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# THE ORIGINAL SOFTWARE FOR MONITORING MEASUREMENT DATA FROM THE INSTRUMENT VICTOREEN 451P VIA INTERNET

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## ABSTRACT

*This paper presents original software for real time acquiring and analyzing data during measuring process using ion chamber radiation survey meter Victoreen 451P. This software improves functionality and provides more user friendly interface than the program provided by the instrument manufacturer. Also, software allows monitoring of measurement data in real time, data analysis, graphical presentation and distribution of the measurement data to remote clients over Internet. In the case of outdoor measurements, collected data can be transferred and stored on the company server via GSM network. The server application allows monitoring of the measurement data in real time and hosts network-published shared variables. The mobile clients (Apple iPhones, Android phones and tablets) can monitor measurement data in real time with National Instruments Data Dashboard application.*

## 1. Introduction

The instrument Victoreen 451P is pressurized ion chamber device, designed to measure gamma, x-ray radiation above 25 keV and beta radiation above 1 MeV. The radiation rate is displayed in digital and analog form on the liquid crystal display (Fig. 1). The digital refresh period is one second while the analog (bar graph) display update period depends on the measuring range and is less than 0.15 seconds [1]. The measurement units are also presented on the LCD display. The instrument has auto-range and auto-zero features. Besides the Rate mode the instrument can work in the Freeze and the Integrate mode. When configured to work in the Freeze mode the instrument remembers the highest measured radiation rate. The highest reading will be shown on the bar graph while the digital display will continue to show current reading. In the Integrate mode the instrument operates continuously 30 seconds after the instrument has been turned on. The instrument can communicate with a computer over a serial RS-232 interface. An optional Excel add-in for Windows can be used for acquiring data from the instrument. In the communication mode measurement data are transferred to computer every second.

## 2. 451 Assistant for Excel

The 451 Assistant for Excel (451EXL) is Excel Add-In software that provides additional commands and features to Microsoft Excel. The 451EXL software provides remote control for many of the Model 451's functions such as its internal data log and integrated dose measurement functions. The 451 Assistant also provides data logging in an Excel spreadsheet in the real time. The 451EXL works with Microsoft Excel versions 97 and 2000. Since the 451 Assistant for Excel is an Excel Add-In, it is automatically loaded with Excel once it is installed [2].

### 2.1 451 Assistant menu and toolbar

The 451 Assistant Menu and Assistant Toolbar provide an interface for the user to remotely control the 451P, configure the 451P, download the internal data log, start real time data logging, and start an integrated dose measurement. With the menu/toolbar

items the user can achieve the following functions:

- Connect/Disconnect the serial communication port;
- Start/Stop real time data log;
- Real time data properties;
- Start integrated dose;
- Download internal data log;
- Configuration of the Assistant options;

## 2.2 Data logging

Once Microsoft Excel has been started and the 451 Assistant has been loaded, data logging can be started and the data recorded in the active Excel worksheet. When a measurement is performed the 451 Assistant automatically places the measured data in the active worksheet cell, then moves down to the next row of cells where it will place the next measured data. The properties dialog allows setting the length of time to record data and the time interval between recording data points [2]. During data logging, the Virtual Instrument Display shows the real time rate measurements from the 451P instrument. Also are displayed the alarm setting, acknowledge alarm button and an alarm indicator (figure 1).

When a measurement is performed the 451 Assistant automatically places the measured data in the active worksheet cell, then moves down to the next row of cells where it will place the next measured data. The different colors displayed in the data log correspond to different alarm and alarm action levels. Measurements that are below the alarm threshold are displayed in black. Measurements that are above the alarm level are displayed in red. Measurements that are still above the alarm level after the alarm has been acknowledged are displayed in yellow. Measurements that are below the alarm level after an unacknowledged alarm states are displayed in blue (figure 2). These alarm state colors and other alarm options may be changed through the 451 Assistant options menu [2].

