Industrial Application Research of Portable Video Recorder based on LabVIEW

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Abstract. In this paper, a portable test recorder is designed and manufactured. As an open test system, the recorder can be self-configuring according to the requirements of measurement tasks to realize the acquisition, analysis and processing of various equipment signals, to meet the needs of high-range, high-precision and multi-channel measurement. At the same time, the recorder has the advantages of compact, portable, wide application range, friendly man-machine. Interactive interface and flexible operation can meet the complex test environment in industrial field. The recorder has been applied to the test of 9020 series plates in a nuclear power plant in China. It provides accurate measurement basis for plate detection and solves the problem of high range and high precision of 9020 series plates in a nuclear power plant.

1. Introduction

In the field of industry, it is often necessary to measure the field signal equipment. Especially in the special working environment of nuclear power plant, in order to ensure that all equipment in the system is in normal working state, it is necessary to collect and measure the signals regularly. However, the traditional measuring instruments often need to be carried manually, and they need to be connected with the equipment to be measured. Measuring instruments often have low range and few channels, so they are not suitable for signal acquisition and analysis of many kinds of equipment. Moreover, because of the large number of field equipment and large workload, the testing time is not allowed.

With the development and popularization of computer technology, computer measurement and control technology play an increasingly important role in the process of scientific research and production. At present, virtual instrument is an important direction of the development of testing technology and instrument technology. In this paper, the idea of virtual instrument is used for reference. With NI-cRIO [1] as the core, based on LabVIEW, NI data acquisition card [2] and personal computer, an integrated platform for industrial field voltage signal acquisition is established [3]. SignalPad measurement and control software is a multi-functional signal acquisition and analysis software, which can complete the functions of signal acquisition, storage, playback, analysis and report generation without programming. SignalPad measurement and control software can collect voltage, current, sound, vibration, strain, temperature, torque and other types of signals; support on-line and off-line analysis, analysis functions include power spectrum, filtering, integration, differential, mathematical formula, octave, vibration level, sound pressure level, joint time-frequency, order analysis, frequency response function, modal analysis, etc. The portable voltage recorder developed in this paper is an intelligent

instrument, which can automatically monitor and record the voltage dynamically, count the qualified rate of voltage, and improve the accurate data for measuring the voltage quality.

2. System function

Portable recorder is an open testing system. It can configure the signal acquisition, analysis and processing of various measuring devices according to its own needs.

The portable data recorder is mainly composed of industrial notebook, data acquisition unit and signal connection unit, as shown in Figure 1 below. It mainly realizes the functions of data acquisition, recording, displaying, processing and alarming of field signals. Acquisition accuracy: 0.1%. Isolation between field and portable recorder, separation of acquisition channels, switching files through recorder, 0-60V and 0-10V range switching can be achieved in each channel.

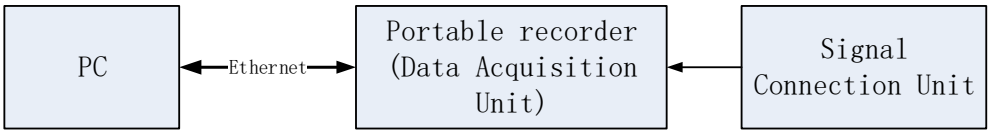

Figure 1. System Structure Block Diagram

Performance indicators:
Acquisition accuracy: 0.1%;
Maximum sampling rate: 5 KS/s;
Full load acquisition: 24 hours 3.5G;
Isolation between field and portable recorder and separation of acquisition channels;
By switching files with recorder, 0-60V and 0-10V range switching can be realized in each channel.
The grounding of the whole system is clearly identified and explained to meet the grounding requirements of the system.
Operating temperature range: - 40 C to 70 C.

3. Hardware design

Design portable recorder chassis, as shown in Figure 2.

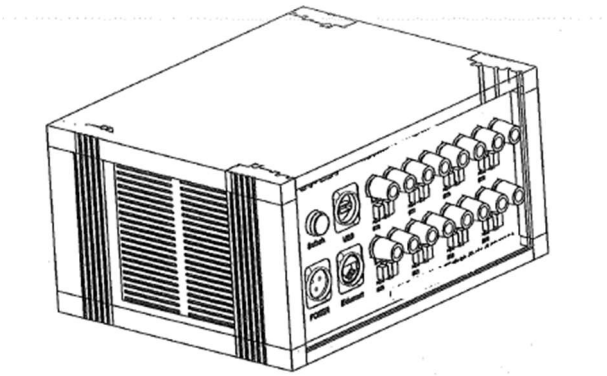

Figure 2. Outward appearance of portable recorder chassis

Eight channels are designed to connect the field signals according to their names. The white terminals under the channels are used for range switching. The left button is pressed in the range of > 10V, and the right button is pressed in the range of < 10V. When both buttons are not pressed, the input signal is suspended.

3.1. Principle block diagram

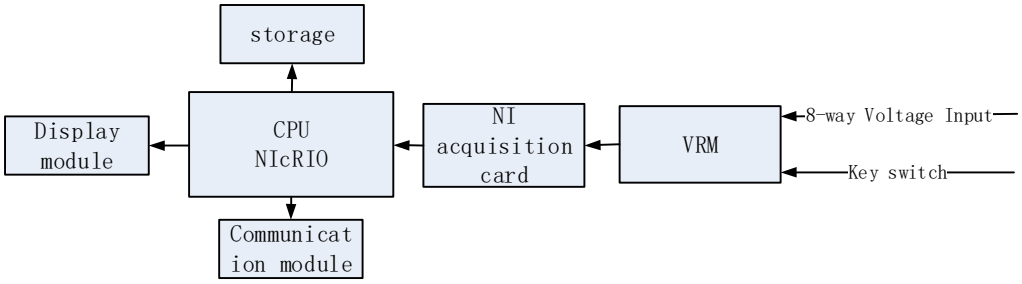

Figure 3. Principle block diagram

3.2. Data Acquisition Unit

The core part of data acquisition unit is NI CompactRIO system [4], which consists of real-time controller, chassis (built-in FPGA chip) and data acquisition module. The specific configuration is shown in the following figure 4. In addition, the measurement and control chassis can be equipped with industrial chassis or plane chassis.

