Applications of Data Acquisition Systems

DAQ Applications

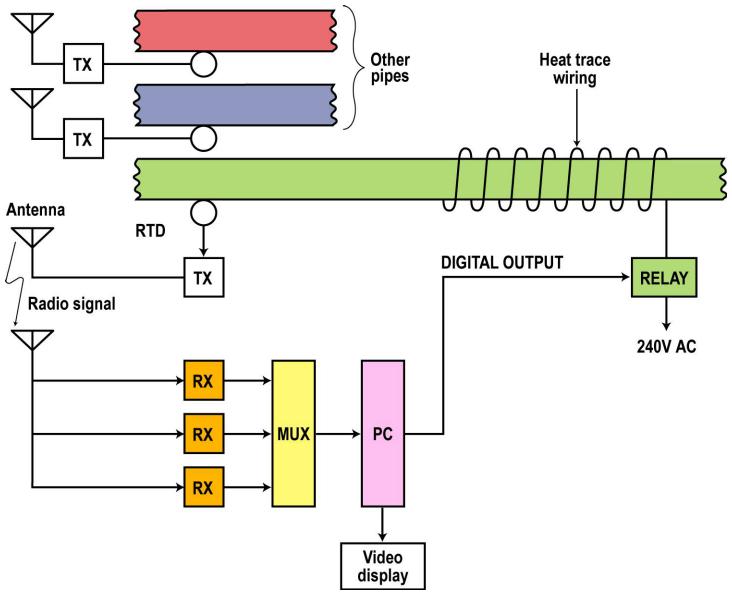
The number of applications for data acquisition systems is enormous if not infinite. They can be adapted to almost any application.

Most of the applications fall into one of the following categories:

- Industrial process control: chemical or petroleum plant
- Manufacturing: testing finished product, quality monitoring
- Automotive: testing car or truck performance on the road, engine monitoring, design evaluation
- Medical monitoring: patient monitoring, lab monitoring
- Environmental monitoring: weather, pollution control
- Research laboratories: experimentation, testing

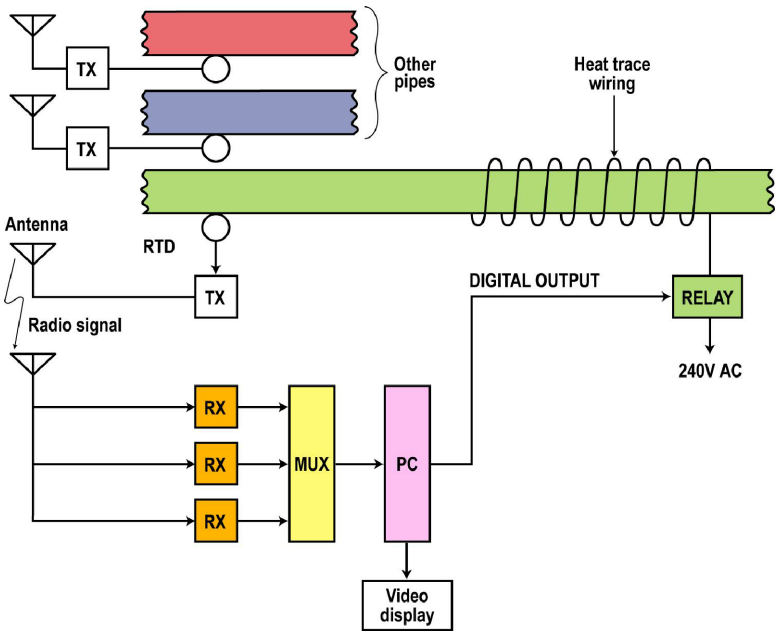
The following examples are only a few of millions of others.