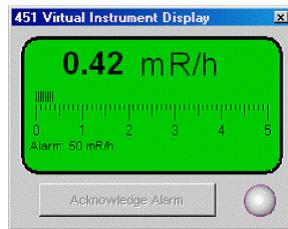
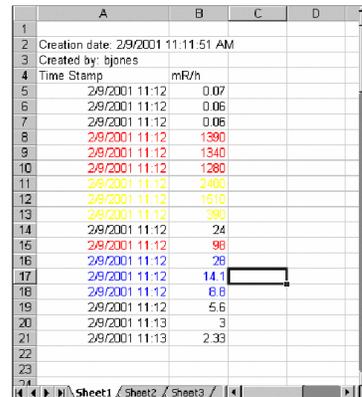


Figure 1. Virtual instrument display



	A	B	C	D
1				
2	Creation date: 2/9/2001 11:11:51 AM			
3	Created by: bjones			
4	Time Stamp	mR/h		
5	2/9/2001 11:12	0.07		
6	2/9/2001 11:12	0.06		
7	2/9/2001 11:12	0.06		
8	2/9/2001 11:12	1390		
9	2/9/2001 11:12	1340		
10	2/9/2001 11:12	1280		
11	2/9/2001 11:12	2400		
12	2/9/2001 11:12	1610		
13	2/9/2001 11:12	390		
14	2/9/2001 11:12	24		
15	2/9/2001 11:12	98		
16	2/9/2001 11:12	29		
17	2/9/2001 11:12	14.1		
18	2/9/2001 11:12	8.8		
19	2/9/2001 11:12	5.6		
20	2/9/2001 11:13	3		
21	2/9/2001 11:13	2.33		
22				
23				

Figure 2. Real time data logged to Excel

## 2.3 Integrated dose

The 451 Assistant can also be used to make integrated dose measurements. The integration period can be specified for automatically timed integration or the user may control the integration and the 451 Assistant simply measures the integration period. The 451 Assistant will then start the 451P in the run mode. The 451 has a 30-second reset period after the run mode is started, after which, the instrument will start integrating.

After the stop button is pressed or the timer has expired, the assistant will read the integrated dose from the 451P and insert the dose in the active cell and the average dose rate in the next cell to the right [2].

#### 2.4 The disadvantages of the program 451 EXL

The 451EXL software does not support graphical presentation of the measured data in real time. The existence of such characteristics is very important for the end user. Instead of graphic presentation in real time the 451EXL software offers the possibility of graphic presentation of measured data (line chart), but it requires interaction with EXCEL program.

Also the 451EXL program does not provide transfer of measured data to remote server computer so other interested persons can not follow the measurement in real time. It is desirable that remote clients can access the measurement data in real time with their smart phones and tablets.

Due to these disadvantages of the factory program 451EXL we decided to write our own program 451NFS that will meet all of our requirements. Unfortunately, the Fluke Biomedical documentation for the device 451P does not contain a communication protocol for the data exchanging between device 451P and the computer. Therefore, the first step in writing our program was discovering the mentioned communication protocol.

### 3. Communication protocol

We recorded the communication protocol for the device 451P with program "HDD Free Serial Port Monitor" [3]. Thanks to this program, we discovered that the device 451P uses commands that are given in the Table 1.

**Table 1. List of the Victoreen 451P commands**

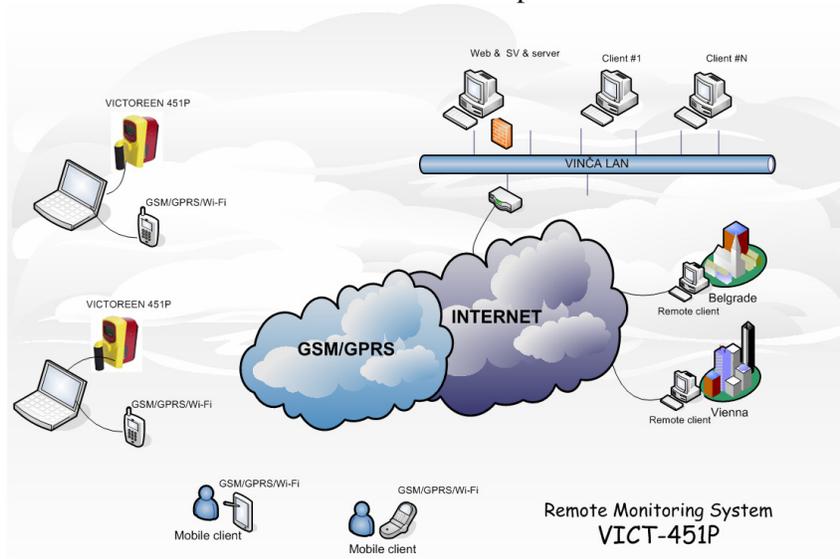
<b>Cmd</b>	<b>Description</b>
F	Read saved
M	Modify
R	Review modified
T	Test
E	Exit & save new
X	Output log data
Q	Quit, keep old
U	Units
H	Freeze / Integrate
S	Set data log parameter
A	Set blink alarm