Figure 4. Measurement and Control Cabinet Configuration

The data collector realizes the ac Data Acquisition Unit question and conversion of 8-channel instrument signals into Modbus protocol, and provides 24V power supply for the field.

NIcRIO-9031 real-time controller includes an industrial processor, which can reliably and accurately execute LabVIEW real-time applications, and can provide multi-rate control, process execution tracking, on-board data storage and external communication functions. In addition, the real-time controller is equipped with 9-30VDC redundant power input, Ethernet port, USB and RS232 interface.

The chassis of the FPGA is directly connected with each data acquisition card to access the I/O circuit at high speed and realize the functions of timing, triggering and synchronization flexibly. Because each data acquisition card is directly connected to the FPGA, rather than through the bus, Compact RIO has almost no response delay of the control system.

The data acquisition system provides 8 0-50VDC voltage measurements.

3.3. Voltage conditioning module

The field signal is connected to the front panel channel of portable recorder by name, and the white terminal under the channel is used for range switching, as is shown in the following figure 5-6. Press the left button and the right button. When the two buttons are not pressed, the input signal is suspended.

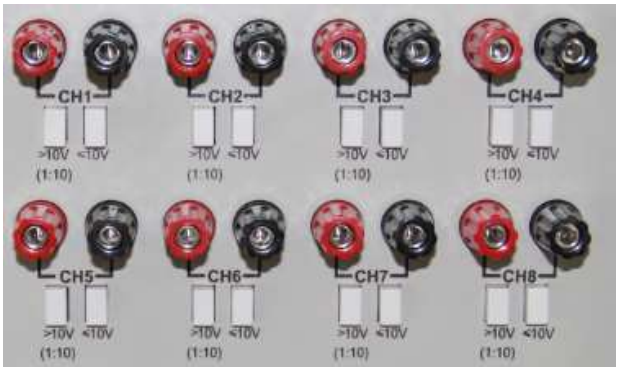

Figure 5. Front panel channel interface of chassis

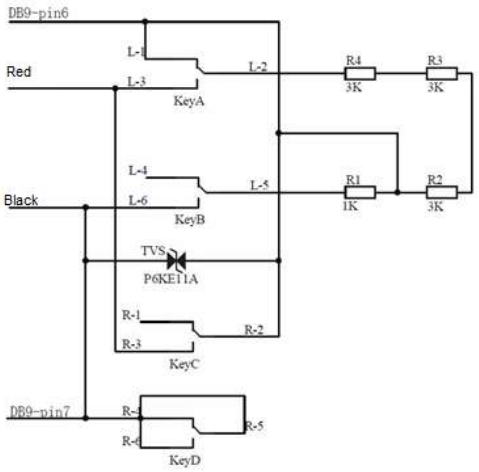

Figure 6. Circuit schematic diagram of voltage conditioning module

The red terminal is connected to the positive of the input voltage signal, the black terminal is connected to the negative of the input voltage signal, and the DB9-pin6 and DB9-pin7 are finally connected to the voltage signal terminal of the acquisition card. R1~R4 are Divider resistances, in which R1 acts as a sampling resistor. TVSP6KE11A is a transient suppression diode, which is a high-efficiency protective device in the form of a diode. When the two poles of the TVS diode are impacted by the reverse transient high energy, it can change the high impedance between the two poles into low impedance at the speed of 10 minus 12 seconds, absorb the surge power up to thousands of watts, and make the voltage clamp between the two poles located at a predetermined value, effectively protect the precise components in the electronic circuit from the damage of various surge pulses.

The working principle of the circuit is that when the left key (> 10V range) is pressed, the input voltage signal V1 passes through R4, R3, R2, R1 in turn, and the acquisition card collects the voltages at both ends of R1 to calculate the input voltage V1. The voltage signal Vs = V1*R1/(R1+R2+R3+R4) collected by the acquisition card; when the right button (< 10V range) is pressed, the input voltage signal V1 only passes through R1, and the acquisition card collects the voltage at both ends of R1. At this time, Vs = V1.

3.4. Communication connection

The upper and lower computers connect and transmit data through ethernet. The IP address of the lower computer is 192.168.0.106. When communicating between the upper computer and the lower computer, it is necessary to ensure that the IP address of the upper computer and the lower computer is in a network segment.

3.5. data storage

Insert U disk into USB interface of portable recorder. Through the software settings of the upper computer, the collected data can be automatically stored in the U disk.

4. Software design

The software consists of upper computer software and lower computer software. The upper computer software runs on PC and communicates with embedded terminal (NI cRIO device, lower computer); it controls the lower computer to collect and store signals, and controls the terminal to collect and transmit commands and data.

The software of the lower computer is responsible for communicating with the upper computer and controlling the front end of the data acquisition module according to the instructions of the upper computer for data acquisition, processing and storage. The embedded terminal of the lower computer can work with the PC or run the same software independently after the configuration is completed.

5. Conclusion

A portable recorder is designed in this paper. The recorder can configure the signal acquisition, analysis and processing of various measuring devices according to its own needs. Good man-machine interface enables users to complete the functions of signal acquisition, storage, playback, analysis and report generation without programming. The portable recorder provides accurate data for measuring the voltage quality on site.

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