TO DESIGN AND FABRICATE A MICROCONTROLLER BASED TEST FACILITY FOR A THREE PHASE FILTER MODULE

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Abstract

In Industrial power plants,noise at high frequency at the generator output is very high. This noise has significant effect on Digital Automatic Voltage Regulator (DAVR).Thus resulting in more than two zero crossing per phase and these extra zero crossing per phase has resultedin channel change over from 'AUTO TO MANUAL' in many of the power plants. To overcome this problem, BHEL developed a Three Phase Filter circuit(Electronic module 69203IA2AA) using active and passive components. This active filter will help in removing the high frequency noise on the generator output and gives near perfect clean AC input to the Interrupt Generator (Electronic module 69203GB1AA) of the Digital Automatic Voltage Regulator (DAVR) system for computation. To functionally test this filter circuit for its specification and performance, we developed a test facility using ' Microcontroller 89S51 and Digital Display Unit ' and is called as "The IA2A TEST JIG".

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INTRODUCTION

Recent years have seen rapid development of electronic devices and technologies such as high performance microprocessors, large-capacity memory and ASIC technology for manufacturing high density integrated circuits. These have contributed to bringing about the technical environment that makes the digital AVR possible. These electronic devices have levels of reliability high enough to enable their application to important control system of plants. In application the digital AVR must have the level of redundancy and control function that confirm to the configuration of the excitation control system and to the importance of a particular generator for the user.The digital AVR is not simply a digital version of the analog AVR but can realize sophisticated control function that were difficult to achieve with analog circuits, thus making it possible to enhance the stability of power system by PSS(Power system stabilizer).

DAVR controller has main digital processor, generator terminal voltage, gridvoltage and load current detecting part, power electronics part for the control of exciter. The basic structure of DAVR system is very simple, but detail care is required in the design of system due to the control resolution, self-starting and timing delay of the generator system.

In power plants ripples on the generator output has a great impact on the digital automated voltage regular (DAVR) system. Due to the higher ripple content DAVR switches its operation from auto to manual mode which causes unsatisfactory performance.The IA2A module is the three phase filter module which acts as a buffer between the IA1A and the GB1A module in the DAVR system. This module filters the ripples or glitches caused due to inductive loads on the generator output which is high in magnitude. This three phase filter module facilitates the clean ac from IA1A into the GB1A module. As this module does critical task it needs an elaborate test setup.

LITERATURE SURVEY

Power station

In recent, Power plant DAVR are much used for AVR(Automatic Voltage Regulator) systems, due to the power control performance, flexibility, and cost advantage DAVR (Digital AVR) regulates various output signals of generator by controlling the exciter field voltage and current. So, the control performance of generator system is dependent on the excitation system with AVR control scheme. Also referred to as power station, generating station or power house. Mainly conversion of one form of energy to another form takes place in a POWER PLANT. At the center of nearly all power stations is a generator, a rotating machine that converts mechanical energy into electrical energy by creating relative motion between a magnetic field and a conductor .The energy source harnessed to turn the generator varies widely. It depends chiefly on which fuels are easily available, cheap enough and on the types of technology that the power company has access to. Most power stations in the world burn fossil fuels such as coal, oil, and natural gas to generate electricity, and some use nuclear power, but there is an increasing use of cleaner renewable sources such as solar, wind, wave and hydro.

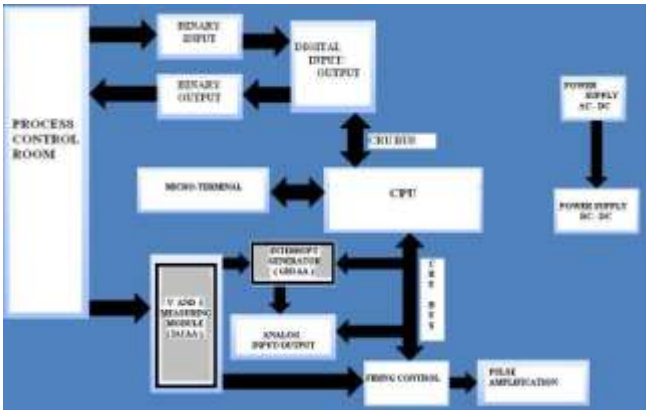
Types of Power Plants

- Nuclear Power Plants
- Thermalpower plants
- Hydro-electric power plants
- Solar power plants

The Digital Automatic Voltage Regulator (DAVR)

In this power plant, we have a system called Digital Automatic Voltage Regulator(DAVR)system, which is the major system of the power generation, in a power plant.

