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Remote Control Software for Rohde & Schwarz Instruments

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***Abstract*—**The paper describes software for remote control and measuring with new Graphical User Interface for Rohde & Schwarz instruments. Software allows remote control through Ethernet and supports basic and advanced functions for control various type of instruments like network and spectrum analyzers, power meters, signal generators and oscilloscopes. Standard Commands for Programmable Instruments (SCPI) and Virtual Instrument Software Architecture (VISA) are used for remote control and setup of instruments. Developed software is modular with user friendly graphic user interface for each instrument with automatic identification of instruments.

***Keywords*—**Remote control, Rohde&Schwarz, SCPI, VISA, MATLAB, spectum analyzer, network analyzer, oscilloscope, signal generator.

I. Introduction

THIS paper describes the development of remote control measurement and data collection software for Rohde & Schwarz instruments. The software is developed using MATLAB environment.

The history of remote control measurement (RCM) began directly since the first instrument was use. The measured data was read from screen of the instrument directly by the user. The measurement and analysis were slow, inaccurate and dependent on the user. The user requirement was to develop automatic a collection of measured data for next processing. The amount of data increased rapidly with the development of faster and more accurate measurement devices. The size of the measured data is from units of bytes up to units of GB. The measured data from a historical point of view was to store on paper, floppy disk, etc. Nowadays, modern devices store data in built-in memory, or allow export of data to flash disk, memory card or through a network. The common interfaces for exporting data are serial port, GPIB, USB, Ethernet. The main problem with modern interfaces like USB or memory cards is the writing speed of the data to memory and supported sizes of memory by instruments (usually up to 32 GB for handle instruments).

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Modern instruments required a settings many parameters before the measurement. The direct controlling of the instrument through a touch screen, keypad, mouse etc. requires good knowledge of each instrument due to complex software menus and sub-menus. The instruments with operating system allow to control through a remote desktop. The interfaces of the remote control and the screen of instruments are the same.

This disadvantage can be eliminated by the development of software for remote control and data collection through an Ethernet. The software will have only parameter settings required by user. The usual speed of the Ethernet is 10/100/1000 Mbps.

Communication through an Ethernet interface is common for the last few years for various types of instruments (oscilloscope, signal generator, network analyzer, and spectrum analyzer).

The disadvantages of a present Ethernet solution are:

- The instruments usually required special software installed in each PC where data is collected.
- The free software has very often limited functionality. The advanced function for data collection or remote control measurement required purchasing software or license update.
- The graphic user interfaces of software are different for various types of instruments.
- The format of measured data is different for each instrument and formatting of data is different also. The next processing of data through third party (like MATLAB) software required conversion of all measured data from various types of instruments to a uniform format.

II. The Background of Software Application

The disadvantages described above can be eliminated by developed new software with highlights:

- Easy connection through Ethernet interface. User only needs information about IP address of instrument.
- The automatic identification of instruments with unique GUI for each instrument.
- The measured data is directly imported to MATLAB workspace for next processing or can be saved to a hard disk.
- RCM of instruments directly from PC.
- Each supported instruments have similar user friendly GUI. The user doesn`t need to learn different software for each instruments like with original software.

The developed software uses Standard Commands for Programmable Instrumentation (SCPI) for communication between PC and instrument. The standard for remote control is described in IEEE 488.2 [1], [2]. The main advantage of SCPI is independence of developer and used programming language because SCPI are transferable across all instruments.

There is only one requirement for using SCPI - installation of Virtual Instrument Software Architecture (VISA) libraries on PC [3]. VISA is used for translating SCPI for two-way communication between a PC and the instrument. Next, VISA contains protocols for transferring data across protocols. The developed software used for communication TCP/IP protocol.

There are two ways how to write application for remote control of instruments at MATLAB [4]. Both need installed MATLAB, Instrument Control Toolbox [5] and VISA. Difference is in using SCPI. It is possible to directly use SCPI or use libraries with functions described below.

Libraries are contained in VXIplug&play drivers for each instrument and can be downloaded from Rohde & Schwarz web site [6]. Functions from libraries are called by *call* function at MATLAB.

