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DATA ACQUISITION SYSTEM FOR TEMPERATURE MONITORING IN A COOLING SYSTEM

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Abstract: The cooling process realized by a refrigeration system requires the determination through mathematical calculus of the temperatures in different points of the cycle. It is absolutely necessary to determine by calculation the refrigeration agent's temperatures in different points and at the same time to verify by measurement those who correspond to the theory. To achieve this goal we present in this study a method of data acquisition with the help of a LabJack U 12 acquisition device, which allows us to identify twelve different values. The measurement method is easy to use in the laboratory and confirms our verifications by providing satisfactory results.

1. THE DATA SYSTEM ACQUISITION

To pick up signals obtained through temperature sensors we used a LabJack U12 acquisition device allowing 8 12-bit "analog/digital" conversion entries, 2 "digital/analog" conversion exits and a 32-Bits counter. The 2 "digital/analog" conversion exits are accessible via screw terminals. Each output can be configured for a voltage between 0 to 5 V (with a resolution of 10 bits). The output voltage can be controlled mode "software" (sending a command/ response) up to 50 Hz per channel. The "LabJack U12" unit features 20 "input/output" ports, out of which each or none of them are individually configurable as input or output. 4 of its pins are accessible via screw terminals installed in the front of the unit. The remaining 16 "input/output" ports remaining are available on a connector sub-D 25 pins available on the rear panel. These latter ones can be ordered (as input or output) in "software" mode (sending command/response) up to 50 Hz per bit. The software for the LabJack U12 acquisition module is based on a Windows 2000/XP platform and is provided by NI-DAQmx.

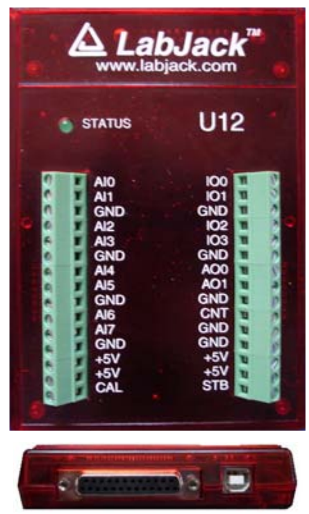

Fig. 1 LabJack U12

The analog input circuit

The AI (analog inputs) use a multiplexer system connected to an amplifier, the signal being digitally converted by an analog-digital converter with successive approximations. The PGA amplification is automatically calculated based on a level of tension selected at the entrance.

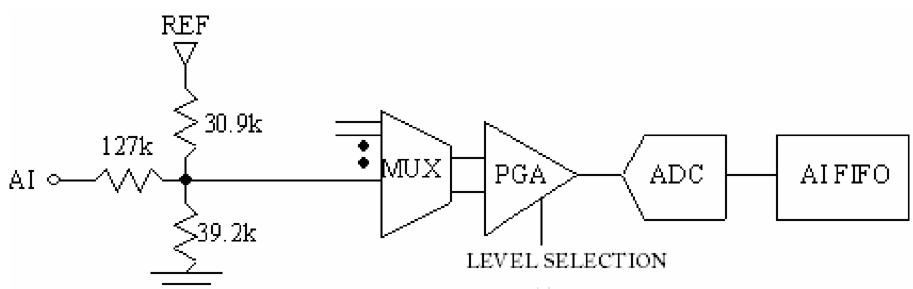

Fig.2. The analog input circuit of LabJack U12

The voltage signals' differential connection

We must connect to the differential signals the positive signal lead to the AI + terminal and the negative lead to the AI- terminal. The differential input module can measure signals between ± 20V. The maximum voltage for each pin is ± 10 V respecting the value of the reference signal. For example, if AI1 is +10 V and AI5 is-10V is the difference +20 V. Examples for measuring differential below and above 20V are presented in Figures 4a and 4b.

