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Construction of Multipoint Temperature Data Acquisition Platform

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Abstract: Multipoint temperature data acquisition platform is built by combining with the microcontroller and sensor technology, using Agilent 34970A, K type thermocouple and computer equipment, the platform has realized temperature test without manual intervention, greatly reducing the workload, meanwhile it has the characteristics of high temperature accuracy, short interval acquisition time, realizing data analysis by computer. *Copyright © 2014 IFSA Publishing, S. L.*

Keywords: Temperature, Agilent 34970A, Data Acquisition, K Type Thermocouple, Platform.

1. Introduction

In the industrial production process, temperature is one of the important parameters to measure and control many physical phenomena and chemical characteristics of an object are related to temperature, many production processes are carried out in a certain temperature range, and need to measure and control temperature, so the temperature measurement occasions extremely widely. It is mostly required for the temperature of medical products operation in GB9706.1-2007 "Medical Electrical Equipment - Part First: General Requirements for Safety" standard in the 42 chapter [1]. While temperature measurement instrument at present prevailing in the market are mostly single point, and the temperature information is not timely, and is not accurate enough. In this case, it is necessary for constructing a capable of multi-point measurement, real-time, high accuracy, and temperature data acquisition platform.

2. Introduction of the Platform

Using the microcontroller and sensor technology, Multipoint temperature data acquisition platform consist of Agilent 34970A with the configuration of the K type thermocouple and the computer with installing IO Libraries Suite and BenchLink Data Logger software, and the RS232 communication mode is adopted to realize the real-time display, multi channel temperature data logging, drawing the curve change trend of temperature and other functions [2].

2.1. Structure of Platform

The structure of platform is shown in Fig. 1.

2.2. Hardware Description

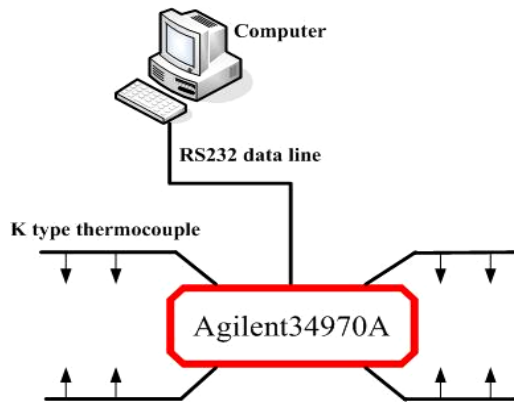The Agilent 34970A is a data acquisition and switching mainframe.

Fig. 1. The structure of platform.

A high performance, low price, very suitable for data recording, data acquisition and general switch and control applications. It is a kind of host half rack width, interior has 61/2 (22 bit) digital voltage meter, the back side is provided with 3 slots, can accept switch and control module some combination [3-4]. Whether you just need a few simple data recording channel, or hundreds of properties of ATE channel, Agilent 34970A could with reasonable price to meet the requirements of data acquisition for you.

Agilent 34970A includes a digital multimeter (DMM) features, you will have proved that Agilent performance, signal conditioning universal input, all of the low-cost, compact data structure benefit. 34970A is a 61/2 bit resolution (22 bit), 0.004 % basic DC voltage accuracy and low readout noise, plus up to 250 channel scanning rate of /s, you can get the speed and accuracy needed to complete tasks. Strong ability to adapt Agilent 34970A unique design allows each channel configuration, in order to achieve the maximum flexibility and convenient automatic range set the internal conversion. DMM has 11 kinds of direct measurement of different functions, without the need for external signal conditioning expensive. Temperature conversion program within C, can be F or (Kelvin) showed that untreated thermocouple or thermistor input, RTD. Use of the output of linear sensor directly to the engineering unit. You can even high / low tolerance is beyond the set.

In general, K type thermocouple is used together with display instruments, recording instruments and electronic regulator. K type thermocouple is usually composed of a temperature sensing element, mounting and fixing device, junction boxes and other components. K type thermocouple has the advantages of good degree of linearity, larger thermoelectric EMFs, high sensitivity, good stability and uniformity, strong antioxidant properties, and good price, can be used for the oxidation of inert atmosphere widely for users.

As one of the communication interface for personal computer, RS232 data line is an asynchronous transmission standard interface set by EIA (Electronic Industries Association) [5]. Usually

RS232 interface has the 9 pin (DB-9) or 25 pins (DB-25) pattern, and there will be two RS232 interfaces for personal computers, which are called COM1 and COM2.

