MonsoonRF, Inc.

"enLIGHTening RFID"

Lantern™ RFID Technical Description

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Executive Summary

The MonsoonRF, Inc (mRF) Lantern™ Series of Radio Frequency Identification (RFID) readers enable a new class of easy to use and deploy RFID possivilities. Replacement of ordinary lightbulbs, fluorescent tubes, or light fixtures with mRF Lantern™ products is provides immediate access to all of the benefits of a fixed-infrastructure RFID enabled tracking and monitoring system.

The Lantern™ products are available in the following forms:

1.   Lantern™ -T: A tracklight fixture containing an RFID reader, antennas, communication system and a dimmable LED spotlight. Currently available in a BR-30 size unit.

2.   Lanter™ -H: A Halo fixture insert, providing RFID reader, anteanns, communications system and a dimmable LED spotlight. Currently available in a BR-30 size unit.

3.   Lantern™ - F: A Flurescent Tube Replacement, providing RFID reader, anteanns, communications system and a dimmable LED illumination sourece. Currently available in a T-8 size.

4.   Lantern™-S: An RFID reader, communcations system, antennas and a dimmable Spotlight with an Edison Base that screws into an existing BR-30 enclosure or an open Edison socket.

In atddition to the Lantern™ readers, mRF provides backhaul servers and communications systems. Depending on the size of the installation, backhaul communications can take several forms.

1. Small Installations (1-25 readers; 100 to 2500 square feet): Backhaul communications can be achieved on existing WiFi installations using IEEE 802.11N protocols.

2. Medium Installations (15 – 50 readers; 1500 to 5000 square feet): Backhaul communications can be provided over a dedicated WiFi using IEEE 802.11N or IEEE 802.11S protocols.

3. Large Installations(30 – 250 readers; 3000 to 25,000 square feet) : Backhaul recommended is custom mRF 915MHz (or Allocated RFID band) backhaul. This customized communication allows the data between the readers and the mRF servers to coexist with existing WiFi networks.

4. Very Large Installations (100 – 10,000 readers; 10,000 to 1,000,000 square feet) : Backhaul recommended is custom mRF 915MHz (or Allocated RFID band) backhaul. This customized communication allows the data between the readers and the mRF servers to coexist with existing WiFi.

Objectives

Introduction

MonsoonRF Inc. introduced the Lantern™ series of readers to ameliorate the cost and complexity of physical RFID installations. Reducing RFID mounting and antenna placement time and cost, mRF products may be installed by typical building maintenance personnel with no network or RF training. Simply replacing lights and ensuring that the area of interest is illuminated by the Lantern™ luminary will ensure that tags within the illuminated area will be seem by the RFID reader as well.

Figure 1 presents a diagram of the components of a hands free RFID inventory management system. Merchandise tagged with EPC- Gen2 compliant RFID tags are read by one or more Lantern™ readers.

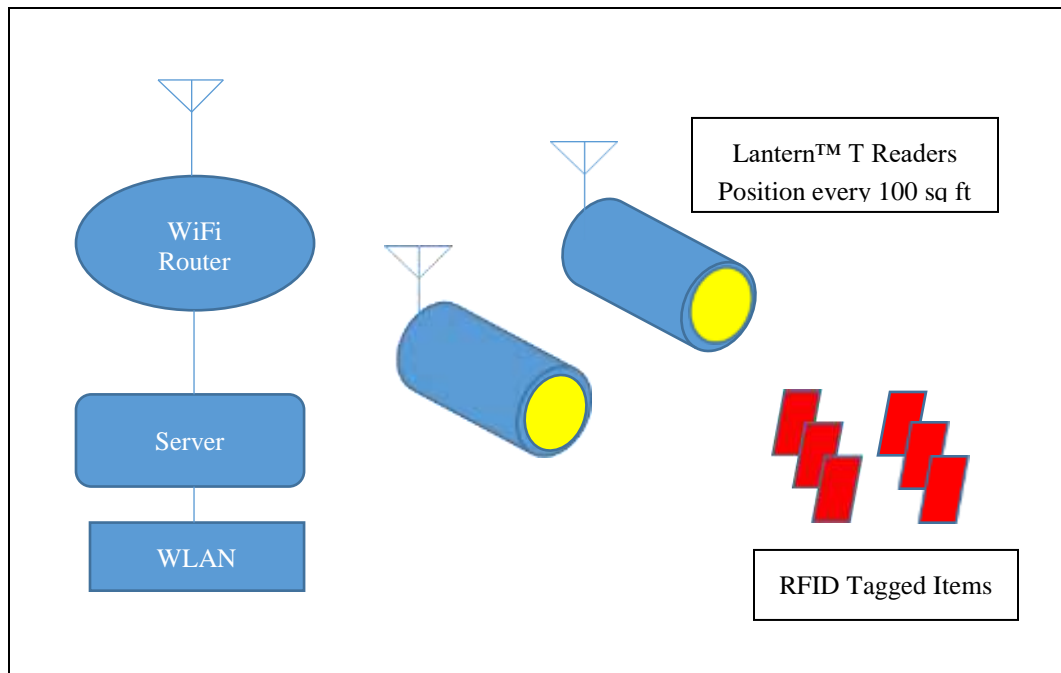*Figure 1 – Hands Free RFID Inventory Management Components.*