The programming process with libraries is more comfortable. There is one main advantage: user does not have to read hundreds of pages in the SCPI manual. On the other hand installation of drivers is needed and there are lots of problems. Some instruments have the same drivers and in this case there are problems with remote control of instruments. In the case of FSH and FSL analyzers, both of them use the instrument driver *rsspecan*. If user works with FSH analyzer we need the instrument driver in version 1.19. FSL analyzer needs the same instrument driver but version 2.4 and this driver version is not FSH analyzer supported. The next problem is the compatibility between operating system architecture: 32 bit and 64 bit instrument drivers are different. We can expect more compatibility problems with instrument drivers with the new Windows 8 and the next versions.

The direct SCPI application is more complicated but this type of application is independent on Window`s versions, computer architecture and does not require any instrument drivers.

Described version of software application supports five series of instruments from Rohde & Schwarz [7]:

- Spectrum / network analyzers FSH with/without power meter
- Spectrum analyzers FSL
- Vector network analyzers ZVL
- Oscilloscopes RTO
- Signal generators SMB and SMC.

III. Software Application for Remote Control

The start of the application opens simple window (Fig. 1) with an editable box for entering IP address of the instrument. The developed software is modular. Each instrument is programmed as a unique function. The flowchart of instrument selection is shown in Fig. 2. The identification SCPI query is sent and the instrument returns the answer which includes information about the model/type of the instrument. Successful instrument selection then opens a unique GUI for individual instruments.

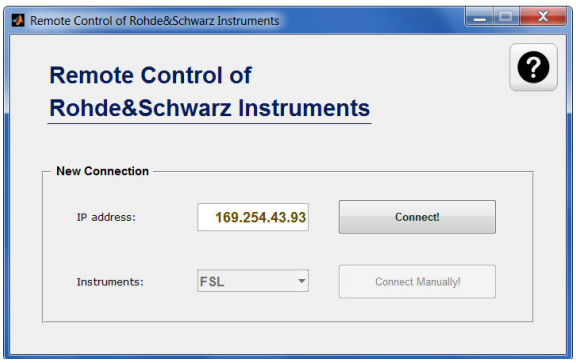

Fig. 1 The connection of instruments

It shows which instrument was detected for user feedback control. In the case of the user agreeing, the GUI for the individual instrument starts.

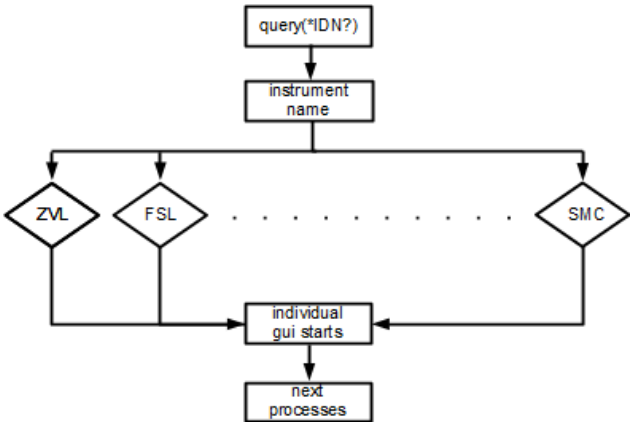

Fig. 2 Flowchart of the instrument selection

The graphical representation of the GUI for each instrument is similar with respect to the unique measured parameters and signal characteristics for each instrument. The SW application is designed for settings/measuring of the required parameters with no additional settings on instruments directly from the application through mouse and keyboard.

It is more comfortable because laboratory instruments often have small display and keypad. The examples of software are shown on Figs. 3 and 5. Fig. 3 shows a screen for R&S signal generators without graphic output and a screen for instruments with graphic output is shown on Fig. 5.

The basis of all GUI with graphical output is a figure for plotting signal characteristics and buttons for saving data. Data can be saved to workspace, CSV or image file.

The next section describes the possibilities of settings/measurement for individual supported instrument.

A. Signal Generator SMx 100A

Signal generator software allows settings of all based parameters like frequency, level, and shape of signal. The

advanced parameters are selectable under Modulation generators (Fig. 4), Modulation, and RF window. The full list of supported function is described at manual which is included in the software.

