Methods to ensure Availability and Operational Flexibility of Performance Monitoring and Control System of ESP

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Abstract

Stringent emission norms for thermal power plants have resulted in need for better ESP performance which can be ensured only with well maintained ESP internals and a good control and monitoring system. ESP performance is affected by various boiler parameters and properties of the coal being used. For field wise control of the high voltage energisation and optimization, microprocessor based controllers are deployed. Similar controls are available separately or in-built with the field controller for rapping functions. For control and monitoring of the entire ESP parameters from a single point, PC based integrated control systems are used. The availability of such PC based systems becomes critical for the effective monitoring and maintenance of the ESP. Requirement is also felt for multiple PC based systems in different locations so as to be able to control and monitor the ESP parameters from multiple locations usually from ESP control room and boiler control room both, to ensure operational flexibility. Availability of the rapping system is another very critical factor as it is directly linked with the collection efficiency, especially for ash with high resistivity. This paper discusses approaches towards introduction of redundancy to rapping control and to the centralised monitoring and control systems to ensure their availability.

Introduction

In olden days analog controllers where used for ESP charging and dust collection, Later, miocroprocessor based stand-alone controllers where used. As the technology in electronics, software and communication areas improve, they have been adopted in ESP controllers to improve the performance, availability and reliability of operation, Latest technologies like Ethernet communication, OLE for process control (OPC) and Controller Area Network(CAN) have been used for interfacing number of ESP controllers and to provide redundancy and multi-level control and monitoring.

The intelligent control systems for High Voltage Transformer-Rectifier (HVR) control and rapping control in an ESP have played pivotal roles in improving and optimizing the performance of ESP. ESP Field HVR controllers and rapping controllers have been deployed to individually monitor and control the associated functions so as to optimize the power fed to the ESP and its collection performance. For user convenience of a single point control of all field HVRs and rapping system, PC based systems have been used. In addition to remote monitoring and control of ESP data, various functionalities have been added to these systems to maximize the collection performance and optimize the power consumption of ESP. These include software algorithms that optimize the operating parameters, namely set current, intermittent charge ratio of various fields, adjust the rapping frequencies corresponding to field availability, variation of boiler load, etc. Alarm/Error conditions are required to be monitored to address the problem and maintain the healthiness of ESP fields.

As the ESP size grows bigger with the increasing boiler capacity, the number of controllers required for ESP control per boiler increases and hence the centralized monitoring and control system becomes inevitable. More so with the additional features of field wise optimization and in built co-ordination of rapping operation using software algorithms that are available in the PC based centralized monitoring and control system. Hence, the continuous availability of the PC based systems has become unavoidable for ESP operation and maintenance.

Similarly, absence of the rapping control system operation for even a few hours will result in serious loss of ESP efficiency due to build up of dust layer on the electrodes. Hence uninterrupted rapping control system operation is also, a necessity.

In order to ensure availability, one or more redundant systems shall be used. This paper discusses approaches to introduction of redundancy at the rapping control system level and the centralized monitoring and control system level.

The rapping control system discussed here is modeled in such a way that if at least one out of three components is available, rapping operation continues uninterrupted.

Redundancy at the PC based centralized monitoring system is introduced in such a way that it can be used to monitor and control the ESP parameters simultaneously from different points like say, the ESP control room and the boiler control room.

One method of such redundant system being discussed here consists of an Ethernet network to which multiple control and monitoring units are connected, one node on this network being a serial device server component. The serial device server component is an embedded hardware which is in addition, part of a second serial communication network to which the ESP controllers for high voltage energisation and rapping functions are connected.

A second method which is based on a multi-master communication network namely Controller Area Network (CAN)communication, to meet the requirements of redundancy of the ESP control and monitoring system is also being discussed.

Background

The ESP control systems perform functions that include field wise control of the high voltage energisation and optimization of collection performance and power consumption of the ESP field, rapping motor control either separately implemented or in-built with the high voltage energisation controls, monitoring of other sensors that indicate the hopper ash level, heaters, the opacity meter inputs and the boiler load. There are independent field wise and sometimes pass wise embedded stand alone controllers to perform these functionalities. These controllers are housed in panels that are located in the ESP control room. With increase in ESP size number of standalone controllers increases and it becomes cumbersome for the user to set / monitor parameters from individual panels. Hence a single point operation for monitoring/control of the ESP controllers is required.

There is an integrated control system which may be a PC based system which is connected to all these independent controllers for centralised monitoring and control. As it has the recent status of all the electrical parameters of the ESP and is able to send control commands to all individual controllers, certain algorithms that combine the control features of multiple controllers can be implemented in this centralized control system, with the objectives of improving the collection performance and optimizing the power consumption like pass-wise optimization and adjusting the rapping frequencies with respect to the boiler load factor.

To maintain ESP efficiencies consistently, periodic dislodging of the collected ash from the ESP electrodes through uninterrupted rapping operation is extremely critical.

