THE UNIVERSITY OF AUCKLAND
FACULTY OF ENGINEERING

An Electrically Isolated UPS System with Surge Protection

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1. Background

Immense damage is caused to electrical equipment from lightning, especially in developing countries with overhead power distribution systems.

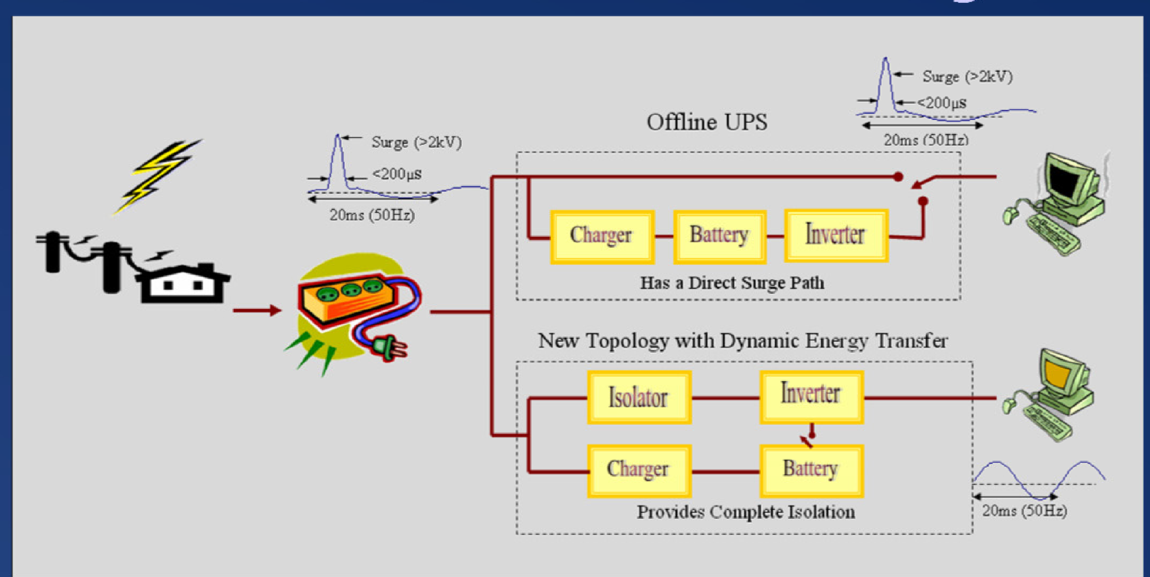
UPSs are commonly used for protection of sensitive equipment, and are mainly three-fold:

1. Offline — Poor protection, but cheap and small.
2. Line-interactive — Similar to offline systems.
3. Online systems — Better protection but more expensive, big and bulky.

Online systems having high power capabilities are generally used commercially. The other two systems are widely used in domestic applications.

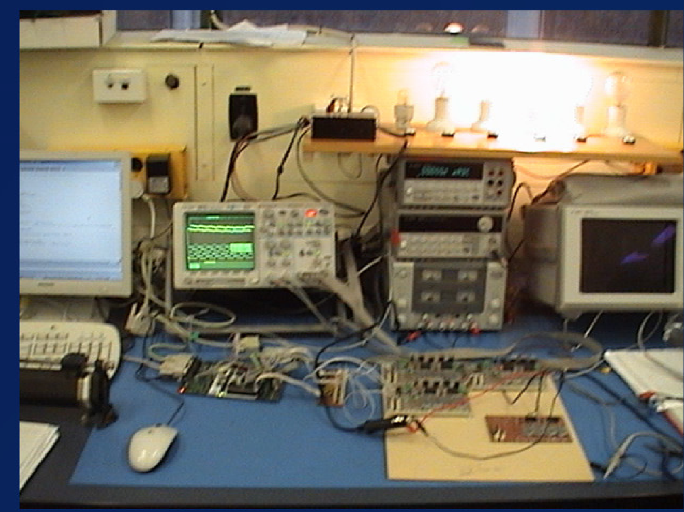
2. Project Goals

A new low power system needed to be developed with 100% supply-load isolation, at a lower cost. Possibilities of using supercapacitors for dynamic energy transfer were also to be investigated.



