to large changes in pressure and also to changes in supply (excitation) voltage. Users with dataloggers should

ensure that the excitation voltage supplied by the logger has stabilised to the required voltage before taking readings. With most commercial loggers (where they can be user set) it is prudent to have the excitation voltage switched on at least 0.25 seconds before readings are taken by the logger.

2b. SKPS 810 / 810D/SKPS 810S

SKPS 810 is available in three versions, SKPS 810, which will accept a power supply of between 8 and 24 volts (at 10 mA) giving an output of 0 - 5 volts over the range 800 to 1100 mbar, SKPS 810D which requires a 4.5 - 6 volt supply (at 22 mA) and gives a 0 - 2 volt output over the same range of pressure and SKPS 810/S which requires an 8-24 volt power supply and gives an output of 0-2 volt over this pressure range.

The outputs of these devices are single ended, ie relative to the analogue ground, and they are simple to use, when the output voltage is full scale, ie 2v. or 5 volts (depending on version) then the

pressure is 800 mbar. The scale is linear for all pressures in between. The units are factory set for sea level use. If they are to be used at other heights above sea level, then it may be desired to adjust the offset control. This is located as shown in Figure 1. When removing and replacing the lid of the sensor be sure that the seal is intact and that no wires are trapped. The offset control indicated is simply adjusted so that the output of the sensor gives an output that corresponds with the pressure expected at the station height, eg. by calculating from readings made prior to the adjustment, or comparison with another instrument, or from Met. Office or airport reports.

Please note that this offset control will not alter the scaling (ie. the number of millibars per millivolt) but simply subtracts (or adds) a pressure to compensate for station height above sea level.

The response time of the sensor to changes in pressure is very fast (less than 1 msec) but the settling time after 'switch on' of power is about 200 msecs. If possible it is best to allow 0.5 or 1 sec. before taking readings after 'switch on'.

The output of the sensor is suitable for connection to any high impedance input, eg. of a datalogger, voltmeter, chart recorder, etc. The circuitry is protected against reverse voltage, but care must be taken to avoid inadvertently connecting the supply voltage to the sensor output.

2c SKPS 820

The sensors give an output between their output leads proportional to barometric pressure. This is a relatively small value compared with the excitation voltage required, but if connected correctly is very stable and precise. The value of the output voltage is made up from two components. By far the largest of the two components is the result of the sensitivity of the device multiplied by the applied air pressure. The second component is a constant offset, either positive or negative that represents the residual output of the device if a vacuum (i.e. zero air pressure) were applied to it. This zero offset is added to the first component to give the output of the sensor. i.e. :-

Sensor Output (mV) = [Applied Pressure (mbar) * Device sensitivity (mV per mbar)] + Zero Offset of the device (+/- mV)

The sensor outputs are ratiometric to their supply or excitation voltage, and thus they can be used with different supply voltages as long as their outputs are scaled accordingly. For example, if a sensor is used with a supply voltage of 5.000 then its output for any given air pressure will be exactly half of that if 10.000 volts were supplied.

The zero offset of the devices is generally very low and in a lot of cases its contribution to the final reading is insignificant. For this reason a user may choose to ignore it. Also, if only the trends of air pressure change are required it may also be ignored since it is constant. Otherwise its value should be added (if a negative offset), or subtracted (if a positive offset from the millivolt output of the sensor.

Please note that although the output may be scaled as above, the supply voltage must be a steady precise DC supply otherwise readings will be in error. Note too that the zero offset (the output for zero pressure) will also be scaled ratiometrically to the supply or excitation voltage.

The output voltage of the sensors is of moderate impedance and for them to work correctly they should only be connected to reading devices (loggers/meters etc.) with an input impedance of 100K ohms or greater. Most modern loggers etc. have input impedances much greater than this and should thus work well.

In order to minimise errors due to extremes of temperature it is recommended wherever possible to locate the sensor in as constant a temperature environment as possible. At room temperature thermal errors are minimal and if the sensor can be located at or around room temperature this is ideal.

The response time of all sensors is less than 100 microsecs to large changes in pressure and also to changes in supply (excitation) voltage. Users with dataloggers should

ensure that the excitation voltage supplied by the logger has stabilised to the required voltage before taking readings. With most commercial loggers (where they can be user set) it is prudent to have the excitation voltage switched on at least 0.25 seconds before readings are taken by the logger.

2c. SKPS 830

The output of this device is 4-20mA over 800-1200 mbar. The excitation voltage must be between 7 and 32 volts d.c.

3. Housing - all types

These instruments are supplied in a weatherproof housing designed to protect the sensor form rain and moisture, but not impede air flow to the sensor. To this end the grey ABS housing is intended to be mounted with the filter pointing downwards, i.e. below the body of the ABS housing. The bracket will allow the sensor that will both allow the sensor to be mounted on a vertical or horizontal pole or a wall, The bracket is part number SKM 224.

If the sensor is used INDOORS or where condensation or rain will not occur, the orientation of the housing is not important and thus the unit can be fixed or stood in any position.

4. Connection Data

All Skye barometers except SKPS 830 are fitted with a 4 core screened cable. Some units orders to be used with a DataHog, MiniMet, HydroSense or other Skye equipment may be fitted with a miniature 5 pin plug. The wire colours and plug pin numbers are shown below.

4a. Connections for SKPS 800 and 820

The output of the device is essentially the output across the arms of the bridge (and temperature compensation components were fitted) and must be connected to a differential input. It is not possible to use the device simply by connecting it to a 'single ended input amplifier' (i.e. where one of the inputs would be connected to ground).

