Three Ways Redundant System for Boiler Plant Automation

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Abstract—**As we know the boiler is very important part in industry and it require continuous inspection without any failure. Currently this inspection and monitoring is done with single controller and human workers. There are number of system failure chances due to single controller system if it's fail. There are number of possibilities of errors with human workers while measuring particular values in boiler operation process. So a reliable monitoring and redundant system is required to avoid these errors and system failures. This paper gives design and development of three ways redundant systems used for boiler plant automation. This system can be implemented in hazardous area and monitoring from control room by using secure wired current communication protocol. This system consists of water level, steam and temperature sensors. In case of one system fail it will automatically takeover by another system and different alarms shown on the system as well as control room.**

Keywords- Boiler, Redundant system, Wired communication.

I. INTRODUCTION

This boiling section produces the high temperature of water and steam. This steam level temperature is used for power generation and the steam waters are applied to the turbine section of the power plant. After the power is generated, steam waters are supplied to various plants for reuses. If the supply of the high temperature is reduced to low temperature, it will be used for all other plants which needs the low temperature. There are possibilities of errors at measuring by human at various stages involved with human. In order to automate a power plant and minimize human intervention, there is a need to develop an embedded system that helps to reduce the errors caused by humans. Embedded system based boiler automation system consist of three different control section along with wired communication protocol is used, and different sensors which is capable of monitoring the entire boiler water level, temperature and pressure. The obtained temperature and pressure measured data are transferred through the two independent microcontroller and hardware logic. The microcontroller read the available data and processed. RLG is an electronic level measuring unit specifically designed for measuring water level inside vessels characterized by high pressures and temperatures. Sensors are made of two metallic parts which are insulated by ceramic part. The electronic unit measures the conductibility of the fluid around the metallic part and the discrimination of water or steam is based on their different conductibility values. Each sensor is connected to the control unit via a pair of conductors to guarantee operating continuity and to signal anomalies.

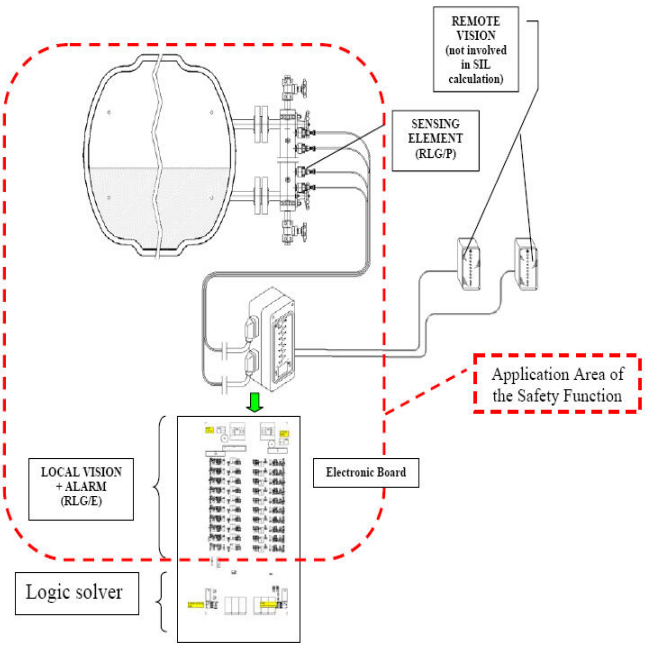

Figure 1: System overview

The figure shows the System overview which is consist of two independent group ODD channels (Group-A) and EVEN channels (Group-B), each group has its own power supply source and feeding cable. It can continue to operate even if there is a failure in the other group. Both groups (even and odd) are not perfectly aligned, due to the gap between sensors, but as the gap is suitable for required resolution commonly needed, each sensor could be considered as having redundancy equal to 1, with reduced resolution. Inside RLG-E (electronic control unit) there are two completely independent sections: Many simple systems are not equipped with DCS control, but nevertheless, they require reliable and easy to manage measurements; specifically for simple boilers. This allows to pre-set the correct configuration (water or steam in the right points) and to obtain a single signaling of the alarms when something unusual is detected; this would typically cause the boiler to shut-off. The use of two independent processing

sections also guarantees very high reliability. At the receiver side one embedded system monitor this all operation called as remote display unit.

II. NEED OF BOILER PLANT AUTOMATION

Boiler is an important part in any power plant. Which require continuous monitoring and inspection at some time interval? In Power plants it has number of boiling section are include. This boiling section produces the hot water of the steam. Boiler water and steam temperature in thermal power plant is very complex to monitor and hard to control, due to poorly understand the working principles; Boilers have many serious injuries and destruction of property. It is critical for the safe operation of the boiler and the steam turbine. Too low a level overheats boiler tubes and damages them. High a level may interfere with separate moisture from steam and transfers moisture into the turbine, which reduces the boiler efficiency. Different controlling mechanism is used to control the boiler system so that it works neatly, many control strategies have been applied to it. In order to automate a power plant and minimize human interface and error, there is a need to develop a Boiler Automation system. It is achieved by using Micro-Controller an Embedded system that helps to reduce the errors caused by humans and avoids the catastrophic failure.