As the performance standards of the ESP are required to be more and more consistent over long periods of time, continuous monitoring of the field parameters like the Average, Peak and Valley KV, Spark rate, various Alarms etc, that determine the healthiness of the ESP fields becomes imperative.

Availability of the components which support these control and monitoring functions is hence a very important factor to consider in the design and deployment of the ESP control system.

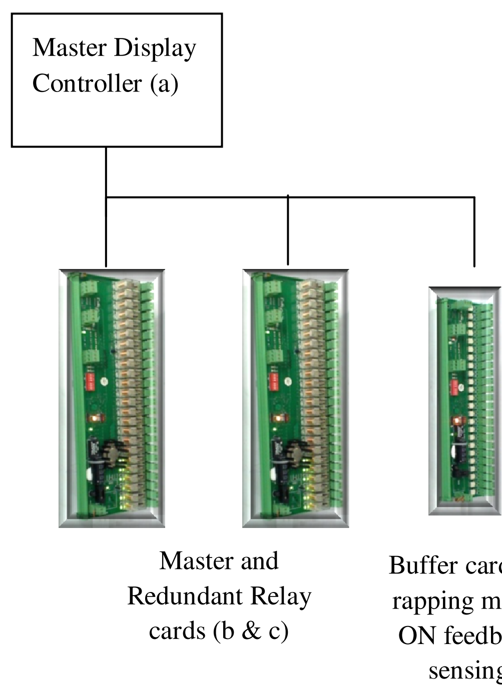
Rapping System with two Levels of Redundancy

The rapping system implementation being discussed here consists of a master display controller that communicates over an RS485 bus with two relay cards, one master relay card and one redundant relay card for motor actuation. The master display controller (a) would display the motor status locally in addition to sending it to the PC based central control and monitoring system. It would accept user commands through local keypad and through communication.

Both the relay cards (b & c) being used in this implementation of the rapping control system are identical, with built in intelligence to assign the master status to one of them through self-arbitration over the redundant communication channel that links them.

The standard and custom timing tables for motor on off and rapper motor control logic are available in all the three components, i.e., master display controller and both master and redundant relay cards. When all three are available the motor on off commands are sent from the master display controller and the master relay card executes them. The rapping motor ON feedback is monitored by the master display controller through a buffer card and alarms set in case the feedback is missing. Thus, any lapse in the rapping motor availability of each ESP field is brought to the operator's notice.

If the master relay card fails, the redundant relay card immediately identifies its absence and assumes the master status and starts executing the motor on off commands from the master display controller within less than a second thus continuing the rapping operation seamlessly.



In a case where the master display controller's functionality is merged to the field controller for the purpose of integrated rapping control, even if there is a field controller panel failure, on sensing the controller failure, the rapping for the field is continued by the relay card and this maintains the field internals clean irrespective of panel failure.

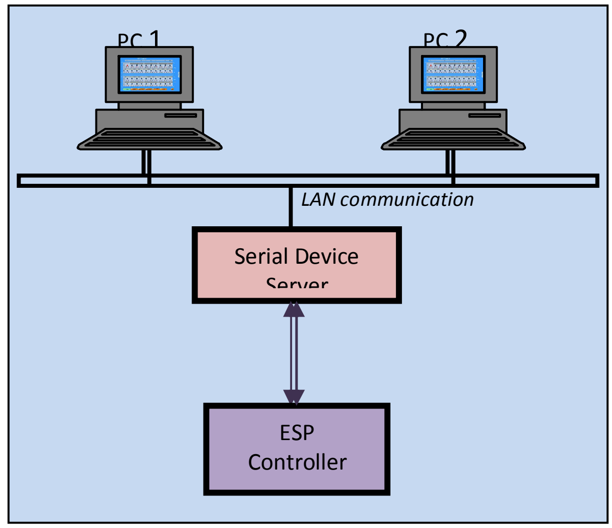
Methods of ensuring availability and operational flexibility for the central control system

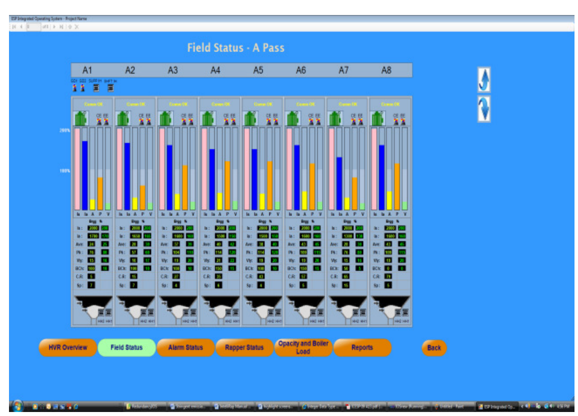
Two approaches will be discussed, Implementation A and Implementation B to establish redundancy and flexibility of data monitoring and control.

