

Custom Controller for Industrial Oven Testing Bench (RS232-Based)

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1. Introduction

Industrial oven testing systems typically rely on PLC-based controllers due to their reliability and industry acceptance [1]. However, these systems are often expensive, inflexible, and unsuitable for small-scale applications [2]. This project investigates the use of embedded microcontroller-based systems as a cost-effective and adaptable alternative for industrial testing environments [5][6].

This project develops a low-cost embedded alternative using a microcontroller.

2. Aim & Objectives

- Develop a **microcontroller-based control system** for an industrial oven testing bench
- Implement **real-time monitoring** of temperature, voltage, and current
- Enable **multi-channel load** control via MOSFET switching
- Establish **RS232 communication** with a PC interface
- Integrate **safety features** (emergency stop, watchdog, fault detection)
- Achieve a **cost-effective** alternative to PLC-based systems

3. Research Overview

A review of industrial control systems was conducted, comparing PLCs, DCS, FPGAs, and microcontroller-based systems. While PLCs offer high reliability and certification, they are costly and less flexible [2]. Microcontrollers provide a balance of cost, performance, and scalability [3], making them suitable for small to medium-scale applications when combined with appropriate signal conditioning and safety design.

8. References

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- [5] R. Ahshan, M. T. Iqbal, and George K.I. Mann, "Controller for a small induction-generator based wind-turbine," Applied Energy, vol. 85, no. 4, pp. 218–227, Apr. 2008,
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4. Design and Implementation

The system was designed using a PIC18F46J50 microcontroller, incorporating signal conditioning circuits, MOSFET-based load switching, and RS232 communication (Fig3). Safety features such as emergency stop, watchdog timer, and fault detection were implemented [4]. The design evolved through iterative improvements, addressing issues such as noise, thermal performance, and manufacturability.

