

MECHANICAL DESIGN MANUAL SUMMARY SHEET

SUBJECT: Building Automation Systems (DDC)

DESCRIPTION: Fundamentals of DDC panels, Operator Workstations, Controllers, sensors and sequencing.

APPLICATION: All Engineers involved in the design and specification of controls and building automation systems should have an understanding of this material.

SPEC SECTION: 15952

APPLICABLE CODES: ANSI/NFPA 70 - National Electrical Code

DATE: July 17, 1992

PREPARED BY: Jim Edward

BUILDING AUTOMATION SYSTEMS (DDC)

BY

Jim Edward

July 17, 1992

General:

Building Automation Systems provide automated control, monitoring and energy management for a facilities mechanical systems. The problems associated with efficient energy use and complicated control schemes can be easily remedied by a properly selected and designed control system.

A. Devices

1. Differential Air Pressure Gauges (DPG)
sense differential or static pressure across, fans, coils, filters or between two reference points and transmit a 3-15 psig signal to controlling and indicating devices.

These devices are one-pipe transmitters which require an external restrictor in the supply line and usually provide pneumatic feedback.

Commonly used in differential pressure to measure filter capacity and static pressure for inlet vane or VFD control.

2. Thermostats

- a. Single Temperature
- b. Dual Temperature (Day/Night)
- c. Heat/Cool
- d. Line Voltage (Rom or Remot Bulb)
- e. Outside Air
- f. Remote Bulb

3. Humidistats

Made of hygroscopic materials which change size in response to changes in humidity. An element similar to a bimetal is made of two strips of metal and wood glued together. The different rates of hygroscopic expansion will cause the strip to bend as humidity changes.

4. Control Valves

$Cv = \text{gpm} @ 1 \text{ psi } \Delta p. \quad \text{gpm} = Cv \sqrt{\Delta p}$
Sized for .75 - 2.5 Δp .

5. Pneumatic Transmitters

Pneumatic transmitters can measure temperature or pressure they provide a wide signal to a receiver controller which in turn generates a usable signal.

6. Pneumatic Receiver Controllers

Receiver Controllers are used with remote pneumatic transmitters to provide proportional control in pneumatic control systems. They may be used with any pneumatic device having a calibrated 3-15 psig output and are available in both direct and reverse acting models.

- Receiver controllers may also be used as limit controllers. These devices utilize an integral limit valve which allows them to be indexed internally for limit control applications.

These devices are of the dual-input type and usually provide pneumatic feedback.

7. P.E. Switches

8. Sensors and Remote Equipment

9. Time Clocks

B. Control Panels

C. DDC Controllers

a. Standalone DDC Panels

- a. Battery Back-up/UPS
- b. Isolation
- c. Point Monitoring
- d. Software
- e. Input/Output Point Processing
- f. PID Loop Control

b. Operator Workstations

- a. CPU
- b. Monitor
- c. Operator Interface

c. Portable Operator Terminals

d. Software

e. Networking/Communications

D. Execution Installation

E. Control Sequences

F. Points List

Control Definitions

Electric Systems:

Electric systems provide control by starting and stopping the flow of electricity or varying the voltage and current by means of rheostat or bridge circuits.

Electronic Systems:

These systems use very low voltage (24 V or less) and currents for sensing and transmission, with application by electronic circuits or servo-mechanisms as required for operation of controlled devices.

Pneumatic Systems:

Pneumatic systems use high (80 psi) and low-pressure (3-20 psi) air. Changes in output pressure from the controller will cause a corresponding position change at the controlled device.

Direct Digital Control (DDC):

The use of a digital computer which periodically compares analog and binary point status to the desired setpoint or state and can directly initiate control action if necessary. Also referred to as digital system controllers (DSC). Digital system controllers are usually integrated into a building automation system.

Distributed Control Systems (DCS):

The use of a digital computer where the control, operator interface, and data acquisition devices perform independent tasks without the need for any other controllers, interfaces, or computers.

Stand Alone Panels:

A panel which utilizes a digital computer to perform basic control and energy management routines without the need for any other controllers, interfaces, or computers.