Constituent Blocks of the DAVR System



Principle Operating Mode of DAVR

System

The digital regulator periodically calculates the control signal from measured and reference values. The calculation is repeated at very short time interval(3.3msec)which produces apparatus continuous regulator output characteristics.

The calculation is carried out in the binary system; therefore the analog measured values of generator voltage and current as well as field current must be transformed in an analog/digital converter into binary signals.The reference values and unity are already present in a digital(binary)form.

The digital automatic voltage regulator (DAVR) performs several control functions.The most important are:

- Regulation of generator voltage.
- Limitation of rotor current.
- Limitation of the rotor angle.
- Limitation of stator current.
- Stabilization of power oscillations.

IA1AA MODULE

The IA1A is a signal conditioning module which serves for conditioning external measuring signals in DAVR module, i.e electrical isolation and matching to the electronics level of the DVR, this includes

- Generator voltage
- Generator current
- Synchronization voltage for control unit
- Field current
- Noise suppression

GB1AA MODULE

The GB1AA also called as INTERRUPT PULSE GENERATOR and it fulfills three tasks at the periphery of DAVR system.

- Generator of pulses for program sequences(interrupts).
- Filtering, adaption and rectification of analog measuring signals from the signal condition IA1A with the analog reference values.
- Monitoring of
- Generator frequency
- Program sequence
- Interrupt pulse continuity(self-test)

It also performs following functions

- Generator Voltage
- Generator current
- Program Execution Control

IA2AA MODULE

The three phase filter module IA2A is designed to filter out any high frequency noise in three phase 50H z signals using active filter circuit. These high frequency noise/ripples are caused due to inductive load on the generator that is sufficiently high in magnitude.The filter circuits are tuned using potentiometer for zero phase angle delay.

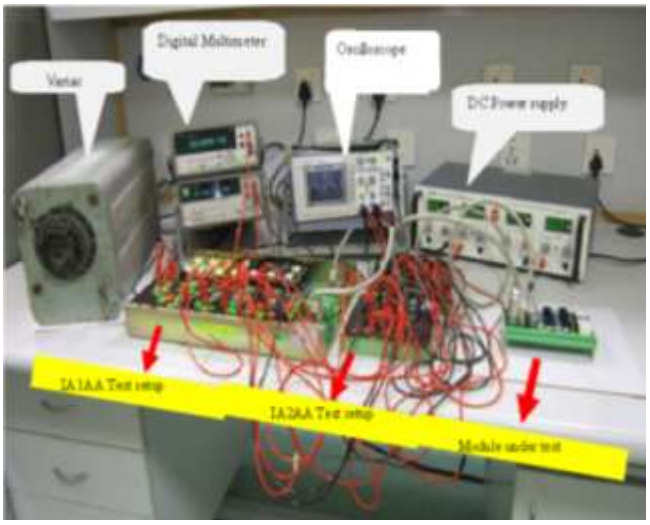
Electrical specifications

Input signal range	:	5Vrms	to
25Vrms,sine,50Hz or 60Hz			
Input connector pins			
R phase	:	CN1.1	
Y phase	:	CN1.2	
B phase	:	CN1.3	
Output signal range	:	5Vrms	to
25Vrms,sine,50Hz or 60Hz			
Output connector pins			
R phase	:	CN2.1,CN3.1	
Y phase	:	CN2.2,CN3.2	
B phase	:	CN2.3,CN3.3	
Power supply	:	24Vdc +/- 15%	
Power supply pins	:	J2.1(+24V), J2.2(0V)	
Mounting style	:	DIN Rail	
PCB size	:	162mm*72mm*1.6mm	
Module size(Max)	:	167mm*89.6mm*39mm	

Existing test setup of testing IA2AA

Filter module

To test the **69203IA2AA filter module,** an existing test setup is being used, which is shown in the image given below. It uses oscilloscope as the reference to adjust the phase delay and it is not accurate also.

