IMPERIAL

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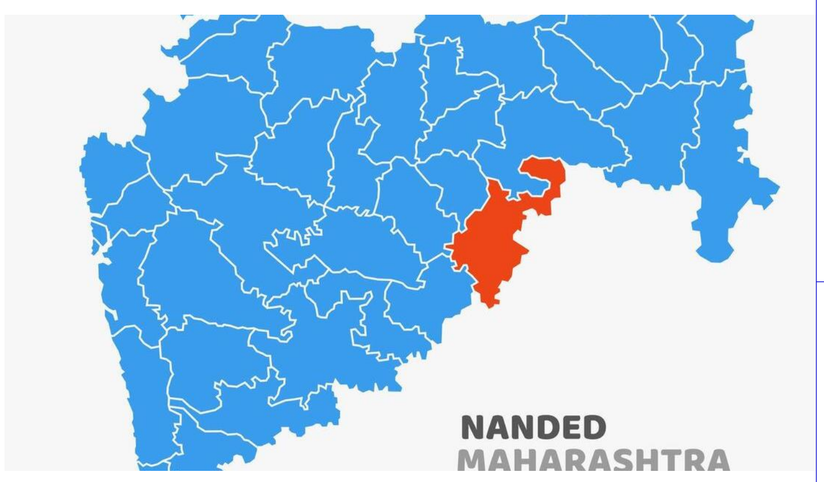
Monitoring Grid Voltage Fluctuations in Rural Schools in Maharashtra

Field deployment of compact voltage loggers and environmental sensors to characterise short-term grid stability and inform resilient electrification for rural schools.

Anhad Singh W.
Dept. Mechanical Engineering
Dr Adrià Junyent-Ferré
Dept. Electrical and Electronics Engineering

Introduction

Power quality and short-duration voltage depressions are common in many rural networks and can disrupt essential services in schools. This study deploys low-cost loggers to measure line voltage, local irradiance, temperature and humidity in school sites across Maharashtra to quantify voltage variability and Its drivers. To focus this research, a small city was picked to initialise data collection – Nanded. For the purposes of anonymity, only the city will be mentioned as opposed to the specific locations within the city



Map of Nanded within Maharastra
https://www.vecteezy.com/vector-art/60306873-map-with-nanded-district-highlighted-in-maharashtra-india

Objectives

- Quantify voltage variability at school distribution points.
- Correlate voltage events with local irradiation and load indicators.
- Publish the first open, academically-curated rural voltage dataset for Maharashtra.

Key Results

Data has been collected but is still pending further in-depth analysis to determine next steps

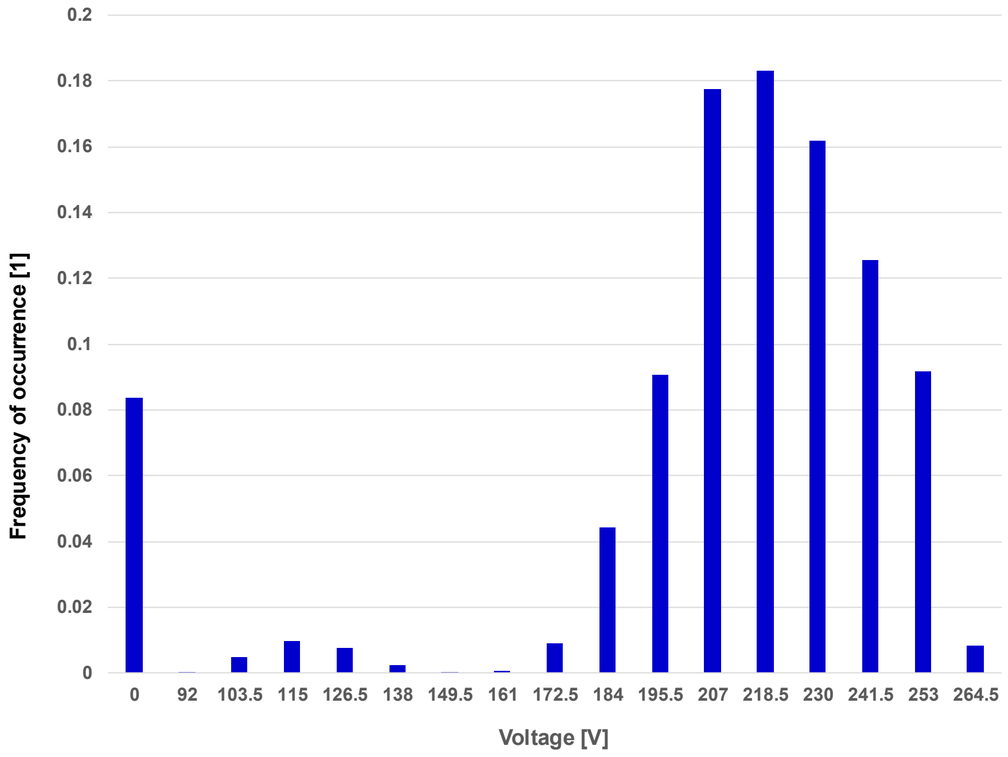


Figure1. one of the three datasets plotted as a frequency-voltage histogram to illustrate the significance of power outages shifting the distribution

Site	Data Received	Data Integrity
A	Yes	Intact
B	Yes	Intact
C	Yes	Corrupt

An Unreliable Electricity Network

In many rural areas electricity is not reliably available. Networks are frequently aged, poorly maintained and overloaded; when many loads coincide, the current and temperature in lines and transformers rise, protection devices may trip, or components may fail. Our preliminary recordings show large deviations from nominal voltage and repeated zero-voltage periods, consistent with temporary disconnections.

