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Good Practice Guide Control Sensor Selection and Installation

A Building Energy Management System (BEMS) is only as good as the sensor used to measure the controlled variable (temperature, humidity, pressure etc.) and transmit it as a measured value to the controller. It is crucial that the sensor should provide an accurate measurement of the controlled variable at the reference point in the control loop. Failure to meet the desired conditions satisfactorily, can lead to poor control, energy wastage and occupant complaints.

Traditional BEMS uses hard wiring between sensors and controllers. Later technologies such as wireless, internet based and SMART sensing technologies are also available and are outside the scope of this document.

This document sets out to describe good selection and installation of HV/AC sensors used in BEMS.

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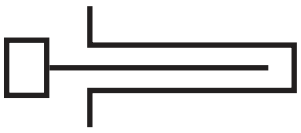
Contents

Sensor selection

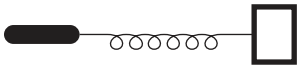
Temperature measurement in pipes

1.1 In most cases the immersion sensor has the most advantages. Ensure the entire active length of the sensor is fully immersed in the pipe.

1.2 Clamp-on sensors are used when installation conditions make the immersion sensor unsuitable.



Sensor with thermowell/pocket



Remote bulb sensor

Temperature measurement in tanks

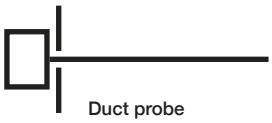
1.2.1 Capillary sensors with probes can have advantages where a clearance is required between the sensor and the device head.

1.2.2 Probe sensors may also be used.

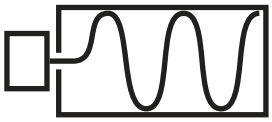
Temperature measurement in ducts

1.2.3 Probe sensors which produce spot measurements should be used only in ducts where there is no stratification.

1.2.4 Averaging sensors may be used when the length of the rod or capillary tube is suitable for the duct cross-section.



Duct probe



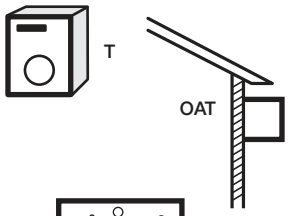
Duct averaging

Room temperature measurement

1.2.5 When used in large spaces it may be necessary to use more than one room sensor. Where possible extract air temperature would provide more accurate reading of space values.

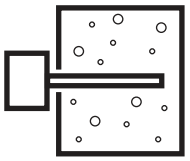
Outdoor temperature measurement

1.2.6 As an alternative to outside air measurement fresh air intake sensors could be used.



Humidity measurement

1.2.7 Solvents in laboratories, chlorine in swimming pools, disinfectants in hospitals etc. can impair the service life and operation of some humidity sensors.

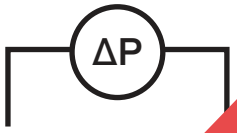


Pressure and differential pressure measurements for gases (air) and liquids

1.3 The nominal pressure PN of the pressure sensor must correspond to the safety pressure of the system.

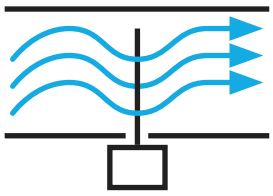
1.4 The maximum load on one side must not be exceeded.

1.5 The pressure sensor must be approved for use with the medium to be measured (water, vapour, refrigerant, foods, gases etc). The measuring range must be selected such that the set value does not occur at the start or end.



Sensor selection

Measurement of velocity and volumetric flow rate

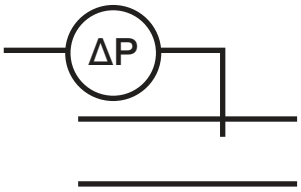


1.6 Various measuring systems are available for measuring velocity or volumetric flow rate. The key factor here is whether a spot measurement or an average measurement is required. In the case of spot measurements the measured result is closely dependent on the flow profile. This is why it is advisable to use measuring systems of the averaging type when measuring velocity and volumetric flow rate.

Cable sensors

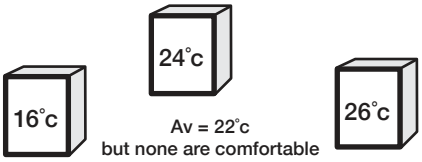
1.7 Cable sensors have distinct advantages because they are small, discreet and sealed.

