VIRTUAL INSTRUMENT WITH PIC 12F675

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Abstract: Virtual instrumentation achieved mainstream adoption by providing a new model for building measurement and automation systems. Keys to its success include rapid PC advancement; explosive low-cost, high-performance data converter (semiconductor) development; and system design software emergence. The paper presents a virtual instrument achieved with the PIC 12F675 microcontroller. The implementation method and the results achieved are presented.

Keywords: virtual instrument, microcontroller, serial interface programming, data acquisition, analog-to-digital converter.

1. INTRODUCTION

The user defines virtual instruments while traditional instruments have fixed vendor-defined functionality.

Every virtual instrument consists of two parts – software and hardware. A virtual instrument typically has a sticker price comparable to and many times less than a similar traditional instrument for the current measurement task. However, the savings compound over time, because virtual instruments are much more flexible when changing measurement tasks.

With virtual instrumentation, software based on user requirements defines general-purpose measurement and control hardware functionality. Virtual instrumentation combines mainstream commercial technologies, such as the PC, with flexible software and a wide variety of measurement and control hardware, so engineers and scientists can create user-defined systems that meet their exact application needs. With virtual instrumentation, engineers and scientists reduce development time, design higher quality products, and lower their design costs.

Virtual instrumentation achieved mainstream adoption by providing a new model for building measurement and automation systems. Keys to its success include rapid PC advancement; explosive low-cost, high-performance data converter (semiconductor) development; and system design software emergence. These factors make virtual instrumentation systems accessible to a very broad base of users.

PC performance, in particular, has increased more than 10,000X over the past 20 years. Virtual instruments takes advantage of this PC performance increase by analyzing measurements and solving new application challenges with each new-generation PC processor, hard drive, display, and I/O bus. These rapid advancements combined with the general trend that technical and computer literacy starts early in school, contribute to successful computer-based virtual instrumentation adoption.

Microchip manufactures a series of microcontrollers called PIC. There are many different microcontrollers available, some basic low memory types, going right up through to ones that have Analogue-To-Digital converters and even PWM built in.

PIC is a family of Harvard architecture microcontrollers made by Microchip Technology, derived from the PIC1650 originally developed by General Instrument's Microelectronics Division.

PICs are popular with developers and hobbyists alike due to their low cost, wide availability, large user base, extensive collection of application notes, availability of low cost or free development tools, and serial programming (and re-programming with flash memory) capability.

The PIC architecture is distinctively minimalist. The following features characterize it:

- Separate code and data spaces (Harvard architecture)
- A small number of fixed length instructions
- Most instructions are single cycle execution (4 clock cycles), with single delay cycles upon branches and skips
- A single accumulator (W), the use of which (as source operand) is implied (i.e. is not encoded in the opcode)
- All RAM locations function as registers as source and/or destination of math and other functions.
- A hardware stack for storing return addresses
- A fairly small amount of addressable data space (typically 256 bytes), extended through banking
- Data space mapped CPU, port, and peripheral registers
- The program counter is also mapped into the data space and writable (this is used to synthesize indirect jumps)
- Unlike most other CPUs, there is no distinction between "memory" and "register" space because the RAM serves the job of both memory and registers, and the RAM is usually just referred to as the register file or simply as the registers.

2. THE PIC 12F675 MICROCONTROLLER

The 12F675 microcontroller is packaged in an 8-pin chip and even though it is tiny it is packed with peripherals. It even has a 10bit ADC built in (this is the same ADC that you can find on the 16F877A and 16F88 used elsewhere on this site). So learning about this peripheral is also useful for these other parts.

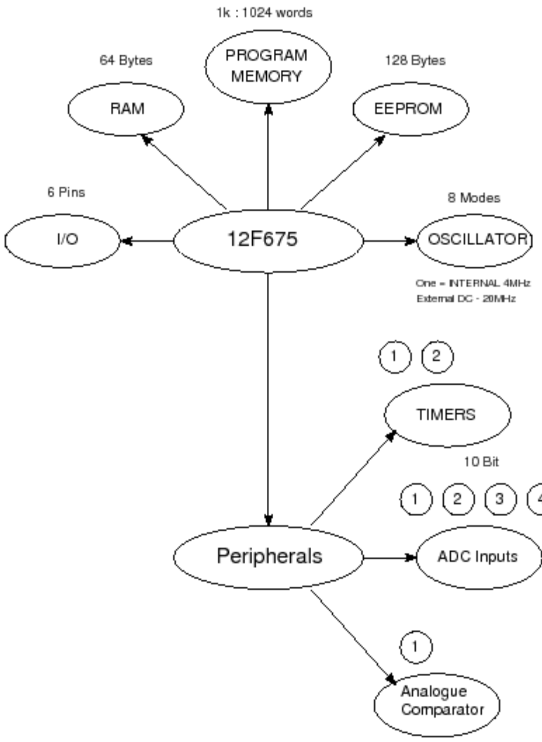

Fig 1. The structure of the PIC 12F675 microcontroller

The 12F675 has 1024 words of program memory, 64 Bytes of RAM and 128 Bytes of EEPROM, an internal oscillator, timers an ADC and a comparator.

The main features of the PIC 12F675 are shown in figure 1.