Local Area Network (N1 LAN):

Primary Communications. Connects the standalone panels to each other and to the operator workstation. Provides "peer-to-peer" communications. Usually operates at 2.5 mega-baud over coaxial cable, twisted pair or fiber optics.

N2 BUS:

Secondary communications device. Connects point interfaces and remote controllers to the stand alone panels. Telephone type cable usually connects up to 100 devices.

Actuator:

A device which is mechanically linked to a damper or mounted on a valve which converts a pneumatic or electric signal to a force which produces movement (opening and closing).

Averaging Element:

A sensing device which is approximately 20 feet long that is criss-crossed a duct to sense the average temperature of the gradient that may occur.

Averaging Relay:

An auxiliary device that accepts the signals from two controllers and produces a signal that is the average of the two values received from the controllers.

Analog Point:

A piece of equipment or a sensor which has a continuous range of settings or values that can be monitored or controlled (temperature, modulated control).

Analog Signal:

A signal in the form of a continuously varying quantity such as voltage or mA.

Binary Point:

A piece of equipment or a sensor which has only two possible contact states that can be monitored or controlled (start/stop, open/close).

Building Automation System:

A modular array of compatible computer components that automate a wide range of building operations from HVAC to energy management, maintenance management, fire alarm, security and lighting control. Also called Facility Management System or Energy Management System.

Control Application Language (CAL1):

High-level programming language which allows the user to build automation programs. The language is customized to simplify DDC program writing.

Change-of-State:

When a binary or analog point experiences a change from normal to abnormal condition or a return from abnormal to normal condition. A key feature of any building automation system is the ability to report change-of-states in a realtime environment.

Controller:

Pneumatic, electronic, or digital device which determines and regulates the position of controlled devices such as valves, dampers and contacts based upon external inputs such as temperature.

Differential Pressure Control:

A system in which two pressure sensors transmit their respective signals to a controller; the controller, in turn, produces an output to the controlled device that will vary in accordance with the difference of the two sensed pressures.

Direct Acting:

The action of a controller that produces an increase in output pressure as the variable increases.

Electric-Pneumatic Switch (EP):

An electrically operated air flow switch with normally closed and normally opened inputs which lead to a common output.

Fail Position:

A characteristic of an actuator in which it returns to a known position upon a loss of a control signal.

Feedback:

A design feature of proportional control in which the controller receives a signal from the controlled device, thereby telling the controller what position the controlled device has assumed.

Hunting:

The action of a controller which causes the controlled device to continuously travel from one end of its stroke to the other.

Normally Closed (N.C.):

A controlled device that reduces the flow of the controlled medium as the branch pressure is reduced, and will go to shut-off if the branch pressure goes to zero.

Normally Open (N.O.):

A controlled device that increases the flow of the controlled medium as the branch air pressure is reduced, and will go to full-flow if the branch pressure goes to zero.

Pneumatic-Electric Switch (PE):

An air pressure operated switch in which the contacts are made or broken in order to operate electrical devices in a pneumatic control system.

Positive Positioning Relay:

An auxiliary device that accepts a signal from a controller and sends a signal on to the actuator at a magnitude, up to main pressure, to extend the actuator to the point the controller signal is calling for, and will decrease the pressure to the actuator to zero to retract the actuator to the point the controller is calling for.

Receiver Controller:

A device which receives the small signal changes from transmitters and amplifies these small changes to a 3-15 psi output to the controlled device.

Relay Control:

A pneumatic control arrangement in which the main air to the controller passes through a valving mechanism to the controlled device. The valving mechanism is operated by the pressure variation of the pilot chamber.

Restrictor:

A device which has a minute opening (.005" or .0075") which changes the velocity pressure of the air line to static pressure.

Reverse Acting:

The action of a controller that produces a decrease in output pressure as the variable increases.

Reversing Relay:

An auxiliary device that produces a decrease in the output to the controlled device as the input from the controller increases.

Sequencing:

A control arrangement in which several actuators move through their stroke in succession as the signal from the controller changes. This arrangement is derived by using actuators with different spring ranges (4-8 and 10-15) or by the use of a pneumatic relay.

