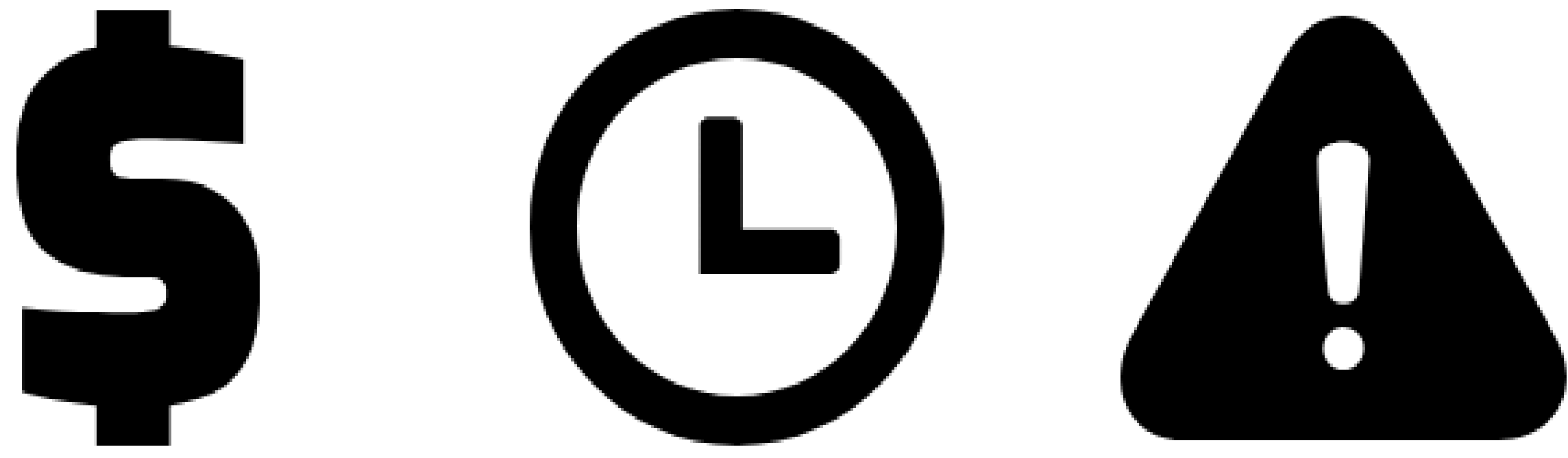


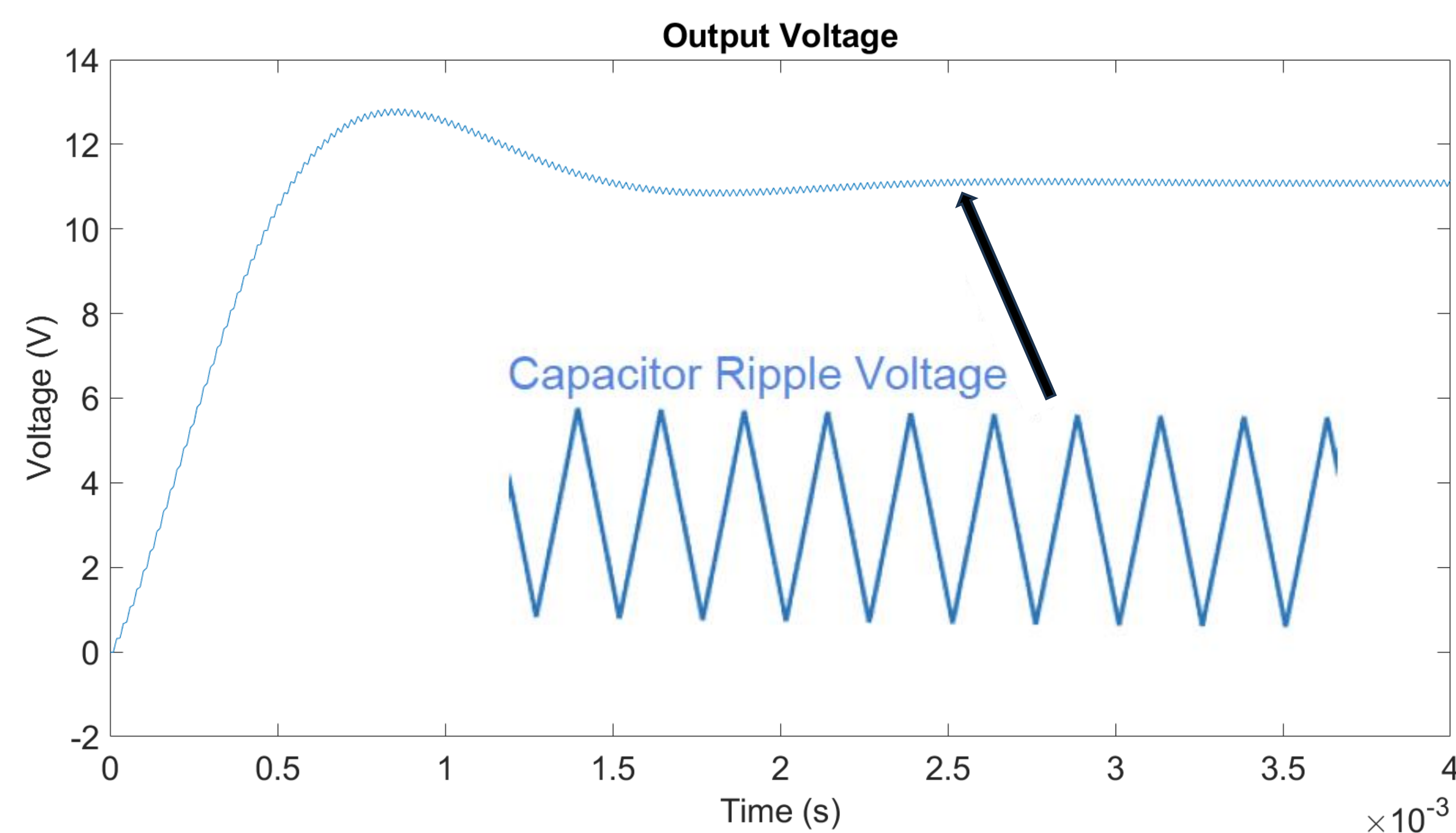


1. Motivation

Companies want to quickly detect and replace failing hardware to mitigate financial losses and downtimes.



Capacitors are a point of failure. To predict capacitor degradation, we first created a state-space representation of a power converter circuit in MATLAB. This is represented by the plot below.



Ideal values from the simulation are then compared to circuit measurements taken by a microcontroller and passed to a raspberry pi.