Conclusion and Next Steps

This pilot demonstrates the feasibility of low-cost, field-deployed voltage loggers to capture supply instability at rural school distribution points. Early traces reveal repeated short-duration voltage depressions; full cross-site analysis is required to quantify causes and recommend mitigation.

Methods

We deployed compact mains-powered loggers at rural school distribution points in Maharashtra. Each unit contains a 230→12 VAC step-down transformer, bridge rectifier, smoothing capacitor and an ADC-equipped logger (RTC + SD). Devices record time-stamped line voltage to simple text files at ~1 sample/min. Units were bench-tested and calibrated before deployment; GPS and contextual metadata were recorded and will be anonymised for public release.

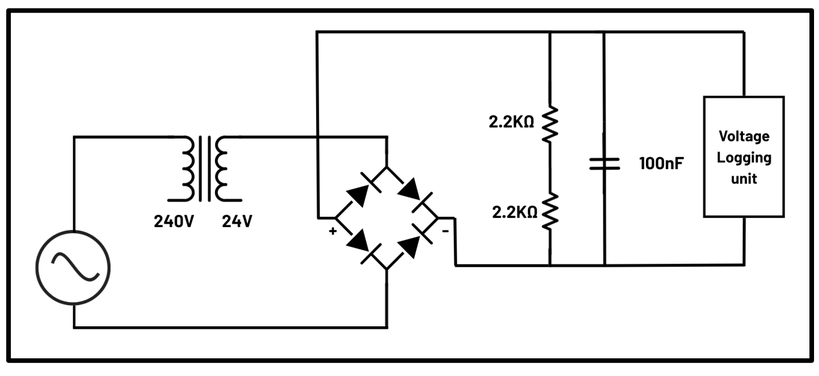


Figure 2. Schematic circuit diagram of the logger

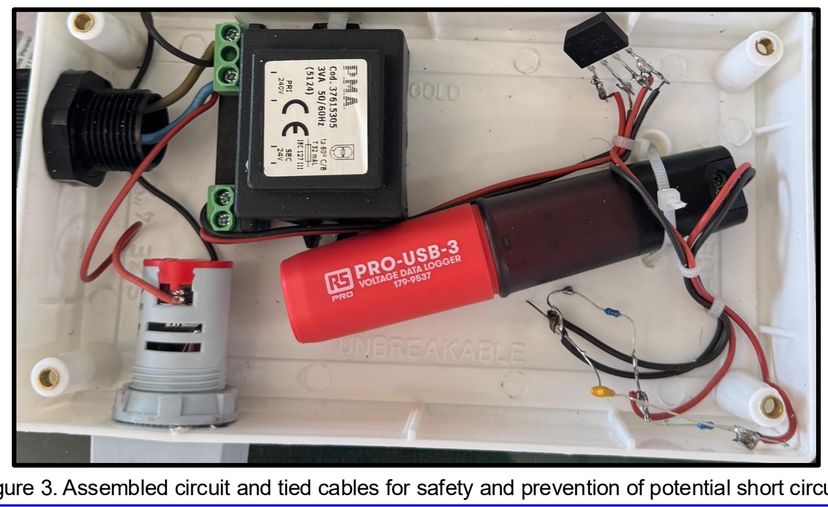


Figure 3. Assembled circuit and tied cables for safety and prevention of potential short circuits

Figure 4. Installed voltage logger box at one of the anonymised locations

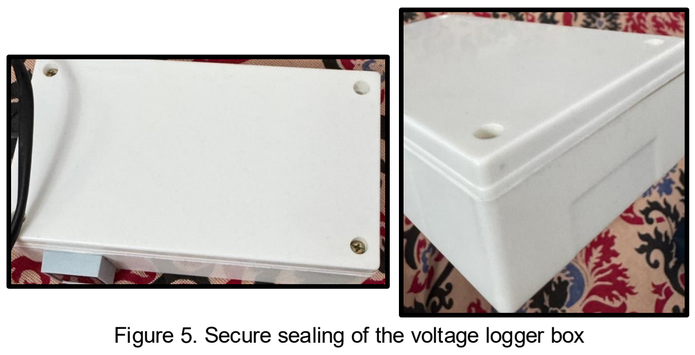


Figure 5. Secure sealing of the voltage logger box