III. SYSTEM ARCHITECTURE

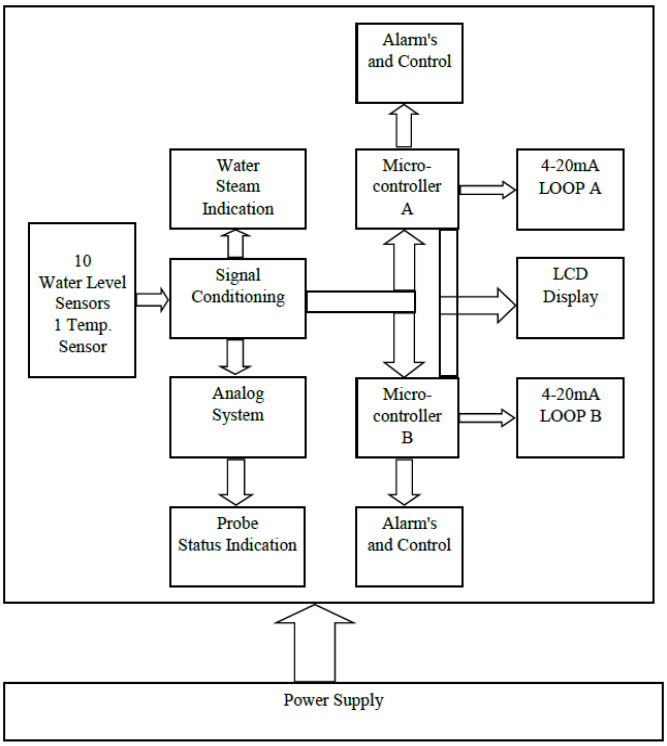

Figure2: Block diagram of RLG Control unit

Processing section has 2 microprocessors that work independently. One microprocessor is associated with Group A sensors (odd) and the other with Group B (even). Nevertheless both micro-controllers read signals from all sensors (odd and even), thus taking full advantage of the complete measuring resolution. Each microprocessor has its own independent alarm outputs and 4-20 mA current loops signal. By means of dip switches is possible to set level alarms for each A/B group. Accurate design has isolated the microprocessors from the measuring circuits: no failure of one of the CPUs can invalidate the main measurement, which remains perfectly valid even if the digital section is out of service. At same way microprocessor A can work even if B one is out of service and vice versa.

1) Verifies congruity of the measuring signals and detects anomalous situations showing the status on the display.
2) Drives of a 4-20 mA analogue output (A/B current loop) proportional to water level for interfacing with remote indicators or DCS.
3) Controls level alarms driving its own fail safe SPDT relays, one for High level (High) and one for Low level (Low) - High and Low Level position can be configured using Dip Switches on RLG-E board.
4) Controls system alarm driving its own fail-safe SPDT relay (Alarm) Alarm is set, after about 30 sec of delay to avoid false signaling, when Level limits has been overcome by at list 2 or more probes.

On the graphical display the operating status of the probes, the level and a clear description of the anomalies are shown.

WATER: Normally Water ->Alarm condition if Steam
DON'T CARE: No alarm for this channel
STEAM: Normally Steam -> Alarm condition if Water

By means of dip switches is possible to set level alarms for each A/B group. Accurate design has isolated the microprocessors from the measuring circuits: no failure of one of the CPUs can invalidate the main measurement, which remains perfectly valid even if the digital section is out of service. At same way microprocessor A can work even if B one is out of service and vice versa. For each channel, simply move the selector on the condition considered ordinary. If measured situation is different from the configured situation, control unit will activate an alarm. In most cases, the four lowest sensors of the column will be configured as "WATER" and the four highest as "STEAM"; those in between, where the level can vary during operation without danger. RLG-E comes with two internal microprocessors that read the status of the analog measuring circuits. Each microprocessor section read independently the status of all the channels to check the correctness of the operating conditions. Each microprocessor pilots its own alarm relays. Relays are energized when in normal conditions, DE energized when in alarm status. There are 4 Leds on each section for signaling the status of the system:

- OK - Green Led - Section Status
- HIGH - Yellow Led - High Level Alarm
- LOW - Yellow Led - Low Level Alarm