For 12F675 PIC microcontroller peripheral features:

- 6 I/O pins with individual direction control
- High current sink/source for direct LED drive
- Analog comparator module with:
    - One analog comparator
    - Programmable on-chip comparator voltage reference (CVREF) module
    - Programmable input multiplexing from device inputs
    - Comparator output is externally accessible
- Analog-to-Digital Converter module:
    - 10-bit resolution
    - Programmable 4-channel

input
    - Voltage reference input
- Timer0: 8-bit timer/counter with 8-bit programmable prescaler
- Enhanced Timer1:
    - 16-bit timer/counter with prescaler
    - External Gate Input mode
    - Option to use OSC1 and OSC2 in LP mode as Timer1 oscillator, if INTOSC mode selected
- In-Circuit Serial ProgrammingTM (ICSPTM) via two pins.

3. THE VIRTUAL INSTRUMENT

The virtual instrument has two parts: PIC 12F675 based hardware structure and personal computer software. In figure 2 is sown the virtual instrument structure.

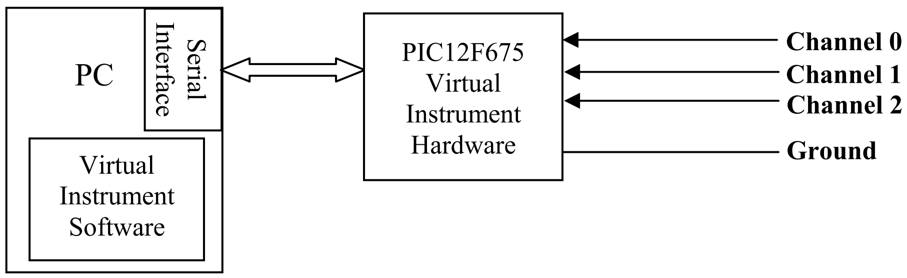

Fig 2. The virtual instrument structure

Hardware structure uses the 12F675 microcontroller thanks to his reduced dimensions and low current consumption. For data acquisition three of four inputs of the analog-to-digital converter are used.

The 12F675 microcontroller case has eight multiplexed pins. The following pins sharing are used:
- Three pins for analog inputs
- Two pins for supply
- Two pins serial interface
- One pin for RESET.

The acquired data of the digital-to-analog converter are transferred to PC via the serial interface. The PIC 12F675 microcontroller has not a hardware serial interface (USART). The serial interface is software-based routine using interrupts.

Virtual instrument continuous or at command transmit data to PC with the following structure: one byte of channel identification, one bit of more significant byte of data and one byte of less significant byte of data.

Assembly language is used for the PIC 12F675 software development. The assembly language allows developing compact and short routines.

The PIC 12F675 microcontroller can be serially programmed while in the end application circuit. This is simply done with two lines for clock and data, and three other lines for power, ground, and the programming voltage. This allows customers to manufacture boards with unprogrammed devices, and then program the microcontroller just before shipping the product. This also allows the most recent firmware or a custom firmware to be programmed. The hardware component a virtual instrument has a program switch witch allow two modes: programming mode and run mode.

In figure 3 is shown the PC software component. The software component allows the serial interface settings, data visualization and commands transmission. Visual Basic programming language is used.

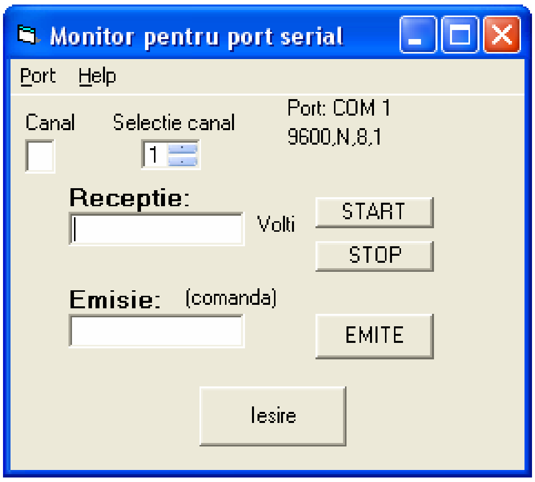

Fig 3. The Virtual Instrument application.

The application search the available serial ports and requires selection of one port. The sequence of finding serial ports:

```
On Error Resume Next
NrPortSer = 0
For Contor = 1 To 16
   Err.Clear
   MSComm1.CommPort = Contor
   MSComm1.PortOpen = True
   If Err.Number = 0 Then
      NrPortSer = NrPortSer + 1
      PortSerial(NrPortSer) = Contor
      MSComm1.PortOpen = False
   End If
Next Contor
```

The acquired data is stored in a database that can be used for subsequent work.

4. CONCLUSIONS

Virtual instrumentation achieved mainstream adoption by providing a new model for building measurement and automation systems. Keys to its success include rapid PC advancement; explosive low-cost, high-performance data converter (semiconductor) development; and system design software emergence. These factors make virtual instrumentation systems accessible to a very broad base of users.

Depending on the definite application the presented virtual instrument can be optimized for particular processing. Remote transmission of data and flexibility of system represent the main characteristics. The analog-to-digital converter has a 10-bit resolution and serial transmission reach 19,200 bauds.

The experimental results show the virtual instrument utility in many applications in energetic domain i.e. the electrical parameters measurement, automation, controller of energy and so on.

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