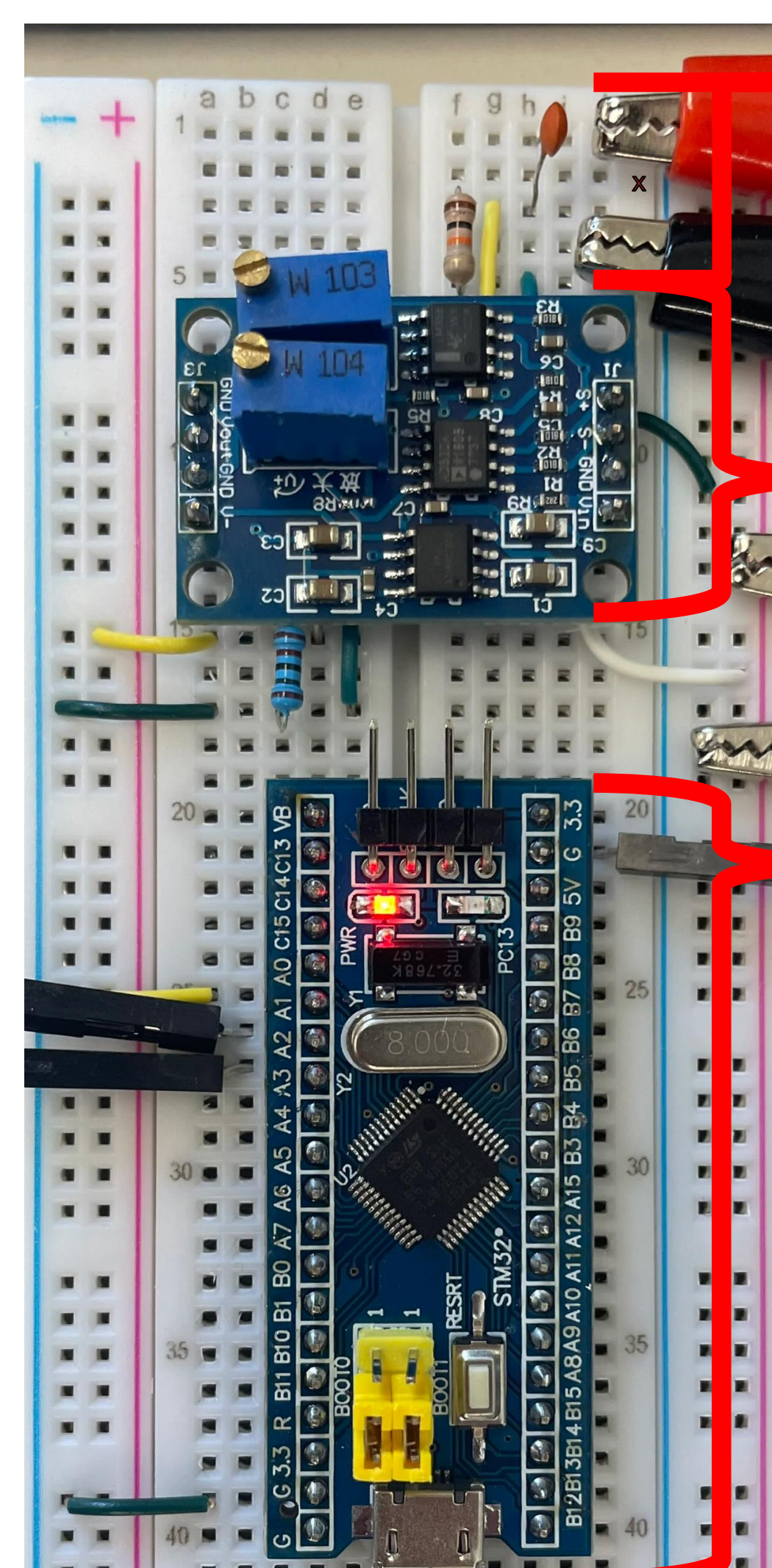
