# SERIAL MULTIPLEXED BASED DATA ACQUISITION AND CONTROL SYSTEM

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*Abstract*

Data acquisition and control system consists of analog to digital converter (ADC), digital to analog converter (DAC), timer, counter, pulse generator, digital input / output (DIO) depending upon requirement. All the system components must communicate with personal computer (PC) for data and control signal transmission via one of the communication protocol like Serial, Parallel, USB, GPIB. Serial communication is advantageous over other protocol due to several reasons, like long distance data transmission, less number of physical connection, ease of implementation etc. The developed Serial Multiplexed based Data Acquisition and Control System, which can control different modules like ADC, DAC, DIO, Timer card using single serial port. A LabVIEW based program is developed for the individual communication of each module.


## INTRODUCTION

The basic data acquisition and control system consists of different types of application module like ADC, DAC, timer, counter, pulse generator, DIO etc. The module is selected depending upon the requirement. The modules are individually controlled with personal computer (PC) for data and control signal transmission using one of the communication protocol. If communication is done using different protocol for different modules in system requires knowledge of different communication protocols, communication hardware and large number of connection with the PC.

In order to overcome the above mentioned difficulties, we developed Serial Multiplexed based Data Acquisition and Control System (SMDACS). In house developed system consists of different application modules and a controller module. The application modules are controlled by controller module having serial connectivity. The control program for each application module is developed in Lab-VIEW environment.

## FUNCTIONAL DESCRIPTION

A block diagram of SMDACS is shown in Fig. 1. The system consists of different application modules which are installed on back panel (mother board) of the system. The physical address for the application module is set on mother board from 000 to 111. When system is switched ON, the application module read the physical address and saves in local register of microcontroller. While transferring command for Read / Write, the logical address is sent first. The microcontroller in application module compares logical address and physical address. The module program command sequence is executed in the application module whose logical address and physical address matches. All the commands are treated as either read or write considering as receive or send by PC. Data and commands are sending or receive by the PC to the application module via serial interface. The application module can be installed in one to eight locations while controller is placed on ninth position. The application module has no physical position limitation, i.e., any module can be installed in any position except the controller module.

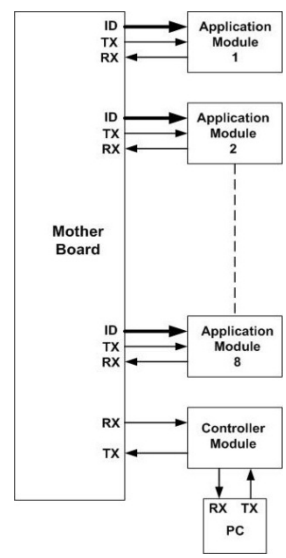


Figure 1: Block diagram of developed SMDACS.

Figure 2 shows the developed SMDACS assembly. The assembly consists of 3U size, nine slot chassis. The chassis as controller module, application module, back panel and in-built power supply. The right-most module is the controller module. Each application module communicates with the controller module using back panel 15 pin D-type for transmit, receive and power. Three pins of the15-pin D-type connector are used for physical address of the module. The application module is used physical address for data and control information transmission. Each application module consists of logic gates, microcontroller (AT89C52) and other related components.

### *Controller Module*

Controller module is the heart of the system. It is the interface module which transmits data and control signals between PC and application module. Front panel of the module has power indicator and a data transmission indicator. It has an external trigger which is used as bus

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ISBN 978-3-95450-124-3

trigger for the entire application module simultaneously. A 9 pin D-type connector is used for communication using serial bus .A 25 pin edge connector on the back panel of this module is used to transmit and receive data or control signal.

