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Design and Develop an Automated and Integrated Test System for Product Life Cycle and Simulations

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ABSTRACT

Today the world is driven towards Automation. Any device which comes in market is expected to have four important features i.e. Reliability, Repeatability, Accuracy and long life span. Of course the cost is also an important factor. In order to ensure proper Reliability, Repeatability and check whether the device operates as per the design requirements there is a need to build a proper test system. These tests can be performed manually but with the advent of advance communication and advanced devices these tests can be programmed so as to save time and improve accuracy.

Keywords: Accuracy, Advanced Communications, Automation, Reliability, Repeatability.

I. INTRODUCTION

Automation is of utmost importance in electrical and electronics industries. Various equipments such as protection relays, fault sensor, RTU etc used for protection and data acquisition at the substation needs to be thoroughly tested for their performance and compliance of standards. As these devices are placed on field they are subjected to various climatic, electrical, and mechanical stresses. It becomes very important to observe the behavior of various devices at different climatic conditions such as different temperatures and humidity. Also their behavior with the variations in source supply voltage etc. In order to simulate such conditions we require special devices which can be programmed and controlled remotely in sequence so as to check the behavior of these devices under different stressed conditions. These special devices will include precision source, DC source, Data logger and Digital Multimeter along with the climatic chamber to simulate different environmental conditions. These devices will be used to carry out different test cases i.e. to set up the physical environment.

Communication protocols. MODBUS, IEC-60870, DNP3 are some examples of communication protocols. In order to check whether the Device Under Test (DUT) adheres to these standards protocol conformance testing (also known as compliance testing) has to be carried out. These involve creating test cases and implementing them to check the response time, correctness and validity of the communication protocol configured in the device under different conditions.

Manual execution of the above techniques is tedious and time consuming. Thus there is a need to develop an automated and integrated test system which has the ability to set up the physical environment required for the

test at the system level and for carrying out conformance testing at the device level. At the same time the test system should be user friendly.

This paper presents an idea of how to implement the above mentioned test system for a device configured as an IEC-104 or MODBUS.

II. THE DEVICES USED FOR THIS PROJECT ARE

1. Series Precision Source / Measurement Unit.
2. Data Acquisition/ Switch Unit.
3. Triple Output DC Power Supply.
4. Digital Multimeter.
5. Personal computer.
6. GPIB interface cable.
7. Climatic Chamber.

III. SOFTWARE USED FOR THE PROJECT

1. Python 2.7 programming interpreter.
2. NI visa software.
3. Notepad++
4. Excel Document

IV. BLOCK DIAGRAM

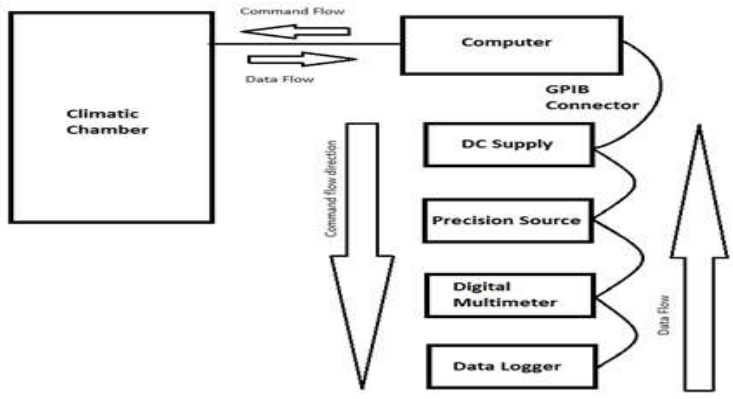


Fig.1 Block diagram showing the various devices along with the direction of command flow and data flow

V. BLOCK DIAGRAM EXPLANATION

The above block diagram depicts the connections to be made and the different devices that will be used in this project. The details and features of all the devices that will be used in this project is studied from the user manuals as specified in reference section and communication of this device using GPIB is made.

Here the PC acts as the master whereas all the other devices act as a slave. The control signals or the command signals flow from the PC to the various devices which are connected in a linear chain using the GPIB interface. All the devices have their own addresses and communicate on the common bus. The direction of Data flow is opposite to the command signal. The chamber is also to be controlled using the PC via the LAN port.