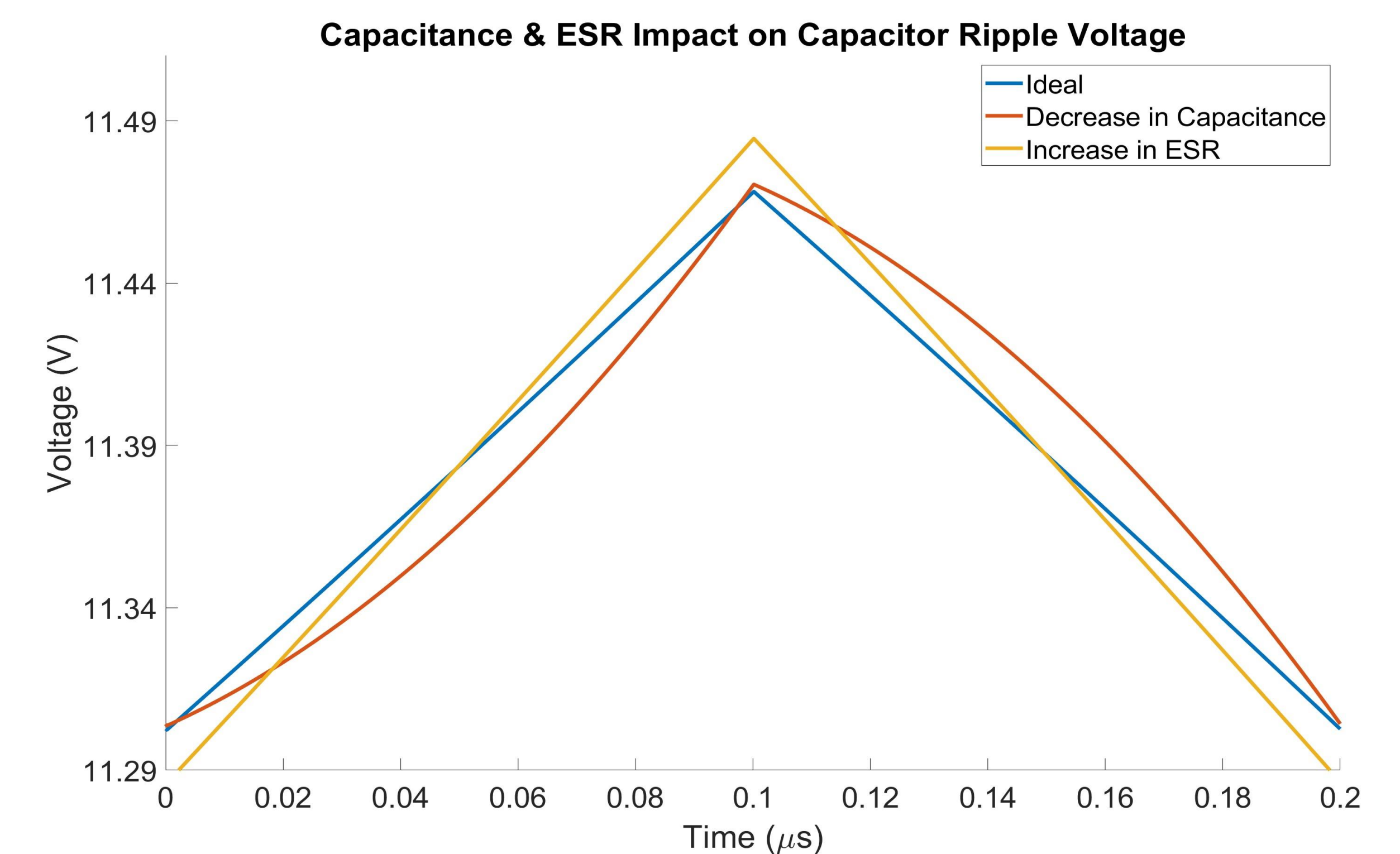
2. Implementation