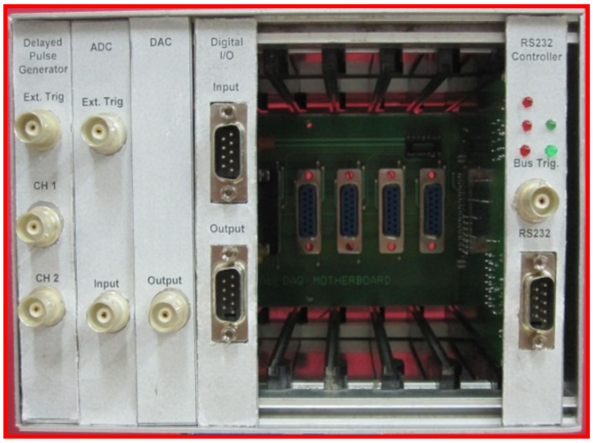


Figure 2: Developed serial multiplexed based data acquisition and control system hardware.

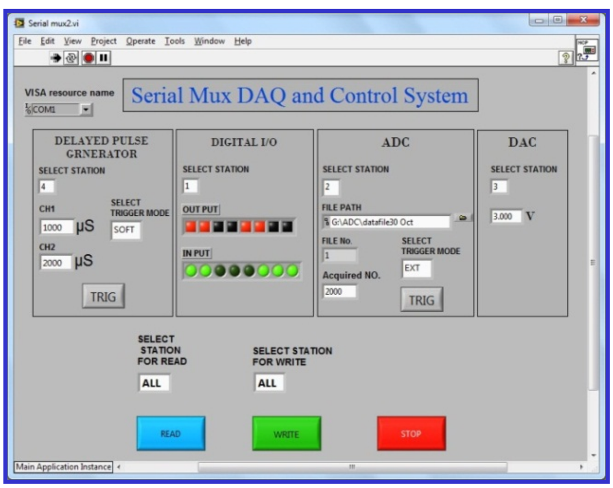


Figure 3: LabVIEW based GUI program for application module.

The system uses two types of programs for its operation namely system program and module program. System program as LabVIEW Graphical User Interface (GUI) which is used by users while the Module program is the program written in the microcontroller of the application module. The LabVIEW GUI program controls the operation of system as shown in the Fig 3. While executing the LabVIEW GUI program, the following sequence is followed:

- Configure serial port by VISA resource name.
- Select Station ID (logical address) and other related parameters which are to be passed to the different application modules.
- Activate required Station ID for passing the parameters (All or specific station).
- Select appropriate command (Write or Read).
- The program can stop forcefully by Stop command.

### *Application Module*

The Module program is written inside the microcontroller [1] of the individual application module. When power is switched ON, the microcontroller inside individual module will read physical address from the back panel and write it in the local memory µC. Figure 4 shows the flow diagram of module program. The LabVIEW program sends the logical address to application module through serial communication. The logical address send by the LabVIEW program and physical address written in microcontroller memory is compared. If the match in address is found, next commands end by the LabVIEW program will be executed on that particular module. Depending upon the command send by the LabVIEW program, data / control word will be read /write in particular application module using the serial interrupt. All the other interrupts are disabled whenever application module places data on the serial bus.

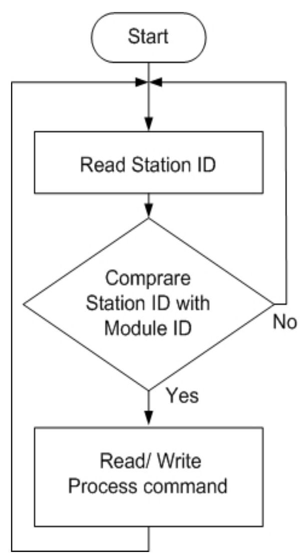


Figure 4: Flow diagram for module program.

The details of the different application modules are as follows:

### *TTL Delayed Pulse Generator Module*

The TTL delayed pulse generator module is one of the application modules. It generates a variable delay between trigger input and two independent channel output. The trigger can be external hardware trigger or bus trigger or software trigger. Both channels of the module have 50 ohm driving capability. The duration of the delay can be set by LabVIEW GUI. The delay duration data is written



ISBN 978-3-95450-124-3

in the application module microcontroller local memory by LabVIEW program. When this application module receives the trigger, it will generate pulses with required delay with respect to the trigger. Figure 5 shows the delayed pulses generated with respect to trigger for two different channels.