Set Point:

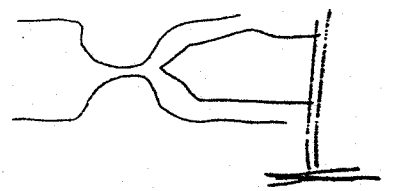
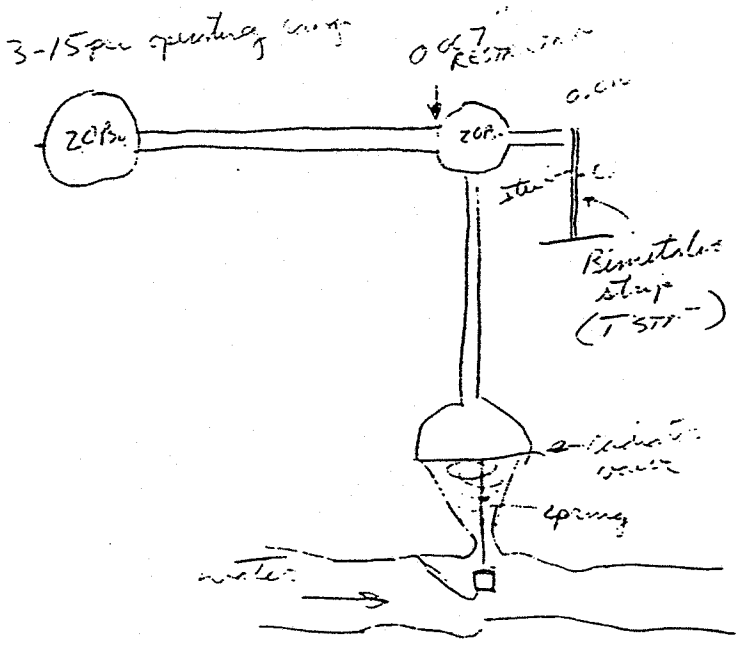
The position to which the control point setting mechanism is set.

Switching Relay:

An auxiliary device that chooses either of two signals to be the output to the controlled device, and the choice is made based on the signal received by the pilot chamber.

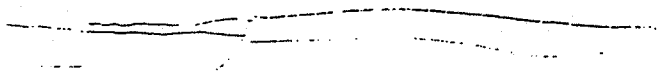
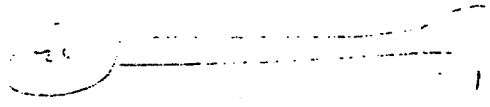
PROJECT CENTRAL SYSTEM	DATE 3/1/96	BY [Signature]	PROJECT NO.
---------------------------	----------------	-------------------	-------------

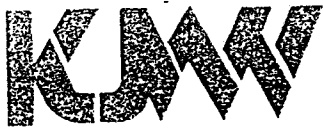
3-15 psi operating range
20-25 psi system pressure



simple bleed T test

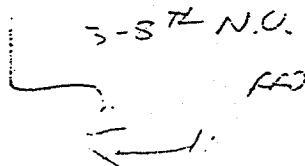
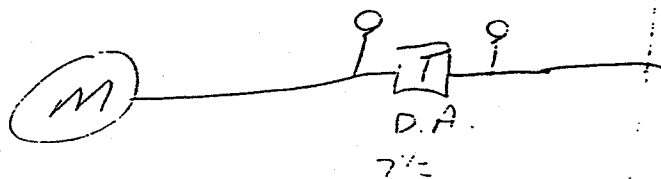
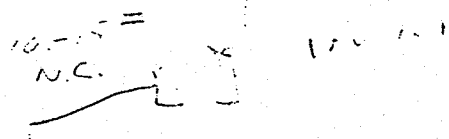
5 micron filter & good air dryer