Please Note:
SKPS 800 - this sensor will not operate with the supply voltage connections reversed.
SKPS 820 - this sensor will operate if the supply voltage connections are reversed

Wire colour	Pin No.*	Function
Red	1	Positive supply / excitation
Blue	5	Negative supply / excitation
Green	4	Positive output
Yellow	3	Negative output
Grey	5 800)	Screen / sheath of cable (plus sensor body and filter of SKPS

* - where the unit has a 5 pin miniature connector fitted.

4b. Connections for SKPS 810 and 810D

Wire colour	Pin No.*	Function
Red	1	Positive supply / excitation
Blue	5	Power ground
Yellow	4	Positive output
Grey	5	Screen / sheath of cable / analogue ground

* - where the unit has a 5 pin miniature connector fitted.

4c. Wire Connections for SKPS 830

Wire colour	Function
Red	Positive
Blue	Negative
Grey	Screen of cable, sensor body and filter

5. Use of Alternative Calibration Units

Skye Air Pressure sensors are calibrated in terms of millibar and millivolts. There is no reason however why these should not be converted to alternative units that are more convenient in a particular application.

Equivalent values are shown below:

1 millibar = 0.001 bar
0.0145 p.s.i.
0.40147 inches water (1.01973 cm) - at 4 °C
0.02953 inches mercury (0.075006 cm) - at 0°C
0.100 kiloPascal
1.000 hectoPascal

6. Use of SKPS 800 or 820 with a DataHog2 logger

If you have purchased your barometer sensor at the same time as your DataHog2 logger, the logger will have been configured ready for use at Skye. If not, or there is need to reconfigure the logger, please follow these simple instructions.

6a. Setting up sensor scaling

The logger requires a Full Scale Value and Zero Offset Count so that it can convert the sensor's millivolt readings into pressure units, such as millibars. These values are individual for each sensor and are shown on the Calibration Certificate at the back of this manual.

Firstly, connect the DataHog 2 up to the PC as usual and start the communications software.

'Wake up' the DataHog 2 by pressing any NUMERIC key to bring up the Main Menu.

Press '9' to choose the option SET Ax+B CALIBRATION FACTORS

Enter the software channel to be used for the barometer (check the Hardware Configuration Certificate at the front of the DataHog 2 manual).

Enter the Full Scale Value from the Calibration Certificate in this manual. The entry is required as 5 digits plus a decimal point, without any leading zeros. So, for example, enter full scale as '4000.0'

Enter the Zero Offset Count from the Calibration Certificate in this manual. The entry is required as 4 digits (no decimal point) plus the sign. For example, enter 0039 and - or + as appropriate.

The full scale and offset values you have entered will be shown for your confirmation. If OK, press 'Y' and you will return to the Main Menu.

Press ESCAPE from the menu to return to logging mode.

IMPORTANT, if you do not press escape when finished, the logger will remain in Main Menu mode, will not log and will drain its batteries in just a few days.

6b. Adjusting readings relative for local altitude

At Skye, a DataHog2 logger with a barometer is set up to measure absolute pressure. To take barometric readings relative to sea level, it is necessary to take account of the altitude at which the air pressure is installed. This altitude is converted into the sensor's millivolt signal and entered as an extra zero offset, as shown below:

Connect the DataHog 2 up to the PC as usual and start the communications software.

Wake up the DataHog 2 by pressing any NUMERIC key to bring up the Main Menu.

Press '9' to choose the option SET Ax+B CALIBRATION FACTORS

Enter the software channel to be used for the barometer (check the Hardware Configuration Certificate at the front of the DataHog manual).

Enter the Full Scale Value from the Calibration Certificate in this manual. The entry is required as 5 digits plus a decimal point, without any leading zeros. So, for example, enter full scale as '4000.0'

To adjust readings to sea level, calculate the offset count in millivolts as follows: (use the sensitivity of your barometer, as shown on the Calibration Certificate in this manual)
e.g. adjusting for 100 m above sea level
1 metre of air = 0.118 mbar so 100 m = 11.8 mbar
sensitivity of example barometer = 20.0000 mbar per millivolt
so 11.8 mbar = 11.8 / 20.0000 = 0.59 mV

The barometer already has an electrical offset which is written on the Calibration Certificate at the back of this manual, and can be either a positive or negative value. The altitude offset in mV must be subtracted from the electrical offset to give the adjusted value.

e.g.1. electrical offset +0.1800 mV, altitude offset 0.59 mV as above
so adjusted offset = +0.1800 - 0.59 = -0.41 mV

e.g.2. electrical offset -0.1800 mV, altitude offset 0.59 mV as above
so adjusted offset = -0.1800 - 0.59 = -0.77 mV

To enter the altitude offset, calculate the Zero Offset Count as shown in the DataHog 2 menu.
Using the example above, adjusted offset -0.41 mV, with a gain of 10,
OFFSET COUNT = -0.41 * 10 * 9.5 = -38.95
The entry is required as 4 digits (no decimal point) plus the sign. So, still following the above example, enter 0039 and - as prompted.

The full scale and offset values you have entered will be shown for your confirmation. If OK, press 'Y' and you will return to the Main Menu.

Press ESCAPE from the menu to return to logging mode.

IMPORTANT, if you do not press escape when finished, the logger will remain in Main Menu mode, will not log and will drain its batteries in just a few days.

NOTE - if the barometer is to be located below sea level, for example underground, the altitude offset in mV must be ADDED to the electrical offset to give the adjusted value.