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State of the art solutions for digital data management of high voltage test systems

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1. Abstract

With the increasing impact of information technology today, the means of data management in high voltage testing are changing. Recent developments show a growing demand for simple to use, comfortable and user-friendly control systems that allow easy data acquisition, evaluation, diagnostics and storage.

The concept of a WINDOWS-based control software will be presented, which provides all the possibilities for an efficient, flexible and reliable control system for high voltage test and measurement systems.

Based on available solutions, the functionality of the control system is demonstrated to be used in a wide range of applications from single unit stand alone control systems to complex host controlled automated routine test environments.

2. Introduction

Covering a wide range, the requirements for controls of HV test systems reach from cost efficient, simple solutions for manual control up to automated, computer-aided systems. Often the system needs to be upgradable to deal with the ever growing demands of future applications.

The rapid development of today's information technology and the innovations in the field of industrial control systems open-up opportunities for new designs, a trend that is also effecting the controls of HV test systems.

Focused on the customer requirements, the HIGHVOLT concept for the control system utilizes the advantages of the technology available today.

A simple to use manual control device, based on a programmable logic controller (PLC), serves on the lower end of the scale. It can be extended with interfaces to provide access to a host computer for automated, computer-aided control. This host computer is the gateway to a network that enables the integration of the control system into a complex control environment that forms the high-end of the scale of the control system.

The HIGHVOLT concept is modular in its design. PLC components are distributed throughout the HV test system and are interlinked by fiber optic connectors. All measuring devices are integrated into the control system. The concept has been used for a long time and was improved over the years.

3. Demands for computer-aided control systems

A characteristic feature of computer-aided control systems is the application of standardized hardware and software components. For the **hardware,** industrial components (industrial PC, PLC and communication modules) are used to guarantee high reliability and availability, thus enabling hardware upgrades in the future.

For the **software** apply the same requirements in terms of reliability and availability, but in addition flexibility and accessibility must be provided. Customers often request source code or interface information to integrate the control system into their environment.

With all the flexibility and accessibility it is important not to jeopardize the safety of the operating personnel. This has a very high priority in the HIGHVOLT concept and therefore all safety rele-

vant operations are still hard wired and can not be over written by the software.

4. Software design

Software principles and control algorithms described in this paper are independent from the type of HV test system. They can be used for any HV test system, provided the sensors and controls are available.

Both software packages IMS21 and WGMS21 provided from HIGHVOLT operate in an Microsoft Windows® NT or Microsoft Windows ® 98/2000 environment.

The actual control software is realized as a system-specific program. Main purpose of the program is to interface between the operator who runs the HV test and the HV test system itself. This includes the clear display of relevant system parameters, system status and support or help information, if required. The program basically replaces the manual controls of conventional control systems. It provides interfaces for communication with other modules, but cannot be modified by the user.

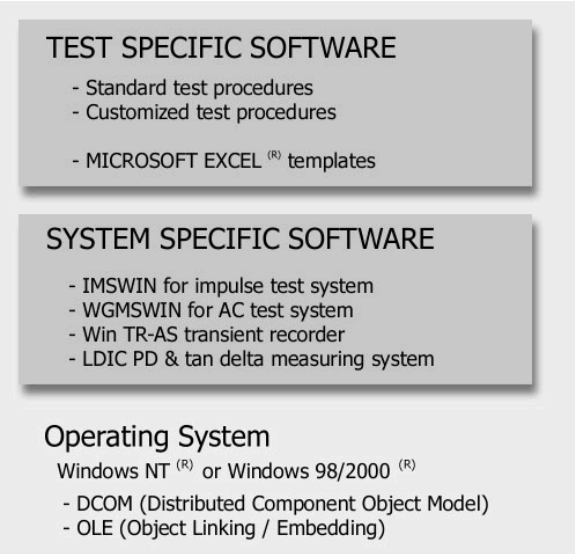

Figure 1: Components of the software

What is the innovative part of the concept?

To answer this question a general examination of the requirements of HV testing is helpful:

Every HV test program is a sequence of operations. Technical standards define the order of the operations in the test routine. Some tests depend on events occurring during the test or on results of a previous test. A good example for an event is the break down of the test object - causing the termination of the complete test or modification of the test parameters. Events can also be triggered from external sources that have direct influence on the performance of the test (e.g. malfunction of the rain making equipment). However not all HV tests can be automated. It is still recommended to perform critical tests under the control of an experienced operator or engineer.

