IMU OPERATIONAL DESCRIPTION

System

The Information Management Unit (IMU) is a 900MHz, spread spectrum transceiver used to communicate between a Local Area Network (LAN) base station (referred to as a Gateway) and gas and water utility meters. In a typical application, a single Gateway would communicate with numerous IMUs installed in a neighborhood. The Gateway periodically queries the IMUs and, in turn, the IMUs transmit their status and meter count back to the Gateway. The Gateway then can forward the IMUs' information to the utility company via several Wide Area Networks (WANs). Since the IMU is battery powered, it typically will be required to transmit only one a month.

The gas meter application does not need an external antenna since these meters are typically above ground. In this case, an IMU equipped with an internal antenna is used. Again, LCD is included for verification of the meter count and the IMU status.

For a water meter application, the IMU will be mechanically attached to a meter that typically will be in a subterranean enclosure. An external antenna will be imbedded in the enclosure lid (i.e. manhole cover) and conduct radiated signal to/from the IMU. LCD is also mounted on the IMU for visual verification of the meter count and IMU status.

Operating in the 902 – 928MHz ISM band, the IMU transmits and receives MSK Direct Sequence Spread Spectrum modulation at approximately 1Mcps. The Transceiver has an output power of +20dBm and remains on for approximately 7ms. The receiver cycles on and off, constantly listening for a signal from the Gateway. When the correct preamble is detected, the receiver remains on to receive the entire message and then remains off while the IMU transmits a response to the Gateway. After the transmission, the receiver resumes cycling.

Circuit Descriptions

ASIC and SUPPORTING CIRCUITRY

The heart of the IMU is an ASIC containing a micro-controller and a communications processor. This ASIC maintains a real time clock using a 32.76KHz internal oscillator and constantly monitors the meter movement to increment the consumption count and to display it on the LCD. Periodically, the ASIC turns on the receiver by energizing a 12MHz crystal oscillator, programming the frequency synthesizer and energizing the down-conversion and demodulator circuits. At this point, the communications processor is also activated.

The communications processor part of the ASIC accepts the demodulated signal and performs two functions to convert the DSSS chips to data. First, the chips are de-spread using 64 bit correctors. Next, the de-spread bits are unscrambled to reverse the effect of spectral whitening done at the Transceiver. Finally, the data is passed to the micro-controller. If the data contains the Unique Word and serial number correctly identifying the target IMU, then the micro-controller allows the receiver and communications processor to continue. The communications processor also accepts data from the micro-controller, scrambles (spectrally whitens) it and spreads it before sending the chips (data bits mixed with the PN sequence) to the modulator. The IMU serial number as well as its configuration information is stored in an external EEPROM.

An external Power-On-Reset IC ensures that when the battery is replaced or near its end of life, the processor will not be subjected to supply voltages that could cause a malfunction.

IMU Operational Description .....

Frequency Synthesizer and Phase Locked Loops

The frequency synthesizer IC controls two Phase Locked Loops (PLLs) which generate an 800MHz Local Oscillator (LO) and a 120MHz LO. The 800MHz LO step in 1.5MHz increments and the 120MHz PLL is fixed. Both PLLs use a 12MHz crystal oscillator as their reference. While the IMU is receiving, the 800MHz LO is set 110.6MHz below the channel. To transmit, the 800MHz LO is directly modulated by the chip stream (from the ASIC) and mixed with the 120MHz to produce the output signal.

Frequency Converter

Down and up-conversion is performed using active mixers. An LNA and a variable attenuator precedes the down-converter and reduces the level of interfering RF signals located in the receiver's pass band. Mixing the received signal with the 800MHz LO produces a 110.6MHz IF. Mixing the 120MHz LO with the modulated 800MHz LO produces the transmitted signal.

The down-converter is followed by a 1.5MHz wide SAW filter, which reduces the receiver's pass band from 25MHz to 1.5MHz.

Demodulator

The FM demodulator provides a Received Signal Strength Indicator (RSSI) that controls the variable attenuator. Additionally, the demodulator down converts filters and limits the IF signals before demodulating it with a LC discriminator. The demodulated signal is converted to binary data that is processed by the ASIC.

Power Amplifier

The transmitted signal from the up-converter is amplified by a class AB transistor amplifier and then amplified again by a class C amplifier. The amplifier's output passes through a Transmit/Receive (T/R) switch, a dielectric filter and a LC matching network before going to the antenna. The output level to the antenna is +20dBm.

Antenna

Two antenna configurations are available. In one configuration, the antenna is soldered to the IMU printed circuit board and enclosed in the sealed IMU housing. This antenna has approximately 2dBi of gain and is used for utility meters that are above the ground (e.g. gas meters). The second configuration uses an external antenna and couples energy through the plastic IMU case to the antenna. This antenna has approximately 3dBi gain and can be mounted in manhole covers for subterranean applications (e.g. water meters).

