HiTech Equipment Corporation Proprietary Data

Theory of Operation and Operating Procedures

The Water Computer™

Designed and Developed by

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Introduction

The Water Computer™ is a wireless utility submetering system that can be used for the collection of residential utility consumption data. This document outlines the principles of operation of this system, and provides information necessary to aid in Federal Communications Commission Certification Procedures. Any questions that are not adequately addressed in this document should be directed to Mr. Ken Arnold, President, HiTech Equipment Corporation.

System Components

The function of **The Water Computer™** system is to collect and transfer residential utility consumption data from individual dwelling units to a centralized location for further processing. Data is acquired within each dwelling unit by a single board microcomputer system interfaced to the utility being measured. The sensor device to which the microcomputer is connected is purely passive, the electrical interface consisting of a dry contact closure. Utility consumption is measured by the frequency of switch closures over a fixed time interval. The microcomputer stores the consumption data in a non-volatile memory.

Once collected, the consumption data must be transferred to a central location for further processing. There are three primary subsystems of which **The Water Computer™** is comprised (Figure 1). The **LPX** is a microcomputer controlled, low power, UHF radio transmitter. The UHF transmitter consists of a Colpitts oscillator operating at 315.0 MHz. The oscillator achieves frequency stabilization with a surface acoustic wave (SAW) resonator. The microcomputer monitors utility consumption and stores this as binary data. At the appropriate times, the microcomputer keys the transmitter with OOK (on-off keying) modulation. Operating from a 5-volt power supply and operating into an

electrically short antenna (electrical wavelength approx. 0.1 wavelength), the effective communications range of the LPX is approximately 100 to 150 feet. The actual communications range is dependent upon the local environment. Each LPX unit is identified by a 32-bit serial number stored in the unit's non-volatile memory.

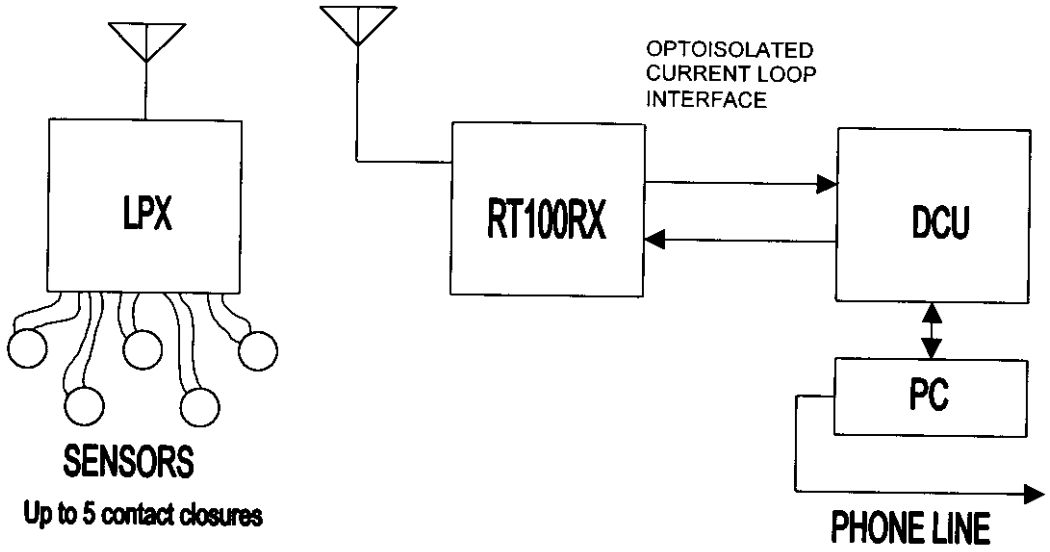


Figure 1 - System Block Diagram

The second part of the system is the **RT100RX Digital Data Receiver**. This device consists of a 315 MHz receiver and a drive circuit for an optoisolated current loop. The RT100RX utilizes its 315 MHz receiver to detect and demodulate the OOK transmissions from the numerous LPX units located within its reception range. The receiver is a single chip superheterodyne with the local oscillator generated by a low frequency PLL (phase locked loop). The receiver IF is centered at approximately 300 kHz, so the PLL frequency is chosen so that the 64^{th} harmonic is equal to the receive frequency offset by the IF. Additional out-of-band signal rejection is provided by a surface acoustic wave (SAW) filter in the receiver front-end circuitry.

Once demodulated, the receiver output drives a comparator which is used as the driver for the optoisolated current loop. The optoisolator itself is located in the last subsystem of **The Water Computer™** , known as the **Data Collection Unit,** or **DCU.** The DCU is a microcomputer-based device which is capable of decoding and processing the data provided to it by the **RT100RX**. The microcomputer is equipped with an asynchronous serial port to transfer the demodulated data to an appropriate central processing device. This device is generally some type of personal computer. The personal computer will, in

general, contain a modem to allow a remote user to access the consumption data by telephone. Each DCU is identified by a 32-bit serial number contained in an on-board, non-volatile memory.

Modulation Format

The LPX Unit utilizes OOK (on-off keying) of an otherwise unmodulated carrier signal. The data is transmitted utilizing a PPM (Pulse Position Modulation) scheme with a fundamental bit period of three (3) milliseconds. Each transmitted pulse is 250 microseconds in duration, yielding a bit period duty cycle of 8.33 percent.