The implemented communication protocol between the instrument 451P and a computer is based on ASCII code. The good side of this solution is that the instrument can be tested using programs for terminal emulation (Hyper Terminal). All commands are one character long and therefore are easy to use in the program. Unfortunately, the command is not ended with termination character (CR or LF) and there is no checksum verification. Better serial protocols use checksum (additional bytes added at the end of the data string) to check the data integrity, as errors might occur during data transmission. There are

many types of checksum, from the simplest uses of it in Modula or BCC (Block Check Character) to sophisticated CRC (Cyclic Redundancy Check) calculation. The manufacturer should improve instrument software with checksum verification code. Also, the instrument answer is not well formatted. For example, after issuing a command T instrument takes about 30 seconds to synchronize with the program, and then sends the measured intensity of the radiation dose every second. After sending fifteen measurement data instrument sends measurement units. This format of sending data is repeated until the operator does not interrupt further transmission of measurement data. When the instrument is controlled by the 451 Assistant software and the instrument sends measurement units as 16<sup>th</sup> data, the 451 Assistant software writes the 15<sup>th</sup> measurement data as a 16<sup>th</sup> data in the spreadsheet. The user does not know that this is happening in the background.

#### 4. Architecture of the monitoring system Victoreen 451P

The monitoring system VICTOREEN 451P (VICT-451) presents distributed measurement system which is realized in three hierarchy levels. Each level of the system VICT-451 plays its role in measurement, processing and visualization of measurement data. The architecture of the monitoring system VICT-451 is shown in figure 3. The lowest level of the monitoring system VICT-451 is consisting of one to several Victoreen 451P instruments. The second level of the monitoring system VICT-451 is consisting of mobile and desktop computers which are connected to Internet via cable, Wi-Fi or GSM network. The third level of the system VICT-451 is consisting of Web and Shared Variable servers and a certain number of client computers.



**Figure 3. Architecture of the monitoring system VICT-451**

The clients from PC Nuclear Facilities of Serbia as well as the special clients out of our computer network would have rights to access measurement data in real time. Access to the measurement data can be limited by defining the authorized IP addresses of computers as well as with appropriate passwords. Also, the measurement data can be accessed by mobile phones and tablets.

## 5. Measurement application

The measurement application is completely written in LabVIEW 8.6 programming language [4]. LabVIEW is a dataflow graphical programming language specifically designed for measurement, analysis and presentation of data.

In the time interval of one second the program collects data from RS-232 serial port, performs processing, displays measurement data in graphic form in real time, writes measurement data to disk, updates the LED indicator to signals the alarm condition and sends measurement data to the Web&SV server via Internet.

At the operator request the program calculates the mean value, the integral dose and the maximum dose. Parallel with measurement data the mean value is plotted on the chart. The measurement data are presented in blue, while the calculated mean value is presented in red (Fig. 4).

