Turf Guard Operational description

The Turf Guard system consists of unit in two different configurations. The In-ground unit is designed to be buried underneath the soil and the Pedestal Repeater unit is designed to be placed on existing irrigation satellite pedestals. Both units have integrated antenna and do not require any external grounding.

The pedestal repeater is approx 1.6”x2.6”x4.7” and has a monopole antenna extending 3.2” out of the top of the unit. The In Ground unit is 1.9”x2.9”x5.3” and has stainless steel sensor pins extending out of the front face approx. 1.8”. Both units use the same internal electronics.

The in-ground devices are buried beneath the turf grass directly in the soil medium.
During operation these devices periodically transmit sensor readings in short digital messages. These messages are received by the pedestal repeaters and relayed over a multi-hop mesh network to the master collection point where they are stored. During operation each node will transmit a sensor reading every 5 minutes. Each node maintains an internal clock in order to remain on the correct frequency hopping schedule. When it is time to transmit data the node transmits on the current hopping frequency. In order to reduce collisions all nodes introduce a random delay into their transmission and sample timing. Over time, this guarantees that all frequencies are used equally.

If a node is reset or determines it has lost synchronization, it will search for the correct synchronization channel by transmitting search messages on each channel until a reply is heard or a time limit expires. If a node is out of synch for an excessive period of time, it will reset itself.

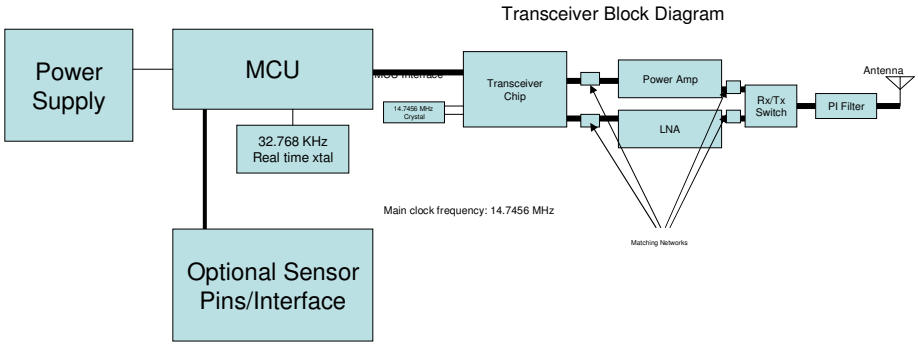

Figure 1 Block diagram of device.

The power supply of the in-ground unit is a set of 3 alkaline batteries while the power supply of the Pedestal repeater is a DC-DC voltage regulator. It provides all the power necessary to run the transceiver, the micro-processor and any sensors. The microcontroller orchestrates communication by managing the transceiver and interfacing with the sensors. In addition to monitoring external sensors it also is configured to

monitor the power supply. Voltage levels are continually monitored and recorded. The device will not function if voltage levels are dangerously low.

It is generally left in the sleeping state. It uses the 32.768 real-time crystal to keep time and schedule communication and sensor sampling. The integrated transceiver is a single chip transceiver with very few external RF components. It utilizes a 14.7456 MHz crystal in order to determine its transmission frequency and bit rate. The transceiver has and internal VCO, bit synchronizer and frequency PLL.

The transceiver output during transmission is fed through an impedance matching network into a power amplifier. The power amplifier has a gain of approx 30 dB and a maximum output in this circuit of approx 25 dBm. The output of the power amplifier is routed to the antenna via an RX/TX switch and a PI filter. The RX/TX switch allows the antenna to be either connected to the output of the power amp or the input of an LNA. The PI filter is designed to reduce the transmission of unwanted harmonics and to limit the impact of unwanted noise during reception. The RX bandwidth is based on the emission bandwidth.

During reception, the RX/TX switch routes signals from the antenna to the Low Noise Amplifier (LNA). Inclusion of an LNA is designed to improve the overall receiver sensitivity. The output of the LNA is fed into the single-chip transceiver. Internally the signal is amplified again and demodulated. The single-chip transceiver produces a CMOS-level bit stream that is received and processed by the microcontroller.