Power Conversion Hardware:

Uses a PWM signal and capacitor to reduce voltage.

We simulated capacitor degradation in MATLAB. As capacitors decline the equivalent series resistance (ESR) increases and capacitance decreases.



High Pass Filter:

Removes the DC offset from the signal.

Instrumentation Amplifier:

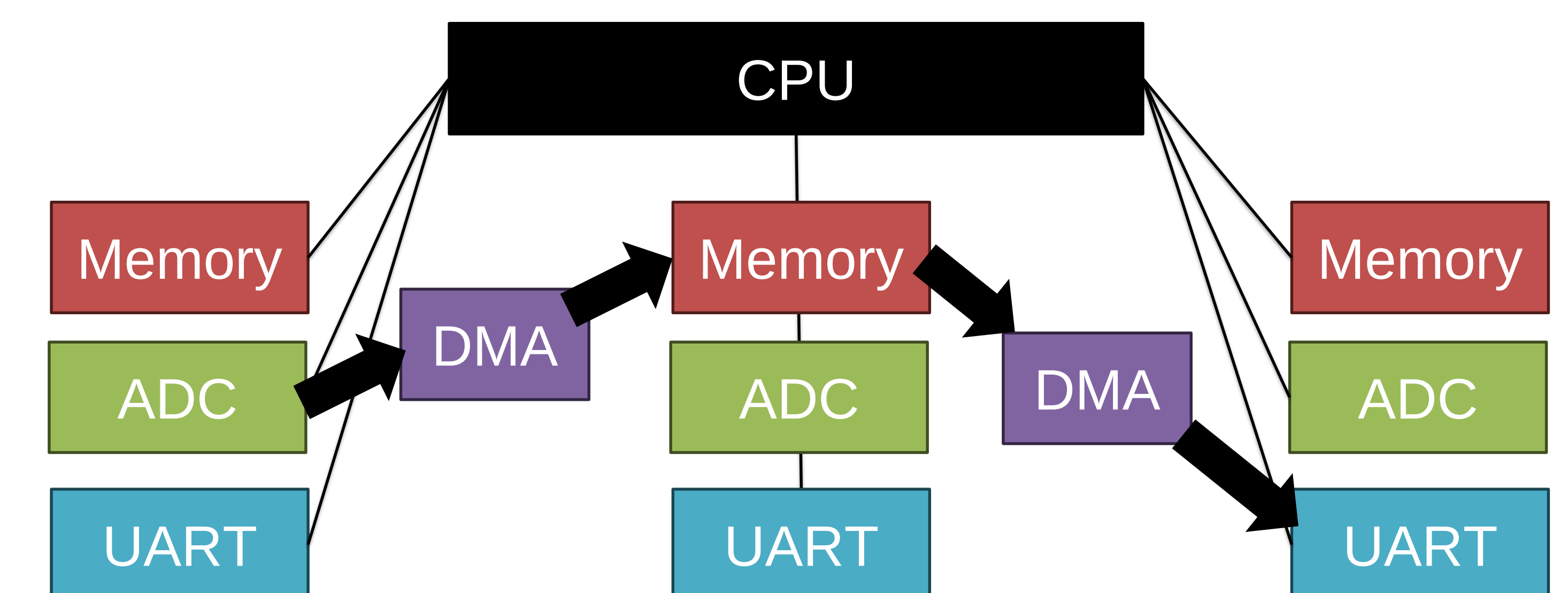
Increases the amplitude of the signal

STM32 Microcontroller:

