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Enhancing Power System Reliability Using a Watchdog-Based SMPS Monitoring Framework in MAXDNA DCS

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Abstract: In thermal power plant instrumentation systems, uninterrupted 24 V DC supply is critical for the reliable operation of control modules, field instruments, communication interfaces, and safety interlocks. However, most installations rely on multiple SMPS (Switched Mode Power Supply) units housed across several field panels, where online health monitoring is limited. Undetected SMPS failures may lead to card malfunction, instrument dropout, or complete panel failure. This paper presents a low-cost, effective, and scalable method of introducing real-time SMPS health monitoring by integrating potential-free fault contacts as digital inputs into the MAXDNA DCS system. A dedicated logic scheme and alarm philosophy were developed to generate instantaneous alerts for any single SMPS failure. The system was successfully implemented in a working thermal power plant, resulting in improved equipment protection, reduced troubleshooting time, and enhanced operational availability. The solution contributes significantly to predictive maintenance and serves as a replicable model for similar process industries.

I. INTRODUCTION

Reliable DC power is fundamental to the operational stability of Distributed Control Systems (DCS) and field instrumentation in thermal power plants. Panels containing PLC/DCS cards, transmitters, positioners, and communication gateways typically operate on 24 V DC derived from SMPS units. A conventional challenge faced in many plants is the lack of centralized visibility of individual SMPS health status. When an SMPS fails, redundancy may mask the issue temporarily, causing personnel to remain unaware until the next failure, leading to disruptive consequences ranging from instrument malfunction to complete panel blackouts. The purpose of this work is to design and implement an online monitoring solution whereby every SMPS health contact is integrated into the DCS as a Digital Input (DI). This ensures that any SMPS failure generates an immediate alarm at the operator workstation and in the alarm management system, thereby enabling timely action. The project not only enhances reliability but also aligns with modern digital maintenance practices and proactive asset management strategies. In this project the DCS version is MAXDNA , where the SMPS output is 24Vdc and its segregated as two types mainly known as "System Power Supply"- PSS and "Field Power Supply"-PSF , where in the PSF is meant the supply and power all Field instruments like smart positioners , sensors , transmitters etc. And the PSS is meant to supply all electronic modules , Racks, Controllers etc.

II. PROBLEMS FACED

1) No online SMPS health visibility at the DCS/operator level.
2) Multiple SMPS across several field and control panels, making manual inspection impractical.
3) Redundancy masking failure, resulting in unobserved single SMPS failures.
4) Potential Risk of Card Failures and Field Instruments failure due to power supply

III. METHODOLOGY

The methodology adopted for developing the SMPS real-time monitoring system followed a structured engineering workflow comprising system study, signal acquisition design, SCADA/DCS integration, logic development, testing, and commissioning.

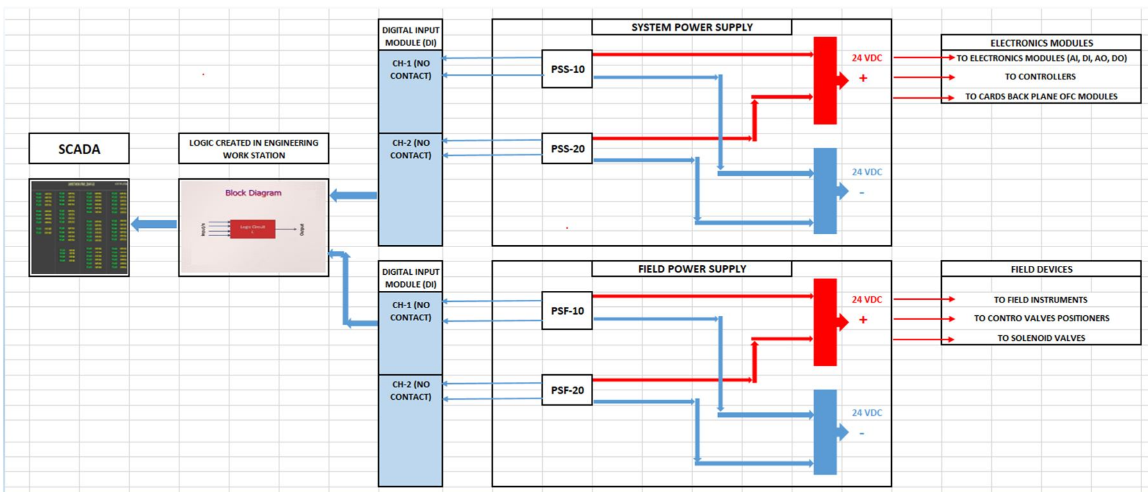
1) System Assessment and Requirement Analysis: A detailed review was conducted across all field and control panels to identify every SMPS supplying 24 V DC power to DCS cards, transmitters, positioners, communication modules, and associated instrumentation. The availability of potential-free (NO/NC) fault contacts on each SMPS was verified and documented. Gaps were identified in the existing monitoring approach, where SMPS faults were undetectable unless manually inspected.

