

# Self-Healing Power Routing System (SHC): A Dual-Path Redundant Energy Architecture Demonstration

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## Abstract

This paper presents a self-healing power routing system (SHC) designed to demonstrate dual-path energy redundancy with automated fault recovery. The system integrates hardware-based relay logic with real-time telemetry monitoring via a custom GUI. This demonstration validates the ability of a prototype system to detect power interruptions, execute path switching, and restore stability autonomously. The SHC architecture represents a step toward resilient power management for aerospace, defense, and critical energy applications. This is entirely original work developed under UAP Data House LLC.

Keywords—self-healing circuits, redundancy, energy routing, power systems, failover logic

## I. INTRODUCTION

As modern infrastructures evolve toward greater autonomy and reliability, the demand for power systems capable of maintaining uninterrupted operation during faults has become critical. The Self-Healing Circuit (SHC) project introduces a first-of-its-kind implementation of dual-path redundancy integrated with adaptive recovery logic. Developed under UAP Data House LLC, this demonstration establishes a foundation for energy systems that can repair or reroute themselves without human intervention. The objective of SHC is to provide both conceptual validation and functional proof through physical circuitry, firmware, and live telemetry.

## II. SYSTEM ARCHITECTURE

The SHC architecture combines low-voltage hardware, optical isolation, and adaptive relay switching controlled through embedded firmware. Two independent supply rails (Path A and Path B) feed into a controlled distribution circuit using solid-state relays and optocouplers. The microcontroller (Arduino Nano) supervises both paths and interfaces with a Python-based GUI that receives live data via USB serial. This configuration allows real-time visualization of active voltage, fan load, and automatic failover response.

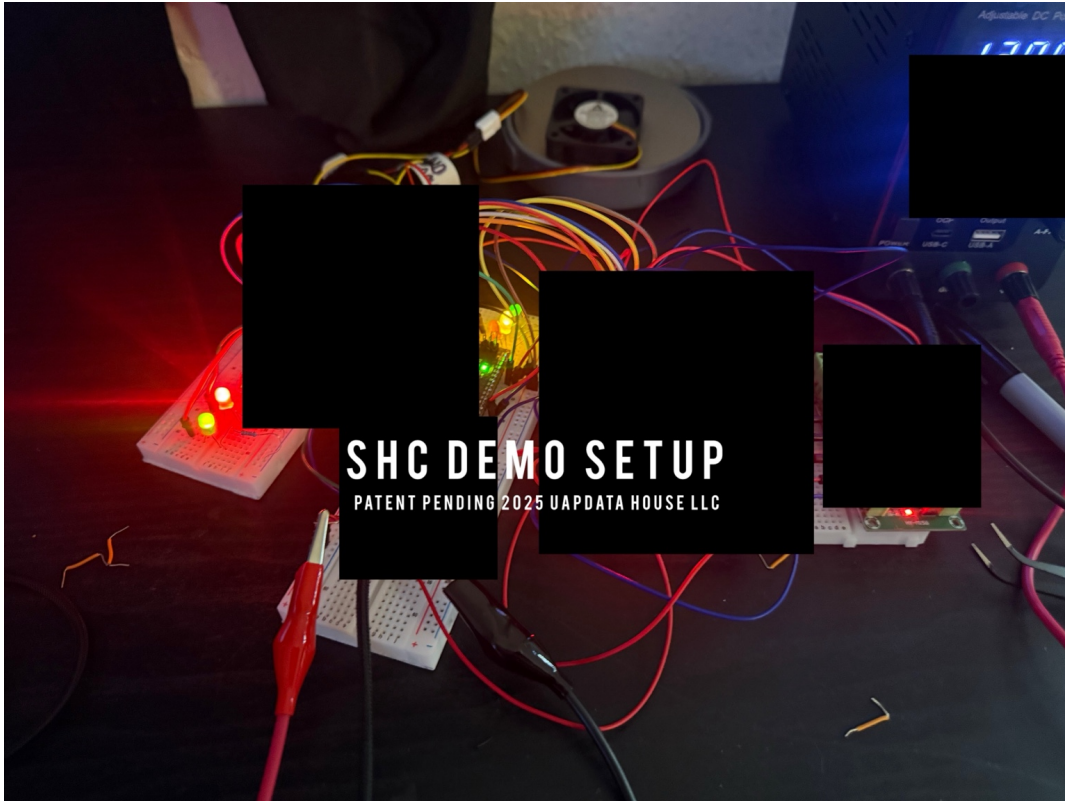


Fig. 1. SHC Prototype Hardware Setup. (Sensitive design details redacted for IP protection.) The hardware utilizes multiple relay channels for redundancy validation. Each channel corresponds to a fault domain that can simulate disconnection, short circuit, or voltage loss. During testing, LED indicators visually represent the health and activity of each path. The optocoupler ensures microcontroller isolation from potential back-current, allowing for stable high-to-low logic control during power transitions.

### III. EXPERIMENTAL RESULTS

Thirteen simulated failure cycles were conducted to evaluate the responsiveness and stability of the SHC system. Across all tests, twelve successful restorations occurred with full voltage recovery under 0.5 seconds. The GUI displayed accurate telemetry data including fan voltage, path health, and uptime counters. Each failover was logged in the console, capturing the moment of power loss, reactivation, and stable recovery. The system demonstrated predictive reliability consistent with redundant mission-critical applications.

