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Long Range Wireless Power Monitoring System

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Bachelor of Engineering

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To my mother and father, whose unwavering love and support has made this all possible.

Executive Summary

This thesis examines the design, construction and implementation of a microcontroller-based long range wireless power monitoring system, suitable for both domestic and industrial use. At its core, the system is based on a number of PICAXE 20X2 microcontrollers and a pair of XBee Pro wireless modules, which are capable of wireless communication to distances exceeding 1.5km.

The Long Range Wireless Power Monitoring system is capable of galvanically isolated single and three-phase current and voltage measurements and is able to calculate real power, apparent power and power factor. The results can be displayed numerically or graphically on a Graphical Liquid Crystal Display. In addition to this, the system has the ability to log usage to an external USB Flash device, allowing for later analysis and for the building of a usage history library.

The Long Range Wireless Power Monitor is equally proficient at measuring power consumption of devices, or power generation from sources such as photovoltaic cells or wind turbines. In the example of power consumption, usage costs are calculated from user-defined tariffs. Conversely, for generation, the income from power generated is calculated.

At the completion of this project, the Wireless Power Monitor is capable of being deployed for use as a fully working prototype. In addition to this, the system provides a solid basis for future adaptation or expansion and due to its open source software can be easily modified for use in specific applications.

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iii Glossary

AC	-	Alternating Current
ACMA	-	Australian Communication and Media Authority
ADC	-	Analogue to Digital Converter
ASCII	-	American Standard Code for Information Exchange
CSMA-CA	-	Carrier Sense Multiple Access-Collision Avoidance
CT	-	Current Transformer
DAQ	-	Data Acquisition System
DIP	-	Dual Inline Package
DSSS	-	Direct Sequence Spread Spectrum
EEPROM	-	Electrically Erasable Programmable Read Only Memory
GLCD	-	Graphical Liquid Crystal Display
GLIC	-	Graphical LCD Interpreter Chip
GPO	-	General Purpose Outlet
I/O	-	Input/Output
IC	-	Integrated Circuit
IEEE	-	Institute of Electrical and Electronics Engineers
LIPD	-	Low Interference Potential Device
LoS	-	Line of Sight
LR-WPANs	-	Low-Rate Wireless Personal Area Networks
NLoS	-	Non Line of Sight
PF	-	Power Factor
PV	-	Photovoltaic
PWM	-	Pulse Width Modulation
RAM	-	Random Access Memory
RF	-	Radio Frequency
RMS	-	Root Mean Squared
ROM	-	Read Only Memory
RSSI	-	Received Signal Strength Indicator
RTC	-	Real Time Clock
Rx	-	Receiver
SCADA	-	Supervisory Control And Data Acquisition
SCK	-	Serial Clock
SCL	-	Serial Clock Line
SDA	-	Serial Data (Line)
SDI	-	Serial Data In
SDO	-	Serial Data Out
TTL	-	Transistor to Transistor Logic
Tx	-	Transmitter
UART	-	Universal Asynchronous Receiver/Transmitter
USB	-	Universal Serial Bus
WLAN	-	Wireless Local Area Network
WPM	-	Wireless Power Monitor