Pressure in VAV systems



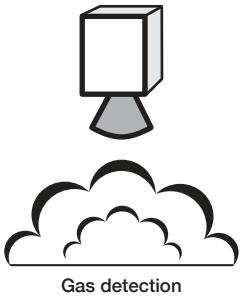
1.8 The pressure sensing point should be sited at the most remote point in the duct system. The use of several sensing points is recommended in duct systems with a large number of branches (the lowest pressure is used for control). When individual sections (zones) of the ductwork are shut off by dampers, the relevant sensors need to be disconnected.

Averaging measurements



1. 9. Average measurements should only be used when no direct measurement is available.

Gas detection sensors



1.10 Indoor air quality sensors can be classified into two types, mixed gas and CO2.

1.11 Mixed gas air quality sensors sometimes referred to as Volatile Organic Compounds (VOC) measure concentrations or odorous substances and gases, such as tobacco smoke, human body odours, kitchen odours, carbon monoxide, methane, ethanol, acetone, methanol, etc. The sensors may be fitted with a self-adaptation algorithm to ensure that the air quality setpoint can be matched to the local supply air quality. They are normally mounted within the controlled space, but duct mounting versions are available.

1.12 CO2 air quality sensors measure the concentration of CO2 in the air and are best used to detect the presence of people.

1.13 The location of an indoor mounted sensor should be representative of the indoor air quality, e.g. on an open wall 1.5 to 3 m above the floor.

1.14 Duct mounted sensors should be located in the extract air duct as close as possible to the room air outlets.

Occupancy and presence detection

1.15 PIR sensors detect heat radiation of moving human bodies within its sensing zone. PIR sensors are much more sensitive to movement across their field of vision than to movement directly towards the sensor. More than one sensor may be necessary to cover an area and different lenses are available for different types of information capture.

Sensor Installation

All sensors

1.16 In all instances sensors should be fitted in accordance with manufacturers instructions.

1.17 Always comply with local installation and safety regulations.

1.18 Install sensors so that they are protected against damage and vandalism and to minimise the risk of injury.

1.19. Be aware of the effects of orientation on the functioning of the sensor.

1.20 Always determine the following before installation.

- 1.20.1 Min/max ambient temperature, humidity and water ingress.
- 1.20.2 Vulnerability to vibration.
- 1.20.3 Explosion protection.
- 1.20.4 External influences (such as sunlight).

1.21 Take account of the active and inactive sections of a sensor probe.

1.22 A tight-sealing test hole should be provided adjacent to every sensor.

1.23 The cable should be installed with a 'drip loop' to discourage water entering the sensor housing.

1.24 Allow adequate space for the sensor to be removed or withdrawn to be maintained or replaced ensuring a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.

1.25 When installing a sensor, avoid compressing the lagging.

1.26 Use a graduated-diameter mounting flange or spacing bushes to avoid compressing the lagging.

1.27 Where sensors will be concealed (e.g. in false ceilings, shafts etc.) mark their locations visibly and record them in the site documentation.

1.28 Fix a labelling plate in the direct vicinity of the sensor. This should include a plain text description and the reference number which appears in the plant schematic. Do not attach the label to the device itself.

1.29 When mounted within pipework and ductwork the sensor element is not affected by orientation but the full active length of the sensor must be immersed in the medium.

1.30 To prevent condensation, extend the immersion pocket inside the lagging by use of a plastic sleeve.

1.31 For each sensing point, an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.

1.32 When mixing mediums at different temperatures always maintain an adequate distance between the mixing point and the sensor (to take account of stratification).

1.33 When routing a sensing probe through walls, always use a lined and insulated conduit. Where the capillary passes through sheet metal, protect it with a rubber grommet.

1.34 Install sensor so that it is measures the desired medium and is not affected by external influences. Where air washers are used for humidification, install the sensor element in the air flow, downstream of the drift eliminator plate.

Read the instructions

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Sensor Installation

Immersion sensors, water

1.35 Install sensors towards the direction of flow.

1.36 Ensure a conductive paste is used to encourage transfer of heat.

1.37 The sensor pocket should be installed such that it cannot collect and hold water.

Immersion sensors (air and water)

1.38 When mixing water at different temperatures, maintain an adequate distance between the mixing point and the sensor (to take account of stratification).

1.39 When fitting measuring tips to pipework or ductwork care should be taken not to contaminate internal spaces with waste materials (such as swarf).

1.40 Ensure that the sensor is correctly sized to reach the heart of the measured medium.

Capillary sensors with probe

1.41 Do not bend the capillary too tightly (radius of bend must not be less than 50mm) and use appropriate fixing clips in accordance with manufacturers recommendations.