Implementation A

There are two networks, one of ESP controllers in a master-slave network with single master and multiple slaves and the second the PC based client MMI systems in a multi-master network with server-client configuration to facilitate redundant and simultaneous operation from multiple locations. A serial device server component is used as the master in the master slave network to link these two networks to manage the cyclic and event driven communication for status monitoring and control commands from the user respectively.

The server is capable of collecting the data associated with the current status of all ESP fields in its memory buffer and pushes the status information to all its clients in a periodic manner. The server is connected to a number of clients with application programs to display the data for user monitoring as well as to enable user to give control commands to the ESP controllers.





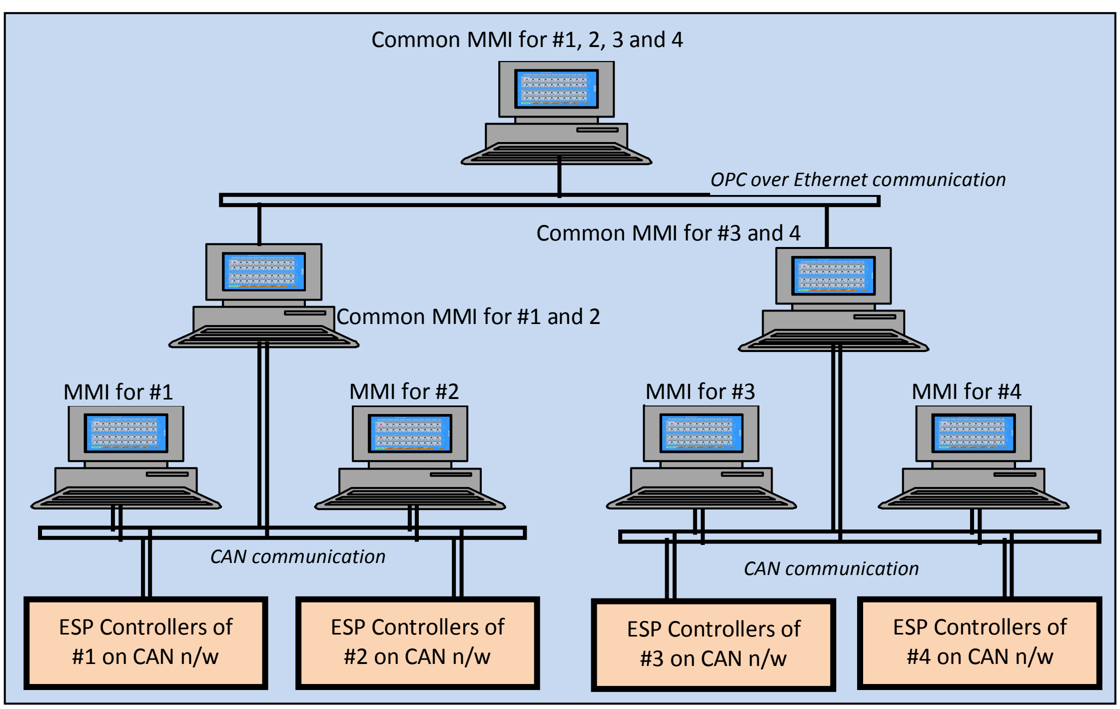
Two or more clients can be connected in hot-standby mode so that the centralized control and monitoring functionality will be continuously available even on failure of one MMI system. They can be placed at far away locations, connected through fiber optics to the server, so that having identical systems at two distant locations does not pose a problem.

Implementation B

Here, the ESP controller communication is implemented through multi-master CAN (Controller Area Network) based network to which the central control system MMI is connected. Generally, for a power plant with multiple boiler units, the ESP corresponding to each boiler is monitored by independent MMI systems.

In a typical implementation of a common monitoring system for a power plant consisting of 4 boiler units, a common hot-standby system is provided together for Units 1 and 2. This common MMI system monitors the controllers of both units i.e., Units 1 and 2. A similar common MMI system is provided for Units 3 and 4.

For providing the flexibility to monitor and control all four individual units from one single point, the Common MMI systems as discussed above host OPC servers. These servers are connected over Ethernet to a Common MMI (This common MMI acts as the OPC client) which is the common point of monitoring & control for Units 1, 2, 3 and 4.



Critical parameters like spark rate, warning and trip alarms like the Low Voltage Level, Ash Level High, Transformer Temperature high, Buchholtz bottom float etc. are monitored by the operating personnel to assess the healthiness and operability of the fields.

By facilitating uninterrupted access to such data monitoring and control, these systems in turn facilitate continuous availability of ESP fields for pollution control.

Conclusions

Ensuring the uninterrupted availability of rapping control system goes a long way in maintaining ESP performance levels high. Availability of the centralized control and monitoring system continuously and at multiple locations such as the ESP control room and the boiler control room also is becoming a highly critical factor for the effective monitoring of the various operating parameters like the current and voltage levels, spark rate, Alarms, etc. The implementations mentioned in the paper have been developed and deployed keeping these needs in mind and are of important practical significance in the area of control and monitoring of ESP.

References

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