The following Fig. 2 displays RS232 data line connection mode of the platform requirements:
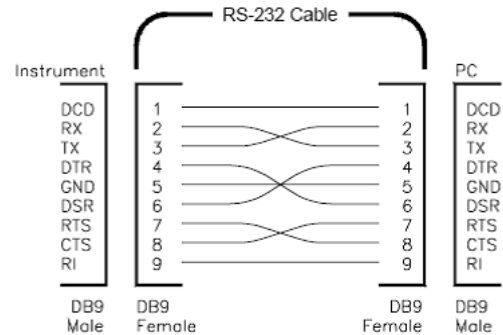

Fig. 2. RS232 data line connection mode.

K type thermocouple as a temperature sensor, thermocouple type K usually and display instruments, recording instruments and electronic regulator using K type thermocouple can direct measurement of the production from 0 ℃ to 1300 ℃ liquid, steam and gas and solid medium surface temperature. K type thermocouple is usually composed of a temperature sensing element, mounting and fixing device and junction boxes and other main components. K type thermocouple is currently the largest amount of base metal thermocouple, the sum of the amount of the other. K type thermocouple wire diameter is 1.2~4.0 mm. Anode (KP) nominal chemical composition: Ni:Cr=90:10, negative (KN) nominal chemical composition: Ni:Si=97:3, the use of temperature is -200~1300 ℃. K type thermocouple of good degree of linearity, thermoelectric EMFs, large, high sensitivity, stability and uniformity is good, strong antioxidant properties, the advantages of cheap, can be used for the oxidation of inert atmosphere widely for users. K type thermocouple can't be directly used for sulfur in high temperature, reduction or oxidation reduction, alternating atmosphere and vacuum, and is not recommended for weak oxidizing atmosphere

Response measurement of K type thermocouple heat time is actually more complex, different test conditions will produce different measurement results, this is due to the rate of heat exchanger of the surrounding medium, high heat exchange rate, the thermal response time is short. In order to make the thermocouple thermal response time is comparable, the national standard: thermal response time should be carried out in a special flow test device. The velocity of flow of the device shall be 0.4 ± 0.05 m/s, the initial temperature in the range of 5-45 DEG C, the temperature of 40-50 ℃ step value. During the experiment, changes in water temperature should be not greater than ± 1 % jump temperature order. A

subject in depth of thermocouple is placed depth 150 mm or design. The thermocouple near room temperature thermopower is small, thermal response time is not easy to measure, so the national standard of thermoelectric type K thermocouple can be used with the specifications of the polar component replacement power of its own polar components, and then test. The test should be recorded to the equivalent output change of thermocouple temperature step change time of 50 % T0.5, time T0.9 response time of T0.1 and 90 % of the variation in thermal response may be necessary to record the changes of hot 10 %. The time response of the recorded thermal, average should be of the same test at least three times the value of each measurement test results, the deviation from the mean value should be within ± 10 %. In addition, the formation temperature step change needed time should not exceed 1/10 of T0.5 was tested. Recording apparatus or instrument response time should not exceed 1/10 of T0.5 subjects.

2.3. The Application of Agilent 34970A Data Collector

The 3 module slots and 8 switch and control module can configure Agilent 34970A to meet your unique needs. You can only buy you need at that time, along with the development of your application, add more modules. 1.5 rack unit can measure up to 120 inputs. Agilent free software simplified data acquisition if the data recording capability based on PC, but do not want to spend time programming, Agilent can solve this problem. Using this software can be set to your test, collecting and archiving management measurement data and make the data real-time display and analysis. Electronic watch familiar environment and can be easily configured and control test, extensive color graphics to display your data provide many options are all convenient click, can use a graph, histogram, X-Y plot and warning lamp build a variety of graphics. In addition, using Data Logger can easily be sent to other application data for further analysis, or include it into your display and report.

When the configuration of the Agilent 34901A 20 relay multiplexer, 34970A becomes the data logger of low price, compact, very suitable for fast testing laboratory or field. Since the intuitive panel boot menu and bright, easy to read display the vacuum independent settings both faster and more convenient. All readings are automatically added memory time labeled and stored in -50000 readings to save a week inside valuable data (every 5 minutes to scan 20 channel). The non-volatile memory can still save the data after the power is turned off, so that you can use the 34970A data, then uploaded to the PC machine. System configuration is stored in a non-volatile memory, so the power down again after the power is switched on automatically resume scanning. In addition, when the

test of basic PC Data Logger software can simplify the test configuration, data analysis and data management.