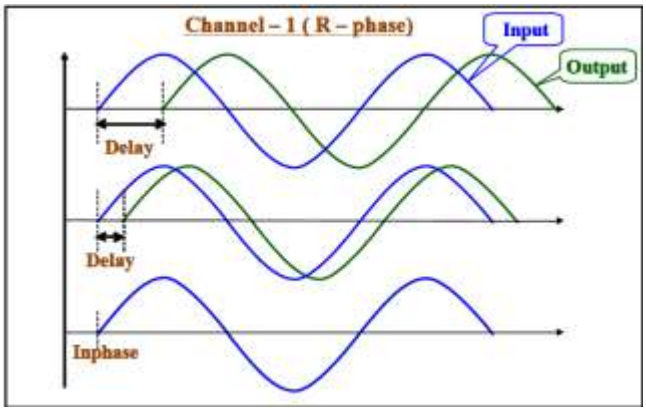


Existing Test Setup

Existing test setup problems:

The testing of the 69203IA2AA module has the following difficulties:

- It requires number of components, i.e. Variac, Digital Multimeters, Oscilloscopes, DC power supply, 38 cables, 69203IA1AA test setup, 69203IA2AA test setup,... And hence this makes the complete test setup very complex.
- It requires more time to make test setup.Hanging wires may cause loose connections.
- More connections confuses the operator. Mobility of three phase Variac is difficult (because of its heavy weight).
- Due to manual made connections & repeated tuning, the operator gets fatigue. If he does any wrong connection the modules gets damage & goes to rework.
- Repeated rework decreases the module quality and also reliability
- Adjusting the delay between 2-phase angles by using oscilloscope is inaccurate & difficult.
- Additionally it also requires IA1A module and its test facility which will add up to the difficulties of testing IA2A.



Phase delay b/w input and output of the filter module 69203IA2AA

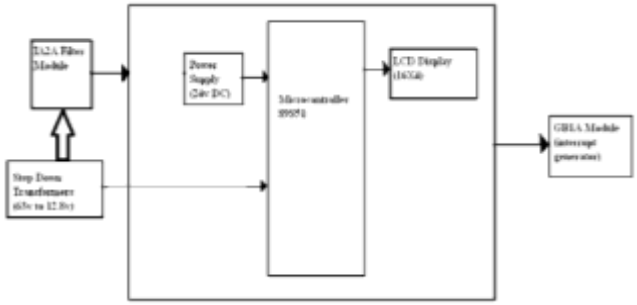
Block diagram and working principle:

Microcontroller 89S51

The main function the microcontroller 89S51 is to detect the gain and phase delay between the input and the output signal one channel at a time, by keeping the frequency at 50Hz. The microcontroller will be continuously testing the signals from the IA2A filter module by keeping the signals from the step down transformer as the reference signal; hence corrections are made and fed as the input signal to the GB1A module (interrupt generator).

Step-down Transformer (12.8 VAC)

The step down transformer performs the task of stepping down the 63V input AC to 12.8V AC which acts as input to the microcontroller as well as IA2A Filter module. We are using 3 single phase transformers as we need 3 phase signals i.e., R phase, Y phase and B phase.



Power supply (24V DC)

The power supply unit is designed to provide the 24V regulated voltage to the microcontroller and the other circuits. The power supply IC LT1107 is a DC/DC converter.

LCD Display

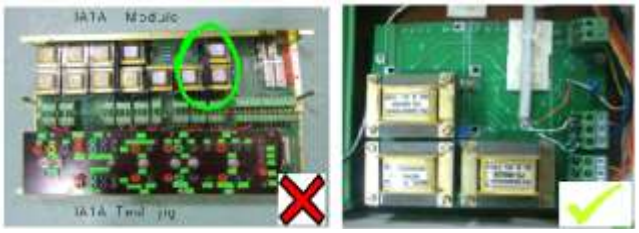
The display unit is used to display the frequency and the phase delay which is set using the potentiometers present in the IA2A Filter module.

