Static Excitation System Control for Power Alternator using PLC

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Abstract— This project proposes a control method for a static excitation system to regulate the terminal voltage of the machine and meets the excitation power requirements under all normal operating conditions. The main parts of Static excitation system are AVR, limiters, power system stabilizers, field breakers, field suppressors, thyristors, auto channel and manual Channel. The major faults in Static excitation system are classified as Trip Fault, Non-Trip fault and Protection change over faults. In any excitation system several logic systems are employed to control various operations like field breaker closing, tripping, pumpless transfer to standby channel when active channel has failed and alarming stages. In the existing system the detection of faults needs a greater number of electromagnetic relays and timers which is a tedious process to control. So, the project aims to replace 35 to 40 electromagnetic relays and timers by a single PLC unit thereby increasing the system reliability.

Keywords: Programmable Logic Controller, Current Limiters, Load Angle Limiter

I. INTRODUCTION

Electromagnetic induction is the basic principle in which the synchronous generators works. Static excitation system is preferred for conventional plants which plays a vital role in modern interconnected power system operation due to its fast acting, good response in voltage and reactive power control and satisfactory steady state stability condition. In this system the AC power is tapped off and fed to the generator field thereby controlling the generator voltage. The generator terminal voltage is stepped down and rectified by fully controlled thyristor bridges. The AVR is used to control the firing angle of the thyristor bridge.

A. AVR Parameters:

- The adjustment of voltage level in all operating modes of generator is +/-10%
- The operating frequency range will be 48.5 to 51.5 hertz
- Accuracy of generator terminal voltage: +/-0.5%
- The drop compensation of transformer in percentage level: 0 to 15%
- Response time: less than 50 ms.

S.NO	PARTICULARS	50 MW	100 MW
1	Max continuous KVA rating	62500 KVA	117500KVA
2	MAX continuous KW	50000KVW	100000KW
3	Related terminal voltage	10500 V	10500 V
4	Related stator current	3400 -3500 A	6450-6490 A
5	Power Factor	0.8	0.85
6	Rated speed	3000 rpm	3000 rpm
7	Rated frequency	50 Hz	50 Hz

Table 1.1:

II. DESIGN FEATURES

A. Auto Channel:

The actual value of voltage through CT and PT is fed into the UCB. AVR compares both the values and gives the desire output. When the auto channel is in operating conditions, then the manual pulses are in blocked condition.

B. Manual Channel:

It follows the auto channel pulses. If auto channel fails, then manual channel will be operated. It operates under open loop control and to reduce pumpless transfer.

C. Trip Fault:

When the system operates in auto channel and if it fails then the system changes into manual channel and if the manual also fails during its service then it is indicated as trip fault.

If the current and voltage value increases beyond the limit. It also results in tripping the system. Here, in this system two bridges are operated in parallel condition. If both the bridges are failed then it also results in trip fault.

D. Non-Trip Fault:

In non-trip fault conditions, if any fault occurs then the whole system will not be tripped but the fault will be indicated.

E. Automatic Voltage Regulator:

It regulates the terminal voltage. The output voltage of the generator is controlled by controlling the firing angle of the thyristors.

F. Follow Up Control:

It is used to follow the auto pulses so that if any fault occurs the shift from auto channel to manual can be done effortlessly.

G. SCR Bridge:

Two SCR bridges are used. If anyone parallel bridge is fails, then another bridge will meet out the nominal excitation without increasing beyond the limit.

H. Protection Change over Fault:

If auto channel fails in service it changes into manual channel. It is indicated as changeover fault.

I. Pulse Amplifier:

It amplifies the auto/manual channel pulse.