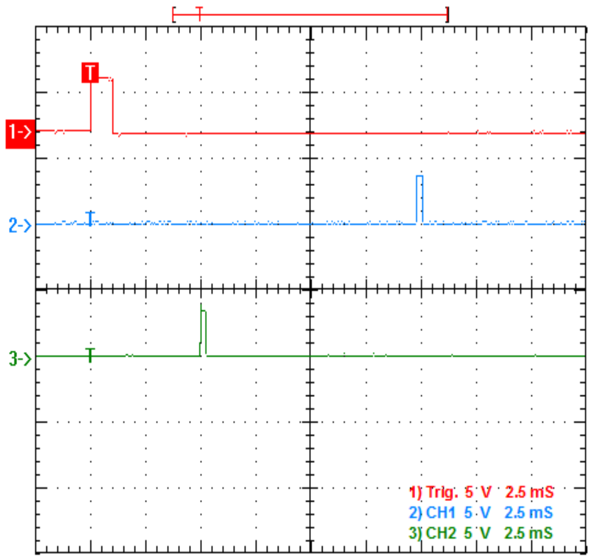


Figure 5: Timing diagram (CH-1 External Trigger Pulse, CH-2 output pulse of channel-1 and CH-3 output pulse ofchannel-2).

## *Digital I/O Module*

The DIO module consists of eight digital inputs and eight digital outputs. This module is developed using AT89C52 microcontroller. The module read the digital input and displays the status of each bit on the Lab-VIEW GUI. The different digital pattern is generated by setting the bit pattern in the GUI. The GUI transfers the digital pattern to the digital output port.

## *Digitizer Module*

Figure 6 shows block diagram of the developed 8bit digitizer module using ADC (ADC0804), Memory (K6X4008) and microcontroller. The module is initialized by the number of sample to read and the mode of trigger. The ADC module continuously read the required number of samples after getting start trigger. The start trigger of the module is selected using either software or bus trigger or external hardware trigger by GUI. The developed module has maximum storage capacity of about 64 KB. After getting the trigger, the microcontroller read the digital data from ADC0804and writes the required number of sample in the memory. When module is selected for reading the data, it will transfer data from the module memory to PC via serial bus. The data for the "number of data to be read" is written by LabVIEW program. It will write the data in user defined file format. User can define a file name or append to a file. The stored data can be retrieved and analysed as per requirement using Origin or MATLAB software.

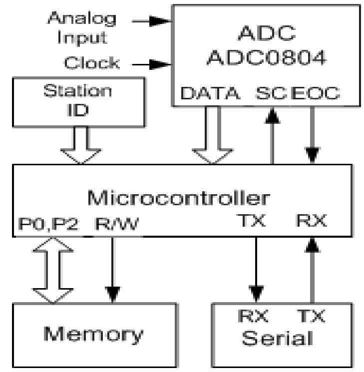


Figure 6: Block diagram of the digitizer module.

## *Digital to Analog Module*

The 8 bit DAC (AD558) is used for the conversion of the digital to analog signal. The required control signals for the DAC are generated using microcontroller. The required output voltage from the DAC is defined in the LabVIEW program. The digital number corresponding to the voltage is loaded in the DAC input using microcontroller. This number is loaded in the microcontroller using LabVIEW "write" command. The DAC module generates corresponding analog voltage from 0 to 10 V on front panel BNC in step of 39 mV.

## CONCLUSION

The developed SMDACS is stand alone and used in small experiment. The system can be used for acquiring slower sampling data for longer duration using digitizer module. Other than this the module generates different timing pulses using TTL delay generator to synchronize with other system. The system also generate digital pattern or to acquire system status using digital input / output module. The analog signals generated using digital to analog converter is used for analog pattern generation.

## ACKNOWLEDGMENT

The authors wish to acknowledge the contributions of the ADITYA data acquisition team. The authors are thankful to S. Sunil and Jinto Thomas for critically evaluating the manuscript.

## REFERENCES

[1] Muhammad Ali Mazidi and Janice Gillispie Mazidi, "The 8051 Micro controller and embedded systems using assembly and C", second edition.

ISBN 978-3-95450-124-3