- Alarm – Red Led- General Alarm

OK Green led is ON when the section is working properly each microcontroller controls level alarms driving its own fail safe SPDT relays and turning ON corresponding Leeds. If Water level goes lower than minimum, LOW level alarm is activated. If Water overcomes an expected Steam position, HIGH level alarm is activated. General Alarm is set when Level limits has been overcome by at list 2 or more probes. When power is lost on one group (odd A or even B) both LOW and HIGH alarms of this group are activated together and control of the level passes to other group that continues reading its sensors (odd or even) High and Low Level alarm position can be configured using Dip Switches on RLG-E board with three positions for each channel. RLG-E comes with two 4-20 mA independent analogue outputs and therefore redundant. The signal is proportional to WATER level (GREEN led) indicated by probes, with this significance:

- 3.5 mA: situation of alarms/anomalies
- 4 mA: scale start: all the sensors in steam
- 20 mA: scale end: all the sensors in water

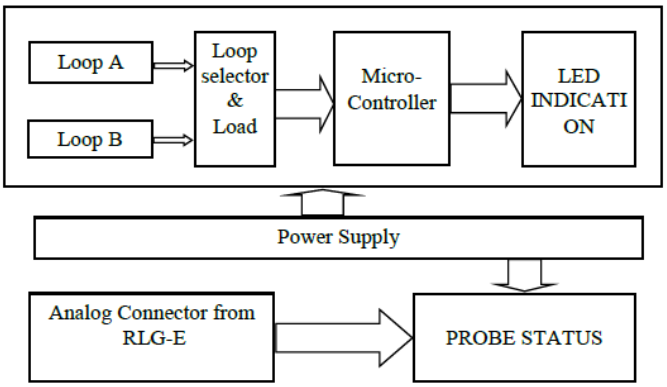

Figure2: Block diagram of RLG Display unit

These 2 outputs have been designed to be connected to any type of 4-20 mA measuring device. In particular analogue signal can be sent to BONETTI RLG-D Remote Display digital gauge. Signal terminals are on the MAIN board and on LOOP-ALARM-POWER external Phoenix connector or internal PCB terminal Loop A and Loop B Connections are physically in parallel which means they can only be used one at a time. The output is of the "current-source" type and is self-powered, which means can be directly connected to a normal passive load. For example, connect a 250 ohm resistor to obtain a signal of 1-5 volt. RLG-D Unit displays water level, the status of all the sensors and alarms and is useful to report system status in a location that is more comfortable for the operator. One or two remote display units can be connected as optional accessory. Depending on configuration RLG-E to RLG-D connection occurs via 2 plug-in connectors located on the right side of RLG-E unit or 2 terminals blocks inside RLG-E enclosure and 2 plug-in connectors on the back of RLG-D display unit.

IV. RESULT

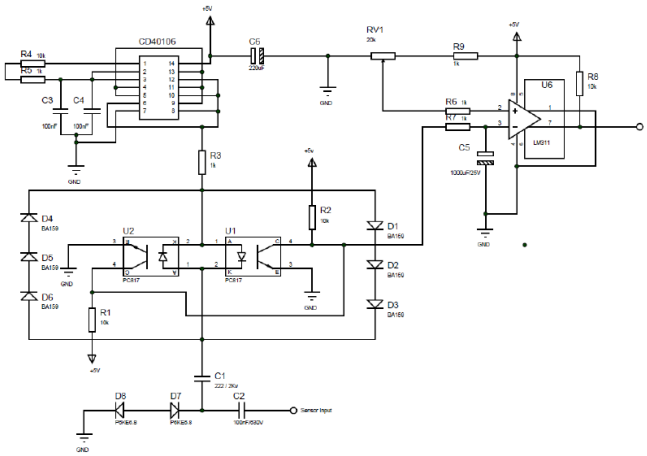

Table 5.1 Sensor Working

Sensor Input	Output Voltage	Water Condition
Ground	5V	Water Present
Open	0V	Water absent

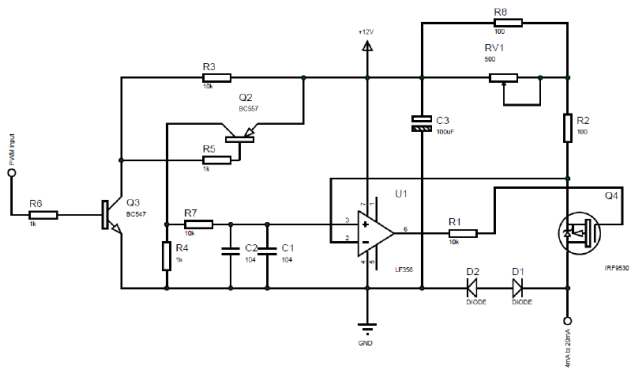

Table 5.2 Current Communication

Sr. No	PWM count	Min load	Max Load	Current
1	65	0 Ω	250Ω	20mA
2	219	0 Ω	250 Ω	4mA

V. CONCLUSION

The use of two independent processing sections also guarantees very high reliability. This allows pre-setting the correct configuration water or steam in the right points and to obtain a single signaling of the alarms when something unusual is detected; this would typically cause the boiler to shut-off.

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