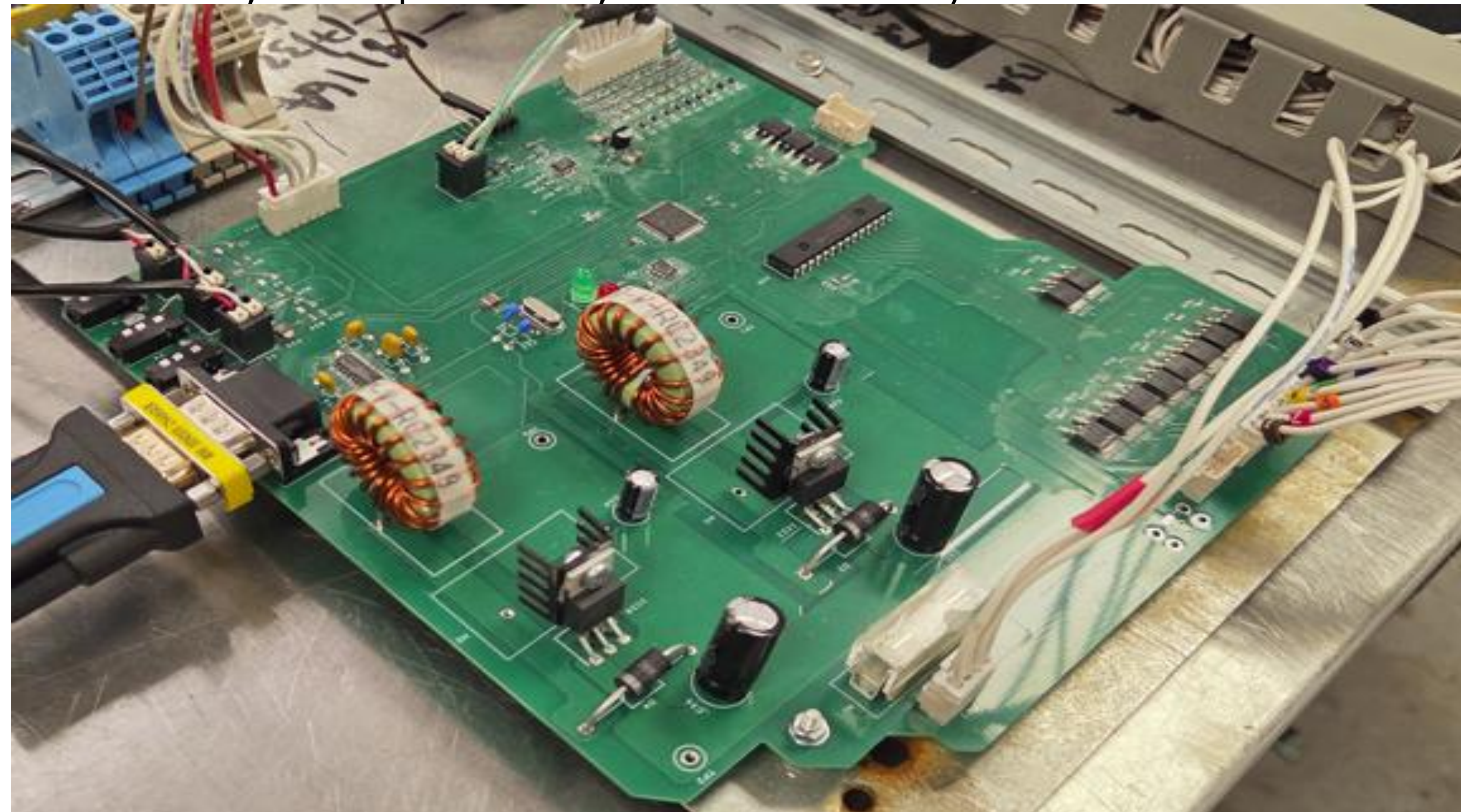


Figure 1: Final Embedded Controller Implementation

5. Testing & Results

The system was tested under various operating conditions to evaluate performance, accuracy, and reliability. Results (Fig2) showed stable operation, accurate sensor measurements after calibration and filtering improvements. Improvements in signal stability and measurement accuracy were achieved through filtering and PCB design techniques, consistent with best practices in embedded system design.

6. Conclusion

The project demonstrates that microcontroller-based systems can provide a reliable and cost-effective alternative to PLC-based solutions for industrial testing applications [5][6]. However, the lack of formal certification limits their use in safety-critical environments [7].

7. Reflection

The project provided valuable experience in embedded system design, hardware and firmware integration, and problem-solving. It highlighted the importance of signal integrity, continuous development, and practical validation in engineering design.

8. Future Work

- Replace RS232 with RS485 or Ethernet for scalability
- Integrate HMI for standalone operation
- Perform EMC and safety certification testing