Temperature Control in a Chemical Plant



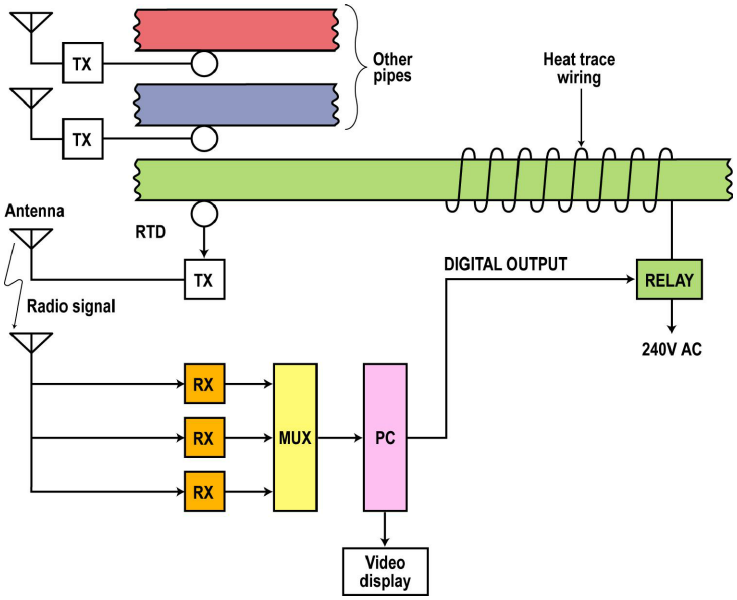
This figure shows a system used in a chemical plant to monitor and control the temperature of liquid flowing in pipes. The temperature is measured on each pipe. If the temperature drops below a specific level, heating elements made with special wiring (called heat trace) are turn on to bring the temperature up to the desired level.

Resistive Temperature Device



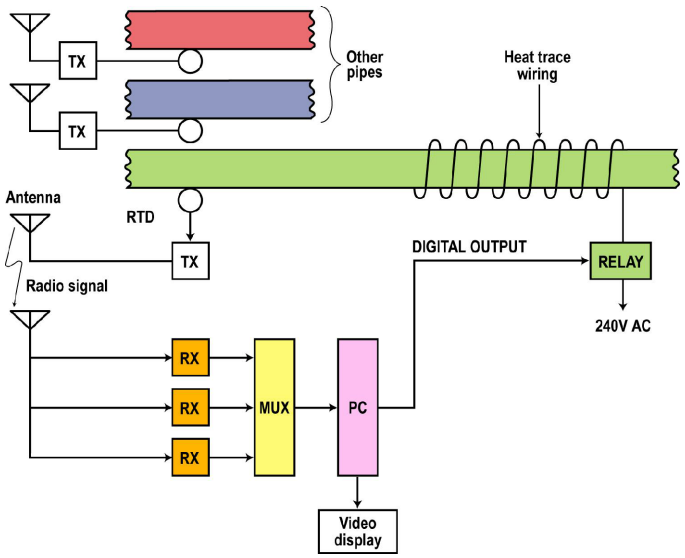
The temperature is monitored by a resistive temperature device (RTD). It is a 100 ohm platinum wire or other resistive element whose resistance increases with temperature. The RTD element is connected in a bridge circuit like that shown earlier. The resulting DC analog signal represents the temperature.

Temperature Control: ADC



The DC voltage representing the temperature is amplified then digitized by an ADC. Because temperature variations are very slow, the sampling rate can be very low (like one per minute). The ADC output is converted to a serial digital signal that is then fed to a wireless transmitter (TX). The TX sends the signal to a receiver (RX). Such a system is referred to as wireless telemetry.

Temperature Control: Receiver

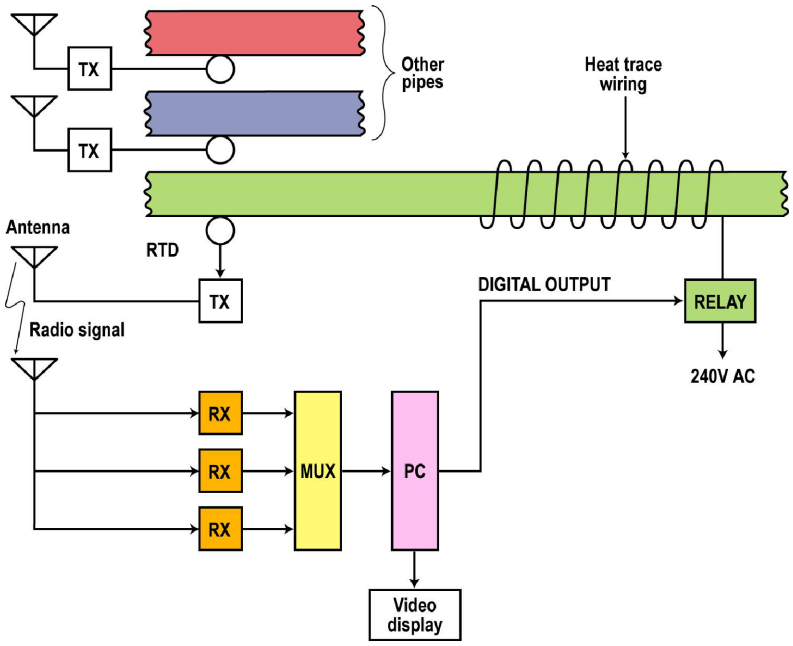


The receiver (RX) is usually one of several. Each monitors a transmitter that sends the temperature data from other pipes. The receiver output is selected by a multiplexer and sent to a personal computer (PC) where software determines if the temperature is high, low, or at the set point (desired value). The PC is programmed to identify each pipe and its temperature.