2) Signal Acquisition Design: A wiring scheme was prepared to connect every SMPS fault contact to spare Digital Input (DI) channels of the MAXDNA DCS. Signal conditioning, DI card loading, cable routing, and panel termination drawings were created.Proper isolation and panel-wise tagging were implemented to maintain system integrity and traceability.
3) SCADA Development along with Logic and Alarm Configuration: All SMPS graphics block development done and colour coding done , a back end logic development done and potential free contact (NO) contact taken for identification of faulty SMPS . And same has been configured in Alarm management System for quick identification . The logic ensured that even a *single* SMPS failure in a redundant system generated immediate attention. The graphics improved operator situational awareness and reduced diagnosis time.
4) Testing, Validation and Commissioning:-

Testing was conducted in three phases:

- Cold testing: Wiring continuity, DI mapping verification
- Warm testing: Signal energization and logic validation
- Live plant testing: Simulated SMPS failure and SCADA graphics response

Test reports confirmed that all alarms, graphics, and logging functions performed accurately. The system was deployed across all targeted panels.



IV. IMPLEMENTATION RESULT

The implementation of SMPS fault monitoring and SCADA visualization produced significant improvements in reliability, operational awareness, and maintenance efficiency.

1) 100% Online monitoring of SMPS Healthiness

All SMPS units across the plant can now be monitored from the DCS/SCADA interface in real time.

Operators can instantly identify which panel and which SMPS has failed, eliminating the previous need for manual inspection.

2) Faster Response to Failures - Before the implementation, SMPS failures often went unnoticed until. After implementation, operators receive alarms within seconds of any failure, enabling immediate corrective action.

- A card malfunctioned
- A field transmitter lost power
- A panel partially shut down

After implementation, operators receive alarms within seconds of any failure, enabling immediate corrective action.

3) Prevention of Equipment Damage – Early Detection Avoided

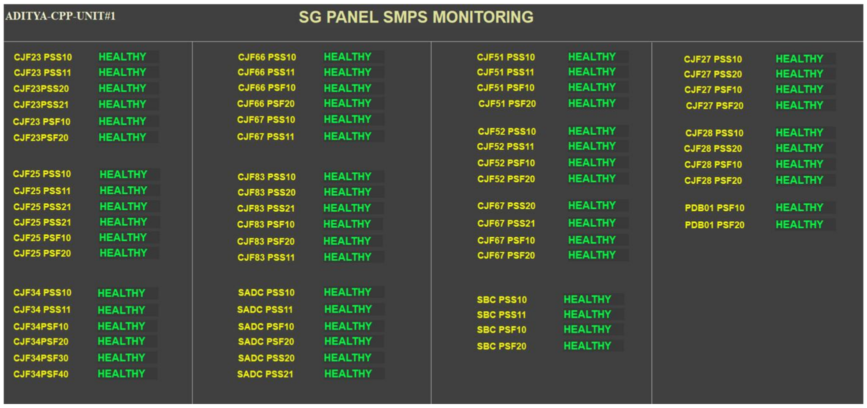
- DCS card under-voltage failures
- Communication module dropouts
- Field instrument malfunction due to unstable 24 V supply

No power-related equipment failures were recorded in the observation period after implementation.