Averaging sensors

1.42 Do not bend the capillary too tightly (radius of bend must not be less than 50mm) and use appropriate fixing clips in accordance with manufacturers recommendations.

1.43 The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.

1.44 Some manufacturers use a series of single sensing points along the length of capillary in order to simulate true averaging along the length of the capillary. Care must be taken to ensure the single sensing points are located within the measured medium in such instances.

Space sensors

1.45 Install sensors at a height of approximately 1.5m in occupied spaces, and at least 50cm from an adjacent wall. Do not install directly adjacent to doors or behind curtains.

1.46 Avoid external walls, recesses and alcoves and walls concealing hot water pipes.

1.47 Do not install near lamps or above radiators or other heat generators (such as printers, photocopiers, monitors).

1.48 Sensors must not be exposed to external influences (such as solar radiation).

1.49 Always use a thermally insulated backing when fitting to solid walls (steel, concrete etc).

1.50 Seal plastic and metal conduits, and cavity walls, to prevent draughts.

Sensor Installation

Outdoor sensors

1.51 Do not expose to direct solar radiation.

1.52 Do not install above windows, extract louvres or ventilation shafts.

1.53 Outside pressure sensors should be located in a sheltered area and not enclosed within individual facades.

1.54 The correct measuring position is somewhere where the air can circulate freely, e.g. on a flat roof (the sensing point should be fitted with a wind shield).

Surface-mounted / clamp-on sensors

1.55 Ensure a smooth, clean contact surface and fill the space between the sensor and the pipe with heat conductive compound to improve thermal conductivity and insulated to exclude external influences.

Weather station (temperature, humidity, wind, solar and rain)

1.56 Where used, a mast should be approximately 2 metres above the building. Do not position the mast in the vicinity or in the shade of the building or trees.

1.57 Install solar sensors on the facade behind which the associated control system is operative.

Duct humidity

1.58 Special care should be taken to ensure the duct probe measures absorbed moisture and not carry-over of water particles from the humidification process.

Air pressure

1.59 Pressure sensors can be affected by orientation and vibration.

1.60 Pressure tubes must be provided with a test point near the device head, for calibration purposes.

1.61 To avoid overload on one side when manipulating the sensor, the connection must always be fitted with a bypass with a stop valve.

1.62 Where there is a risk of condensation, the differential pressure tube must be installed with a drain mechanism and the drainage point should be lower than the device head and sensing point. Be mindful of the risk of frost.

1.63 Pressure tubes containing circulating air should not pass into the open air or through cold rooms or ducts to prevent the risk of condensate freezing in the tubes.

1.64 The pressure-tapping point must not be located in turbulent air flow. There should be a sufficiently long steadying zone consisting of a straight section of pipe or duct without obstructions.

1.65 Avoid using tips which protrude into the duct for static pressure measurements. These probes are installed parallel to the flow and either with or against it.

1.66 The tapping point must not be located where it will be affected by obstructions to the flow.

1.67 Where more than one sensor is used, the sensors should be installed at the same point in the flow, and not in a position where one device will obstruct the air flow to the other.

1.68 The end of the pressure tube leading into the room should be protected by a porous cover.

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Sensor Installation

Liquid pressure

1.69 Ensure pressure tappings are fitted with a smooth interior (no burrs) finish.

1.70 The sensing device should be installed in a location which is lower than the pressure tapping point to avoid air bubbles forming.

1.71 To avoid overload on one side when manipulating the sensor, the connection must always be fitted with a bypass with a stop valve.

Velocity /flow rate

1.72 To measure flow velocity, the differential pressure is measured with a detector such as an orifice plate or flow grid etc. In general, the installation instructions are the same as for the differential pressure sensors. Remember to allow a steadying zone both upstream and downstream of the flow detector.

1.73 Electrothermal flow switches should be installed in locations with a high flow velocity (e.g. narrow sections of the duct).

1.74 The flow or differential pressure must not be monitored where there is a variable resistance such as a filter, cooling coil, fan etc.

1.75 The flow velocity can be determined by measuring the differential pressure and converting it appropriately. Special detectors are available for this purpose:

1.76 Like air velocity, water velocity can be measured with orifice plates.

Calibration and ongoing maintenance

1.77 The calibration of measuring sensors is a process based on comparison to a known value.

1.77.1 The calibration process must be carried out at the sensor. Offsets and resistance tables may be used to compensate the measured value.

1.77.2 Cleaning and calibration is an important part of the ongoing maintenance programme which should be carried out in accordance with manufacturers guidelines.