PROJECT	DATE	BY	PROJECT NO.
---------	------	----	-------------

Direct Acting T. Stat Temp ↑ pass ↑
 Reverse Acting T. Stat Temp ↑ pass ↓



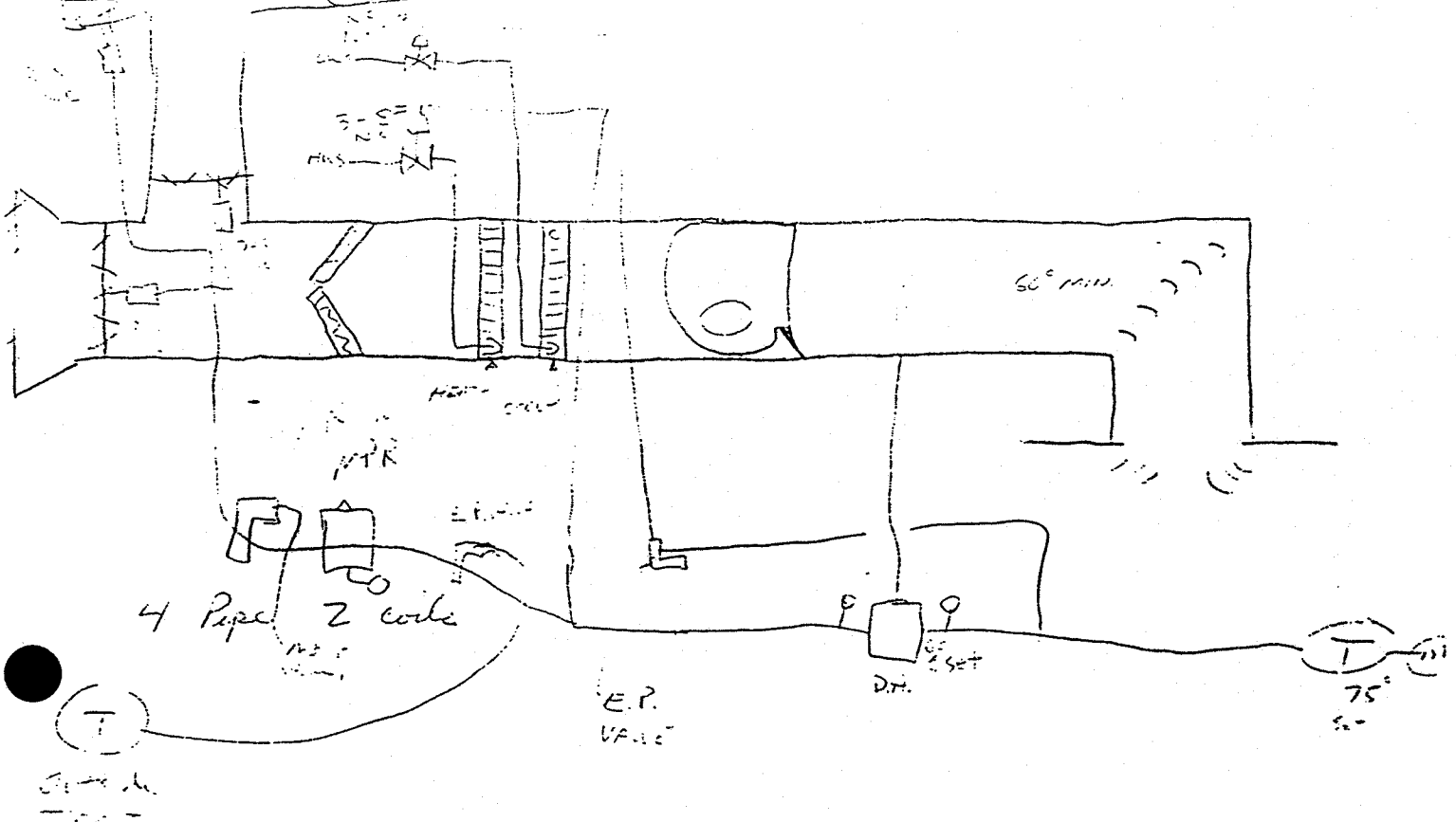
Switching Relay
 Amp. relay
 Powering relay
 E.P. relay
 P.E. switch

- 100% ...



ENGINEERING CONSULTANTS

PROJECT	DATE	BY	PROJECT NO.
---------	------	----	-------------



also in then supply ...

water take 1/3 distance from end of duct run
control VFD