Each of these readers store the tags seen, along with the time that they were seen, and how often they were read in a given time period. This information is communicated back to the database server using a wireless data link operating in one or more of the license free RF allocations, such as the 915 MHz ISM band, the 2.402 – 2.482 GHz WiFi band or the .

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Technical Discussion

This section will highlight the concerns and considerations that guide the development and deployment of the MonsoonRF products. Compliance with regulatory rules, health and safety considerations, manufacturing, test, validation and quality controls.

The Lantern™ readers produce the maximum legal RF field strength, along with customer selected luminaries, providing client selected Color Rendoring Index (CRI) and Color Temperature (CT). Tag EPC information collected by the Lantern™ readers are stored in the readers and made available to the network controllers on demand, via a wireless (WiFi or custom RF backhaul) data link. The Lantern™ readers are powered directly from existing AC mains or low voltage lighting power.

Customer safety is assured through the use of UL and CE marked Power convertors, and low voltage electronics.

The monsoonRF Lantern™ devices utilize shielding on all critical electronic components to minimize interaction or interference with co-located electronic devices and to limit the electromagnetic radiation emitted to that necessary and sufficient to illuminate and read the RFID tags and to communicate the reads to the database server.

Requirements Review

RFID Performance – Reader

The MonsoonRF Lantern™ products are available with several different reader modules, includeing Impinj R2000 based readers, Alien ALR-700 readers, and PhyChips RED 5 reader modules. This allows the user or the solution provider to choose the RF platform that meets both their cost and performance goals.

MonsoonRF Impinj 2000 based reader module.

The MonsoonRF R2000 based reader module is closely related to the Impinj R2000 SDK platform design. It is designed to allow flexibility in setup and operation. It is the module introduced in the

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original MonosooRF Lantern™ - T and Lantern™ H modules, and is suitable for lighting where the lamps being replaced are BR-30 size fixtures.

The mRF R2000 module internal communication is based on the LLRP standards.

Alien ALR-700 R2000 based reader module

The MonsoonRF ALR-700 based reader utilizes the Impinj R2000 reader IC, and custom firmware and software developed by Alien. It is flexibile in setup and operation. This module replaces the mRF R2000 module in MonosooRF Lantern™ - T and Lantern™ H modules, and is suitable for lighting where the lamps being replaced are smaller than BR-30 size fixtures.

PHYchips RED 5 reader module

The MonsoonRF PHYchips RED 5 reader module is not related to the Impinj R2000 platform. It is designed to allow flexibility in setup and operation. It is the module which permits the MonsoonRF Lantern™-S to be produced. It has a very small footprint, mechanically, and while it operates at maximum legal RF Power for the US, backed off to 27dBm it is ideal for use the 9dBic antennas integral to the Edison base Lantern™ -S spotlights.

Other

MonsoonRF, Inc. Lantern™ readers are powered by 'reader agnostic' interface drivers which present the Solution Provider with a simple and consistent interface, regardless of the specific Reader module in use. As new reader modules become available, permitting new and interesting RFID solutions, these readers will be incorporated into the MonsoonRF driver library.

RFID Performance – Tags

MonsoonRF Lantern™ Readers are designed to work with the EPC Gen 2 protocols, and support all tags which comply with that protocol. At present, MonsoonRF does not manufacture RFID Tags, but will provide technical guidance to the end user or Solution Provider during the Tag selection process.

Specific performance variations in both the RFID tag silicon (IC) and the antennas utilized (InLay) affect the performance of the overall RFID installation. Read range and read speed are strongly connected to the antenna and tag IC capabilities.

Light

Lighting is a critical design element in most applications involving fixed infrastructure (Hands Free) RFID. In the Lantern™ product line, along with intensity (lumens), both the color temperature and the color rendering index are user selectable. This ensures the user will be able to 'mix and match' the Lantern™ products with existing lighting, or enhance areas with more or less light.

All Lantern™ products utilize LED luminence sources, in keeping with minimizing overall lighting power requirements, while maintaining superior customer satisfaction.

Power Sources

All Lantern™ reader products utilize low voltages and low power levels. The basic power to the modules is 5V DC and is further regulated to lower voltages for microprocessors and control function.