VI. IMPLEMENTATION

The communication of the various devices is made and script is written for each device in which functions of each device is present. For e.g. if we want to apply a certain value of voltage than we need to import the function file corresponding to that device and creating an object and then using the various functions such as apply certain value of voltage. The function has arguments which need to be entered and this can be used to generate the logics such as ramping of voltage or applying voltage inputs as per the requirements.

Similarly data can be read from the various devices and can be logged in excel which can be used for data analytics such as plotting the response against time etc.

By using python we can make systematic test cases.

Example Test Case:

Aim: To test the response of Binary Output Module and Check for the response time.

Step 1: We enter the start value of the voltage and the value of end voltage.

Step 2: Enter the step size in which the voltage has to be increased and time interval in which the voltage must be increased by one step size.

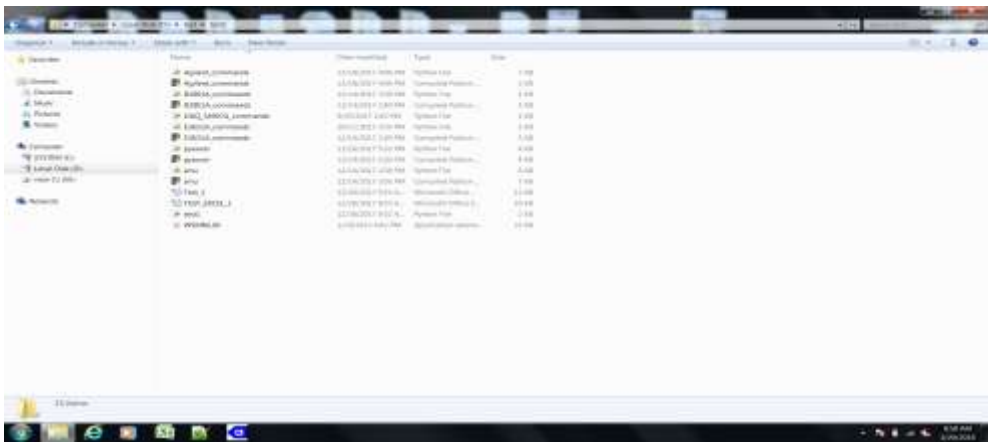
Step 3: Read the response of the BO if the BO has become high or low.

Step 4: Print the response in Excel report file along with the corresponding time stamp and applied voltage.

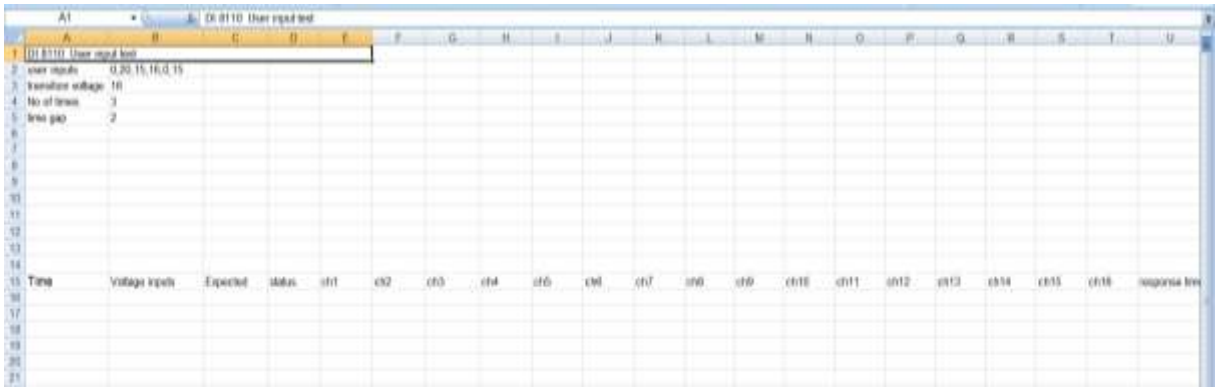
Step 5: It compares the result with the expected voltage at which the BO is supposed to read high and generates a pass or fail result.