III. BLOCK DIAGRAM

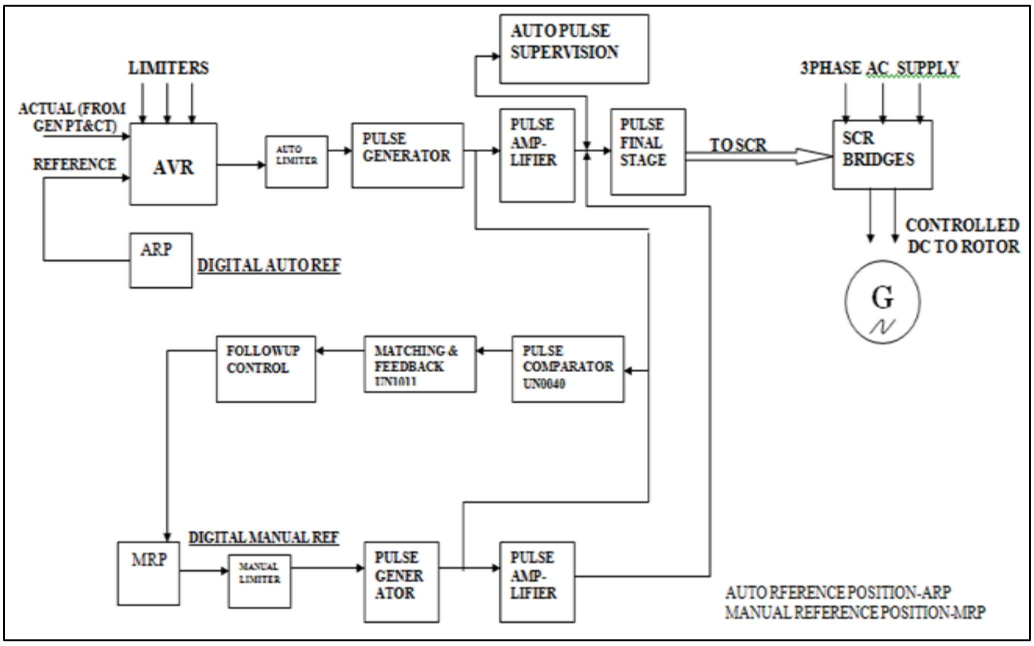

Fig. 1.2:

IV. PLC CONTROL FOR VARIOUS PARAMETERS

PLC is a solid-state device that can be programmed sequentially. The OMRON PLC is loaded with program in the form of ladder diagram using Zen software tool. The ladder diagram operates with the logic. PLC used in this project has 12 inputs (I0, I1, I2, I3, I4, I5, I6, I7, I8, I9, Ia, Ib) and 8 outputs (Q0, Q1, Q2, Q3, Q4, Q5, Q6, Q7).

A. 12 Inputs:

I0 – Trip Coil Healthy
I1 – 3.3kv Supply on
I2 – Class A problem Trip fault
I3 – P/C to manual channel
I4 – Trip Fault Acted
I5 – Non-Trip Fault Acted
I6 –Test/Service Switch
I7 – Local/Remote Switch
I8 – Fault in follow up
I9 – Manual Channel supply fail
Ia – Accept button
Ib – Reset button

B. 8 Outputs:

Q0 – Field Breaker On/Off
Q1 – Auto Channel On
Q2 – Manual Channel On
Q3 – Protection C/O to Manual Channel
Q4 – Trip fault Acted
Q5 – Non-Trip Fault Acted
Q6 – To operate Class A master relay
Q7 – Latch circuit

C. Algorithm for PLC:

Initially the system will be in Manual Channel

1) Step 1: I0 is used for checking whether the trip coil is healthy or not.
2) Step 2: I1 is used for checking whether the 3.3kv bus voltage is available or not.
3) Step 3: If both conditions are satisfied field breaker can be switched on using B1 button (Q0 HIGH).
4) Step 4: Since Auto reference and manual reference voltage will be minimum and it can be raised using B5 and B6 buttons.
5) Step 5: By pressing B6 we can switch over to auto channel (Q1 HIGH).
6) Step 6: When I2 contact closes class A protection is acted, field breaker goes to off (Q0 LOW) position and it got changed over to Manual Channel.

Follow the steps 3,4 &5.

V. LADDER LOGIC DIAGRAM

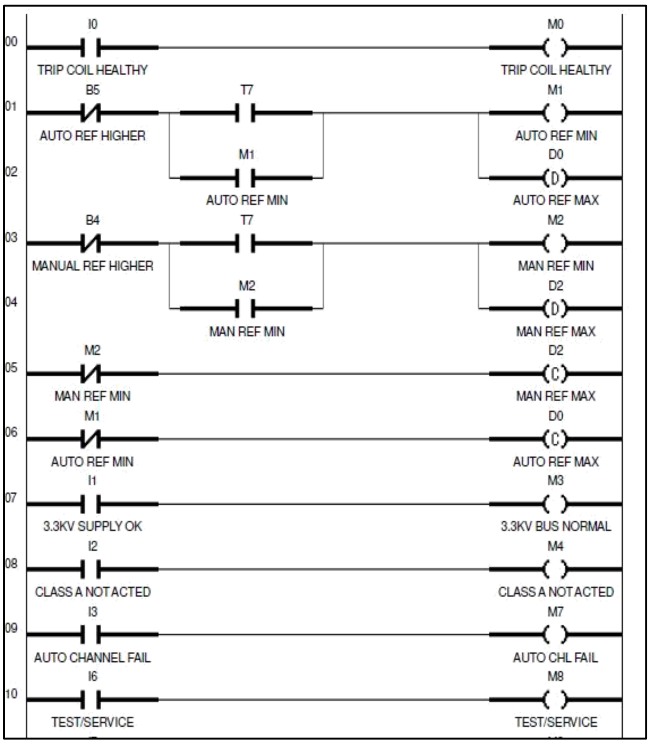

Fig. 1.3: Ladder logic diagram

VI. Conclusion

In this project, the Static Excitation system is performed by using PLC. We have achieved our objective that is to replace the several electromagnetic relay and timer. The fault detection can be very easily, quick response, high reliability, wiring problem can be reduced. PLC has to control the various alternator parameters of the machine. The logic diagram made in this project is mainly used for developing programs and used in industrial application.

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