

PC-BASED COST EFFECTIVE DATA ACQUISITION AND CONTROL

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Key words: data acquisition, ISA bus, printer port and control

ABSTRACT

Cost effective PC-based data acquisition systems employing ISA bus and printer port have been designed and developed. As real-time experimentation two applications have been considered of which the first one uses PC with the data acquisition board for developing a storage oscilloscope. The second application is ON-OFF temperature control for maintaining the temperature of any liquid at any desired reference temperature. Critical evaluations of the ISA bus and printer port are made by comparing with other type of buses such as PCI available.

determined by 4-bit binary address lines $A_0 - A_3$. These address lines connected the data lines $D_0 - D_3$ in order to switch desired input to output. The multiplexer #1 is used for input channel numbers 1 to 16, the multiplexer #2 used for channel numbers 17 to 32, the multiplexer #3 used for channel numbers 33 to 48 and multiplexer #4 used for channel numbers 49 to 64.

For analog to digital (A/D) conversion the 16-bit AD976A is used. The AD976A is a 16-bit, 200kSPS BiCMOS A/D converter. It has internal 2.5V reference and a high speed parallel interface. It operates from a single 5V supply.

I. INTRODUCTION

Over the last few years the power of PC-based DAQ systems become ubiquitous and indispensable in industry, education and other engineering fields. It is not surprise that the personal computer has become the most popular platform for data acquisition. PCs are so abundant in the workplace now that it is hard to find a business or home that doesn't use them. In modern PC architecture we only find five platform that can be used for data acquisition purposes. They are named as: PCI bus, ISA bus, serial port, parallel port [1] and newly developed Universal Serial Bus (USB). Each of them has several functions. According to these functions the ISA bus and printer port are considered to be a right choice for cost-effective general purpose applications.

The analog outputs are obtained by four 16-bit D/A converters (AD569). The D/A converters connected to data bus to convert digital data to analog signal. Each converter makes conversion independent of each other. For accuracy the reference voltage of the AD569 obtained by low-cost AD588

The 8-bit digital input is buffered by bi-directional bus transceivers with 3-state outputs (74LS245), and 8-bit digital outputs are latched by 3-state transparent latch (74LS373). The detailed circuit is given in Figure 1. [1,3,4] and all the necessary addresses can be found on the output lines of the address decoder

II. DATA ACQUISITION WITH ISA BUS

In this section a general purpose DAQ card for ISA bus has been developed and used for storage oscilloscope program application.

SYSTEM DEVELOPMENT

The general purpose DAQ board designed has 64-channel analog input, 4 analog output and 8 digital I/O lines as given in Figure 1. For 64 channels analog input four identical 16-input analogs multiplexer (ADG 426) [2] is used. Each multiplexer has its own decoder-latches to switch one of the sixteen inputs to a common output as

STORAGE OSCILLOSCOPE DESIGN

Any hardware, which is related to computer, cannot be thought without software. For DAQ hardware beside the specially designed software like labview we can use some high-level language. Today most of the users prefer user-friendly program to use with their DAQ hardware. For this reason, this and the following sections the Visual Basic (VB) programming language has been used [5].

If we have migrated from DOS' QuickBasic to VB, we realize that QuickBasic's INPUT and OUTPUT (or Turbo C's inportb and outportb) functions were not implemented in VB. These functions are crucial for PC hardware developers and programmers because they allowed us to read and write to ports. Thus without INPUT or OUTPUT

**Private Declare Function InMSPRO Lib
"MSPRO.dll"
(ByVal PortAddress As Integer) As Integer**

To *write* to a port, we must use OutMSPRO:

Dummy = OutMSPRO(Cntrl, 128)

where Dummy, Cntrl are integers. Here, the decimal value 128 is written to the port address assigned to Cntrl. It is necessary to use associate an integer variable (called "Dummy" in here) with the OutMSPRO function. This is because the DLL was built using VC++'s outp(), which returns an integer.

To *read* from a port, we must use InMSPRO:

PortValue = InMSPRO(PortSelected)

where PortValue and PortSelected are integers. The 8-bit number at port PortSelected will be assigned (in decimal form) to PortValue.