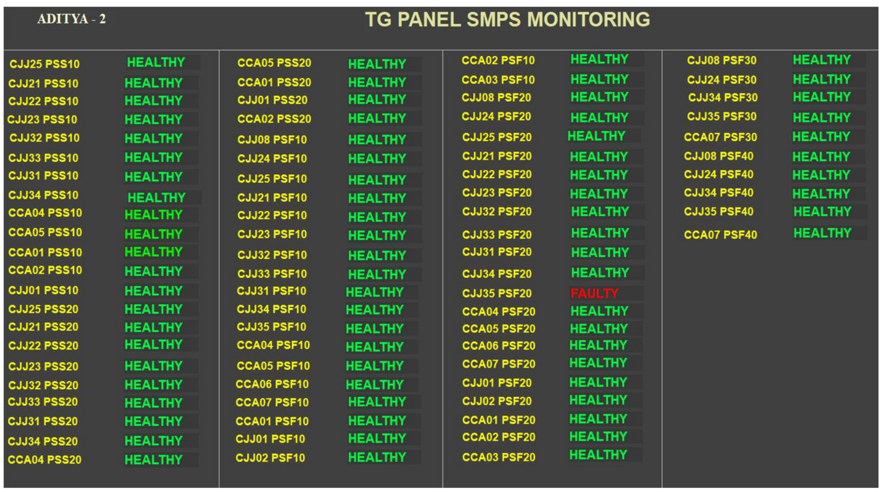
4) Enhanced Operator Experience through SCADA Graphics - The newly created SCADA screens provided:

- Color-coded visual health monitoring
- Grouped panel-wise representation
- Plant-wide SMPS dashboard

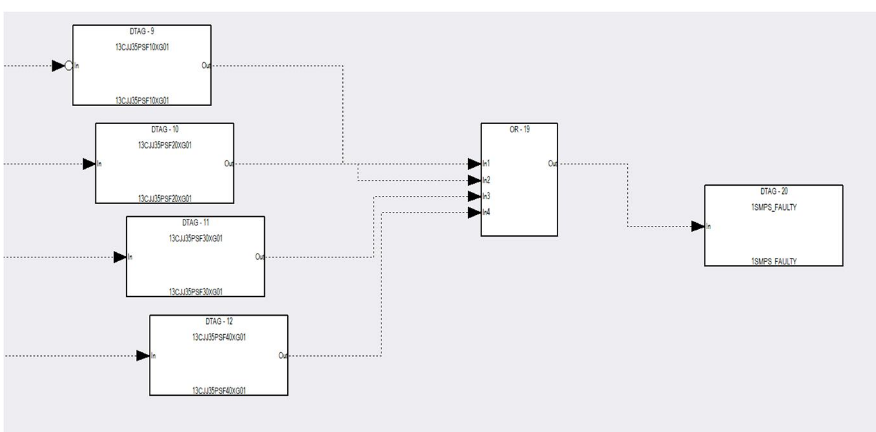
This significantly reduced troubleshooting time and helped operators quickly interpret equipment conditions.



PANEL WISE SMPS GROUPING , DASH BOARD CREATED, ALSO COLOR CODE MONITORING .



PANEL WITH ONE SMPS FAULTY IN PANEL NO.CJJ35 AND SMPS NO – PSF-20 , COLOR CODE ALSO CHANGED TO RED .



LOGIC IMPLEMENTED AS IF ANY SMPS GETS FAILED (OR GATE) IT WILL TRIGGER AN ALARM

V. ROOT CAUSE

The primary root cause identified was absence of a real-time monitoring mechanism for individual SMPS units. Although many SMPS models provide potential-free contacts, these were not wired to the DCS earlier. As a result, failures remained unnoticed until redundancy was lost or an instrument malfunction occurred.

A. Secondary Causes Included

1) Inadequate panel health monitoring philosophy.
2) Overreliance on manual inspection during preventive maintenance.
3) Lack of integration between power supply components and the control system.

VI. LESSON LEARNED

1) Critical auxiliaries like SMPS must be included in online monitoring, similar to other control system components.
2) Even simple potential-free contacts, when integrated systematically, can significantly enhance system reliability.
3) Alarm management should include equipment health alarms, not only process alarms.
4) Predictive maintenance is directly supported by improved visibility of power supply failures.
5) Small, low-cost modifications can lead to major improvements in plant availability, especially in power-critical environments.

