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UHF-based RFID Animal ID Tags – Why are they the best?

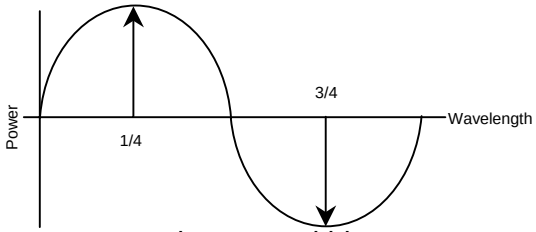
With the outbreak of BSE (mad-cow) disease, and the subsequent closing down of national beef exports, ensuring the security of our food supply has become critical. With Canada losing over US$1 Billion in revenue because of mad-cow, and the US losing hundreds of millions of dollars due to the one cow found in Washington State in 2004, food safety is critical to protect a country's people and its economy.

In 1994 ISO published the first animal tagging standards – ISO 11784 (Coding) and ISO 11785 (Technical Specification). Texas Instruments (TI), the largest manufacturer of ISO 11785-compliant chips, stated at the March 2nd, 2005 RFID World Conference that they have made 30 million animal tracking chips. The worldwide annual population of beef food animals is approximately 1 Billion, with an estimated 295 Million harvested each year, with North America at approximately 110 Million head of cattle, harvesting approximately 95 Million animals. And only 30 Million Low Frequency RFID chips have been produced over 10 years. Why?

Following is a formula, and a graphic that gives some explanation why UHF is better than LF.

The formula for wavelength is 300/frequency (in MHz) expressed in meters:

- 134.2 KHz (LF); 300/.1342 = 2235.5 meters = 7334.3 feet
- 13.56 MHz (HF); 300/13.56 = 22.1 meters = 72.5 feet
- 915 MHz (UHF); 300/915 = .33 meters = 13 inches
- 2.45 GHz (SHF); 300/2450 = .12 meters = 4.73 inches



Near-field energy propagation is where the distance between the antenna and tag are within one wavelength; energy is magnetically coupled. Far-field is where the distance between the antenna and tag is greater then one wavelength; energy is radiated. Near-field propagation easily penetrates liquids/flesh but is affected by nearby metal absorbing the transmitted energy and is drastically affected by harmonics of 60 Herz. Far-field propagation bounces off of metal (metal can block far-field energy), but is absorbed by liquids/flesh. However, the UHF tags antenna can be tuned to overcome this phenomenon to get very long ranges. LF can not be tuned to overcome its problems.

For maximum effectivity, interrogator and tag antennas need to be equal to or equal divisions of the length of one cycle. In one RF cycle there are two maximum power points – at ¼ and ¾'s of the wavelength (See graphic, above). Antennas of these lengths are very effective. At ¼ wavelength, that still makes the LF antennas over 1800 feet long and HF antennas over 18 feet long. UHF antennas are just over 3 inches long with SHF being a little over 1 inch long.

So that they can be used in the real world, existing LF antennas are approximately 1 meter tall. Power is determined by the area under the curve. Look at the 1 meter point (in relation to the LF one cycle wavelength) on the sinewave, above; it's 1/2235th of the wavelength. You can see why LF has ranges of contact to 24 inches, and why UHF has ranges out to 10 feet, at the same power levels, using full wave antenna's.

UHF-based RFID technology is also covered by standards; ISO/IEC 18000-6, ISO/IEC 15961, and numerous others. RFID for Animal Tagging is also covered by the just-released draft of the AIM Global RFID for Animal Tagging Standard that incorporates UHF and LF technologies under one standard. Many other parameters affect overall performance and are not covered here. However, UHF outperforms LF theoretically - but more importantly – empirically! *** END ***