According the knowledge about VB programming the storage oscilloscope program has been developed .The program has appearance like in Figure 2

The program uses MSPRO.dll function to communicate with DAQ board. As it is seen Figure 2 it has selectable 64 channel input which each case only one can be selected. The sampling speed determined by HscrollBar and it can be adjusted from 1 to 1000 mSec. By hitting the 'SAMPLE' button program starts to collect data into an array. The size of the array is set 10000 as a default but it is changeable in program. When hitting the stop button the collecting process stops. The time between sample and stop actions determines the number of the samples taken. The sampled data's are collected in an excel file.

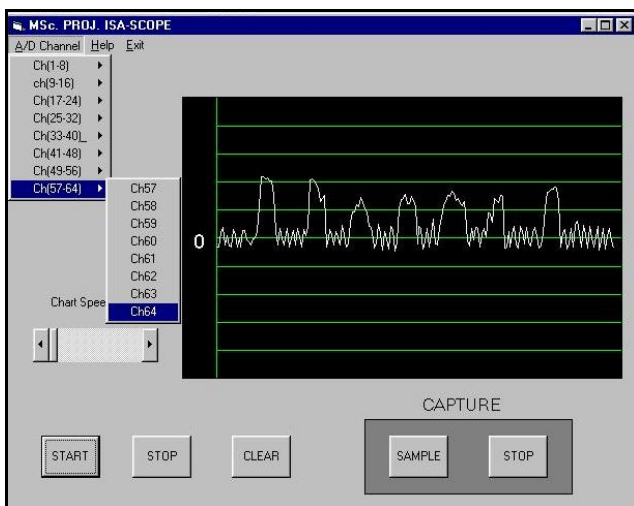


Figure 2. The appearance of storage oscilloscope

Today programmers write DAQ software as possible as user- friendly. So choosing the data collection environment as an excel file is preferred [6] bause we can

easily see the sampled data and process it whenever we want as it is seen in Figure 3.

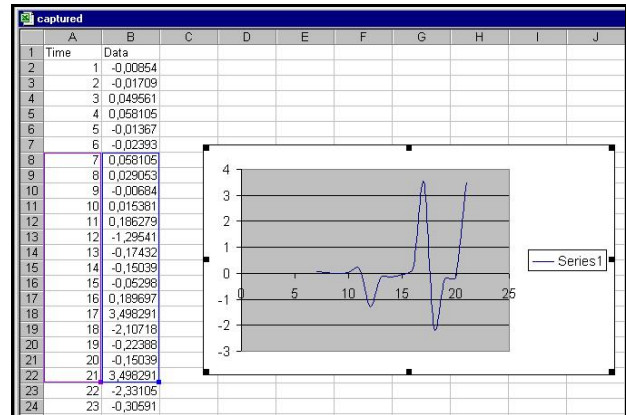


Figure 3. The saved excel file by storage oscilloscope program. The small portion of the collected data have been used for drawing graph in order to examine the wave-form of the selected portion.

By this arrangement a transient wave to be registered in storage oscilloscope would be captured and the sampled data stored in files. Subsequently, the waveform could be elaborated in time and amplitude as to be examine and investigate more about the nature of the signals at selected instants.

III. DATA ACQUISITION WITH PRINTER PORT

A PC printer port is an inexpensive and yet powerful platform for implementing projects dealing with the control of real world peripherals. The printer port provides eight TTL outputs, five inputs and four bi-directional leads. In this section, real time temperature control application was implemented for observing the DAQ ability of printer port.

HARDWARE DESCRIPTION

The temperature control hardware consist of TLC1543 from Texas Instrument [7] (or MC145050P from Motorola) and its peripheral components (see Figure 4).The 100K resistors are used to protect the TLC1543 input.