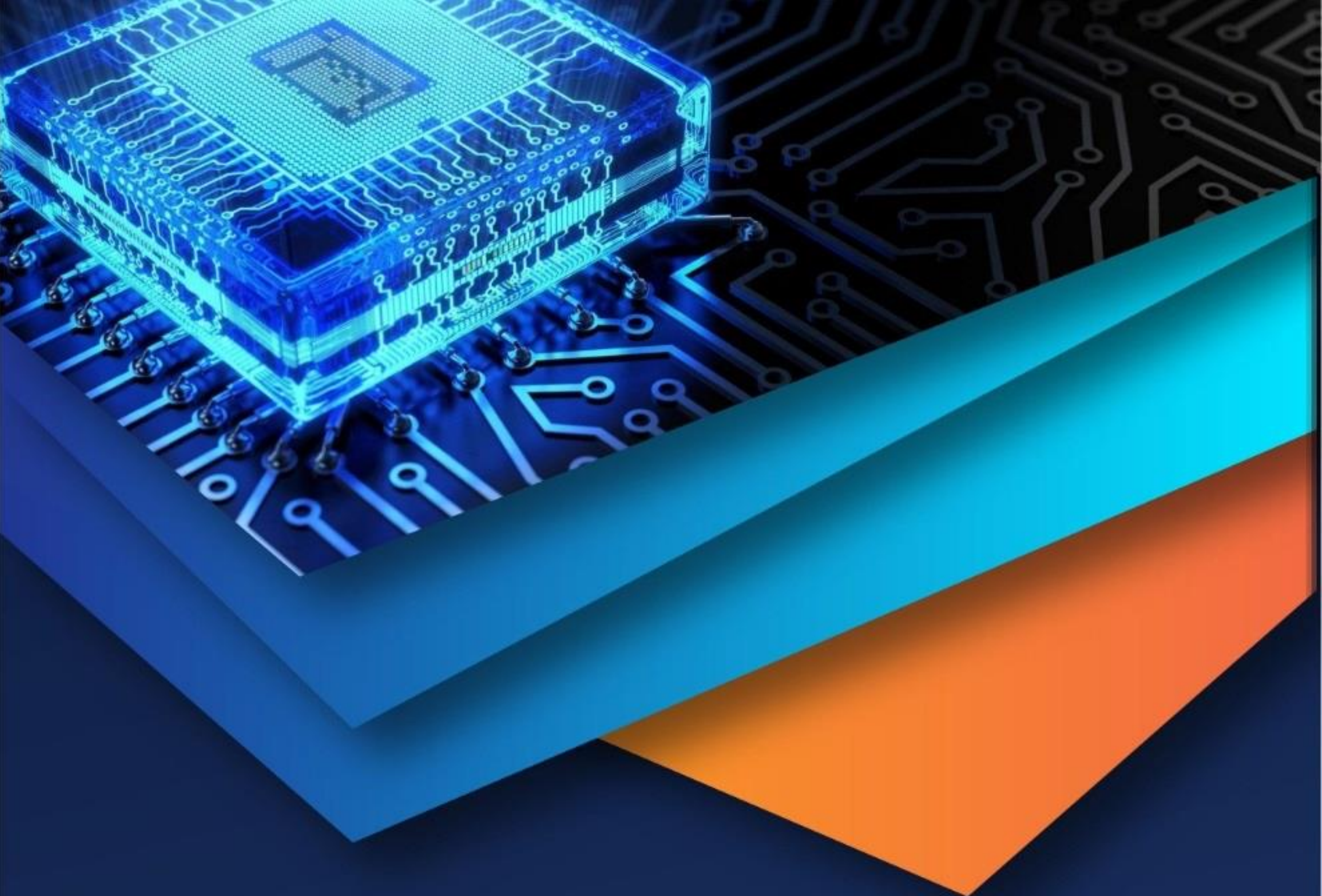
VII. CONCLUSION

The integration of SMPS fault contacts into MAXDNA DCS successfully established a real-time monitoring and alarm system for power supply health in the thermal power plant. This solution eliminated delays in identifying SMPS failures, thereby preventing potential breakdowns of DCS cards, communication modules, and field instruments. The project demonstrates how minor digital enhancements can yield significant reliability improvements.

The approach is scalable, economically feasible, and can be replicated across various industrial sectors relying on 24 V DC control systems. The implementation aligns with modern maintenance philosophies, including condition-based and predictive monitoring.

REFERENCES

[1] MAXDNA Distributed Control System – Hardware and Engineering Manuals, General Electric.
[2] IEC 61131 & 61508 standards for control system reliability and safety.
[3] "Switched Mode Power Supply Design and Operation," Texas Instruments Technical Series.
[4] Thermal Power Plant Instrumentation Guides – O&M Best Practices Reports (CEA, India).
[5] OEM Operation Manual and Data Sheet.



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