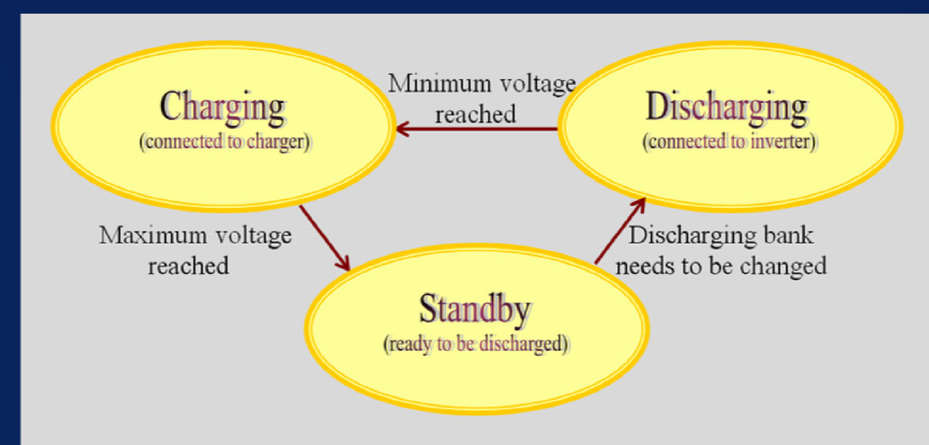
System specification were:

- Input voltage — 230VAC at 50/60Hz
- Output voltage — 230VAC at 50Hz
- Output Power — 100W
- Output regulation — ±5%



3. Dynamic Energy Transfer

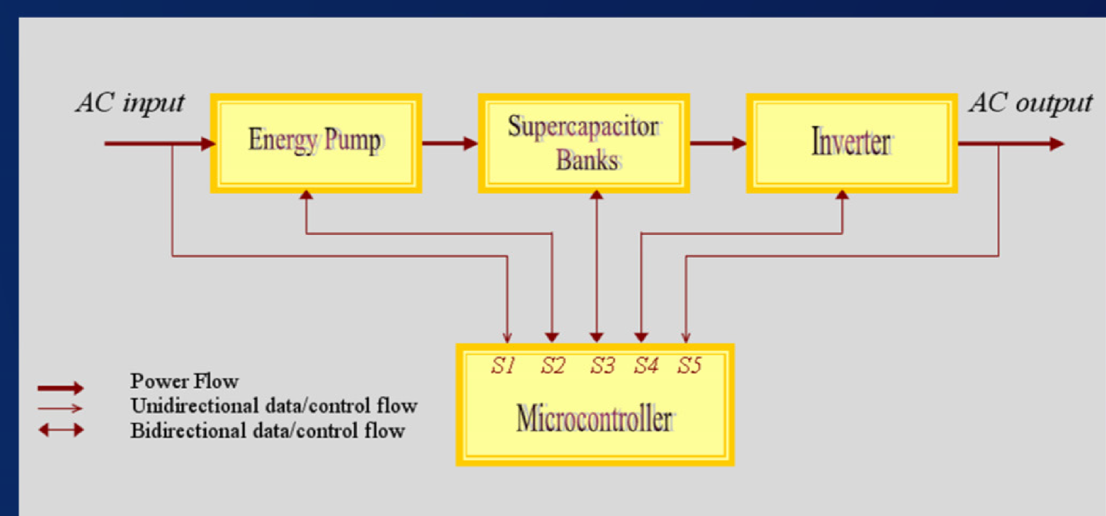
Three supercapacitor banks were continuously cycled through 3 states to supply the load. Complete isolation was achieved by ensuring the discharging bank was always disconnected from supply.



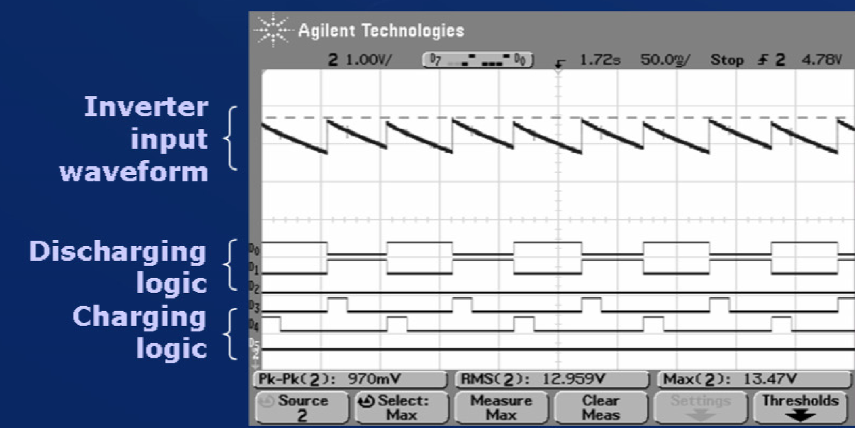
The complete system consist of:

- Energy Pump — Charges supercapacitor banks.
- Supercapacitor banks — Self contained energy storing elements used in dynamic transfer.
- Inverter — Converts bank output to AC.
- Microcontroller — Controls overall system behaviour.

