Knogo North America

UHF Wrap Desk

Theory of Operation

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Introduction

The Knogo North America UHF Wrap Desk is an accessory product to the “Ranger” family of UHF anti-theft (EAS) systems. These systems are generally installed in retail stores to protect merchandise from theft. The main elements of the system are the Ranger detection system installed near the store exit and the tags, which are attached to the items to be protected. Tags brought within a certain distance or “range” from the detection system cause an audible alarm to be generated. At the point of sale these are tags are removed from the merchandise by the store clerk as the items are paid for, allowing the customer to take the merchandise past the system without causing an alarm. The “wrap desk” described in the following, is a small tag detection system, which is placed near the checkout to help the clerk identify items, which may have a tag that is not readily visible.

General Principle of Operation

Both the primary Ranger system and the accessory wrap desk operate on the same 2nd harmonic principle. In each case a transmit signal within the 902 to 928 MHz ISM band generated within the unit and radiated into the detection zone. The tag, which is a passive device containing a stamped metal antenna and a schotkey diode. The diodes non-linearity produces a strong 2nd harmonic at approximately 1830MHz. This re-radiated 2nd harmonic is detected by a receive antenna and processed to produce an alarm. The primary difference between the Ranger system and wrap desk is that the system has sophisticated circuitry to detect the distance to the tag and thus produce a precisely controlled detection zone. The wrap desk on the other hand has its detection zone determined by its substantially lower power transmitter. In both cases dual transmit antennas provide spatial diversity to reduce the effects of nulls.

Circuit Description

Overall Architecture

The system is comprised of three basic sections: the transmitter, the receiver, and the power supply. While they are all on the same PCB along with their respective 915 and 1830MHz antennas, for the purposes of isolation, there is virtually no connection between the transmitter and the receiver. Further, the transmitter and receiver are each provided with a completely shielded enclosure from which on the necessary signals enter and exit. Power is supplied from an external wall plug in 12VAC transformer. DC supply voltages of +12V and +5V are then regulated and provided to the active circuitry.

Transmitter

The transmitter derives its basic timing and frequency control from U1, a PIC16C54 microcontroller which operates on a 14.31818MHz crystal. The crystal signal output is used as a reference for a PLL transmitter while a pair of complementary 4.00KHz RF switch control leads are generated in software. The main transmit carrier generating device is U6, an RF Microdevices RF2513 single chip UHF transmitter. This PLL based device is configured to generate a carrier at 64 times the crystal reference or 916.363MHz. The RF level out of this device is approximately +2dBm. This CW carrier is then routed to an M/A-COM SW339 GaAs A/B switch. The control inputs of this switch are connected to the 4KHz outputs of U1, which have been AC coupled and clamped to +0.7V by diodes to produce the necessary negative control voltages. Each output of the switch thus produces a 4KHz on/off modulated 916.363MHz signal of opposite phase. The modulated signals are then passed through a cascaded pair of lowpass filters to provide as much rejection of 2nd harmonic as possible. Note, any residual 2nd harmonic would be indistinguishable from a tag. Once filtered, each transmit signal is applied to a ¼ wave end fed antenna which are positioned 90deg with respect to each other. These signals then propagate to the tag where the two different phase and positions produce differing responses with a 4KHz modulation rate.

Receiver

The receive antenna is a single end fed ¼ wave element. It is connected directly to a 1840 MHz bandpass filter FLT1 at the input of the receive electronics. The output of this filter is fed to U8 an HP MGA86563 GaAs wideband amplifier, which provides over 20dB gain at 1840 MHz. Following this amplifier is a second bandpass filter FLT2 and another MGA86563 amplifier, U11. This collection of components amplifies the second harmonic tag signal while rejecting the 916.4MHz transmitter signal and other out of band interference.

Following this RF receive circuitry the signal is then applied to a BAT17 schotkey diode detector, which produces a baseband signal corresponding to the envelope of the received 1832 MHz tag signal. Low level 4KHz output of the detector is applied to U4A, a low noise op-amp section which is configured for a gain of 100 (+40dB).

The next two identically configured stages, U4B and U4C, are 2nd order bandpass stages at 4KHz with a “Q” of 4. These are of the multiple feedback configuration which is used to provide a gain of 32 (30dB) each and further reject out of band energy. The remaining section of U4 is used to provide DC bias for the op-amps, which are running from a single 12VDC supply rail.

The output of the 4KHz bandpass filters is then applied to U3, an AD7858L 12 bit analog to digital converter. The digitized output of the A to D converter is passed to U2 an ADSP2184 DSP processor for final signal processing and alarm decision logic. The processing in the DSP consists primarily of a DFT (Discrete Fourier Transform) to further narrow the detection bandwith and provide guard detection bands either side of the 4KHz channel to aid in rejecting environmental noise.

If the DSP detects 4KHz energy of a level significantly greater than that in any of the other N x 1KHz bands, an alarm is declared. The status LED is then flashed while the beeper is activated.

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