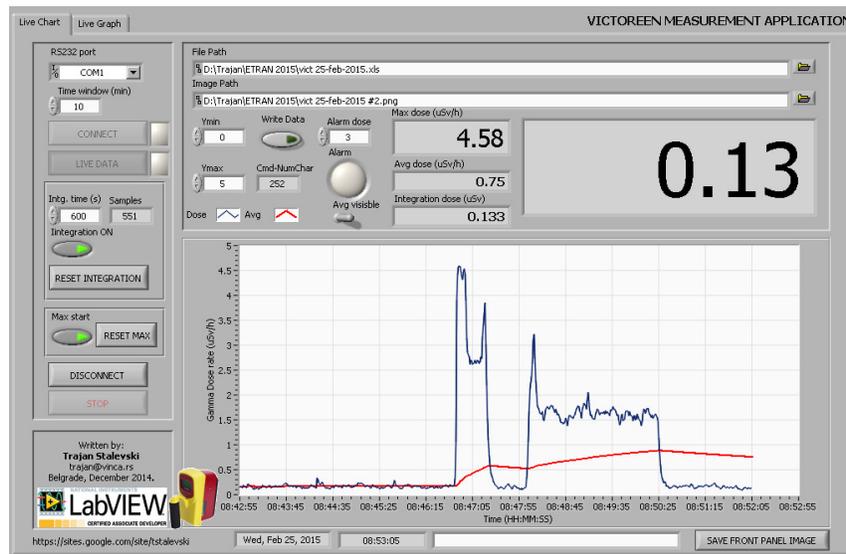


Figure 4. Front panel of the measurement application

At any time the active user front panel can be remembered as a PNG image file for documentation purposes. Besides displaying measurement data in real time the program allows displaying the history of measured data. Using the two graphical cursors operator can define an area on the time axes to calculate the mean, integration, minimum and maximum dose. Moving cursor along the measured curve the operator can read each measured data.

## 6. Server application

The server computer has a role of web and Shared Variable server. The web server allows individual clients to access measurement data via Internet using a web browser. Shared Variable server allows the distribution of measurement data in real time over Internet. Both servers can reside on the same computer. The server must have a static IP address. The server application has all the features that has the measurement application. The only difference is in the method of collecting measurement data. While the measurement application communicates with the instrument, the server application communicates with shared variables. The shared variables are only supported on Windows machines. For other operating systems (Linux, Mac OS) DataSocket technology can be used. The

shared (network) variables simplify data exchange between applications on the same system or across the network. The network variables use the NI Publish-Subscribe Protocol (NI-PSP) to send and receive data across the network.

## **7. Client application**

The client application is installed on the client side and works under operating systems MS Windows XP/2000/ VISTA. Also, this application is written in the programming language LabVIEW 8.6. Each client has unique identification information (username and password) and these data are automatically saved on the Web&SV server. The client application allows clients to monitor live measurement data via Internet. They can be located in different cities, countries, continents and is only necessary to have any access to the Internet. The remote clients can exchange text messages and download measurement data from Web&SV server.

## **8. Monitoring measurement data with web browser**

The graphical programming language LabVIEW has embedded web server since version 5. Thanks to this server developer can easily make visible user front panels with the web browser. There is no need for special coding in the block diagram. To see a static image of the virtual instrument (LabVIEW program) it is necessary to enter the following command in the address field of the web browser: *http: //IP\_Host/.snap? program-name.vi*. Also, LabVIEW web server enables displaying of animated images. It is only necessary to replace the snap command with monitor command. Both commands are not supported by standard web servers. In addition to the integrated web server, company National Instruments has developed external web server, known as G web server. G web server is a standalone application that runs independently of other virtual instruments. This server enables developers to interact with measurement application via a web browser. This interaction is performed using CGI (Common Gateway Interface) functions [5].