Conversion from Line (120 VAC – 250 VAC, 50 – 60 Hz potentials to 5 VDC is handled by power efficient switching convertors. These convertors provide isolation from the Line supply

and enable the Lantern™ to be 'universal' in the sense that it can be connected directly to Mains power in most location on the globe. These modules are UL or CE marked and comply with all current user safety requirements.

In most cases the DC required by the RFID subsystem is less than the power required by the LED lighting subsystem. To replace a 60 W or 75 W conventional spotlight with an LED equivalent generally reduces the AC power requirements to 7 to 10 Watts. The RFID subsystem, including the backhaul communication to the servers consumes an additional 7 -10 Watts, so the overall heat signature of the illumination system is reduced to 1/3 of that required for conventional (heated filament) sources.

Replacing a conventional lamp with a Lantern™ RFID equipped lamp reduces the AC mains power from 60 or 75 Watts to 20 Watts and provides RFID capabilities.

Backhaul Communication

The backhaul communications between Lantern™ readers and the database server can managed in a number of ways. Classically, either wired (CAT-5 or CAT-6 ethernet) or IEEE 802.11abgn wireless protocols are used. In small installations, these methods would still be viable, except that the use of a CAT-5 or CAT-6 wired interface entails adding physical infrastructure to the RFID install, and that is something the MonsoonRF Lantern™ products are designed to eliminate.

In passing, it is noted that Ethernet over AC is possible in facilities that can ensure that all lamps and the servers are powered on the same phase of Mains power and that there are no transformers or other 'barriers' (line isolators) separating them. While possible, use of Ethernet over AC introduces an unknown performance variable into the installation, and may again require a change to the existing physical infrastructure to have a working system. Again, MonsoonRF Lantern™ products are designed to minimize (eliminate) the need to change anything about the facility's existing communications or power infrastructure.

Supported Modes

The following standards are supported

> IEEE 802.11ABGN WiFi
>
> IEEE 802.11S Mesh
>
> mRF 915MHz Mesh
>
> Other

Regulatory

Lantern™ products may be ordered for different Regulatory Regions. Please contact the factory for further information.

Electrical Description

Antennas

RFID Interrogator Antennas

MonsoonRF recognizes that many factors influence customer acceptance, and that all lighting products have a material impact the desired ambiance at the insallation sites. The Lantern™ T and other Lantern™ products may be customized to our clients needs, especially in regard to styles. The basic Lantern™ antenna is a dual dipole cavity backed crossed dipole antenna, offering circular polarization