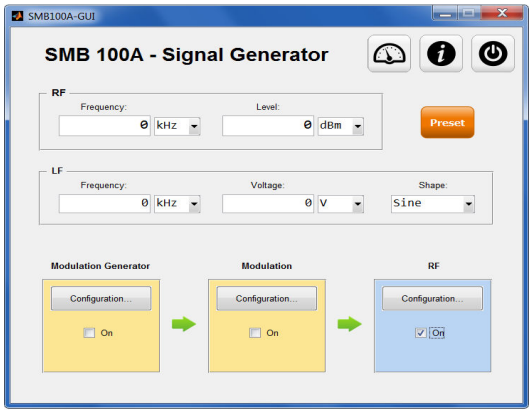

Fig. 3 The examples of GUI for instruments without graphical output (Signal generator SMB 100A)

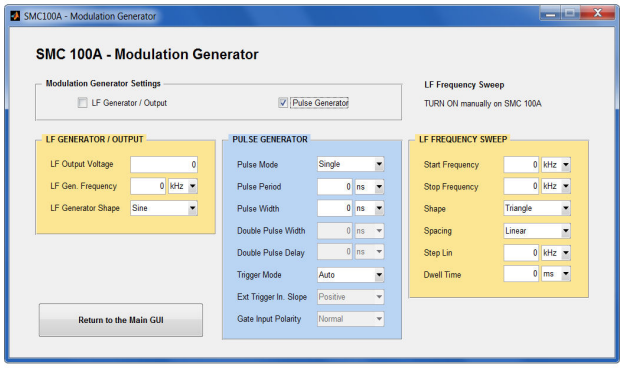

Fig. 4 The example of signal generators modulation settings

B. Spectrum Analyzers FSL Series, Network Analyzers ZVL, and Handel Network/Spectrum Analyzers FSH Series

The screenshots for spectrum and network analyzer are shown on Figs. 5, 6. User can set basic parameters:

- frequency range
- up to 4 markers (values on selected frequency, minimal and maximal value, peaks)
- number of measured points
- sweep time (single/continuous sweep)

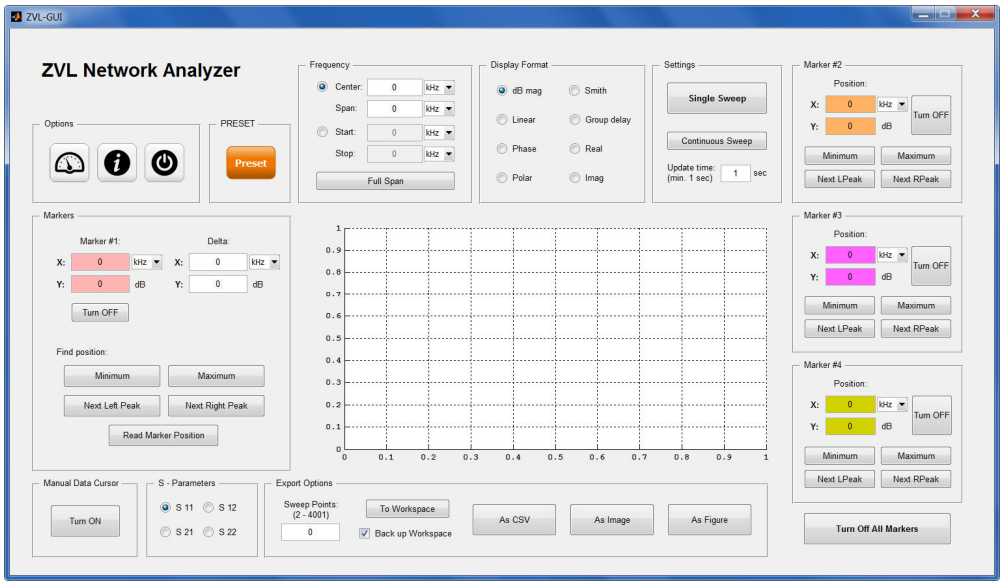

Fig. 5 The Spectrum analyzers GUI

FSL spectrum analyzers can also set trace mode (average, max hold, min hold, write).