For the HIGHVOLT control system a generalized description of the test process is sufficient. A test template that defines the test routines is loaded into the test specific software. The source code for the template is open for the user and can be modified or adapted. This template provides the data for the system specific software and starts the test process. During the test, data from the test system, measurements or status reports, can be called from the test specific software. All safety relevant functions are entirely controlled by the system specific software.

After the test is performed the test specific software is used to evaluate and visualize the test results. In order to make it easier for the operator to interact with the test specific software a common interface was used - Microsoft Excel ®.

Microsoft Excel ® comes with an integrated programming language "Visual Basic for Applications" (VBA). VBA was used for programming the test specific software.

Everybody who is able to read or program in BASIC can read and modify the source code for the test routine. The following script belongs to the template of an up and down test:

```
If break_down then
        Urated=Urated-10
Else
        Urated=Urated-10
End If
StartNewCycle
```

The BASIC-code enables the operator to include on-line data from other programs, running on the PC at the same time, to be included into the test routine.

All features included in the Microsoft Excel ® package can be used for the evaluation and visualisation of the test results. Graphical displays and diagrams of the rated and actual data can be arranged to generate customer specific test reports. Various mathematical and statistical calculations can be performed as the data are collected. Data export to different programs and

data storage is possible. With all the network features data can be shared on a computer network.

5. Operating modes and applications

Computer based manual control mode

In the computer based manual control mode only the system specific program is employed (IMSWIN or WGMSWIN). The user interface of the programs can be modified, so that only the required information is displayed. For every component in the test system that is controlled from the software, there is a virtual plug-in (e.g. impulse voltage test system - windows for the charging control and the operator device can be hidden or displayed). In manual mode every test has to be started seperately. All measuring results are stored.

The system specific program controlls all measuring systems that are connected to the test system (transient measuring system type TR-AS, partial discharge measuring system type LDS-6). Configuration of measuring instruments (e.g. measuring range, trigger level and sampling rate of transient recorder) as well as acquisition of the measuring data are performed by the system specific program in the background. The measuring device specific software (e.g. Win TR-AS for transient measuring system) is remote controlled, but fully accessible for the user in a separate window. This guaranteees the full functionality of the respective program.

Automatic mode

During automatic mode the system specific software is complemented by the test specific software. It is loaded as a test template and cannot be differentiated as a separate program by the user. The content of the test template defines the sequence of test procedures. Each test template is an EXCEL template that contains rated, actual test parameter and diagrams with graphical display of the test results.

The VBA code of the test template displayed in Figure 3 performes a simple test sequence. On the right hand side a graphical display is shown of the test sequence. Included are the following features: stop test after breakdown, continue after breakdown or repeat previous test cycle after beakdown.

While the test is running the user can access all functions and features of Microsoft Excel ®. This can be used to generate diagrams of the test results, perform calculations or statistical evaluations.

Complex mode

Complicated test procedures require interaction between the operator and the program during the test. A good example for an automated test program is the test of tap changers of transformers. In sequence all contacts of the tap changer are subjected to a lightning voltage with both polarities. A matrix defines the values for each contact pair. If no breakdown occurs, then the test of one contact is completed. In the event of a breakdown further tests depend on several conditions. The operator can evaluate the conditions and activate the related sequences in the control software.

The complex mode is a combination of automated test routines and operator control. During the test the operator has access to all information available. Figure 4 shows an example of the voltage waveform measured with the transient recorder during an impulse test.

Remote control

Some applications require the integration of the control system of the HV test system into a complex control architecture. Test parameters are sent from a host system onto the HV system control. In reverse, data is uploaded to a system data base.

The control software is equipped with an OLE automation interface which enables host programs to communicate with the system specific program (e.g. start test procedures, acquire results and status information of the test system).

If client and system specific program are working in a Windows NT environment configured for DCOM, then the client and server can be distributed in a TCP-IP network. Clients must have a suitable interface (connection point interface) to access full capabilities of the system specific program. The system specific program uses the interface to inform the client about events relevant for the test procedure.

The automation interface can be used for setting system specific parameters (e.g. test voltage, charging time, start/ stop) and provides remote control of the test system. Complex test procedures are defined in MS-Excel templates using VBA code. Clients can load and execute the test specific software.