Dual Dipole, CP Cavity Backed Co-Linear

The basic antenna offered with the Lantern™ T is a colinear cavity backed crossed dipole antenna offering circular polarization and a gain of 6 to 7 dB. The performance of this antenna si shown below
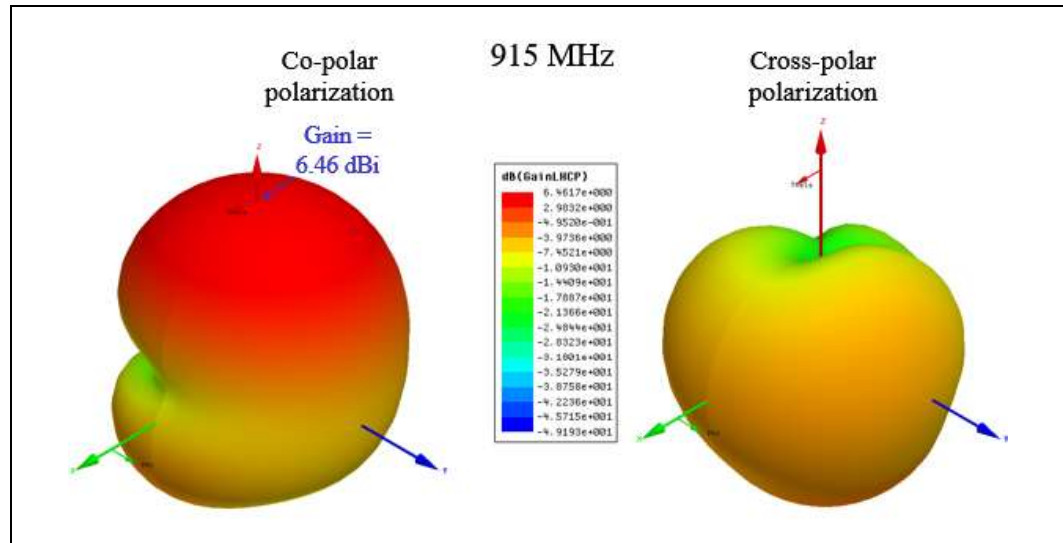
This antenna, when combined with the 30dBm power output setting of the RFID reader board, results in 36dBm EIRP, the maximum allowed in North America under FCC rules and regulations.
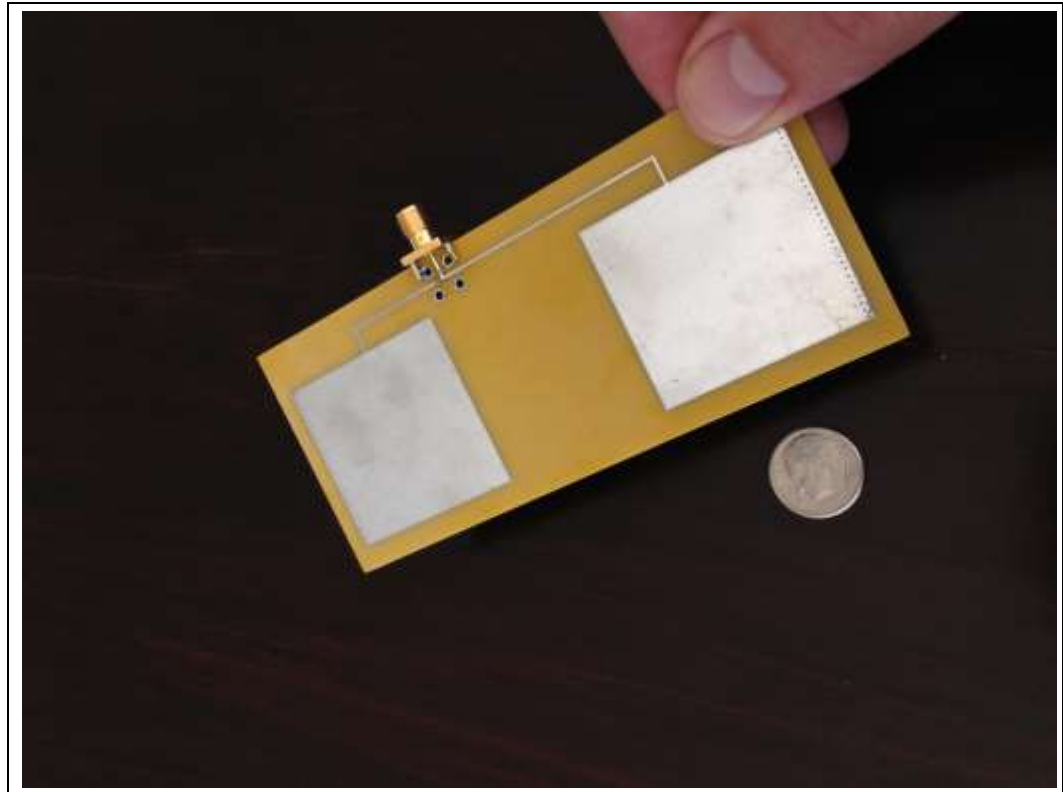
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Data Backhaul Antennas

2.4 GHz WiFi (IEEE 802.11S Mesh) Antenna

When the Lantern™ is configured to use 80211S mesh networks, it is done through the use of WiFi USB dongle. The 2.4 GHz antenna is an integral part of the WiFi USB dongle and is not a user configurable item, for a given product.

915 MHz Custom Backhaul Antenna.

The mRF custom 915 MHz wireless backhaul antenna is a planar patch antenna (see below) offering a low profile and an omnidirectional pattern. This antenna is an integral part of the custom RF interface, and MonsoonRF can work with the client to determine the best backhaul approach.

915 MHz Dual Quarter Wave Patch Omni Directional Antenna.

Mechanical Description

Lantern™ – T (Tracklight)

The Lantern™ T is contained in a BR30 floodlight enclosure, with a co-linear antenna. The Lantern™ is 112mm in diameter and _____ long, including the protrusions for the LED lamp assembly. The RFID antenna is mounted either in front (Yagi) or colinear (cavity backed) depending on the ordering option.

Lantern™ T

Controller Description

RaspberryPi

The controller internal to the Lantern™ is a RaspberryPi Zero (RPiZ) module. The RPiZ uses a Linux based operating system and provides control to the Reader Module on a serial data communications path. The firmware running on the RPiZ, described elsewhere in the API document provides several convenient ways to connect to the Lantern™. The reader can run an internal monsoon_c protocol, which will load a local or remote SQL database, or it can run a "Connect" mode.

In the Connect mode:

1. Addressing the reader on port 10002 will allow direct control of the Reader RFID board, for use with development software such as Indy Tools.
2. Addressin the reader on port 1415x where x is the desired Session Mode, will allow the reader to stream Tag data to a standard ASCII terminal.

The program and stored data resides on an SD Card and the Firmware may be upgraded remotely or by exchanging the SD card.