For automatic test and automatic desk application, Agilent 34970A 3 slots and 8 insertion type switch and a control module selection allows for easy configuration. Provides properties and functions of the application of DMM but take up space and the price is only a fraction of the 61/2 internal DMM for you. Provide support and National Instruments Lab VIEW software, which can easily integrate 34970A into your system, the standard RS-232 and GPIB interface and the SCPI programming language makes this integration easier. Three year warranty is standard, as our exclusive relay maintenance system, automatic calculation and storage switch every time alone, you are expected to assist relay life, avoid production line stop.

For testing the application does not require internal measurements of 34970A, can be ordered with no internal DMM unit. This provides a solution that exceeds low price, used as a test signal and measured pathway and the allocation of various instruments such as external DMM, oscilloscope, counter, power supply etc. In addition, if your needs change, still can add DMM later.

3. Platform of Software and Hardware Configuration

After Multipoint temperature data acquisition hardware connection is completed, it is necessary for hardware configuration and software necessary driver installation to realize multi-point temperature data collection requirements.

3.1. Hardware Configuration

First, the settings of the computer, it is confirmed that the computer COM port settings consistent with the Rs232 interface of Agilent 34970A. The method is as follows: open the system properties dialog box in control panel, open device manager in hardware, set the COM1 port attribute, so that the "bits per second" and "data" numerical and Agilent 34970A Rs232 corresponds to the numerical consistency.

Second, the Agilent 34970A settings, coming into the configuration interface of the RS232, and keeping the "rate" and "data digital" settings consistent with the computer in the "bits per second" and "data" settings. So as to ensure the normal communication with computer.

3.2. Installation and Configuration of Software

Agilent IO Libraries Suite is a collection of libraries that give you the ability to use your instruments from a test and measurement program,

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and utilities that help you quickly and easily connect your instruments to your PC.

Agilent IO Libraries Suite speeds your success with software utilities that let you quickly connect your instruments to your PC, configure and verify your connection, and get on with your job — whether that entails programming instruments or using pre-existing application software. For test and measurement programmers, the IO Libraries Suite brings the power of the industry-standard VISA and VISA COM libraries, as well as SICL and Agilent 488, to your programming experience.

Agilent IO Libraries Suite includes an implementation of VISA (Virtual Instrument Software Architecture), one of three available application programming instruments for instrument control. The VISA standard requires that visa32.dll, the dynamic-link library that implements the VISA interface, be installed in prescribed locations; therefore, only one installed implementation (the primary implementation) can fully comply with the standard at any one time. Because of this, you must take special care if you want to use Agilent IO Libraries Suite alongside any other implementation of VISA, such as National Instruments' NI-VISA.

Agilent IO Libraries Suite supports the option to install Agilent VISA in side-by-side mode, which allows Agilent VISA to be used simultaneously with another vendor's VISA implementation. In side-by-side mode, Agilent VISA is installed only in a secondary location and therefore does not overwrite another vendor's VISA if it is present on the computer. In general, non-Agilent VISA implementations do not support operation as the secondary VISA (in side-by-side mode). This means that you must operate Agilent VISA in side-by-side mode as the secondary VISA, and the other vendor's VISA as primary.

To control the 82357A/B USB-GPIB interface of Agilent 34970A, IO Libraries Suite software must be installed as a driver, and it can keep the data interface normal in the process of temperature data acquisition. The temperature data collected by thermocouples can be transmitted to the computer correctly. After installation, you can test whether the computer is connected via a graphical interface [6]. Fig. 3 shows the setting of configuration software.

BenchLink Data Logger software: Installing on the PC, it is used to collect the data and analysis results, configure the test, collect and archive data, and it displays the results of analysis for real-time measurement data. The line chart, histogram, the plots and scatter plots are realized through the RS-232 programming interface, and the data can also be transmissed to other applications through the BenchLink Data Logger, creating the analysis report.