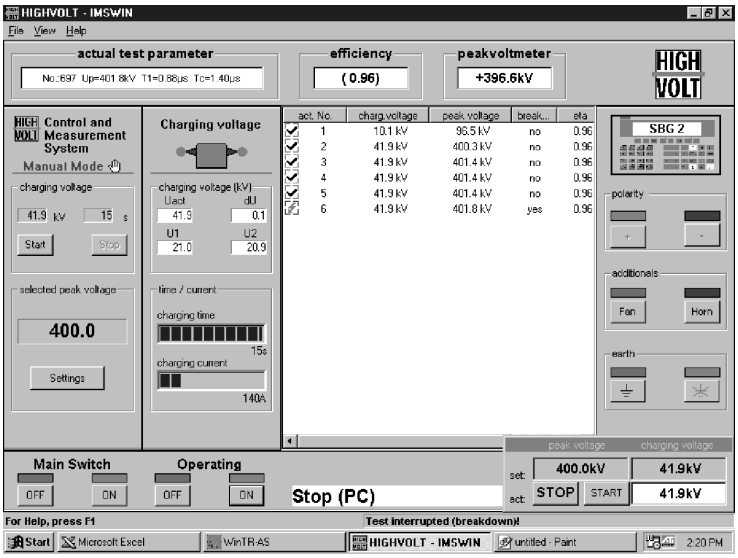

Figure 2: System specific program IMSWIN in manual mode

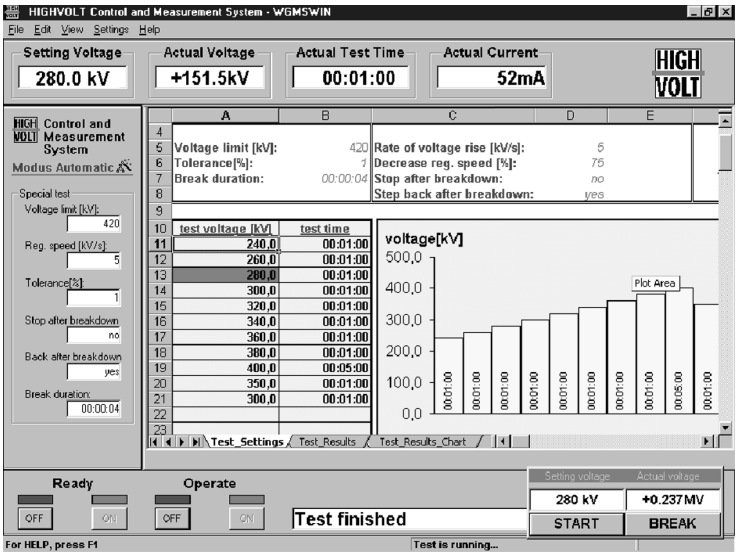

Figure 3: User interface of WGMSWIN with integrated EXCEL window in automatic mode

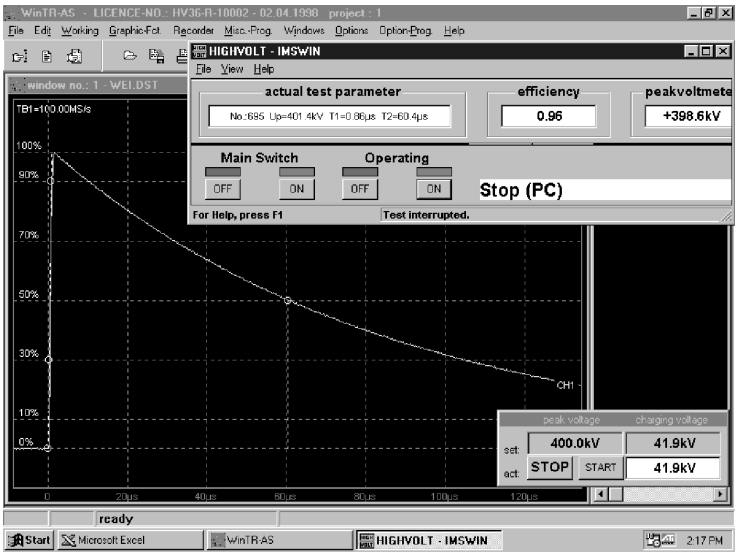

Figure 4: IMSWIN and transient recorder control WINTR-AS

Conclusion

A main key for successful software programming is a uniform concept of the user interface, the data management, the availability of help menus and remote control.

With presently available hardware and the system platform of WINDOWS ®, standard technologies can be applied. Professional applications can be linked together and extend the capabilities (Object Linking and Embedding). Modern concepts for help menus provide interactive documents to provide the user with the information needed in an efficient way (Dynamic Hypertext Markup Language, DHTML). Applications can be distributed on local or wide area networks to allow remote control and data exchange (Distributed Component Object Model, DCOM).

The software described in this paper is based on the latest technology available today. It is intended to provide easy control and open interfaces to satisfy the demands of the customer.

References

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