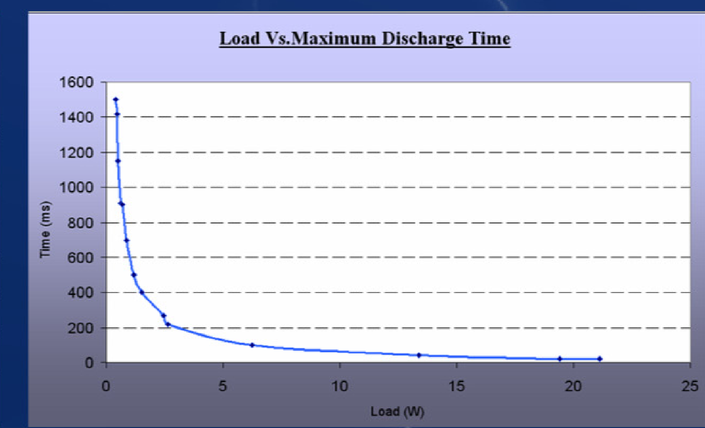
4.7mF electrolytic capacitor (left) Vs. supercapacitor up to 2F (right)



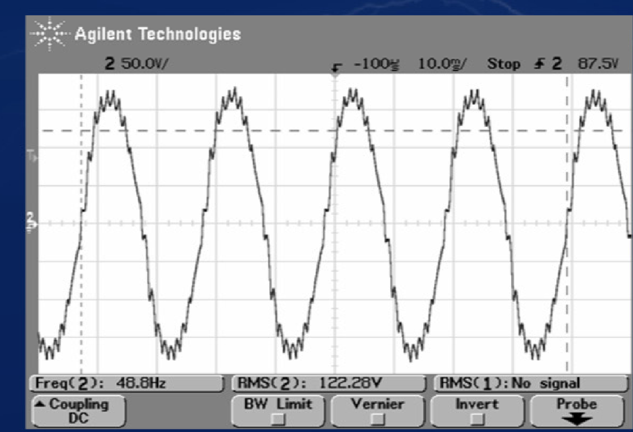
4. Results



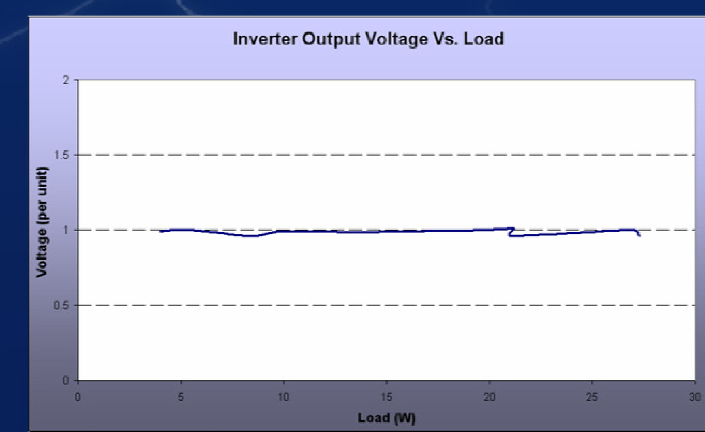
Input-output isolation maintained since discharging bank is not connected to supply



Supercapacitor bank switching frequency is generally < 1kHz for loads up to 60W



Inverter output with a low pass notch filter



System output regulation

5. Recommendations

- Develop a commercial prototype.
- Consider using cheaper supercapacitors with higher capacitance.
- Consider an FPGA or DSP implementation.

6. Conclusions

- A supercapacitor based energy transfer scheme has successfully been implemented.
- Complete electrical isolation between supply and load has been achieved using 3 supercapacitor banks with dynamic energy transfer.
- Complete scheme consists of a well developed energy pump, 3 self-contained supercapacitor banks, an inverter and a controller.