## **9. Data Dashboard Android application**

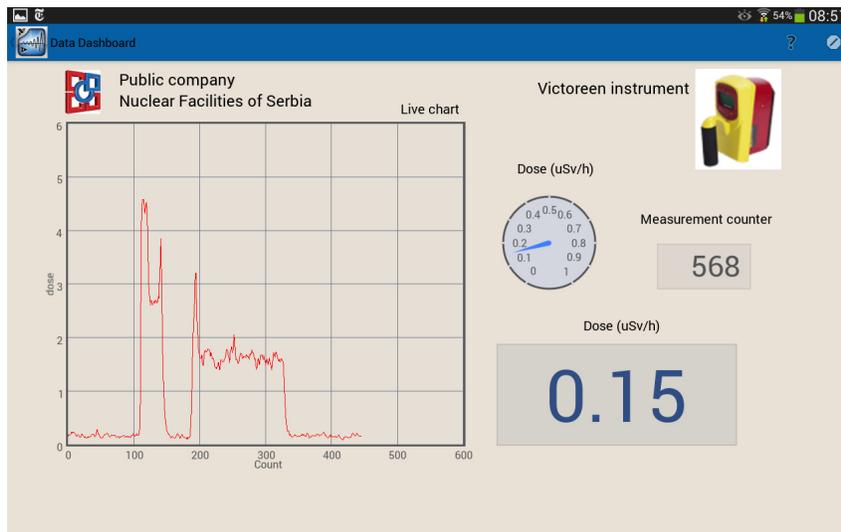
With the Data Dashboard for LabVIEW application, developers can create a custom, portable view of NI LabVIEW software applications. The application displays the values of network-published shared variables and/or web services on charts, gauges, text indicators, and LEDs (figure 5). Users can create custom layouts of one, two, four, or six indicators and quickly swipe between multiple layouts [6]. After the application is developed and web services or shared variables are deployed, building a dashboard is as simple as browsing to the server and choosing the signals to monitor. Numeric, Boolean, or string data types can be monitored and each data type features multiple indicator types including LEDs and charts.

The Data Dashboard Mobile for LabVIEW applications has the same functionality, but only has one indicator per dashboard instead of the multiple indicator layouts more easily readable on a tablet. With the Data Dashboard for LabVIEW applications on the iPad or Android tablet, programmers can develop customized dashboards that can both monitor and control remote applications.

## **10. Conclusions**

The manufacturer software for communication between the instrument Victoreen 451P and a computer is very simple and does not support checksum verification. Therefore is

not immune on errors that might occur during data transmission. Vendor software 451EXL for PC does not enable graphical presentation of measured data in real time.



**Figure 5. Real time monitoring of measurement data on the Android tablet**

Described measurement applications for monitoring gamma dose rate outdoors and indoors is fully developed and implemented in public company Nuclear Facilities of Serbia. In the time interval of one second the measurement application collects data from the Victoreen 451P instrument, performs processing, displays measurement data in graphic form in real time, writes measurement data to disk and sends measurement data to the shared variable server via Internet.

The measurement application communicates with the server computer via the mobile Internet. The server computer can reside anywhere.

The program is fully written in a graphical programming language LabVIEW 8.6 which has integrated web server. The remote clients can access the measurement data via Internet with web browsers. Also, the measurement data can be monitored in real time with tablets and mobile phones.

The client application allows remote clients not only to monitor the measurement data in real time but also to transfer measurement data from the server to the remote client computers. Additionally, the client application allows remote clients to exchange text messages.

## 11. References

- [1] Fluke Biomedical, Victoreen 451P & 451P-DE-SI Ion Chamber Survey Meter, *Operator manual*, June 2009.
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- [3] HHD Software, <http://www.serial-port-monitor.com>
- [4] National Instruments, *LabVIEW Fundamentals*, 2008.
- [5] Trajan Stalevski, Kontrola uređaja pomoću veb pretraživača, *55. konferencija ETRAN*, Banja Vrućica, 6.-9.juna 2011, str. RT5.4 1-4.
- [6] National Instruments, *Smartphones and tablets for measurement and control*, November 2014.

## ORIGINALNI PROGRAMI ZA MONITORING MERNIH PODATAKA SA INSTRUMENTA VICTOREEN 451P PREKO INTERNETA

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### SADRŽAJ

U radu je opisan skup originalnih programa za prikupljanje i analizu podataka koji se mere instrumentom Victoreen 451P u realnom vremenu. Ovi programi poboljšavaju funkcionalnost i pružaju mnogu ugodniji korisnički interfejs nego što to nudi program proizvođača instrumenta. Takođe, programi omogućavaju monitoring mernih podataka u realnom vremenu, analizu podataka, grafičku prezentaciju i distribuciju mernih podataka udaljenim klijentima preko Interneta. Ako se merenja obavljaju na terenu, prikupljeni podaci se prenose do serverskog računara preko GSM mreže. Serverska aplikacija omogućava monitoring mernih podataka u realnom vremenu i ujedno servisira mrežne varijable. Mobilni klijenti ( Apple telefoni, Android telefoni i tableti) mogu pratiti merne podatka u realnom vremenu pomoću National Instruments Data Dashboard aplikacije.