LPX Data Message Format. The primary function of the LPX Unit is to acquire utility consumption data from within a residential dwelling unit. At randomly spaced intervals (generally once or twice per day) the LPX Unit activates its 315 MHz transmitter and uploads all of its consumption totals to an RT100 Node Repeater. A complete LPX message consists of eight groups of binary data. **Group 1** is a preamble sequence consisting of 20 pulses of 250 microsecond duration with a PRR (Pulse Repetition Rate) of 333 Hz. After a period of silence six (6) milliseconds in duration, **Group 2** is transmitted. Group 2 consists of 41 pulses of 250 microseconds in duration. Spacing between adjacent pulses in Group 2 can take on values of two, three, or four milliseconds. The PPM modulation scheme in use defines binary "1" and binary "0" values by the spacing between a given pulse and the pulse which immediately preceded it. The end of Group 2 is signaled by a six (6) millisecond period of silence. **Group 3** through **Group 7** are identical in structure to Group 2. **Group 8** is again identical in structure to Groups 3 through 7, but contains only nine (9) pulses, rather than 41.

In summary, an entire LPX message consists of 275 pulses, and requires approximately 0.95 seconds to complete. Figures 2, 3, and 4 on the next page are timing diagrams of the LPX Message Format.

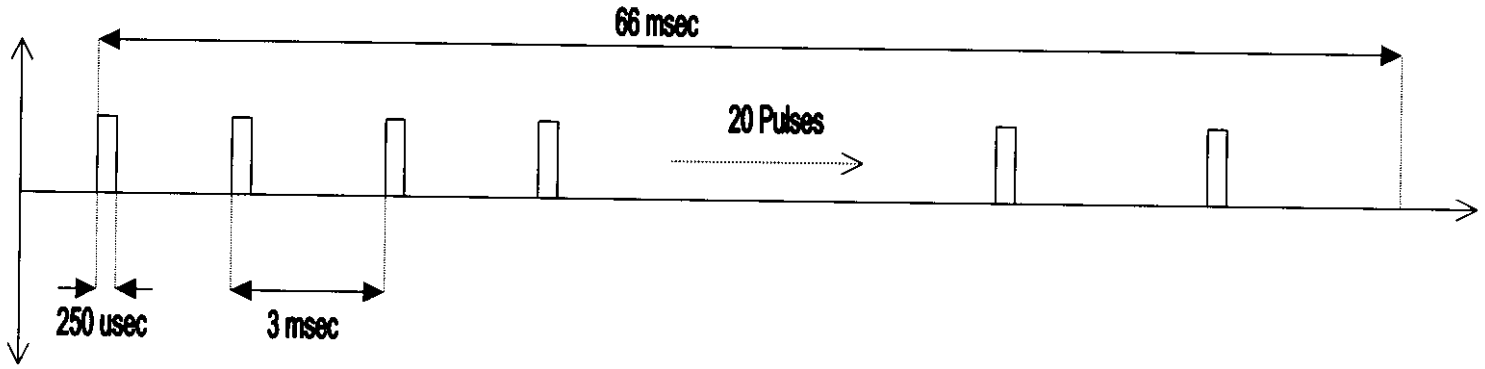
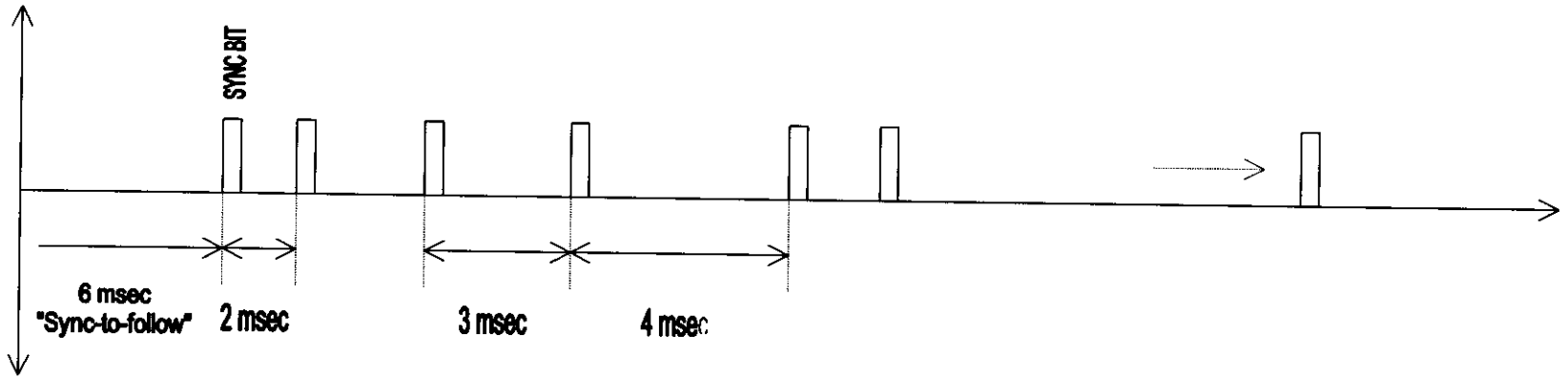


Figure 2 - LPX Message Preamble



FEDERAL COMMUNICATIONS COMMISSION RADIO AND TELEVISION INTERFERENCE STATEMENT

Changes or modifications not expressly approved by HiTech Equipment Corporation (HTE) could void the user's authority to operate the equipment.

NOTE: This product was FCC certified under test conditions that included the use of shielded I/O cables and connectors between system components. To be in compliance with FCC regulations, the user must use shielded cables and connectors and install them properly.