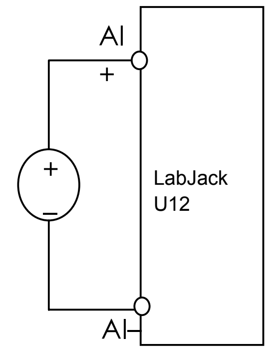

Fig.3. The voltage signals' differential connection

Fig.4. Examples for the differential measurement

The single-pole connection of voltage signals

In order to realize this kind of single-pole connection to an analog port of LabJack U12, it is necessary to connect the necessary positive terminal voltage and the reference signal to the GND terminal as shown in Figure 5.

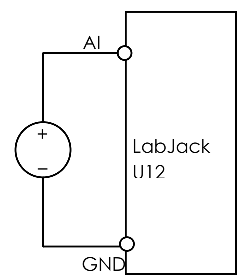

Fig.5. Single-pole Connection

The analog output circuit

The connection of the charge and the analog output circuit are presented in Figures 6,7.

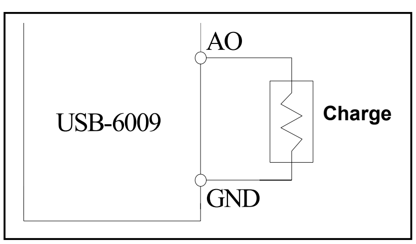

Fig. 6. Charge connection

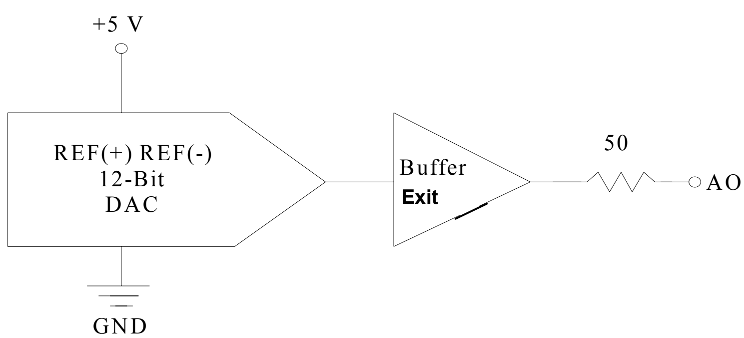

Fig. 7. The analog output circuit

The LabJack U 12 interface has two independent channels AO that can generate output voltages of 0V to 5 V. LabJack U 12's connection conceived as an analog output is realized between the charge 's positive lead at the terminal AO and the negative lead to the GRD terminal.

When using a digital - analog converter to generate waveforms it is possible to appear some distortions in the generated signal. At the time of change of two voltages, the converter generates distortions that are based on a charge drop. The biggest distortions arise during the change of the DAC most significant bit code.

A low-pass filter can be used for removing distortions

The digital input – output ports

LabJack U12 has twelve digital connections, P0. <0 .. 7> and P1. <0 .. 3> including the DIO port. Each of the signal lines can be programmed as input or output. Examples for connecting the load are shown in Figure 8.

P0.0 is conducting a configuration of a digital open collector who activates a light emitting diode at the output.

P0.2 configures a digital active command and activates a light emitting diode (LED).

P0.4 configures a digital input and can receive a TTL rectangular signal provided by an inverter port.

P0.7 configures a digital input and can receive a signal from 0 to 5 V provided by a selector.