The A/D converter powered by parallel port data lines D4 and D5 [8] so the reference voltage obtained from data line D6 by using Ref25Z voltage reference diode. The TLC1543 is a CMOS 10-bit A/D converter This device has three inputs and a 3-state output [chip select (CS),input-output clock (I/O CLOCK) ,address input (ADDRESS) and data output (DATA OUT)] that provide direct 4-wire interface to the computer port, serially. The chip has on-chip 14-channel multiplexer that can select one of 11 analog inputs or any of three internal self-test voltages. The end-of-conversion (EOC) output goes high to indicate that conversion is completed. This output is

connected to the acknowledgement (ACK) input pin of the printer port. The serial address input (ADDRESS) is used for selecting the desired analog input or test voltage that is to be converted next. A 4-bit serial address

port As Integer)

Declare Function adc_get_data Lib "adc1543.dll" () As Integer

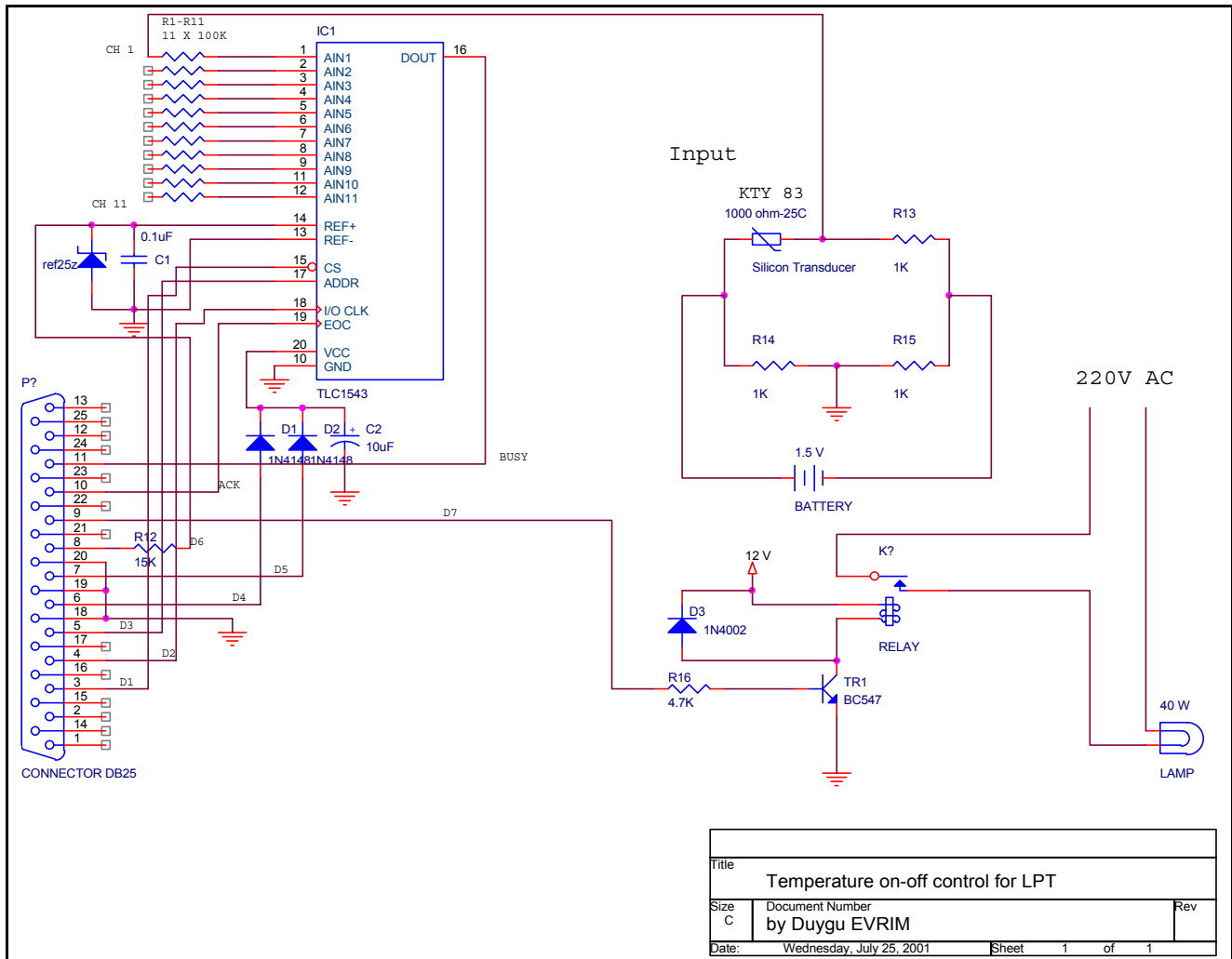


Figure 4. Schematic of real-time temperature control

is used for this purpose and it has connected to D3 data line of printer port.