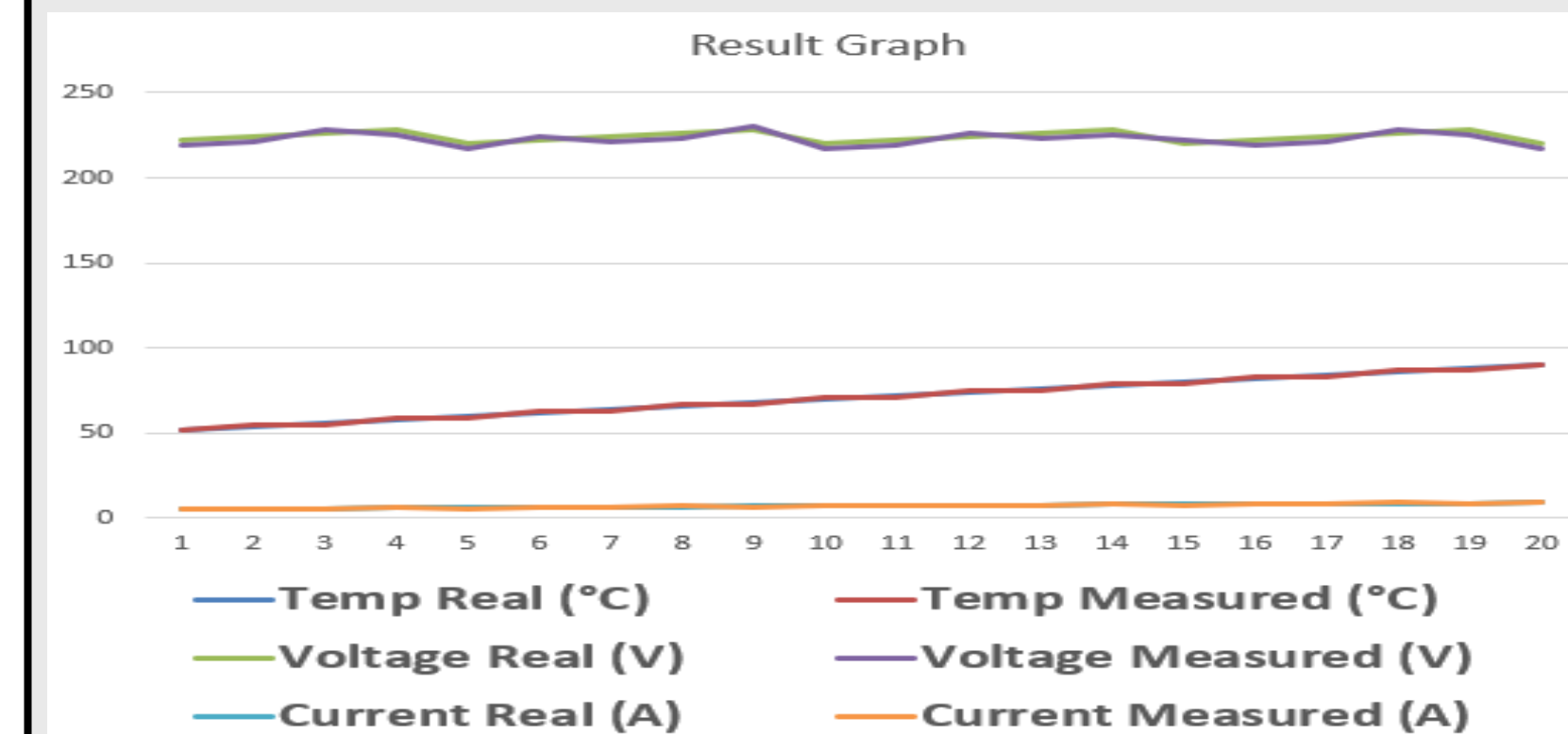


Figure 2: Measured vs Real Performance (Temperature, Voltage, Current)

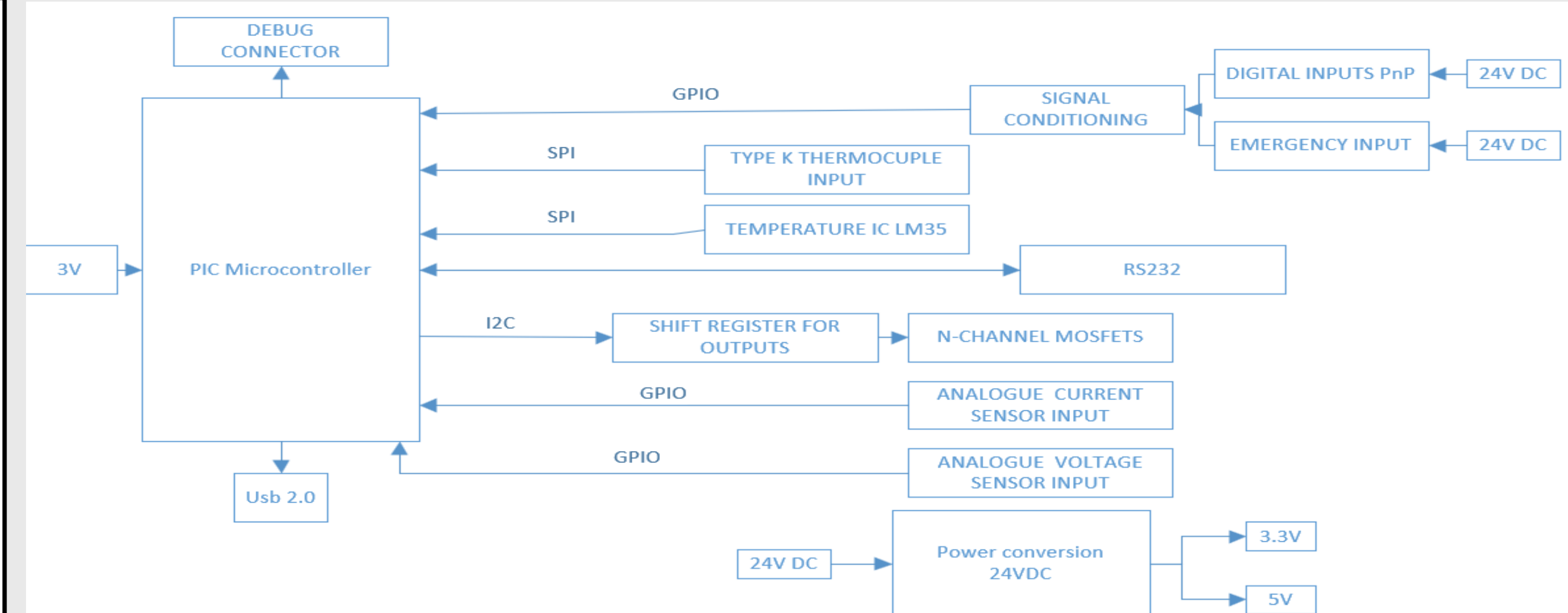


Figure 3: Hardware Design and System Architecture