Data Logger 3 can be used in either of these two modes:

Connected to Instrument (Connected Mode) — Select this mode if you have one or more instruments connected via interface to your computer. Connected Mode is the recommended mode to use whenever possible. This is because, in Connected Mode, the software automatically determines the instrument address and installed modules.
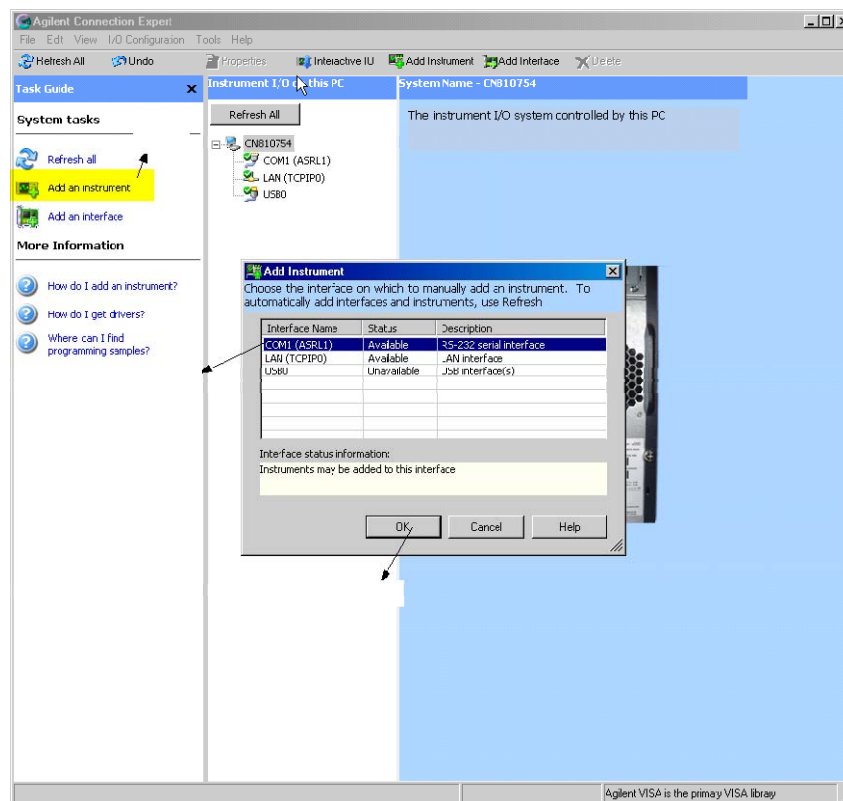

Fig. 3. Configuration of Software.

Not connected to Instrument (Not Connected Mode) — this mode allows you to develop scanning configurations "off-line" without being connected to any instruments. For example, you can develop a configuration in your office and later connect to instruments on the production floor.

BenchLink Data Logger 3 software is not dependent on any earlier versions of Data Logger software. It will install in a separate directory on your PC. You can import the configuration files from previous versions into Data Logger 3. Data logs collected using Data Logger 1 or Data Logger I requires those versions of Data Logger to export the data.

3.3. The Data Acquisition Unit Module Configuration

Up to 3 of any combination of modules into a host, 34970A internal DMM connection can be accessed only by 34901, 34902A and 34908A multiplexer. The precision index of 34970A had included adapter offset and the reference node error, as shown in the following table, these errors are listed separately, to determine a system error has an external measuring device. 34901A 20 channel multiplexer is used to scan the most general module, it will have a 60/s scanning rate of dense multifunctional switching combined, suitable for all kinds of data acquisition application.

34902A 16 high speed multiplexer is the realization of the scanning rate of up to 250/s using a reed relay. This module is ideally suited for the efficient application of automatic test and high-speed data recording and monitoring tasks. 34908A 40 single terminal multiplexer for the highest density of public, such as battery test, component test and bench test me.

34903A 20 universal switch module is suitable for the product to be measured on and off the power, control indicators and status lights, incentive external requirements drive signal relay and the establishment of the conventional switch configuration. The 34904A is a dual 4*8 crossover matrix, provides the most flexible for the connection path between the measured and the test equipment, allowing different instrument received at the same time be measured multiple point element.