As it is seen in Figure 4, a silicon sensor has been placed as one of the component of bridge circuit and the A/D converter detects the error voltage of the bridge proportional to the environmental temperature of silicon transducer. For controlling the heat source a relay circuit extended to data line D7. A table lamp serves as a heat source.

SOFTWARE DESCRIPTION

The temperature control hardware controlled by temperature control program named as "TEMPEX" given below:

Declare Sub adc_driver_open Lib "adc1543.dll" (ByVal
Declare Function OutMSPRO Lib "MSPRO.dll" (ByVal
PortAddress As Integer, ByVal PortData As Integer) As
Integer

Declare Function InMSPRO Lib "MSPRO.dll" (ByVal
PortAddress As Integer) As Integer

Dim over As Single

Dim stum5 As Single

Dim tam As Single

Dim ivalue As Single

Dim Dummy As Integer

Dim Loopflug As Integer

Private Sub Form_Initialize()

Image2.Visible = False

```

End Sub
Private Sub Image1_Click()
If Loopflag = True Then
Image1.Visible = True
End If
End Sub
Private Sub Image2_Click()
End Sub
Private Sub start_Click()
Loopflag = True
End Sub
Private Sub stop_Click()
Loopflag = False
Text3.Visible = True
End Sub
Private Sub Text4_Change()
If Loopflag = True Then
Text4.Visible = True
Label3.Visible = True
End If
End Sub
Private Sub Timer1_Timer()
If Loopflag = True Then
Call adc12_driver_open(1)
Value = adc12_get_value()
tam = value * 2.5 / 1024
itam = Int(tam)
stum = tam - itam 'subtrack the integer part to real
stum1 = stum * 1000
stum2 = Int(stum1)
stum3 = stum2 / 1000
stum4 = itam + stum3
ivalue = stum4      'Int(tam)
Text2.Text = ivalue
stum5 = Int((26 * 0.031) / ivalue)
Text1.Text = stum5
over = Text3.Text
Text3.Visible = False
Label2.Visible = False
Text4.Text = over
If stum5 > over Then
Dummy = OutMSPRO(888, 70)
Image1.Visible = False
Image2.Visible = True
End If
If stum5 < over Then
Image1.Visible = True
Image2.Visible = False
End If
Text1.Text = stum5
End If
End Sub
...

```

The program mainly uses two dll function “MSPRO.dll” and “adc1543.dll” for communication with hardware. The MSPRO.dll has routine named as *OutMSPRO* which sends data to a given port address. The *adc1543.dll* has

two routine *adc_driver open* which enable to power up the A/C and *adc_get_data* which get data from specified port address.

When the program executed it takes the error voltage from bridge and convert it to corresponding temperature value. While the value is below the over temperature limit which is determined by user before executing the program, the heat source enabled to rise the temperature. When the temperature is over the limit, program disables the heat source by relay circuit to reduce the temperature. This process repeated until end of execution.

This software reads the signal in selected channel, process and controls. In other applications where there are many signals to be read the software need be modified accordingly to multiplex several analog inputs.

IV. CONCLUSION

Extending the PC for real-time processing of analog signals needs data acquisition systems to be implemented with PC

There are several PC -based DAQ devices in markets from simple to complicated. The important thing is, which system is right for use. The features of systems vary from system to system

With this investigation, we find that for general purpose low cost applications ISA bus could be opted. For cost effective portable applications, parallel port implementation shows to be a good choice. PCI bus could be preferred for high performance applications

In general, for cost and performance, choosing right system for right application is important.

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