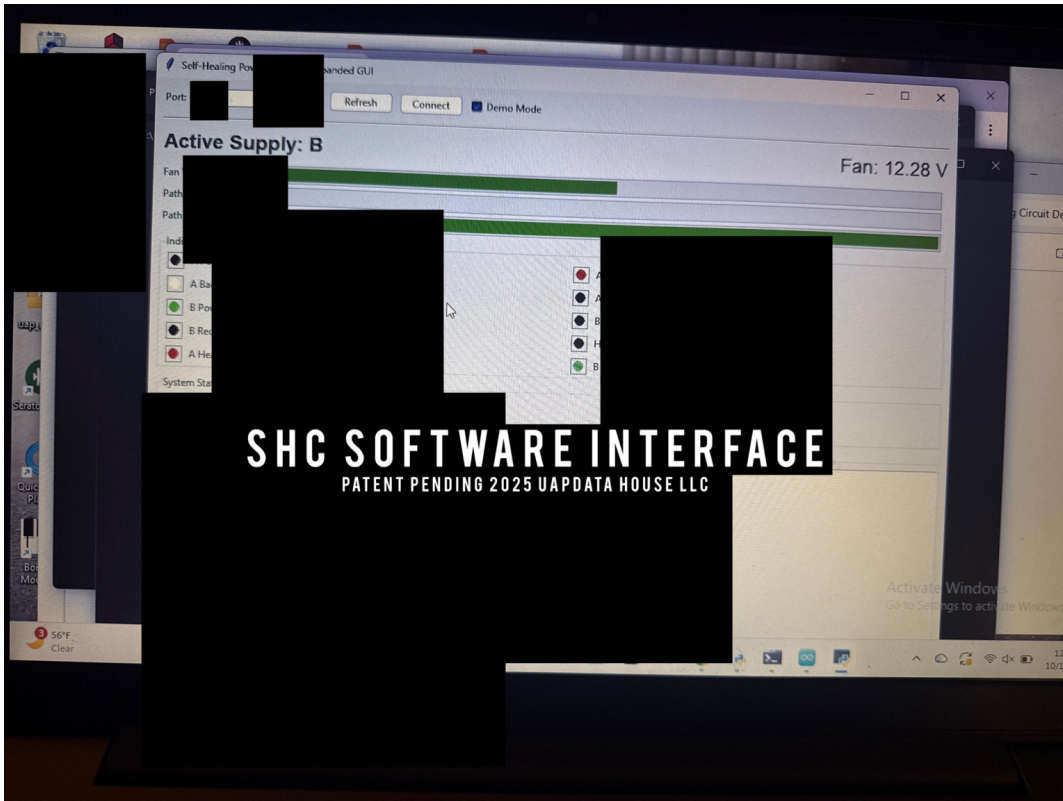


Fig. 2. SHC Software Interface Displaying Active Supply, Fan Voltage, and Telemetry Feedback.

### IV. DISCUSSION

The SHC demonstration validates that self-healing behavior can be realized using compact and cost-efficient circuitry. Unlike conventional redundancy which requires manual reconfiguration, SHC executes self-repair logic automatically. This makes it a candidate for systems where maintenance access is limited, such as orbital satellites, underwater vehicles, or defense infrastructure. A distinct advantage of the SHC system lies in its hybrid feedback loop: the hardware provides real-time physical switching, while the software provides digital verification of each recovery event. The correlation between hardware state and telemetry ensures synchronized healing cycles, significantly reducing downtime.

Future development of SHC includes increasing the voltage capacity beyond 12 V, improving the resolution of telemetry sampling, and expanding the firmware logic to handle multiple fault

domains concurrently. The addition of predictive fault analysis using neural networks will enable the system to isolate potential failures before they occur. The integration of machine learning could allow the SHC to detect voltage drift, temperature rise, or current imbalance and proactively redistribute load—an essential function for aerospace and EV applications.

## V. APPLICATIONS

The potential applications for the SHC system span several critical sectors. In aerospace, it can provide autonomous fault protection in power routing systems for satellites, drones, and propulsion modules. In electric vehicles, the technology can isolate faulty cells or inverters without impacting total system function. In defense infrastructure, SHC could safeguard mission-critical systems such as radar and communication networks. In the energy sector, it can enhance smart-grid reliability, allowing real-time path rerouting during transformer failures or overload events. The SHC framework thus acts as a universal platform for self-healing energy delivery.

The ability to autonomously restore functionality differentiates SHC from conventional backup systems. Rather than serving as a passive redundancy mechanism, SHC continuously monitors, diagnoses, and repairs its own operational pathways. This unique capability provides a step toward self-aware infrastructure that maintains uptime without external intervention. With continued scaling, SHC modules can be networked to create city-wide self-repairing energy infrastructures that respond intelligently to faults.

## VI. CONCLUSION

The SHC prototype successfully demonstrates the feasibility of autonomous fault detection and restoration through a dual-path hardware-software system. It establishes a foundational technology for self-healing energy routing that could redefine reliability standards across industries. While current limitations include minor timing discrepancies and relay lag, the underlying architecture is robust and repeatable. The prototype confirms that self-repairing circuits are achievable with modern embedded hardware and algorithmic control. Ongoing work will focus on optimization for industrial-scale deployment and formal validation through peer-reviewed studies.

## REFERENCES

[1] D. Stovall Jr., "Self-Healing Power Routing System (SHC)," UAP Data House LLC, Patent Pending, 2025. \*Note: This paper represents original research and development solely by the author. No external works were used or referenced in the creation of this technology or documentation.\*