34905A and 34906A RF multiplexer provides broadband switching capability for high frequency until the 2 GHz and pulse signal, which you can use on the measured signal pathway is made between generator, oscilloscope, spectrum analyzer, video amplifier or receiver.
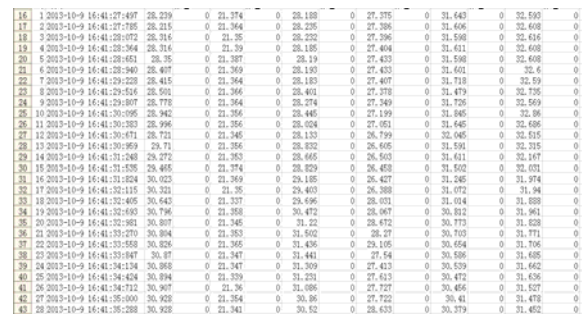
34907A multi function module provides great flexibility for a variety of sensing and control applications, it will simulate the output of two 8 bit digital input and output port, 100 kHz two ± 12 V all of these are concentrated in a module. The general performance of power: 100 V/120 V/220 V/240 V.

4. Temperature Data Acquisition Results

The above is installing and setting of software and hardware, and multipoint temperature data acquisition platform can collect the temperature of measured equipment, and the temperature data display EXCEL file and chart in two ways.

The data can be display preferences dialog and this dialog will appear the default value in the derived data. It also allows you to export to a CSV (comma separated values) file, after scanning the automatic recording data. Setting of derived data preferences can prevent each derived data from repeating.

Fig. 4 shows the exported data as a CSV file.

Fig. 4. Display of CSV file.

The results of temperature acquisition data displays as a Chart, so that the results are more intuitive, and can be achieved at a chart, the chart and histogram display. In addition, using the BenchLink Data Logger can send data to other applications for further analysis, and create the final analysis report. The chart is shown in Fig. 5.

5. Conclusion

Taking Agilent34970A as the control core and basing on the design of type K thermocouple multipoint temperature data acquisition system are introduced in this paper. It is achieved of the medical electrical detection process for real time and accuracy of multipoint temperature test data, and data acquisition time interval can reach 5 ms, moreover, the temperature value can be accurate to 3 digits after the decimal point. Greatly it reduces the complexity of the temperature data acquisition, and improves the detection efficiency [7]. In addition, this platform has strong scalability, and data can provide the source for other analysis software. The experimental results show that, the multi-point temperature data acquisition platform can meet the requirements of laboratory measurement, a wide range of uses.
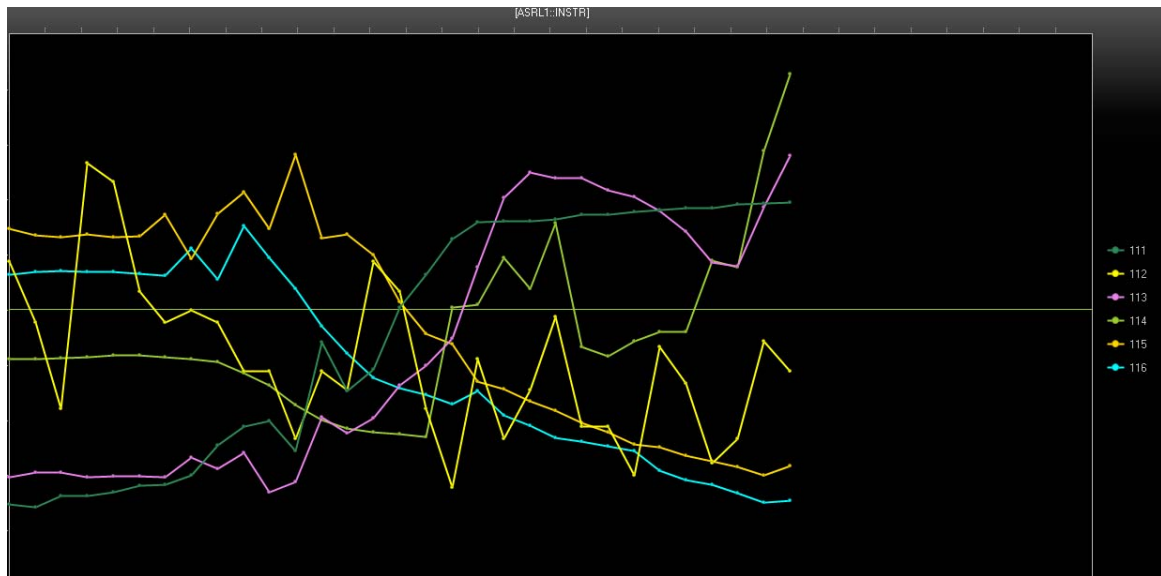
Fig. 5. Display of Chart.

Acknowledgements

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