Used to measure and store the signal output from the amplifier

To transfer voltage values to a raspberry pi the STM32 has three main components:

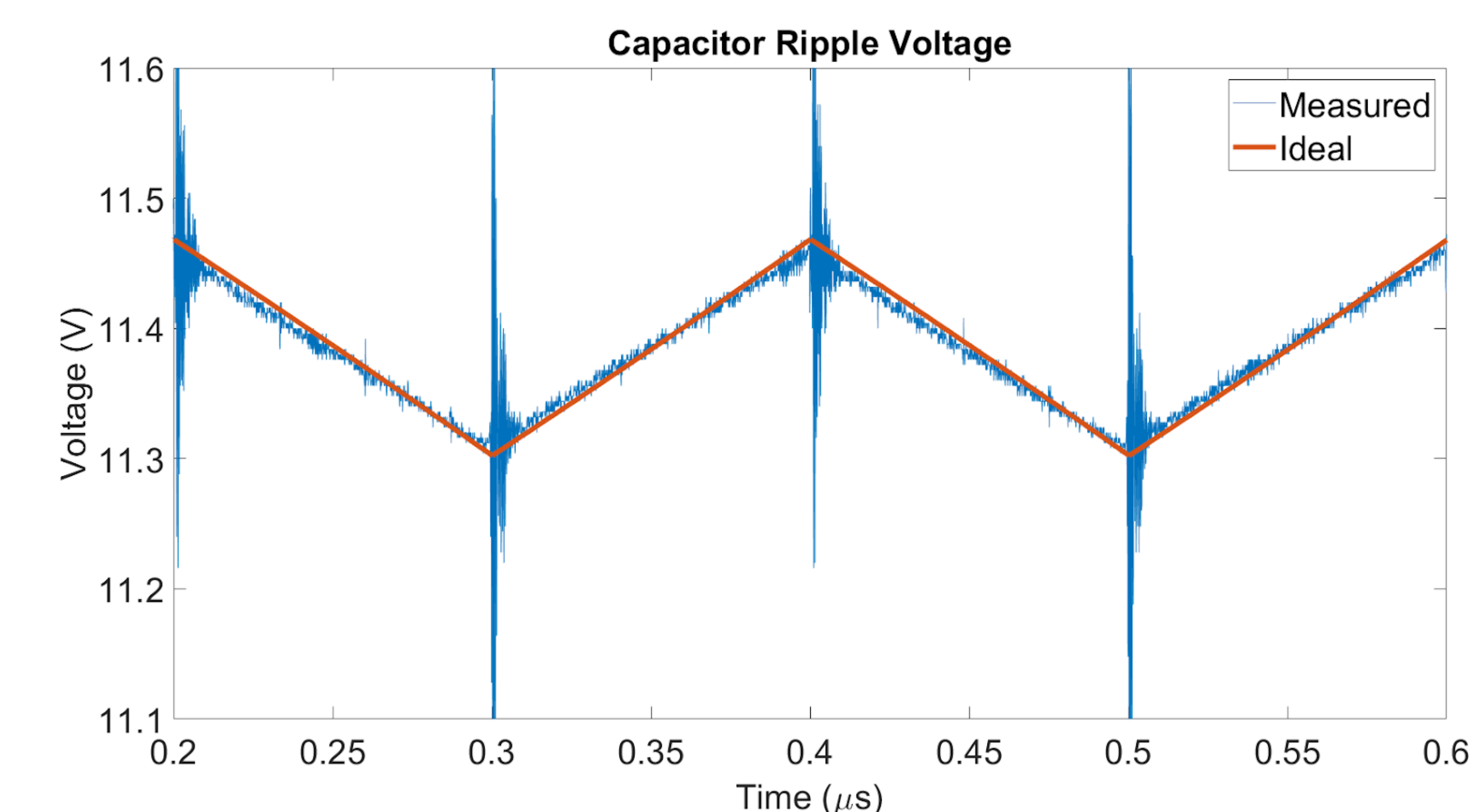
1. Analog-to-Digital Converter (ADC)
2. Direct Memory Access (DMA)
3. Universal Asynchronous Receiver/Transmitter (UART)