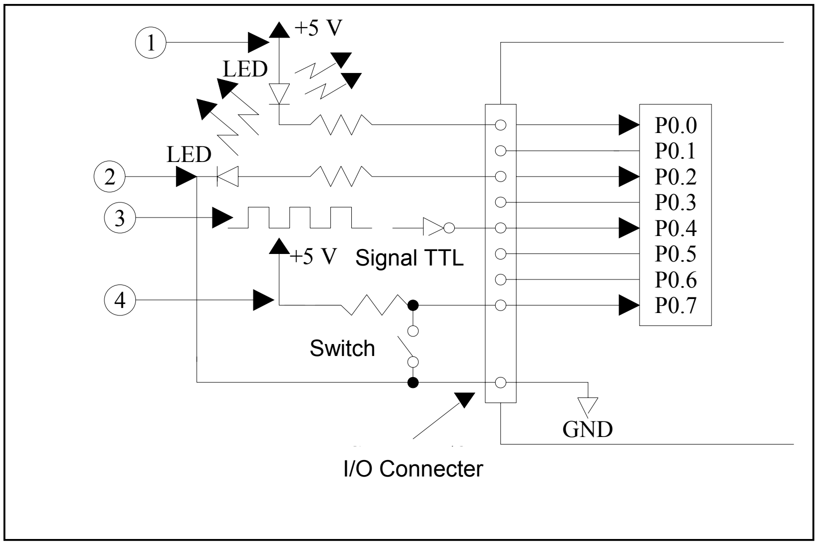

Fig. 8. Charge connections

2. LM35 - PRECISION CENTIGRADE TEMPERATURE SENSOR

The LM35 integrated circuit is part of a high precision integrated sensors family type. The linear voltage at the output of sensor is proportional to the temperature in degrees Celsius. The technical characteristics of this sensor are:

- ✓ A precision of 1/4 C° for the measurement of temperature within the (-55÷150) °C and a precision of 3/4 C° outside these values;
- ✓ A supply voltage of (-0.2÷35) V;
- ✓ An output voltage of (-1÷6) V, 10mV /° C;
- ✓ An output current of 10mA;
- ✓ A self-heating <0.08°C for the operation in wide spaces.
- ✓ An initial linearity and a calibration, which are insured for 10mV /° C.

For this measurement, we have used 8 LM35 sensors and the electronic printed circuit board depicted in Figure 9.

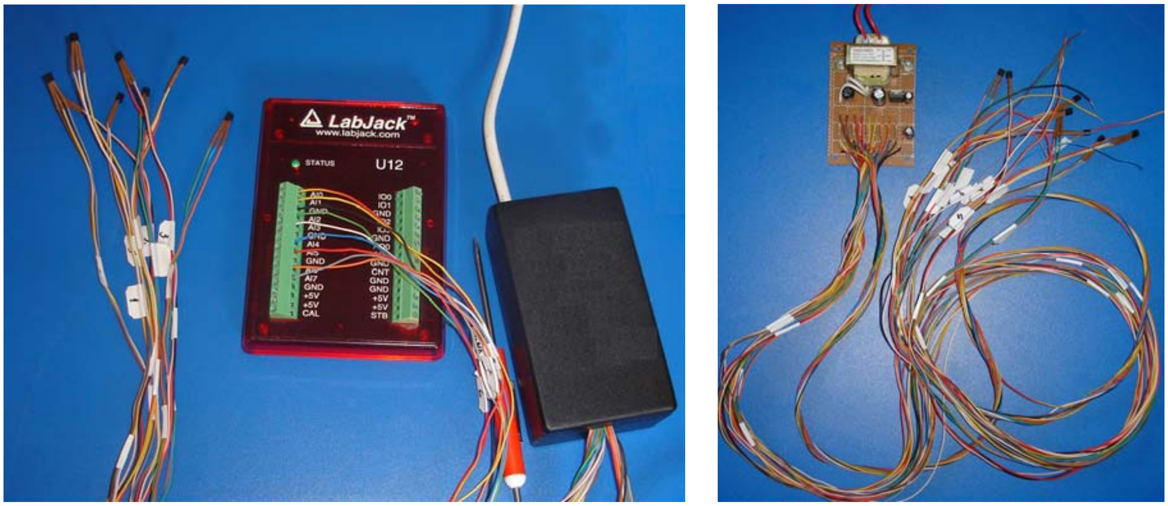

Fig.9. Data acquisition card and the LM 35 sensors

The sensors can be fitted on all cooling surfaces.

3. CONCLUSIONS

In this study we have introduced a system of data acquisition for a cooling unit. We can get eight values that correspond to the entry and exit of the main components of the installation. The temperature values can be logged and displayed on a computer using the acquisition device LabJack U12 and supplied software. Once you determine the temperature, other software, CoolPack, can verify if the values correspond to the theory.

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