ZVL series network analyzers have unique functions:

- switch of scattering parameters (S11- S22, S12-S21)
- different display modes (amplitude, phase, real, imag, polar, Smith chart)

A handheld spectrum/network analyzer FSH can change modes directly from SW application. Remote control of the power meter and displaying measured data is possible as well. FSH does not support changing of the data points; preset number is 631 data points.

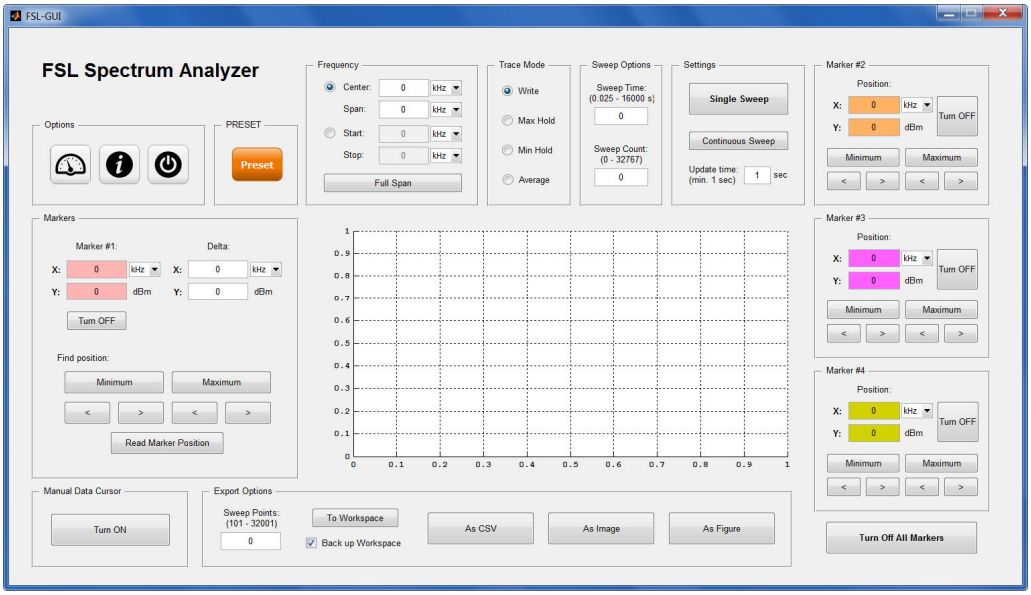

Fig. 6 The Network analyzers GUI

An application window for RTO oscilloscope is shown in Fig. 7. This type of oscilloscopes has many options and is not possible to control all the functions by user friendly GUI. The software application is built mainly for saving data. The arrangement is clear and minimalistic because this type of oscilloscope has 10.4" LC TFT touch screen and all setting can be easily set directly using the instrument (opposite to spectrum/network analyzers). The application enables saving data from all channels and for all waveforms. The number of data points is dependent on length of a signal and sampling frequency.

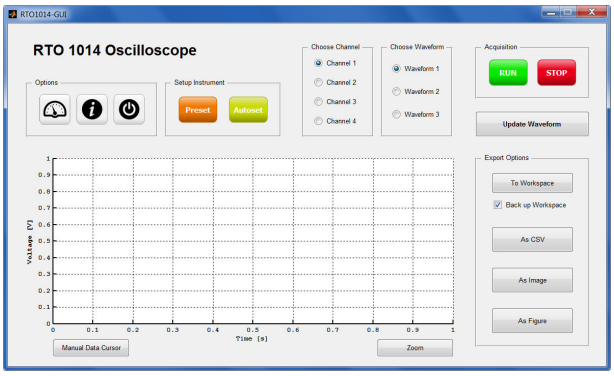

Fig. 7 Application window for oscilloscope

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IV. CONCLUSION

The remote control measuring software was developed for various types of Rohde & Schwarz instruments and does need any driver or special software from R&S. The software automatically identifies connected instruments and opens appropriate GUI for each instrument. The developed GUI supports basic functions and also advanced function for remote measurement. The big advantage of software is the automatic export of measured data to MATLAB workspace for further processing. The modularity of the software allows for an easy extension of new supported instruments.

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