To Reduce the Backlogs of IA2AA Filter Module:

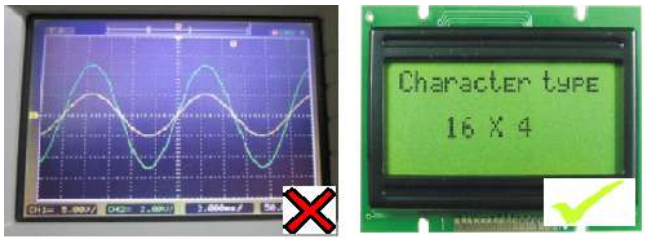
As this module are very critical acts like a buffer between 2 different modules.This module requires elaborate test set up. Because of precise adjustment and non-availability of dedicated test facility, it consumes more time.And these backlogs are overcome by using "The IA2A Test Jig", using *micro-controller chip 89S51 and LCD display unit.*Steps involved in eliminating the problems/difficulties are as follows

Step - 1: 1st Alternate solution for Test Setup is to"*Use 3 phase voltage source instead of Variac*", because adjustment of 3-phase Ac voltage become easy & stable. Manual voltage adjustments eliminated.

Step - 2: 2nd Alternate solution for Test Setup is to "*Use 3 numbers of single phase transformers instead of a whole IA1A setup"*.The IA1A module along with its test setup is required to simulate the input conditions to test IA2A module. By analysing it isfound that, in IA1A module only 3nos. of transformers are active. The whole test setup & entire IA1A module is idle. Thus only three transformers are used.

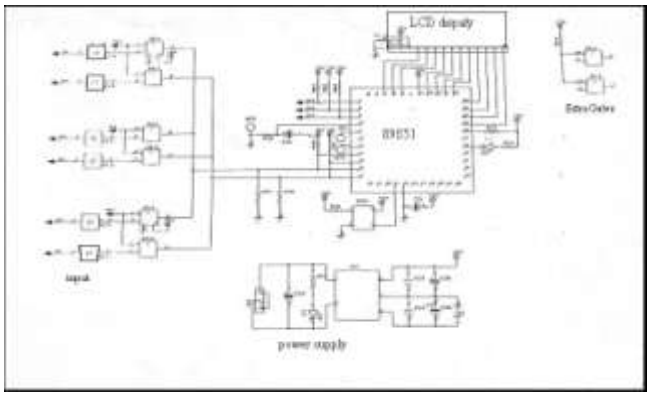


Step - 3: Use Digital display for delay measurement instead of oscilloscope, because digital values are accurate and can be easily calculated.

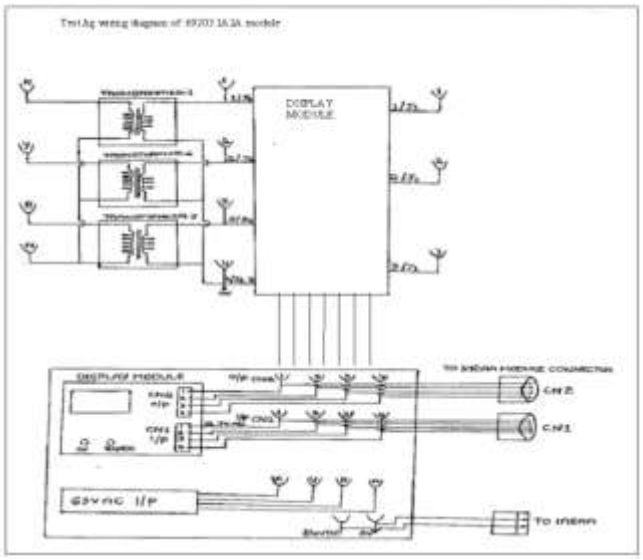


Circuit design & implementation:

Circuit diagram was prepared by keeping in mind the functional testing of IA2AA module.