Temperature Control: Set Point

If the temperature is not at the set point, the computer will activate an external relay with a digital output. The relay contacts connect or disconnect a 240 volt AC power line voltage to/from a heating element called heat trace. Heat trace is a two wire cable covered in a material that is not a perfect insulator as it is in conventional cables. Instead, the cable has a controlled amount of resistance between the conductors. When voltage is applied to the conductors, current flows and heat is produced along the length of the cable. This in turn heats up the pipe. When the temperature rises to the set point, a sample from the RTD tells the computer that the temperature is OK. The computer turns off the power to the heating element. In this way, the temperature of the pipe and the liquid flowing in it is maintained within a few degrees of the desired level.

Temperature Control: Display



The PC in the system is programmed and a display is created. The display may show a graphical representation of the pipes, each with a digital display of its current temperature. The display can also show things like which heating element is off or on.

Automotive Instrumentation

A common application of DAQ systems is in automotive development and testing. For example, an engine under evaluation can be set up with sensors to monitor just about any physical characteristic desired. Critical conditions such as engine speed in rpm, block temperature, exhaust temperature, fuel flow, throttle opening percentage, and other factors can be monitored. Then, the engine output horsepower, torque, and levels of output pollution can be measured using a dynamometer.

A portable data logging system can be installed in a car and data collected while the car is tested on a track or closed course.

Handling systems, stability controls, and anti-lock brakes are tested and designed this way. Data collected from sensors is stored and later analyzed in the office where design changes can be made.

Semiconductor Manufacturing

In semiconductor manufacturing, electronic circuits are made on a wafer of silicon by exposing the wafer to different gases, temperature variations, and other processes. The key to creating a successful chip is the precise application of just the right amount of gas with the correct concentration, a specific chamber pressure, and the appropriate temperature. A data acquisition system can be used to build and operate a gas delivery system for a fab or a specific process tool.

Semiconductor Manufacturing

Sensors are used to monitor gas pressure, temperature, and vacuum level. Control outputs can be used to turn gases off or on using valves to control the temperature and vacuum pressure. Mass flow controllers (MFCs) are also used to feed the gas at just the right pressure and concentration.

Semiconductor Manufacturing

A front panel, like the one shown here for Equipment Support Company horizontal sputtering machine, can be constructed on the computer screen to sensors, pipes, gas sources, valves, or other equipment along with actual sensor readings.

Cell Phone Manufacturing

A data acquisition system can be set up to automate the testing of cell phones after they are manufactured. Cell phones must meet rigid requirements for frequency precision, power output, adjacent channel interference, and electromagnetic radiation limits. Because cell phones are produced in quantities of millions, it is impractical and uneconomical to test each manually.

An automated test system can be built with test instruments and virtual instruments such as signal generators, radio receivers, spectrum analyzers, power meters, and other equipment to put each completed cell phone through a predetermined test sequence. A connector attached to the cell phone picks up signals that are measured then compared to preset desired values in the computer. The phone then either passes or fails.

A front panel screen will show the test in progress, pass/fail status, and other desired information.

Explore DAQ Equipment

There is no better way to become familiar with a topic than to look at examples of modern electronic products. It is strongly recommended that you go to the websites listed below and explore the available DAQ equipment and products.

ADLINK Technology www.adlinktech.com

Data Translation www.datx.com

DATAQ Instruments www.dataq.com

Keithley Instruments www.keithley.com

Measurement Computing Corp. www.mccdaq.com

National Instruments Inc. www.ni.com

Omega Engineering Inc. www.omega.com

Pico Technology www.picotech.com

Explore each site for products, application notes, white papers, tutorials, and other information. Don't forget to look at software as well as hardware.

Test your knowledge

Data Acquisition Systems
Knowledge Probe 4
Applications of Data Acquisitions Systems

Click on Course Materials at the top of the page.
Then choose **Knowledge Probe 4**.

Development Team

Project Principal Investigator	Dr. Michael Lesiecki
Project Manager	Tom McGlew
Principal Module Author	Louis E. Frenzel
Editor	Phyllis J. Cooke
Graphics	Bryan McIntyre
Contributing Faculty	Jesus Casas, Joe Neglia, Laura Marmolejo

Special thanks to National Instruments Inc. for the use of photos and LabVIEW screen shots used in this module.