VII. IMPLEMENTATION OF TEST 1

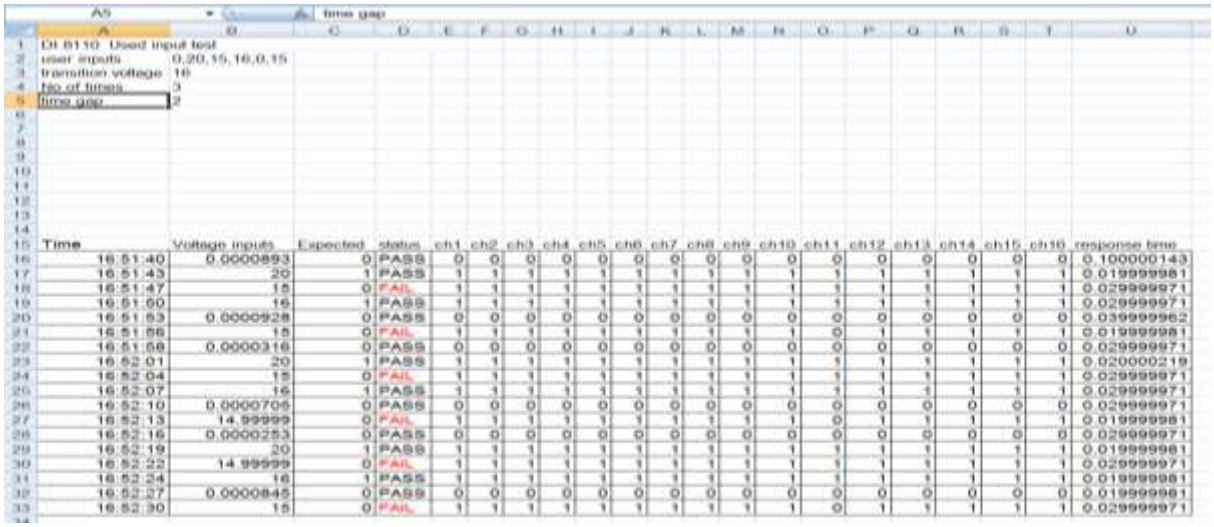
1. Image below shows the various function files created for different devices used in Test 1 and these functions will be used in the main test case script.



2. Enter the user defined inputs in excel file as shown in the image below and save the file.



3. Run the test from command prompt window. Result of the test will be displayed in the excel sheet and it will be automatically saved.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	DI 8110 Used input test																				
2	user inputs	0,20,15,16,0,15																			
3	transition voltage	16																			
4	No of times	3																			
5	time gap	2																			
6																					
7																					
8																					
9																					
10																					
11																					
12																					
13																					
14																					
15	Time	Voltage inputs	Expected	status	ch1	ch2	ch3	ch4	ch5	ch6	ch7	ch8	ch9	ch10	ch11	ch12	ch13	ch14	ch15	ch16	response time
16																					
17																					
18																					
19																					
20																					
21																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
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9																					
10																					
11																					
12																					
13																					
14																					
15	Time	Voltage inputs	Expected	status	ch1	ch2	ch3	ch4	ch5	ch6	ch7	ch8	ch9	ch10	ch11	ch12	ch13	ch14	ch15	ch16	response time
16	16:51:40	0.0000893	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.100000143
17	16:51:43	20	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.019999981
18	16:51:47	15	0	FAIL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.029999971
19	16:51:50	16	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.029999971
20	16:51:53	0.0000928	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.039999962
21	16:51:56	15	0	FAIL	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0.019999981
22	16:51:58	0.0000316	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.029999971
23	16:52:01	20	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.020000219
24	16:52:04	15	0	FAIL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.029999971
25	16:52:07	16	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.029999971
26	16:52:10	0.0000706	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.029999971
27	16:52:13	14.99999	0	FAIL	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0.019999981
28	16:52:16	0.0000253	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.029999971
29	16:52:19	20	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.019999981
30	16:52:22	14.99999	0	FAIL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.029999971
31	16:52:24	16	1	PASS	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.019999981
32	16:52:27	0.0000845	0	PASS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.019999981
33	16:52:30	15	0	FAIL	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0.029999971

Similarly different test cases were carried out to test the functionality of various devices using Python programming language.

VIII.CONCLUSION

1. Study of python Programming language.
2. Also the various features of various devices are studied from the user manual.
3. Test cases pertaining to automation of the various devices in block diagram have been done.
4. Tests scripts using these devices are written and verified. Study of basic working of RTU and Substation automation is also studied.
5. Study of overview of various modules like DI (Digital input), DO(Digital Output).
6. Some basics of Modbus protocol is also studied.

IX. ACKNOWLEDGMENT

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