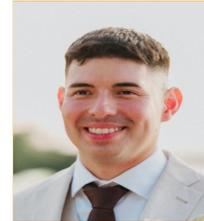


# A Smarter Solution for Tire Pressure Management

By Team 21: Daniel Chiriff, Edgar Izurieta, Carlos Macias, Steven Nunez

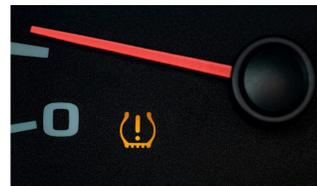


Mentor Dr. Raja Ayyanar:



## INTRODUCTION:

Cold weather significantly affects tire pressure, increasing the risk of accidents, fuel consumption, and accelerating tire wear. Team 21's project introduces a resistive-heating system integrated into car tires to maintain optimal pressure. This innovation reduces the need for manual adjustments, improves safety, and enhances vehicle performance, especially in cold climates. The project explores principles of resistive heating, related research, and the potential impact on modern vehicle safety.



## PROJECT OBJECTIVE:

The objective of Team 21's project is to design and develop a cost-effective resistive heating system that autonomously maintains optimal tire pressure in cold climates. By integrating real-time temperature feedback and high-efficiency silicon-based power devices with a synchronous buck converter, the system aims to enhance vehicle safety, fuel efficiency, and tire longevity. The project seeks to deliver a scalable, energy-efficient solution that minimizes manual maintenance while providing a reliable safety feature adaptable to modern automotive systems.

## THEORY:

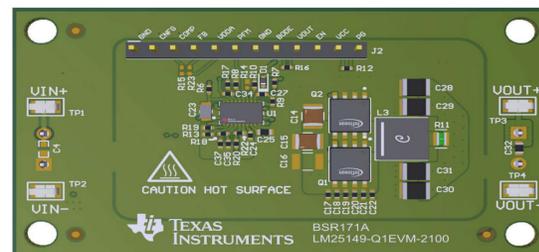
According to the Ideal Gas Law, pressure is directly proportional to temperature when volume and the amount of gas remain constant. So, as the temperature drops, tire pressure falls. The project's goal is to develop a heating-based tire pressure management system using Silicon Carbide (SiC) MOSFETs and a synchronous buck converter. This technology will automatically regulate tire temperature, reducing the need for manual intervention and improving overall vehicle efficiency and safety. The system architecture includes four main components.

**Power Supply & Conversion:** The battery connects to a synchronous buck converter using SiC MOSFETs for efficient, precise voltage and current control.

**Resistive Heating Module:** A heating element, such as a resistor or nichrome wire, transfers heat to the rim with minimized energy losses through shielding and direct DC excitation.

**Current Sensing & Feedback:** A sensing IC chip or shunt resistor, along with a microcontroller and PID control, maintains stable heating by adjusting the converter output.

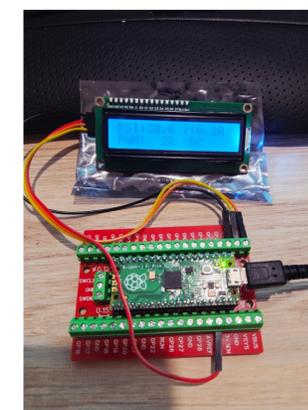
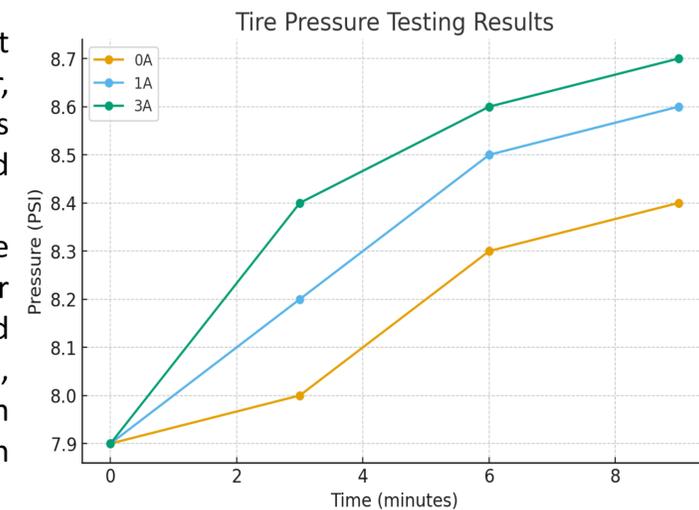
**Communication & Safety:** The system interfaces with the vehicle's ECU for automation and includes overcurrent and overheating protection to ensure safe operation.



## RESULTS:

The tire pressure monitoring system, using heat-resistant film sensing and powered by a synchronous buck converter, was evaluated at 0 A, 1 A, and 3 A load conditions. Across all tests, the system demonstrated stable, consistent, and predictable measurement performance. Pressure readings increased gradually over the 9-minute test window for all load levels, indicating proper sensor responsiveness and stable converter regulation. Higher load conditions produced slightly larger pressure increases, suggesting a mild load-dependent influence on system behavior—likely due to electrical or thermal interaction between the converter and the sensing element.

Pressure readings increased gradually over the 9-minute test window for all load levels, indicating proper sensor responsiveness and stable converter regulation. Higher load conditions produced slightly larger pressure increases, suggesting a mild load-dependent influence on system behavior—likely due to electrical or thermal interaction between the converter and the sensing element.



## CONCLUSION:

The integration of a heat-resistant film sensor with a synchronous buck converter produced consistently stable and accurate tire pressure measurements across the evaluated load conditions. The system maintained smooth pressure regulation even under increased electrical load, indicating strong thermal and electrical resilience. This performance illustrates that the proposed sensing and control architecture is both robust and load-tolerant, making it a viable foundation for next-generation tire pressure management systems. Its reliability, responsiveness, and adaptability highlight its potential for seamless adoption in modern automotive platforms seeking improved safety, efficiency, and reduced maintenance.