Hence this setup is further improved by placing both the units(Assemble transformers unit and Digital phase angle measuring unit) on a single wooden enclosure.Now the above units are inter-connectedwith the help of circuit diagram given below.



Now the test jig is fabricated in a wooden enclosure.

Testing & Verification:

Module 69203IA2AA Functional Test Procedure: The module testing is done for Zero Phase shifting Unity Gain between the I/P and O/P.

Clause 1: (Phase Adjustment)

1) Connect 24 VDC supply at J2 (+24 at Pin 1 i.e. leftmost, Ground at Pin 2 i.e. centre) of IA2AA module **[connected through a cable from the JIG**] and TB1 (similar to J2 of IA2AA) of Test Jig [inbuilt in the JIG supply given by connecting 24 VDC to the Jig socket]
2) Check DC voltage (Vcc) at Pin 7 of U1 and (Vee) at Pin 4 of U1 to be within ± 30 VDC ± 10% record the observed reading.
3) Connect the X280 25-Pin DSUB Connector of IA1AA Module to CN1 of IA2AA and apply 3-Phase 63 Volts AC w.r.t Neutral to IA1AA Module.[IA1AA Module connected inside the Jig, AC supply given to the Jig]
4) Connect 3-phase input and output from CN1 and CN2/CN2 (Pin 1,2,3,and 4) of IA2A module to J1 and J2 (Pin 1,2,3 and 4) of Test Jig (connection done internally in the Jig)
5) Adjust P1, P3 & P5 (Phase setting pots) to get less than 0.1° Phase between Input and Output in all the 3-channels. Observe and record the respective readings. [on the digital display of the Jig].

Clause 2: (Gain Adjustment)

1) Adjust P2, P4 & P6 (Gain setting Pots) to get Voltage at Pin 1-3 of CN2 equal to CN1 Pin 1-3 = 12.8 VAC (± 50mV) of IA2AA module, (Pin 4 connected to Ground) and record the respective readings.

Clause 3: (Continuity Testing)

Check continuity between CN2 and CN3 of 3-phase filter module IA2A

Results & Observation:

Table chart of each process testing time before & after

Task	Activity	Time spent	
		Before	After
A	Test setup	80 minutes	05 minutes
B	Simulation	10 minutes	Nil
C	Unity setting	10 minutes	10 minutes
D	Delay setting in oscilloscope	75 minutes	10 minutes
E	Continuity check	05 minutes	05 minutes
F	Test report	05 minutes	05 minutes
	Total	**185 minutes**	**35 minutes**

List of activities carried out to complete the project:

SL. NO.	List of Activities	Duration
1	Project Selection	4 Days
2	Synopsis Preparation & Approval	2 Days
3	Block Diagram	2 Days
4	Logic Development	3 Days
5	Selection of components	3 Days
6	Development of Jig	2 Days
7	Interfacing Microcontroller I/P & O/P	3 Days
8	Microcontroller Programming	3 Days
9	Interfacing LCD	1 Days
10	Assembly of Test Jig	2 Days
11	Testing of Test Jig	2 Days
12	Feedback of Project Guide & Draft Report Approval	3 Days
13	Documentation & Binding	4 Days
14	Project Submission	2 Days

CONCLUSION

This system is compact in size, it provides high rate of safety and security to the user. Using this Test set up it become possible on time delivery of tested 69203IA2A Module with more precise parameters. It is widely and most importantly useful in power generating stations. It provides initial test facility for the Module 69203IA2A before implementing it in the actual working environment. This test equipment avoids malfunctioning of the user electrical equipment.

With the available facilities, infrastructure and guidance provided, the project was completed successfully. The project was demonstrated to concerned authorities.

Scope of future study:

Given more time the project can be enhanced with additional features. Module 69203IA2A can be embedded in Module 69203IA1A of DAVR Control system. This will make system more compact & further it will reduce the cycle time of manufacturing & testing, than individual module.

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3. Training manual on static excitation systems BHEL-EDN.

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