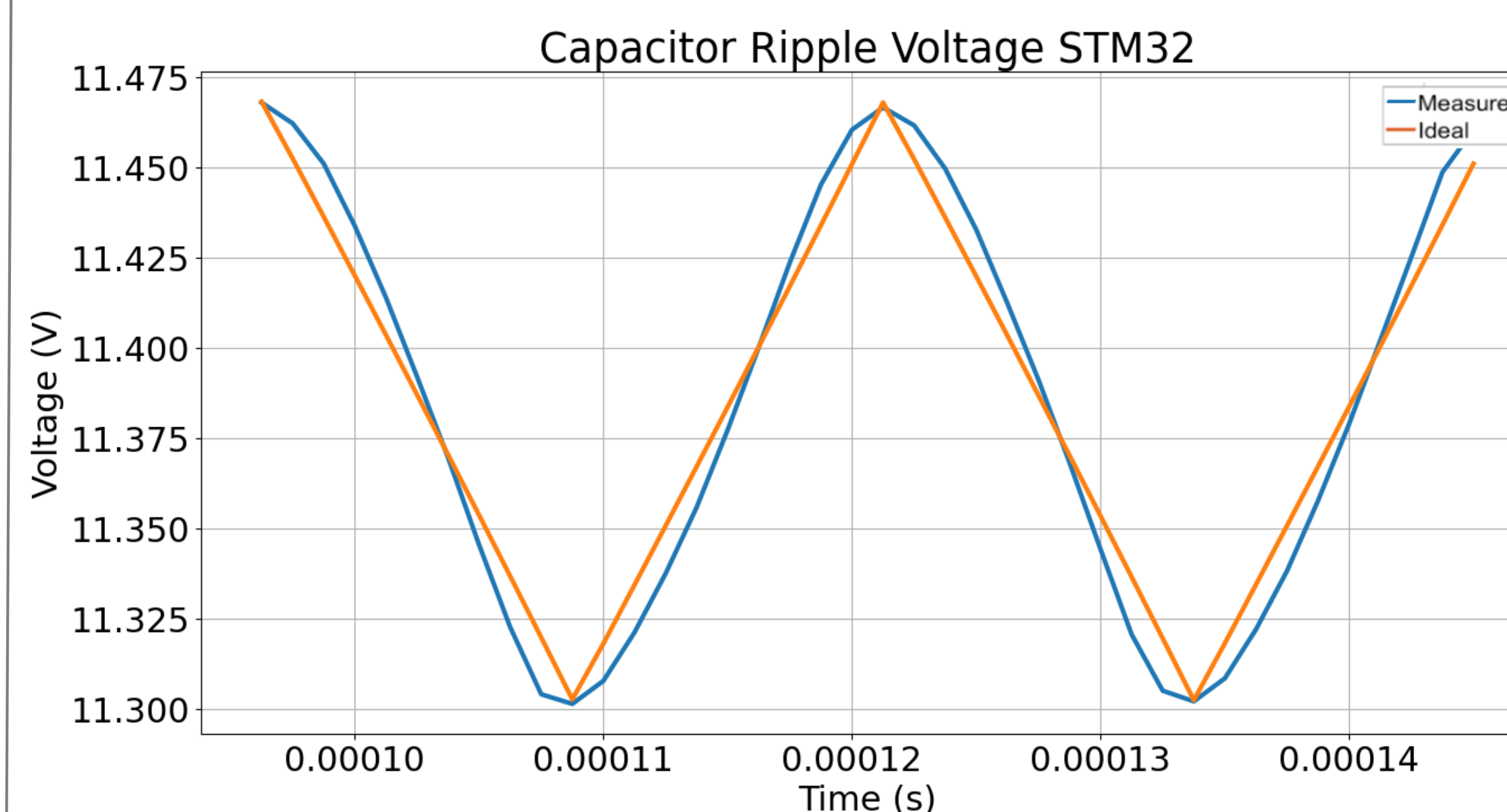
Direct Memory Access (DMA) was specifically chosen for its ability to handle large amounts of continuous data.

3. Conclusion

The plot below compares simulation values to measurements from a high-end oscilloscope which costs around \$10,000. While the oscilloscope has a very high resolution its cost makes in an impractical solution for predicting circuit failure.



The plot below compares simulation values to measurements from the STM32 which costs less than \$8. The resolution of the STM32s ADC is practical for accessing the capacitors health and provides a cheap solution to predict circuit failure.



In the future, this low-cost combination of hardware and software can be used to analyze the shape and magnitude of a capacitors ripple to predict failure. In industry this could be used to optimize preventative maintenance schedules and improve safety standards.