NCI RF Specifications Per FCC 2.1033 (b)(4)

- Frequency Range 903-927 Mhz
- Spectrum Technique Direct Sequence Spread Spectrum
- Modulation Scheme Minimum Shift Key (MSK)
- Bit Rate 62.5 kb/sec (12Mhz/192)
- Chipping Rate 1Mc/sec (62.5kb/sec x 16 chips/bit)
- Channel Capacity 17(From 0-16)
- Channel Spacing 1.5 Mhz
- Power supply 3.6Vdc/240 mA (Constant Tx)
- Power Consumption 3.6Vdc/90 mA (Constant Rx)
- PLL VCO 1.4 V max
- Null to Null Bandwidth 1.6 Mhz
- 6 dB Bandwidth 600 Khz
- First Side-lobe Level 29dBc
- Output Power 20dBm
- Receive Sensitivity -90 dBm
- Frequency Tolerance ± 20ppm
- Total Frequency Drift ± 45ppm
- List of Channel Frequency:

CHANNEL	Freq.(Mhz)
0	903.0
1	904.5
2	906.0
3	907.5
4	909.0
5	910.5
6	912.0
7	913.5
8	915.0
9	916.5
10	918.0
11	919.5
12	921.0
13	922.5
14	924.0
15	925.5
16	927.0

DSSS Processing Gain Calculation Per FCC 15.247 (4)(d)

- The Transmit module generates the spread spectrum binary sequence for output to the RF modulator (directly modulated VCO.

- The Transceiver logic encodes two consecutive bits of data into one of four possible 32-bit (chip) PN sequences. Consequently, an improvement in the signal to noise ratio is achieved since each pair of the data bit is now represented by 32 chips. The improvement, or processing gain in decibel is as follows:

  Processing Gain = 10 log (32chips/2 bits)
  Processing Gain = 12 dB

- The Transmitted PN sequence is further randomized by modulus-2 addition with a fixed 2047-bit PN sequence. This operation smoothes (spectral Whitens) the output spectrum by eliminating discrete spectral components.

IMU Installation Instructions

Innovatec IMU Installation Instructions

The IMU is a combination meter register and two-way radio transceiver designed to replace an existing mechanical water meter. The electronics and antenna are completely enclosed in a watertight tamper-proof sealed enclosure suitable for outdoor mounting or installation in a below grade meter pit. Using various adapter plates, it can be mounted on a variety of brands of water meters.

The IMU performs two basic functions:

- It gathers and records usage data from the mechanical meter to which it is attached.
- It sends and receives messages to and from the utility company computer system.

The IMU utilizes a 900 MHz spread sequence radio transceiver. This radio communicates to the Innovatec gateway that passes messages to the utility via a variety of common-carrier wide area networks.

Installation Instructions

Note: Installation and programming of the Innovatec IMU is to be performed by properly trained personnel only.

Note: The Innovatec IMU is designed to operate only with the internal antenna supplied. Do not substitute any other antenna. Violation of FCC regulations may result if the gateway is operated with any other antenna.

The IMU should be located at least 20 cm away from any area where people may be present in order to minimize exposure to radio frequency radiation.

Remove the existing mechanical meter register from the meter base by removing any locking screws or pins and sealing wires. Rotate the register head one quarter revolution counter clockwise, then lift straight up.

Select the proper mounting plate for the corresponding brand of meter. The mounting plate is secured to the IMU with three 6-32 x ½ brass screws.

Install the IMU onto the meter base by rotating the IMU one-quarter turn clockwise. Lock the IMU to the meter base by tightening the security screw in the mounting plate with the appropriate security screwdriver.

The mechanical meter base uses a magnetic drive system to turn the mechanical register head. The Innovatec IMU replaces the mechanical register head and counts the magnetic pulses produced when the magnetic drive rotates. To convert these pulses into

IMU Installation Instructions

appropriate unit of measure (gallons, cubic feet etc.) the IMU must be programmed with the proper pulse conversion factor.

Programming is accomplished with the Innovatec ENICS software. ENICS is used to select the proper radio channel within the 902-928 MHz band, set serial numbers and to enable other functions such as alarms.

No adjustments to the IMU itself are possible since the IMU is sealed and uses an internal antenna. If the unit to be installed does not communicate with the Innovatec ENICS software or does not configure properly, return it to the Meter Shop for evaluation. Do not attempt to open the IMU enclosure.

FCC WARNING STATEMENTS

NOTE: This equipment has been tested and found to comply with the limits for class B digital device pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. The equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced Radio/TV technician for help.

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.